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METHODOLOGIES FOR THE EVALUATION AND IMPROVEMENT OF EMERGENCY MEDICAL SERVICES SYSTEMS

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Final Report

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16. Abstract

This project developed and demonstrated methodologies for the evaluation of existing and of proposed systems for the delivery of emergency medical services, which are adaptable to a wide variety of situations. An appreciative overview is presented which examines emergency medical services in terms of a historical perspective; the evolving social, cultural and technical environments in which they are embedded; how they are viewed by the users, health professionals and provider organizations; and the forces that tend to facilitate and to inhibit their change. Three kinds of models are presented: (1) those for the prediction of the demands for emergency medical services, (2) those for the prediction of the operating characteristics of proposed EMS systems, and (3) those for the prediction of medical outcomes. Six modifications of existing emergency medical services were demonstrated and their results examined, including benefits and costs where appropriate. A household survey was conducted to explore: (1) How citizens view medical emergencies, medical emergency services and the role of the citizen during the course of an emergency, (2) The experiences of citizens at the scenes of actual medical emergencies, and (3) What changes citizens want in emergency medical services.

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The diverse activities of the Project required a wide range of skills, whose mix varied over time. This necessitated that the staffing be matched to the activities that were being carried out at each point in time. The permanent staff, therefore, was kept small. The remainder of the staff was hired, as needed, for specific assignments.

We gratefully acknowledge the contributions of each and every member of the staff.

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PUBLICATIONS OF THE PROJECT

Working Papers

No. 1 Andrews, R. B., Criteria Selection in Emergency Medical System Analysis, (EMS-69-1-W), June 1969, 24 pages.

No. 2 Hisserich, J. C., Lave, L. and Aldrich, C., An Analysis of the Demand for Emergency Ambulance Service in an Urban Area, (EMS-69-2-W), September 1969, 30 pages.

No. 3 Cook, A. A., Jr. and Wurzburg, D. B., A Methodology for the Analysis of the Demand for Emergency Medical Care in an Urban Area, (EMS-70-3-W), June 1970, 45 pages.

No. 4 Cook, A. A., Jr. and Wurzburg, D. B., Obtaining a Sample of Emergency Loads on Public Emergency Medical Facilities in the San Fernando Valley Area of Los Angeles, (EMS-70-4-W), June 1970, 25 pages.

No. 5 Cook, A. A., Jr. and Wurzburg, D. B., The Demands of Five Selected Incident Types on Public Emergency Medical Facilities in the San Fernando Valley of Los Angeles, (EMS-70-5-W), August 1970, 32 pages.

No. 6 Burt, J. M., Jr. and Dyer, J. S., Estimation of Travel Times Between Points on a Map, (EMS-70-6-W), August 1970, 28 pages.

No. 7 Burt, J. M., Jr., All Shortest Distances in Large Serial Networks, (EMS-71-7-W), April 1971, 21 pages.

No. 8 Fitzsimmons, J. A., Siler, K. F. and Granit, R. K., Emergency Medical Systems Simulation Model: Documentation of SIMSCRIPT 1.5 Version, (EMS-71-8-W), April 1971, 210 pages.

No. 9 Fitzsimmons, J. A., A Methodology for Ambulance Deployment, (EMS-71-9-W), August 1971, 26 pages.

Interim Reports

No. 1 Report of Initial Study of Helicopter Operations of Los Angeles Fire Department, (EMS-68-1-IR), December 1968, 62 pages.

No. 2 A Description of Helicopter Landings at Selected Sites in the City of Los Angeles, (EMS-69-2-IR), 29 pages

No. 3 The Los Angeles County Helicopter Ambulance Demonstration, (EMS-69-3-IR), April 1969, 56 pages.

PREFACE

The origins of this project lie in the formation of the research program in socio-technical systems within the Graduate School of Management, University of California, Los Angeles. This program brought together researchers from a variety of disciplines who were concerned with the joint consideration of the technical and social aspects of complex systems. The group has examined problems which ranged from the management of technological innovations in a basic manufacturing industry to the management of national forests.

Emergency medical services also are typified by a level of complexity that necessitates that they be studied and designed in socio-technical terms. The relevant technologies include the states-of-the-art for the:

- Diagnoses of the natures, severities and rates of change of the pathophysiologic states of victims of emergent illnesses and injuries.
- Medical practices for the life support and stabilization of victims of critical illnesses and injuries.
- Supportive transportation and communication.
- Concepts and methodologies for the analyses and syntheses of complex systems.

The relevant social considerations include:

- The perceptions and behavior of victims of medical emergencies and of those who act or could act on their behalf.
- The forces that have acted to keep emergency medical services a fractionated "nonsystem" and make them difficult to change.
- Processes for the involvement of many individuals and organizations in the identification and solution of difficult problems.

In addition to a staff that was comprised of a highly diversified mixture of faculty, professional practitioners, and graduate students,

the activities of the project required the cooperation and assistance of many other individuals and organizations. Our sincere appreciation to all of them is gratefully acknowledged. At the risk of unintentional omissions, these contributors were:

- Organizations that participated in demonstrations

Communications Links Between Traveling Ambulance and the Emergency Medical Facility

Antelope Valley Ambulance Company
Antelope Valley Hospital
Encino Hospital
Los Angeles City Fire Department
Swan Memorial (now Palmdale General) Hospital
Wilson Ambulance Company

Telemetering of Physiologic Data From Ambulance to Emergency Medical Facility

California Ambulance Company
Division of Emergency Services, UCLA Hospital
Flight Research Center, National Aeronautics and Space Administration

Ambulance Attendant/Physician on Ambulance

California Ambulance Company
Central Receiving Hospital, City of Los Angeles
Los Angeles City Fire Department
Division of Emergency Services, UCLA Hospital

Mobile Intensive Care Field Paramedics

County Supervisor Kenneth Hahn
Carson Ambulance Company
Harbor General Hospital
Los Angeles City Fire Department
Los Angeles County Fire Department

Helicopter Evacuation System

County Supervisor Warren Dorn
Antelope Valley Ambulance Company
Antelope Valley Hospital
California Highway Patrol
Golden State Hospital
Gorman Ambulance Company
Intervalley Hospital
Los Angeles City Fire Department
Los Angeles County Fire Department
Los Angeles County Sheriff's Department
Newhall Ambulance Company
Palmdale General Hospital
Wilson Ambulance Company

- Computing Facilities

Campus Computing Network, UCLA
Health Sciences Computing Facility, UCLA
Institute of Transportation and Traffic Engineering, UCLA
United States Navy, Point Mugu

- Survey Research Center, UCLA

Special appreciation is due the National Highway Traffic Safety Administration of the U.S. Department of Transportation for the opportunity to undertake this challenging task and for its unfailing support. Particular acknowledgement is due our Contract Technical Managers, Mr. Dwight Fee, Captain Frank Parker (U.S. Coast Guard) and Captain William Harvey (U.S. Coast Guard) for their continuing guidance, assistance and patience.

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I. INTRODUCTION AND SUMMARY OF ACTIVITIES

A. INTRODUCTION

Present day emergency medical services (EMS) have evolved as a consequence of political subdivisions, special interest groups, economic forces, historical occurrences and topsy-like growth. They are delivered by a largely uncoordinated aggregation of public and private organizations. They have achieved a certain measure of adequacy in providing life sustaining care to victims of critical injuries and illnesses. They also have become a portal to ambulatory outpatient care for the indigent, those without a regular physician, and those seeking services when other health care facilities are not open. Predictably, they are producing uneven results, experiencing spiraling costs, and encountering the increasing dissatisfaction of both patients and health care professionals.

Because they often occur in remote places and at off-hours, traffic accidents tend to bring the limitations and inadequacies of emergency medical services into sharp focus. The Department of Transportation has been and continues to be interested in improving the availability and quality of the care that is provided to victims of traffic accidents. Emergency medical services, however, are rarely organized and delivered in terms of a category of victims, such as those of traffic accidents. In almost all instances, the same set of providers serve the accidently injured and the acutely ill. Therefore, regardless of the specificity or breadth of one's concerns with respect to emergency medical services, significant improvements need be sought in terms of the total system and all of its users.

The UCLA EMS Project represented an effort to develop and demonstrate methodologies for the evaluation of existing and of proposed systems for the delivery of emergency medical services, which are readily adaptable to a wide variety of situations. This effort had three stated objectives:

- Characterize the relative roles of time and medical care in the final outcome of traffic accident injuries.
- Indicate the relative benefits and associated costs of demonstrated modifications of an existing emergency medical service system.
- Indicate preferred configurations of the information (detection, communication, and dispatch), transportation (emergency vehicle, allocation, and routing), and medical care (on-scene, in-transit, and emergency facility) subsystems and their interconnections in terms of benefits and cost.

B. SUMMARY OF ACTIVITIES

1. The Role of Data

At the outset of the Project, factual data were scarce. Those data that did exist could not be analyzed meaningfully because of their incompleteness and incomparability. Sufficient data regarding such things as time of occurrence, location, nature and severity, etc., were not available to characterize either highway accidents or other kinds of incidents that can lead to medical emergencies. Additionally, medical data could not be found on the role of time, nor on the effects of alternative kinds of medical care, on the final outcomes of particular kinds of injuries and illnesses. The only extensive data of this kind were based upon military experience and their utilities for civilian traumata were unknown.

In addition to the scarcity of factual data, little was known about the perceptions and knowledge of the citizenry in terms of the natures of medical emergencies and the services that are provided in their communities for assisting the critically ill and injured. Similarly, not much was known about what lay persons, at the scene of a medical emergency, perceive as being needed to be done to assist or get assistance for the victim(s). Further, there was little knowledge as to the factors that influence the willingness of lay persons at the scene to become involved and, if they attempt to help, what their actions are.

Because of the paucity of facts and knowledge about all facets of the emergency medical problem, most of the activities undertaken during the project were either directly concerned with data collection or had data collection built in as an ancillary function. The design of the household survey, which was used to collect information on citizens' perceptions of the properties of their local emergency medical systems and data on their actual experiences in medical emergencies, is presented in Section IV-C. The existing data bases, from which historical information was retrieved, and the information system, which was used to track on-going activities, are set forth in Section IV-D.

2. <u>Appreciative Overview</u>

Without a conceptual framework, it is difficult to pinpoint the critical dimensions of a complex problem. An appreciative overview, which is intended to provide an understanding of the context within which medical emergencies arise and are dealt with, is presented in Chapter II. The emergency medical service system is examined in terms of its historical perspective; the evolving social, cultural and technical environments in which it is embedded; how it is viewed by its users, providers and professional and allied members, and the forces that tend to facilitate and to inhibit its change.

3. <u>Proposed Methodology for Evaluation</u>

A procedure is suggested in Chapter III by which a large number of potential alternatives for delivering emergency medical care can be explored and evaluated. The procedure requires five components, namely three kinds of models, cost estimates for any proposed EMS system, and predictions of the indirect outcomes from any proposed

EMS system. The three kinds of models are: (1) models that predict the nature and distribution of demands for emergency medical services, (2) models capable of generating estimates of the operational characteristics of any proposed EMS system, and (3) models that relate the kind of illness or injury, its severity, and the operational characteristics of any proposed EMS system to its probable medical outcomes.

The resulting packages of estimates identify as fully as possible the mix of inputs and the mix of outcomes that are associated with each alternative.

4. <u>Models for Predicting the Demands for Emergency Medical Services</u>

The locations, at which medical emergencies arise, and the sources, from which the victims of such incidents and those acting on their behalf will seek assistance, are influenced by a large number of factors. It is possible to examine the demand for emergency medical services in terms of surrogates for the conditions that cause incidents to be more likely to occur in one location than another and for the decision processes by which help is sought.

The uses of linear multiple regression models, which employ the characteristics of a geographical area and of the people who live and work there, to predict the demand for ambulances and for treatment in the emergency departments of hospitals are reported in Chapter V.

5. <u>Models for Predicting and Operational Characteristics of Alternative EMS Systems</u>

To provide bases for the determination of preferred configurations of the emergency medical subsystems for communications, transportation, and care and treatment, one must be able to estimate the operational characteristics of alternative configurations of these services. Three models were developed for this purpose.

The first, the computerized ambulance location logic (CALL) model, is described in Section IV-A-1. It is an analytic model that can be used to determine the optimum number and location of emergency medical vehicles under a limited variety of dispatching and retrieval policies and of system configurations. The computerized shortest travel distance model provides a method for determining the optimal routing of emergency medical vehicles from a given initial location to a given destination. It is presented in Section VI-A-2.

Finally, the computerized simulation package, which consists of two separate models and an analysis program, is described in Section IV-B. The incident generation model creates a representative stream of incidents leading to medical emergencies and simulates the detection, recognition and reporting of these incidents. The dispatch, allocation and retrieval model simulates the dispatching, on-scene and in-transit care and retrieval policies for almost any configuration of emergency medical vehicles and treatment facilities. The analysis program permits the user to analyze practically any and all aspects of the simulated system and to generate reports that are tailormade to his needs.

6. Models for Relating the Nature of Medical Emergencies and the Operational Characteristics of an EMS System to Medical Outcomes

A generalized model for predicting the probabilities of various medical outcomes as a function of the kind of illness or injury and its severity, the lapsed time to treatment and the kind and quality of treatment is presented in Section VI-D. A reduced form of this model, in which medical outcomes are only survival and death and three additional simplifications were made, was examined empirically for several categories of illness and injury.

7. Demonstrations

Eight demonstrations, in which facets of existing emergency medical services would be modified and the results evaluated, were proposed originally. For a variety of reasons, which ranged from constraints placed by local jurisdictions to the exploitation of unique opportunities, and with the approval of the Contract Technical Manager, some of the demonstrations were modified, another activity was substituted for one of the demonstrations, and one demonstration was abandoned. Descriptions of the demonstrations, as planned originally, and the actual activities that were implemented follow.

a. <u>Establish Communication Links Between the Traveling Ambulance and the Emergency Medical Facility</u>. This demonstration was carried out as originally conceived. Four kinds of direct voice communication links between ambulances and the emergency departments of hospitals, to which the victim was being transported, were examined. These direct communications were employed to alert the hospital as to the nature of victim's condition and to discuss problems directly with physicians. The quality of transmissions for the various kinds of links and the advanced preparations, which were made in the emergency department as a result of the direct communications, were examined. This demonstration is depicted in Section VI-B-1.

b. <u>Telemetering of Physiologic Data from Ambulance to Receiving Hospital</u>. It was originally intended that electrocardiograms (ECG's), pulse rates and possibly blood pressures would be telemetered from an ambulance to the emergency department, to which the victim was being transported. The demonstration was conducted in cooperation with The National Aeronautics and Space Administration, which supplied the telemetry system. The initial system, which NASA had packaged for civilian use, however, was limited to the telemetry of two-lead electrocardiograms. The demonstration was used to evaluate the quality of the ECG's that were transmitted and the ability of a trained cardiologist to make clinical evaluations from them. This demonstration is described in Section VI-B-2.

c. Improve Training of Four Ambulance Attendants. It was envisioned originally that attendants would be trained to the level of Red Cross Advanced First Aid with special training in cardiopulmonary resusitation. In fact, almost all ambulance attendants in the County had Advanced First Aid training. Further, the organizations, both public and private, that provided ambulance service were well into the training of their attendants in cardiopulmonary resusitation. It was decided, therefore, to combine this demonstration with the one in which physicians were to be assigned to ride in ambulances. The combined demonstration is described below.

d. Assign Physician to Ride an Ambulance. As originally conceptionalized, a physician was to be assigned to ride an ambulance during peak hours to determine the value of a physician at the scene of a medical emergency. Instead, a combined study was carried out to examine four questions. The questions were: (1) what activities were ambulance attendants performing at their present level of training?, (2) how well were these activities being performed?, (3) what kinds of advanced care could higher trained personnel have rendered to the benefits of the victims?, and (4) were there significant differences among different ambulance services in terms of the performances of their ambulance attendants?

Six surgical residents, all of whom had recent and extensive experience in an emergency department, rode with the crews of four ambulance services on all calls during selected shifts. The physicians did not intervene except in cases of critical illnesses or injuries. This activity is detailed in Section VI-A. Its results were instrumental in the design and development of the paramedic demonstration described below.

e. <u>Train and Employ Four Paramedics (Ex-Military Corpsmen) As Ambulance Attendants</u>. It was planned originally to examine the utilization of trained and experienced military paramedics in civilian ambulance services. It was found that because of the low pay rates that prevailed for ambulance attendants and availability of alternative health care careers, few ex-corpsmen were interested in jobs as ambulance attendants, other than as temporary employment. The demonstration, therefore, was modified to utilize another resource, namely firemen, as paramedics (Emergency Medical Technicians-II).

Eighteen fire department paramedics were trained and two different concepts of mobile intensive care units were created, as means of delivering advanced paramedic care at the scene and during the transport of patients to hospitals. This demonstration and its benefits and costs are described in Section VII-A.

f. <u>Increase the Number of Ambulances and Deploy Them in a Different Way</u>. It was originally conceived that the available ambulances in a designated area would be increased and deployed in various different ways, such as constant cruising, assigned to hospitals, etc. With the development of the computerized models for ambulance location and for simulation, it was not necessary to perform this demonstration and it was abandoned. The operational characteristics of an almost unlimited number of variations in the number and deployment of ambulances can be predicted by these models with less time and at a lower cost than by the manipulation of actual ambulances.

g. <u>Helicopter Evacuation System</u>. This demonstration was carried out in two phases as originally designed. Initially, the helicopter was dispatched in urban and suburban areas in parallel with existing ground ambulance services to compare the response times of the two kinds of vehicles and to identify any difficulties that might be encountered in navigation, landings, etc. In the second phase, the helicopter was deployed in a rural environment and used for actually picking up and transporting victims to hospitals. This demonstration and its benefits and costs are reported in Section VII-B.

h. Develop Citizen's Alert System. It was visualized originally that a communitywide system of surveillance would be developed to reduce the length of the delay between the occurrence of a traffic accident and the notification of the public safety agency that originates the dispatch of emergency medical vehicles. The anticipated surveillance system was to utilize the large numbers of mobile telephones and radios, which are now in use in private and organizational vehicles, and the home telephones of citizens living adjacent to roadways that have high accident potentials, such as freeways.

Early in the planning of this demonstration, however, the public safety agencies, which would have to play central roles in any such effort, opposed the demonstration. They reported that they were already receiving multiple notifications of a significant portion of all traffic accidents. They projected that a program aimed at mobilizing and further motivating the citizenry to perform such a surveillance role would result in the inundation of their switchboards.

As a substitute, a household survey was designed and conducted. Its purposes were to gain greater understandings of how citizens view medical emergencies and emergency medical services and of the various roles that citizens can play in the course of medical emergencies. The respondents were asked about their knowledge and perceptions of medical emergencies and the emergency medical services in their communities, about their specific experiences at the scenes of actual medical emergencies and about what they want changed and how they did, or what they might do, to bring about such changes. The design of this survey is described in Section IV-C and its results are reported in Section VI-E.

II. APPRECIATIVE OVERVIEW

A. INTRODUCTION

The purpose of an "appreciation"--a term we are using in its British rather than its American sense--is to provide a subtle and many leveled understanding of the whole of a complex system and the relationships within it. This appreciative overview should provide an understanding of the significant changes in expectations and relationships between patients (users) and the various parts of the emergency medical care "system". These changes are occurring as one element in a broader family of changes within the general system of health care delivery. Some of these changes challenge fundamental assumptions about the provision of emergency medical care; solving an individual problem in any of the system's parts is not likely to provide hoped for improvement in care because the effectiveness of the overall system will not have been improved. This is the lesson of the 1970's, and it is a hard one to learn.

An appreciation permits us to develop an overview in an appropriate historical perspective so that we can understand the system's present state. An appreciation also provides us with an opportunity to develop an understanding of the relationships between specific subsystems and the total. It further permits the development of an understanding of the dynamics of the system so that we can anticipate and evaluate the forces for change.

Our appreciation begins with a definition of the term "medical emergency" and proceeds to an examination of antecedents. This is followed by a look at the evolving social and cultural environments within which emergency medical care is embedded and then by a look at the system itself, its functions, technology, and the theories of its operation. To aid in the formation of our appreciation, the emergency medical care system will be examined from different points of view--those of the user of the system, the providers of service or system members, and of others who carry on activities within it.

The framework to be used for examining emergency medical care systems is that borrowed from sociotechnical systems, which postulates an operating system existing within a cultural, social, and technological environment and open to the forces generated within the environment. Sociotechnical systems also postulates that each system or subsystem employs a technology that interacts with the social system of the organization in accomplishing the work to be done. Further, each system, given the forces operating upon it from the environment, will seek to maintain itself in a quasi-stable relationship with its environment. It will seek to maximize its performance based on its perceived objectives. Further, it will undertake self-modification in response to changes intruding from the environment. These changes may be cultural, technological, and social in origin. This requires us to identify and evaluate the various environmental changes that are taking place. For instance, two major changes have intruded to upset the previously existing homeostatic or quasi-stable relationship between emergency medical care systems and their environment; the present state of disarray of emergency medical care reflects the attempt to achieve a new balance or relationship. The changes in the social environment referred to are that the state of emergency is now defined by the patient or user rather than by some external authority and that health care has emerged as a right of citizens, to be expected of society, rather than a burden to be borne by the individual.

Two conceptual models within this framework will be used to aid in developing an appreciation of the emergency medical care system. The first is a user model that focuses on the patient or victim involved in an emergency care situation. The second views emergency medical care as a response network--a system made up of discrete care-providing subsystems linked together in some fashion to provide comprehensive emergency care.

The framework we are using emphasizes the structure of systems rather than the process by which institutions are formed; this emphasis facilitates an understanding of the way in which the system's components (users, providers, etc.) are interlocked and interdependent.

B. MEDICAL EMERGENCIES

Approximately 23 years were added to the life expectancy of the average American during the first two-thirds of the 20th century.[1] This gain has been achieved largely through the control of infectious and parasitic diseases. The leading cause of death has become arteriosclerotic heart disease with cancer and accidents ranking second and third. Yearly deaths in this country from motor vehicle accidents alone, which constitute less than half of all accidental deaths, now exceed the total number of deaths from all communicable diseases.[2]

An important property shared by arteriosclerotic heart disease, accidents, and other trauma-producing incidents is their potential for producing medical emergencies, whose time and place of occurrence as well as nature can be predicted only as random variables. Medical emergencies may be defined as situations characterized by physiological instability that poses an immediate life threat or that has a high potential for becoming life threatening. Common examples include respiratory, circulatory and intracranial insufficiencies; acute metabolic, acid base, fluid and electrolyte disturbances; hypo- and hyperthermia, etc. Survival in medical emergencies depends on the immediate application of appropriate treatment. Fortunately, medical emergencies occur relatively infrequently.

Medical emergencies of special concern to emergency medical systems because they often occur at home or in home and road accidents, are (1) cardiopulmonary failure, (2) hemorrhagic shock, (3) abdominal viscera damage and (4) brain or nervous system damage.

Cardiopulmonary failure may result from a wide variety of causes including airway obstruction, heart disease, drowning, ingestion of drugs

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[1] National Center for Health Statistics, Vital Statistics of the United States 1966, Volume II-Section 5: Life Tables, Public Health Service, United States Department of Health, Education and Welfare, Washington, D.C., 1968.

[2] National Center for Health Statistics, Vital Statistics of the United States 1966, Volume II-Mortality, Part A, Public Health Service, United States Department of Health, Education and Welfare, Washington, D.C., 1968.

or noxious agents, acute allergic reactions, and traumatic injuries of the chest, skull, and spinal cord. Cardiopulmonary failure is the most urgent category of medical emergency, since irreversible brain damage generally occurs within three to four minutes of cardiopulmonary collapse.[1]

Hemorrhagic shock results from heavy blood loss. The body has compensatory mechanisms that assist in maintaining sufficient perfusion of vital organs. If blood loss continues, however, these compensatory mechanisms can neither be bolstered nor returned to normal by treatment.

Serious damage to abdominal viscera results from blunt and penetrating traumata and from the ingestion of noxious agents. The mortality rate resulting from abdominal trauma is quite high, with a range from about 15% for colon injuries to about 70% for liver injuries due to blunt trauma.[2] Brain or nervous system damage results from blunt and penetrating traumata. In automobile accidents, damage to the brain and spinal cord causes 70% of all deaths.[3]

An important modification should be made to the definition of medical emergencies to include those situations that threaten permanent disability to the individual. Examples of extremely serious medical emergencies that threaten permanent disability are chemical burns of the eye and occlusion of the central retinal artery.[4] The extent of permanent injury resulting from alkali or acid burns of the cornea is a direct function of time lapse before decontamination as well as the nature and concentration of the chemical. Prolonged compression of the eye from external pressure or from

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[1] Gaal, P.G., "Cardiac Arrest and Resuscitation," in Early Management of Acute Trauma, A.M. Nahum (editor), C.V. Mosby, St. Louis, 1966, 53-63.

[2] Orloff, M.J., "Abdominal Injuries," in Early Management of Acute Trauma, A.M. Nahum (editor), C.V. Mosby, St. Louis, 1966, 148-161.

[3] Shelden, C.H., "Prevention: Only Cure for Head Injuries Resulting from Automobile Accidents," Journal of the American Medical Association 159:10, November 1955, pp. 981-986.

[4] Paton, D. and M.F. Goldberg, Injuries of the Eye, the Lids, and the Orbit: Diagnosis and Management, W.B. Saunders, Philadelphia, 1968.

severe intra-orbital swelling can occlude the central retinal artery. To prevent permanent loss of vision, therapy must be begun within minutes.

The above kinds of illnesses and injuries are frequent causes of conditions to which an emergency medical system will respond. There are uncertainties associated with the time, manner and place of their occurrence. Additionally the need for emergency care, to a large extent, is defined by laymen such as the victim himself, his family or friends, the police or passersby. The consequence is that:

- The decision that emergency medical care is required is made largely in the absence of an accurate diagnosis. At one extreme, apparently minor complaints can be harbingers of life-threatening conditions. At the other extreme, a high level of apprehension on the part of the victim, his family or friends, can result from a relatively minor condition.
- Most people are infrequently faced with medical or surgical emergencies. As a consequence, they have little occasion to develop an accurate understanding of how the emergency medical care system in their community works and how to use it properly. The demands placed on the public and private sectors for emergency care depend, to a considerable extent, on misconceptions and expectations, and lack of knowledge and experience.

The proportion of all "emergencies," which result in the victim(s) being transported by ambulance, that can benefit from earlier care has been estimated to be only about 10 percent.[1, 2] The proportion that pose an immediate threat to life is estimated (See Section VI-D) to be 12 percent.

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[1] West, I., et. al., "Speeding Ambulance Survey," AID, Sept.-Oct. 1964, pp. 8-10 and 14.

[2] Report of Initial Study of Helicopter Operations of Los Angeles City Fire Department, Emergency Medical Systems Project, University of California, Los Angeles, October 1968, pp. 33-36.

C. HISTORICAL EVOLUTION OF EMERGENCY MEDICAL SYSTEMS

1. Outpatient Services

The evolution of emergency medical systems can be traced through the development of outpatient care, ambulances, and emergency rooms. Outpatient clinics in the United States evolved from the poor-relief traditions of England's Poor Law, under which public almshouses for the indigent and the aged were established. By 1696, the pattern of hospital-based outpatient clinics had been initiated by the College of Physicians in London. This tradition was brought to the United States, and the first clinic was established by the Quakers in Philadelphia in the mid-1770's. The New York Hospital Outpatient Department was opened in 1795, and the venerable Boston Dispensary, with its full-functioning home care service, was established one year later. The significant American departure from English practice was the vesting of public responsibility for aiding the poor in the hands of local government rather than in the parish. Local governments developed and maintained almshouses or poor farms to which the indigent, the sick, and the disabled were sent. This practice continued in the United States until well into the 19th century.

The early clinics were essentially drug-dispensing stations for the poor and for impoverished immigrants. The clinics were housed in basements of hospitals or public buildings and were staffed by practitioners who donated a few hours from their private practices. As late as 1914, Michael Davis labeled these as "medical soup kitchens". Costs of operating these clinics were low, and the minor deficits incurred were deemed a reasonable price to pay to assuage the local community's conscience. Most states provided some care for their poor at public expense.

In the early 1900's the poor were cared for in public dispensaries; for instance, in 1927 Baltimore had 50 such dispensaries, 14 operated by the City Health Department, 16 by general hospitals, and 20 by philanthropic agencies. The Great Depression of the 1930's brought the federal government into the arena of providing for the poor through various welfare measures, and a shift in responsibility for medical care to the indigent placed clinics and dispensaries under public welfare agencies. As early as 1935 the Department of Public Welfare in Baltimore arranged for the handling of emergency calls from persons unable to travel to a dispensing hospital. In the daytime, emergency calls were answered by physicians staffing dispensaries, and at night the calls were linked with the telephone switchboard of the City Fire Department, which called a physician from lists furnished by the Department of Public Welfare. This set the pattern, which continues to the present, of having outpatient and emergency activities under the auspices of welfare agencies. The present confusion between outpatient care and emergency care has its origins in the original support by welfare agencies. Present developments will be reviewed subsequently.

2. Ambulances

The first recorded organization of an emergency ambulance service occurred during the Napoleonic Wars in the early 1800's. Baron Larrey, Surgeon-General of the French army initiated a system of horse-drawn cars to carry wounded soldiers from the battlefield to medical facilities located at the rear. Reports of Larrey's success are confirmed by Napoleon's high regard for his chief medical officer.[1]

In the U.S. another military surgeon, Dr. Edward B. Dalton, utilized his experience in the Army of the Potomac during the Civil War to establish the first city ambulance service at Bellevue Hospital, New York, in 1869. Since then, progress in providing transport for the sick and injured has come about in a singularly haphazard and disorganized fashion. In many rural areas and small towns, morticians owning vehicles of requisite dimensions have acquired the responsibility for providing ambulance service. The concentration of demand has forced many urban areas to provide ambulance services for the sick and injured.

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[1] Jackson, Laura G., Hospital and Community, Macmillan, New York, 1964.

The steady increase in demand for ambulance service is accounted for in most part by the four percent annual increase in accidental deaths during the early 1960's.[1] This increased demand for ambulance service has created an immediate problem of providing adequate service. One expert predicts that in response to this problem all medical facilities and personnel will be eventually woven together into regional medical service areas. Within each, hospitals will operate on a community-wide basis requiring "careful planning and an efficient transportation and communication system."[2]

The present predominating view of ambulances is that they are transportation services. This is reflected in the fact that so many communities and regions do not possess central communications and dispatch for directing ambulances; neither do they have appropriate rules to permit ambulances to make the best decision about where and how to deliver patients.[3,4]

Ambulance services rarely have physician advisors, and existing standards for ambulance personnel are outdated in terms of present and emerging concepts of medical science.

With the exception of a few pilot programs,[5,6] which employ specially equipped vehicles and specially trained personnel, (physicians, nurses,

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[1] Accidental Death and Disability: The Neglected Disease of Modern Society, National Academy of Science, National Research Council, Division of Medical Sciences, Washington, D.C., Sept. 1966.

[2] Rutstein, David D., The Coming Revolution in Medicine, M.I.T. Press, Boston 1967.

[3] West, I., et. al., "Speeding Ambulance Survey," AID, September-October 1964, pp. 8-10 and 14.

[4] Report of Initial Study of Helicopter Operations of Los Angeles City Fire Department, Emergency Medical Systems Project, University of California, Los Angeles, October 1968, pp. 33-36.

[5] Pantridge, J.F. and J.S. Geddes, "A Mobile Intensive Care Unit in the Management of Myocardial Infarction," Lancet, 2:7510, August 1967, pp. 271-273.

[6] "Mobile 'CCU' Improves Survival," Journal of the American Medical Association 208:5, May 1969, pp. 777-778.

or paramedics), ambulance and rescue vehicle personnel cannot deliver all of the kinds of life support and definitive therapy required by life-threatening conditions. Many if not all of these can currently be exported outside of the hospital for on-scene and in-transit care. Exportable therapies include the administration of antiarrythmic and cardiopulmonary resuscitative drugs, defibrillation and cardiac pacing, intravenous infusion of blood substitutes, and tracheal intubation. Under most of our licensure laws, such therapies can be performed only by a physician or by a nurse under the direction of a physician.

3. Emergency Rooms

The growth of emergency rooms is intertwined with the development of outpatient services and ambulances. Until the mid-1950's, emergency rooms devoted themselves to providing for the needs of victims of trauma, accidents, severe injuries, or physiological collapse.

From 1958 to 1962 the U. S. Public Health Service noted that the total number of patient visits to all emergency rooms in the United States increased from 18 million to 28.5 million. This represented for 1962 approximately one visit for every six persons in the population.[1]

Holding constant the effect of population growth, the U. S. Public Health Service projected for the decade 1960 to 1970 a 79% increase for emergency services in contrast to an 18% increase for all outpatient services and an 8% increase for inpatient admissions.[2] At this rate of overall increase hospital outpatient facilities including emergency rooms, will provide almost one-sixth of all ambulatory service rendered in the United States.

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[1] McGiboney, J. R., "Is Your Emergency Room Ready," Medical Annals, 32:1, January 1963, pp. 23-26.

[2] United States Department of HEW, Public Health Service, Facts and Trends on Hospital Outpatient Services, Washington, D. C. 1964, publication No. 930C6

Most accredited community hospitals have an emergency department. A recent Annual Survey of Hospitals[1] by the American Hospital Association shows that 90 percent of the 5,444 reporting hospitals have organized facilities and around-the-clock staffing for the provision of emergency outpatient services. For hospitals of all sizes except the 100-199 bed category, the emergency department was the most frequently reported service other than short-term general beds. Although the percentage of hospitals reporting a 24-hour emergency department understandably increases with the number of beds, 73 percent of the hospitals with only 6 to 24 beds reported this service.

Despite their prevalance, emergency rooms typically are little more than isolated appendages to general hospitals. Although nurses may be available around the clock, staff physicians and surgeons are usually available only on an "on-call" basis. This is a common problem for smaller suburban and rural hospitals.

The staff physicians and surgeons, including those in training, are not necessarily skilled and experienced in emergency medical treatment. Few physicians are experienced in cardiopulmonary resuscitation, respiratory care, treatment of shock, coronary control, acid-base balance, electrolyte control or temperature control. Neither the possession of the license to practice nor of specialty board certification requires competence to administer such life-saving or life-supporting therapies.

The current "emergency room crisis" has been brought about by the enormously increased use of emergency rooms by ambulatory patients who have defined their own conditions as emergencies. Studies of hospital emergency usage show a constant rate of increase in patient visits from 400 percent to 500 percent over the fifteen year period 1945 to 1960.[2,3]

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[1] "The Nation's Hospitals: A Statistical Profile," Hospitals, 43:(15-Part 2), December 1969, pp. 463-500.

[2] Shortliffe, E. C., Hamilton, T. S., and Noroian, E. H. "The Emergency Room and the Changing Pattern of Medical Care", New England Journal of Medicine, 258:1, January 1958, pp. 20-25.

[3] McCarroll, J. R. and Scutter, P. A., "Hospital Emergency Departments: Conflicting Concepts of Function Shown In National Survey", Hospitals, 34:23, December 1960, pp. 35-38.

What makes for the crisis conditions is that one-third to one-half of the cases can be classified as nonurgent. Weinerman[1] in his studies at Yale's New Haven Hospital found that about 50 percent of the visits were of a nonemergent nature. He indicated, "much of the contradictory nature of present day medical care is mirrored in the paradox of the nonurgent emergency. The disproportionate increase in total visits to hospital emergency facilities is largely due to their use for general health problems by those who remain outside the private medical care system on the one hand, and those who find it too inflexible on the other. The emergency room. . .has become the last, and now increasingly the first resort for those for whom even the hospital clinic is too limited a resource."

Complications are introduced for the effective functioning of emergency medical systems because "emergency" victims, whether requiring immediate care or not, are mingled at emergency treatment facilities with nonemergency patients. The nonemergency demands on emergency rooms are created by:[1,2]

- persons seeking services at the emergency room at hours when outpatient clinics are closed,
- indigents using the emergency room as a portal to the medical treatment system,
- persons sent by physicians treating nonemergency outpatients in the emergency room while they make hospital rounds.

4. Intensive Care and Other Specialized Care Units

An American Hospital Association survey of hospitals revealed that intensive care units (including coronary care) exhibited more growth than

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[1] Weinerman, E. R. and Edwards, H. R., "Yale Studies in Ambulatory Medical Care: I, Changing Patterns in Hospital Emergency Service," Hospitals, 38:10, November 1964, pp. 55-62.

[2] Davidson, R. A., "What is an Emergency? Broad Definition Needed for Effective Community Service," Hospital Topics, 41:3, February 1963, pp. 33-35.

any other category of community hospital services--a 133 percent increase in five years. Hospitals reporting that they had intensive care services jumped from 18 percent in 1963 to 42 percent in 1968. Ninety-one percent of hospitals with 200 or more beds provided such services in 1968.

This rapid rate of growth reflects two trends. First, medical science can now offer sophisticated systems for monitoring patients[1] and improved methods of titrated life support and definitve therapy. Second, there is a growing awareness that concentrating seriously ill and injured patients in units under the care of teams of full time medical specialists improves the quality of care.

Despite improvements in the care provided by specialized units, the situation with respect to emergency conditions is far from ideal. There has been a proliferating of specialized care units reflecting medical subspecialties, e.g., intensive care, postoperative, coronary, respiratory, shock, burn, spinal injury, etc. This specialization, in turn, has resulted in a fragmentation of critical care into small, autonomous, geographically dispersed units. Such units are characterized by:

- personnel and equipment that, in many ways, duplicate the facilities of other specialized units and of the emergency room;
- inadequate staffing in terms of both physician coverage and experience;
- excessive area-wide capacity;
- inefficiencies of small scale.

5. Summary

In summary a system is characterized by the existence of interdependent parts. Viewed as a whole, few medical facilities have developed and fewer, if any, communities have developed the means to provide sufficient linkages among their various components to merit designation as "systems"

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[1] Caceres, C. A. and D. K. Baner, "Computerized Care," Hospitals, 43:23, December 1969, pp. 49-51.

for the delivery of emergency medical care. About the only universally present interdependence, with apologies for stretching the meaning of the words, among ambulances, emergency rooms and special care units is the transfer of patients from one to another. Aside from making the patient far too vulnerable to the emergencies of this disjuncture, the transfer of patients provides to the casual observer a false sense of the existence of systems.

Existing systems to deliver care to victims of medical emergencies have evolved as a consequence of political jurisdictions, special interest groups, and unplanned growth. They continue to operate disjointedly as part of, or under the regulation of, different jurisdictions. Typically, such systems are little more than an aggregation of autonomous or semi-autonomous public and private organizations. Each organization performs one or more of the functions in the chain of activities associated with the care of superacute conditions.

The mismatch between the need for prompt life support and definitive therapy and the capabilities of existing medical care systems to deliver such measures prevents the saving of many of the approximately 700,000 victims who die annually in the United States as a result of medical emergencies.[1]

The aim of this appreciative overview is to provide insights, useful for policy development and operational improvement, that will shed light on the nature of these mismatches and why they exist.

The statistics revealing the rapid growth of emergency care facilities and our understanding of the requirements of the emergency medical care process make us immediately aware of the interrelatedness of all of the elements of what should be an emergency medical care system. Improvement in ambulances, or in communication systems, or in emergency rooms will, in and of themselves, contribute little to improving the total response

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[1] The Committee on Acute Medicine of the American Society of Anesthesiologists "Community-Wide Emergency Medical Services," Journal of the American Medical Association, 204:7, May 1968, pp. 133-140.

to emergency medical care needs. Amelioration of the present problems must be sought within the broader framework of total integrated systems, and this, in turn, is only possible if we understand the relevant social and technological environments of emergency care. We turn to a consideration of these factors in the next section.

D. SOCIAL AND TECHNOLOGICAL ENVIRONMENTS OF EMERGENCY AND HEALTH CARE

Our society has entered on a period of transition from the previously dominant industrial era into the post-industrial era. The transitional period, as is true of all great changes, is marked by dislocations and mismatches. Of particular relevance to this study is the growing mismatch between post-industrial expectations and the process, structure, and context of health and emergency care systems. Unless adaptation occurs (sooner rather than later), this mismatch may lead to consequences unacceptable to health care providers. Rational leaders and professionals will seek to avoid these consequences by designing integrated emergency care systems that conform both to health needs and to evolving values.

The values of a society and its institutions emerge in response to social and physical conditions and to the conceptions the society holds of its environment. Perhaps the best way of illuminating such changes is to present two tables derived from E. L. Trist (see Tables II-D-1 and II-D-2).[1] The shift in values that we can see in these tables is undergirded by the potency of developed technology, which appears to provide for material needs without limit and to banish (for the great majority) the fear of scarcity.[2] The apparent ease with which technology can provide material goods forms a sharp contrast to the difficulty of providing personal services. Such dissonance does not long go unresolved in an open society.

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[1] Trist, Eric L., "Urban North America: The Challenge of the Next Thirty Years," PLAN, 10:3, June 1970, pp. 4-20.

[2] It is not at all clear that high-production technology can, in fact, supply material needs in abundance over the long term. The present levels of technological production may not be quasi-stable, and if it eventuates that there are inexorable limits to growth (depletion of resources, deleterious by-products, etc.), then another shift in values must occur, reflecting the modified social and technological environments of the future. However, our concern here is not with the reality of these perceptions, but with their nature and their present impact on the emergency medical system.

TABLE II-D-1

OCCUPATIONAL STRUCTURE AND EDUCATION

Aspect	Salient in 1935	Salient in 1965 (and 1970)
Composition of work force	Blue collar	White collar
Educational level	Not completing high school	Completing high school
Work/learning ratio	Work force	Learning force
Type of career	Single	Serial

TABLE II-D-2

CHANGES IN EMPHASIS OF SOCIAL PATTERNS IN THE TRANSITION TO POST-INDUSTRIALISM

Type	From	Toward
Cultural values	Achievement	Self-actualization
	Self-control	Self-expression
	Independence	Interdependence
	Endurance of distress	Capacity for joy
Organizational philosophies	Mechanistic forms	Organic forms
	Competitive relations	Collaborative relations
	Separate objectives	Linked objectives
	Own resources regarded as owned absolutely	Own resources regarded also as society's resources
Ecological strategies	Responsive to crisis	Anticipative of crisis
	Specific measures	Comprehensive measures
	Requiring consent	Requiring participation
	Short planning horizon	Long planning horizon
	Damping conflict	Confronting conflict
	Detailed central control	Generalized central control
	Small local government units	Enlarged local government units
	Standardized administration	Innovative administration
	Separate services	Co-ordinated services

Adding to this dissonance is a special feature of the present day United States--the presence of enclaves of unskilled, unemployed, economically disenfranchized minorities whose status has been marginally improved. The rising expectations generated by the process of improvement only makes for the perception of greater relative deprivation. Thus demands for access to material needs and personal services are accelerated by minorities who begin to see movement into the societal mainstream as a realistic expectation.

Our present social environment is characterized by the view of the majority that we have moved from an economy of scarcity to an economy of abundance. However, our political and economic theories are still based on scarcity, which serves only to produce frustration with leadership--a frustration that is being exacerbated with the passage of time. The view of an economy of abundance supports both rising expectations and a reappraisal by individuals of their roles relative to societal needs. Minorities increasingly expect a share of mainstream rewards, and majorities increasingly expect equality between satisfaction of personal needs and material needs.

The individual's reappraisal of his societal role calls into question all relationships to social institutions. "Do I exist to serve the institution (for society's needs)? If not, then should not the institution conform to my needs?" The rapid rise in use of emergency care facilities by non-medically urgent users is strongly associated with this view, although the phenomenon is partially masked by the large numbers of economically underprivileged who are seeking access to care.

Lastly, we need to recognize that urbanization is continuing, and that education levels are rising. Both of these factors place much stress on the existing organization that provides health care and on the process by which care is provided.

The technological environment of emergency and health care is also changing in directions having two quite different sets of consequences. First, improved medical technology is providing greater means for prolonging life and restoring victims to their former state of health.

As before, such improvement sets off the chain of rising expectations and consequent perceived increased relative deprivation. Second, advances in biological and medical science are increasing our knowledge of cause and effect relationships in pathology, and are facilitating concomitant advances in the science underlying medical technology. Medicine-as-technology is more predictable than medicine-as-art, but it changes the status of its practitioners in the social system. The protected status of the performer of mysteriously "good" activities is more and more challenged. For the professional providers of direct health care this will be seen (inappropriately) as a reduction in status. These professionals require a thoroughgoing analysis of the organizational forms and process needed to carry on technology as distinct from maintaining status and authority. To say the least, this is a formidable undertaking, which is necessary if new health and emergency care systems are to be evolved that satisfy the post-industrial values of users and that continue technological development.

Another technological environment of emergency health care stems from developments that give promise of more effective early warning, detection, communication, diagnosis, treatment, patient rescue, and retrieval in medical emergencies. The dissonance is growing between the potential offered and the availability of these advances within a fractionated non-system of health care, particularly of emergency health care. The view is growing, and will continue to grow, that providers of direct health care are only very competent technicians incapable of designing operating care systems.

In summary, we are well into an era that has elevated expectations and increased the dissonance between the existing process of health care and perceived needs. It is unclear that appropriate change will flow from attempts to reduce the dissonance by employing new technologies and meeting newly visible needs. The conserving dynamic of the existing health and emergency care organizations will tend to undertake changes at the margin while preserving the core of the existing non-system. New forces, probably from federal government, may shift the dynamic and provide demonstrable means of designing and operating care systems open to their environments.

E. CONCEPTUAL FRAMEWORKS

The burgeoning demand on emergency medical care has upset a long-existing equilibrium established by health care providers in which they offered kind, manner, and place of care for patients to accept or reject. To use the language of economics--the emergency medical care apparatus is being used by consumers to recapture the market. No amount of handwringing and crisis-invoking by health care producers is going to diminish or reverse this development, which is supported and reinforced by other changes in our social environment (as noted in the section above). It is unfortunate that emergency medical care is the entry point through which this redefinition is taking place, but this is the health system portal available to all consumers in the U.S.

The conceptual frameworks described in this section are intended to provide a basis for understanding these emerging phenomena. The discussion of the emergent user provides insights in the "market redefinition" development, which can be seen as an extension of consumer behavior, which in the past required self-management by the consumer of the network (not system) of available health resources to achieve satisfaction of health needs.

1. The Emergent User: Distress-Anxiety Analysis

"I have an emergency that requires immediate medical attention!" Implicit in this declaration is a surprisingly complex series of health management decisions. The initial decision process leads to the recognition that an individual has lost or is in the process of losing his ability to maintain a desired health status. The second decision involves the searching for, and selection of, some means for reestablishing control and direction over his health. Should this second process arrive at the conclusion that help is needed, then a third decision centers around finding a suitable strategy for gaining that assistance.

"Self-defined" emergencies of this type differ from what are normally thought of as "medical" emergencies, in which victims are judged by others to be in a life-threatening situation and are incapable of caring for themselves. While not denigrating the individual's ability to estimate the seriousness of his incapacity, we recognize that self-defined emergencies are a growing aspect of emergency care. They include a potentially broader range of physiological and psychological needs than do medical emergencies. An effective emergency medical response system will be required to cope with both self-defined emergencies and involuntary "medical" emergencies.

Of course, not all individuals are fully conscious of the decision-making processes in which they engage when reacting to tense health situations. In fact, many (if not most) people behave instinctively in their search for assistance, giving very little thought to health evaluation, available alternatives, or strategies for obtaining assistance. The purpose of analyzing the voluntary, self-defined emergency is not to describe actual behavior, but to understand the decision-making framework that underlies the behavior that takes place in relation to emergency medical care. An emergency medical system that can successfully accommodate the widest variety of potential behaviors should be better able to care for those individuals who are too distraught to make logically optimal choices.

a. Health Diagnosis. The analysis of voluntary, self-defined emergencies begins with the assumption that every individual has a certain capacity to make diagnostic assessments of his well-being. As indicated in Figure II-E-1, the process begins when the individual pulls together everything that makes up his physiological and psychological health state. This health state is then compared to an internalized standard of how that individual believes he ought to feel. The degree of closeness or divergence between the perceived health state and the idealized health standard is typically reflected in expressions of either satisfaction or distress.[1]

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[1] Vickers, Geoffrey, "The Concept of Stress in Relation to the Disorganization of Human Behavior," in Walter Buckley (Ed.), Modern Systems Research for the Behavioral Scientist, Chicago: Aldine Publishing Co., 1968, pp. 354-355.

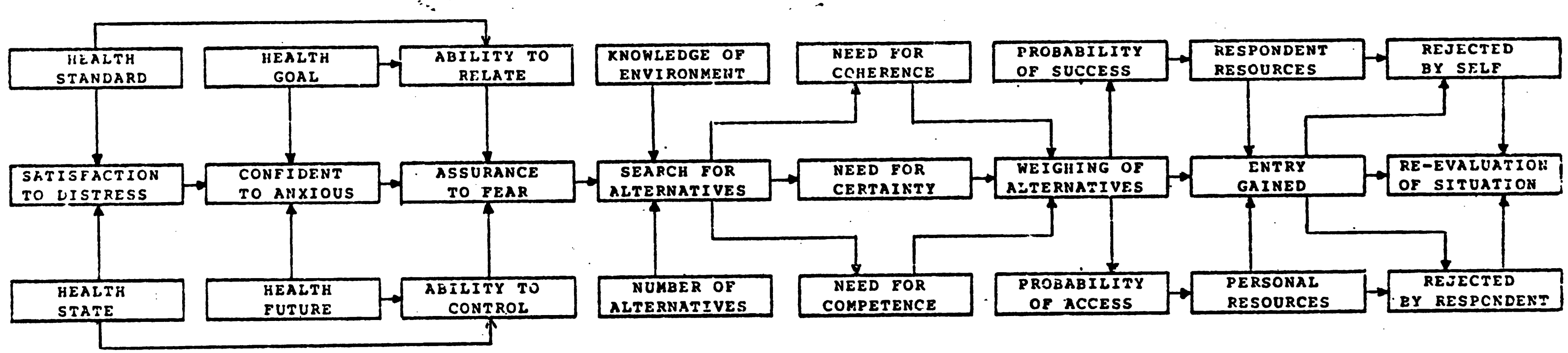

FIGURE II-E-1

<u>INDIVIDUAL HEALTH SELF-MANAGEMENT MODEL</u>

A similar process is employed when the same individual attempts to compare his future health state to an idealized future health goal describing how he would eventually like to feel. He once again goes through the process of checking for closeness and divergence between the expected and the desired. The outcome of this assessment may be seen in expressions of confidence or anxiety about his future health condition.[1]

It is also postulated that individuals have a potential capacity to make a diagnostic evaluation of their health state and health standard. These evaluations attempt to identify the sources of distress or anxiety and to find appropriate strategies to respond to to them. The most familiar diagnosis is one that concludes that something within the present health state is causing a deterioration that may adversely affect future health. The individual then attempts to generate a treatment strategy that will control the direction of the present health state to bring about a more desirable future. The diagnosis may also conclude that the deterioration may occur in some future health state unless a preventive strategy is adopted. Typical preventive strategies include proper diet, disease inoculation, or the elimination of hazards that might result in injury.

The second form of diagnostic evaluation is less well understood because it attempts to relate present health standards and future health goals to the realities of the world in which an individual finds himself. Of course, standards and goals are largely predetermined by such physiological regulators as body temperature, blood pressure, metabolism, and the aging process. They are also influenced by family, friends, and society through social training. Nevertheless, each individual still retains a degree of latitude in how he links these physiological and societal guidelines with observations of himself and his world in coming up with a set of standards and goals

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[1] Time Magazine, "The Anatomy of Angst," in Harold J. Leavitt and Louis R. Pondy (Eds.), Readings in Managerial Psychology, Chicago: The University of Chicago Press, 1964, pp. 50-51.

that assist him in making health decisions. For example, distress cannot be accurately gauged unless there is a realistic idea of what proper health should be. Neither can anxiety be reduced if an individual sets an unrealistic health goal. (For example, the search for eternal youth is in effect a search for eternal anxiety.)

Successful health self-management may thus be summarized as the feeling of assurance about one's physiological and psychological well-being. This feeling grows out of the belief that the individual's present health state satisfactorily approximates a realistic health standard. Assurance also grows out of the belief that this approximation can be confidently projected into the foreseeable future because the individual can control events to achieve a future health goal, and that this desired future is realistically related to the environment in which the individual finds himself.

Conversely, unsuccessful health self-management can be summarized as the feeling of fear that arises from the divergence that an individual observes between his present health state and health standard. Fear may also grow out of a feeling of anxiety that this divergence will continue or worsen in the future. In addition to these sources, fear may be increased as an outcome of diagnostic evaluation. The individual may find that he is relating unrealistic health standards and goals to his physiological or psychological self, or that he cannot find an effective means for controlling his observed or anticipated deterioration. Whatever the specific cause, the existence of distress reinforced by anxiety develops the sense of fear which motivates the individual to seek relief.

b. Search for Relief. The readiness of an individual to search for relief of fear largely develops out of his assessment of distress and anxiety. Search motivation, however, is also influenced by the perceived availability of alternatives. An individual will be less motivated to search if his past experience or knowledge of the immediate environment indicates that search would be futile. Increased fear may motivate an individual to travel beyone his immediate environment for relief. On the other hand, the ready availability of alternatives may make small amounts of distress and anxiety bearable since relief is seen to be readily obtained.

The problem of where to search for relief is primarily related to the outcome of the diagnostic evaluation which in turn is related to individual education and prior experience operating in conjunction with the obviousness of the symptoms.

Where there is an inability to relate standards and goals to the perceived realities of life a markedly different search pattern may ensue. Individuals in this situation need to find some way of giving coherence to the world in which they find themselves by seeking either support from someone whose sympathy, understanding, and affection provide reassurance that the selected standards are adequate and that the selected health goals are desirable, or guidance from someone who is identified as a leader or authority in establishing health standards and goals.[1]

There are many persons, however, who are uncertain as to the seriousness or cause of their difficulties. In these cases it is the uncertainty itself that becomes the motivating force in seeking assistance. The search for relief of health care anxiety may provide another way of looking at emergency medical systems. When an individual's search for relief is beyond his capability, either psychologically or physiologically, he becomes dependent, in whole or part, on external support and enters, or is entered, into the domain of emergency medical systems.

c. Strategy for Entry. The inability to resolve health fears leads individuals to search for assistance from persons who may be able to provide the needed competence, coherence, or certainty. The knowledge and experience that helped in diagnosis also helps in

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[1] Helmreich, Robert L., and Barry E. Collins, "Situational Determinants of Affiliative Preference Under Stress," Journal of Personality and Social Psychology, 6:1, May 1967, pp. 79-85.

judging the adequacy of the relief alternatives. Yet it is unusual for a person in need to have enough specialized knowledge to be completely certain in judging the professional capability of a potential respondent. The consequence is that most persons are forced to rely very largely on public image. This image has traditionally been based on reputation gained from the past experience of the individual in need, his friends, or the recommendation of another responding agent such as a family physician.

Paralleling this is the weighing of access probabilities. In other words, an individual in need must find someone who is willing to provide assistance. This weighing process begins when the individual develops an awareness of the filtering or regulating principles that are being employed by appropriate respondents in accepting new responsibilities. The four predominating principles seem to be: the ability to pay for services rendered, membership in an organization that the respondent is under contract to serve, the acceptability of the individual to the provider, and the good Samaritan obligation to care for the helpless. Once the regulating principle is recognized, the individual is then in a position to build probabilities of acceptance around his ability to put together the proper set of credentials and resources in relation to that principle.

Whether in the end the individual gives up or is rejected by the respondent, the individual must still re-evaluate himself if physically capable, and his remaining alternatives. Perhaps his health standard is too high. Perhaps he will have to accept a new reality in his health state. Perhaps he will have to do something to change the responding system to make it more receptive to the needs and problems of people in his particular situation.

d. The System's Response to the Emergent User. The fundamental difference between emergency medical systems and the general system for the delivery of health care lies in the access criteria used. Unlike private medicine, which employs an economic criterion, emergency facilities have obligated themselves or have contracted, to care for the helpless under the social responsibility principle. The difficulty with applying this principle, however, lies in determining who are the legitimately helpless. Medical personnel traditionally define emergency medical helplessness as a major physiological or psychological incapacity of individuals to care for themselves. Challenging this interpretation are those who claim that such incapacity is too narrow a criterion for the realities of modern life. This may explain the uncertainty and confusion surrounding the use of emergency medical facilities despite the introduction of filtering schemes by medical personnel seeking to regulate the flow of self-defined emergencies.

The Individual Health Self-Management Model (Figure II-E-1) was developed to serve as an analytical tool for understanding health problems by focusing attention on how entry into health care may take place, thus building an appreciation of how broader environmental forces have an effect on entry into emergency medical care.

2. The Respondent Network: Interaction Analysis

In this framework, emergency medical systems are viewed as an interaction between users (patients and victims) and the network of respondents. The term "network of respondents" is used very deliberately to emphasize that even in those instances exhibiting the greatest integration to date, emergency medical care is made available through the fragmented elements of what could be conceived as a "system." The differences between a highly integrated and a disjoint "system" is the degree of fragmentation. Perhaps the best description of emergency medical systems at present is that they are a network of differentiated, specialized response organizations that coordinate at their interfaces for throughput of patients assessed to be medical emergencies. For all other purposes the elements or subsystems are autonomous or semi-autonomous organizations, even if not completely independent. In relation to their institutional environments each is pursuing its own objectives and seeking to maximize its own objectives. Such a throughput system is fragile indeed, and that it performs at all in medical emergencies is to the credit of those operating in each subsystem.

Of course, such fractionated nonsystems exact a price from resource providers as regards effective utilization of facilities. They also exact a price from the patients or victims in exhibiting a very slow rate of technological advance and in poorly matching patients' needs to the most appropriate response agency.

When examining how the various component units perceive emergencies, it is important to keep in mind the growing change in expectations of patients. Basic to our appreciation of the respondent network is that emergency medical care, as defined by the patient or victim is increasingly perceived as a right available from society. Emergency care as an integrated system is seen to be available as needed, rather than as a collection of subsystems each carrying out its functions, whether efficiently or otherwise. The expectation is growing that these health care services will be available to suit needs of users rather than providers as to time, manner, and place.

a. Viewpoints of the Medical Emergency. Doctors, hospital administrators, ambulance personnel, payers, victims, and lay persons who assist have differing perspectives on the medical emergency. In most cases, these perspectives reflect the regulating principles which the actors use to delimit their participation in the event.

- Doctors: an emergency is a medical event brought to the doctor during his duty hours that is life-threatening or threatening of disablement to the victim.
- Adminstrators: an emergency is an event at the door of the facility that requires emergency medical care and that the hospital is organized and equipped to evaluate and treat.
- Ambulance personnel: an emergency is an event to which an ambulance is called and dispatched. The service links the distressed person to definitive care.
- Third-party payers: a medical emergency belongs to that class of events for which there is (a) an insurable interest, a computable risk exposure, and a mechanism for collection of payment; and (b) support provided on behalf of society to its members in need.

- Victim and involved laymen: a medical emergency belongs to that class of events having any mix of the characteristics of stress--pain, unconsciousness, anxiety, and uncertainty. It may be somatic or psychological, and of recent or ancient origin.

b. Components of the Respondent Network. The components of the respondent network can be grouped into (1) detection-communication, (2) transfer-transportation, (3) stabilizing care, (4) definitive care, and (5) administrative support (public agency, insurers, etc.).

The domain of the communication component is to activate the transportation and care components by notifying them of an emergency. The domain of the transportation component is to deliver the distressed person to receiving centers or emergency rooms as quickly as possible through the efficient allocation and routing of ambulances. If the assumption is accepted that diagnosis begins with the recognition of an emergency, the communication, transport, and receiving subsystems can be combined into a single linking subsystem with an encompassing objective of reducing the gaps between notification, diagnosis and therapy.

Affecting the care components is that initial diagnoses or entry decisions are almost always made by laymen--the distressed individual himself, or other laymen, policemen, firemen, etc. Most frequently stabilizing care, which could be attached to the transportation component, is kept with the definitive care component because of failure to employ available technology, to provide for appropriate competence in on-scene personnel, or to overcome the jurisdictional boundaries between definitive care personnel and others.

The treatment of medical emergencies requires the expenditure of some kind of resources by the transportation and care components, which require reimbursement if the emergency medical system is to continue. However, in emergencies, the responding agents cannot require a contractual agreement before providing service. Consequently the maintenance of the system necessitates a mediating support subsystem to make the necessary reimbursement arrangements between distressed persons and agents.

Table II-E-1 shows estimated national resource flows for emergency medical activity for 1969, grouped by technologies where the data permit. Missing from the flows are the utilization of communication linkages and private physician visits. Care should be exercised in interpreting these flows to a finer level than indicated in the aggregations. There are wide variances in demand between urban, suburban, and rural areas, as well as between states. For example, California reports[1] that 32 percent of ambulance trips in rural areas are for nonresidents, whereas for urban areas the figure is five percent. Also, the State of California has one-half the ambulance utilization rate of the nation as a whole. New York City reports the following variances between two urban and suburban hospitals:[2]

ER Activity	Ratio of Urban to Suburban
Trauma	1 to 9
Eye, ear, nose & throat	4 to 1
Billing to welfare	12 to 1
Government financial assistance	3.7 to 1
Private or employer insurance	1 to 3
Presentation within 0-11 hours	1 to 4.5
Private care for transportation	1 to 11

The urban hospital was a 713-bed voluntary institution located in a low-income residential area of apartment houses and tenements, somewhat removed from the mid-town area of Manhattan. It did not operate an ambulance service. The suburban hospital was a 268-bed voluntary institution located in a middle-upper income suburb of single-family residences at some distance from the heart of the city. It maintained an ambulance service that covered a rather wide geographic area, including three major expressways. The wide variances show the

[1] California Department of Public Health, California Ambulance Survey--Final Report, Sacramento, California, 1971.

[2] Torrens, P. R., M.D., and Yedvab, D. G., "Variations Among Emergency Room Programs: A Comparison of Four Hospitals in New York City," Medical Care, 8:1, January-February, 1970, pp. 113-116.

TABLE II-E-1

1969 ESTIMATED NATIONAL RESOURCE FLOWS FOR MEDICAL EMERGENCIES IN TERMS OF ER VISITS AND TRANSPORTATION

DISTRESSED PERSON

Age Group	65 and older		19 to 64		0 to 18	
Percentage	7%		53%		40%	
Incident Type & Subtype	Accident	Non-Accident $496 (62%)				
		Psychiatric	Patient Lacking Family Doctor	After Hrs Sub. For Family Doctor	Primary Medical Care--Indigent	Private Patients of Member Doctor
ER Charges ($M)	$304	$40	$168	$128	$64	$88
Visit Percentage	38%	5%	21%	17%	8%	11%

TRANSPORT LINKAGE

Mode of Transportation	Driven by Self, Kin, or Friend	Public Trans. or Taxi	Private Ambulance	Public Ambulance	Ambulance Dry Runs	Undetermined
Cost ($M)	$30	$1	$130	$195	$32	
Visit Percentage	76%	5%	4%	6%	2%	9%

Motility on Arrival	Carried In	Walked with Help	Walked without Help
Visit Percentage	22%	12%	66%

Motility vs. Sickness: Only 10% of those who walk in are as sick as those who are carried in.

Ambulance vs. Sickness: Only 9% of ambulance transports are nonurgent or nonemergent.

Condition upon Arrival	Emergent Requires Immed. Att'n	Urgent Requires Att'n in Hours	Non-Urgent Unplanned, Not Acute	Scheduled Planned in Advance
Visit Percentage	10%	50%	30%	10%

TREATMENT

Disposition	Admitted or Transferred	Treated, Sent Home Without Inst'ns to Return	Dead on Arrival	Treated and Told to Return	Treated and Referred to Private M.D.	Treated and Referred to OPD
Visit Percentage	15%	34%	1%	3%	41%	6%

SUPPORT

Source	Federal	State and Local Government	Patient, Employer or Insurance Agency	Absorbed by ER Facility
ER Billing ($M)	$48	$120	$600	$32
Visit Percentage	6%	15%	75%	4%

NOTE: Owing to the nonavailability of data, costs of private treatment and communications are not included.

Estimates in this table are derived by calculation and extrapolation of data contained in the following studies: Gibson, G., Bugbee, G., Anderson, O. W., Emergency Medical Services in the Chicago Area, Center for Health Administration Studies, University of Chicago, Chicago, Illinois, 1970; Torrens, P., M.D., and Yedvab, D. G., "Variations Among Emergency Room Programs: A Comparison of Four Hospitals in New York City," Medical Care, 8:1, January-February, 1970; "Emergency Types and the Non-Emergency Deluge," in A Collection of Cover Stories from Medical World News, New York: McGraw-Hill, 1971.

adaptability of the emergency room as an institution to the differing environmental conditions that influence treating, linking, and support subsystems.

Analyses that obscure these important differences in activity also obscure significant system adaptations and constraints. However from the data of national resource flows, certain aspects of the system emerge:

- Transportation to emergency room ($M):

Formal direct servers	$325
Formal indirect servers	$ 1
Informal servers	$ 30

- Emergency room treatment ($M)

Public payers	$168
Private payers	$600

- The system as a formal indirect agent (by providing nonurgent and scheduled health care) ($M): $350
- The system as a formal direct agent for emergency medical needs ($M): $775

That there are various forms of arrangements of emergency medical services is obvious. Some rural communities have only a doctor, his car, and his office. Others have a community hospital and some forms of private or municipal transportation, which may limit services to local residents. Some large cities have an extensive system of ambulance services, central call and dispatching systems, and medical centers with treatment guaranteed to any individual in need. Other cities provide only a minimal degree of support to an extensive entrepreneurial arrangement of services. There is no such local or national object as an emergency medical system in which the parts share in well-defined, agreed-upon goals and coordinated programs for reaching them, and in which the parts all rely on the same constituency for support and reference. In all instances of emergency medical care delivery, important parts of the arrangement are borrowed from portions of other systems. The doctors, payment sources, facilities, and criteria for service are always taken from surrounding health care systems within the environment. At best, emergency medical care is a partially coordinated collection of borrowed and separately managed parts. In no way does it resemble a fire or police department, except in the presumed urgency of its mission. Its wholeness is that of the image and expectations we hold for it. In every other respect, emergency medical care is a nonsystem. It neither controls its policies, its resources, nor its technologies. These observations will be further developed and their implications explored in later sections of the analysis.

c. Principles of Relation and Regulation. The distressed person faces an emergency medical system described as consisting of partially autonomous components. Each of these portions of the system, represented by its respective technologies and objectives, confronts the others, usually cooperatively, sometimes aggressively, but almost always with a differing view of the patient. It is no coincidence, for example that only two percent of the ambulance services in the country are operated by hospitals. It is also no coincidence that, except for a few communities, doctors and interns no longer ride ambulances. It is to be expected in the present system that an ambulance company wishing to install EKG monitoring and transmitting equipment in its vehicles will have difficulty persuading hospitals to install and man the matching system. It is not unexpected that the insurance industry has taken so long in covering ambulance fees, nor that the 911 dialing system has remained in a state of awkward infancy.

There are two principles of regulation that are followed by all service systems, regardless of whether they function as linkages, offer treatment, or provide support. The first principle springs from the necessity to survive. It is addressed to the clients of the service, and through the image it projects toward those clients it says, "We invite you to depend on us (for message relay, for ambulance service, for first aid, for medical care, or for financial support)."

The second principle comes from the fact that any service system performs a transformation on some entity, usually the client himself--but in some manner always important to the client. Yet providing this service consumes resources of the service. Therefore, unless the resources are seen to be renewed through services rendered to the clients, there is a move to regulate demand so that resources will not be so depleted as to reduce capacity to continue. The second principle is not projected. Its dimensions are not apparent to the naive user, and many of its details may never come to the attention of the experienced user of the system. Therefore, distressed persons, to varying degrees, are unaware of the screening or filtering procedures applied to them, and the explicitness of the procedures is manifest only at the moment when service is denied or made conditional: "We reserve the right to refuse you service (because you cannot pay our bills, have no regular job, have arrived after hours, are not a member of our community, are not having a true emergency, and so forth)." The principle operates not only in a refusal to serve, but also inhibits the request for service because the distressed person may not know that he could qualify. In this way, the second principle not only serves to regulate the demand generated by the first principle, but also counters the image of the first principle by obscuring the specific services provided. The bind placed on the client invites the following strategy on his part: "I will exaggerate my claims on the system in terms of need and distress, exaggerate my qualifications for service, or seek to be accepted as a client by the system." The individuals experiencing emergent awareness largely define the complaint and give it, consciously or not, the urgency and attention-getting quality that will enhance responsiveness from the system. The search by the client for appropriate means for admittance to the system is an important aspect of the expenditure of system resources. A doctor may be called to make arrangements for transportation and admittance. Free ambulance service may be obtained with the knowledge that arrival by ambulance can bring more immediate attention. Through selective expression of need and association with parts of the system, the victim or his first agent acquires acceptance for an initial rapid response by another part of the system. It is only later that expert screening ascertains the relative somatic, psychological, and environmental needs of the patient.

F. MISMATCHES AND GAPS, AND IMPLICATIONS FOR CHANGE

The mismatches and gaps in the present emergency medical system are of two types: those that keep emergency medical systems the way they are, or make it very difficult for them to change, and those that inhibit their more effective operation at present. If we turn to those that inhibit more effective operation, we find that they seem to be related to demographic characteristics of a locality, fractionation of components of the emergency medical care system, and publicly held concepts or images of what is effective in providing medical care in emergencies. Let us review these in reverse order.

1. Enduring Views of EMS

Publicly held images of affective emergency medical care systems see them as consisting of highly competent experts performing segregated functions with great speed. This view supports racing ambulances to and from scenes of emergencies to bring victims to centers where experts can render definitive care. Missing is the realization or appreciation that many time-critical tasks can be performed on-scene if the necessary transfer of skills has been made from the emergency room to the on-scene actors (technicians, paramedics, etc.). The image of competence, while very comforting, masks the fact that the rapid advance of medical science requires considerable deep skill training to master the substantial number of response capabilities that are needed at the scenes of true emergencies. Lastly the image of emergency medical systems as Good Samaritan's who will always be there removes public pressure as a force for change.

2. Fractionated Subsystems

There are numerous gaps and mismatches in the emergency medical care system that are associated with its fractionation. These are complicated by the fact that emergency care functions bear the burden of providing first-instance direct health care overflowing from the larger, comprehensive health care "non-system" of which the emergency system is a part. Nowhere can there be said to exist a fully integrated system; the best examples merely have fewer discrete subsystems. In the worst instances all subsystems are autonomous--some privately owned, some public, and other simply independent non-profit. In such instances there are differing objectives within each subsystem and attendant mismatches as to resources collected and utilized by each. Agreement on objectives and such coordination as is developed is far too frequently based on political (rather than medical or technological) considerations insuring continuation of the existence of the subunits. There are discontinuities in care for a patient who becomes a victim of arrangements made between fractionated functional semi-autonomous units, usually for purposes other than the most effective and expeditious rendering of treatment.

Fractionation of the care system can at best only produce suboptimization of performance of both the units and total system, accompanied by waste of resources. Resources are wasted through underutilization of facilities, which in cities is not infrequently a result of the competitive buildup of facilities, equipments, and functions. Resource losses to the community or region also occur because a wide spectrum of response competences is not built up when there are many small units, particularly if each performs only some of the necessary response functions in rendering emergency medical care. It also contributes to the flowering of well-intended developments, such as cardiac care ambulances, among others, that further contribute to the dispointedness of emergency medical systems and fractionation of on-scene care.

Utilization of personnel in short supply is difficult to maintain in fractionated subunits. Functions, duties, and activities cannot be reallocated, which contributes to under- or over-supply of needed competence. This further makes it difficult, if not impossible, to develop meaningful new occupations and careers to help with the manpower shortage. Where functions and duties have been broken off from physicians (and nurses in a few instances) truncated occupations not leading anywhere have resulted. Certainly the development of new health manpower careers will not hasten the integration of the fractionated nonsystem. Such developments are in the hands of higher level systems. The movement to develop comprehensive emergency-paramedic careers will not proceed except in odd instances, since no one of the fractioned subsystems feels it can bear the development costs.

Even in these instances, given fractionation of units, it has been extraordinarily difficult and costly to maintain competence and to maintain the social system itself, as witness the high turnover of ambulance personnel. How, for instance, can a emergency medical care paramedic maintain the considerable skills he has to acquire and what future can he look forward to for himself in the health care system as he becomes more competent? Can his skills and future career opportunities be maintained if he is not integrated into the work of the emergency room? If he is to be so integrated, what of the separation between emergency rooms and ambulance services? In fractionated subsystems, who is to decide what new skills are needed and when appropriate competence is achieved? Lastly fractionation has made licensing and accreditation practices rigid, protective of the status quo, and nonresponsive to innovations.

A gap also exists with respect to technological devices and systems, and even simple devices that would enhance effectiveness of small units are not in use. Technological innovations appear to be difficult if not impossible to diffuse among large numbers of fractionated units. Innovators cannot provide demonstrations with adequate evaluation because of widely differing organizational forms existing in each location. Two significant consequences result from this state of affairs. First, technological devices flourish that focus on fractionated function, usually making a marginal contribution to system effectiveness. Innovations addressed to system operation, and so having the greatest potential for system improvement, are retarded in development or held in abeyance awaiting nonexistent opportunities for trial. It is not difficult to forecast discouragement of technological innovation. The retardation of technological innovations is related to their dependence on integrated systems for application. We may expect the retardation of development of total system information support by radio linkage between physicians, paramedics, nurses and hospital emergency and cardiac care units, which is so necessary to raising the level of emergency care that can be provided to victims. Further, fractionated units cannot provide the base for necessary investment in the development of technological innovations, nor the costs of the internal reorganization and retraining that a new technology often requires. So the emergency medical care system remains relatively impervious to new technology and will probably continue to do so as long as it remains a fractionated nonsystem. The exceptions, of course, are the unifunctional technological innovations that, while likely to improve a single activity, usually provide only marginal improvement for the system and may have negative total system effects.

Localities with low density demographic characteristics may need to overcome fractionation at a higher level, i.e., between emergency medical system and other emergency services such as police, sheriff, and fire agencies. One such form of useful integration is suggested in the report of the Helicopter Demonstration.

3. Inhibitors to Change

Lastly turning to those forces that keep emergency medical systems the way they are or make it very difficult for them to change, we found a number that particularly deserve rethinking. Among these are the methods of economic reward or of furnishing economic resources to each semi-autonomous subsystem, which supports maximization of strategies that enhance individual economic goals without regard to the total system. In the public arena, emergency services are administratively treated as separate segments, separately supported, which has the effect of maintaining fractionated subsystems.

Within the medical profession, in both the training of physicians and the operation of emergency rooms, emergency medical care is seen as Siberia, to be suffered through and then avoided. Thus is maintained ignorance of both the competences needed to respond to emergencies and of the considerable prospects for improving outcomes for patients by shortening time to treatment through transfer of competence to on-scene performers and through close connections between experts in hospital's emergency rooms, cardiac care units, trauma units, etc., and those working on-scene. Not to be overlooked are the consequences flowing from the fractionated methods of licensing and accrediting various professionals, paraprofessionals and operators of emergency medical care. These reinforce and support segmented practice of emergency medical care, unnecessarily inhibit innovations, and even retard demonstration of the efficacy of innovations already known to be useful.

The implications for changes leading to improved emergency medical systems are implied in this review. The opportunity for significant improvement will lie in finding a situation where there is both a commitment to building an integrated system and plans for successfully facing the severe complications of overcoming, dismantling, or combining the various fragmented subsystems.

III. EVALUATION OF EMERGENCY MEDICAL SERVICE SYSTEMS

A. STATE OF THE ART IN RESEARCH AND EVALUATION

The state of the art in research and evaluation of on-going public systems is plagued by a number of particular difficulties. Some of these arise because the system under study is an on-going social system in which changes are frequently non-reversible. Others arise because of data problems which are of two types: (1) the data about the variables of interest are either unavailable or exist in incomplete form and, (2) the conditions under which we wish to study the variables do not exist and must be created, if this is possible, if relevant evaluation is to take place. Most frequently, since the conditions, i.e., organization design, functions, etc., do not exist, secondary data taken from various parts of the system are used to achieve a hoped for approximation of the system desired. The consequence is that the actual conditions desired to be studied and evaluated are only inferred. Another way of saying this is that we must first change an existing system to introduce the conditions desired, permit them to be exercised so that evaluation can then be undertaken.

This method of doing research which has been evolving for some time in the social sciences is known as action research. It includes but is more extensive than the conduct of demonstrations and evaluation of their outcomes for it includes prior analysis of which conditions to change before testing them in a demonstration. The particular requirements imposed on the action researcher may be seen in the following taken from a report on research on on-going organizations:[1]

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[1] Social Research and National Policy for Science, Tavistock Institute of Human Relations, Pamphlet No. 7, London, 1964.

In the natural sciences, the fundamental data are reached by abstracting the phenomena to be studied from their natural contexts and submitting them to a laboratory. It is only some time later that possible application may be thought of, and it is only then that a second process of applied research is set under way. The social scientist can use these methods only to a limited extent. On the whole he has to reach his fundamental data (people, institutions, etc.) in their natural state, and his problem is how to reach them in that state. His means of gaining access is through a professional relationship which gives him privileged conditions. The professional relationship is a first analogue of the laboratory for the social sciences. Unless he wins conditions privileged in this way the social scientist cannot find out anything that the layman cannot find out equally well, and he can earn these privileges only by providing his competence in supplying some kind of service. In a sense, therefore, the social scientist begins in practice, however imperfect scientifically, and works back to theory and the more systematic research which may test this and then back again to improved practice. Though this way of working is well understood in the case of medicine, it is not so well understood, even among social scientists, that the same type of model applies to a very wide range of social science activities. The model may in fact be called the professional model...

(One) advantage of following the professional as compared with the pure-applied model is that it allows the problems studied to be determined to a greater extent by the needs of the individuals, groups, or communities concerned than by the social scientist

> himself. This is not, of course, to say that presenting symptoms are accepted at their face value or that the client's prescription is obediently followed. The professional role implies interpretation and redefinition...
>
> ...there is, of course, a great difference between simply acting as a consultant and acting as a researcher in a role where professional as well as scientific responsibility is accepted. In the first case there is no commitment to the advancement of scientific knowledge, either on the part of the consultant or on the part of those for whom the inquiry is being made. In the second case this commitment is fundamental and must be explicitly accepted by both sides. It is this that makes the relationship truly collaborative. Though far from all social science research needs to follow such an approach, it is unlikely that the study of change processes, and of dynamic problems more generally, can be extended without it...

The pattern of engagement by the EMS Project, with levels of government, organizations and individuals, was that described above as the action research model. Our participation was given willingly, whenever needed, to develop the professional relationship that would earn for the Project the kinds of privileged conditions, which were needed for collaborative efforts. The levels of government, organizations and individuals with whom we engaged came to understand that they were not simply "objects" of our research but that we were engaged in collaborative developments.

B. ISSUES IN HEALTH SERVICE EVALUATION

Administrators and legislative bodies must make decisions about the allocation of scarce resources. Health-related services compete for resources with other services and activities. Is it "better" to spend money on health-related services or on national defense? Within the health system, there is competition between problem areas. Is it "better" to spend money on problems of cancer or on those of traumata produced by traffic accidents? Within a health problem, there is competition between prevention and treatment. Is it "better" to spend money to reduce traffic accidents or to improve the system for delivering emergency medical care to victims of traffic accidents? Within a treatment service such as emergency medical service (EMS) system, there is competition among the component activities. Is it "better" to train emergency medical technicians or to develop a command and control system for the management of emergency medical resources? For a given activity, within the EMS system, there is competition among the alternative means of its performance. Is it "better" to transport emergency care personnel and victims with a mixed fleet of helicopters and ground vehicles or with a fleet composed solely of ground vehicles?

At each level, the answer to the question of what is "best" requires a method of evaluation. Issues involving competition among functions rarely reach the stage at which one or more of the functions is eliminated. Few dispute that we need to provide both health services and national defense. The method of evaluation must facilitate the search for answers to questions about the relative amounts of support for the various functions. Issues involving alternative means of performing a given function, however, typically require that we identify the "best" means and reject all the alternatives that it dominates. The approach that we advocate for the evaluation of emergency medical service systems is designed primarily for resolving questions of the latter kind, namely, what is the "best" means of delivering emergency medical services. In addition, it can provide data useful for deciding questions of the former kind--questions about the relative level of support for emergency medical service system as a whole or about allocating available resources among the activities that comprise the EMS system.

C. COMPLEXITIES IN THE EVALUATION OF EMERGENCY MEDICAL SERVICE SYSTEMS

The assessment of EMS systems is complicated by the fact that they are used for purposes other than reducing unnecessary deaths and avoidable permanent disabilities. For example, in our analysis of about 6000 incidents occurring in the County of Los Angeles and involving the use of ambulances, we found that at most 12 percent could properly be classified as true medical emergencies. This figure is roughly comparable to that found in similar surveys.[1]

There are three main dimensions to the expanded role of EMS systems. First, the duration and/or severity of temporary disabilities associated with certain non-life-threatening conditions may be reduced by prompt treatment. Second, society values the alleviation of unnecessary suffering, both physical and mental. Although the treatment of many kinds of injuries can be postponed without affecting the medical prognosis, prompt treatment reduces the anxiety of family and friends concerned for the victim as well as the anguish of the victim. Third, emergency treatment facilities are used by persons seeking out-patient services at hours when out-patient clinics are closed and by the indigent seeking a portal to the medical treatment system.[2] Clearly a central issue is whether or not the multiple use of an EMS system is the most cost-effective way in which to respond to these kinds of needs.

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[1] West, I., _et al._, "Speeding Ambulance Survey: A Preliminary Report," _AID_, September-October 1964, pp. 8-10 and 14.

[2] Weinerman, E. R., _et al._, "Yale Studies in Ambulatory Medical Care: V Determinants of Use of Hospital Emergency Services," _American Journal of Public Health_, 56:7, July 1966, pp. 1037-1056.

Another reality that complicates the assessment of EMS systems is the myriad of autonomous and semi-autonomous public and private organizations that are involved. These operate as part of, or under the regulation of, different political jurisdictions. The private organizations may or may not be under contract to a local government. The almost limitless number of possible combinations and configurations taxes the generality of any evaluative methodology.

D. A GENERAL APPROACH TO EVALUATION

It is most likely that EMS systems will continue to be hybrids that serve nonemergent as well as emergent medical needs and whose elements are drawn from numerous public and private organizations. As a practical matter, the assessment of the nonemergency functions of EMS systems, with the exception of responses made to nonemergent medical incidents that either must be presumed to be emergencies until proven otherwise or that involve nonambulatory victims, can be separated from the assessment of the emergency functions. The noted exceptions require the same chain of responses as do true medical emergencies. Ambulatory victims of nonemergent medical incidents, persons seeking out-patient services, and indigents seeking a portal to the medical treatment system compete with victims of true medical emergencies only for treatment at the actual emergency treatment facility. Even here, operating procedures typically assign preemptive priorities to true medical emergencies.

Our concern is with the assessment of an existing or proposed EMS system in terms of true medical emergencies and of emergency-like medical incidents, namely those presumed to be emergencies or involving nonambulatory victims.

The evaluation of EMS systems, in general terms, is like the evaluation of any other service system. It involves two principal components. The first is that of identifying the demands for services, the input resources, and the outcomes of the existing or proposed system. The second is that of valuing the identified inputs and outcomes.

1. Demands for Emergency Medical Services

One needs to be able to predict the occurrence of incidents that lead to the placing of demands on emergency medical services in terms of their nature and severity, their timing, and their geographic location. The aggregation of such incidents defines the total demand placed on the EMS system. Equally important is how the total demand is divided among the public and private sectors and among the components of each sector.

When alternative designs for delivering emergency medical services are under consideration, it is essential to go beyond the historical demand for such services. Methods and insights are needed for estimating how a given change in an existing system or a given difference between proposed systems will alter the magnitude of the total demand and/or shift its division among the numerous providers of emergency medical services. Techniques for predicting demand as a function of geography, demography, public perceptions and expectations, etc., are discussed in Section C of Chapter VI.

2. Input Resources

The inputs to an existing or proposed system, almost without exception, can be expressed in terms of dollars. The costs of personnel, facilities, equipment, and supplies can be estimated with reasonable accuracy. The estimation of costs depends, of course, on the nature, timing, and location of the demands for services that are placed on the system as well as on the design of the system itself.

Only those inputs of resources should be included in the evaluation that are related directly to the change or alternative under consideration. For example, in the demonstration described in Section VII-B, a helicopter that had already been justified on the basis of aerial fire surveillance and fire fighting was assigned a secondary role as an air ambulance. In evaluating this demonstration, it was inappropriate to charge any portion of the fixed costs of the helicopter or of the salaries of the pilots and maintenance personnel to the secondary mission. The helicopter had already been purchased and its infrequent utilization as an air ambulance did not interfere with its primary mission. Similarly, no new pilots or support personnel had to be hired. Clearly, however, many costs were incurred as a result of the addition of a secondary role. These included the cost of the litter kits, medical malpractice insurance and "consumables" based on the actual flight time while functioning as an air ambulance. The latter includes a prorated contribution to the costs of engine and airframe parts that are replaced on a time schedule, as well as fuel and lubricants.

3. Outcomes

The outcomes of an existing or proposed system can be conveniently divided into two kinds--namely, direct and indirect. The direct outcomes are those associated with the primary mission of the system. For an EMS system, they can range from complete recovery to the death of the victim, with varying degrees of morbidity and permanent disability in between. These outcomes are mainly functions of three factors: (1) the nature and severity of the victim's injury or illness; (2) the elapsed times from the onset of the illness or the occurrence of the injury to care and treatment; and (3) the nature and quality of care and treatment. The first factor is defined by the demands placed on the EMS system. The last two factors are functions of the operational characteristics of the EMS system itself.

The operational characteristics of most proposed emergency medical service systems are difficult, if not impossible, to estimate in advance. Traditionally, the operating characteristics of a new system or of changes in an existing system are projected in one of two ways. The first is on the basis of a pilot demonstration that introduces a new system or effects changes in an existing system on a limited basis. The results of the pilot demonstration are extrapolated to predict the consequences of the implementation of the change on a full scale. Unfortunately, pilot demonstrations tend to suffer from three serious deficiencies. First, they are expensive and require a substantial period of time to implement. Second, they rarely provide a representative test of the full system.

Distortions can arise in a number of ways. For example, in our cooperative demonstration of mobile intensive care units (see Section VII-A), it was not possible to create career ladders within the Los Angeles City or County Fire Departments for the intensive care paramedics. Participating firemen who became eligible sat for promotion examinations that, if passed, would remove them from their duty assignment as paramedics. The loss during the pilot demonstration of paramedics to other duty assignments, therefore, does not necessarily portend a comparable attrition under full implementation (which would include appropriate career ladders for paramedics).

Third, it is unfortunately true that in too many cases the data collected during a pilot demonstration of a prototype system are totally inadequate. At the end of the trial period, advocates of the change (typically those who proposed it) and opponents alike still feel that their initial views are correct. Sometimes one or both sides can find a few facts to bolster its contentions. Largely, however, the predictions by both sides are based on impressions or beliefs, not on data.

When feasible, direct analysis of proposed systems is the quickest and least expensive method of predicting operational characteristics. The Computerized Ambulance Location Logic model described in Section IV-A is an example of such an analytical tool. Given the geographical pattern of incidents resulting in medical emergencies, the model predicts a number of important operational characteristics of emergency medical vehicles as a function of their locations (base stations). These include the distributions of time to the scene, time to the emergency medical facility, and the utilization of each emergency medical vehicle. The present state of analytical models and solution methods simply does not permit one to deal with systems much more complex than this.

It was to predict the operational characteristics of systems amenable to direct analysis that the computerized EMS system simulation package described in Section IV-B was developed. This package has been designed to be extremely general. It can be tailored to mimic almost any existing or conceivable system for delivering the extra-hospital aspects of emergency medical care.

Indirect outcomes of an existing or proposed system are its secondary consequences, whether intended or unintended. With regard to existing systems, they frequently go unnoticed; with regard to proposed systems, they are frequently unforeseen. Secondary consequences take many forms. They may be as obscure as the psychological impact of a fire rescue vehicle being called from the scene of a fire and arriving with its crew begrimed and smelly at the scene of a medical emergency involving a citizen.

4. Valuing of Inputs and Outcomes

Valuing is a subjective process. The decision made must ultimately assess an existing system and potential alternatives to it in terms of the inputs and outcomes. Typically, inputs and outcomes are expressed in different units that cannot be directly compared. After analysis, what can be supplied to a decision maker are estimates of the costs (inputs expressed in dollars) plus the set of outcomes (direct and indirect) that are associated with each system, existing or proposed. The set of outcomes is the most difficult to value. The direct outcome of greatest interest is an increase in the number of victims who survive life-threatening medical emergencies. Next in importance are the duration of suffering, duration of morbidity, and the final condition of survivors ranging from complete recovery to permanent disability. Traditionally, an operational characteristic--the elapsed time from the onset of the illness or the occurrence of the injury to care and treatment--has been used as a surrogate for these direct outcomes. Clearly, it is an appropriate measure for the duration of suffering. It is a quite inadequate measure, however, for the other outcomes. The relationship between the elapsed time to care and treatment and the medical outcome, other things being equal, differs markedly with the kind of illness or injury and its severity. A preliminary study of these relationships is described in Section VI-D. Once a large-enough data base is available, definitive models can be developed that relate the kind of illness or injury, its severity, the elapsed time to treatment, and kind of treatment to medical outcomes.

E. SUMMARY OF PROPOSED METHODOLOGY FOR EVALUATION

A procedure has been proposed by which a large number of the potential alternative systems for delivering emergency medical care can be explored and evaluated quickly and inexpensively. The procedure requires three components:

- Models that predict the nature and distribution of demands for emergency medical services under the EMS system of interest.
- A simulation model capable of generating estimates of the operational characteristics of the EMS system of interest.
- Models that relate the kind of illness or injury, its severity, and the operational characteristics of the EMS system of interest to medical outcomes.

Examples of studies of the kinds necessary to produce the demand models of the first requirement are described in Section V-A. A simulation model for the extra-hospital aspects of emergency medical services, which fulfills the second requirement, is described in Section IV-B. Examples of studies of the kinds necessary to produce medical outcome models (the third requirement) are described in Section VI-D.

The procedure enables a community to input to the simulation model a representative pattern of its medical emergencies, in terms of kinds of illness or injury, time, and location. The simulation model configured to mimic a specific kind of EMS system would generate the operating characteristics of that system. The models that relate the time-to-treatment and kind-of-treatment relationship to medical outcomes would then be used to estimate the number of victims who would die and the number who would survive.

Only two additional sets of data would be needed. Estimates would be required of all relevant costs. These would include the costs of implementation, as well as the operating costs once implemented. Finally, the indirect outcomes, including the "political" costs and other consequences of implementation, as well as the secondary consequences of operation, would have to be anticipated.

In the face of such mixed "packages" to choose among (and even to do nothing is to make a choice), how does a planner make a recommendation or an administrator or legislator make a decision? There are only two cases in which the choice is clear-cut. First, if two sets of outcomes (direct and indirect) are, in essence, identical, but the inputs are different in total cost, one should choose the alternative with the lower cost inputs. Second, if the two sets of inputs are the same in total cost, and the differences between the two sets of outcomes are all viewed as being in a favorable direction for one of the alternatives, choose that alternative. Unfortunately, these two circumstances rarely, if ever, occur. Instead, the decision maker is faced with the task of choosing between alternatives that differ in the total costs of their inputs and in their sets of outcomes, with some of the differences in outcomes being viewed favorably and others unfavorably with respect to each of the alternatives. At this stage, the personal preferences of the decision maker permit him to screen a large number of alternatives so that if the need was felt to do so, one or a few could be examined by prototype testing. At this stage, pilot demonstrations can be conducted of systems that have a high probability of being effective and efficient. In addition to data about inputs and direct outcomes, pilot demonstrations (perhaps uniquely) can yield information on an indirect outcome of the unanticipated variety.

A good evaluation is one in which the inputs and outcomes that are associated with each alternative (including doing nothing) are identified as fully as possible. The indirect outcomes are the hardest to identify. They are nevertheless crucial. Frequently it is the unintended consequence, whether viewed favorably or unfavorably, that results in a decision being judged, with 20-20 hindsight, as good or bad.

IV. METHODOLOGICAL DEVELOPMENT

A. ANALYTIC

1. Computerized Ambulance Location Logic (CALL)

Results of computer simulation experiments conducted by Fitzsimmons[1] and Savas[2] show that a significant reduction in emergency ambulance mean response time can be achieved by improving the deployment of the ambulances. However, the problem of determining the optimal deployment of ambulances is not trivial. As an example, we can consider the experience of the Los Angeles City Fire Department, which was directed by the L.A. City Council in 1968 to assume responsibility for operating a fleet of 14 emergency ambulances. A survey of the firehouses in central Los Angeles identified 34 that could accommodate one ambulance and crew. The Fire Department was faced with the problem of selecting from these 34 the ones to be used to station the 14 ambulances placed under their control. The number of possible combinations from which the selection might have been made is approximately 1.4×10^9, an incomprehensibly large number to consider, even when the obviously inadmissible deployments are eliminated.

Clearly, it would be useful to have an efficient and general method for solving problems of this kind--a method that selects the optimal deployment from the set of all possible ambulance assignments. The use of computer simulation for this purpose is computationally prohibitive

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[1] Fitzsimmons, J. A., Emergency Medical Systems: A Simulation Study and Computerized Method for Deployment of Ambulances, Ph.D. Dissertation, Graduate School of Business Administration, University of California, Los Angeles, 1970.

[2] Savas, E. S., "Simulation and Cost-Effectiveness Analysis of New York's Emergency Ambulance Service," Management Science, Vol. 15, No. 12, August 1969, pp. B-608 through B-627.

and provides no assurance of optimality. An analytical model of the emergency medical system that would predict mean response time for any given ambulance deployment was needed. This model could then be used with an optimum-seeking search routine to identify the near optimal ambulance deployment. The model would be an abstraction of the real system based on a definition of the emergency medical system in which only the most important features affecting response time were included.

An emergency ambulance system can be defined by the sequence of events that begins with dispatcher notification of a medical emergency and ends with the transfer of the patient to an emergency medical facility for definitive care. Figure IV-A-1 describes the typical sequence of activities that a patient experiences in an emergency ambulance system. The time elapsed from notification of an emergency until an ambulance arrives at the scene is identified as response time. Response time is an important performance criterion for emergency ambulance systems because the probability that death or permanent disability will result from a trauma can be described as a function of the time to treatment.[1]

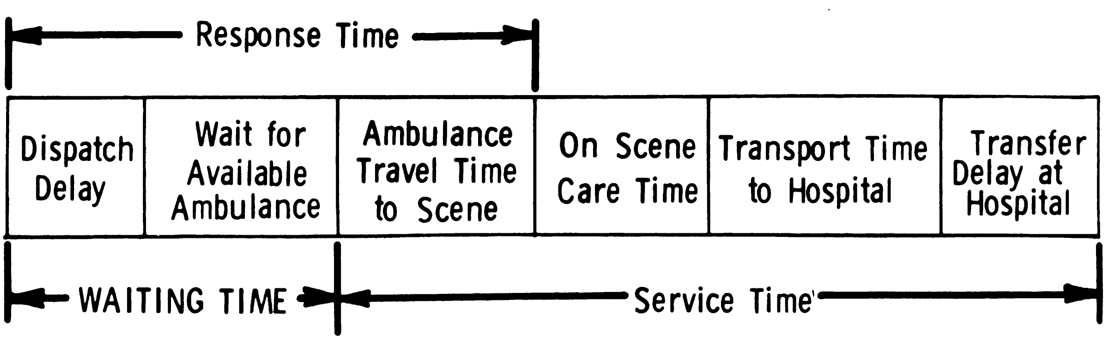

FIGURE IV-A-1

SEQUENCE OF EVENTS IN PATIENT SERVICE

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[1] Andrews, R. B., Criteria Selection in Emergency Medical System Analysis, EMS Working Paper No. 1, University of California, Los Angeles, June 1969.

Some of the events in Figure IV-A-1 are identified as waiting and others as service, suggesting that the emergency ambulance system can be thought of as a queuing system with one or more mobile servers. Using this conceptual framework, an analytical ambulance response model was developed to evaluate the mean response time for a variety of different emergency ambulance system configurations. Using an optimum-seeking computer search routine with the analytical model, the ambulance deployment methodology CALL (Computerized Ambulance Location Logic) was developed. CALL permitted the deployment of the 14 ambulances of the Los Angeles City Fire Department in such a way as to minimize mean response time.

a. Description of CALL. Recall from Figure IV-A-1 that response time consists of three components: (1) dispatch delay, (2) waiting for available ambulance, and (3) travel time to scene. Results from computer simulation experiments and field studies indicate that response time may be considered as, essentially, travel time to scene. The short delay to locate the appropriate ambulance for dispatch is insignificant and, because it is experienced by every caller, need not be explicitly considered. Simulation studies show that waiting for a busy ambulance to become available is negligible because the probability of finding all the ambulances busy is essentially zero. (A major catastrophe would be an exception.) Further simulation results show that response time for a particular call depends on the state of the system when the call is received. Often, when a medical emergency occurs, the ambulance that would normally be assigned may be busy; therefore an idle, but more distant, ambulance is dispatched. This phenomenon makes the response time dependent on the number of ambulances busy when the call is received. Finally, two remaining observations concerning emergency ambulance systems are of interest: The arrival rate of emergency calls was found to exhibit a Poisson distribution based on data collected by the City of Los Angeles. And the number and location of hospitals have an indirect effect on response time by their direct influence on retrieval time, a component of ambulance service time. The larger the ambulance service time, the more likely it is that a call will be received while the ambulance is busy.

These observations provide the justification for using the $M/G/\infty$ queuing model as an approximation of the actual emergency ambulance system. This queuing model describes a system in which the arrival rate is Poisson-distributed, the service time may have any distribution, and no waiting occurs because the available servers are infinite in number. Parzen[1] derived the following result for the probability distribution of the number of busy servers in such a system:

$$P(i) = \frac{e^{-(a/s)}(a/s)^{i}}{i!} \tag{1}$$

where: a = Mean arrival rate

s = Mean service rate

i = Number of busy servers

e = Base of natural log

Thus, for a queuing system in which no waiting occurs, the number of busy servers (or state of the system) is Poisson-distributed with mean equal to the ratio of mean arrival rate to mean service rate. The mean response time for an ambulance system can therefore be calculated by determining the conditional mean response time for each system state and then weighting each by the probability of the state's occurring. (For notational convenience, the quantity a/s will be denoted in subsequent equations by "m".)

As an example of the use of the model, consider the hypothetical emergency medical system depicted in Figure IV-A-2. The system contains two ambulances, each with an average speed of 30 mph; there is one centrally located hospital. Consider the mean incident

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[1] Parzen, E., Stochastic Processes, Holden-Day, 1962, pp. 144-148.

arrival rate to be 15 calls per day with a uniform incident location pattern throughout the 64-square-mile service area. The travel distance model used in the calculations is based on summing the rectangular displacement between the x, y coordinate points of departure and arrival. Gordon and Zelin[1] found the rectangular displacement model adequate in describing ambulance movements in urban areas where streets are normally laid out in orthogonal patterns.

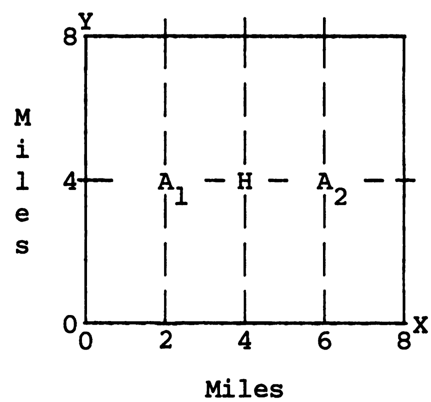

FIGURE IV-A-2

AMBULANCE SYSTEM FOR EXAMPLE USE OF MODEL

A dispatch policy of sending the closest available ambulance is used also. Finally, consider the on-scene care time to be a constant seven minutes and transfer time at the hospital to be a constant three minutes. The following additional notation is adopted for calculations based on the model:

R (System State)	=	conditional response time for system state
RBAR	=	mean response time
RET	=	mean retrieval time (i.e., transport time to hospital)

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[1] Gordon, G. and K. Zelin, "A Simulation Study of Emergency Ambulance Service in New York City," IBM New York Scientific Center Technical Report No. 320-2935, March 1968.

RH = mean response time from hospital

C = mean on-scene care time

T = mean transfer delay at hospital

1/s = mean ambulance service time

Recall from Figure IV-A-1 that the service time can be denoted by the following equation:

$$1/s = RBAR + C + RET + T \tag{2}$$

The choice of a uniform incident location pattern simplifies the calculation of the conditional mean response times. The mean travel distance to scene when both ambulances are idle = 2.0 + 1.0 = 3.0 miles.

$$R(\text{Both Idle}) = \frac{(3)(60)}{30} = 6.0 \text{ min.}$$

The probability that either one of the ambulances will be busy is identical and equal to .5 because of the uniform incident location pattern and symmetry of the ambulance locations. The mean travel distance to scene for either ambulance, given that the other ambulance is busy, is (.5)(3.0) + (.5)(6.0) = 4.5 miles.

$$R(A_1 \text{ Busy}) = R(A_2 \text{ Busy}) = \frac{(4.5)(60)}{30} = 9.0 \text{ min.}$$

The mean retrieval distance to the hospital and mean travel distance from the hospital are identical and equal to 4.0 miles because there is a single centrally located hospital.

$$RET = RH = \frac{(4)(60)}{30} = 8.0 \text{ min.}$$

The initial calculation of the mean service time must be an estimate because one component of the service time is, in fact, the mean response time, the very statistic the model is being used to estimate. Because the conditional mean response time for the idle state can be readily determined, it is used in calculating the first estimate of the mean service time. Using Equation (2),

$$\begin{aligned} 1/s &= R(\text{Both Idle}) + C + RET + T \\ &= 6.0 + 7.0 + 8.0 + 3.0 \\ &= 24.0 \text{ min.} \end{aligned}$$

The ratio of mean arrival rate to mean service rate used in Equation (1) can now be calculated.

$$m = a/s = \frac{(15)(24)}{(60)(24)} = .25$$

The calculation of RBAR using Equation (1) and the conditional mean response time is shown in Table V-A-1. A computer simulation model of this hypothetical system estimated RBAR to be 6.67 minutes, which represents a difference of 0.7%.

TABLE IV-A-1

CALCULATION FORMAT FOR EXAMPLE USE OF MODEL

System State	Probability of State	Conditional Response Time	Expected Response Time
Both Idle	e^{-m} = .779	6.0	4.67
A_1 Busy	$(\frac{1}{2}m)e^{-m}$ = .097	9.0	.87
A_2 Busy	$(\frac{1}{2}m)e^{-m}$ = .097	9.0	.87
Both Busy	$1-[(m+1)e^{-m}]$ = .027	8.0	.22
	1.000		RBAR = 6.63

The analytical estimate of RBAR can be improved by recalculating the mean service time using 6.63 minutes for RBAR instead of the 6.0 minutes used originally. In this second iteration, the estimate of RBAR is recalculated to be 6.65 minutes, representing a difference now of only 0.3%.

The ambulance response model clearly can be used for estimating a system's mean response time for any set of possible ambulance locations. The approach used in this location methodology, referred to as CALL (Computerized Ambulance Location Logic), is one of combining the ambulance response model with an optimum-seeking computer search routine. Based on evaluations of the ambulance response model for particular ambulance locations, the search routine directs changes in the ambulance locations with the object of progressively decreasing the system mean response time.

Throughout this study, the pattern search routine developed by Hooke and Jeeves[1] is used. The pattern search routine appears intuitively promising for use in CALL; however, it is impossible to make an a priori selection of the search code that will be most efficient for a particular model. The question of finding the most efficient computer search routine for use with CALL will necessitate further research. For a detailed discussion of optimum-seeking search routines, the reader is directed to Wilde[2].

b. Use of CALL in Planning Emergency Medical Systems. The ambulance response model appears promising as an alternative to computer simulation for analysis of emergency medical systems. Some advantages of its use in lieu of computer simulation include the following: (1) savings in cost of computer processing; (2) minimal input data requirements; and (3) the opportunity to determine optimal ambulance deployment. Furthermore, many policy variations and system configurations can be accommodated. The following examples will illustrate this capability.

Dispatch Policies. A mixture of helicopters and surface vehicles can be accommodated by the use of a special travel time calculation for helicopters reflecting vector flight instead of rectangular displacement. For helicopter calculations, a fixed delay for warmup should also be included. Ambulances may be assigned a predetermined set of response districts rather than being dispatched by choosing the closest ambulance. In this case, a first-in priority table could be established for each district in lieu of searching for the closest ambulance.

Retrieval Policies. Nontransport cases can be accounted for by reducing the mean retrieval time and mean transfer delay

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[1] Hooke, R. and T. A. Jeeves, "'Direct Search' Solution of Numerical and Statistical Problems," J. Assoc. Comp. Mach., Vol. 8, No. 2 (April 1961), pp. 212-229.

[2] Wilde, D. J., Optimum Seeking Methods, Prentice-Hall, Englewood Cliffs, N.J., 1964.

by the appropriate amount. If Code 2 retrieval is desired (no siren and normal speed), then the average speed used in calculating the retrieval time portion of the service time is adjusted accordingly. The use of a special retrieval policy in which a certain percentage of the calls are taken to a specially equipped hospital can be accommodated by adjusting the retrieval time portion of the average service time equation to reflect the longer-than-normal trip.

Deployment Policies. The object of an adaptive deployment policy is to redeploy idle ambulances in response to changes in the state of the system (i.e., when an ambulance is dispatched to a call or completes a call) so that the mean response time to the next incident is minimized. An adaptive deployment policy can be accommodated by assuming that the relocation of idle ambulance is accomplished instantaneously with each change in system state.

Alternative System Configurations. The use of Mobile Intensive Care Units (MICU) in an ambulance system can be evaluated in the following manner. A mixed system of MICU and general-purpose ambulances would necessitate the screening of calls, with dispatch of the MICU only to critical cases. If we assume that the screening process is effective, we can split the total number of calls into separate streams, creating a two-level response system. The model then treats each subsystem independently in its evaluation of the total system's performance.

c. An Application of CALL in Los Angeles. At about the time that research and development of CALL was coming to a close, the Los Angeles City Council decided to make a change in the administration of public ambulance service in the central Los Angeles area. Previously, the service had been under the control of the Central Receiving Hospital. During the year 1968, its service had come under attack because of the handling of several wounded police officers and of the fatally wounded Senator Robert Kennedy. The City Council decided to assign the responsibility for ambulance service in the central city to the Fire Department, which was currently providing that service in the San Fernando Valley area. A survey of the firehouses in central Los Angeles identified 34 firehouses that could accommodate one ambulance and crew each. The Fire Department was faced with the problem of selecting from the 34 firehouses the ones to be used to station the 14 ambulances now under its control[1].

An initial deployment was arrived at by Fire Department personnel based on their desire to "cover" the central Los Angeles area completely. To "cover" in this sense meant that no location in the area would be more than 2½ miles from a firehouse with a rescue ambulance, approximately a five-minute response at 30 mph. This original deployment represented a highly dispersed arrangement.

Fortunately, data had already been compiled on the frequency of emergency calls by census tract for all of Los Angeles for the year 1967. From this information, the probability of a call from each of the 308 census tracts in the central Los Angeles area was calculated. Using an existing municipal grid system on which the centroid of each census tract was identified, the x,y coordinates of the original set of 14 firehouses and 17 emergency hospitals were also determined. This information, together with an estimate of the percentage of non-transport calls, average ambulance speed, average number of calls per day, average time at scene, and average transfer time at the hospital comprised all the necessary input data for the CALL program.

The results from running the program and generating a set of improved locations are reported in Table IV-A-2. The data indicate that more than 3 of the 14 ambulances will be busy, on the average,

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[1]Assistant Bureau Commander W. C. Runyan agreed to have the EMS Project staff apply the CALL routine to the problem of locating these ambulances in the appropriate firehouses.

at any given time. This statistic serves as a partial explanation for the improvement in mean response time produced by CALL over the original plan. Recall that the original plan was developed without explicitly considering the necessity for ambulances to respond outside their immediate districts when a neighboring ambulance is busy on a call.

TABLE IV-A-2

RESULTS OF USING CALL FOR LOS ANGELES SYSTEM

System Statistic	Initial Locations	Final Locations	Percent Improvement
Mean Response Time	3.96	3.68	7.1
Mean Service Time	18.23	17.26	5.3
Mean Number in System	3.46	3.27	5.2
95th Percentile Response	9.43	8.80	6.7
Probability Response > 6 min.	.222	.167	24.8

A consideration of the response time distribution is particularly important to a city administrator who wishes to guarantee public satisfaction and acceptance; complaints about inadequate service will ensue if the system exhibits excessive response times. Therefore, in addition to minimizing mean response, a fractile criterion should be considered when deploying ambulances. In fact, a differential fractile criterion based on the type of injury might be appropriate in a cost-benefit context. For example, a life-threatening cardiac arrest might have a fractile response time of 5 minutes; for a simple fracture, a few hours might be acceptable. The selection of appropriate fractile response times is a function of the relationship between time-to-treatment and the corresponding prognosis for the particular type of injury.

The CALL program is designed to select ambulance locations in a service area without any constraint as to a particular set of possible locations, because in many systems (e.g., New York City), ambulances are stationed at curb sites. Also, CALL can fix a subset of the ambulances at predesignated sites and permit the remaining ambulances in the system to be considered for alternate locations. Because of this unconstrained location capability, the final locations selected by CALL did not necessarily coincide with firehouse locations. Of the 14 ambulances, CALL relocated 6; each was, in fact, placed at the nearest firehouse, which, in all cases, was within one-half mile of the specific coordinates selected by CALL. The final firehouse locations were compared to the CALL results in order to measure the sensitivity of mean response time to these minor adjustments in location. The increase in mean response time was less than one %.

The essential difference between the original and final deployment plans is a general movement of ambulances into the downtown area. This area happens to be the "skid row" section of Los Angeles. CALL, as it sought to minimize mean response time, moved several ambulances into the area of most frequent calls and moved nearby ambulances in that direction to provide the necessary backup during busy periods.

An ancillary benefit of using CALL is reported in Table IV-A-3. This table compares the daily workload for each ambulance for the initial and final deployment patterns. CALL, in its effort to reduce mean response time, has also smoothed the workload among the ambulances. For the initial deployment plan, the expected number of calls ranged from a low of 9 to a high of 43, representing an imbalance in workload of 34 calls per day. However, for the final plan determined by CALL, the workload range is reduced to 19 calls per day from a low of 10 to a high of 29.

It should be noted that CALL need not be used only in the optimization mode. CALL could be used in conjunction with simulation to plan emergency medical systems. CALL could be used initially to determine the appropriate number of vehicles and their preferred location. Simulation could then be used to study alternate dispatch and retrieval policies for the system.

TABLE IV-A-3

ESTIMATED NUMBER OF CALLS PER DAY

Ambulance	Initial Plan	Final Plan
1	18	29
2	17	24
3	18	27
4	9	14
5	16	15
6	35	26
7	10	21
8	43	20
9	19	19
10	26	18
11	18	18
12	17	13
13	10	10
14	13	15

2. Shortest Travel Distance

As noted in the preceding section, travel distances in CALL were initially computed by summing the rectangular displacement between the x,y coordinate points of departure and arrival. This travel-distance model provided a usable foundation for the development and first application of the CALL system. However, project personnel were cognizant that a more sophisticated and realistic travel distance model would be desirable--one that would fit applications requiring the computation of a least-travel component. This capability would be required for the analysis of empirical data on the emergency medical system, for the operation of the EMS simulation models, for the future development of CALL, and as a practical tool for the solution of real-world problems. Therefore, analytical models to facilitate the computation of accurate travel times were developed. This section considers the outcome of this work.

A property common to dispatching and routine problems is the repetitive generation of "shortest routes," or estimates thereof, between sources and destinations. The locations of sources and destinations may be specified or generated randomly and "shortest routes" may be measured in terms of minimum travel time, shortest distance, or least cost, depending on the particular problem.

The accuracy of estimates of travel time may be of considerable importance. For example, the probability that death or permanent disability will result from an illness or trauma can be described as a function of the time between the onset of the illness or the occurrence of trauma and the provision of adequate medical care. The problem was formulated as the determination of the minimum travel time from a source to a destination where the route must lie along the surface roads, freeways, bridges, etc. The enormous number of such possible pairs of sources and destinations precludes the use of computer-based network algorithms for computing travel times exactly. Therefore, heuristic methods must be used to estimate such travel times.

A common practice has been to approximate travel times by superimposing a two-dimensional orthogonal grid on a map of the area under study. The distance between pairs of points on the map are then computed as either along routes parallel to the axes or along a vector connecting the source and destination points. Even with cleverly chosen functions for determining the rate of travel, time metrics based on such orthogonal and vector approximations of routing may produce substantial errors.

A computerized heuristic procedure was developed to reduce the error involved in the estimation of the minimum travel time between points where multiple speeds are involved. It combines two different methods for computing travel times: (1) a shortest-distance, Serial-Cascade algorithm for travel along a network of high-speed routes, e.g., freeways, and (2) an orthogonal distance computation for travel along relatively short, low-speed routes. Such a route will be along surface roads from the source to some node, N_s, of the freeway network; then along freeways from N_s to another freeway node, N_d; then by surface roads from N_d to the destination (See Figure IV-A-3).

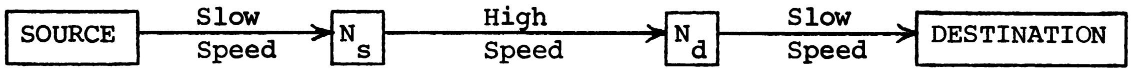

FIGURE IV-A-3

STEPS IN TRAVELING BY FREEWAYS

In our procedure, the minimum travel time from N_s to N_d is generated the Serial-Cascade algorithm, described below. Orthogonal distances are computed from the source point to N_s and from N_d to the destination point. These orthogonal distances are divided by an assumed mean rate of travel for surface roads to approximate the time associated with non-freeway travel. Clearly, these orthogonal approximations may suffer from errors induced by grid orientation or by the implicit assumption that travel in an orthogonal path is possible. However, the proportion of the total time required for a trip which results from travel on surface roads may be relatively small. For each pair of source-destination points, estimates of the proportion of the trip which is covered via each potential mode of travel are provided.

For a given source and destination, a rectangular search procedure (described below) is used to determine the closest freeway interchanges to each of the two points. The orthogonal distances from the source to "closest" interchange are calculated. Similarly, orthogonal distances from the destination point to its closest interchange are calculated. The distance from the source interchange to the destination interchange is obtained from stored information.

a. The Serial-Cascade Algorithm. The first step of the Serial-Cascade algorithm is to compute the distances (in both directions) between all pairs of nodes on each serial path and store the results in a matrix. The computation of these distances is accomplished rapidly by following along serial paths, or by "stepping through" the matrix, from immediate neighbor to immediate neighbor until a multiple or end-point node is reached. During this step, the multiple node neighbors, MN1(i) and MN2(i) for all i<m, are also determined. It should be clear that during this first step of the algorithm, the distances between all pairs of multiple nodes, along those paths which contain no intermediate multiple nodes, will be computed[1]. The second step of the algorithm is to perform the Cascade procedure upon the upper-left m x m part of the matrix; i.e., to compute the shortest distances between all pairs of multiple nodes.

The necessity for the third step of the algorithm can best be illustrated with the subnetwork of Figure V-A-4.

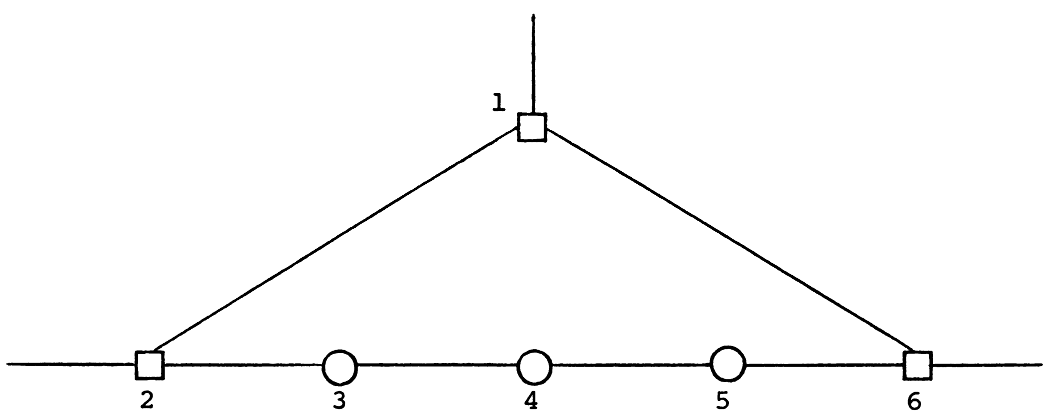

FIGURE IV-A-4

SUBNETWORK OF DISTANCES

During the serial path-following procedure, the distance from node 3 to node 6 is determined and stored as D(3,6). In fact, this may not be the shortest distance between these nodes; the distance from

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[1] If there are parallel serial paths between multiple nodes, i.e., more than one path between a pair of multiple nodes each containing no other multiple nodes, then the smaller multiple-node to multiple-node distance is stored in the matrix.

nodes 3 to 2 to 1 to 6 may be less than that of 3 to 4 to 5 to 6. This phenomenon may occur frequently when non-Euclidean distances are involved or when paths are quite nonlinear. To check for this, the non-zero entries in the m x m multiple node matrix, just before the Cascade Algorithm is applied, must be compared with the entries following the application. If an entry changes, it means the shortest distance between those two nodes does not lie along the serial path connecting them. When this occurs, the D(i,j) entries for some pairs of nodes on that serial path must be checked. Suppose m_1 and m_2 are the multiple nodes at the ends of the serial path and $D(m_1,m_2)$ changed during the Cascade procedure. Then for all nodes i and j lying on the serial path connecting m_1 and m_2, such that it is closer to m_1 than j,

$$D(i,j) = D(i,m_1) + D(m_1,m_2) + D(m_2 j) \tag{3}$$

if the right-hand side is less than the current entry in the matrix.

The fourth and final step of the algorithm uses the multiple node neighbor data along with the results from the first three steps to fill in all the remaining zero entries in the D(i,j) matrix, $i \neq j$. The reader will note at this point in the algorithm that $D(i,j)>0$ for all $i \neq j \leq m$ (because of the application of the Cascade Algorithm to multiple nodes) and also that $D(i,j)>0$ if i and j are on the same serial path. Thus, the only remaining $D(i,j)=0$ are those for i and j, $i \neq j$, on different serial paths where at least one of the nodes is not a multiple node. Suppose $D(i^*,j^*)=0$, $i^* \neq j^*$. There are, at most, four paths which are candidates for the shortest route from i* to j*: two of them go from i* to MN1(i*) and thence by the shortest route to either MN1(j*) or MN2(j*) and then to j*, two other routes go from i* to MN2(i*) and thence by the shortest route to either MN1(j*) or MN2(j*) and then to j*. If either i* or j* is a multiple node or if either of them lies on a serial path with an end-point node, then there are, at most, two possible shortest routes. The final step of the Serial-Cascade Algorithm computes the possible shortest distances between i and j and stores the smallest of these in the matrix.

A more precise description of the Serial-Cascade algorithm and its computer implementation is provided in a working paper by J. Burt.[1]

b. The Rectangular Search Procedure. The major problem encountered in calculating travel times is the determination of the proper choice of N_s and N_d for given source-destination locations. Let S and D denote the source and destination points located respectively at (x_s, y_s) and (x_d, y_d) on the two-dimensional grid, and let T(i,j) denote the travel time between points i and j. The problem is to choose N_s and N_d from among all freeway nodes so as to minimize the expression:

$$T = T(S, N_s) + T(N_s, N_d) + T(N_d, D) \qquad (4)$$

The optimal choice of N_s need not be the "closest" node to S, as measured in terms of the time required to travel the orthogonal distance from S to N_s. If travel times were proportional to the distances shown in Figure IV-A-5, n_1 would be the optimal choice of N_s even though n_2 is closer to S.[2]

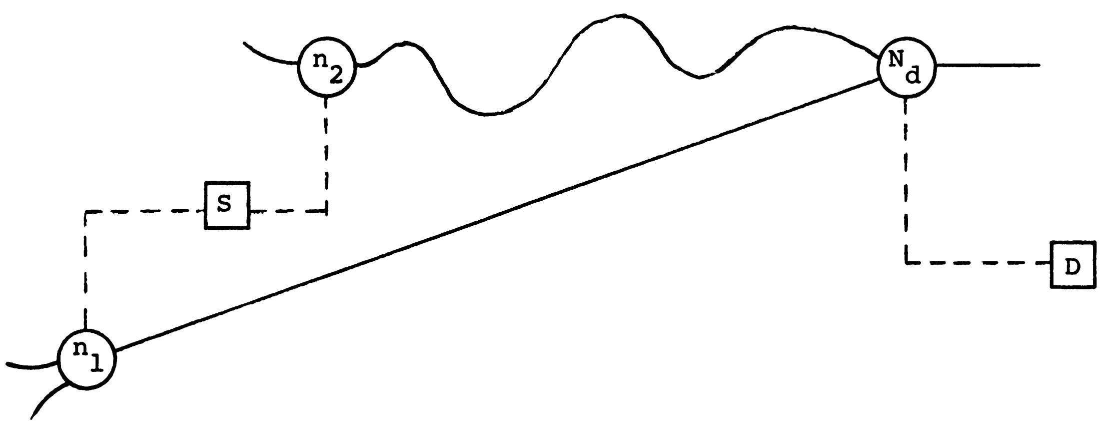

FIGURE IV-A-5

SIMPLE NETWORK

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[1]Burt, J. M., All Shortest Distances in Large Serial Networks, EMS Working Paper No. 7, University of California, Los Angeles (April 1971).

[2]This would, of course, depend in part on the relative rates of travel on freeways versus surface roads. If freeway rates were several times as great as those of surface roads, then n_2 would be the optimal choice.

This situation results from the fact that the optimal choice of N_s will depend on all three of the terms in Equation (4). The same comments apply to the choice of N_d. It is interesting to note in Figure IV-A-5 that the direction from S to n_1 forms an angle of greater than 90 degrees with the direction from n_1 to N_d. Thus, the optimal choice of N_s may lie in a direction opposite to the general direction of source-destination travel.

The optimal choices of N_s and N_d are interrelated, and hence, should be made simultaneously. This can be accomplished through the use of a rectangular search procedure which selects two subsets of nodes; one set contains nodes "close" to a given source point, and the other contains nodes "close" to a given destination. The pair of nodes, one from each set, which minimizes Equation (4) can be used in the estimation of minimum travel time for this particular source-destination pair. In order to guarantee that the best choice of N_s and N_d is selected, Equation (4) would have to be evaluated for all pairs of nodes in the freeway network. In most practical applications, this would be computationally arduous, if not impossible. Thus, although the procedure using subsets of all nodes must be considered a heuristic, it has led consistently to optimal or near-optimal choices for N_s and N_d in the network on which it was tested.

The search procedure produces two lists of nodes close to the source and destination respectively by identifying those nodes which lie within rectangles which expand in a particular stepwise fashion. For conciseness, the search procedure is described only for the source; the procedure for the destination is similar. The procedure for selecting a subset of nodes for a particular source should reflect the following desirable properties:

(1) Ceteris paribus, nodes closest to S, in terms of orthogonal distance, should be chosen first.

(2) The rate at which the search rectangle expands in different directions should reflect the directions from S to D; i.e., the growth of the rectangle should be relatively faster in the direction of D from S than in the opposite direction.

(3) If the ratio of freeway speed to surface road speed is relatively small (large), then the growth of the rectangle should be relatively faster (slower) in the direction of D from S; i.e., as freeway speeds decrease (increase) relative to surface road speeds, we should be more (less) adverse to searching in directions away from D.

For conciseness, the discussion is limited to the manner in which the searching rectangle expands in the left-right direction, the direction parallel to the x axis of the grid. As a first attempt at deriving the desired expansion rates, conditions were computed for the rate of search to the left as a proportion of the rate of search to the right under the assumption that once an interchange is reached, travel to the destination interchange would occur along an orthogonal route. This situation is illustrated in Figure IV-A-6 where the solid lines denote surface road travel, and the dashed lines denote freeway travel.

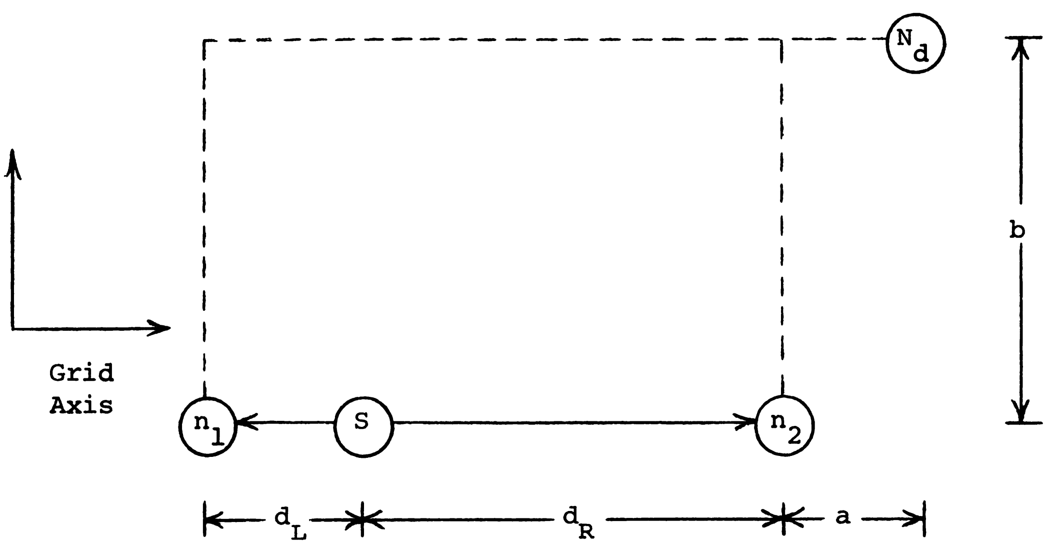

FIGURE IV-A-6

ORTHOGONAL TRAVEL ROUTES

In order for one to be indifferent between going from S to N_d via interchange n_1, rather than n_2, the following equations of equal travel times must hold:

$$\frac{d_L}{V_s} + \frac{b + d_L + d_R + a}{V_f} = \frac{d_R}{V_s} + \frac{a + b}{V_f} \tag{5}$$

where V_s is defined as "slow" or surface road speed, and V_f is defined as "fast" or freeway speed. Equation (5) simplifies to:

$$\frac{d_L}{d_R} = \frac{V_f - V_s}{V_f + V_s} \tag{6}$$

This equation correctly reflects property (3) above. For example, if freeway speeds were twice those of surface roads, we would search for freeway interchanges to the right three times as far as for interchanges to the left (away from the destination). However, if freeway speeds were three times faster than surface road speeds, we would search to the right only two times as far as to the left. As freeway speeds become relatively large, we are less adverse to searching for interchanges in the "wrong" direction. Unfortunately, Equation (6) does not properly reflect property (2). The ratio of d_L to d_R will remain constant for all locations of D in the first quadrant relative to S.

Consideration of the desirable properties of the search procedure led to a modification of Equation (6). For destinations in the first quadrant relative to the source, the rate of search parallel to the x axis is governed by:

$$\frac{d_L}{d_R} = \begin{cases} \left(\dfrac{V_f - V_s}{V_f + V_s}\right)^{2\alpha} & \text{for } d_R < x_d - x_s \\ 1 & \text{for } d_r \geq x_d - x_s \end{cases} \tag{7}$$

where

$$\alpha = \frac{(x_d - x_s)^2}{(x_d - x_s)^2 + (y_d - y_s)^2}$$

and (x_s, y_s) and $(x_d y_d)$ are the locations of the source and destination, respectively. The expression for α is simply the cosine of the angle between the vector connecting S to D and the x axis.

Equation (7) exhibits all of the desired search procedure properties discussed earlier. Property (1) results from the fact that nodes are accepted as the search rectangle expands in a stepwise fashion. Property (3) holds for the equation for the same reasons that were presented for Equation (6).

Further details of the search procedure and its computerized implementation are provided in Burt and Dyer.[1]

A computerized version of the method for calculating shortest travel distances was applied to the Los Angeles metropolitan area, which encompasses approximately 900 square miles. A two-dimensional orthogonal grid was superimposed on a map of this area. Each of the 357 freeway interchanges was located in terms of its grid coordinates. A total of 5,000 source and destination pairs was selected by randomly determining their grid coordinates from a uniform distribution. Each of the 5,000 pairs was examined separately. Mean travel speeds of 30 miles per hour on surface roads and 60 miles per hour on freeways were assumed.

Naturally, no empirical data on the actual minimum travel times between the 5,000 pairs of points are available. However, since the model uses actual distances between freeway interchanges (a significant portion of the total distance between many of the pairs) the results are good approximations to the actual minimum travel times. The best form of orthogonal estimate between the 5,000 pairs of points produced a discrepancy relative to the two-speed model and expressed as a standard deviation of over four minutes. Since the

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[1] Burt, J. M. and Dyer, J. S., Estimation of Travel Times Between Points on a Map, EMS Working Paper No. 6, University of California, Los Angeles (August 1970).

average trip time was less than 26 minutes, the standard deviation of the discrepancy associated with traditional orthogonal estimates is about 15%.

B. COMPUTERIZED SIMULATOR OF EMERGENCY MEDICAL SERVICE SYSTEMS

Simulation is the act of creating and using a substitute that feigns the appearance or behavior of something else. It is an ancient art that encompasses many diverse surrogates, such as drawings, scale models, laboratory experiments in the social sciences, and controlled field tests or demonstrations. With the development of the electronic computer, simulation has more and more become the process of using a computer to experiment with a mathematical model that represents a system of interest. Simulation by means of a computerized model makes it possible to mimic the behavior of existing systems or to predict the behavior of hypothetical systems.

To meet the need for a quick and inexpensive tool for the examination and evaluation of alternative means of delivering emergency medical services, a flexible and generalized computerized simulation model was developed by the EMS Project. The model encompasses those services and activities that begin with the occurrence of an incident capable of producing a medical emergency and that end with the delivery of the victim(s) to a medical facility. Although the model does not track the progress of a victim through treatment at the medical facility to his ultimate outcome, the capability of adding these aspects exists.[1]

The model was developed in two phases. The Phase I version was developed both as a prototype for the Phase II version and as a research vehicle for the Project staff. In 1968, when work on the Phase I version was begun, it was decided to write the program in the SIMSCRIPT I.5 language for the following reasons:

- SIMSCRIPT I.5 was an accepted and widely used simulation language;
- The structure of SIMSCRIPT I.5 was appropriate for the characteristics of emergency medical systems;
- The UCLA Computing Center owned an IBM 7094 computer system, which was leased by the Department of Transportation and made available to the Project; this computer had a SIMSCRIPT I.5 compiler.

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[1] Hare, Robert R. and Abigail B. Wemple, Model for the Analysis of Emergency Medical Service Systems, Operations Research, Inc., prepared under Contract PH 86-68-175, May 1969.

The Phase I version of the model is documented in a working paper prepared by members of the Project staff.[1]

The Phase II simulation is user oriented. It is sufficiently general to allow its use by any community to examine a very wide range of "what if" questions concerning alternative emergency response vehicles deployment policies, dispatching rule, levels of on-scene care, retrieval policies governing the medical facility to which the victim is taken, etc. Its generality and flexibility permit its being tailored to represent systems that are very simple, that are very complex and sophisticated, or that fall between these extremes.

Input procedures are simple and quite foolproof. The simulator thoroughly scans the inputs for errors and omissions. If one is detected, it is reported, and the program will not execute further. This avoids the loss of time and/or the generation of false results that would inevitably occur if the program were permitted to execute with erroneous or incomplete data.

The procedures for analyzing and reporting the results of simulation are unique. The analyses of the results are tailored to create the specific reports requested by the user. The user can call for as many as 100 reports to be generated at one time. For each report, the user specifies the variables or values of interest and the manner in which they are to be represented. Four methods of representing the results are available: (1) totals, (2) means and variances, (3) cross-tabulations, and (4) distributions (both density and cumulative frequencies). Further, for each report the user can specify either default titles or titles of his own choice.

1. Choice of Programming Language

In mid-1969, the computer that had been leased by the Department of Transportation was sold by UCLA. Computer support for the project was

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[1] Fitzsimmons, James A., Kenneth F. Siler and Ronald K. Granit, Emergency Medical Systems Simulation Model: Documentation of SIMSCRIPT I.5 Version, EMS Working Paper No. 8, April 1971.

shifted by the Department of Transportation to the naval facility at Point Mugu, California. This facility had no system support for SIMSCRIPT I.5. As a consequence, Project programmers were forced into systems programming in addition to their primary programming tasks. By the time work was ready to begin on the Phase II model, two improved versions of SIMSCRIPT were available, namely SIMSCRIPT II and SIMSCRIPT II PLUS. Two considerations, however, made us uneasy about further use of SIMSCRIPT. First, events began to suggest that of the two organizations that had been behind the continuing development of SIMSCRIPT, one was not interested in providing user support and the other was in financial difficulty. Second, our systems problems at Point Mugu had made us acutely aware of the fact that even though a special language, such as SIMSCRIPT, may be used widely by persons actively working in the particular area for which the language was developed, most computing facilities cannot support its use. Either the facility does not have a compiler for the language or, if it has the compiler, it provides little system support for the compiler. On the other hand, to switch to a general-purpose language would mean that little of the Phase I program, beyond the basic conceptualization of the model, could be incorporated into the Phase II version. Further, a change to a general-purpose language would necessitate a considerably larger programming effort than would continued use of SIMSCRIPT. Not only would our programmers have to refresh themselves in terms of the specific general-purpose lanquage selected, but any such language would pose problems that would have to be solved before it could be adapted to the special structure and requirements of simulations.

In the final analysis, primary consideration was given to the need for a simulation model that could be employed by a broad class of users. Therefore, the decision was made to program the Phase II version of the simulator in a general-purpose language that is available and supported at most computer centers. The language selected was PL/1, which combines the best features of "mathematical" languages, such as FORTRAN and ALGOL, and "sentence" languages, such as COBOL, into a single language of general utility. Programmers familiar with the languages mentioned above will find it easy to become proficient in PL/1.

2. <u>An Overview of the Phase II Simulation Package</u>

The Emergency Medical System Simulation Package consists of three separate programs. As previously indicated, each is written in the PL/1 programming language. Figure V-B-1 shows the interrelationships among the three programs. The Incident Generation (IG) Program creates a "representative" stream of incidents leading to medical emergencies and simulates the detection, recognition, and reporting of the incidents. As an alternative, the stream of incidents can be supplied directly in terms of a historical data bank. In this case, the historical records must be placed into the same format as that supplied by the Incident Generation Program. All emergency vehicles, facilities, dispatch policies, on-scene care policies, and retrieval policies are simulated by the Dispatch, Allocation, and Retrieval (DAR) Program. Analysis of the simulation is performed by the Analyze Program. The separation of the simulation package into three programs greatly enhances its flexibility. Users desiring to examine the effect of various changes in the magnitude and pattern of demands being placed on specified systems of emergency medical services can change the IG Program to create various streams of incidents without altering the DAR Program. Similarly, a user desiring to test different configurations of the system or different kinds of policies can perform Dispatch, Allocation, and Retrieval without having to recreate a stream of representative incidents. Furthermore, the separation of the DAR Program from the Analyze Program allows the model user to perform multiple analyses of a given set of simulation results without having to rerun the simulation itself.

Since each program of the model requires only a minimal knowledge of the other programs, large and complex studies can be organized around the separate programs. One person can be in charge of generating and testing "representative" incident streams. A second person can be in charge of developing and testing different system configurations and possible dispatch, allocation, and retrieval policies. Finally, a third person can construct the appropriate reports and analyze the results for feedback to the others and to a project leader. This organizational method was used by the EMS Project in its own studies. When the study is not complex or large, the package is sufficiently easy to learn and understand so that one person can perform the entire study.

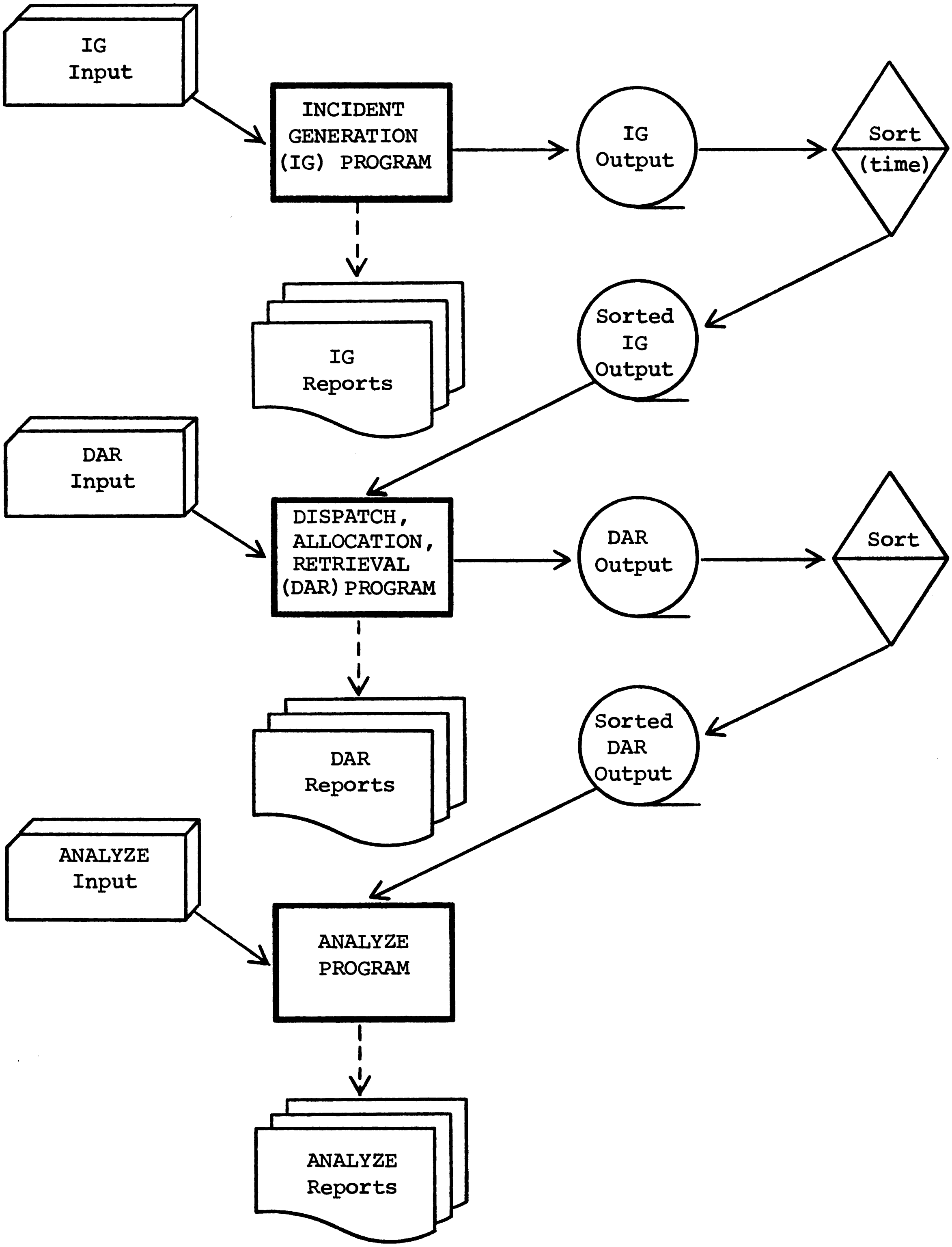

FIGURE IV-B-1

RELATIONSHIPS AMONG THE PROGRAMS THAT COMPRISE

THE EMERGENCY MEDICAL SYSTEM SIMULATOR

3. Activities Portrayed by the Simulator

The simulation model encompasses those services and activities that begin with occurrence of an incident capable of producing a medical emergency and that end with the delivery of the victim(s) to a medical facility. Figure IV-B-2 portrays the entire Emergency Medical Simulation Package in terms of this sequence of events as they affect both the emergency medical vehicles and the victim(s) of the medical emergency.

4. Uses of the Emergency Medical System Simulation Package

a. Incident Generation (IG) Program. The pattern of demands generated by the Incident Generation Program must be fixed for each run. This is not a serious handicap. To study the consequences of different patterns of demand, the user simply parameterizes the incident generator to create a separate stream of incidents for each situation of interest. The process is the same whether the demand pattern is to represent special days, such as holidays and those of severe weather conditions, or is to represent the population and its activities expected in ten years.

The Incident Generation Program offers numerous options so that an incident stream can be generated that closely resembles the real or anticipated situation of interest. The following questions are representative, but not exhaustive, of the options provided.

(1) Where does the incident leading to an emergency occur?

Option 1. Incident occurs with equal likelihood anywhere in the service area.

Option 2. Incident occurs with a likelihood that differs from district to district within the service area.

Option 3. Incident occurs with a likelihood that differs from district to district within the service area and by time of day.

Option 4. Incident occurs with a likelihood that differs from district to district within the service area, by time of day, and by incident type.

(2) When will the emergency incident occur?

Option 1. Incident occurs with equal likelihood at any time of

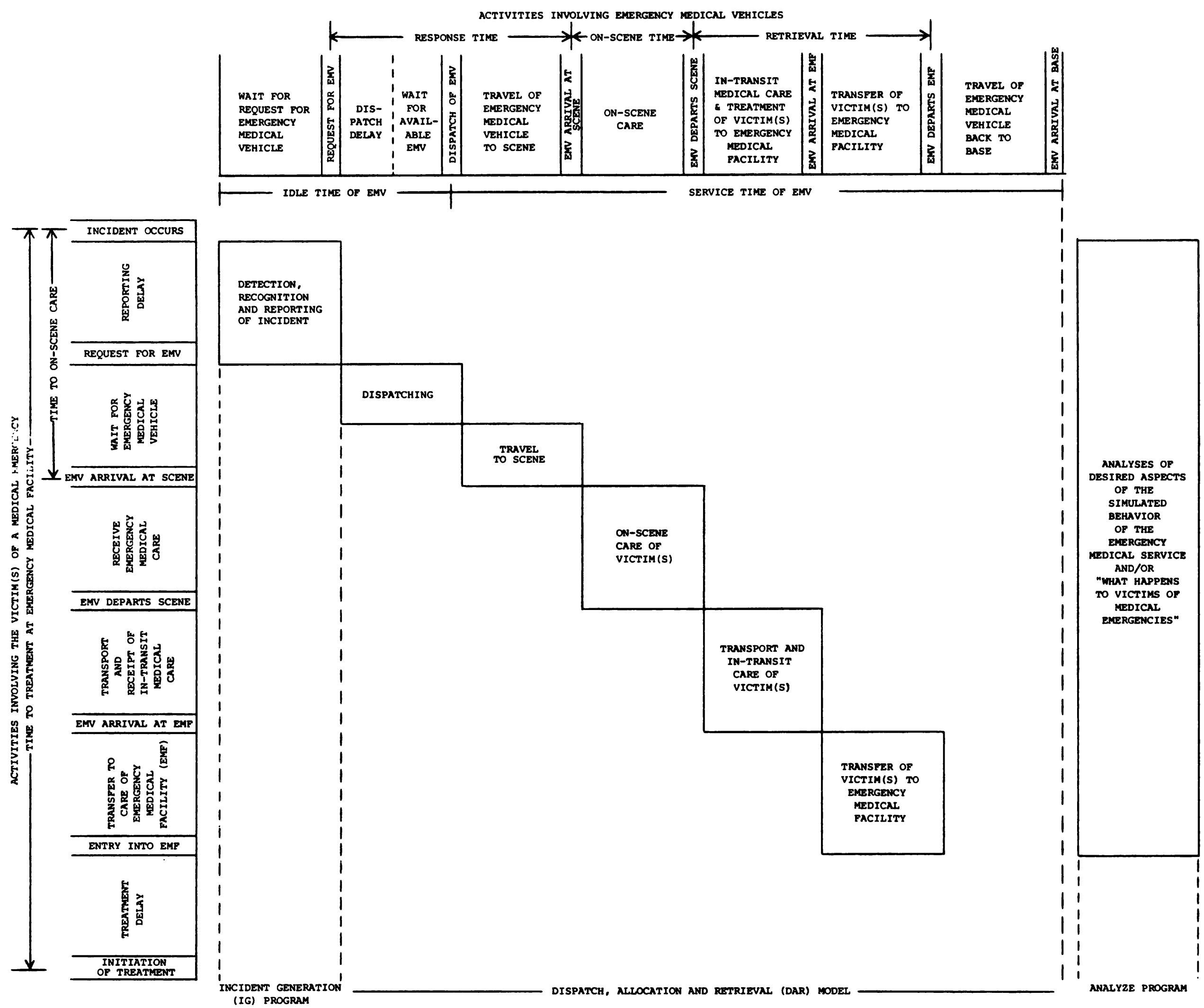

FIGURE IV-B-2

EVENTS REPRESENTED BY THE EMERGENCY MEDICAL SYSTEMS SIMULATION PACKAGE the day. The average number of incidents occurring in a day is specified by the user.

Option 2. Incidents occur with a likelihood that varies with the time of day. The average number of incidents occurring at any given time of day is specified by the user.

Option 3. Incident occurs with a likelihood that varies with the time of day and with the kind of incident. The average number of incidents occurring at any given time of day and for each kind of incident is specified by the user.

(3) What are the kinds of incidents that occur?

Option 1. There is only one kind of incident; that is, incidents are not categorized.

Option 2. There are several kinds of incidents. The user determines the categories for classifying the incidents.

(4) How many victims are in an incident?

Option 1. There is only one person injured in an incident.

Option 2. There may be several persons injured in an incident. The user specifies how many persons may be injured for each kind of incident.

(5) How are victims characterized?

(5a) Victim is characterized by injury or illness:

Option 1. There is only one kind of injury/illness.

Option 2. There may be several kinds of injuries/illnesses. The user determines the categories for classifying the injuries and illnesses.

(5b) Victim is characterized by severity of injury or illness:

Option 1. No severity is specified.

Option 2. One of several degrees of severity is specified. The user determines the severity categories.

(5c) Victim is characterized by age:

Option 1. No age is specified.

Option 2. One of several age groups is specified. The user determines the age groups.

(5d) Victim is characterized by state of health:

Option 1. No state of health is specified.

Option 2. One of several states of health is specified. The user determines the health states.

(5e) Victim is characterized by a priority for care and transport:

Option 1. No priority is specified.

Option 2. One of several priorities is specified based on the injury/illness, severity, age, and/or health of the victim. The user specifies the priorities for each combination of the victim's characteristics.

Option 3. One of several priorities is specified based on user-defined likelihoods.

The above questions and the corresponding options show how a user can tailor the Incident Generation Program to represent any desired incident pattern. Incident patterns can be made very simple by choosing the first options under each of the questions. As the user chooses higher-numbered options, the simulated system becomes more complex. Typically, the higher-numbered options have many categories and contingencies. The appropriate choice of options will depend on the user's purpose.

Once an incident occurs that leads to a medical emergency, there are an almost infinite number of ways in which demands may be placed on the emergency medical service system. The victim may make his way to a source of treatment, such as a physician's office or emergency room. He may be taken to such a source of treatment by a relative, friend, or stranger. The victim may seek assistance, such as phoning his physician or for an ambulance. The victim may be unable to seek for assistance, and assistance, if any, must be sought on his behalf by relatives, friends, strangers, or public agents such as the police. The Incident Generation Program is concerned only with those incidents that place a demand on the emergency medical service system under study. Hence, it treats all combinations of detection, recognition, and reporting of incidents as a single event.

The following questions and options in the program describe this event.

(1) Who notifies the emergency medical service system and how is notification made?

Option 1. No informant and no notification devices are specified.

Option 2. One of several combinations of informant and notification device is specified. The user determines the categories of informants and the categories of notification devices. In addition he must specify the likelihood for each allowed combination of informant and device. Each likelihood may be dependent on time of day and kind of incident.

(2) How long is the time interval between incident occurrence and notification?

Option 1. An interval with an average time equal to 15 minutes.

Option 2. An interval with an average time specified by the user.

Option 3. An interval that depends on incident type, incident location, informant, and notification device. The user specifies the average time of the interval for each allowed combination of the dependent parameters.

The output of the Incident Generation Program is a stream of incidents that are reported to the emergency medical service system of interest.

b. <u>The Dispatch, Allocation and Retrieval (DAR) Program</u>. An emergency medical vehicle (EMV) may be dispatched in response to a reported incident. The dispatching of emergency medical vehicles is one of the most complex problems of emergency medical service (EMS) systems. Most EMS systems dispatch the emergency vehicle that is closest to the incident by distance or by time. The DAR program permits many other alternatives. For example, an emergency vehicle without a capability for transporting patients may be sent to the scene of an incident; upon reaching the scene, it may call back for a vehicle that does have the transportation capability.

Dispatching involves the consideration of many factors, among which are:

- What is the kind of incident?
- How many people are injured?
- Where is the incident located?
- What vehicles are available for dispatch?
- What kinds of vehicles are needed?
- How does the vehicle affect the dispatching?

Combinations of these considerations and others make dispatching a complex process. Furthermore, community considerations (i.e., geographic, demographic, and political considerations) will bear heavily on the methods of dispatching. Recognizing the many alternatives for dispatching, the DAR program contains a generalized and flexible dispatching methodology. Some of the dispatching alternatives are described by the following options:

(1) How are dispatching policies chosen?

Option 1. Accept the default policy that selects the closest EMV in terms of the travel time to arrive at scene.

Option 2. Choose one policy from a set of programmed dispatch policies and use this policy for all incidents. The DAR program provides several alternative policies.

Option 3. Choose one policy for each district and let this policy govern all dispatching for that district. Each district can have its own dispatching policy.

(2) To which incidents can an emergency vehicle be dispatched?

Option 1. All EMV's can be dispatched to incidents in any of the districts of the service area.

Option 2. Each EMV can be dispatched to incidents in only those districts of the service area that the user specifies. Here, each district has a feasible set of EMV's that will respond to incidents within the area.

Option 3. Each EMV has a priority value for each kind of incident. Hence, a particular kind of incident defines the dispatching priorities for the EMV's that may respond.

(3) How many emergency vehicles can be dispatched?

Option 1. One EMV is dispatched to an incident, but additional EMV's can be requested from the scene of the incident.

Option 2. Several EMV's are dispatched to an incident, and additional EMV's can be requested from the scene of the incident.

Option 3. One EMV of a particular kind is dispatched to an incident, but additional EMV's can be requested from the scene of the incident.

Once at the scene, the personnel manning the emergency medical vehicle may administer various levels of care. At a minimum, this may simply be careful handling and first aid. With physicians, nurses, or highly trained paramedic personnel aboard the EMV, however, more advanced care and treatment may be rendered at the scene.

Which victims are given priority in medical care?

Option 1. No priority is given in medical care.

Option 2. Priority is based on a combination of kind of injury, severity of injury, health of victim, age of victim. The user specifies the priority for each allowed combination.

Option 3. Priority is based on user-defined likelihoods.

The EMS system is responsible for choosing an appropriate emergency medical facility (EMF) to which to take the victim(s) of the incident. Most EMS systems simplify this decision by requiring that the victim(s) be taken to the closest medical facility. It may prove to be very valuable, however, to match the patient's injuries or illness to the choice of EMF's. When a person is severely burned, it may be important to transport the patient to a facility having a specialized "burn center." Such a facility may not be the facility closest to the incident. The following questions and options provide some description of how victims are selected for transport and where they are taken:

(1) Who is transported to an emergency facility?

Option 1. All people injured in the incident are transported.

Option 2. Each injured person in the incident has a likelihood of transport specified by the user based on his injury or illness and its severity.

(2) How are EMF choice policies selected?

Option 1. Choose the EMF that is closest by time.

Option 2. Choose one of the alternative set of policies for selecting EMF's. The EMS Simulation Package defines several alternative policies. For instance, "choose the EMF that is assigned to the district." Assignment of EMF's to districts is specified by the user.

Option 3. Choose one policy for each district of the service area and let this policy govern all EMF selection for the district. Each district can have its own policy for choosing EMF's.

(3) To which EMF's can an EMV transport?[1]

Option 1. All EMF's can receive any EMV.

Option 2. Each EMF can receive only certain EMV's. The user specifies the feasible EMV's for each EMF.

(4) Which kinds of incidents can be handled by an EMF?[1]

Option 1. All EMF's can handle any kind of injury/illness.

Option 2. Each EMF can receive only certain kinds of injury/illness. The user specifies the feasible injuries/illnesses for each EMF.

These questions and options not only facilitate the simulation of current EMS systems, but also facilitate experimentation with many alternatives that may be policies for future systems. As medical treatment and medical facilities become more complex and specialized, and as on-scene care and EMV transportation improve, it becomes more important to send patients to the "right" EMF. The EMS Simulation Package facilitates EMF selection by providing straightforward techniques for specifying both simple and complex EMF selection policies.

Time is the critical dimension of emergency medical services. The times required by the events depicted by the DAR model are crucial

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[1]This question is necessary since some EMF's may not be able to receive some kinds of incidents (e.g., burn injuries, brain injuries).

to the evaluation of existing systems and the design of improved systems. Two such events are defined directly:

(1) How long does an EMV spend at the scene to render on-scene care?

Option 1. An average time is specified by the user.

Option 2. An average time is specified by the user but depends on the emergency vehicle and the greatest severity of the injuries in the incident.

Option 3. An average time is specified by the user but depends on the number of people injured in the incident.

Option 4. An average time is specified by the user but depends on the kinds of injuries and the number of people injured in the incident.

(2) How long does it take to transfer patients at an EMF?

Option 1. Transfer takes between 7 and 12 minutes. The times between 7 and 12 minutes have equal likelihood.

Option 2. A minimum transfer time and maximum transfer time are specified by the user. The times between the extremes have equal likelihood.

The time intervals associated with the remaining events are determined by choice of EMV and EMF, and by location of the incident. The interval between incident reporting and dispatching is determined by the availability of EMV's. If there is an EMV immediately available, then there is no dispatch delay. However, if all EMV's are busy or if the dispatch policy requires a particular EMV that is busy, then there is a dispatch delay until an EMV is available to respond to the incident. The time that an EMV takes to travel to an incident and to an EMF depends on the speed of the EMV and the distance traveled. All of the following questions except the last consider EMV speed and travel distance. The last question considers the only remaining time interval--transfer time at the EMF.

(1) How fast does an EMV travel?

Option 1. All EMV's travel at an average speed of 35 m.p.h.

Option 2. Each EMV may have two differing average speeds--one for city travel and another for highway travel. These speeds are specified by the user.

Option 3. Each EMV may have different average speeds based on normal travel or red lights and siren. Each mode of travel (i.e., normal or red-light) may have an average speed for city travel and an average speed for highway travel. These speeds are specified by the user.

(2) When does an EMV go to red lights and siren?

Option 1. Red-light mode of travel is never used. It is assumed that the average travel speed takes into account the red-light speed.

Option 2. For travel to an incident, each EMV uses red-light speed for a fixed percentage of the trip based on the injury/illness of the incident. These conditional percentages are specified by the user.

Option 4. For travel to an EMF, each EMV uses red-light speed for a fixed percentage of the trip. These percentages are specified by the user.

Option 5. For travel to an EMF, each EMV uses red-light speed for a fixed percentage of the trip based on kind of incident and degree of severity within the incident. These conditional percentages are specified by the user.

Option 6. For additional EMV's requested from the incident scene, each EMV uses red-light speed for a fixed percentage of the trip. These percentages are specified by the user.

Option 7. For additional EMV's requested from the incident scene, each EMV uses red-light speed for a fixed percentage of the trip based on kind of incident and degree of severity within the incident. These conditional percentages are specified by the user.

(3) Do EMV's have delays in preparing for travel or in arriving at an incident scene or EMF?

Option 1. EMV's do not have delays in preparation or arriving.

Option 2. Each EMV may have a fixed preparation delay and also a fixed arrival delay. These delays are specified by the user. They represent the time required to load emergency equipment onto the EMV and time for special EMV's, such as helicopters, to warm up, take off, and land.

(4) In which directions does an EMV travel?

Option 1. Travel is assumed to be on city streets where EMV's travel in perpendicular directions. This implies that the travel distance is not "as the crow flies," but a distance equal to the sum of the horizontal and vertical distances.

Option 2. Travel is assumed to be by air or water where EMV's travel "as the crow flies." This direction of travel is useful for describing helicopter or boat travel.

An extremely wide variety of real-world situations can be represented with the Simulation Package if the user makes an appropriate choice of options. In instances where a combination of options cannot be found that adequately represents the system under study, the user has the option of programming his own distinctive features. This alternative, of course, is the most difficult and requires considerable knowledge of the basic structure and logic of the DAR program.

c. Analyze Program. The EMS Simulation Package provides a unique method for analyzing EMS systems. Results from the simulation are fed into a program that permits an analysis of practically any and all aspects of the simulated system. This analysis permits the user to generate reports that are tailormade to his needs. There are four types of reports:

- totals
- means and standard deviations
- cross-tabulations
- percentiles.

The first type of report provides frequency counts and their sum for any variable in the EMS system. In the second type of report, means and standard deviations of the interval time in the simulation are reported. The user specifies the interval as the time between any two events in the simulation. The third type of report is a more complex form of the first report. Rather than providing frequency counts and their sum for one variable, it provides the frequency counts for a matrix of two variables. In this two-way cross-tabulated analysis, the user can specify any two variables. The last type of report provides a complex analysis of the time intervals in the simulation. A time interval is specified as in the second report type. However, the output of this report is the description of the complete time interval distribution in three forms: in a tabular form, in the form of a probability density function, and in the form of a cumulative probability function. With this report a user can see what percentage of the simulated incidents had a response time less than 10 minutes, less than 15 minutes, less than 30 minutes, etc. The user specifies not only the time interval for the analysis but also the degree of detail that is desired. Intervals can be analyzed in terms of half minutes, minutes, two minutes, etc.

In all of the above reports the user is permitted to accept default titles for his reports or to specify his own titles. Also the user can select the kind of incident(s) that constitute the basis of his report. If a user wishes to analyze incidents involving helicopters, then this selection criterion is specified by the user. Finally, as many as 100 reports can be generated at one time. Each report is tailormade to user specifications.

C. SURVEY

The major objective of the household survey was to collect information on citizens' perceptions of the properties of the emergency medical system and data on their actual experiences with the emergency system. These experiences were to be those defined as emergencies by the citizen, not those defined as emergencies by some external criteria. This information, as explained more precisely below, was deemed to be relevant to policy-making and decision-making about emergency medical care. A review of the literature failed to disclose any previous study that looked at the entire sequence of emergency-related information and events:

- General perceptions and images of the emergency system and medical emergencies
- Specific experiences in perceived medical emergencies
    - -- Incident occurrence
    - -- Incident discovery and reporting
    - -- On-scene circumstances and behavior
    - -- System intervention and treatment
    - -- Final outcome
- Evaluation of system performance and desired changes.

Other studies have examined only smaller subsets of this sequence, such as emergency room operation. However, it was felt that an understanding of the entire sequence was necessary to estimate the potential effects of system changes.

More specifically, the following policy-oriented questions were to be answered by examining the data generated by the survey:

(1) What characterizes citizens' images and perceptions of the emergency medical system? How do these cognitive maps correspond to actual system properties? What roles do citizens see as appropriate for themselves and for public and private medical agencies? Do these perceptions differ for differing types of systems?

To understand and evaluate the effectiveness of differing system configurations, we must understand how the public sees those configurations. If citizens misperceive aspects of the system, this can affect system performance, so any misperceptions must be uncovered and taken into account. Also, it is necessary to know what roles citizens think they are expected to perform, and what roles they think should be left to trained personnel. Finally, since different communities have different emergency system configurations, it is necessary to know whether certain types of actual systems induce more misconceptions than others.

(2) What factors influence the division of the consumers' demand for emergency medical services between the public and private sectors and among the various components of each sector?

At present, there is no accessible data collection system with respect to the emergency services rendered by the private sector within an entire community or region (e.g., private emergency clinics, doctors' offices, prepaid medical groups). Identification of these facilities and of the relative magnitude of their influence is essential to the examination of the costs and benefits of alternative policies and system configurations. This information would permit one to predict whether a specific policy or program would shift demand for emergency medical services between public and private suppliers. It was hypothesized that citizens' perceptions (see question 1) would exert a substantial influence on this public-private choice. Thus, records of households' actual choices in perceived medical emergencies were necessary. Perceived emergencies were used because it is the citizens' perceptions in a situation that govern their behavior and the demands they place on the system.

(3) What factors influence bystander behavior in medical emergencies? How do characteristics of the emergency situation influence behavior? In particular, does the type of incident--e.g., illness or traffic accident--affect on-scene behavior? What inappropriate behaviors occur?

In recent years there has been much concern with public apathy and a presumed lack of helping behavior. However, there has been little field study in this area. Identification of factors influencing bystander and passerby behavior can help in devising methods to increase citizens' willingness to give appropriate aid in medical emergencies. Knowledge of inappropriate behaviors can give insights into which citizen behaviors now existing need to be changed.

(4) What factors influence public responsiveness and <u>support for system change</u> and improvement, and in what ways can the public be a resource for change and improvement? What are desired changes? Do these changes differ for differing system configurations?

There appears to be a general lack of public involvement in emergency medical issues. There is a paucity of consumer or community groups, and few mechanisms for the public to provide feedback on system performance. The factors influencing the public's involvement in emergency medical issues must be better understood if the public is to be recruited as a support and resource for system change and improvement. Also, studies can be make of citizens' priorities with respect to system improvements and the relationship between these priorities and the current emergency system in a community.

To answer these questions, knowledge of the entire sequence of emergency related events, from prior information through an emergency incident itself, was needed, as outlined above. Accordingly, a questionnaire was designed to obtain this information. The analyses of the data gathered are given in Section VI-E.

1. <u>The Design of the Survey Instrument</u>

The four specific research issues discussed above provided some structure for questionnaire design by pointing to required question areas. However, since the information desired had never been collected by other surveys, difficult questions of measurement were encountered. These measurement questions were attacked by attempting to structure the type of information desired so that question order and flow would seem logical to respondents. In particular, this implied that questions about system perceptions were sequenced from the general to the specific, and questions about actual incidents were structured to reflect the time sequence of events that occurred during the incident. Given this overall structure, specific questions were developed and (after many iterations caused by subtleties in the phenomena under study) were finalized.

At this stage, consultation with the UCLA Survey Research Center was begun, and the first formal field-test version of the questionnaire was developed. At this stage, the questionnaire was partitioned into two components, one dealing with images and perceptions, and one dealing with actual emergency experiences. This partition was in keeping with our development of the research questions and was also a logical one for respondents. A preliminary field test was then undertaken. This preliminary testing was essential to:

- Familiarize the interviewers with the survey instrument;
- Measure how well the questions communicated to respondents;
- Uncover problems that the interviewer had with specific questions.

Based on the results of the preliminary test, questions were changed and some rethinking was done on the number of actual emergencies reported. In particular, timing of the questionnaire became a problem, since each actual emergency described in detail took approximately 40 minutes to report. However, all emergencies where a household member was a victim were needed to answer the question of the division of demand between the public and private sectors. Accordingly, a shortened emergency description questionnaire was developed so that only one emergency was covered by the longer questionnaire. Any additional household member emergencies were covered by the shortened version. This both shortened total response time for the questionnaire administration to a reasonable length and allowed essential data to be collected. Thus, the questionnaire was finalized in three parts: one dealing with perceptions, one with a detailed account of one emergency incident, and one with descriptions (one or more) of emergencies suffered by household members.

Table IV-C-1 presents an outline of the topics covered by the final form of the survey incident. Each topic is listed and the research questions it addresses are indicated. Note the three sections referred to above.

The first section of the instrument, the Main Form, gathered the needed perception and image information to address the four policy-oriented research questions. Also, information on household non-emergency demand and demography was obtained.

Near the midpoint of the Main Form, a branch was made to the second section, the Supplemental Long Form. This branch was made on the condition that in the last four years the respondent had been present when a medical emergency (as he perceived it) had occurred or had been told about such an emergency by a person who was present. The Long Form obtained a detailed description of the emergency, yielding not only demand information if the emergency involved household member victims, but also detailed information about incident characteristics and victim, bystander, passerby, and trained personnel behavior in the situation. These data were the main source of information needed to attack the research questions on bystander behavior and support for system change.

On completion of the Long Form, the third section, called the Supplemental Short Form, was filled out for only those incidents of the last four years in which the victim was a member of the respondent's household. The purpose of the Short Form was to compile complete demand information for analyzing the split of public and private demand. After all incidents were described, the Main Form was completed and the interview was terminated. The forms themselves are given in Appendix B.

2. Sampling Plan

In initiating the sampling procedure, the primary objective was to obtain a data base representative of the population in the greater Los Angeles area. Such a data base allows the results of the analyses of the

TABLE IV-C-1

TOPICAL OUTLINE OF INSTRUMENTS

Main Form	Images and Perceptions	Public vs. Private Demand	Bystander Behavior	System Change
Perceptions of time criticality and threats of emergency situations	X		X	
Perceptions of system boundaries	X		X	
Perceptions of role expectations; system responsibility	X		X	
Behavior in non-aiding situations			X	
Perceptions of unmet demands	X			X
Perceptions of ambulance services (suppliers, system properties, personnel)	X	X	X	X
Perceptions of rescue squad services (suppliers, personnel)	X	X	X	X
Perceptions of emergency rooms (suppliers, hours open and waiting time to treatment, presence of doctor, quality of care)	X	X	X	X
Payment for medical services	X	X		
Non-emergency demands		X		
Proposed system changes and methods of implementation				X
Personal data (demographic, medical care)	X	X	X	X
Medical emergency insurance	X	X		
Supplemental Long Form				
Time of occurrence; location of emergency incident		X	X	
Characterization of victims and others present	X	X	X	
Characterization of injury or illness	X	X	X	
On-scene information (treatment, threat to victim, where treatment should be given)	X	X	X	X
Characterization of scene of incident	X	X	X	X
Characterization of on-scene care (supplies, treatments required and rendered)	X	X	X	X
Characterization of on-scene communications (supplies, contacts required and made)	X	X	X	X

TABLE IV-C-1 (Cont'd)

TOPICAL OUTLINE OF INSTRUMENTS

Supplemental Long Form	Images and Perceptions	Public vs. Private Demand	Bystander Behavior	System Change
Transportation of victims (mode of transport, treatment at facilities)	X	X	X	X
Assessment of behaviors during incident (bystanders, system, personal involvement in changing system)	X	X	X	X
Time sequence of events		X	X	

Supplemental Short Form	Images and Perceptions	Public vs. Private Demand	Bystander Behavior	System Change
Time of occurrence; location		X		
Household membership		X		
Characterization of victims		X		
Characterization of injury or illness		X		
Characterization of on-scene care (source of treatment, time delay)		X		
Transportation of victims (mode of transport, treatment at facilities)		X		

data sample to be generalized to the population at large. However, to ensure that the sample yields data that are both representative and useful for analysis, it is essential that the research questions discussed above be explicitly considered in generating the sampling procedure. The research questions implied the following special concerns for the sampling plan: (1) all of the research questions were concerned with effects of different system configurations, hence, areas with such system differences must be chosen; (2) existing data on public emergency system usage relevant to the questions of public vs. private demand were available for the San Fernando Valley, so advantage should be taken of this fact; finally, (3) to allow any policy implications to be based on as broad a base as possible, different socio-economic cross-sections should be sampled. The way the sampling plan was designed to meet these concerns is detailed below.

Four separate and distinct areas in greater Los Angeles were chosen for the survey: the San Fernando Valley area of the City of Los Angeles, the city of Azusa, the city of San Gabriel, and the city of Pasadena. Each of these areas possesses a unique aspect of the public emergency medical system not possessed by the other areas, and thus provides an opportunity to examine the effect of system configuration differences. In the San Fernando Valley, a fee is attached to the use of the ambulance system and the contract emergency rooms. In Pasadena, a physician accompanies each ambulance that responds to a medical emergency. In San Gabriel, the ambulance and emergency room services are well advertised as completely free to residents. In Azusa, the emergencies are initially screened by a policeman who investigates to determine their seriousness and the appropriateness of dispatching an ambulance.

Socio-economic status undoubtedly influences the participation of individuals in public services. Therefore, the sample was stratified by income and ethnic origin in each area. Although other stratifications, such as age and education, are also important, such information is more difficult to obtain and its inclusion increases considerably the required sample size. Prior designation of income in an area is difficult. However, an excellent surrogate is the value of the housing within the areas. The value of housing was therefore used as a basis for stratifying the sample into socio-economic classes.

The stratification of the survey is based on census tract and block data from the decennial census of 1960. Although the population has changed over the last decade in each area, the distribution of the population among the four areas has not changed materially:

	Population	
	1960	1970 (est.)
San Fernando Valley	888,494	1,022,560
Pasadena	116,407	126,000
San Gabriel	22,524	30,000
Azusa	16,985	29,000

Similarly the value of housing has, for the most part, increased over the decade. However, under the assumption that the distribution of housing values has not been radically altered among the socio-economic strata, the value of housing contained in the 1960 census was used for stratifying the sample. The rationale underlying the income stratification was that gross income classes should be equally represented. The actual valuations of housing were available on a house-by-house basis for San Fernando Valley and Pasadena. In the San Fernando Valley, the following stratification of the 1970 value of housing yields three strata of approximately equal size: (1) all housing less than or equal to $27,000; (2) all housing from $27,000 to $35,000 (where reported value increments are $500); and (3) all housing in excess of $35,000. For Pasadena, the strata that contained approximately equal populations were: (1) all housing less than $28,000; (2) all housing from $28,000 to $36,000; and (3) all housing in excess of $36,000. The value of housing in Azusa and San Gabriel was established by experienced personnel who cruised the relevant areas to determine three approximately equal classes. Each area was further stratified into three classes depending on ethnic origin: (1) Anglo and other; (2) Mexican-American; and (3) Negro. To reduce sampling errors, boundaries were drawn so that each income group contained proportional numbers from each ethnic group.

Based on the above information and procedures, the following sample sizes were established: San Fernando Valley--1,000, Pasadena--500, San Gabriel--250, and Azusa--250. The basic sampling unit is the household, not the individual. Since the population composition and the emergency medical systems are different in each of the four areas, they are treated as independent universes in designing the sampling schemes.

Before describing the actual determination of the sample, there are a number of general considerations that must be made explicit and that aid in understanding the sampling procedure. First, there is no body of information on the private sector. Therefore no explicit a priori information as to the distribution and range of private sector demand was avail-ablve. Intuition and extrapolation from studies of the public sector had to be used to define sampling procedures. Second, the present distribution of individuals by socio-economic class could be checked as the results of the 1970 census became available. Third, the actual data were stratified in terms of the characteristics that were needed to confirm hypotheses about the nature of the population.

Finally, the San Fernando Valley area was sampled more heavily than the other areas because we possessed a potential source of corroboration of the results of our analysis there. The EMS Project had earlier conducted a separate study of historical data on public-sector demand in the Valley. If the public-sector demand data generated by the Household Survey were found to square with the public-sector demand data generated in the earlier study, we would be justified in placing a considerable degree of confidence in our data base, and therefore in extrapolations made from it with respect to private sector demand. This opportunity for validating some information on the elusive subject of private sector demand was considered to be very valuable.

As noted, the sampling plan considered each of the four areas--the San Fernando Valley, Pasadena, San Gabriel, and Azusa--as an independent universe. Each area was then stratified as above to ensure appropriate representation within each socio-economic stratum. This stratification process determined in which stratum each census tract was placed. Then the selection of the tracts to be sampled was made by a probability weighted random selection with the probabilities determined by the size of the tracts --that is, by the number of housing units in the tract. Within the tracts designated for sampling, the selection of the appropriate blocks was made randomly. The probability of selection was defined by the number of housing units in each block relative to all housing units. Once the blocks had been selected, a fixed number of listing units, which were treated as housing units, was drawn by systematic randon selection from the list of addresses obtained by field work. For each area, the specific sampling procedure is described below:

a. San Fernando Valley. The San Fernando Valley area consists of 177 census tracts. The stratification process involved selecting census tracts for three strata based on the median housing value of the tract and for one stratum of Negro-dominant tracts. This allowed a sample of various socio-economic levels to be drawn. These stratification criteria, the number of tracts, and the size of the ultimate sample are given in the table below.

TABLE IV-C-2

SAN FERNANDO VALLEY STRATIFICATION CRITERIA

Strata	Stratification Criteria	No. of Tracts	No. in Ultimate Sample
1	Median Housing Value ≤ $17,000	61	316
2	$17,000 < Median Housing Value ≤ $20,000	53	317
3	$20,000 < Median Housing Value	60	317
4	Negro-Dominant Tracts	3	50
	TOTAL	177	1000

For the three white-dominant strata, strata 1, 2, and 3, a total nonresponse rate[1] of 25 percent and a 20 percent population growth since the 1960 census[2] were assumed. For the Negro-dominant stratum, the

[1] Assumptions on nonresponse rate are based on the field experience of the Survey Research Center, UCLA.

[2] Assumptions on population growth since 1960 census are based on estimated population for 1968 by the Division of Records and Statistics, County of Los Angeles Health Department.

Pacoima area, a higher nonresponse rate of 50 percent and no change in population since 1960 was assumed. The computation of the initial sample size for each stratum based on the above assumptions is then:

3 white-dominant strata: $\frac{950}{(1.20)(.75)} = 1056$

1 Negro-dominant stratum: $\frac{50}{(1.00)(.50)} = 100$

With consideration given to both costs and practicality, six tracts, with 12 city blocks per tract and five housing units (HU's) per block, were drawn for the Negro-dominant stratum. Thus, the initial sample consisted of 360 housing units for each white-dominant stratum and 120 housing units for the Negro-dominant stratum, as seen in Table IV-C-3.

TABLE IV-C-3

SAN FERNANDO VALLEY--INITIAL SAMPLE

Stratum	Number of Tracts/Stratum		Number of Blocks/Tract		Number of HU's/Block		Total
1	6	x	12	x	5	=	360
2	6	x	12	x	5	=	360
3	6	x	12	x	5	=	360
4	3	x	10	x	4	=	120
					TOTAL	=	1,200

b. Pasadena. This area consist of 28 census tracts. A stratification process similar to that used for the San Fernando Valley was used for Pasadena, as shown in Table IV-C-4. The assumptions on both the nonresponse rate and the rate of population growth are presented in Table IV-C-5, together with the allocation of the number of tracts per stratum, the number of blocks per tract, and the number of HU's per block.

TABLE IV-C-4

PASADENA STRATIFICATION CRITERIA

Strata	Stratification Criteria	No. of Tracts	No. in Ultimate Sample
1	Median Housing Value < $17,000	6	133
2	$17,000 < Median Housing Value < $21,000	7	133
3	$21,000 < Median Housing Value	8	134
4	Negro-Dominant Tracts	7	100
	TOTAL	28	500

TABLE IV-C-5

PASADENA, GROWTH AND NONRESPONSE RATES--INITIAL SAMPLE

	Assumptions		Allocations						
Strata	Pop. Growth	Non-Response	Number of Tracts/Stratum		Number of Blocks/Tract		Number of HU's/Block		Total
1	10%	30%	3	x	12	x	5	=	180
2	10%	30%	3	x	12	x	5	=	180
3	10%	30%	3	x	12	x	5	=	180
4	18%	40%	3	x	10	x	5	=	150
							TOTAL	=	690

c. Azusa. This area consists of three census tracts: 4006, 4043, and 4044. The assumptions on the rate of population growth and the nonresponse rate in the area were 5 percent and 27 percent, respectively. This yielded the initial sample size of $\frac{250}{(.95)(.73)} = 360$. Twelve blocks per tract and ten HU's per block were allocated for each tract, for a total of 360 housing units.

d. San Gabriel. This area consists of three census tracts: 4802, 4811, and 4814. Assuming no population growth in the area for the past decade and a nonresponse rate of 28 percent, the initial sample size was computed as $\frac{250}{(1.00)(.72)} = 347$. The allocation of the number of blocks per tract and the number of HU's per block is shown in Table IV-C-6.

TABLE IV-C-6

SAN GABRIEL--INITIAL SAMPLE

Tract	No. of Blocks		No. of HU's/Tract		Total HU's
4802	12	x	7	=	84
4811	16	x	7	=	112
4814	22	x	7	=	154
			Total for the Area	=	350

Since there were no published block data on housing units available for the Azusa and San Gabriel areas, preliminary field work to estimate the size of blocks was needed. The selection of blocks was also made by systematic random selection with probability of selection in respect to the block size. A fixed number of housing units was then drawn from the lists of addresses by systematic random selection.

D. INFORMATION SYSTEM

When the EMS Project began, each of the many city and county agencies involved in the handling of emergency incidents was maintaining its own system of records to serve its own particular purposes and functions. In general, each agency's record-keeping system was unique and discrete; little commonality existed in the kinds of data recorded or the format in which they were noted down. This statement is not meant as a criticism of the existing record-keeping system; for the usual administrative and statistical purposes, each agency's records were adequate and timely. However, the Emergency Medical Systems Project wanted to be able to track a particular incident, involving particular patients, from the time of its occurrence to its final disposition. Therefore, one of the first tasks that faced the Project staff was to investigate each of the disparate data bases to determine what usable information was already available, what new information needed to be gathered, and how incident-specific information could best be tracked across agency boundaries. The Project then devised an auxiliary data-gathering system (i.e., a set of supplementary forms) to facilitate its own information needs.

Since the EMS Project covered only certain demonstration areas within the Los Angeles Metropolitan Basin, it could not supersede the existing information system. EMS data-gathering efforts operated in parallel with, and as an adjunct to, the on-going system; they did not replace it.

The following pages describe the record-keeping system as it existed before the inception of the EMS Project. They point out some of the gaps and omissions that necessitated the creation of new information sources. The forms and procedures for data-gathering under the Emergency Medical Systems Project are described. Finally, some problems that eventuated within the context of the EMS Data System are detailed.

1. <u>Existing Data Sources</u>

Following an emergency incident, four kinds of data inputs are made. They are described below in the order in which they occur.

a. Dispatch Data. Following the occurrence and identification of an emergency medical incident, the first information is recorded when the public system is notified, normally by phone or radio. These calls are usually received by the Los Angeles County Sheriff's Department (Shf), the Los Angeles City Fire Department (LAFD), or the Los Angeles County Fire Department (LACoFD); calls received by local police departments within Los Angeles County or by the California Highway Patrol are referred to one of the first three agencies mentioned for dispatching of emergency ambulances or rescue squads.

(1) Los Angeles City Fire Department. For more than three million people residing in the City of Los Angeles, the LAFD is the primary dispatcher and operator of emergency ambulances. (One of these ambulances now operates as a Mobile Intensive Care Unit, carrying certified paramedical attendants.) On receipt of a report, the dispatcher records the following data (see Appendix A, Figure A-1):

- Incident Type
  - Emergency
    - Injury
    - Illness
  - Rescue
  - Fire
  - False Alarm
- Incident Location
- Source
  - Telephone (call-back number)
  - Radio
  - Alarm Box
- Time Report Received
- Time Unit Dispatched
- Unit Number and Type Dispatched
- Time of Arrival On-Scene

- Time Complete at Scene (if not a hospital run)
- Hospital Name (if patient transported)
- Time Complete at Hospital
- Time Return to Quarters

In addition to the above data, a tape recording is made of the original report.

(2) Los Angeles County Sheriff's Department. Within 69 of the 77 incorporated cities in Los Angeles County, as well as in all the unincorporated areas, the Sheriff is the dispatcher of emergency contract ambulances.[1]

Normally the data taken by the dispatcher include (see App. A., Figure A-2):

- Incident Type
  - Illness
  - Injury
  - Drunk
- Incident Location
- Informant Name and Number
- Time Call Received
- Time Ambulance Company and Sheriff's Unit Dispatched
- EAP Case Number
- Hospital Name

In the case of a traffic accident or a respiratory or cardiac call, the Sheriff contacts the Los Angeles County Fire Department for a Rescue Squad.

(3) Los Angeles County Fire Department. On receipt of a report from either the public or the Sheriff's Department, the

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[1] Emergency contract ambulances are vehicles owned and operated by private ambulance companies but under contract to Los Angeles County to provide emergency treatment and transportation in specific areas of the county when contacted by the Sheriff's Department.

dispatcher records the following data (see App. A., Figure A-3).

- Incident Type
  - Emergency
    - Injury
    - Illness
  - Rescue
  - Fire
  - False Alarm
- Incident Location
- Source of Report
  - Telephone
  - Radio
  - Alarm Box
- Informant Name and Number
- Type Unit Dispatched
- Time Report Received
- Time Unit Dispatched

The County Fire Department dispatches Rescue Squads that are capable of two levels of emergency medical treatment but do not transport patients. Level one is basic first aid treatment until an emergency contract ambulance arrives to transport the patient(s), if necessary. Level two is provided by Rescue Squads whose attendants have been trained and licensed as certified paramedics (see Section VIIA); they can administer drugs, defibrillate cardiac victims, and provide other advanced emergency treatment. If a victim is in serious condition, the Rescue Squad attendants may accompany him to the hospital in the contract ambulance.

b. Emergency Vehicle Data. Personnel who operate emergency vehicles that render first aid record information in a log or journal related to the operational and medical aspects of the runs performed. However, these data are collected for patient billing, not for evaluating the operational efficiency or medical effectiveness of first aid service.

(1) Los Angeles City Fire Department. Rescue Ambulances of the City Fire Department complete a Rescue Report, called an F-660 (see App. A, Figure A-4), for every call to which they respond whether or not the call results in the transporting of victim(s). The F-660 represents the most comprehensive emergency report completed by any of the public or private agencies. The F-660 contains the following types of data:

- Time
- Incident Type
- Incident Location
- Injury/Illness Description
- Services Rendered
- Equipment Used
- Outcome of Response
- Disposition of Patient(s)
- Transportation Charges

Most of the objective data on this form are keypunched by the Fire Department and presented as an annual summary report of the rescue services provided in the City of Los Angeles. The annual reports are used as planning aids for projecting future budgets.

(2) Los Angeles County Sheriff's Department. Whenever the Sheriff dispatches a contract ambulance company to an emergency incident an Emergency Aid Plan (EAP) case number is assigned to that call. Additionally, an EAP slip (see App. A, Figure A-5) is completed in triplicate by the deputy sheriff, highway patrolman, or policeman at the

incident scene.[1] This form is initiated for billing purposes and is distributed as follows: page one is for the contract hospital to which the patient(s) are transported; page two is for the sheriff; and page three is for the contract ambulance company providing emergency service.

If the patient is unable to pay for the services rendered, the county guarantees to reimburse the ambulance company and the hospital who provided these services.

The data contained on the EAP slip consist of the following:

- Date
- Incident Location
- Hospital (if patient transported)
- Method of Transport (if other than ambulance)
- Number of Patient(s)
- Patient Names and Addresses
- Ambulance Company
- Time of Dispatch
- Time of Arrival

(3) Private Contract Ambulance Companies. Ambulance companies that have contracted with the county to provide emergency care and transportation services maintain a log or journal, in addition to the EAP slips, on each incident to which they are dispatched by the sheriff. The purpose for which these data are gathered is operational. Data recorded include:

- Name(s) of Patients*
- Number of Patients
- Illness/Injury Type(s)
- Oxygen (if administered)

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[1] A deputy sheriff, highway patrolman, or policeman is dispatched to the incident location if one is not already present for this purpose.

- Special Handling (if extra supplies required)
- Hospital (if transport required)
- Run Code (to hospital)
- Day/Night Call
- Time of Call
- Time Dispatched
- Time of Arrival at Scene*
- Waiting Time at Scene
- Time of Departure*
- Time of Arrival at Hospital*
- Time Available
- Location of Call
- Mileage

The starred items are seldom obtained.

(4) Los Angeles County Fire Department. All Rescue Squads of the County Fire Department maintain a log book on all calls to which they respond. The information contained in these log books consists of the following:

- Patient Name
- Incident Location
- Injury/Illness Type
- Condition of Patient Upon Arrival
- Diagnosis
- Treatment
- Time Dispatch Received
- Time of Arrival On-Scene
- Time in Quarters

It should be noted again that Rescue Squads provide first aid treatment only, and do not provide transportation to hospitals (that service is provided by contract ambulances).

c. Emergency Room Data. Information regarding patients treated in the emergency room (ER) is contained in the ER logbook and the patient's file. In general, ER logbooks indicate the approximate time a patient was delivered to the ER, the patient's name, the ER file number, and whether the patient was admitted to the hospital (including the hospital file number if different from that of the ER).

Contained in the ER file are the following data:

- Injury/Illness Description
- Time of Patient Examination*
- Vital Signs
  - Blood Pressure
  - Pulse
  - Respiration
- Treatment Administered* (including drugs or solutions)
- Patient Disposition

The starred items tend to be more complete if the patient has been admitted.

d. Hospital Data. For patients admitted to the hospital, records are kept of all laboratory tests, surgical procedures, and major medical procedures. Included in the records is a prognosis of the patient's condition at discharge, as well as at the time of each examination. If the patient has to undergo additional care and treatment, the facility to which he is discharged is indicated or the reports of outpatient visits are listed.

2. Limitations, Omissions and Problems with Existing Data Sources

Problems common to all the data sources include the following: (1) system service times are rough estimates (i.e., occurrence, notification, dispatching, arrival on-scene, departure from scene, arrival at hospital, treatment in ER, departure from ER); (2) injuries and illnesses are inconsistently classified and described; (3) there are no "pointers" to link the various data sources in the emergency medical service system;

and (4) most data sources are not computer oriented.

a. Dispatching Data. There are two primary limitations to existing dispatching data forms. First, the formats of the forms are tailored by the dispatching agencies so that they contain wide variations (see App. A, Figures A-1, A-2, and A-3). Second, none of the formats was intended for keypunching.

A data element that seldom appears on these forms is the estimated time of incident occurrence (it should be mentioned that this item is difficult to obtain). Another data element frequently missing is the type of incident.

A problem that the EMS Project encountered in gathering emergency data across agencies was that each emergency system (i.e., City Fire Department, County Sheriff's Department, and County Fire Department) had its own case-numbering method, which linked dispatching data to the emergency vehicle data. Some emergency systems did not possess case numbering systems. This necessitated a collating procedure based on matching times, dates, and agencies.

b. Emergency Vehicle Data. Most emergency vehicle data are kept in log or journal format, which is not amenable to direct data processing. Furthermore, there is variation in the data gathered by different agencies. The greatest limitation is the omission of detailed medical, treatment, and temporal data, which include:

- Patient Injury/Illness Description
- Severity
- Patient Stability
- Patient Prognosis
- Treatment On-Scene Versus Treatment Enroute
- Inclusive Times
- Code of Retrieval Response

A major problem of most emergency vehicle information is the difficulty in linking it to subsequent hospital records if the patient's name is unknown.[1]

c. Emergency Room Data. Data related to ER treatment is piecemeal in that it consists of forms representing the attending physician's or registered nurse's examination of the patient, forms indicating laboratory reports, and forms itemizing drugs administered. Therefore, the primary problem associated with the ER data is the lack of a single form that summarizes services rendered to the patient by clock time and gives a detailed evaluation of the patient's prognosis prior to and subsequent to ER treatment. Finally existing ER data are not amenable to computer data processing so that a summary report is required to consolidate all these data.

d. Hospital Data. For patients admitted to the hospital, records are kept of all examinations, forms are submitted for all laboratory tests, and detailed notes are made of major medical and surgical procedures; however, all these data are in piecemeal form so that again the need exists for a consolidating summary.

3. EMS Project Data Systems

The primary advantages associated with the EMS Project data system include:

- forms that facilitate the use of computer data processing techniques
- uniform data reporting formats across similar emergency agencies
- data linkage between the independent contiguous emergency service agencies by EMS case number
- reporting of all system service times
- provision for reporting comprehensive operational data, medical data, and treatment data

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[1] This is not true of the Los Angeles County Sheriff's Department which assigns to each call an EAP number that is subsequently used by both the contract ambulance company and the contract hospital.

- provision for assessing patient prognosis at several times.

There are five elements of the system for collecting information related to the level of service provided to emergency incident victims (see Table IV-D-1 and Appendix A).

a. Dispatching Data. As can be seen from the ambulance dispatch form (Figure A-6), the data elements from the diverse dispatching agencies (see Figures A-1, A-2, and A-3) have been synthesized into a format which facilitates their evaluation. Several data elements have been added or emphasized on this form; these are the estimated time of incident occurrence, the specific type of incident, and the source of the incident report.

b. Medical Attendant Report. The Medical Attendant Report (Figure A-7) contains two sections; the first half is completed by all emergency vehicle personnel, and the second section is completed only by certified paramedical personnel. Although the questions in the first section of the report appear in order of expected chronological occurrence, they comprise six specific categories of detailed information:

- patient data (1, 4, 5, 6)[1]
- medical data including injury/illness description,
- patient status, and prognosis before and after treatment (20-26, 28, 29, 30)
- treatment data (18, 19, 27, 31, 36, 37)
- operational data (10, 32-35, 38)
- incident data (2, 3, 7, 15, 16, 17)
- system service and response times (8, 9, 11-14)

Section two of the report relates to data associated only with those patients treated by certified paramedics and consists of

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[1]Numbers in parentheses refer to the question numbers on the Medical Attendant Report.

TABLE IV-D-1

EMS PROJECT DATA SYSTEM[1]

FORM:	Dispatching Data →	Medical Attendant Report (see Figure A-7) →	Emergency Room Report (see Figure A-8) →	Hospital Medical Record Abstract →	Three-Month Post Discharge Abstract
COMPLETED BY:	Dispatcher or EMS Staff from Logs	Emergency Vehicle Attendants; During and After Run	Attending Physician or Registered Nurse; During and After Treatment	Registered Nurse; On Release of Patient	Registered Nurse: Three Months after Release of Patient
COLLATED BY:	EMS Case # EAP Case # Time & Date	EMS Case # EAP Case # Time & Date	EMS Case # Time & Date	EMS Case # Hospital #	EMS Case # Hospital #
	Element One	Element Two	Element Three	Element Four	Element Five

[1]Data flow is indicated by arrows. Element three is completed if patient is transported to emergency room. Elements four and five are completed if patient is admitted to hospital.

three specific categories of information:

- detailed medical data (39, 40)
- telemetry and communications data (40, 41)
- treatment data by time (40, 43-46)

In actual use in the field, the Medical Attendant Report and the Emergency Room Report (described under "c" below) were printed on the two sides of a single sheet of legal-sized paper. Two such sheets, one yellow and one white, were then bound together with an interleaved carbon. As the medical attendant completed the portions of the form relevant to his functions, he simultaneously created a carbon copy of his notations on the reverse side of the Emergency Room Report. The medical attendant retained his original (the white copy). The yellow copy (that is, the ER Report) accompanied the patient into the emergency room. This duplication provided the ER personnel with data that might be of medical assistance and that would not otherwise have been available.

c. Emergency Room Report. The ER Report (Figure A-8) represents a single source upon which all ER data can be summarized by the attending physician or nurse. These data cover the following categories:

- patient identification and disposition (63, 65)
- medical data including injury/illness description, patient status, prognosis, stability (49-57, 61, 62)
- treatment including comments and suggestions and attendant care (58, 59, 60, 64)
- operational (67)
- system treatment and departure times (47, 48)

These data augment and amplify those supplied by the attendant and identify the disposition of the patient (i.e., question 63) or point to the hospital records for additional data for admitted patients.

d. Hospital Medical Record Abstract. This data form (Figure A-9) represents a repository of all the medical, treatment, and patient information associated with the patient's stay in the hospital. It is only from these data that initial assessments can be made of the medical outcome of those patients who were transported and subsequently admitted to the hospital.

These data include the following categories:

- patient identification (1, 2, 3, 6, 11, 14)
- medical, including complications, discharge diagnosis, and status (10, 12, 13)
- treatment including surgical and major medical procedures (7, 8, 9)
- operational (4, 15)

e. Three-Month Post Discharge Medical Record Abstract. The data provided on this form (Figure A-10) enable an accurate assessment of the patient's medical outcome on the basis of any readmissions or outpatient visits that occurred within three months from the hospital release date. These data augment those of the hospital abstract within most of the same categories:

- patient identification (1, 2, 3)
- medical-patient status (8)
- treatment (5, 6, 7)
- operational (4)

4. Problems and Inadequacies in the EMS Data System

Two types of problems were encountered in the use of the EMS data forms--those relating to their utilization by dispatching, ambulance and hospital personnel, and those relating to their design.

a. Personnel and Organizational Problems. In some instances there were differences between the data requirements of the participating agencies and those of the EMS Project, which necessitated a change in the normal working procedure of some personnel.

- Most dispatchers were not normally required to ascertain the time of incident occurrence so these personnel had to be briefed as to additional data requirements. However, there were varying degrees of cooperation across the participating agencies which necessitated the continuous briefing of personnel throughout the Project's duration.

- Many ambulance attendants preferred not to answer the question regarding patient prognosis before and after treatment, either because they did not understand the question or because they did not feel competent to respond; the problem was partially resolved by more precisely defining the purpose of the question.

- Owing to heavy work loads or acts of omission, personnel involved in completing the medical attendant reports and the emergency room reports would collect a number of forms and complete them at one time. Since this technique seriously affected the reliability, accuracy, and completeness of patient case histories, direct and continuous contact with these personnel was required.

- Time changes across system boundaries sometimes caused inconsistencies in service times. The effect was brought about by the fact that the dispatcher's clock, the attendant's watch, and the emergency room clock were not synchronized.

b. Design Problems. The primary problem attributable to the design of the data system was the difficulty associated with identifying the patient who was involved in the use of emergency services more than once during the course of the EMS Project. Identifying these patients is important in order to determine whether the subsequent use of the services was attributable to the initial injury/illness. Since the emergency cases are identified by number rather than by patient name, repeated use of the system by a specific patient could not be identified until that patient was admitted to the emergency room or hospital.[1]

One possible way of remedying this problem would be to change the EMS case numbering system to include a decimal figure representing a patient's repeated uses (i.e., EMS #1234.1, #1234.2, etc.). The identification would be accomplished at the time of completion of either the Hospital Release Abstract or the Three-Month Post-Discharge Abstract.

A second design problem concerned the use of the "comments" sections of the data forms. In practice, these portions of the forms were little used, and the comments that did appear were of low utility. A way of improving the quality of these data would be to ask questions on the data forms that would serve to direct the responses in these "free-form" areas of the data retrieval instruments. Personal interviews with the medical attendants could also augment the amount and relevance of information gathered.

[1]At some hospitals, a patient is assigned a new file number each time he enters the hospital; therefore, it is possible that his subsequent admissions may not be identified for the purposes of the Project even at Elements Three and Four in the data stream.

V. STUDIES OF THE EXISTING SYSTEM BASED ON AVAILABLE DATA

A. ANALYSIS OF DEMAND BY MULTIPLE REGRESSION METHODS

Although both private and public sectors provide services for the victims of medical emergencies, the public sector carries the primary responsibility in many areas. Public agencies may provide ambulance and/or emergency medical facilities directly, or by contracting with the private sector to provide them. A significant problem in planning for the provision of public emergency medical services is to estimate the demand for these services and to discover the factors that give rise to such demand.

As indicated earlier in this text, the source from which the victim of a medical emergency (or those acting on his behalf) will seek assistance is influenced by a large number of factors. However, it is possible to examine the demand for public emergency medical services against the background of an existing situation--a situation in which the exact nature of the complex process of individual reaction to the stress of an emergency is relatively unimportant. The occurrence of any particular incident that leads to a demand on the public sector may appear to be random, but the occurrences of many apparently random incidents may follow recognizable patterns. Conditions may exist that render incidents more likely to occur in one location than in another. It may not be possible to deduce precisely what these conditions are, but it may be possible to identify characteristics that are excellent surrogates for the conditions themselves.

The characteristics of a geographic area (e.g., urban or rural, residential or commerical) and the characteristics of the people who live and work there provide a promising base from which to explore patterns of incidents and incident types. To make such studies readily, the investigators must be able to gain access to existing sources of data concerning two topics: the frequency with which emergency incidents occur in a given location, and the characteristics of that location.

Typically, records containing information on the first topic are kept by public agencies. The agencies either operate ambulance services and emergency hospitals, or contract with some other entity to perform these functions. In either case, the public agency maintains records of ambulance runs and of visits to the emergency treatment facilities.

Ideally, information on the second topic would be gathered with respect to geographic areas uniquely defined for the purposes of a specific study. Practically speaking, there is only one general system of geographically defined areas for which demographic and socio-economic data are readily available. It is the one used by the U. S. Bureau of the Census, which subdivides the nation into census tracts.

Since census tracts are entities arbitrarily defined for another purpose, they may not be entirely appropriate as units for planning a study of emergency medical demand, they may complicate the analysis of demand because of the wide variances from tract to tract. A few brief comments on the census tract system in the City of Los Angeles will illustrate these problems.

Within Los Angeles, as shown in Figure V-A-1, there are 632 census tracts. These tracts exhibit vast differences in size, income, employment, and other characteristics. Based on the 1960 census,[1] population per census tract ranged from zero to 10,108, with a mean of 3,920. The size of the tracts ranged from 63 acres to 7,842 acres. White population per census tract had a mean of 82.4 percent, with a standard deviation of 6.8 percent. The proportion of the population over 65 years of age had a mean of 10.5 percent, with a standard deviation of 6.8 percent. For men, the median age across census tracts was 32.7 years; for women, it was 34.9 years. The mean of age within individual census tracts ranged from 8.9 years to 60 years. Median income had a mean of $7,148 and a standard deviation of $2,928, with a range from $2,345 to $35,000. The proportion of families whose income was less than $4,000 averaged 5.7 percent, with a standard deviation of 3.3 percent. Finally, employment per

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[1] The Project's studies of the demand for public medical emergency services were conducted before the 1970 census data were available.

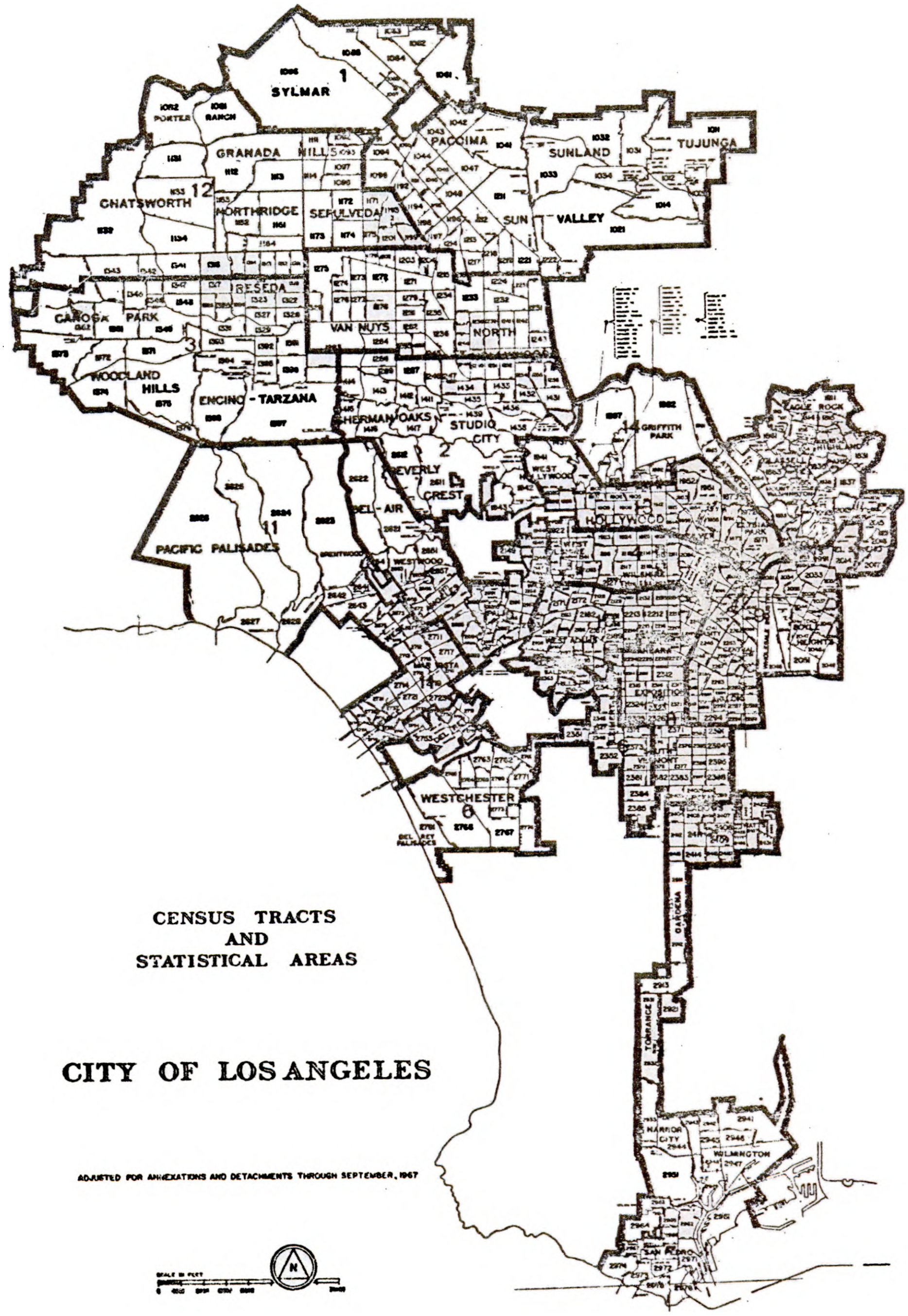

FIGURE V-A-1

CENSUS TRACT MAP OF LOS ANGELES

census tract ranged from zero to 46,543, with a mean of 1,308.

What the Project wished to study was the feasibility of using census data of the kind described, along with historical records of emergency incidents, to predict the demand for public emergency services. The method employed was multiple regression analysis. The number of incidents leading to demand for public services in a specified time period, and within a given census tract, can be assumed to be a linear function of the geographic, socio-economic, and demographic characteristics of the census tract (and possibly of the characteristic of the emergency service itself). The following estimation equation describes the number of occurrences of incidents leading to a demand for emergency medical services as a linear function of such characteristics.

$$Y_j = \alpha_o + \sum_{k=1}^{s} \alpha_k X_{kj} \qquad (1)$$

Where the subscript j represents the j^{th} census tract, k denotes the k^{th} characteristic (from a set of characteristics whose total is s), Y_j is total demand for the emergency medical service under study in the j^{th} census tract, and α_k reflects the contribution per unit of the k^{th} characteristic, X_{jk} being the value of that characteristic in the j^{th} census tract. We assume that the linearity of the model is a reasonable approximation to a much more complicated specification. Each coefficient α_k indicates the change in demand Y_j that would result from a unit change in characteristic X_{kj} in a given tract, assuming all other factors were held constant.

This kind of statistical estimation can be used to predict the total demand for a defined emergency medical service arising in a census tract from the occurrence of incidents of all types. The method involved screening a large set of potentially explanatory variables that characterize the census tracts (and, if desired, the emergency medical system) for which demand is to be predicted. By the use of stepwise multiple regression analysis, independent variables are selected one at a time from among the set. The first variable selected is that which explains the largest amound of variation in the dependent variable. The next variable selected is that which explains the largest amount of residual variation. And so on. The outcome is an ordered set of independent variables that best predicts the total demand for some particular, defined emergency medical service. As a consequence, the set of independent variables will vary from analysis to analysis (i.e., as different services are defined). For example, the set of independent variables that is the best predictor with respect to ambulance services will be different from the set that is the best predictor with respect to emergency rooms.

This same method of selecting independent variables can be used to predict demand arising from subcategories of incidents, such as automobile accidents. As before, this differing analysis can be expected to generate a different set of independent variables. However, it is possible to constrain the analyses of the demands arising from subcategories of incidents for the purposes of analytical economy and consistency. Logically, the set of variables included in predicting the demand for a given emergency medical service arising from subcategories of incidents that represent the disaggregation of the total is constrained to be the same as that set of variables found to be the best predictor of total demand. Constraining in this manner sacrifices some predictive capability at the level of subcategories, but it permits the predictive models to be organized around a consistent set of variables.

The occurrence of any specific subcategory of incidents in a census tract (giving rise to the demand of interest) can also be represented as a proportion of the total number of incidents occurring within that census tract. Analysis can determine the probability of demand resulting from the occurrence of any specific incident type by considering the proportion of that incident type arising in a census tract to be a linear function of the geographic, socio-economic, and demographic characteristics of the tract (and, if desired, of the emergency medical service itself). Thus we can formulate a system of equations, each of which is representative of the demand arising from a given incident type. These equations predict the percentages of total demand that result from the different incident types, and can be written as:

$$p_j^i = {y_j^i}/{y_j} = \alpha_o^i + \sum_{k=1}^{s} \alpha_k^i X_{kj} + u_j^i , i = 1, . . . m; \quad (2)$$

where the superscript i designates the i^{th} type of incident, y_j^i is the demand for service resulting from the occurrences of incident type i in census tract j, y_j is the total demand resulting from incidents of all types in census tract j, α_k and X_{kj} are defined as in Equation (1), and u_j is a normally distributed error term $N(0,\sigma)$ independent of the X_{kj}. Each coefficient α_k^i indicates the change that would occur in the percentage of all demand in the j^{th} census tract resulting from the i^{th} type of incident if there were a unit change in the characteristic X_{kj} in that tract, assuming all other factors were held constant.

B. CLASSIFICATION OF INCIDENTS

In addition to considering the total number of incidents leading to demands for emergency medical services, many planning and evaluative activities require some disaggregation of the total. There are innumerable ways in which incidents may be classified. Two salient points must be considered in developing such a classification system.

First, the incident type must be definitive of the injury or illness. If the incident types are too broad, knowledge about the number of a given type that may be expected loses value because the treatment of the illnesses or injuries within the incident type will be too varied. For example, the definition of an incident type such as "external injuries" would be of little value, since the varieties of skills and equipment required to treat such injuries would differ considerably. On the other hand, too detailed a categorization must also be avoided. A classification system yielding a category such as "minor fracture of the forearm" leads to such numerous incident types that the benefit of any statistical analysis is substantially decreased.

Second, the incident types should be of a nature that one might expect to depend on definable characteristics. For example, heart attacks seem to be highly correlated with age and hence should not be included in a general category called "chest problems," where their dependence on age could be lost in the presence of other conditions (such as asthma, traumatic chest injuries, etc). Both the effect and its possible cause must be considered in the determination of any structure of incident types.

Most classification schemes use one of the following seven basic methods of categorization (or some combination of these basic methods). These classifications are by no means mutually exclusive, but merely reflect different emphasis in categorization.

(1) Causal Mechanism

- Illness
- Accident
- Psychiatric
- Assault
- Attempted suicide
- Obstetrical, rape
  (etc.)

(2) Location

- School or recreational area
- Home or private yard
- Office or commercial building
- Factory
- Residential street
- Business street
- Freeway
- Rural street or road
- Rural open county
  (etc.)

(3) Part of Body

- Head and neck
- Eye
- Back
- Chest
- Abdomen
- Pelvis
- Extremities
  (etc.)

(4) Type of Injury

- Fractures
- Lacerations
- Contusions
- Abrasions
- Burns
- Dismemberment
  (etc.)

(5) Illness or Injury

- Heart arrest
- Hemothorax
- Rupture of intra-abdominal vessels and/or organs
- Diabetes
  (etc.)

(6) Bodily System

- Skeletal
- Respiratory
- Cardiovascular
- Skin
- Urinary
- Reproductive
- Digestive
- Nervous

  (etc.)

(7) Medical Specialty

- Psychiatry
- Obstetrics
- Ear, eye, nose, throat
- Internal medicine
- Genito-urinology
- Gastro-intestinal
- Neurology
- Cardiology
- Orthopedics

  (etc.)

For historical studies, the choice of an appropriate classification scheme depends on the kinds of data available and on the purpose of the study. In the following description of the two EMS Project studies, an explanation is given of the considerations that dictated the choice of classification scheme in each case.

C. THE DEMAND FOR PUBLIC AMBULANCE SERVICES

As an example of how multiple regression analysis can be used to predict and explain the demand for public ambulances, we studied historical data for the City of Los Angeles. Los Angeles was selected because it could provide the best source of data. Ambulance attendants complete a report form for every public emergency ambulance run performed. These forms include information on the time required to get to an incident, the nature of the emergency, and its location. These forms are filed in booklets of 25 and stored at Central Receiving Hospital by ambulance station and year.

An examination of the records revealed that complete data were available for the calendar years 1964, 1965, 1966, and 1967, with one exception which did not become evident until sampling was completed.[1]

For the period studied, 1964 to 1967, the City of Los Angeles used three modes to provide public ambulances for transporting the victims of medical emergencies. In the western and harbor areas, the City contracted with private ambulance services to respond to public calls and transport the victim to a specified contract hospital emergency room. In the San Fernando Valley section of the city, ambulances were provided by the Los Angeles City Fire Department. In the downtown area, service was provided by ambulances of the Los Angeles Central Receiving Hospital Department. Some changes took place in the public system over the period of the study. For most of the first three years, no change was made for ambulance services. Late in the third (1966), a fee system was instituted stipulating that all people transported to a hospital were to be charged for this service. The billing procedures for this fee system were not fully operational during 1967; hence, its impact on demand was somewhat attenuated. This source of variance has also been considered in analyzing the data.

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[1] The private ambulance firm providing service in the West Los Angeles area of the city ceased filing tickets midway through 1967 owing to contractual difficulties. The problem was noted and dealt with in subsequent analysis.

1. Classification of Incidents

The code used by the City of Los Angeles for its public emergency ambulance is shown in Table V-C-1. It is a two-mode classification by type of incident and by type of illness or injury. This classification was judged to be too complex for our study. The following set of six categories was developed jointly by the physicians and systems analysts for the study of the demand for public ambulance services:

automobile accidents
other accidents
suspected cardiac cases
suspected poison cases
other illnesses
ambulance dry runs[1]

2. Sampling Plan

Figures obtained from the Central Receiving Hospital indicated that approximately 317,049 ambulance tickets were filed at Central Receiving Hospital during the years 1964 through 1967. Given the Project's limitations on time and funds, we could not examine the 75,000 public ambulance runs made each year in the City of Los Angeles. A statistical sample of four percent was taken.

A systematic sampling procedure was facilitated by the manner in which the data were stored, but it was necessary to compensate for the fact that ambulance tickets were sometimes used by attendants to record time away from the station not connected with public emergency runs. The policy for recording such nonemergency runs was not consistent across all ambulance stations. It was therefore necessary to adjust the sampling procedure to maintain consistency. Forms that had been used for recording time spent refueling, repairing vehicles, eating, and performing nonemergency trips and emergency runs aborted before reaching the scene were eliminated, and a procedure of sampling approximately five percent (or every 21st form of the remaining forms) was used.

[1]Runs in which the ambulance crew could not locate the victim or found that the matter had been handled before its arrival.

TABLE V-C-1

THE CITY OF LOS ANGELES CODE FOR INCIDENT TYPES

CODE	TYPE OF INCIDENT	CODE	
101	Accident-Auto	201	Asphyxiation
102	Accident-Home	202	Burns
103	Accident-Industrial	203	Convulsions or Seizure
104	Accident-Miscellaneous	204	Drowning or Near Drowning
105	Accident-Playground	205	Drug Reaction
106	Animal Bite	206	Electric Shock
107	Assault or Fight	207	Fever
108	Drowning or Near Drowning	208	Gun Shot
109	Heart Attack	209	Heart Symptoms
110	Homicide or Attempted Homicide	210	Hemorrhage
111	Mental or Emotional	211	Injury
112	Obstetrics	212	Intoxication
113	Respiratory Problem	213	Mental or Emotional
114	Return by Radio	214	Obstetric
115	Sick Call (Bedside)	215	Respiratory Problems
116	Sick Call (Misc.)	216	Stroke
117	Stroke	217	Suffocation (Plastic Bag)
118	Suicide or Attempted Suicide	218	Unclassified
119	Unclassified	219	Unconsciousness

This procedure yielded a sample of 14,345 cases, broken down yearly as follows:

1964......3,400;

1965......3,509;

1966......3,781;

1967......3,655.

The distribution of incident types in the sample compares favorably with the expected percentage distribution (see Table V-C-2).

TABLE V-C-2

PERCENTAGE DISTRIBUTION OF CASE TYPES, EXPECTED VS. SAMPLED

Incident Type	Expected Occurrence	Occurrences in Sample
Automobile Accidents	0.263	0.279
Other Accidents	0.272	0.190
Cardiac cases	0.039	0.053
Poison cases	0.022	0.040
Other Illness	0.342	0.330
Dry Runs	0.062	0.104

3. Data

The forms used by the ambulance attendants contained entries recording the following kinds of information:

- ambulance station
- date
- time at which the ambulance left the station
- time at which the ambulance arrived at the scene of the incident
- location of the incident
- incident type

The Project was therefore able to collect large amounts of data on all these variables and to derive from them other factors (such as elapsed times).

The 1960 census was used for socio-economic variables. Comparable data would be available in any community. Land-use data were obtained from another group within UCLA's Graduate School of Managment.[1] Comparable information on zoning, for example, would be available in other communities.

Other data, such as the number of physicians practicing in a census tract and the distance from the centroid of the census tract to the nearest hospital with an emergency room, were determined specifically for the study.

4. Model

Demand for public ambulances was examined as a linear function of several factors:

- socio-cultural variables
- economic variables
- land-use variables
- variables in the public emergency ambulance system itself
- variables having to do with alternative medical systems in the census tract in which the incident occurred.

The predictive equations were estimated by least squares regression analysis. The linearity of the model is regarded as a reasonable approximation to a much more complicated function that is not amenable to specification.

An indication of the efficiency of an ambulance service is the average response time (the elapsed time between the receipt of a request for an ambulance and its arrival on the scene). This time is determined by the dispatch procedure, the availability of an ambulance, and travel to the scene. A long response time could lead people to choose an alternative means of transportation. Although most users are probably not

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[1] Housing, Real Estate and Urban Land Studies, Graduate School of Management, University of California, Los Angeles, Combined Housing and Socioeconomic Data for the 1297 Los Angeles County Census Tracts From the 1960 Census, (tape), 1965.

aware of average response time, many, such as the police, have had direct experience and have a feeling for whether or not the ambulance arrived promptly. A variable indicating mean ambulance travel time for each census tract was included in the analysis as a partial indication of this factor. No data were available to indicate the total response time.

Data were collected on alternative sources of medical care. These data included the number of physicians practicing in a tract, the distance to the nearest hospital with an emergency room set up to handle medical emergencies, and the distance to the nearest contract emergency hospital. The distance data have the undesirable characteristic of giving a zero distance when a hospital is located in a census tract. For accidents occurring close to a hospital, the distance measure is a poor indicator of the convenience with which the hospital can be reached. It was not surprising that the distance variables contributed nothing to the analysis and were later dropped. Similarly, data on the number of physicians whose offices were in the tract did not add to the analysis.

Within the City of Los Angeles, several different dispatch procedures were employed and an attempt was made to isolate their varying effects on demand. In some areas, calls are screened by a registered nurse, who makes a decision as to whether the call warrants an ambulance. However, in the areas where firemen or police handle dispatching no screening takes place. A dummy variable was employed to differentiate census tracts in areas where most calls are screened.

As noted above, total demand for public ambulance service was disaggregated into categories by type of incident. The categories were analyzed with subsets of the variables used to predict total demand. Table V-C-3 presents a list of the variables used in the analysis.

5. Empirical Results

A number of similar models were estimated. First, we aggregated all four years and estimated a demand relation for each category.

TABLE V-C-3

VARIABLES USED IN ANALYSES OF THE DEMAND FOR PUBLIC AMBULANCE SERVICE IN THE CITY OF LOS ANGELES

Variables	Mean	Standard Deviation	Description
Total demand[1]	.144	.241	Number of calls per capita by public ambulances in this census tract during 1964-1967
Auto accidents	.038	.052	Number of calls per capita arising from automobile accidents
Other accidents	.030	.082	Number of calls per capita arising from accidents other than auto
Cardiac	.007	.006	Number of calls per capita involving heart attacks
Poison	.005	.004	Number of calls per capita involving poison
Other illness	.049	.116	Number of calls per capita involving an illness other than heart attack or poison
Dry runs	.014	.019	Calls per capita in which the driver could not locate the patient or in which the incident was handled before the ambulance arrived
1. Constant term[2]	---	---	
2. Housing density	.382	.129	Number of housing units per capita in tract
3. Recently moved	.151	.075	Percentage of individuals who moved into the tract during the two years before the census was taken
4. White population	.824	.290	Percentage of population that is white

[1] When each year's demand is divided by population and the years are pooled, the result is .030 (mean) and .028 (standard deviation).

[2] See Table V-C-4; the value of the constant term varies with the variable being predicted.

Variable	Mean	Standard Deviation	Description
5. Percent over 65	.105	.066	Percentage of population over 65 years of age
6. Percent single females	.190	.084	Percentage of population that is female, over 14, and unmarried, separated, divorced, or widowed
7. Percent single males	.113	.058	Percentage of population that is male, over 14, and unmarried, separated, divorced, or widowed
8. Percent poor families	.057	.033	Percentage of population with a family income less than $4,000
9. Percent males unemployed	.019	.014	Percentage of population that is male and unemployed
10. Percent males employed	.262	.049	Percentage of population that is male and employed
11. Percent females in labor force	.158	.059	Percentage of population that is female and either employed or looking for a job
12. Total employment	.576	2.833	Number of persons employed in census tract divided by number of persons residing in tract
13. Percent non-children	.749	.111	Percentage of population 15 years of age and over
14. Percent single white males	.139	.095	Percentage of population that is white, male, and unmarried, separated, divorced, or widowed
15. Percent married whites	.466	.074	Percentage of population that is white and married
16. Percent male farmers	.009	.027	Percentage of working males residing in tract who are employed as farmers

	Variable	Mean	Standard Deviation	Description
17.	Percent males in aggregated occupations[1]	.513	.090	Percentage of working males residing in tract who are employed as managers, clerks, salesmen, craftsmen, and laborers
18.	Percent males in household service	.084	.057	Percentage of working males residing in tract who are employed as household workers or in other household service
19.	Percent females in aggregated occupations	.912	.074	Percentage of working females residing in tract who are employed as professionals, managers, clerks, craftsmen, operatives, in household service, or in other service
20.	Percent female farmers	.003	.040	Percentage of working females residing in tract who are employed as farmers or farm managers
21.	Percent female laborers	.005	.010	Percentage of working females residing in tract who are employed as general laborers
22.	Acres per capita	.156	.825	Total tract acreage divided by tract population
23.	Percent commercial land	.077	.092	Percentage of tract acreage in commercial use
24.	Percent industrial land	.039	.080	Percentage of tract acreage in industrial use
25.	Percent transportation land	.012	.051	Percentage of tract acreage in transportation use

[1] The names of these variables are not identical with occupation titles used by the Bureau of the Census. For the purposes of our analysis, several census categories of male (or female) occupation were summed in this composite group. It should also be noted that the three variables referring to male occupations (as well as the three variables referring to female occupations) were not exhaustive of all the occupational categories included in the census data; we analyzed only a selection of occupations, either separately (variables 16, 18, 20, and 21) or under composite headings (variables 17 and 19).

	Variable	Mean	Standard Deviation	Description
26.	Freeway	.316	.465	A variable taking on a value of 1 if a freeway runs through the census tract (and 0 otherwise)
27.	Ambulance response time	10.037	2.973	The average time (in minutes) from ambulance call to ambulance arrival
28.	Area #1	.283	.451	San Fernanco Valley (served by fire department, which did not screen incoming calls on medical grounds)
29.	Area #2	.019	.137	Central and eastern area (with screening by nurse on medical grounds)
30.	Area #3	.046	.209	Western area(with screening by nurse on medical grounds)
31.	Area #4	.022	.147	Westchester area (with screening by nurse on medical grounds)
32.	Area #5	.051	.219	Harbor area (served by contract ambulance company, with dispatching by the police department which did not screen incoming calls on medical ground)
33.	Area #2 in 1967	.011	.105	

To ascertain possible underreporting bias,[1] we fit relations for 1964-66 and 1967 separately.

While the four percent sample was an adequate representation of the total demand, it introduced large sampling errors when disaggregated categories of incidents were being analyzed. To lessen the importance of sampling error, we aggregated the 632 census tracts into 157 contiguous areas. Using these reaggregated data, we refit the 1964-67 relations. In all cases, the results of the analysis of the contiguous areas were similar to the original analysis. This similarity suggested that sampling errors were not important.

We extended the analysis of the re-aggregated data by analyzing cardiac and poison categories separately. Finally, we pooled all years to get 628 (4 X 157) sample points to examine changes in demand over time. Since many of the fitted relationships replicate one another, Table V-C-4 includes only a few of each kind (by pooled years, by census tract, and by aggregated data).

The model explains total demand with a high degree of accuracy, yielding a coefficient of determination (R^2), when adjusted for lost degrees of freedom, of .927; the F-statistic is 275 with 31 and 600 degrees of freedom (F must be greater than 1.70 for a level of confidence of .99). The regressions explaining subcategories are nearly as good, since the lowest coefficient of determination (for poisoning) is .444. In all of the regressions reported, the F-statistic implies that one can be confident at extremely high levels (considerably beyond .99) that the regressions explain a significant amount of variation in the dependent variables. One might further note that R^2 is directly proportional to the mean of the dependent variable across regressions. We concluded that this result follows from sampling error, as discussed above.

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[1] As previously noted, during the second half of 1967, the private ambulance company responsible for one section of the city failed to report all of its calls.

TABLE V-C-4

MODELS OF PUBLIC AMBULANCE DEMAND

Disaggregated Demand by Type of Incident

	Variables	Total Demand[1/]	Pooled Years[3/]	Auto Accidents[4/]	Other Accidents[4/]	Other Illness[4/]	Dry Runs[4/]	Cardiac[5/]	Poison[5/]
	R^2	.927	.904	.672	.857	.865	.597	.731	.444
	Degrees of Freedom	600	592	600	600	600	600	125	125
1.	Constant term	161 (3.14)[2/]	-1 (-0.07)	5 (.20)	72 (2.94)	67 (1.99)	9 (0.96)	6 (0.47)	-6 (-0.45)
2.	Housing density	-534 (-6.30)	-43 (-1.74)	135 (3.48)	-273 (-6.80)	-391 (-7.04)	31 (1.95)	29 (1.77)	-11 (-0.70)
3.	Recently moved	593 (5.74)	151 (5.40)	-206 (-4.38)	283 (5.78)	451 (6.67)	-11 (-0.56)	10 (0.59)	24 (1.66)
4.	White population	-98 (-5.09)	-19 (-4.64)	-15 (-1.70)	-38 (-4.12)	-39 (-3.11)	-5 (-1.41)	-4 (-1.30)	1 (0.30)
5.	Percent over 65	838 (7.19)	131 (4.82)	-78 (-1.46)	262 (4.73)	598 (7.82)	11 (0.50)	38 (1.94)	4 (0.25)
6.	Percent single F	-455 (-2.45)	-120 (-2.77)	-188 (-2.22)	140 (1.59)	-308 (-2.54)	-129 (-3.70)	-15 (-0.38)	28 (0.77)
7.	Percent single M	929 (4.92)	206 (4.91)	-233 (-2.72)	398 (4.44)	716 (5.79)	41 (1.16)	-25 (-0.81)	6 (0.30)
8.	Percent poor families	705 (4.12)	160 (3.55)	139 (1.78)	259 (3.19)	177 (1.58)	43 (1.35)	16 (0.53)	125 (4.47)
9.	Percent M unemployed	1563 (4.61)	346 (3.11)	28 (.18)	279 (1.73)	1129 (5.09)	214 (3.36)	-86 (-1.18)	-80 (-1.22)
10.	Percent M employed	1324 (10.88)	216 (5.58)	-175 (-3.15)	669 (11.59)	789 (9.90)	-36 (-1.56)	-5 (-0.20)	57 (2.62)
11.	Percent F labor force	-143 (-1.17)	-164 (-6.82)	98 (1.77)	-146 (-2.53)	-61 (-0.77)	11 (0.50)	-51 (-2.52)	36 (1.94)
12.	Total employment	49 (37.24)	9 (14.13)	12 (20.39)	13 (20.67)	17 (19.52)	4 (16.16)	2 (4.77)	1 (2.27)
13.	Percent children	519 (3.46)	14 (.62)	-219 (-3.20)	323 (4.53)	-416 (-4.23)	-21 (-0.74)	-11 (-0.44)	46 (2.00)
14.	Percent sing. wh. M	428 (3.79)	-27 (-1.38)	57 (1.11)	64 (1.19)	258 (3.49)	46 (2.15)	9 (0.45)	22 (1.13)
15.	Percent married whites	125 (1.01)	-26 (-1.39)	-97 (-1.73)	112 (1.93)	117 (1.45)	-9 (-0.37)	-2 (-0.10)	11 (0.56)
16.	Percent M farmers	-417 (-2.46)	-56 (-1.38)	-24 (-.31)	-228 (-2.84)	-155 (-1.39)	-3 (-0.11)	-44 (-1.53)	57 (2.62)
17.	Percent M agg. occ.	179 (3.01)	17 (1.16)	-179 (-6.61)	171 (6.07)	190 (4.88)	-24 (-2.17)	5 (0.48)	-44 (-1.69)
18.	Percent M house. serv.	-44 (-0.50)	106 (4.08)	-218 (-5.40)	90 (2.13)	104 (1.80)	-35 (-2.11)	8 (0.46)	11 (1.21)
19.	Percent F agg. occ.	-180 (-3.00)	-6 (-0.28)	94 (3.40)	-147 (-5.14)	-127 (-3.22)	20 (1.75)	-7 (-0.42)	2 (.10)
20.	Percent F farmers	1313 (4.60)	34 (0.21)	-917 (-7.04)	1059 (7.82)	1317 (7.04)	-170 (-3.18)	24 (0.21)	210 (2.07)
21.	Percent F laborers	220 (0.72)	-209 (-2.08)	539 (3.86)	-550 (-3.78)	122 (.61)	99 (1.71)	2 (0.03)	-213 (-3.51)
22.	Acres/capita	36 (2.66)	12 (2.69)	41 (6.62)	-2 (-0.30)	-5 (-0.61)	7 (2.67)	0 (0.00)	3 (1.18)
23.	Percent comm. land	170 (3.03)	11 (.87)	76 (2.97)	-5 (-0.20)	88 (2.39)	2 (0.20)	-4 (-0.49)	-8 (-1.02)
24.	Percent indust. land	-129 (-3.07)	11 (1.33)	-1 (-0.04)	-40 (-2.02)	-83 (-3.01)	1 (0.19)	10 (1.85)	1 (0.23)
25.	Percent transp. land	-137 (-2.36)	-1 (-0.11)	35 (1.30)	-60 (-2.16)	-93 (-2.45)	-7 (-.61)	-2 (-0.28)	-5 (-0.79)
26.	Freeway	7 (1.22)	-1 (-0.26)	16 (5.90)	-3 (-1.20)	-7 (-1.73)	2 (1.78)	0 (0.00)	1 (0.23)
27.	Amb. response time	-1.3 (-1.23)	-0.1 (-0.78)	-0.6 (-1.32)	-0.1 (-0.97)	-0.3 (-0.42)	-0.1 (-0.21)	-0.2 (-1.31)	0.0 (0.00)
28.	Area #1	10.9 (1.07)	3.9 (2.34)	3.6 (.78)	-1.6 (-0.34)	-4.4 (-0.66)	7.7 (4.06)	2.9 (2.37)	2.8 (2.52)
29.	Area #2	-16.1 (-0.77)	-6.4 (-1.93)	-3.7 (-0.38)	-1.4 (-0.14)	-6.8 (-0.50)	-3.9 (-0.98)	1.0 (0.48)	-1.0 (-0.53)
30.	Area #3	-4.1 (-0.28)	1.3 (.53)	-1.5 (-0.22)	-.1 (-0.00)	1.1 (.12)	-5.2 (-1.92)	1.2 (0.77)	1.9 (1.31)
31.	Area #4	2.7 (.13)	-3.5 (-0.93)	-17.2 (-1.79)	7.8 (.78)	11.7 (.85)	-2.4 (-0.61	1.0 (0.38)	2.5 (1.08)
32.	Area #5	25.8 (1.75)	-0.4 (-0.15)	14.8 (2.20)	6.6 (.95)	2.7 (.28)	.6 (0.20)	-1.2 (-0.74)	.6 (0.39)
33.	Area #2 in 1967		-10.4 (-2.78)						
	1964		-3.5 (-3.46)						
	1965		-2.8 (-2.75)						
	1966		.5 (.52)						
	1967		0 (---)						

1/ Ambulance calls per capita, for each census tract, summed over 1964-7 and multiplied by 1000.

2/ The figure in parentheses is the t-statistic.

3/ Total calls per capita (157 areas) pooled for all four years (times 1000).

4/ Calls per capita per census tract, summed over 1964-7.

5/ Calls per capita for the aggregated data (157 areas) summed over 1964-7.

The regression coefficients are to be interpreted as described in Section V-A, above. For example, for total demand, the coefficient value of -98 associated with white population (Variable 4) means that an absolute increase of one percent in the white population of a census tract would decrease the total per capita demand for ambulance service in that census tract by 0.098, assuming all other factors remained constant.

In the interpretation of the influences of the variables on the demand per capita for public ambulances, only those variables were considered whose regression coefficients had t-statistic values indicating that the coefficients differed from zero by a statistically significant amount. If the regression coefficient is not significantly different from zero, it can be assumed that the variable has little or no influence on demand. For the size of the sample used in this study, there is a probability of only 10 percent that a regression coefficient whose true value was zero would have an associated t-statistic value of 1.65. A t-statistic value of 2.58 can occur only one percent of the time when the true value of the regression coefficient is zero. The total demand per capita for public ambulance transportation is influenced by 21 variables the t-statistics of whose regression coefficients are sufficiently large to be taken as different from zero.

One must be careful in interpreting many of the variables. Population characteristics and land-use variables are measured relative to an excluded category. Thus, the negative sign of the regression coefficient for non-children (Variable 13) and the positive one for people over 65 (Variable 5) mean that children aged 14 and under and persons over 65 generate more calls than do people aged 15 to 64, though the latter category is not, in itself, represented by a variable in our study.

The percentage of single males (Variable 7) and the percentage of single white males (Variable 14) had positive regression coefficients while the percentage of single females (Variable 6) had a negative one. Single females generated fewer calls and single men more calls than married persons.

Housing density[1] (Variable 2) was negatively related to total demand. The percentage of poor families (Variable 8) and percentage of males unemployed (Variable 9) were positively related to total demand. These factors suggest that census tracts having a low socio-economic status create above-average demands for public ambulance services. The percentage of white population (Variable 4) was negatively related to total demand. Thus whites appear to call the public ambulance system less than do non-whites, even when both groups are poor.

The percentage of land devoted to commercial use (Variable 23) and total employment (Variable 12) had positive signs for their coefficients. These variables are surrogates for areas generating large numbers of pedestrians and heavy automobile traffic. Census tracts with these characteristics can be expected to generate more ambulance calls than the average census tract simply because of their high level of activity. In view of this, the fact that acreage per capita (Variable 22) also had a positive regression coefficient seems contradictory. However, the less heavily populated areas of the city include recreational areas. These, in common with commercial areas, have periodic influxes of persons who are not residents of the tract. Other less populated areas, as will be seen later, tend to generate above-average demand for public ambulances because of automobile accidents.

Relative to other land uses, census tracts with more industrial use (Variable 24) and transportation use, namely airports, train yards and docks (Variable 25), generated few calls. The demand for public ambulance service in heavily industrialized areas may be artificially low, however. Many industrial firms have set up procedures to handle accidents without calling the public system. The imposition of the fee schedule in 1966 had its most immediate impact in eliminating calls from the few industrial firms who continued to take advantage of the free service for minor illnesses and injuries.

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[1] The reader should remember that "housing density" is a measure of the number of housing units per capita in a tract, and therefore grows smaller as living conditions grow more crowded.

Per capita demand for public ambulances generated by specific kinds of incidents was examined. In addition, an attempt was made to assess the impact of some characteristics of the ambulance services themselves. Some interpretations of the results of these studies are given below. As an example, the demand generated by automobile accidents is examined in detail.

a. Automobile Accidents. When an illness or an injury unconnected with an automobile accident occurs, there is often a choice available between public and private means of transportation to treatment. The victim may be driven to the treatment facility in a private car, or in a private ambulance, or may even arrive on foot. This choice between the private and public sectors is largely absent in auto accident injuries. The law enforcement agencies--in addition to their desire to secure rapid treatment for victims--are interested in clearing the traffic lanes as rapidly as possible, and they rely on public ambulance services to perform this function.

In the absence of a public versus private sector choice, the predicting of demand per capita for public ambulance is very nearly equivalent to predicting the incidence of the accidents themselves. This task is quite different from predicting the demand for public ambulances to handle illnesses.[1]

The presence of a freeway running through the census tract (Variable 26) had a positive influence. Other land-use variables suggest the kinds of areas in which serious automobile accidents, which require transportation of victims by ambulances, are likely to occur. Less densely populated areas created more demand. Acreage per capita (Variable 22) was positively related to demand. This suggests that automobile accidents involving serious injuries tend to occur in less densely populated areas where vehicle speeds tend to be higher. Total employment (Variable 12), land devoted to

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[1]King, B. G., "Estimating Community Requirement for the Emergency Care of Highway Accident Victims," American Journal of Public Health, 58, 1968, pp. 1422-1430.

commercial uses (Variable 23) and land devoted to transportation uses (Variable 25) all had positive coefficients. In these cases, the variables seem to be operating as surrogates for high traffic volume and, therefore, reflect the accompanying absolute increase in numbers of accidents.

The interpretation of the sociological variables is not as obvious because of apparently conflicting influences. The percentage of persons who had recently moved (Variable 31), the percentage of males in aggregated occupations including managers, salesmen, etc., (Variable 17) and the percentage of males employed (Variable 10) all had negative coefficients. The percentage of non-children (Variable 13) had a positive coefficient. This suggests fewer serious automobile accidents in mobile, middle-class family residential areas.

Housing density per capita (Variable 2) had a positive regression coefficient, indicating fewer serious automobile accidents in areas with larger numbers of persons per housing unit. The percentage over 65 (Variable 5), percentage of single females (Variable 6), and percentage of single males (Variable 7) all had negative regression coefficients. Together, these suggest fewer serious automobile accidents in residential areas composed of apartments.

The percentage of poor families (Variable 8), the percentage of males unemployed (Variable 9) and the percentage of females either employed or looking for a job (Variable 11) had positive coefficients. This suggests more serious accidents in areas with higher proportions of persons of lower socio-economic status.

The coefficient of determination for automobile accidents was 0.672. This is lower than that for total demand, but still indicates a reasonable ability of the model to predict variations among census tracts in the per capita use of public ambulances for transporting victims of traffic accidents.

b. Other Accidents. This category includes all injuries resulting from causes other than automobile accidents. Falls and similar accidents are more likely to occur among children and the elderly.

Because of the prevailing higher rates of overt violence, accidental injuries are also more likely to occur in lower socio-economic areas. The results tend to support these hypotheses. The percentage non-children was inversely related to demand indicating that the unrepresented, complementary variable, percentage of population under 15 years of age, was positively related to demand from accidents not involving automobiles. The elderly (Variable 5), and single males (Variable 7) were related positively to demand. The regression coefficients for variable indicating low socio-economic neighborhoods (Variable 2, 8, and 9) were of the expected signs, and the land-use variablesindicate that the demand generated by accidents occurs more frequently in residential areas than elsewhere. As indicated in the discussion of the results for total demand, industrial areas tend to handle their accidents outside the public system.

The coefficient of determination of 0.857 indicates a high capability for predicting variations among census tracts in the per capita use of public ambulances for transporting victims of accidents that are nontraffic in origin.

c. Other Illness. Illness with some acute distress symptoms is an extremely common event; only a portion of those incidents, however, result in demands on the public ambulance system. Families that can afford to, use a family physician unless he cannot be reached. Transient or low-income families would be less likely to handle these incidents through a private physician. The results tend to support these hypotheses. The regression coefficients indicating low socio-economic neighborhoods (Variables 2, 8, and 9) are of the expected signs, and with the exception of Variable 8, highly significent. The percentage of the population who recently moved into the tract (Variable 3) was strongly and positively related to demand. The land-use variables indicate that commercial areas generate more calls than industrial and transportation areas. Together with total unemployment (Variable 12), the percentage of commercial land is indicative of areas with levels of activity.

The coefficient of determination of 0.865 indicates a high capability to predict variations among census tracts in the per capita use of public ambulances for transporting ill persons.

d. Cardiac. One would hypothesize that socio-economic variables would predict quite well the public ambulance demand arising from cardiac problems. Difficulties arise, however, because of the small sample of such cases. The mean number of ambulance calls per census tract (not per capita) for cardiac problems was only 26 for the entire four years. For the 157 aggregated areas that averaged about four census tracts per grouping this figure was increased to 110 calls. Only four socio-economic variables had regression coefficients that were significant at the 0.10 level and only half of these were significant at the 0.05 level. As expected the percentage of the population over 65 (Variable 5) has a positive effect.

The positive effects of housing density (Variable 2), indicating fewer persons per housing unit, and of Area #1 (Variable 28), namely the San Fernando Valley, probably reflect to some degree a reliance of the residents of the San Fernando Valley on the Los Angeles City Fire Department ambulances that serve this suburban area in the event of heart attack. The units have developed a reputation for prompt responses to calls.

The percent industrial land (Variable 24) and total employment (Variable 12) were positively related to demand. The percent females in the labor force (Variable 11) was negatively related. This suggests cardiac calls involving employed males at work. The positive influence of industrial land use is at odds with the propensity of industrial firms to handle industrial accidents outside of the public system. Perhaps they deviate from this practice in the event of heart attacks.

Despite the relatively small number of cases and weakness of the individual variables (probably due to collinearity), the coefficient of determination was 0.731. This indicates a reasonable ability to predict the variation between the groups of census tracts in the demand per capita for public ambulance services that arises from cardiac problems.

e. Poison. This category includes drug overdoses as well as other forms of poisoning. The sample size of calls per census tract for poisoning cases was even smaller than that for cardiac cases. Aggregating census tracts into the larger groupings resulted in an average of only 78 ambulance calls in four years.

Seven variables were significant at the 0.05 level. The fact that the percent children (Variable 13) had a strongly positive influence coincides with expectations. The strongly positive effect of percent poor families (Variable 8) is consistent with expectations that low income groups rely on the public system.

The coefficient of determination of 0.444 was the lowest of any category. Probably because of the small sample size for the category, less success was achieved in developing a regression equation that predicted the variation between the groupings of aggregated census tracts in terms of the demand per capita for public ambulance service arising from poisonings.

f. Dry Runs. A dry run occurred when the ambulance driver either could not locate the patient, or when he saw that the situation was being handled without his assistance. Area #1 (Variable 1), namely the San Fernando Valley, was one in which no screening of calls was done. As one would expect, the automatic dispatch of an ambulance to every call produced more dry runs in that area than occurred in the other areas, where the nurse, who did the dispatching, had to be satisfied that a medical emergency was involved. The influence of other variables in this equation was not clear. The coefficient of determination of 0.60 for this category, however, is quite significant.

g. Response Time. The average time in minutes between the call for an ambulance and its arrival at the scene was estimated for each census tract from data supplied by the City of Los Angeles. The sign of the coefficient of response time in the regression equation was negative and the t-statistic for its statistical difference from zero was at the 0.22 level of significance. This suggests that ambulance utilization per capita was lower in census tracts with longer ambulance response times. This, of course, is what would be expected if residents knew the length of delay to anticipate in their census tract.

h. Screening Mechanism. As the descriptions for variables 28 through 32 shown in Table V-C-3, the City of Los Angeles was divided into five geographical areas for the regression analyses. During the years from which the data were drawn, the dispatching of ambulances in three of the areas was done at Central Receiving Hospital. Registered nurses received incoming requests for ambulances and decided on medical grounds whether or not to disptach an ambulance. Dispatching was handled differently and without screening on medical grounds in the remaining two areas. In the San Fernando Valley, ambulance services were provided and dispatched by the City Fire Department. In the Harbor area, ambulance services were provided by a private ambulance service that was under contract to the city and were dispatched by the Police Department.

In the regression equation, the latter two areas had large positive coefficients. The t-statistics for their statistical differences from zero were at 0.08 and 0.28 levels of significance. For the three areas, in which there was a mechanism for screening requests for ambulances on medical grounds, two had negative coefficients and one a small positive coefficient. For none of the three areas, however, was the coefficient in the regression equation statistically different from zero with any forceful level of significance. These results tend to confirm that the utilization of ambulances per capita is lowered in these census tracts where there was a screening mechanism.

i. Charge for Ambulance Service. For the first three years that were encompassed by the data (1964-66), there was no charge for the use of an ambulance in the City of Los Angeles. In 1967, a basic charge was inaugurated of $15.00 for the transport of a person to a hospital. In order to isolate the effect of the charge on utilization, a separate regression analysis was made by pooling all four years of data with an allowance for the under-reporting in the one area in 1967. There were significant increases in demand from 1964 to 1966. The 1964-65 increase was 23% and the 1965-66 increase was 11%. Demand actually fell by 1.7% from 1966 to 1967. This was a significant departure from the historical trend. It is reflected, in the regression equation for the pooled years, by the trend in the signs and absolute magnitudes of the coefficients for the individual years, namely -3.5, -2.8, 0.5 and 0 for 1964 through 1967 respectively. The first two coefficients were statistically different from zero at the 0.01 level of significance; the later two were not significantly different from zero at forceful levels of significance.

D. DEMAND FOR EMERGENCY MEDICAL TREATMENT AT PUBLIC FACILITIES AND ITS DISTRIBUTION OVER ALL INCIDENT TYPES

As an example of the way in which multiple regression analysis can be used to predict and explain the demand for treatment at public emergency facilities, we studied historical data for the San Fernando Valley. As Figure V-D-1 shows, the Valley comprises 179 census tracts. This portion of the City of Los Angeles was selected because it constitutes a geographically well-defined catchment basin, being almost completely encircled by mountains. In addition, the public ambulances serving the San Fernando Valley are dispatched solely by the Los Angeles Fire Department. Therefore, the Valley's emergency medical system tends to be more homogeneous than that of the rest of the City. These two features (uniform ambulance dispatching and natural boundaries) assure that the majority of incidents occurring in the Valley create demands on emergency medical facilities located there. Although the Valley contains more private emergency facilities (14) than public ones (9), the public contract facilities account for approximately 75 percent of the total load on emergency medical facilities. All these factors made the San Fernando Valley an appropriate area for the study of the demand for public emergency treatment.

During 1966, 80,007 emergencies were recorded at the nine contract emergency facilities. The average number of emergencies per census tract was 441. Also, in 1966, all contract hospitals were required to fill out a record on every entering patient, regardless of the mode of transportation by which that patient had arrived at the hospital. In later years, this requirement was relaxed and the amount paid by the city to the hospitals for each record was reduced. Hence, after 1966, some hospitals ceased to complete a full set of such records. Therefore 1966 was deemed to be the appropriate year for our study.

A brief description of the nature and use of the public treatment facilities will aid the reader in understanding the subsequent analysis. The hospitals constituting the public emergency system are called "contract hospitals" because the City of Los Angeles enters into contracts

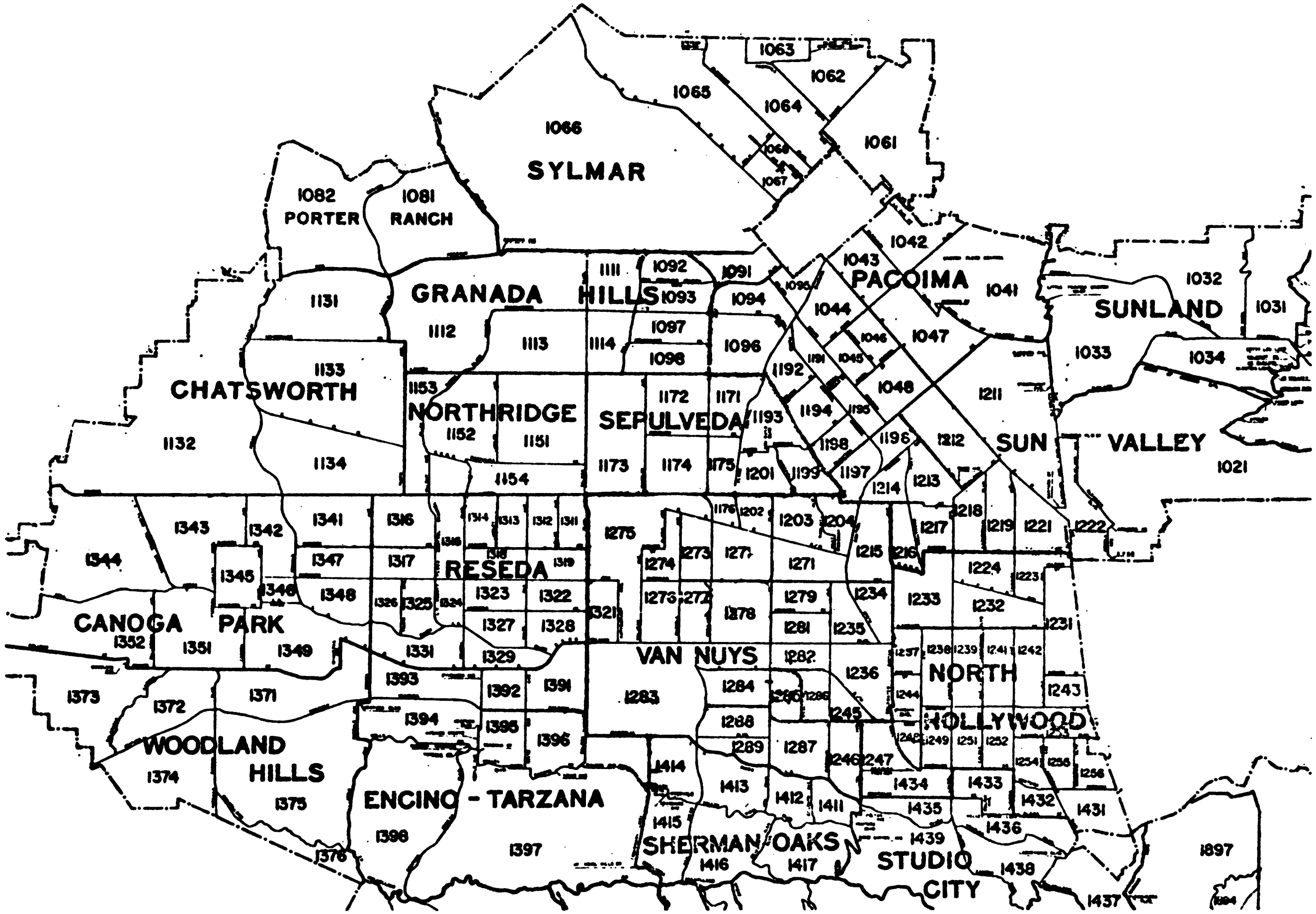

FIGURE V-D-1

CENSUS TRACT MAP OF THE SAN FERNANDO VALLEY with each of them to provide emergency treatment. Although public ambulances deliver patients only to hospitals designated as contract hospitals, the emergency rooms at these hospitals accept all patients, whether they arrive in a public ambulance, a police vehicle, a private car, a taxi, or on foot. In this sense, consideration of the emergency rooms is more comprehensive and inclusive than consideration of any single conveyance in the public sector.

In order to obtain an emergency services contract from the City of Los Angeles, a hospital must be accredited and must agree to maintain a 24-hour emergency facility staffed by a doctor and a registered nurse. In addition, the hospital must agree to accept all patients regardless of their ability to pay and to submit records for each case treated. Nine hospitals in the San Fernando Valley have contract with the City to provide emergency treatment under these terms. Emergency treatment is defined by the City of Los Angeles as treatment reasonably necessary to relieve the emergent health threat so that time is no longer critical to the patient's ultimate well-being and so that treatment will not have to be unnecessarily repeated.

For a number of years, no charge was made to patients for these services. Contract facilities were paid a small sum--approximately $3.00--for each treatment rendered under City auspices. In late 1966 the City Council authorized that a fee be charged to patients. Initially, the fee was $7.00, plus $2.00 for a tetanus shot if required; by the time of our study, the fee had risen to $11.00, plus $3.00 for a tetanus shot. Each contract facility is authorized to make this charge, but if they are unable to collect, the contract facilities are not reimbursed by the City.

1. Classification of Incidents

In developing a classification scheme for studying demands on emergency treatment facilities, we initially considered classifying the incidents or conditions according to the nature of appropriate treatment. This produced two broad classifications--"medical" and "surgical"--with a further subdivision of the surgical area into "traumatic" and "nontraumatic" conditions. This initial classification scheme was based on *a priori* information and on discussions with medical authorities.

To establish the relevance of this initial scheme, we obtained a random sample of 400 emergency room cases from the UCLA Medical Center and attempted to classify these cases under our system. Although only five cases in the sample could not be classified, a number of the categories in the classification scheme were not used, and others were used very infrequently. Based on the results of this first classification attempt, we combined and restructured the categories; using the new incident types, the frequencies in the UCLA data were computed again, with better results.

The revised classification was then tested at Central Receiving Hospital in Los Angeles to determine whether individual interpretations of the incident types were sufficiently well-correlated to warrant the general use of the classification scheme. This test indicated that more definition was required for each incident type, with specific emphasis on the categorization of multiple injuries. Final refinement along these lines yielded the configuration shown in Table V-D-1, which was suitable for analyzing the demands on public emergency medical facilities.

2. Sampling Plan

In order to determine the size of the sample required to insure that the true distribution of incidents would be adequately represented, a stratified random sampling plan was used.[1] The number of occurrences of each incident type is some fraction of the total number of occurrences of all incidents. For each definable incident type, there is a true proportion for the entire population and a proportion observed by sampling. The difference between these two proportions should not be greater than some *a priori* amount. This *a priori* amount, in our study, was established with respect to two factors: (1) the relative frequency distribution of the occurrences of the specified types of incidents

[1] Cook, A. A., Jr. and Wurzburg, D. B., *Obtaining a Sample of Emergency Loads on Public Emergency Medical Facilities in the San Fernando Valley Area of Los Angeles*, Emergency Medical Systems Project Doc. No. EMS-70-4-W, University of California, Los Angeles, California, June 1970.

TABLE V-D-1

CLASSIFICATION OF INCIDENTS BY TYPE

1. Major Head Injuries (includes skull fracture, concussion, gunshot wound, etc., to the head).

2. Major Penetrating Wounds & Lacerations (from gunshot, knife, glass, etc.; a major laceration is six inches or longer, or it is a partial or complete amputation; all others fall under 4).

3. Major Fractures (does not include skull fracture; does include fractures of back, neck, jaw, ribs, arms, legs, etc.).

4. Minor Injuries (includes minor fractures, mainly of the fingers, toes, nose, ankle, wrist, etc., abrasions, contusions, minor lacerations--mainly lacerations less than six inches in length).

5. Minor Burns (cover less than ten percent of the body area, regardless of degree).

6. Major Burns (cover ten percent or more of the body area, regardless of degree).

7. Eye, Ear, Nose, Throat (does not include fractures of the nose--see 4; does include injuries, infections, foreign bodies, etc.).

8. Ingestion, Narcotics (includes ingestion of poison, pills, chemicals, and overdose of narcotics, whether accidental or intentional).

9. Psychiatric, Mental, or Emotional (only if no other major injury or condition and if stated as psychiatric, mental, or emotional).

10. Cardiac (includes heart complaint, heart attack, arrhythmias, pulmonary edema, cardiac arrest, myocardial infarction, etc.).

11. Pulmonary (includes respiratory problems, drownings, lungs, asthma, breathing difficulties, pneumonia, etc.).

12. Obstetric, Gynecologic (includes rape).

13. Abdominal (includes internal bleeding, ulcer, gastritis, etc.).

14. Neurologic Disorders (includes cerebral stroke, comatose patient, convulsive disorders, cerebrovascular disorders).

15. Miscellaneous (includes alcoholism, poison ivy, diabetes, animal and insect bites, police prebooking noninjury, boils, rashes of skin).

16. D.O.A. (dead on arrival).

obtained from a sample of records kept by the Emergency Room of the UCLA Medical Center, and (2) the necessity that it should meet the usual 0.05 level of significance. On this basis, the required sample size was determined to be 6,981 incidents for the nine contract hospitals.

Using a random systematic sampling technique, a sample of 6,920 hospital records was examined. (Though slightly smaller than the calculated sample size, this number of records is within the limits of precision of the method.) The distribution of this sample by hospital and incident type is given in Table V-D-2. Further, the percentage distribution of occurrences by incident type for each hospital is given in Table V-D-3, and the percentage distribution of occurrences by hospital of each incident type is given in Table V-D-4.

3. Data

As was true of ambulance records, the records of the hospitals contracting with the City of Los Angeles to provide emergency medical treatment to the public were kept at Central Receiving Hospital. The following data were extracted from the sample of case records for the contract emergency hospitals:

- Date and time of the incident
- Whether the victim was brought in by ambulance or came to the hospital by some other means
- Sex of the victim
- Location at which incident occurred
- Census tract in which incident occurred
- Hospital to which victim was taken.

Demographic characteristics were obtained for each census tract from the 1960 census. Estimates of 1966 demographic information were used to adjust for the migration patterns among the census tracts, holding the distribution of other data constant with respect to the 1960 census baseline. The rectilinear distance in miles from the centroid of the census tract to the nearest emergency medical facility was determined from maps.

TABLE V-D-2

FREQUENCY OF INCIDENTS BY TYPE AND BY HOSPITAL

Incident Type	Hospital									
	Van Nuys	En-cino	North-ridge	Pacoima	Sun Valley	Valley Pres.	Valley Hospital	West Park	Holy Cross	Across All Hospitals
1. Major Head	7	9	47	2	11	6	12	0	12	106
2. Major Penetrating	18	12	6	8	1	4	7	1	6	63
3. Major Fractures	5	13	11	14	5	6	40	2	15	111
4. Minor Injuries	303	448	923	274	338	703	437	48	779	4253
5. Minor Burns	8	5	18	6	7	21	13	0	15	93
6. Major Burns	0	0	0	0	1	0	1	0	0	2
7. Eye, ENT	44	44	117	35	65	82	57	16	41	501
8. Ingestion	28	60	67	38	28	55	80	1	41	398
9. Psychiatric	5	4	5	15	10	9	7	11	6	72
10. Cardiac	7	8	9	11	4	10	20	15	10	94
11. Pulmonary	16	13	33	40	36	48	24	11	26	247
12. Gynecologic	3	5	9	22	28	15	9	1	7	99
13. Abdominal	12	6	38	24	37	23	34	7	15	196
14. Neurologic	8	13	15	23	4	11	24	7	17	122
15. Miscellaneous	36	50	73	60	66	52	84	22	52	495
16. D.O.A.	0	0	0	1	1	3	4	11	3	68
TOTALS	500	690	1371	573	642	1048	853	198	1045	6920

TABLE V-D-3

PERCENTAGE DISTRIBUTION OF OCCURRENCES

BY INCIDENT TYPE FOR EACH HOSPITAL

Incident Type	Hospital									
	Van Nuys	En-cino	North-ridge	Pacoima	Sun Valley	Valley Pres.	Valley Hospital	West Park	Holy Cross	Across All Hospitals
1. Major Head	1.4	1.3	3.4	0.3	1.7	0.6	1.4	0.0	1.7	1.5
2. Major Penetrating	3.6	1.7	0.4	1.4	0.2	0.4	0.8	0.5	0.6	0.9
3. Major Fractures	1.0	1.9	0.8	2.4	0.8	0.6	4.7	1.0	1.4	1.6
4. Minor Injuries	60.6	64.9	67.3	47.8	52.6	67.1	51.2	24.2	74.5	61.5
5. Minor Burns	1.6	0.7	1.3	1.0	1.1	2.0	1.5	0.0	1.4	1.3
6. Major Burns	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0
7. Eye, ENT	8.8	6.4	8.5	6.1	10.1	7.8	6.7	8.1	3.9	7.2
8. Ingestion	5.6	8.7	4.9	6.6	4.4	5.2	9.4	0.5	3.9	5.8
9. Psychiatric	1.0	0.6	0.4	2.6	1.6	0.9	0.8	5.6	0.6	1.0
10. Cardiac	1.4	1.2	0.7	1.9	0.6	1.0	2.3	7.6	1.0	1.4
11. Pulmonary	3.2	1.9	2.4	7.0	5.6	4.6	2.8	5.6	2.5	3.6
12. Gynecologic	0.6	0.7	0.7	3.8	4.4	1.4	1.1	0.5	0.7	1.4
13. Abdominal	2.4	0.9	2.8	4.2	5.8	2.2	4.0	3.5	1.4	2.8
14. Neurologic	1.6	1.9	1.1	4.0	0.6	1.0	2.8	3.5	1.6	1.8
15. Miscellaneous	7.2	7.2	5.3	10.5	10.3	5.0	9.8	11.1	5.0	7.2
16. D.O.A.	0.0	0.0	0.0	0.2	0.2	0.3	0.5	28.3	0.3	1.0
TOTALS	100	100	100	100	100	100	100	100	100	100

TABLE V-D-4

PERCENTAGE DISTRIBUTIONS OF OCCURRENCES

BY HOSPITAL FOR EACH INCIDENT TYPE

Incident Type	Van Nuys	En-cino	North-ridge	Pacoima	Sun Valley	Valley Pres.	Valley Hospital	West Park	Holy Cross	TOTALS
1. Major Head	6.6	8.5	44.3	1.9	10.4	5.7	11.3	0.0	11.3	100
2. Major Penetrating	28.6	19.0	9.5	12.7	1.6	6.3	11.1	1.6	9.5	100
3. Major Fractures	4.5	11.7	9.9	12.6	4.5	5.4	36.0	1.8	13.5	100
4. Minor Injuries	7.1	10.5	21.7	6.4	7.9	16.5	10.3	1.1	18.3	100
5. Minor Burns	8.6	5.4	19.4	6.5	7.5	22.6	14.0	0.0	16.1	100
6. Major Burns	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	0.0	100
7. Eye, ENT	8.8	8.8	23.4	7.0	13.0	16.4	11.4	3.2	8.2	100
8. Ingestion	7.0	15.1	16.8	9.5	7.0	13.8	20.1	0.3	10.3	100
9. Psychiatric	6.9	5.6	6.9	20.8	13.9	12.5	9.7	15.3	8.3	100
10. Cardiac	7.4	8.5	9.6	11.7	4.3	10.6	21.3	16.0	10.6	100
11. Pulmonary	6.5	5.3	13.4	16.2	14.6	19.4	9.7	4.5	10.5	100
12. Gynecologic	3.0	5.1	9.1	22.2	28.3	15.2	9.1	1.0	7.1	100
13. Abdominal	6.1	3.1	19.4	12.2	18.9	11.7	17.3	3.6	7.7	100
14. Neurologic	6.6	10.7	12.3	18.9	3.3	9.0	19.7	5.7	13.9	100
15. Miscellaneous	7.3	10.1	14.7	12.1	13.3	10.5	17.0	4.4	10.5	100
16. D.O.A.	0.0	0.0	0.0	1.5	1.5	4.4	5.9	82.4	4.4	100
Across All Hospitals	7.2	10.0	19.8	8.3	9.3	15.1	12.3	2.9	15.1	100

4. Model

Demand for public emergency treatment was examined as a linear function of seven variables associated with the census tract in which an incident occurred. Six of these were sociocultural and economic variables; the seventh was a geographic variable (distance from the centroid of the tract to the nearest emergency medical facility). The predictive equations were estimated by least squares analysis.

Analysis of the socio-economic characteristics of patients entering emergency rooms was used to determine both the distribution of incidents by type and the characteristics of the individuals most prone to use emergency rooms. Demands for emergency care could thus be related to the specific occurrences of the incidents generating the demands. The explicit linkage of the types of incidents observed in the various hospitals to the census-tract locations of their occurrence allocated the demands faced by all the area hospitals to their tracts of origin. Finally, the relative frequency of occurrence of an incident type over all census tracts delineated the demand generated by the incident in terms of the relevant characteristics within the larger area.

In essence, the demand of interest was that for medical treatment needed to care adequately for a given medical emergency generated by the incident. The frequency of occurrence of incidents could be predicted for a given census tract by using estimating equations that determined the occurrences as a function of the set of characteristics within the census tract. Extension of the analysis to include the proximity of a contract hospital relative to other contract and noncontract hospitals provided an indication of the relative demand as seen by other emergency facilities.

5. Empirical Results

a. Prediction of Total Demand Per Census Tract. The predictive equation for total demand (per census tract) for public emergency medical treatment is given in Table V-D-5. The coefficient of determination of 0.69 signifies a very good explanation of the

TABLE V-D-5

REGRESSION MODEL FOR TOTAL DEMAND PER CENSUS TRACT FOR PUBLIC EMERGENCY MEDICAL TREATMENT IN THE SAN FERNANDO VALLEY

	Variables	Regression Coefficient	t-statistic	Description of Variable (per census tract)
1.	Constant Term	196.1	(2.69)	
2.	Median Age	-0.518	(-2.21)	Median age of population living in the census tract
3.	Employment	34.6	(3.26)	Number of people employed (in thousands) in the census tract
4.	Total Acreage	55.0	(3.52)	Total area of the census tract (in thousands of acres)
5.	Population	73.1	(11.60)	Population of the census tract (in thousands) based on a 1966 estimate revising the 1960 census figure
6.	Distance to Nearest Hospital	-17.2	(-1.63)	The rectilinear distance from the centroid of the census tract to the nearest contract emergency medical facility
7.	Value of Housing	-2.95	(-1.07)	The median value of the housing in the census tract
8.	Percent Nonwhite	551.6	(3.44)	The percentage of the population in the census tract that is nonwhite

Multiple Correlation Coefficient (R^2) 0.69
Standard Error of Estimate 162
Mean Number of Incidents per census tract 447

variance across census tracts in the total number of incidents that result in demands on public facilities. It implies also that the assumption of linearity is not unwarranted. The standard error of estimate (162) is relatively low compared to the mean number of incidents per census tract (447).

The equation indicates that the size of the census tract, the number of people living there, and the number of people employed there all relate strongly and positively to the total number of incidents within a census tract that result in a demand for service at a public emergency medical facility. The median value of all housing in the census tract is negatively related to total demand. The percentage of population that is nonwhite is positively related to total demand. The latter two relationships imply that the rate of demand is higher in low-income, minority areas than in higher income, predominantly white areas. The median age of the population living within the census tract is negatively related to the total demand. This implies greater demand in areas having many families with children. Finally, the distance to the nearest contract emergency medical facility is negatively related to demand, as it would have been reasonable to suppose.

b. <u>Percentage of Total Demand Predicted by Given Incident Types.</u> The same set of independent variables was used to develop a set of 15 equations for estimating the distribution of incident types within a given census tract. Each equation predicts the percentage of all incidents occurring within a census tract that are of a given type. (The types, of course, are those listed in Table V-D-1, with the exception that the two burn categories, 5 and 6, have been considered together.) The results are given in Table V-D-6. It can be observed that when summed across all 15 equations, the constant terms total almost exactly 100 and, for each independent variable, the coefficients total approximately zero. If the estimates of the percentages of each incident type occurring in a census tract are unbiased, and if there is no intercorrelation between

TABLE V-D-6

REGRESSION MODELS FOR THE PERCENTAGE OF ALL INCIDENTS OF A GIVEN CATEGORY RESULTING IN DEMAND FOR EMERGENCY MEDICAL TREATMENT AT A PUBLIC FACILITY (PER CENSUS TRACT)

Variables[1]	Incident Type[2] 1	2	3	4	5&6
R^2	0.050	0.043	0.064	0.16	0.071
Standard Error of Estimate	0.22	0.18	0.29	1.25	1.46
Mean Percentage of All Incidents	1.3	0.8	1.8	60.1	1.4
Constant Term	2.19 (2.18)[3]	-1.23 (-1.51)	-1.55 (-1.20)	69.3 (1.23)	0.856 (0.78)
Median Age	-0.053 (-1.65)	0.028 (1.06)	0.126 (3.02)	0.806 (-4.45)	0.045 (1.30)
Employ-ment	0.074 (0.50)	0.055 (0.45)	-0.100 (-0.52)	0.641 (0.77)	-0.058 (-0.36)
Total Acreage	0.086 (0.32)	-0.044 (-0.25)	-0.039 (-0.14)	-0.837 (-0.69)	0.079 (0.34
Population	0.082 (0.95)	0.073 (1.05)	0.148 (1.32)	0.545 (1.12)	0.007 (0.07)
Distance to Nearest Hos-pital	0.099 (0.68)	0.037 (0.31)	-0.214 (-1.14)	-0.833 (-1.02)	-0.29 (-1.90)
Value of Housing	0.001 (0.04)	0.039 (1.26)	-0.037 (-0.75)	0.687 (3.20)	-0.015 (-0.36)
Percent Nonwhite	-3.09 (-1.40)	0.356 (0.20)	0.451 (0.16)	-26.3 (-2.12)	-1.30 (-0.55)

[1] See Table V-D-5 for definition of variables. [2] See Table V-D-1 for classifications of incident types.

[3] The figure in parentheses is the t-statistic.

TABLE V-D-6 (CONT'D)

REGRESSION MODELS FOR THE PERCENTAGE OF ALL INCIDENTS OF A GIVEN CATEGORY RESULTING IN DEMAND FOR EMERGENCY MEDICAL TREATMENT AT A PUBLIC FACILITY (PER CENSUS TRACT)

Variables[1]	Incident Type[2] 7	8	9	10	11
R^2	0.091	0.029	0.10	0.079	0.128
Standard Error of Estimate	0.59	0.56	0.29	0.41	0.24
Mean Percentage of All Incidents	7.3	6.3	1.6	3.7	1.4
Constant Term	9.97 (3.72)[3]	6.46 (2.54)	-2.12 (-1.64)	4.27 (2.31)	3.71 (3.49)
Median Age	-0.079 (-0.92)	0.057 (0.70)	0.171 (4.12)	0.087 (1.46)	-0.046 (-1.34)
Employ-ment	0.307 (0.78)	-0.434 (-1.16)	-0.160 (-0.84)	-0.358 (-1.31)	0.181 (1.15)
Total Acreage	0.629 (1.10)	-0.56 (-1.04)	0.061 (0.22)	-0.281 (-0.71)	0.061 (0.27)
Population	-0.405 (-1.76)	0.054 (0.25)	-0.010 (-0.09)	0.017 (0.11)	-0.092 (-1.00)
Distance to Nearest Hos-pital	-0.550 (-1.42)	0.260 (0.71)	0.173 (0.63)	0.125 (0.47)	0.376 (2.45)
Value of Housing	0.105 (1.03)	-0.090 (-0.94)	-0.072 (-1.47)	-0.159 (-2.26)	-0.070 (-1.73)
Percent Nonwhite	-2.94 (-0.50)	-2.92 (-0.52)	2.08 (0.73)	7.99 (1.97)	4.22 (1.81)

[1] See Table V-D-5 for definition of variables.

[2] See Table V-D-1 for classification of incident types.

[3] The figure in parentheses is the t-statistic.

TABLE V-D-6 (CONT'D)

REGRESSION MODELS FOR THE PERCENTAGE OF ALL INCIDENTS OF A GIVEN CATEGORY RESULTING IN DEMAND FOR EMERGENCY MEDICAL TREATMENT AT A PUBLIC FACILITY (PER CENSUS TRACT)

Variables[1]	Incident Type[2] 12	13	14	15	16
R^2	0.067	0.093	0.122	0.097	0.08
Standard Error of Estimate	0.32	0.62	0.20	0.57	0.27
Mean Percentage of All Incidents	2.8	1.7	1.0	7.4	1.3
Constant Term	2.63 (1.81)[3]	-0.514 (-0.46)	0.094 (0.11)	7.73 (3.02)	-1.86 (-1.56)
Median Age	0.113 (2.40)	0.063 (1.74)	0.025 (0.87)	0.183 (2.22)	0.092 (2.33)
Employ-ment	-0.090 (-0.42)	0.170 (1.02)	0.065 (0.49)	-0.221 (-0.58)	-0.083 (-4.67)
Total Acreage	-0.122 (-0.39)	-0.198 (-0.82)	-0.119 (-0.62)	1.28 (2.33)	-0.005 (-0.02)
Population	-0.005 (-0.64)	0.059 (0.61)	0.007 (0.094)	-0.389 (-1.77)	-0.084 (-0.82)
Distance to Nearest Hos-pital	-0.160 (-0.76)	0.503 (3.09)	0.541 (4.16)	-0.037 (-0.10)	0.044 (0.26)
Value of Housing	-0.141 (-2.53)	-0.035 (-0.81)	-0.034 (-0.98)	-0.235 (-2.41)	0.055 (1.21)
Percent Nonwhite	2.88 (0.90)	3.12 (1.26)	2.88 (1.46)	12.40 (2.20)	0.454 (0.17)

[1] See Table V-D-5 for definition of variables. [2] See Table V-D-1 for classification of incident types.

[3] The figure in parentheses is the t-statistic.

the equations for predicting these percentages, these sums should be 100 and zero.

The regression coefficients are to be interpreted as before. For example, for major head injuries, the coefficient value of -0.053 for Variable 2, median age, means that an increase of one year in the median age in a census tract would decrease by 0.053 the percentage of demands for treatment at contract hospitals arising from head injury incidents in that census tract, assuming all other factors were held constant.

By its nature, the process used to develop regression equations for predicting the apportionment of total demand among incident types leads to relatively low coefficients of determination. This, in itself, is no cause for concern. With the exception of grouped incident types 5 and 6 (burns), the standard error of estimate for all incident types is small in comparison with the mean percentage for the incident type across all census tracts. This does not mean that caution need not be exercised. For example, the t-statistics indicate that only a few of the regression coefficients differ from zero by a statistically significant amount. This means that, for the San Fernando Valley, the relative proportions of incident types occurring within a census tract are influenced by only a few of the variables that most directly affect total demand within that tract.

The category that, on the average, comprises the largest percentage of incidents leading to demands on contract hospitals for emergency treatment is minor injuries, i.e., minor fractures, abrasions, contusions, lacerations, sprains, and strains. In 1966, for the San Fernando Valley as a whole, this incident type resulted in approximately 60 percent of the total demand. Three variables--median age, value of housing, and percentage of nonwhite population--largely determine the proportion of all demand (per census tract) arising from minor injuries. Of these, the regression coefficient for median age is the most significant statistically and indicates a negative relationship with demand. It seems reasonable to suppose that most of the demand arising from minor injuries would be associated with children. The combination of the fact that minor injuries constitute 60 percent of all incidents and that they are most influenced by a negative relationship with median age undoubtedly goes far to explain why the total number of incidents occurring in a census tract is negatively related to median age.

The regression coefficient for median age is also the most significant statistically in predicting the percentage of incidents that are cardiac and major fractures. For both of these incident types, the relationship is positive, i.e., the greater the median age in a census tract the greater the proportion of total demand in the census tract resulting from cardiac and major fracture incidents. In 1966, however, for the San Fernando Valley as a whole, cardiac and major fractures constituted only 1.6 and 1.8 percent of all incidents. Hence, their contributions to total demand for emergency treatment at public facilities were small relative to the incidence of minor injuries.

E. DEMAND FOR EMERGENCY MEDICAL TREATMENT AT PUBLIC FACILITIES BY SELECTED INCIDENT TYPES

To examine how well the demand on public emergency medical facilities (per census tract) could be predicted from a large set of independent variables, stepwise regression was used to develop models for five selected incident types from among the 16 subcategories of Table V-D-1. The incident types were: (1) Minor Injuries; (2) Ear, Eye, Nose and Throat; (3) Ingestion, Narcotics; (4) Pulmonary; and (5) Abdominal. The independent variables selected by one or more of the regression analysis are given in Table V-E-1.

The results are given in Table V-E-2. The coefficients of determination range from 0.78 for the category of Minor Injuries to 0.30 for that of Abdominal. Excluding the constant term, 9 to 11 of the 36 different independent variables were required to develop each "best fit" regression model. As would be expected, the size of the population residing in a census tract (Variable 10) was the most important determinant of demand. For four of the five selected incident types, the relationship was positive and strong. Proximity to the nearest contract hospital (Variable 37) was a significant determinant of demand arising from Minor Injuries and from Ingestion, Narcotics. The other variables in the regression equations are surrogates for the predominant land use in a census tract and for the characteristics of its residents.

The variables in the regression equation suggest that the category of Minor Injuries is associated with two kinds of environments. The first is a residential area. In addition to total population, the number of persons residing in the area who are employed and employed as professionals (Variables 20 and 25) were positively related to demand. Together with centrality (Variable 9) which was related negatively to demand, these variables suggest a residential area. The second is a rural environment. This is reflected by the positive relationships to demand of the rural population (Variable 11) and the number of persons employed in agriculture (Variable 21) and the negative relationship of centrality (Variable 9). Finally, the positive relationship of mobility (Variable 33) to demand

TABLE V-E-1

VARIABLES INCLUDED IN REGRESSION ANALYSES FOR PREDICTION OF DEMAND ON PUBLIC EMERGENCY MEDICAL FACILITIES IN THE SAN FERNANDO VALLEY (PER CENSUS TRACT)

		Mean	Standard Deviation	Description
1.	Constant term[1]	---	----	
2.	Total acreage	7.77	10.10	Number of acres in census tract
3.	Percent commercial	4.10	4.10	Percentage of acreage that is in commercial use
4.	Percent community service	4.00	8.50	Percentage of acreage that is in community service use
5.	Percent industrial	2.70	5.50	Percentage of acreage that is in industrial use
6.	Percent residential	49.30	16.90	Percentage of acreage that is residential
7.	Percent streets	16.70	6.40	Percentage of acreage that is streets
8.	Street acreage	0.92	0.54	Total acreage in streets
9.	Centrality[2]	9.26	2.68	Factor scale denoting a business district as opposed to residential (0-100)
10.	Total population	53.60	25.20	Number of people living in census tract (in hundreds)
11.	Rural	3.10	40.00	Number of people living in rural portions of census tract
12.	Males over 45	4.56	2.23	Number of males over 45 years of age (in hundreds)
13.	Males over 65	97.90	60.40	Number of males over 65 years of age

[1]See Table V-E-2; the value of the constant term varies with the variable being predicted.

[2]One of seven factors created from the grouping of 67 census and land use variables for the Los Angeles metropolis; see Burns, L. S. and Harman, A. J., The Complex Metropolis, Research Report No. 9, Housing, Real Estate, and Urban Land Studies Program, Graduate School of Business Administration, UCLA, 1968.

TABLE V-E-1 (Continued)

		Mean	Standard Deviation	Description
14.	Females 15-45	9.17	3.74	Number of females 15-45 years of age (in hundreds)
15.	Females over 45	485.00	270.10	Number of females over 45 years of age
16.	Divorced females	84.00	51.30	Number of divorced and separated females
17.	Agedness[1]	65.30	54.00	Factor scale denoting higher age (0-100)
18.	High school education	14.30	6.71	Number of persons with at least high school education (in hundreds)
19.	High school education only	7.70	3.16	Number of persons with only high school education
20.	Total employed	6.56	11.80	Number of people employed (in hundreds)
21.	Agriculture	17.10	14.80	Number of persons employed in agriculture
22.	Construction	103.40	48.20	Number of persons employed in construction
23.	Food and beverage	43.80	22.80	Number of persons employed in food and beverage
24.	Female in households	21.30	19.20	Number of females employed in private households
25.	Professionals	4.61	2.63	Number of persons employed as professionals (in hundreds)
26.	Transportation	21.60	16.70	Number of persons employed in transportation
27.	Wholesale	52.50	30.50	Number of persons employed in wholesale trade
28.	Family income under 3K	88.30	55.20	Number of families with income under $3,000
29.	Family income under 6K	295.20	153.30	Number of families with income under $6,000

[1]One of seven factors created from the grouping of 67 census and land use variables for the Los Angeles metropolis; see Burns, L. S. and Harman, A. J., The Complex Metropolis, Research Report No. 9, Housing, Real Estate, and Urban Land Studies Program, Graduate School of Business Administration, UCLA, 1968.

TABLE V-E-1 (Continued)

		Mean	Standard Deviation	Description
30.	Individual income (4-8K)	59.90	60.10	Number of individuals with income $4,000-$8,000
31.	Individual income (8-15K)	15.20	18.20	Number of individuals with income $8,000-$15,000
32.	Affluence[1]	88.40	69.00	Factor scale denoting affluent and more highly educated persons (0-100)
33.	Mobility[1]	74.60	221.10	Factor scale denoting mobile families and individuals (0-100)
34.	Property value under 25K	473.10	319.90	Number of houses with value $15,000-$25,000
35.	Property value 15-25K	685.40	346.70	Number of houses with value less than $25,000
36.	Unsound housing	53.80	62.10	Number of deteriorating and delapidated houses
37.	Distance to nearest contract hospital	3.45	1.78	Rectilinear distance from centroid of census tract to nearest contract hospital (in miles)

[1] One of seven factors created from the grouping of 67 census and land use variables for the Los Angeles metropolis; see Burns, L. S. and Harman, A. J., The Complex Metropolis, Research Report No. 9, Housing, Real Estate, and Urban Land Studies Program, Graduate School of Business Administration, UCLA, 1968.

TABLE V-E-2

BEST FIT REGRESSION MODELS FOR THE DEMAND ON PUBLIC EMERGENCY MEDICAL FACILITIES IN THE SAN FERNANDO VALLEY FOR FIVE SELECTED INCIDENT TYPES (BY CENSUS TRACT)

	Variables	Minor Injuries		Eye, Ear, Nose and Throat		Ingestion, Narcotics		Pulmonary		Abdominal	
	R^2	0.78		0.48		0.38		0.45		0.30	
1.	Constant term	9.02		0.42		1.12		0.49		0.37	
2.	Total acreage			0.100	(0.021)						
3.	Percent commercial					0.089	(0.040)				
4.	Percent comm. serv.							-0.026	(0.011)		
5.	Percent industrial							-0.036	(0.017)		
6.	Percent residential			0.047	(0.011)						
7.	Percent street					-0.041	(0.024)				
8.	Street acreage							-0.514	(0.275)		
9.	Centrality	-0.681[1]	(0.256)[2]	-0.099	(0.051)						
10.	Total population	0.379	(0.052)	10.040	(0.013) 3	0.450	(0.070)	0.033	(0.008)		
11.	Rural	0.074	(0.017)								
12.	Males over 45	-2.590	(0.515)								
13.	Males over 65							0.009	(0.005)	-0.008	(0.003)
14.	Females 15-45			0.343	(0.133)						
15.	Females over 45							0.003	(0.001)		
16.	Divorced females					0.012	(0.005)				
17.	Agedness							0.004	(0.002)		
18.	High school educ.			-0.187	(0.048)						
19.	High sch. ed. only							-0.193	(0.061)		
20.	Total employed	0.108	(0.058)	0.038	(0.012)						
21.	Agriculture	0.233	(0.054)							0.005	(0.003)
22.	Construction			0.009	(0.005)					0.008	(0.003)
23.	Food and beverage			-0.012	(0.007)					-0.008	(0.005)
24.	Female in house.	0.110	(0.038)					0.013	(0.005)	0.008	(0.005)
25.	Professionals	1.540	(0.518)								
26.	Transportation			-0.029	(0.010)					-0.017	(0.007)
27.	Wholesale	-0.102	(0.033)			-0.026	(0.006)				
28.	Family inc. under 3K					-0.014	(0.006)				
29.	Family inc. under 6K					0.005	(0.002)	0.004	(0.001)	0.003	(0.001)
30.	Individ. inc. (4-8K)									0.013	(0.003)
31.	Individ. inc. (8-15K)									-0.022	(0.008)
32.	Affluence					-0.007	(0.003)				
33.	Mobility	0.012	(0.005)								
34.	Property value under 25			-0.002	(0.001)						
35.	Property value 15-25K									-0.00054	(0.00039)
36	Unsound housing							0.0025	(0.0019)		
37.	Dist. to near. hospital	-0.756	(0.395)			-0.131	(0.077)				

[1] Regression coefficient.

[2] Standard error of estimate for regression coefficient.

suggests that a transient population is more reliant on public emergency medical facilities than is a more stable population that has established ties to the private primary medical care system.

Similarly, the variables in the regression equation suggest that the category Eye, Ear, Nose, and Throat is associated primarily with residential areas. Total employed (Variable 20), females aged 15-45 (Variable 14) and the percentage of tract that is residential (Variable 6) are all positively related to demand. The number of persons residing in the tract with at least a high school education (Variable 18) is negatively related to demand. This suggests a greater use of public emergency facilities by persons of lower socio-economic status as a substitute for private primary care system.

For the category of Ingestion, Narcotics a very different picture emerges. This category is largely composed of alcoholic intoxication and drug overdose cases. In addition to the usual relationships to total population and the distance to the nearest contract hospital, the demand arising from this type of incident appears strongly related to low socio-economic areas. It is positively related to divorced females (Variable 16), the number of families with incomes under $6,000 (Variable 29), and the percentage of the census tract that is in commercial land use (Variable 3). It is negatively related to affluence (Variable 32).

For the Pulmonary category, the principal determinants of demand for treatment at a public emergency facility would appear to be age and (again) lower socio-economic status. Agedness (Variable 17), females over 45 years of age (Variable 15) and males over 65 years of age (Variable 13) were related positively to demand. The number of families with incomes under $6,000 (Variable 29), unsound housing (Variable 36), and the number of female residents employed in private households (Variable 24) were also related positively to demand.

The nature of the area and the characteristics of its residents were the least successful in explaining the demand on public emergency treatment facilities arising from Abdominal incidents. It again appears that demand is related to the dichotomy of public versus private care as a function of socio-economic status. The number of families with incomes under $6,000 (Variable 29), the number of individuals with incomes of $4,000-$8,000 (Variable 30), and the number of persons employed in agriculture (Variable 21) were related positively to demand. The number of houses valued from $15,000 to $25,000 (Variable 35) and the number of individuals with incomes from $8,000 to $15,000 (Variable 31) were related negatively to demand.

F. SUMMARY

In general, the demand for public ambulances and for treatment at public emergency facilities appears to be highly predictable, using a linear model employing socio-economic variables and land-use variables. The assumption of linearity over the relevant range is supported by the high percentage of variance explained and the similarity of the paramater estimates to a priori expectations. Substantively, it was found that census tracts with low income, with nonwhite families, and with high unemployment rates tended to generate many calls. Areas with elderly people or children also generated many calls. It would be expected that the demand for public emergency services would be highest in tracts with a concentration of people of low socio-economic status.[1] These people may use the emergency system even in the absence of real emergencies because they generally do not have a regular physician.

The most significant reservation about the analyses concerned the currency of the socio-economic data. Since Los Angeles is a rapidly changing city, data from the 1960 census were not likely to be perfect descriptions of what prevailed in 1967. A number of years passed between the census data collection in 1959 and the demand data collection in 1966/67. However, there were some indications that the data were a reasonable description: Estimates of demand were stable over time and tended to be similar across types of incidents. The relationship between variables and the number of calls tended to be of predictable sign and magnitude.

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[1] Alpert, J. A., Kosa, J., Haggerty, R. J., Robertson, L., and Haggerty, M. C., "The Types of Families that Use an Emergency Clinic," Medical Care, Vol. 7, 1969, p. 55.

[2] Lavenhar, M. A., Ratner, R. S., and Weinerman, E. R.,""Social Class and Medical Care: Indices of Nonurgency in Use of Hospital Emergency Services." Medical Care, Vol. 6, 1968, p. 368.

[3] Weinerman, E. R., Ratner, R. S., Robbins, A., and Lavenhar, M. A., "Yale Studies in Ambulatory Medical Care: V. Determinants of use of Hospital Emergency Services," A.J.P.H., Vol. 56, 1966, p. 1037.

Typically aggregated data on demand are readily available for services offered by, or contracted by, the public sector. Such data may also be available for the private sector (although they were not available for the County of Los Angeles during the period covered by the Project). Aggregated data must be used with caution, however. The characteristics of the geographical subunits, such as census tracts, and their population in toto are used. There may be extensive variations within the geographical subunit as to its nature and the kinds of activities that take place within it. Similarly, there may be extensive variations among the demographic and socio-economic characteristics of the residents of a given geographical subunit. The San Fernando Valley portion of the City of Los Angeles is a patchwork of enclaves of various kinds that bear no particular relationship to the boundaries of its numberous census tracts. Residential areas, of varying levels of housing value, and suburban business districts are intermingled. While census tract data can indicate the magnitudes of such variations, they cannot be used to associate the demand for emergency medical services arising from any particular component to the specific characteristics of that component.

The use of readily available information such as that provided by the census creates another kind of problem. The variables that are provided may be only surrogates for the variables of interest to the analyst or decision-maker. For this reason, as has been seen, it may be difficult to interpret the meaning of the variables that are identified by the regression analysis as influencing the demand for a defined kind of emergency medical service.

The alternatives to the use of readily availables, aggregated data are twofold: The first is to link pieces of historical data, such as ambulance trip tickets, emergency room records, and hospital records, to recreate and integrate the detailed data recorded by various components of the emergency system. The second is to collect data prospectively--recording the desired information about medical emergencies as such emergencies occur. In the former method, there is no guarantee that the desired data were recorded or are retrievable. Both alternatives are expensive.

When time and/or money do not permit, or when the nature of the study does not demand detailed information on individual medical emergencies, aggregate studies can be useful. By exercising care in his choice of assumptions and premises, the analyst can use census tracts and historical demand data to develop predictive regression models that relate the characteristics of the census tract to the demands arising within it for various emergency medical services. Such regression models can be used for planning purposes. For example, if the demographic composition and/or land use of an area is expected to be altered in the future, such models can be useful in providing a first approximation to the shifts that might be expected in demands for emergency medical services.

While the methods described would be applicable to any region, in general the specific regression models will not. Many variables influence the demand for emergency medical services that were not represented in our studies. Not the least of these relate the public's understanding, and expectations of the emergency medical services in a given area and the attitudes that the public possesses toward the use of these services. Therefore, while in general the results were supportive of hypotheses that could be formulated reasonably from other studies, the regression models themselves should not be used to predict the demands for public emergency medical services outside of the City of Los Angeles.

VI. STUDIES OF THE EXISTING SYSTEM BASED ON SPECIALLY COLLECTED DATA

A. STUDY OF AMBULANCE ATTENDANT PERFORMANCE

As a preliminary to later demonstration studies in which the existing system would be modified, the Project conducted an information-gathering and evaluative study of ambulance attendant performance. The study was carried out in the City of Los Angeles between August 1968 and March 1969. Its objectives focused on four questions:

- What activities were ambulance attendants performing, given their then-current levels of training and the existing standards and expectations of the emergency medical system?
- How well were those activities being performed?
- What activities were ambulance attendants <u>not</u> performing that, if personnel had been more highly trained, could have been carried out with a beneficial effect on medical outcomes? What level of training would such additional activities require?
- What significant differences in the performance of ambulance attendants were observable among the various public and private services in the area studied? How did these differences relate to the attendants' background, training, and experience?

It was expected that the answers to these questions--and in particular Question 3--would provide data necessary for the design and development of a later, more comprehensive demonstration involving the deployment of a Mobile Intensive Care Unit (see Chapter VII).

1. The Methodology of the Study

Since the ambulance attendant study contained a heavy evaluative component, it had to be conducted by persons qualified to make the necessary judgments. Therefore, physicians were enlisted to act as observer-evaluators. Six residents in Surgery from the UCLA Medical Center and the County of Los Angeles Harbor General Hospital were chosen, all of whom had recent and extensive emergency room experience.

During the six-month period of the study, these physicians rode with the ambulance crews to a total of 210 emergency incidents. The doctors waited with the crews at the ambulance stations, and went out on all calls to which an ambulance was dispatched during an eight-to-twelve-hour shift. For the most part, these were Friday and Saturday night shifts, when incident loads reach their peak levels. The observer-evaluators did not intervene except in an immediately life-threatening situation; their task was to evaluate activities performed by attendants and to identify activities not performed that might have been within the range of capabilities of more highly trained personnel. The doctors recorded their observations on prepared forms.

Four ambulance organizations were observed by members of the observation team:

- A private ambulance service company (P.A.C.);
- An ambulance unit from the Central Receiving Hospital[1] (C.R.H.);
- A Fire Department Rescue Ambulance unit from a well-populated suburban district (F.D.-A);
- A Fire Department Rescue Ambulance unit from a remote industrial district (F.D.-B).

These organizations were selected as representative of the different types of public and private ambulance services in the City of Los Angeles and because, a priori, there appeared to be significant differences in the levels of training and experience of their attendants. Table VI-A-1 summarized the major characteristics of each organization.

Observation of the ambulance crews began on August 30, 1968, at P.A.C. A large amount of time was spent with this organization while data forms were tested and revised. Observation then began at F.D.-A and F.D.-B in early November 1968, and at C.R.H. in January 1969.

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[1]No longer in operation; the ambulances stationed at Central Receiving Hospital at the time of the study have been transferred to the Fire Department.

TABLE VI-A-1

COMPARISON OF AMBULANCE SERVICES

	P.A.C.	C.R.H.	F.D.-A	F.D.-B
Dates of Observation	8/30/68-10/20/68	1/17/69-3/1/69	10/26/68-3/1/69	11/16/68-3/1/69
Ownership	Private	Public	Public	Public
Services Provided	Emergency, non-emergency transport	Emergency Only (99%+)	Emergency Only	Emergency Only
Service Area	Middle to high income Residential area	Downtown and Central City	Middle income, Residential areas	Port and industrial area
Attendant's Average Age	Mid-twenties	40	31	32
Attendant's Average Experience	6-12 months	15 years	5½ years	4 months[1]
Attendant's Training	Advanced First Aid required; National Ambulance Training Institute course given in service	Advanced First Aid required and two years experience; refresher training course every two years by Central Receiving Hospital	Advanced First Aid as fireman; additional training given informally by Rescue Ambulance personnel and by hospitals	Advanced First Aid as fireman; additional training given informally by Rescue Ambulance personnel and by hospitals
Monthly Salary	$450-600	$575-800	$840-1,000	$840-1,000

[1] Unit was activated in 1968 replacing a contract private ambulance company that had been under contract to the City of Los Angeles to provide service in the area.

Observations of P.A.C., the only private company in the study, were discontinued after data had been collected for 109 incidents. A combined total of 101 observations were made of incidents attended by the three publicly sponsored services.

Samples of standard data forms developed by EMS Project personnel for recording observations are shown in Figures VI-A-1, VI-A-2, and VI-A-3. Using these forms, the physicians evaluated five basic aspects of ambulance attendant performance in emergency situations:

- accuracy of "on-site" diagnosis of the nature and extent of the injury or illness;
- accuracy and timeliness of any treatment selected;
- quality of treatment administered;
- adequacy of available equipment or attendant training to permit the minimum level of emergency care;
- estimates of higher levels of training that would be needed if better emergency care were to be provided.

Initially the data form consisted of Part One only (see Figure VI-A-2). The observing physicians noted the equipment used and actions taken, gave their opinion about whether it was necessary or unnecessary, and evaluated the quality of each act performed on a one-to-five scoring basis. These scores were judgmental and corresponded to: (1) excellent; (2) good; (3) fair; (4) poor; and (5) unacceptable.

One aim of the study was to explore potentially useful expansions of the ambulance attendants' role; therefore, the equipment listed on the data form included items such as drugs and IV solutions, which the attendants were not, in fact, permitted to administer. Blank spaces were also provided for the observing physician to add any other actions he felt would have been appropriate. While not specifically requested to do so, the physician generally included a brief description of the incident and his diagnosis of illness or injury, permitting later analysis of the attendants' performance.

The letters "NR" and the term "Rendered" refer respectively to services not rendered and rendered by the ambulance attendant. The terms "Unused" and "Used" refer respectively to equipment not used or used by the attendant in caring for the injured person.

U = unnecessary for service to be performed or equipment to be used.

N = necessary for the attendant to perform the service or use the equipment.

P = physician's personal choice, i.e., that choice of service or equipment which the physician would have chosen if the injured person were his patient in the ambulance.

The numbers represent a rating system for the way the attendant performs a service or uses a piece of equipment.

1 = First class - excellent
2 = Second class - good
3 = Third class - fair
4 = Fourth class - poor
5 = Fifth class - -unacceptable

The physician is asked to circle the appropriate letters or numbers. Example: If the letter U of the first column and row is circled it means that the attendant did not maintain an airway but it was unnecessary to do so.

Example: If the letter N and the letter P for the second and third columns of the first row are circled, it means that the attendant did not maintain an airway but that it was necessary and would be a service which the physician would have performed. The P of the sixth column should be circled in the case where the physician renders aid when it is not rendered by the attendant.

Code II - Expedite
Code III - Red Light and Siren

FIGURE VI-A-1

PROTOCOL FOR COMPLETING THE "PHYSICIAN'S OBSERVATIONS" FORM

PHYSICIAN'S OBSERVATIONS

NOT RENDERED	RENDERED	SERVICES
U N	U N 1 2 3 4 5	Airway maintained
U N	U N 1 2 3 4 5	Artificial respiration
U N	U N 1 2 3 4 5	Ascertain if limbs are fractured
U N	U N 1 2 3 4 5	Check blood pressure
U N	U N 1 2 3 4 5	Check pulse
U N	U N 1 2 3 4 5	Control hemorrhage
U N	U N 1 2 3 4 5	Cover with sheet
U N	U N 1 2 3 4 5	External cardiac massage
U N	U N 1 2 3 4 5	Give oxygen
U N	U N 1 2 3 4 5	Immobilize injured area
U N	U N 1 2 3 4 5	Mouth-to-mouth resuscitation
U N	U N 1 2 3 4 5	Protect from additional trauma
U N	U N 1 2 3 4 5	Protect from contamination
U N	U N 1 2 3 4 5	Raise feet
U N	U N 1 2 3 4 5	Reassure
U N	U N 1 2 3 4 5	Restraint of patient
U N	U N 1 2 3 4 5	Transport Code 2
U N	U N 1 2 3 4 5	Transport Code 3
U N	U N 1 2 3 4 5	Stop initiating agent
U N	U N 1 2 3 4 5	Cover with blanket

Other Services (list)

U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________

UNUSED	USED	EQUIPMENT
U N	U N 1 2 3 4 5	Stretcher
U N	U N 1 2 3 4 5	Blanket
U N	U N 1 2 3 4 5	Sheet
U N	U N 1 2 3 4 5	Thigh splint
U N	U N 1 2 3 4 5	Leg splint
U N	U N 1 2 3 4 5	Arm splint
U N	U N 1 2 3 4 5	Back board
U N	U N 1 2 3 4 5	Sling
U N	U N 1 2 3 4 5	Dressing
U N	U N 1 2 3 4 5	Gauze pads
U N	U N 1 2 3 4 5	Gauze or muslin bandages
U N	U N 1 2 3 4 5	Triangular bandages
U N	U N 1 2 3 4 5	Water
U N	U N 1 2 3 4 5	Peroxide
U N	U N 1 2 3 4 5	Adhesive tape
U N	U N 1 2 3 4 5	Tourniquet
U N	U N 1 2 3 4 5	Suction unit
U N	U N 1 2 3 4 5	Oxygen tanks and mask
U N	U N 1 2 3 4 5	Oropharyngeal airways
U N	U N 1 2 3 4 5	Mouth-to-mouth resuscitation
U N	U N 1 2 3 4 5	Bag mask resuscitator
U N	U N 1 2 3 4 5	IV solutions
U N	U N 1 2 3 4 5	IV or IM medicines
U N	U N 1 2 3 4 5	Diuretics
U N	U N 1 2 3 4 5	Demarol
U N	U N 1 2 3 4 5	Morphine
U N	U N 1 2 3 4 5	Tracheostomy equipment
U N	U N 1 2 3 4 5	Adrenalin
U N	U N 1 2 3 4 5	Digitalis
U N	U N 1 2 3 4 5	Aminophyllin
U N	U N 1 2 3 4 5	Hemostats
U N	U N 1 2 3 4 5	Pneumatic splints

Other Equipment (list)

U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________
U N	U N 1 2 3 4 5	________________

FORM FOR RECORDING PHYSICIAN'S OBSERVATIONS: PART ONE

FIGURE VI-A-2

		1st Attendant	2nd Attendant
	Type of basic training:		
Date: ____________	Supplementary courses:		
Observer: ____________	Refresher courses:		
	Years of full time experience:		

1. Severity level: unknown ___; minor ___; moderately urgent ___; extreme urgency ___; DOA ___.

2. What treatment was provided before arrival of ambulance?

   If treatment was provided, who provided it?

3. What did the attendants do:
   a. on-scene:

   b. enroute:

4. What would you have done:
   a. on-scene:

   b. enroute:

5. What additional care could only a physician have provided?
   a. on-scene:

   b. enroute:

6. What was the attendant's diagnosis?
   a. 1st attendant:

   b. 2nd attendant:

7. What was your diagnosis?

8. Did the attendants adequately communicate the facts of this case to ER personnel? Yes _____ No _____

   What more could the attendants have said?

9. On the basis of this case, do you think the attendant training program could be improved?
   If yes, in what way?

10. Please rank the following training programs as to how well you feel they prepare attendants to handle cases such as the one you now have. Use the numbers 1 through 4 where 1 indicates best.

    _____ Advanced Red Cross

    _____ Military

    _____ Los Angeles Fire Department

    _____ National Ambulance Training Institute

    _____ Bureau of Mines

FORM FOR RECORDING PHYSICIAN'S OBSERVATIONS: PART TWO

FIGURE VI-A-3

The first form did not permit adequate exploration into some relevant dimensions of the attendants' activities. To correct this weakness, Part Two (Figure VI-A-3) was added to the backside of the data form to collect more comprehensive information about each incident. Part Two also asked the observer to note specific information about the background and experience of the attendants and asked the observer to make the following assessments:

- case severity level;
- treatment provided on-scene prior to arrival of the ambulance;
- a comparison between treatment provided and what the physician-observer would have done;
- additional care that could have been provided, but could be given only by a physician;
- a comparison between the attendant's and the observer's diagnoses;
- adequacy of communication between attendant and emergency room;
- suggestions for improvement in the attendant's training program based on attendant's performance during the emergency incident.

The expanded data form was used during observations of C.R.H., F.D.A. and F.D.B. Data from P.A.C. were recorded only on the original form.

Between September 1968, and March 1969, the physician-observers logged a total of 498 hours of observation time. About 40 percent of the time was spent at P.A.C. and 20 percent at each of the other three services. Of all calls answered, 166 (79%) required the ambulance attendants to perform some services. A data form for each of these runs was completed by the physician-observer. The remaining 44 calls were "dry runs" during which the ambulance attendants were not required to provide either emergency services or transportation. (See Table VI-A-2)

TABLE VI-A-2

NUMBER OF EMERGENCY AMBULANCE CALLS OBSERVED

Ambulance Organization	Total Emergency Calls	Calls Requiring Services	Dry Run Calls
P.A.C.	109	78	31
C.R.H.	21	17	4
F.D.-A	35	29	6
F.D.-B	45	42	3
TOTAL	210	166	44

The uneven distribution of calls between C.R.H. and the two Fire Department ambulances was caused in part by uneven distribution of incidents in the ambulance service areas. On the average, physician-observers would be involved in emergency ambulance runs once every three hours, or four per typical observation period. However, this rate was exceeded at C.R.H. and never attained at F.D.-A and F.D.-B despite efforts to have physicians present on days of the week and times of the day when ambulance calls were heaviest.

2. Part One Study Results

The data were aggregated by ambulance organization for comparison and analysis of the various services. The performance scores were added by category and both frequencies and averages were tabulated. In the strict mathematical sense, the scores assigned by the physicians-observers to the performance of services and use of equipment fall between an ordinal and an interval scale and, therefore, are not readily susceptible to this form of analysis. There is no guarantee, for example, that the differences between the first and second classes, and that between the second and third classes reflect equal increments of performance. Therefore, the significance that might be attached to the differences in scores between ambulance companies should be with the qualification that the numerical representations of the attendants' performances are at best only indications of their abilities to provide emergency care.

The "U" or "Unnecessary" score was assigned a total of 20 times in 166 incidents, primarily for very minor acts such as the unwarranted use of a stretcher, blanket, or oxygen. Such acts tended to reflect caution and thoroughness on the part of attendants, and in no instance were judged to have impaired definitive treatment. Given these considerations, no detailed analysis was conducted on the unnecessary activity scores and they were dropped from further consideration.

A second deletion was made of scores for the following services and equipment: "cover with blanket," "cover with sheet," "blanket," "sheet," and "stretcher." These services and pieces of equipment were managed very effectively by the attendants. Their inclusion tended to reduce the sensitivity of any aggregation of attendants' scores, while their exclusion had no effect on the rankings of attendants later developed from measures of their performance of the other activities.

The average emergency run for each ambulance organization differed significantly in the number of opportunities for action it provided the attendants. The "opportunities for action" scores, by organization, were derived from two components: (1) the total number of times attendants were given scores for their performance of services and use of equipment, and, (2) the total number of times attendants were given "N" scores indicating that opportunities for actions existed but were not taken.

Table VI-A-3 illustrates the differences among the four organizations. They ranged from a average of 5.29 opportunities per run experienced by P.A.C. to a average of 3.11 for F.D.-A.

The average number of opportunities can be construed as a surrogate measure of the complexity of the incidents. As P.A.C. had a greater number of opportunities, it is highly probable that their incidents also required the continuous exercise of a greater number of skills and could therefore be considered the most demanding on the attendants. It is interesting to note, moreover, that P.A.C. was highest in both the actions-provided and necessary-actions-not-provided categories.

Table VI-A-3 also shows "necessary actions not provided" as a percentage of "total opportunities for actions," a figure that provides

TABLE VI-A-3

TOTAL OPPORTUNITIES TO PROVIDE SERVICES AND USE EQUIPMENT AS DERIVED FROM PHYSICIANS' OBSERVATIONS

Category	P.A.C.	C.R.H.	F.D.-A	F.D.-B
Actions scored per emergency incident	4.51	3.52	2.45	3.76
Necessary actions not provided per emergency incident	.78	.50	.66	.59
Total opportunities for action per emergency incident	5.29	4.02	3.11	4.35
Actions not provided as a percent of total opportunities for action	14.8%	12.4%	21.2%	13.5%

some measure of the completeness of the services provided. F.D.-A, despite the apparently lower level of complexity of its cases, had the highest ratio (poorest performance) by this measure.

Table VI-A-4 provides a more complete delineation of "necessary actions not provided." The ambulance organizations were cited far more often for services not performed than for equipment not utilized. In fact, over 55 percent of the total "actions not provided" were attributed to omissions of the basic monitoring function of checking vital signs. If this activity is discounted, the average of "actions not provided" per incident falls dramatically.

Other than the functions just noted, there was no single dominant failing of the ambulance attendants. In other studies, ambulance attendants frequently have been criticized for "mishandling" victims; the chances of mishandling in a case have been estimated to be as high as three out of ten.[1] Data for the four organizations under observation in this study did not support this contention.

Table VI-A-5 details how many times the attendants were given scores, their total points received and average scores. A perfect average score would have been 1.0. When compared to this standard, all organizations performed well and no marked differences were apparent among them. For all organizations, the "equipment used" averages were slightly better than the "services performed" averages.

Table VI-A-6 gives a detailed analysis of low scores in order to determine more precisely under what conditions and in what areas performance was weakest. Forty-three scores of 3, 4, or 5, were recorded. Nearly half (20) were recorded for poor performances by attendants during diagnostic procedures, such as checking the pulse, blood pressure, and injured limbs. Of the ten scores of 4, six also fell in the diagnostic category. One incident emerged as note-worthy insofar as it received a set of low scores. The ambulance crew failed to adequately restrain

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[1] Uzemack, Edward, A. "First, Aid the Ambulance Crews," Physician's Managment, November 1966.

TABLE VI-A-4

ACTIONS DEEMED NECESSARY BUT NOT PROVIDED BY AMBULANCE ATTENDANTS

Category	P.A.C.	C.R.H.	F.D.-A	F.D.-B
Number of emergency incidents	78	42	29	17
Total actions not provided	61	21	19	10
(Per incident)	(.78)	(.50)	(.66)	(.59)
Services not performed	47	19	19	9
(Per incident)	(.60)	(.45)	(.66)	(.53)
Equipment not used	14	2	0	1
(Per incident)	(.18)	(.05)	(.00)	(.06)
Total actions not provided, exclusive of "check pulse" and "check blood pressure" citations	33	6	7	3
(Per incident)	(.42)	(.14)	(.24)	(.18)

TABLE VI-A-5

PERFORMANCE SCORES FOR SERVICES AND EQUIPMENT BY AMBULANCE ORGANIZATION[1]

Category	P.A.C.	C.R.H.	F.D.-A	F.D.-B
1. Total Emergency Incidents	78	42	29	19
Services and Equipment				
2. Total Services and Equipment Scores	352	148	71	54
3. Average Scores per Incident	(4.51)	(3.52)	(2.45)	(3.76)
4. Total Points Received	480	156	98	86
5. Average Score per Service-Equipment	1.36	1.05	1.38	1.34
Services				
6. Total Services Scores	272	102	51	42
7. Average Scores per Incident	(3.49)	(2.43)	(1.76)	(2.47)
8. Total Points Received	375	108	76	56
9. Average Score per Service	1.38	1.06	1.49	1.33
Equipment				
10. Total Equipment Scores	80	46	20	22
11. Average Scores per Incident	(1.02)	(1.09)	(0.69)	(1.29)
12. Total Points Received	105	48	22	30
13. Average Score per Piece of Equipment Used	1.31	1.04	1.10	1.36

[1] Excludes scores for the following services and equipment: "cover with sheet," "cover with blanket," "stretcher," "blanket," "sheet." These were ubiquitous and virtually always received scores of 1. Their removal tends to make the above analysis more sensitive to scores in other areas. Moreover, their exclusion does not change any of the relative positons of the ambulance companies

TABLE VI-A-6

DISTRIBUTION OF ATTENDANT PERFORMANCE

SCORES OF 3, 4, AND 5--"AVERAGE," "POOR," "UNACCEPTABLE"--

BY AMBULANCE ORGANIZATION

	Score		
Organization--Activity	3 (Average)	4 (Poor)	5 (Unacceptable)
P.A.C.			
Ascertain if limbs are fractured	3	1	
Check blood pressure	1	2	
Check pulse	8	3	
External cardiac massage	1		
Give oxygen	1		
Immobilize injured area			1
Protect from additional trauma		1	
Reassure			
Restraint of Patient		1	
Dressing	1		
Bandages	1		
Airway	1		
Other	1		
TOTAL: P.A.C.	18	8	1
C.R.H.			
Ascertain if limbs are fractured	2		
TOTAL: C.R.H.	2		
F.D.-A			
Ascertain if limbs are fractured	3		
Check pulse	3		
Reassure	2		
Transport Code 2		2	
TOTAL: F.D.-A	8	2	
F.D.-B			
Restraint of patient	2		
Bandages	4		
TOTAL: F.D.-B	6		

an intoxicated person injured in an auto accident. Because the patient was not adequately secured, the crew received a series of low scores in categories such as "immobilize injured area," "restraint of patient," and "protect the individual from further trauma." This incident points to the interrelatedness of the categories and consequently suggests some intercorrelation of scores. It should also be repeated, as noted above, that P.A.C. performed a greater number of activities per incident and probably faced more demanding situations during the periods of observation than did the other organizations. The scoring system may therefore tend to discriminate against P.A.C. in its disproportionate share of the low ratings.

It is fairly clear that the ambulance companies all performed very well at the tasks for which they were evaluated by the resident physician-observers. The average score per activity for all groups of attendants was 1.31, a score ranging between "good" and "excellent." Of the four services investigated, the C.R.H. received the best scores, both in terms of average score per activity and the lowest number of failures to provide service per incident. The other three organizations cannot be considered much inferior to C.R.H. in terms of their quality of service.

3. Part Two Study Results

The revised data collection form was used for only 64 observations, since it was not put into operation until late in the study (December 1, 1968). It was not used at all during the assessment of P.A.C. The total data represent 43 incidents covered by C.R.H., eight by F.D.-A and thirteen by F.D.-B. Because the number of cases was so small, they were considered together.

The results of the first question, relating to incident severity (Table VI-A-7), indicate that the physician-observers considered time as significant in about one-third of the cases, i.e., those classified as moderately urgent or extremely urgent. The second question asked what treatment had been provided to the injured party at the scene prior to arrival of the ambulance. In 10 instances (15.6% of the cases), the

TABLE VI-A-7

SEVERITY OF INCIDENTS

Severity Level	Number of Incidents	Percent of Total
Unknown	1	1.6
Minor	39	60.9
Moderately Urgent	20	31.2
Extremely Urgent	1	1.6
Dead on Arrival	3	4.7
TOTALS	64	100.0

resident physician noted that some treatment had been provided before the attendants' arrival, usually minor assistance provided by the Los Angeles Police Department or friends of the injured. In two instances, doctors had provided previous assistance, effectively reducing the attendants' role to one of supervising transportation of the injured person.

Questions three and four asked the physician-observer to compare the attendant's treatment with what the physician would have done, given the context of the incident and the existing constraints upon attendants (for example, attendants do not administer intravenous fluids or drugs). In 28 incidents (43.8% of the cases), the physician differed with the attendant, primarily regarding his failure to provide what the physician considered as necessary monitoring and diagnostic functions, such as checking the pulse, blood pressure, pupils, and other vital signs, and taking a history of the injury. Other minor differences included citations where the physician felt greater patient reassurance should have been provided, service should have been faster, or vomiting should have been induced (in an overdose incident). It is doubtful whether any of these failures would have had an effect on the medical outcomes for the injured or ill persons. In summary, the attendants made no major errors in administering care.

A related question (Number 5) asked the observers to consider what kinds of activities only a physician could have provided during the incident. Seven times out of 64 (10.9%), the doctors felt additional treatment should have been provided. In five instances the suggested additional treatment was a special type of examination of the injured person--a continuation of the "diagnostic-monitoring" theme evidence in questions 3 and 4. While potential additional benefits which might come from treatment by a physician rather than the attendant cannot be discounted, there is reasonable doubt that such actions would have significantly changed the outcomes for patients.

Questions 6 and 7 were similar in format to question 3 and 4, asking the physician-observer to compare his diagnosis with that of the attendant. The physician's diagnosis, for purposes of analysis, was considered to be an accurate "immediate appraisal" of the condition, one suitable for judging attendant's emergency activities and suitable for communication to the emergency room of a hospital. In 11 of the 64 cases, the attendant and physician-observer disagreed. Of these, only six were significant and none led to improper treatment by the ambulance attendant or to dangerously misleading information being given in the emergency room.

Question 8 dealt with ambulance attendant's communication with the emergency room. In 81 percent of the cases (34 out of 42 times) such communication was necessary, the physician-observer was satisfied with the facts about the case related by the attendant to the emergency room personnel. In eight cases, the doctors felt more could have been said; five of these related to providing better detail and description of the patient's injuries or condition.

There were three cases in which additional information from the attendant might have been useful to the emergency room physician. In one incident involving serious abdominal bullet wounds, the attendant failed to note that the victim was in shock; a second instance involved the attendant's failure to communicate the history of a person suffering from heart disease; in the final case, related to hemorrhaging, the attendant gave no details about the time of onset of the bleeding or the amount of blood loss.

In summary, the study indicates that the attendants performed reasonable satisfactorily in most instances. Their errors, as noted by the physician-observers, did not appear to have a significant effect on the medical outcomes of the patients. In all but a few instances, the attendants appeared adequately trained and qualified to perform in the capacity for which they were assigned.

The major criticism reflected in the physicians' opinions was that attendants should make more extensive examinations, such as neurological screening examinations, and should monitor the patient's condition more frequently. Otherwise, the attendants' performances, as measured here, were considered to be at a very high level.

4. Conclusions

As the two prior sections indicate, all four organizations performed with reasonable effectiveness on the tasks monitored in this study. Ambulance crewmen tended to perform well up to the level of their training. However, determining the exact nature of ambulance attendant performance was less central to this study than determining the direction in which subsequent field demonstrations of emergency system modifications should move. To this end, an implicit purpose of Part Two of the data-collection form was to have the doctors explore the differences between the care administered by the attendants and potential care that could have been rendered. Judging from the responses received, the characteristics of emergency incidents were such that a doctor's special talents seldom were necessary. There, however, were a few situations in which the physician-observer made a decision to intercede and either examine or treat a seriously ill or injured victim himself. In these cases, it was the professional judgment of the physician-observer that failure on his part to so act would have endangered the victim. The most serious of these cases was one in which a physician-observer was credited with saving the life of a victim by performing a tracheotomy.

The study sought to identify the kinds of training that would be required to prepare emergency care paramedics for functioning in a role between the level of physician and that of ambulance attendants. Two themes were reflected in the 23 yes responses to Question 9 of Part Two of the data collection form, which asked "on the basis of this case, could you suggest improvements in the attendants' training?" The first theme dealt with the inability of the ambulance attendants to monitor vital signs and adequately evaluate the condition of victims. It was suggested that attendants be taught the physiology and evaluation of signs and symptoms of:

- traumatic shock
- neurological injuries
- heart attacks
- pulmonary problems

The second theme dealt with higher level of care. It was suggested that attendants should be able to render immediate, life supporting care of the kind that at the time of the study could be performed only by a physician and, in some instances, by nurses.

Given these observations, Project staff members explored the necessity for revising and/or increasing levels of training for the crews of emergency medical vehicles in terms of the following issues:

- Can and should crews (non-physicians) be trained (and licensed) to perform the above stated duties?
- How long a training period would be necessary?
- How much more time would be required at the scene to perform these additional duties?
- If crews were trained (and licensed), what would be the benefits?
- What additional equipment would be required in the emergency medical vehicle?
- What legislation would be required to enable non-physician personnel to perform these additional duties?

The results of these considerations were instrumental in the design and development of the Mobile Intensive Care Unit field demonstration discussed in Chapter VII.

B. PRELIMINARY STUDIES OF COMMUNICATIONS BETWEEN EMERGENCY MEDICAL VEHICLES AND EMERGENCY DEPARTMENTS OF HOSPITALS

As a preliminary to later demonstration studies, in which the existing system would be modified, the Project conducted two studies of communications in support of the care and treatment of victims of medical emergencies. Each study involved communication between the emergency medical vehicle (ambulance) and the emergency department of the hospital to which it is transporting the victim(s). The first study was of voice communication; the second of the telemetry of physiological data, specifically electrocardiograms.

1. Study of Voice Communications

Voice communications between an emergency medical vehicle and the emergency department of the hospital, to which the victim is being transported, can be for one or more of several purposes:

- Notification to the emergency department as to the number of victims being transported and the natures and severities of their illnesses or injuries so that advanced preparation can be made
- Physician direction of the crew of the emergency vehicle as to the medical care to be given to the victim(s) at the scene and/or enroute to the hospital
- Instructions to the crew of the emergency vehicle on matters such as whether or not to transport the victim(s) under red light and siren conditions, selection of hospital to which victim(s) should be taken, etc.

A study was undertaken to provide tentative answers to two classes of questions. What are the characteristics of the alternative kinds of communication equipment that could be used? What medical uses could be made of voice communications at the then existing level of training of ambulance attendants?

a. Methodology Of The Study. Four kinds of communication links between an emergency vehicle and the emergency department of a hospital were examined:

- One-way radio (with telephone backup). The emergency department was supplied with a radio receiver at a cost of $60. This receiver was tuned to the frequency used by the ambulance. The emergency department staff used this receiver to monitor the two-way communications between the crew of the ambulance and the ambulance dispatcher. The normal transmission from the ambulance to the dispatcher was modified to include a partially coded message. Further, when critically ill or injured victims were involved, the ambulance dispatcher telephoned the hospital and repeated the message that had been broadcast by the crew of the ambulance. This redundancy insured the receipt of the message by the staff of the emergency department.

- Two-way radio (direct). The emergency department was supplied with a radio transmitter-receiver, which was lent to the Project by the Department of Public Utilities and Transportation of the City of Los Angeles. Upon leaving the scene of the incident, the crew of the ambulance directly transmitted a partially coded message to a designate member of the staff of the emergency department.

- Two-way radio (indirect). The hospital had an existing radio transmitter-receiver which had a replacement value (including the antenna and installation) of $7,300. The remote console of this system was located adjacent to the hospital's telephone switchboard and was operated by the switchboard operator. Upon leaving the scene of the incident, the crew of the ambulance transmitted a partially coded message. The switchboard operator verbally relayed the messages to the staff of the emergency department.

- Two-way mobile telephone. A mobile telephone was installed in the ambulance at an initial charge of $50 and with a monthly service charge of $13 plus a charge per call. A telephone with the unlisted numbers was installed in the emergency department. The mobile telephone was equipped with a headset to permit the driver of the ambulance to operate it with little interference to his driving. Upon leaving the scene of an incident, the ambulance crew contacted the mobile operator of the telephone company, who completed the link to the emergency department. The ambulance crew transmitted a partially coded message to the staff of the emergency department.

The transmission, which the crew of the ambulance made as soon as it had loaded the victim(s) into its vehicle and begun its drive to the hospital, was standardized. This standard message indicated:

- the hospital to which the ambulance was proceding
- the number of victims being transported
- the nature and severity of each victim's illness or injury
- the estimated time of arrival at the hospital

In order to provide a uniform, medically appropriate, method for describing the nature and severity of illnesses and injuries, a three part code was utilized. The code permitted a description of: (1) severity at four levels (unknown, non urgent, moderately urgent, and emergency), (2) the kind of illness or injury in terms of 25 categories, and (3) in the case of injuries, the bodily area of the injury. An example of such a partially coded message would be:

"RA 100 proceding to Encino Hospital with one male stretcher case, level 2, type 8, area 59. ETA in five minutes."

The various kinds of communication links were examined in either a suburban or rural location in cooperation with the ambulance organization and emergency department that delivered the public emergency medical services in the area. The suburban locale was the San Fernando Valley portion of the City of Los Angeles. The San Fernando Valley occupies approximately 227 square miles or slightly less than half of the total area of the City of Los Angeles. At the time of the study, it had an estimated population of almost 1,000,000 persons, who were served by eight rescue ambulances of the Los Angeles City Fire Department and nine hospitals that were under contract to the City to provide 24-hour, physician-staffed emergency services. The rural locale was the Antelope Valley-Newhall portion of the County of Los Angeles. This region contains approximately 2200 square miles or roughly the northern half of the county. It is largely high desert plains and mountainous terrain. With the exceptions of the cities of Lancaster and Palmdale, it is sparsely populated. At the time of the study, it had a population of roughly 120,000. Public emergency medical services in the region are provided by four private ambulance companies and four hospitals which are under contract to the County to provide respectively emergency transportation and 24-hour, physician-staffed emergency services. Table VI-B-1 identifies the locale in which each of the four kinds of communication links was studied and the organizations that participated in the study.

Three data forms were developed for use by the crew of the ambulance and the staff of the emergency department. These forms, which are shown in Figures VI-B-1, 2, and 3, were designed to provide data for assessing the nature of the information that was transmitted, the uses that were made of this transmitted information, and the quality of the transmission. In addition, recordings were made of the messages that were transmitted during each of the ambulance runs encompassed by the study. These recordings were made by means of voice-activated tape recorders that were supplied by the Project.

TABLE VI-B-1

SUMMARY OF THE FOUR COMPONENTS OF THE PRELIMINARY STUDY OF VOICE

COMMUNICATIONS BETWEEN AMBULANCES AND EMERGENCY DEPARTMENTS OF HOSPITALS

Kind Of Communication Link	Geographical Location	Participating Organizations		Inclusive Dates	Total Number Of Ambulance Runs During Which transmissions Were Made
		Ambulance (s)	Hospital		
One-way radio (with telephone backup)	Suburban-San Fernando Valley	2 ambulances from Los Angeles City Fire Department	Encino Hospital (80-bed facility)	December 13, 1968-February 5, 1969	122
Two-way radio (direct)	Suburban-San Fernando Valley	2 ambulances from Los Angeles City Fire Department	Encino Hospital (80-bed facility)	February 6, 1969-April 11, 1969	74
Two-way radio (indirect)	Rural-Antelope Valley	1 ambulance from Wilson Ambulance Co	Swan Memorial Hospital[1] (49-bed facility)	November 8, 1968-April 13, 1969	70
Two-way mobile telephone	Rural-Antelope Valley	1 ambulance from Antelope Valley Ambulance Co.	Antelope Valley Hospital (153-bed facility)	November 9, 1968-April 13, 1969	76

[1] now renamed Palmdale General Hospital

AMBULANCE ATTENDANT FORM

UCLA-EMS PROJECT
COMMUNICATIONS STUDY

A. INVOICE RUN # ________ ATTENDANT ________

B. EMS # ________ DRIVER ________

C. DATE OF RUN [| |] MO DAY YEAR

D. TIME OF CALL TO AMBULANCE COMPANY (best estimate, if necessary) ________ A☐ P☐

E. LOCATION OF INCIDENT, TIME, AND MILEAGE INFORMATION

Location of Incident ________
____
____
Street Address or Highway Route AND Nearest Intersection

	Time	AM	PM	Odometer Reading
Call Received	________	☐	☐	________
Arrive Scene	________	☐	☐	________
Depart Scene	________	☐	☐	xxxxxx
Arrive ER	________	☐	☐	________
Depart ER	________	☐	☐	xxxxxx

F. DIFFICULTIES ENCOUNTERED ENROUTE

NONE☐

	To Scene	To ER
Severe Traffic Congestion	☐1	☐1
Adverse Weather Conditions	☐2	☐2
Mechanical Trouble	☐3	☐3
Tire Trouble	☐4	☐4
Other ________	☐5	☐5

G. USE OF LIGHTS & SIREN

To Scene Yes☐ No☐ To ER Yes☐ No☐

H. ARRIVAL AT SCENE

Dry Run ☐Yes ☐No

I. HOSPITAL SELECTED

1. Name of Hospital ________
2. Number of Injured Transported ________
3. Number of Passengers Transported ________

4. Hospital selected because:
- Standard Practice–All Accident Victims ☐
- Standard Practice–All Emergencies ☐
- Nearest Hospital ☐
- Patient's Request ☐
- Decision Based on Type/Severity of Injury ☐

Was This the Nearest Hospital? Yes ☐ No ☐

J. COMMUNICATIONS

Did you experience any difficulties with communications Yes ____ No ____

ER NOT CALLED ____

If yes, please check where applicable:	1st call	2nd call	3rd call
1. Ambulance out of range of hospital radio	____	____	____
2. Hospital could not hear attendant clearly	____	____	____
3. Attendant could not hear hospital clearly	____	____	____
4. Communications equipment hindered movement in amb.	____	____	____
5. Difficult to give care and communicate at same time	____	____	____
6. Communications took too much time and bother	____	____	____

IF ER WAS NOT NOTIFIED, PLEASE EXPLAIN BELOW:

____

FIGURE VI-B-1

PART ONE OF DATA FORMS COMPLETED BY AMBULANCE ATTENDANTS

UCLA-EMS PROJECT
COMMUNICATIONS STUDY

CASE INFORMATION FORM
(TO BE COMPLETED BY AMBULANCE ATTENDANT)

CODES
(to be used in completing question D on this form)

CASE SEVERITY LEVEL

0 level = NOT SPECIFIED (doubtful or unknown)
1st level = NON-URGENT
2nd level = MODERATE URGENCY
3rd level = EMERGENCY (including possible DOA)

CASE TYPE

0 = ABRASIONS
1 = BLEEDING: MAJOR
2 = BLEEDING: MINOR
3 = BURN
4 = CEREBRAL CONCUSSION
5 = CONTUSIONS
6 = DROWNING OR NEAR
7 = DRUGS
8 = FRACTURES
9 = HEART COMPLAINT
10 = INTERNAL INJURIES (possible)
11 = LACERATIONS
12 = MENTAL
13 = OBSTETRIC
14 = PAIN: UNKNOWN ORIGIN
15 = POISONING
16 = PUNCTURE
17 = RAPE
18 = RESPIRATORY PROBLEM
19 = SHOCK
20 = SICK CALL
21 = STRAINS OR SPRAINS
22 = STROKE
23 = UNCONSCIOUS
24 = OTHER (PLS SPECIFY)

AREAS OF INJURY

50 = HEAD
51 = FACE
52 = EYE
53 = NECK
54 = BACK
55 = CHEST
56 = ABDOMEN
57 = PELVIS
58 = UPPER EXTREMITY
59 = LOWER EXTREMITY
60 = GENERAL, MULTIPLE
61 = NON-WOUND INJURY

A. INVOICE RUN #________ B. DATE OF RUN [MO | DAY | YEAR]

PATIENT NAME________

C. SEX: ___M___F

D. CASE INFORMATION (USE CODES AT LEFT FOR QUESTION #1)

1.________severity level________type________area

2. Nature of incident: traffic_____Other (specify)________

E. ASSISTANCE RENDERED

1. By other than ambulance attendant (pls indicate who rendered assistance)

____

2. By ambulance attendant

____

F. EQUIPMENT USED

1. By other than ambulance attendant (pls indicate who used)

____

2. By ambulance attendant

____

G. SURVIVAL INFORMATION

	yes	no	unknown
1. Was victim alive when you arrived on scene	___	___	___
2. Did victim expire on scene after your arrival	___	___	___
3. Was victim alive at arrival at ER	___	___	___
4. Was victim pronounced dead prior to attendant leaving ER	___	___	___

H. COMMUNICATIONS

Were communications helpful to attendant ____yes ____no

If yes, please check where applicable

1. Reassurance to patient ___
2. Reassurance to patient's parents or guardian ___
3. Treatment information was obtained from ER ___
4. Disturbed patient or relatives ___
5. Other (pls specify) ___

____

FIGURE VI-B-2

PART TWO OF DATA FORMS COMPLETED BY AMBULANCE ATTENDANTS

EMERGENCY ROOM FORM

UCLA-EMS PROJECT
COMMUNICATIONS STUDY

CODES
(to be used in completing items E & F on this form)

CASE SEVERITY LEVEL

0 level = NOT SPECIFIED (doubtful or unknown)
1st level = NON-URGENT
2nd level = MODERATE URGENCY
3rd level = EMERGENCY (including possible DOA)

CASE TYPE

0 = ABRASIONS
1 = BLEEDING: MAJOR
2 = BLEEDING: MINOR
3 = BURN
4 = CEREBRAL CONCUSSION
5 = CONTUSIONS
6 = DROWNING OR NEAR
7 = DRUGS
8 = FRACTURES
9 = HEART COMPLAINT
10 = INTERNAL INJURIES (possible)
11 = LACERATIONS
12 = MENTAL
13 = OBSTETRIC
14 = PAIN: UNKNOWN ORIGIN
15 = POISONING
16 = PUNCTURE
17 = RAPE
18 = RESPIRATORY PROBLEM
19 = SHOCK
20 = SICK CALL
21 = STRAINS OR SPRAINS
22 = STROKE
23 = UNCONSCIOUS
24 = OTHER (PLS SPECIFY)

AREAS OF INJURY

50 = HEAD
51 = FACE
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53 = NECK
54 = BACK
55 = CHEST
56 = ABDOMEN
57 = PELVIS
58 = UPPER EXTREMITY
59 = LOWER EXTREMITY
60 = GENERAL, MULTIPLE
61 = NON-WOUND INJURY

A. ER KNEW OF CASE BY ____ RADIO; ____ PHONE; ____ NOT ALERTED

B. TIME OF ALERT ________ A ___ P ___

C. NUMBER OF CASES TRANSPORTED TO ER ________

D. DATE OF ALERT [MO | DAY | YEAR]

E. NATURE OF ILLNESS OR TRAUMA ASSESSED PRIOR TO ARRIVAL OF AMBULANCE (USE CODES AT LEFT)

1st case ________ level ________ type ____________ area
2nd case ________ level ________ type ____________ area
3rd case ________ level ________ type ____________ area

F. NATURE OF ILLNESS OR TRAUMA AS DETERMINED BY ER (USE CODES)

1st case ________ level ________ type ____________ area
2nd case ________ level ________ type ____________ area
3rd case ________ level ________ type ____________ area

G. QUALITY OF AMBULANCE COMMUNICATION EQUIPMENT

	1st call	2nd	3rd
1. Clear and satisfactory	___	___	___
2. Difficult to hear amb. attendant	___	___	___
3. Other (pls specify) ____________	___	___	___

H. QUALITY OF ER COMMUNICATION EQUIPMENT (Pls check where applicable if ER contacted ambulance)

1. Clear and satisfactory ____
2. Difficult to hear ambulance attendant ____
3. Other (pls specify) ____
____

QUESTIONS I-M SHOULD BE COMPLETED BY AN M.D. OR R.N.

I. WHAT ON-DUTY PERSONNEL WERE NOTIFIED OR MOBILIZED PRIOR TO ARRIVAL OF AMBULANCE

____ Specialist	____ R.N.	____ Clerk
____ Physician	____ Lab technician	____ Orderly
____ Supervisor	____ LVN or NA	____ None

J. WHAT PERSONNEL WERE NOTIFIED OR MOBILIZED FROM OUTSIDE THE ER PRIOR TO ARRIVAL OF AMBULANCE

____ Specialist	____ R.N.	____ Clerk
____ Physician	____ Lab technician	____ Orderly
____ Supervisor	____ LVN or NA	____ None

K. WHAT ROOMS OR OUTSIDE ER EQUIPMENT WERE PREPARED PRIOR TO ARRIVAL OF AMBULANCE AS A RESULT OF ALERT

Pls specify equipment ____________
Number of rooms ________ Neither ________

L. INFORMATION COMMUNICATED WAS:

	1st case	2nd	3rd
1. Correct	___	___	___
2. Incorrect	___	___	___
3. Incomplete	___	___	___

M. ADVANCE PREPARATION WAS:

	1st case	2nd	3rd
1. Necessary & performed	___	___	___
2. Not performed	___	___	___
3. Unnecessarily performed	___	___	___

FIGURE VI-B-3

DATA FORM COMPLETED BY STAFF OF EMERGENCY ROOM

b. Results. Table VI-B-2 summarizes the number of ambulance runs in which radio transmissions were made, for each of the four kinds of communications links. On the average, these transmissions led to the alerting of the emergency room half (50.8%) of the time. Alerting meant that the person at the hospital, who monitored the radio receiver or answered the telephone, judged the situation, as described by the crew of the ambulance, to warrant the notification of the emergency room physician. Typically, the emergency room physician was alerted in two kinds of situations, namely when the severity level was either moderately urgent or "emergency" or when several victims were being transported. The quality of the transmissions, which resulted in the alerting of the emergency room, were such as to be judged clear 87.9% of the time. The quality of transmission was judged to be poorest for the one-way radio. It is suspected that, in part, this was due to the fact that in the one-way link, the personnel, at the hospital had the relatively passive task of only monitoring transmissions. Thus, it was easy for the staff member assigned to the monitoring task to be busy with his or her primary responsibility and miss part of the message. Further, the crew of the ambulance had no means of knowing whether or not their message had been received at the hospital, or, if received, whether or not it was clear. It was for this reason that the ambulance dispatcher placed a telephone call to the emergency room and repeated the message when the severity of the condition of a victim was evaluated by the crew of the ambulance as "emergency."

Unique kinds of difficulties were encountered with the mobile telephone, which arose from its party-line mode of operation. These are summarized in Table VI-B-3. The ambulance crew was unable to get the mobile operator roughly ten percent of the time. It was almost as common for them to be able to get the mobile operator only to learn that there were no open lines. Under regulations, which govern telephone procedures, the ambulance crew could request that the mobile operator interrupt an on-going call to free a line

TABLE VI-B-2

NUMBER OF TRANSMISSIONS THAT RESULTED IN ALERTING OF EMERGENCY ROOM AND THE QUALITY OF THESE TRANSMISSIONS

Kind Of Communication Link	Number Of Ambulance Runs In Which Transmissions Were Made		Quality Of Transmissions Resulting In Alerting Of Emergency Room	
	Total	Resulting In Alerting Of Emergency Room	Clear For Both Parties	Not Clear For One Or Both Parties
One-way radio (with telephone backup)	122	66 (54.1%)[1]	54[2] (81.8%)[3]	12 (18.2%)[3]
Two-way radio (direct)	74	46 (60.8%)	43 (93.5%)	3 (6.5%)
Two-way radio (indirect)	70	35 (50.0%)	32 (91.4%)	3 (8.6%)
Two-way mobile telephone	76	27 (35.5%)	24 (88.9%)	3 (11.1%)
Totals	342	174 (50.8%)	153 (87.9%)	21 (12.1%)

[1]Number of ambulance runs resulting in alerting of emergency room expressed as a percentage of the number of ambulance runs in which transmissions were made.

[2]In one-way radio links, the number of ambulance runs in which the transmission was clear or not clear refers to the quality of the transmission only as monitored by the staff of the emergency room.

[3]Number of ambulance runs in which transmission was clear or not expressed as a percentage of the number of ambulance runs in which the transmission resulted in the alerting of the emergency room.

TABLE VI-B-3

SPECIAL DIFFICULTIES ENCOUNTERED WHEN

COMMUNICATION LINK WAS BY MEANS OF MOBILE TELEPHONE

Kind of Special Difficulty	Number of Ambulance Runs in Which Difficulty was Encountered
None	56 (73.8%)[1]
Could not get mobile operator	8 (10.5%)
Could not get an open line	7 (9.2%)
Call interrupted by another party	2 (2.6%)
Obscenities heard on line	2 (2.6%)
Necessary to interrupt another call	1 (1.3%)
Total	76 (100.0%)

[1]Number of ambulance runs in which specified kind of difficulty was encountered, expressed as a percentage of the total number of ambulance runs in which transmissions were made by mobile telephone.

only when a true emergency was involved. Such a request was made by the crew of the ambulance only once. Twice, however, calls being made by the crew to the hospital were interrupted by physicians who telephoned from their private cars and claimed involvement in medical emergencies.

Table VI-B-4 summarizes the advanced preparations which were made as a result of the alerting of the emergency room. Both the frequencies and the patterns of the advanced preparations were different in the suburban and rural hospitals. Only about one-quarter (24.2%) of the suburban alerts resulted in advanced preparations. In contrast, roughly three-quarters (77.4%) of the alerts in the two rural hospitals resulted in advanced preparations. In terms of emergency room personnel, only nurses and inhalation therapists were mobilized in the suburban hospital as a result of the alerting of the emergency room physician. In the two rural hospitals, laboratory and x-ray technicians and orderlies were mobilized as well. In terms of facilities and equipment, in the suburban hospital treatment areas or examination rooms, oxygen and resuscitators were readied in advance. In the rural environment, one hospital also readied intravenous therapy and suction equipment. A major determinant of the extent of advanced preparations that can be made is the length of time between the notification of the staff of the emergency room and the arrival of the ambulance at the hospital. In the suburban area, the mean travel time of the ambulance from the scene to the emergency room was 6.5 minutes. In the two rural areas, the equivalent mean travel time was 11.7 minutes or almost twice as long. A striking example, of the extent of the advanced preparation that can be made when time permits, was provided by an accident which occurred in a remote recreational section of the rural area in which the study of two-way radio (indirect) was being conducted. A female camper was severely burned by the explosion of a gasoline camp stove. Upon its notification by crew of the ambulance from the scene of the accident, the staff of

TABLE VI-B-4

ADVANCED PREPARATIONS MADE AS A RESULT OF THE ALERTING OF THE EMERGENCY ROOM

Reference Statistics	Kind Of Communication Link		
	One-Way Radio (With Telephone Backing)	Two-Way Radio (Indirect)	Two-Way Mobile Telephone
Mean Travel Time From Scene To Emergency Room	6.5 minutes	13.1 minutes	10.4 minutes
Number Of Alerts Resulting In Advanced Preparations	16 (24.2%)[1]	29 (82.8%)[1]	19 (70.4%)[1]
Kind Of Personnel Mobilized	**Number Of Alerts In Which Specified Kind Of Personnel Were Mobilized**		
Physician (Emergency)	16 (100.0%)[2]	29 (100.0%)[2]	19 (100.0%)[2]
Physician (Specialist)	0	1 (3.5%)	0
E.D. Nurse (Supervisor)	0	4 (13.8%)	4 (23.5%)
E.D. Nurse (Registered)	16 (100.0%)	28 (96.6%)	16 (94.1%)
E.D. Nurse (Licensed Vocational)	0	5 (17.2%)	1 (5.9%)
Technician (Laboratory)	0	4 (13.8%)	1 (5.9%)
Technician (X-ray)	0	3 (10.3%)	1 (5.9%)
Technician (Inhalation Therapist)	8 (50.0%)	8 (27.6%)	8 (47.1%)
Orderly	0	17 (58.6%)	7 (41.2%)
Kind Of Other Preparations	**Number Of Alerts In Which Specified Kind Of Other Preparations Were Made**		
Treatment Area Or Room	16 (100.0%)	29 (100.0%)	14 (82.4%)
Intravenous Therapy Equipment	0	2 (6.9%)	0
Oxygen	8 (50.0%)	10 (34.5%)	7 (41.2%)
Resuscitator	2 (12.5%)	1 (3.4%)	2 (11.8%)
Suction Unit	0	2 (6.9%)	0

[1] Number of alerts resulting in advanced preparations expressed as a percentage of the total number of alerts of the emergency room.

[2] Number of alerts in which specified type of personnel were mobilized or other preparations were made expressed as a percentage of the total number of alerts of the emergency room.

the emergency room started to assemble the necessary medical team and supplies from both within and outside of the hospital. By the time the ambulance arrived at the hospital, some three-quarters of an hour later, all preparations, including the acquisition of an adequate supply of ice, had been completed.

Aside from time-saving preparations in the emergency room, there was little use of two-way voice communications in support of care and treatment. On three occasions, the emergency room physician did use two-way voice communications to obtain more detailed information from the crew of the ambulance about the condition of a victim than was contained in the standard partially coded message. All three cases involved poisoning, namely carbon monoxide, barbiturate (an attempted suicide), and an unknown toxicant.

On no occasion did an emergency room physician order or advise the crew of an ambulance to give any specific kind of care to a victim. The then existing level of training of the ambulance crewmen was that required by the State of California, namely the American Red Cross Advanced First Aid Certificate. This level of training and the then existing applicable state statutes simply did not permit crewmen of ambulances to administer the kinds of care that the emergency room physician might wish to be given immediately. Clearly, the use of two-way voice communication to improve the level of diagnosis and care prior to arrival of the victim at the emergency room had to await the completion of advanced training of crewmen of emergency medical vehicles and the removal of medicolegal constraints. The results of such modifications are examined in Chapter VII, Section A "Mobile Intensive Care Units."

2. Study of the Telemetry of Physiologic Measurements (Electrocardiograms)

The term "telemetry" is derived from two Greek words: "tele," which means distant, and "metron," which means measure. It denotes the complete process of acquiring measurements at a remote location, transmitting them by means of an appropriate medium (electrical circuit, radio, pneumatic or hydraulic line, modulated light, etc.), and interpreting or reproducing them in a suitable form at a convenient location. The telemetry of vital bodily functions, namely those physiologic properties of bodily systems that are necessary for life, has been advocated as an important adjunct to two-way voice communication in the remote diagnosis and direction of paraprofessional care of victims of medical emergencies.[1,2,3] In particular, the telemetry of electrocardiograms (ECG's) has been seen as an important contribution to the prehospital care of cardiac victims.

In September 1968, the Project, in cooperation with the National Aeronautics and Space Administration (NASA) Flight Research Center, the California Ambulance Company, and the Emergency Department of the University of California Hospital, Los Angeles, began a study of the telemetry of ECG's. This study was intended to provide tentative answers to two classes of questions. What is the quality of the ECG's that can be telemetered, under operating conditions, from an ambulance to a hospital? What are the enabling conditions for and constraints on the effective medical use of this technology?

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[1] Owens, J.C., "Ideal Communications," Proceedings of the 21st National Conference on Rural Health, American Medical Association, Seattle, Washington, March 1968.

[2] Nagel, E.L., "Telemetry of Physiologic Data: An Aid to Fire-Rescue Personnel in a Metropolitan Area," Southern Medical Journal, 61(6), June 1968, pp 598-601.

[3] Committee on Emergency Medical Services, Medical Requirements for Ambulance Design and Equipment, Division of Emergency Health Services, Public Health Service, Department of Health, Education and Welfare, Washington, D.C., September 1968, p. 22.

a. Setting of the Study. The study of the telemetry of electrocardiograms was conducted within the existing emergency medical services for a suburban area in the western portion of the City of Los Angeles. The area can be defined roughly as that lying north of the Santa Monica Freeway, south of the Santa Monica mountains, east of the City of Santa Monica and west of the City of Beverly Hills. The ambulance serving this area, under contract to the City of Los Angeles, was a van-type vehicle of the California Ambulance Company. In addition to the then existing requirement of the State of California that ambulance attendants hold an American Red Cross Advanced First Aid Certificate, the crewmen who manned this ambulance had completed the 69-hour course of the National Ambulance Training Institute. The emergency department serving this area was that operated by the University of California, Los Angeles.

b. Equipment. The telemetry system, which was used in the study, was packaged and installed by NASA personnel. This assistance reflected NASA's in encouraging civilian use and applications of technologies which had been developed as part of the space program. NASA had developed and used components for the telemetry of a number of physiologic functions. The system which initially was packaged for civilian use, however, was limited to the telemetry of two-lead ECG's. The electrodes of this system were of a special "spray-on" type, which were literally manufactured as they were applied.[1] Slender wires were held to the body by means of a silver and adhesive compound, which dried very soon after being sprayed on.

The NASA package included circuits and devices for filtering and amplifying the ECG signal from the patient and for coupling the "conditioned" signal to the ambulance's radio transmitter.

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[1] Spray-on Electrodes Enable ECG Monitoring of Physically Active Subjects, Technical Brief 66-10649, National Aeronautic and Space Administration, Washington, D.C., December 1966.

The transmission of the ECG's from the ambulance to the hospital could be made by means of any of the kinds of links that were discussed in the preceding section in connection with voice communications. The link that was used in the study was a combination of radio and telephone elements.[1] The ECG was transmitted by radio from the ambulance to its dispatching center. This transmission was relayed to the hospital by means of a telephonic hard line. A special telephone was installed behind the receiving desk of the UCLA Emergency Department. This telephone was coupled to a demodulator which in turn was connected to a Burdick electrocardiographic machine. The latter machine recorded the ECG tracing directly onto a paper strip.

The crews of the ambulance, which was used in the study, were trained by NASA personnel in the use of the equipment. There was no device, such as an oscillascope or strip recorder, for visually displaying the ECG aboard the ambulance. The members of the crew, therefore, could not monitor and evaluate the quality of the ECG while it was being taken. For this reason, particular care was taken by the NASA instructors to insure that each crewman was knowledgeable and proficient in the proper location and application of the electrodes and in the operation of the equipment that conditioned the ECG signal and fed it into the ambulance's radio transmitter.

c. Data Collection and Analysis. The crews of the ambulance were instructed to obtain as many ECG's as possible, within the following guidelines regarding subjects:

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[1] Electrocardiograph Transmitted by RF and Telephone Link in Emergency Situations, Technical Brief 68-10233, National Aeronautics and Space Administration, Washington, D.C., July 1968.

- Patients had to consent voluntarily to be subjects.
- Only male patients were to be asked to participate as subjects. Female patients were excluded because the application of the electrodes requires some degree of disrobing of the upper portion of the torso.
- No patient was to be asked to participate if his participation would delay or interfere with the administration of care to him by the crewmen.

A cardiologist, who was a member of the clinical faculty of the School of Medicine, University of California, Los Angeles, examined the ECG recordings, which were made at the hospital. He was asked to determine, from a clinical viewpoint, whether or not each ECG tracing was:

- Legible
- Sufficient, as the sole source of information, for determining if the patient had a critical (life threatening or potentially life threatening) heart disorder. If yes, and the patient was deemed to be in such a condition, what treatment was indicated? If no, what additional information would be needed to make a determination and to prescribe treatment?
- Sufficient, as the sole source of information, for making an initial diagnosis when a heart disorder was indicated. If yes, what was the diagnosis; if no, what additional information would be needed to make a diagnosis?

The consulting cardiologist's diagnosis and recommendations for treatment were compared with the emergency room record and, if any, the hospital record of each patient who participated in the study.

d. Results. ECG's were taken in the ambulance and transmitted to the hospital for a total of 59 patients. Table VI-5 summarizes the legibility of these tracings and their adequacies for determining criticality and making an initial diagnosis.

Approximately ninety percent (52 out of 59) of the tracings showed "artifacts," namely aberrations in the graphic record which could not have been present in the original patterns of variations in electrical potential caused by the actions of the heart. From his personal experience, the consulting cardiologist felt that these artifacts were of the kinds produced by:

- Electrical currents associated with actions of skeletal muscles, such as muscle tremor and bodily movements
- Improper electrode placement

Since no equipment for oscillographic display or graphic recordings of ECG's was on board the ambulance, it was impossible to determine whether or not:

- Any of the artifacts had been produced within the radio and/or telephone links of the transmission process
- With visual monitoring of the ECG's, the crew readily could have eliminated the artifacts

Only three tracings were totally illegible. The remaining 56 or approximately 95 percent were legible enough to indicate whether or not the patient's condition involved a heart disorder which was critical or potentially critical. Of these, however, only 39, or approximately two-thirds of the total, were legible enough for diagnostic purposes.

Table VI-6 summarizes the consulting cardiologist's evaluations of the criticality of each patient's condition. Four of the ECG tracings indicated that the patient's condition involved heart disorders which were life threatening or potentially life threatening. In none of these cases, however, did the consulting cardiologist feel that life sustaining treatment could be prescribed solely on the basis of the information that could be derived from the ECG tracings. More clinic signs and, in at least one case, prior history would have had to have been available before treatment could be decided upon.

TABLE VI-5

LEGIBILITY OF ELECTROCARDIOGRAMS TRANSMITTED FROM AMBULANCE AND RECORDED IN THE EMERGENCY DEPARTMENT OF HOSPITAL

Amount of Distortion in the ECG Tracing	Number of Tracings	Was ECG Tracing Sufficiently Legible to	
		Evaluate Criticality?	Make Initial Diagnosis?
None	7 (11.9%)	Yes	Yes
Slight to Moderate	32 (54.2%)	Yes	Yes
Serious	17 (28.8%)	Yes	No
Illegible	3 (5.1%)	No	No
Total	59 (100%)		

TABLE VI-6

CRITICALITY OF PATIENTS IN TERMS OF HEART DISORDERS AS EVALUATED FROM ECG TRACINGS

Criticality of Patient in Terms of Heart Disorders	Number of Tracings
Critical heart disorder	4 (16.8%)
Non critical heart disorder	15 (25.4%)
No discernible heart disorder	37 (62.7%)
Illegible tracing	3 (5.1%)
Total	59 (100%)

Nineteen patients were judged by the consulting cardiologist as having some sort of heart disorder. As noted above, he evaluated four of these as being critical. The hospital records for these four disclosed that three were admitted for heart disorders. The diagnoses for these three, which were contained in the hospital records, were similar but not identical to those of the consulting cardiologist. The differences were deemed to be within the limits of variation which would result from the more complete information that was available to the attending cardiologists at the hospital. In the fourth case, the victim was treated for traumatic injuries, which had been suffered in an automobile accident, and released from the emergency department. The consulting cardiologist had identified an irregular tachycardia of about 200 beats per minute with accompanying ventricular (or possibly atrial) fibrillation from this patient's ECG tracing. Since this patient's emergency room record indicated no examination for heart disorders, no comparison could be made of the two diagnoses.

Fifteen cases were identified by the consulting cardiologist as involving non critical heart disorders. The hospital records for these patients indicated that eleven were treated as cardiac cases, with diagnoses similar to those made by the consulting cardiologist. By the time one of these patients was examined in the emergency department, however, he was in a state of cardiovascular collapse. This patient's ECG tracing, taken at an earlier point in time, indicated to the consulting cardiologist a probable myocardial infarction. Since the emergency room records for the remaining four patients indicated no examinations for heart disorders, no comparison of diagnoses could be made.

Examinations of the emergency room and, if available, hospital records for the remaining 37 patients, whose ECG tracings had been considered by the consulting cardiologist to show no heart disorders, revealed only one case where a heart disorder might have been involved. In this case, the attending physician's diagnosis was angina pectoris. This diagnosis, however, appeared to have been strongly influenced by the patient's history.

C. CLASSIFICATION SYSTEM FOR INJURIES AND ILLNESSES

The classification systems used in our studies of emergency medical services based on historical data are described in Sections V-C and V-D. For studies based on specially collected data, however, and for studies of modifications of the system, we needed a different classification scheme. The elapsed time to treatment and the nature of the treatment are the only determinants of the medical outcome that are related directly to the design and operation of an emergency medical service system. Therefore, we sought a system of classification that would be appropriate and sensitive to these factors.

Initially, it was thought that a search of the literature would reveal a classification system that was applicable to most, if not all, of the possible injuries and illnesses. It was found, however, that existing classification systems had serious limitations for our purposes. First, no single scale covered all acute illnesses. Second, the systems for classifying injuries were based on a wide variety of factors (i.e., mortality, morbidity in terms of days in hospital, days off from work, permanent disability, tissue loss, hospital costs, etc.).[1] Third, the injury classification systems were far too detailed. It became apparent that it would be necessary to develop a classification system tailored to our purposes.

1. Structured Interviews with Physicians and Surgeons

It was felt that interviewing physicians and surgeons who represented different fields of specialization could generate the kinds of information necessary to develop a classification system for medical and surgical emergencies. A procedure for conducting such structured interviews was developed.

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[1] See, as examples, Ad Hoc Committee on Injury Scaling, American Medical Association, Abbreviated Injury Scale, Detroit, Michigan, August 1969, and Ryan, G. A. and Garrett, J. W., A Quantitative Scale of Impact Injury, Cornell Aeronautical Laboratory, Inc., Doc. No. VJ - 1823-R, October 1968.

First, we explained our need for a system that could be used for the classification of illnesses and injuries and for the scaling of their severity. The explanation included a brief identification of the kinds of studies of emergency medical systems that we had undertaken or were undertaking. Next, the protocol to be employed was explained. It consisted of three major tasks. The first dealt with the selection of a major category in terms of severity. The subprotocol asked the respondent to:

- select a major category of injury or illness, from among the medical problems related to his field of specialization, that could lead to medical emergencies;
- choose a criterion or set of criteria for scaling the injuries or illnesses, within the major category, in terms of severity;
- identify the least severe injury or illness according to the criterion or criteria chosen;
- identify the most severe injury or illness according to the criterion or criteria chosen;
- assign the remaining injuries or illnesses within the major category to one of three remaining levels of severity, lying between the least and most severe, in terms of the criterion or criteria chosen.

The second task dealt with alternative means of treatment. The physician or surgeon was asked to specify, for the illnesses or injuries assigned to each of the five levels of severity, the alternatives that exist for the treatment of these conditions.

The third task required a subjective assessment of the relationship between medical outcome and the elapsed time from the onset of symptoms of an illness (or the occurrence of an injury) to treatment. Five categories of medical outcome were specified. These ranged from "no residual effect" to "death". For all the categories except death, medical outcome was defined as the condition existing after a normal period of recuperation. For the illnesses or injuries within each of the five levels of severity, the subprotocol asked the physician or surgeon to:

- estimate the longest time to treatment that would not detrimentally affect medical outcome (i.e., for which the distribution of victims among the five categories of medical outcomes would remain the same as if treatment had been rendered immediately);
- estimate the shortest time to treatment that would most detrimentally affect medical outcome (i.e., for which the distribution of victims among the five categories of medical outcomes would be the same as if no treatment had been rendered);
- estimate the length of time representing the midpoint of treatment effectiveness with respect to medical outcomes (i.e., in terms of its influence on the distribution of victims among the five categories of medical outcomes);
- distribute 100 victims among the five categories of medical outcomes for each of the three aforementioned periods of elapsed time to treatment.

Two forms (see Figures VI-C-1 and VI-C-2) were developed for recording the responses of the physicians and surgeons. Prior to their use, the protocol for the interview and the forms themselves were tested on two doctors working with the Project, one a physician, the other a surgeon. The protocol and forms were subsequently tested at a meeting of the Ad Hoc Committee on Injury Scaling of the American Medical Association in Detroit in May 1969. No difficulties were encountered in administration and the forms appeared to gather the kinds of information that could be used to develop a system of classification and severity rating.

Forty-eight medical practitioners were interviewed between September 1969 and June 1970. They were selected by the medical co-directors of the Project from among the professors, clinical staff, and residents of the UCLA School of Medicine. On the average, each participating physician or surgeon judged two major categories. Ninety-seven sets of forms were

Condition FRACTURES

Physician ______ # ______

Affiliation ______

		least severe 1	2	3	4	most severe 5
SEVERITY		avulsion fract- tures and frac- tures of bones of wrist and feet	single long bone fractures with- out displacement, angulation or comminution	single long bone fractures with displacement, angulation or comminution	multiple long bone fractures	fracture dislo- cation of cerical spine
criteria: potential for disability and mortality						
TREATMENT	A	none	closed reduction	closed reduction	closed reduction	traction
	B	cast	open reduction	traction	traction	open reduction
	C			open reduction	open reduction	

FIGURE VI-C-1

SEVERITY AND TREATMENT FORM

Physician________________#____________

Condition FRACTURES Affiliation____________________

SEVERITY LEVEL	EQUIVALENCE TO	TIME	NO RESIDUAL	TEMPORARY DISABILITY OR EXTENDED MORBIDITY	SLIGHT COSMETIC DISFIGUREMENT AND/OR SLIGHT PERMANENT IMPAIRMENT	MARKED COSMETIC DISFIGUREMENT AND/OR MARKED PERMANENT IMPAIRMENT	DEATH
1	immediate treatment	10 days	100	0	0	0	0
	no treatment	3 wks.	80	10	10	0	0
	mid point	2 wks.	90	5	5	0	0
2	immediate treatment	2-3 days	95	3	2	0	0
	no treatment	3 wks.	60	20	15	5	0
	mid point	1½ wks.	70	10	18	2	0
3	immediate treatment	24 hrs.	80	10	7	3	0
	no treatment	2-3 wks.	0	0	25	75	0
	mid point	1½ wks.	45	5	15	35	0
4	immediate treatment	3 hrs.	80	10	5	5	0
	no treatment	48 hrs.	20	25	25	25	5
	mid point	24 hrs.	55	20	10	10	7
5	immediate treatment	1-2 hrs.	55	15	10	13	7
	no treatment	12 hrs.	30	5	10	43	12
	mid point	6 hrs.	50	12	10	18	10

FIGURE VI-C-2

EXPECTED DISTRIBUTION OF VICTIMS AMONG CATEGORIES OF MEDICAL OUTCOMES AS A FUNCTION OF THE ELAPSED TIME TO TREATMENT obtained covering 38 major categories, 22 for injuries and 16 for illnesses. Figures VI-B-1 and VI-B-2 also include a composite example for the "Fracture" category. In this example, the potential for permanent disability and mortality is used as the criterion for scaling severity.

The interviews were reviewed with the Project co-director, who was himself a surgeon, and with the Project physician. The results for severity scaling are summarized in Tables VI-C-1 and VI-C-2 for injuries and illnesses, respectively. It is readily apparent that no common viewpoint is represented. When two or more physicians or surgeons assessed a given category, they differed in terms of the criteria that they deemed most appropriate for scaling the severity of medical emergencies and in terms of the illnesses or injuries that were used to illustrate severity. There was, however, a greater commonality among surgeons than among physicians. For 14 of the 16 categories of injuries selected by two or more surgeons, there was enough commonality to make some comparisons. The closest that the surgeons approached a consensus was for category 20, "Dislocations." All eight of the surgeons selecting this category included in their severity scaling 6 of the 14 injuries named.

The situation was strikingly different for the physicians. In only one of eight categories for which there were two or more respondents was there enough commonality to make comparisons. Even in this category, "Obstetrical Emergencies," four of the nine conditions were named by only one respondent and none of the nine was included by all respondents. This lack of a shared viewpoint among physicians may explain why there is no system to be found in the literature for classifying and rating the severity of illnesses, although a number of systems exist for injuries.

If a more or less common viewpoint had emerged from the limited number of interviews, it had been envisioned that a technique such as Delphi[1] would have been used to seek a consensus of views. However, given the vast conceptual differences among the initial respondents,

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[1]Dalkey, N. and Helmer, A., "An Experimental Application of the Delphi Method to the Use of Experts," Management Science, Vol. 9, 1963, pp. 1575-1588.

TABLE VI-C-1

INTERVIEW RESULTS: INJURIES AND SEVERITY

Category	Number of Respondents	Total Number of Specific Injuries	Number of Times a Specific Injury Was Mentioned: By All Respondents	Number of Times a Specific Injury Was Mentioned: By Only One Respondent	Criteria Used for Severity Scaling
1) Cranio-cerebral	4	14	5	4	a. amount of central nervous system complication b. probability of neurologic damage c. threat to life, functional impairment d. percent of recoverable patients
2) Skull fractures	1	9	--	9	a. likelihood of brain damage
3) Peripheral nerve injury	2	8	2	6	a. amount of severance
4) Trauma to spinal cord	2	14	4	10	a. amount of neurologic loss b. amount of severance
5) Trauma to eye	3	12	2	10	a. probability of losing eye b. threat to loss of vision
6) Burn to eye	1	2	--	2	a. morbidity

TABLE VI-C-1 (cont'd)

Category	Number of Respondents	Total Number of Specific Injuries	Number of Times a Specific Injury Was Mentioned: By All Respondents	By Only One Respondent	Criteria Used for Severity Scaling
7) Facial fractures	5	21	0	11	a. permanent injury with probability of complications b. proximity or involvement of brain, major blood vessels or airway; probability of respiratory or bleeding complications c. location of fracture d. number and importance of bones involved
8) Traumatic airway obstruction	2	8	4	4	a. distance of object from mouth
9) Foreign body in airway	2	6	4	2	a. location, difficulty in removing
10) Soft tissue facial injuries	1	4	--	4	a. morbidity
11) Blunt trauma, thorax	5	21	2	6	a. mortality

TABLE VI-C-1 (cont'd)

Category	Number of Respondents	Total Number of Specific Injuries	Number of Times a Specific Injury Was Mentioned: By All Respondents	Number of Times a Specific Injury Was Mentioned: By Only One Respondent	Criteria Used for Severity Scaling
12) Abdominal trauma	6	15	4	4	a. mortality b. by organ affected c. hollow vs. solid organs d. nonessential vs. essential organs
13) Kidney trauma	2	5	5	0	a. mortality, morbidity b. no specific reason
14) Bladder trauma	2	5	5	0	a. mortality (but only associated with fractured pelvis) b. no specific reason
15) Trauma to urethra and genitalia (male)	2	5	5	0	a. amount of disruption
16) Vascular trauma, neck	1	5	--	5	a. mortality
17) Vascular trauma, thorax and abdomen	1	10	--	10	a. importance of vessel affected

TABLE VI-C-1 (cont'd)

Category	Number of Respondents	Total Number of Specific Injuries	Number of Times a Specific Injury Was Mentioned: By All Respondents	By Only One Respondent	Criteria Used for Severity Scaling
18) Vascular trauma, extremities	2	7	5	2	a. necessity for active intervention b. time to treatment, morbidity
19) Fractures	7		*		a. single bone to combination to those involving central nervous system b. short to long bone to multiple fractures c. mortality, functional impairment
20) Dislocation	8	14	6	1	a. morbidity b. probability of involving central nervous or vascular systems
21) Burns	1	5	--	5	a. percentage of body burned
22) Poisonings	2		*		a. type of agent or drug

* An asterisk indicates that, for the given category, the severity scales of the respondents could not be compared because of the use of totally different criteria for scaling or the inclusion of different kinds of specific injuries.

TABLE VI-C-2

INTERVIEW RESULTS: ILLNESSES AND SEVERITY

Category	Number of Respondents	Total Number of Specific Illnesses	Number of Times a Specific Illness Was Mentioned: By All Respondents	Number of Times a Specific Illness Was Mentioned: By Only One Respondent	Criteria Used for Severity Scaling
1) Cardiac emergencies	6		*		a. mortality b. myocardial infarctions only discussed c. signs and symptoms d. causal effects (e.g.,gastro-intestinal bleeding, pulmonary emboli) e. arrythmias only discussed
2) Cerebro-vascular disease (stroke)	2		*		a. mortality b. signs and symptoms
3) Convulsions	1	3	--		a. rate of spasms
4) Functional airway obstruction	1	7	--		a. time to treatment
5) Pulmonary embolism	1	3	--		a. number and size

* An asterisk indicates that, for the given category, the severity scales of the respondents could not be compared because of the use of totally different criteria for scaling or the inclusion of different kinds of specific illnesses.

TABLE VI-C-2 (cont'd)

Category	Number of Respondents	Total Number of Specific Illnesses	Number of Times a Specific Illness Was Mentioned		Criteria Used for Severity Scaling
			By All Respondents	By Only One Respondent	
6) Pulmonary failure	3		*		a. drowning only discussed b. myocardial infarctions only discussed c. many causes discussed
7) Mass legions, brain	1	5			a. no specific reason
8) Eye infection	1	5			a. probability of eye loss
9) Communicable infections	6		*		a. respiratory only discussed b. meningo-encephalitis only discussed c. bacteria d. bacteremia only discussed
10) Kidney diseases	1	5			a. no specific reason
11) Urologic infections	1	9			a. no specific reason
12) Hemorrhage, general	1	5			a. by area

*An asterisk indicates that, for the given category, the severity scales of the respondents could not be compared because of the use of totally different criteria for scaling or the inclusion of different kinds of specific illnesses.

TABLE VI-C-2 (cont'd)

	Number of Respondents	Total Number of Specific Illnesses	Number of Times a Specific Illness Was Mentioned: By All Respondents	Number of Times a Specific Illness Was Mentioned: By Only One Respondent	Criteria Used for Severity Scaling
13) Spontaneous gastro-intestinal bleeding	2		*		a. rate with cause b. rate with duodenal ulcer only
14) Intra-abdominal hemorrhage	3		*		a. total volume of blood lost
15) Ruptured aneurysms	2		*		a. amount of rupture or tear b. only those in brain discussed
16) Obstetrical emergencies	3	9		4	a. by type, threat to life b. rate of blood loss

*An asterisk indicates that, for the given category, the severity scales of the respondents could not be compared because of the use of totally different criteria for scaling or the inclusion of different kinds of specific illnesses.

the use of Delphi to seek a convergence of views would have required time and resources that were not available. Similarly, it was apparent that simply conducting more interviews would most likely have contributed to the divergence, rather than to the convergence, of viewpoints.

Overall, the study was of value in providing a greater understanding of the medical practitioner and his relationship to medical emergencies. In their careers, physicians and surgeons tend to become specialized in the proficient handling of specific illnesses or injuries. This specilization gives them acute insight into part of a category and less appreciation for the rest. The study also revealed some aspects of the relationship between medical outcomes and the elapsed time to treatment for certain categories, providing a basis for the scaling of severity.

2. Development of a Simplified Classification System

The next attempt to develop a system for classifying injuries and illnesses and scaling their severity was made by a physician working on the project. This physician had worked with the Ad Hoc Committee on Injury Scaling of the American Medical Association and had participated in the development of a qualitative method of scaling injuries for the United States Public Health Service.[1]

A decision was made to limit the criterion of severity to the dimension of the threat to life. One of the by products of the interviews with surgeons was an appreciation that the major determinant of permanent impairments is the nature and extent of the original trauma, not the elapsed time from the trauma to treatment or the treatment itself. Further, orthopedic surgeons, for example, indicated that the elapsed times to treatment that would be necessary to introduce a significant risk of complications in orthopedic conditions, such as osteomyelitis, far exceeded the response and retrieval times of present emergency medical systems. Therefore, a dichotomous severity scale was adopted. The injury

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[1] Douglass, J. M. and Burg, F. D., A Qualitative Method of Scaling Injuries Danger to Life, United States Public Health Service Program Guide, 1969.

or illness was to be classified as either posing a significant threat to life or not posing such a threat.

The classification of injuries and illnesses was approached with the aim of balancing differentiation and aggregation. A sufficient number of categories was required to permit distinction among the injuries and illnesses in terms of their appropriate treatments and their respective relationships between medical outcomes and elapsed time to treatment. Conversely, too large a number of categories would result in too few cases in any one category to be able to perform statistically meaningful analyses.

The final system of classification contained a total of 22 categories, 11 for injuries and an equal number for illnesses. These categories are presented in Table VI-C-3. This system was used to classify medical emergencies in our demonstration studies of helicopter ambulances and mobile intensive care units manned by paramedics. It also was used to classify actual medical emergencies reported by the respondents in the household survey.

TABLE VI-C-3

CLASSIFICATION SYSTEM FOR EMERGENCY MEDICAL CONDITIONS

Injuries

A. Burns and heat injuries (including heat strokes, heat exhaustion, and related conditions)

B. Cold injuries (such as frostbite, chilbains, exposure, etc.)

C. Electrical injuries (other than burns)

D. Fractures and dislocations

E. Lacerations and penetrating injuries

F. Crushing, perforation, and internal injuries

G. Poisonings and overdoses (ingestions, inhalations, and contacts)

H. Bites and stings

I. Suffocations, asphyxiation, drowning, and strangulation

J. Central nervous system injuries

K. Minor injuries (e.g. contusions, backaches, soft tissue injuries, etc.)

Illnesses

1. Hypertensive and arteriosclerotic heart disease (myocardial infarctions, arrhythmias, pulmonary edemas)

2. Hypertensive and arteriosclerotic cerebro-vascular disease (stroke with or without bleeding, hypertensive crises)

3. Nontraumatic blood loss (e.g., gastro intestinal)

4. Infection (central nervous system, septicemia, and other)

5. Influenza and prostration

6. Convulsions and delirium tremens

7. Coma, fainting, dehydration, and metabolic disorders

8. Obstetrical complications

9. Respiratory dysfunction (e.g., asthma, emphysema, etc.)

10. Minor illness (e.g., colds, etc.)

11. Emotional distress (depression or agitation)

D. SURVIVAL RATE AS A FUNCTION OF THE TIME TO CARE OR TREATMENT

An essential element of the methodology, which is proposed in Chapter III for the evaluation of alternative designs for a system of emergency medical services, is a set of models for predicting the distribution of medical outcomes that would be produced by each alternative design. The development of such a set of models requires:

- Definition of medical outcomes
- Identification of the principal factors that influence the defined medical outcomes
- Sufficient empirical data to determine the mathematical forms and to estimate the parameters of the relationships between the medical outcomes and the factors that affect them.

1. Definitions of Medical Outcomes

The spectrum of possible medical outcomes for victims of medical emergencies ranges from complete recovery to death with varying degrees of cosmetic disfigurement and functional impairment in between. Each such medical outcome that is influenced significantly by the dimensions, in which existing or potential systems of emergency medical services can differ, should be included among the measures of effectiveness.

Clearly death dominates all other negative outcomes. It is a single valued medical outcome and its occurrence can be established easily. Other negative medical outcomes are multi-valued and so require a determination of their magnitude as well as their existence. Referees, arbitrators, insurance adjusters, judges, and jurors are familiar with the considerable difficulties and imprecisions that characterize the state-of-the-art with regard to the determination of the magnitude of a victim's cosmetic disfigurement or functional impairment. Further, there is considerable uncertainty as to the degrees to which disfigurement and functional impairment are functions of the design of the emergency medical system. As discussed in Section VI-C, one of the by-products of the interviews, which were conducted with surgeons, was the belief that the major determinant of many kinds of permanent functional impairment is the nature and extent of the original trauma. Orthopedic surgeons, for example, indicated that the lengths of elapsed time to treatment that would be necessary to introduce a significant risk of complications, such as osteomyelitis, in many kinds of orthopedic cases far exceed the elapsed times to treatment of present systems of emergency medical service.

Because of the primacy of death as a negative medical outcome and the aforementioned difficulties and uncertainties surrounding the evaluations of cosmetic disfigurement and functional impairment, a decision was made to limit medical outcomes initially to the dichotomy of survived-died.

2. Identification of The Principal Factors that Influence the Survival Rate

Deaths that result from medical emergencies can be reduced in a number of different ways. Clearly the prevention of illness or injury is to be preferred. Once a severe illness or injury has occurred, however, whether or not the victim survives is determined by numerous factors. These factors may be classified into two categories, namely those that are independent of and those that are determined to a significant extent by the design of the system of emergency medical services.

The principal factors that are independent of the design of the emergency medical system are: (1) the kind of illness or injury, (2) the severity of the illness or injury, and (3) the physical and mental constitution of the victim. Although outside the purview of the emergency medical system, these factors, of course, are under some degree of control. In terms of injuries, for example, alternative designs for automobiles can yield different patterns of the kinds and severities of injuries, which are sustained by occupants as the result of crashes. In terms of illnesses, the inoculation of a vaccine, which has been produced from attenuated or killed virus or bacteria, can confer protection against the disease that is caused by the unmodified pathogen.

The principal factors that are determined to a significant extent by the design of the emergency medical system are: (1) The elapsed time from the onset of symptoms of an illness or the occurrence of an injury to the administration of care or treatment, (2) The kind(s) of care and/or treatment that is rendered, and (3) The levels of quality with which the kind(s) of care and/or treatment is rendered. Because they are under considerable control by planners, these are the factors whose relationships to medical outcomes must be established.

a. Elapsed Time to Care or Treatment. The elapsed time between the onset of symptoms of an illness or the occurrence of an injury and the administration of care or treatment is under less control than the kind and quality of care or treatment. There are two reasons for this. First, it is very rare that fortuitous circumstances place, at the scene and time of a serious medical emergency, a person who is competent and willing to render appropriate care or treatment. Most commonly, the emergency medical system must be called upon to deliver care or treatment. The location and time of the incident, although not controllable, are major determinants of the time either to bring care to the scene or to transport the victim to where treatment is available. Second, the elapsed time to care or treatment is composed of two segments. The initial portion is the interval of time between the onset of symptoms of illness or the occurrence of injury and the notification to the emergency medical system of the need for assistance. Notification either is given by means of a communication device, such as a telephone or radio, or it occurs with the arrival of the victim at an emergency room through a mode of transportation that is not part of the emergency medical system, such as a private automobile. The final portion is the interval of time from the notification of the emergency medical system to the administration of care or treatment.

The initial portion of the elapsed time to care or treatment depends upon the behavior of the victim and of those acting on his or her behalf, such as a relative, passerby or law enforcement officer. Numerous factors influence the delay that takes place between the occurrence of the emergency incident and the decision to bring assistance to the scene or to take the victim to where treatment is available. This decision is complicated by the fact that laymen are not capable of accurately determining the nature and severity of an illness or an injury. Further, the victim of an acute illness may engage in psychological denial of the significance of his symptoms. This kind of behavior has been identified as one of the factors that contribute to the delay between the onset of signs and symptoms of myocardial infarction and the seeking of assistance.[1] Such delays substantially add to the elapsed time to treatment. The distribution of patients, in terms of the time from the onset of symptoms of acute myocardial infarction until admission to an intensive care unit was studied at London Hospital. The results showed that approximately one third of all confirmed MI victims were admitted in each of three intervals of elapsed time, namely 0 - 6 hours, 6 - 12 hours and greater than 12 hours. Undoubtedly, much of the delay in these cases was due to the ignorance, disregard or denial of the signs and symptoms by the victim and those around him or her.

Estimates of the mean durations of the interval, between the onset of the symptoms of the illness or the occurrance of the injury and the contacting of the emergency medical system to request an ambulance, were obtained from the demonstration studies of mobile intensive care units (Section VII-A) and of a secondary role

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[1] Hackett, T.P. and Cassem, N.A., "Factors Contributing to Delay in Responding to the Signs and Symptoms of Acute Myocardial Infarction," American Journal of Cardiology, 24 (5), 1969, pp. 651-658.

[2] Thomas, M., Jewitt, D.E., and Shillingford, J.P., "Analysis of 150 Patients with Acute Myocardial Infarction Admitted to an Intensive Care and Study Unit," British Medical Journal, 5955, March, 1968, pp. 787-790.

for helicopters as air ambulances (Section VII-B). These mean durations for each of the twenty-two categories of illnesses and injuries that are described in Section VI-C are shown in Table VI-D-1. With the exception of category 1 (Hypertensive and

TABLE VI-D-1

MEAN DURATION IN MINUTES OF THE NOTIFICATION DELAY FROM ONSET OF ILLNESS OR OCCURRENCE OF INJURY TO REQUEST FOR AN AMBULANCE

	Category of Illness or Injury	Number of Observations of Elapsed Time	Mean Duration of Notification Delay (Minutes)	Comments
A	Burns	20	33.9	
B	Cold Injuries	1	-	See Footnote 1
C	Electrical	4	9.0	
D	Fractures	342	15.7	
E	Lacerations	571	10.3	
F	Crushing	105	11.6	
G	Poisoning	333	48.8	
H	Bite	1	-	See Footnote 1
J	Suffocation	11	13.7	
K	C.N.S.	240	13.5	
L	Minor Injury	713	14.5	See Footnote 2
1	Cardio-Vasc.	205	23.4	See Footnote 3
2	Cerebro-Vasc.	73	26.8	
3	Bleeding (non-traumatic)	33	56.3	
4	Infections	46	35.2	
5	Flu, etc.	12	15.9	See Footnote 2
6	Convulsions	24	34.1	See Footnote 2
7	Coma, etc.	349	27.4	

[1] Insufficient data to estimate the mean duration for this category.

[2] No life threatening cases were handled in this category.

[3] Mean duration for 95 critically ill victims was 16.5 minutes and for 110 non-critical victims it was 29.2 minutes.

TABLE VI-D-1
(Contd.)

	Category of Illness or Injury	Number of Observations of Elapsed Time	Mean Duration of Notification Delay (Minutes	Comments
8	Obstetrical	24	24.6	
9	Respiratory	134	26.0	
10	Minor Illness	93	25.5	See Footnote 2
11	Emotional	81	27.6	

Arterosclerotic Heart Disease), the mean duration of the notification interval was not significantly shorter for critically ill or injured victims than for non-critical victims. Therefore the values in the table are averaged over critical and non-critical victims. It is apparent from the table that in general the notification interval is less when the medical emergency results from trauma than when it results from illness. For the five principal categories of trauma: D (Fractures), E (Lacerations), F (Crushing and Perforations), K (Central Nervous System Injuries) and L (Minor Injuries), the average notification interval for the 1971 aggregated incidents was 13.2 minutes. For the eight principal categories of illness: 1 (Hypertensive and Arteriosclerotic Heart Disease), 2 (Hypertensive and Areriosclerotic Cerebro Vascular Disease, 4 (Infections), 5 (Influenza and Prostration), 6 (Convulsions and Delirium Tremens), 7 (Coma, Fainting, Dehydration and Metabolic Disorders), 9 (Respiratory Dysfunction) and 10 (Minor Illnesses), the average notification interval for the 916 aggregated incidents was 26.6 minutes or approximately double. This difference is not surprising since the signs and symptoms of trauma are readily linked to the incident that produced them whereas those of illness are more ambiguous and may not be dramatic at their onset. The longest mean notification intervals were 56.3 and 48.8 minutes respectively for categories 3 (Non-Traumatic Bleeding) and G (Poisonings and Drug Overdoses). The shortest was 9.0 minutes for category C

(Electrical Injuries).

Various approaches have been employed to reduce delays in notification. These include the installation of free emergency telephones along expressways and informational programs that seek to familiarize the public with the signs and symptoms of various life threatening illnesses and what to do if they appear. At best, such programs provide only enabling and indirect means of reducing this component of elapsed time to treatment.

The final portion of the elapsed time to care or treatment is highly controllable. If a response is sought in the form of bringing assistance to the scene, the interval between the notification of the emergency medical system and the administration of care at the scene depends upon the:

- communication network
- kinds, number, crew compositions and deployments of emergency medical vehicles
- dispatching and on-scene care policies for emergency medical vehicles.

The interval between notification and the administration of treatment at an emergency room depends upon the above three sets of determinants plus the:

- retrieval policies for emergency medical vehicles
- number, location and staffing of emergency rooms
- triage and treatment policies of emergency rooms.

If assistance is sought directly at an emergency room, the interval between arrival at the emergency room and the receipt of treatment depends upon the last two determinants that are given above, namely the:

- number, location and staffing of emergency rooms
- triage and treatment policies of emergency rooms.

b. Kinds and Quality of Care or Treatment. The kinds of care or treatment and the quality with which they are rendered are highly controllable dimensions of the design of a system of emergency medical services. The options with regard to the kinds of care or treatment for a specific illness or injury will depend upon the state-of-the-art of medicine or surgery and the level of personnel, viz., physician, nurse, paramedic, ambulance attendant, etc., who is to deliver it.

The quality with which a given kind of care or treatment is rendered depends upon both training and the maintenance of the skills which the training provided. A critical aspect of the maintenance of a skill is the frequency with which the individual is called upon to apply it in practice. The demands that are generated by actual medical emergencies may be insufficient for some members of the emergency medical system to maintain their proficiency in a given skill. In such cases, there are several alternatives to maintain the level of quality. One is to limit the number of individuals who are authorized to perform procedures that are required only infrequently. The recommendations for broadening California's Wedworth-Townsend Paramedic Act, which were made by the physicians and surgeons at Harbor General Hospital, embodied this approach. As discussed in Section VII-A-3, their recommendations differed from those advocated by the National Academy of Science - National Research Council for the training of ambulance personnel. The staff of Harbor General Hospital did not recommend the expansion of the training of paramedics to include puncture decompression of tension pneunothorax or tracheotomy. In 15 months of operation, the MICU teams had not handled enough victims, who would have benefitted from the earliest possible initiation of these procedures, for the medical staff to believe that the paramedics could maintain the requisite skills. A second approach to maintain infrequently used skills is to use a substitute for the handling of actual victims. An example would be the use of training dummies to maintain skills in cardio plumonary resuscitation.

3. Predictive Models

a. Generalized Form. Ideally, what is required for the evaluation of alternative designs of emergency medical systems is a set of models of the general form:

$$P_{gh} = f(S_k, T_{ij}, t_i)$$

Where: P_{gh} = probability of the g^{th} outcome or the proportion of all outcomes falling in the g^{th} category of illness or injury.

S_k = severity rating of the illness or injury at the k^{th} level.

T_{ij} = treatment or care of the i^{th} kind at the j^{th} level of quality.

t_i = elapsed time from onset of symptoms of illness or occurrence of injury to treatment or care of the i^{th} kind.

b. Reduced Form. As noted above, the medical outcomes for this initial investigation were reduced to two, namely survival or death. Specifically, survival for each category of illness or injury was defined as still being alive ninety days after initial discharge from the hospital. Death was defined comparably as a cessation life as a direct result of the illness or injury or of its sequelae within ninety days after initial discharge.

Three additional simplifications were made. First, the kinds of treatment or care for each category of illness or injury were not differentiated. It was assumed that the treatment administered by physicians and surgeons and the care administered by paramedics were representative of the current state of practice for the stabilization of critically ill or injured victims. The paramedics were considered to administer such care only within those categories of illness or injury for which the kinds of advanced therapy that they were trained and authorized to perform, such as the use of intravenous solutions, specified drugs, and defribillation, were definitive procedures for stabilization.

Second, the levels of quality with which treatment or care was administered were not differentiated. It was assumed that the same quality of treatment or care was rendered by all physicians, surgeons, and for those categories for which their kinds of stabilizational care were appropriate, paramedics.

Finally, the ratings of severity of illness or injury were reduced to two, namely the posing of a threat to life or not. The categories of illness or injury were reduced concomitantly to those in which some threats to life occurred.

In reduced form, the models became:

$$P_{gh} = f(S_k, t_i)$$

Where: P_{gh} = Probability of the g^{th} outcome or the proportion of all outcomes falling in the g^{th} category of outcome ($g = 0$, survived; $g = 1$, died) ninety days after discharge from the hospital for the h^{th} category of illness ($h = 1, 2, \ldots, 11$) or injury ($h = A, B, \ldots, L$)

S_k = severity rating of the illness or injury at the k^{th} level ($k = 0$, non life threatening; $k = 1$, life threatening).

t = elapsed time from onset of symptoms of illness or occurrence of injury to stabilizing treatment or care.

4. Empirical Data Base

Data for the study of the relationship between medical outcomes and the elapsed time to care or treatment were drawn from two demonstration studies which were made by the Project. These were the studies of: (1) mobile intensive care units manned by paramedics (See Section VII-A), and (2) a secondary role for helicopters as air ambulances (See Section VII-B). Both of these studies employed the Project data system. As described in Section IV-D-3, this data system provided a uniform reporting format for all organizations participating in the studies and a linkage, by victim, of operational and medical data from the onset of symptoms of illness or the occurrence of injury to the point of discharge from the emergency room or, if hospitalized, ninety days after discharge from the hospital. The combined studies encompassed 5874 victims of medical emergencies. As shown in Table VI-D-2, roughly half of the victims came from each study. The areas in which the two studies were conducted were substantially different.

a. General Nature of the Areas. The study of mobile intensive care units was conducted in the Harbor City, Wilmington, and San Pedro portions of the city of Los Angeles and in the Carson area. As shown in Figure VII-A-1, these areas form a contiguous region of approximately 49 square miles in the center of the South Bay portion of the County of Los Angeles. The region is residential, commercial, and industrial. At the time of the study, it had a population of approximately 249,000 persons. All victims included in this study were handled by one of two ambulance organizations (one private and one operated by the City of Los Angeles) or by one of two mobile intensive care units (one operated by the County of Los Angeles and one by the City of Los Angeles). With only a few exceptions, victims were taken to Harbor General Hospital. This is a large County medical facility which is affiliated with the UCLA School of Medicine as a teaching institution.

The study of a secondary role for helicopters as air ambulances was conducted in the Antelope Valley-Newhall portions of the County of Los Angeles. As shown in Figure VII-B-3, this area of approximately 2200 square miles roughly constitutes the

TABLE VI-D-2

SOURCES OF DATA THAT WERE USED TO ESTIMATE THE MATHEMATICAL RELATIONSHIPS BETWEEN THE MEDICAL OUTCOME AND THE ELAPSED TIME TO CARE OR TREATMENT

	Victims of Medical Emergencies				
Study in Which Data Were Gathered	Total Number	Number With Threat to Life	Percentage With Threat to Life	Inclusive Dates for Collection of Data	Geographical Location in Which Study was Made
Demonstration of mobile intensive care units manned by paramedics	3134	342	10.9	December 1969-May 1971	Wilmington and San Pedro areas of the City of Los Angeles and the Carson area of the County of Los Angeles (See Figure VII-A-1)
MICU's	(1379)	(196)	(14.2)		
Ambulances	(1755)	(146)	(8.3)		
Demonstration of secondary role for helicopters as air ambulances	2740	357	13.0	April 1970-May 1971	Antelope Valley - Newhall portion of the County of Los Angeles (See Figure VII-B-3)
Helicopters	(88)	(24)	(27.3)		
Ground Ambulances	(2652)	(333)	(12.6)		
Combined	5874	699	11.9		

northern half of the County. It is largely high desert plains and mountainous terrain. With the exception of the cities of Lancaster and Palmdale, it is sparsely populated. At the time of the study, it had a population of approximately 120,000 or less than two percent of the total population of the County. This figure, however, does not accurately reflect the population which is subject to medical emergency incidents in the area. The area experiences heavy recreational usage by non-residents throughout the year. All victims included in the study were handled by one of four private ambulance companies, which are under contract to the County of Los Angeles, or by the Los Angeles County Fire Department's air ambulance helicopter. They were transported to one of the four hospitals in the area, which are under contract to the County of Los Angeles to operate physician-staffed, 24-hour emergency medical services.

Because of the differences between the two portions of the County, it is not surprising that there were some differences in the temporal profiles of the activities leading to the administration of treatment or care. These can be seen in Table VI-D-3. Because of their smaller service areas, the ambulances and mobile intensive care units in the South Bay on-the-average could travel to the scene in less than half of the time required by their counterparts (excluding the helicopter) in the Antelope Valley. The mean time spent at the scene by the crews of the emergency medical vehicles was almost two minutes longer in the South Bay than in the Antelope Valley. This reflected the additional time spent at the scene by the paramedics, who manned the mobile intensive care units, determining the nature of the illness or injury and administering stabilizing care to some victims before transporting them to the hospital. Finally, the mean delay from the arrival of the emergency medical vehicle at the emergency room until the beginning of the physician's examination is slightly more than double at Harbor General Hospital (South Bay) than at the four contract hospitals in the Antelope Valley.

TABLE VI-D-3

COMPARISON OF MEAN TIMES IN MINUTES, BETWEEN SOUTH BAY AND ANTELOPE VALLEY PORTIONS OF LOS ANGELES COUNTY, FOR ACTIVITIES INVOLVED IN RENDERING CARE TO VICTIMS HANDLED BY EMERGENCY MEDICAL VEHICLES

	Mean Duration		Cumulative Mean Elapsed Time	
	South Bay	Antelope Valley	South Bay	Antelope Valley
1. Notification	22.2	19.2	22.2	19.2
2. Dispatching	0.3	1.2	22.5	20.4
3. Travel to Scene	4.3	10.1	26.8	30.5
4. On Scene	8.2	6.4	35.0	36.9
5. Transport to Hospital	8.6	8.9	43.6	45.8
6. Delay at Emergency Room	26.8	12.0	70.4	57.8

b. General Nature of the Data. Table VI-D-4 summarizes the data from the two studies for the total 4416 victims falling in the sixteen categories of medical emergencies which involved some cases of serious threats to life. Of these 4416 victims, 699 or 15.9 percent were evaluated by the attending physician or surgeon at the emergency room to have been in a life threatening condition. These 699 victims were the cases which were used to examine empirically the relationship between survival or death and the elapsed time to care or treatment. As can be seen from Table VI-D-4, only a few of the categories contained enough cases to even attempt to estimate the mathematical form and numerical values of the parameters of the relationship. Even for these categories, the numbers of complete cases were less than indicated because of missing estimates for some cases of the notification interval between the onset of symptoms of the illness or the occurrence of the injury and the requesting of an emergency medical vehicle.

TABLE VI-D-4

NUMBERS OF VICTIMS AND SEVERITIES OF THEIR ILLNESSES AND INJURIES FOR CATEGORIES OF MEDICAL EMERGENCIES WHICH INVOLVED SERIOUS THREATS TO LIFE

Category of Illness or Injury	Mobile Intensive Care Units: Total		Mobile Intensive Care Units: Life Threat		Helicopter as An Air Ambulance: Total		Helicopter as An Air Ambulance: Life Threat		Combined Studies: Total		Combined Studies: Life Threat	
A Burn	20	(0.6)[1]	1	(5.0)[4]	19	(0.7)[2]	5	(26.3)[4]	39	(0.7)[3]	6	(15.4)[4]
B Cold	0	(0.0)	0	(--)	2	(0.1)	1	(50.0)	2	(0.0)	1	(50.0)
C Electrical	3	(0.1)	1	(33.3)	3	(0.1)	1	(33.3)	6	(0.1)	2	(33.3)
D Fractures	249	(8.0)	7	(2.8)	439	(16.0)	16	(3.6)	688	(11.7)	23	(3.3)
E Laceration	500	(16.0)	32	(6.4)	342	(12.5)	18	(5.3)	843	(14.3)	50	(5.9)
F Crushing	68	(2.2)	26	(38.2)	169	(6.2)	58	(34.3)	237	(4.0)	84	(35.5)
G Poisoning	370	(11.8)	74	(20.0)	177	(6.5)	52	(29.4)	547	(9.3)	126	(23.1)
J Suffocation	21	(0.7)	8	(38.2)	8	(0.3)	0	(0.0)	29	(0.5)	8	(27.6)
K C.N.S.	151	(4.8)	33	(21.8)	302	(11.0)	40	(13.3)	453	(7.7)	73	(16.1)
1 Cardio-Vasc	296	(9.4)	71	(24.0)	191	(7.0)	87	(45.6)	487	(8.3)	158	(32.5)
2 Cerebro-Vasc	63	(2.1)	27	(42.8)	65	(2.4)	33	(50.8)	128	(2.2)	60	(46.8)
3 Bleeding	34	(1.1)	12	(35.3)	26	(0.9)	12	(46.2)	60	(1.0)	24	(40.0)
4 Infections	42	(1.3)	2	(4.8)	51	(1.9)	3	(5.9)	93	(1.6)	5	(5.4)
7 Comas, etc.	368	(11.7)	20	(5.4)	183	(6.7)	20	(10.9)	551	(9.4)	40	(7.3)
8 Obstetrical	38	(1.2)	4	(10.5)	10	(0.4)	0	(0.0)	48	(0.8)	4	(8.3)
9 Respiratory	137	(4.4)	24	(17.5)	68	(2.5)	11	(16.2)	205	(3.5)	35	(17.1)
TOTALS	2360	(75.3)	342	(14.5)	2056	(75.0)	357	(17.4)	4416	(75.2)	699	(15.9)

[1] Percentage of 3134 victims in all categories of illness or injury from study of mobile intensive care units.

[2] Percentage of 2740 victims in all categories of illness or injury from study of helicopter as an air ambulance

[3] Percentage of 5874 victims in all categories of illness or injury from combined studies.

[4] Percentage of victims in this category of illness or injury and from this study (or studies) with a threat to life.

This time interval proved to be the single most difficult item of information to gather. It requires the crew of the emergency medical vehicle to obtain from the victim, or other knowledgeable persons, an estimate of the time of the onset of symptoms of illness or the occurrence of the injury. The more serious the condition of the victim, the more totally the crew of the emergency medical vehicle becomes involved in the care of the victim and the more likely that they fail to obtain this particular item of information. For this reason, the Project personnel urged the crews to obtain an estimate of such times for all cases. Further, a particular emphasis was given to the importance of this estimate for seriously ill or injured victims. The data were monitored closely and cases with missing data were identified promptly. Chronic offenders were cajoled to eliminate omissions. Despite these efforts estimates of this time were obtained for only 60 percent of all cases and 67 percent of the cases involving serious injury or illness. The latter figure undoubtedly was higher because of the emphasis that was given to the importance of serious cases as the basis for developing the relationships between medical outcomes and elapsed times to treatment or care.

5. Empirical Relationships

If other factors are held constant, the proportion surviving (probability of survival) for a given category of critically ill or injured victims should be either independent of or should decrease as a function of the elapsed time to care or treatment. Independence would characterize any category for which survival or death was determined entirely by the nature and severity of the victim's condition. Such independence exists for any condition, such as the severing of the aorta, which is always fatal or minor injuries such as abrasions and contusions which for all intents are never fatal. For other conditions that fall between these extremes, the probability of survival still can show a high degree of independence of the elapsed time to treatment. For example, in a study of acute subdural hematomta, which were treated by the surgical removal of the blood clot, the survival rate was approximately ten percent. The ten percent of the victims who survived were distinguishable from the 90 percent who died largely, if not entirely, in terms of the extent of the original injury to the brain.[1]

For those categories of illness or injury, within which survival or death is significantly dependent on the elapsed time to treatment or care, numerous mathematical functions satisfy the requirement that the dependent variable (proportion surviving) decrease monotonically as the independent variable (elapsed time to treatment) increases.

a. Candidate Functions. Four candidate functions were selected after examination of graphic plots of the observed proportions surviving against their associated elapsed times. The candidate functions were linear and three that were convex to the origin. The latter were:

$P_{oh} = \gamma e^{\beta t}$ $(\beta < o)$. Negative Exponential Function.

$P_{oh} = \gamma t^{\beta}$ $(\beta < o)$. Negative Power Function.

$P_{oh} = \gamma e^{\beta / t}$ $(\beta > o)$

where: P_{oh} = proportion of critically ill or injured victims that survive for 90 days after discharge from the hospital (or the probability of survival for at least 90 days) for the h^{th} category of illness (h=1, 2, ..., 11) or injury (h=A, B, ..., L).

β = constant

γ = constant

e = natural logarithmic base (2.718 ......)

t = elapsed time from onset of symptoms of illness

[1]Echlin, F.A., S.V.R. Sordilo, and T.Q. Garvey, "Acute, Subacute and Chronic Hematoma," Journal of the American Medical Association, 161:14, August 1956, pp. 1345-1350.

or occurrence of injury to stabilizing treatment or care.

The general natures of these four functions are depicted in Figure VI-D-1. The linear function intersects the axis of the independent variable. The negative exponential and negative power functions are asymptotic to the axis of the independent variable. Such an intersection of or tangential approach to the axis of the independent variable depicts the survival rate dropping to zero at some magnitude of elapsed time. For the Project's system for categorizing illnesses and injuries, however, some critical victims in each category would be expected to survive without any care or treatment. Thus, these three functions could be used to represent the relationship only for elapsed times that are smaller than that corresponding to the lower bound on the proportion of victims who survive (which at a minimum can be 0.0). The third convex function has an asymptote that is defined parametrically and presents a positive lower bound to the proportion of victims who survive.

The linear and negative exponential functions intersect the axis of the dependent variable. They depict a finite upper limit to the proportion of critical victims who would survive even if stabilizing treatment or care were to be begun immediately after the onset of symptoms of illness or the occurrence of injury. The negative power and third convex functions are asymptotic to the axis of the dependent variable. Therefore, these two functions could be used to represent the relationship only for elapsed times that are larger than that corresponding to the upper bound on the proportions of victims who survive (which at a maximum can be 1.00).

b. Procedure For Curve Fitting. For each category of illness or injury, with enough cases to be able to attempt curve fitting, the candidate functions were parameterized by conventional regression analyses. The dependent variable was the observed proportion of critically ill or injured victims who survived for 90 days after discharge from the hospital. The independent variable was the elapsed time from the onset of symptoms or occurrence of

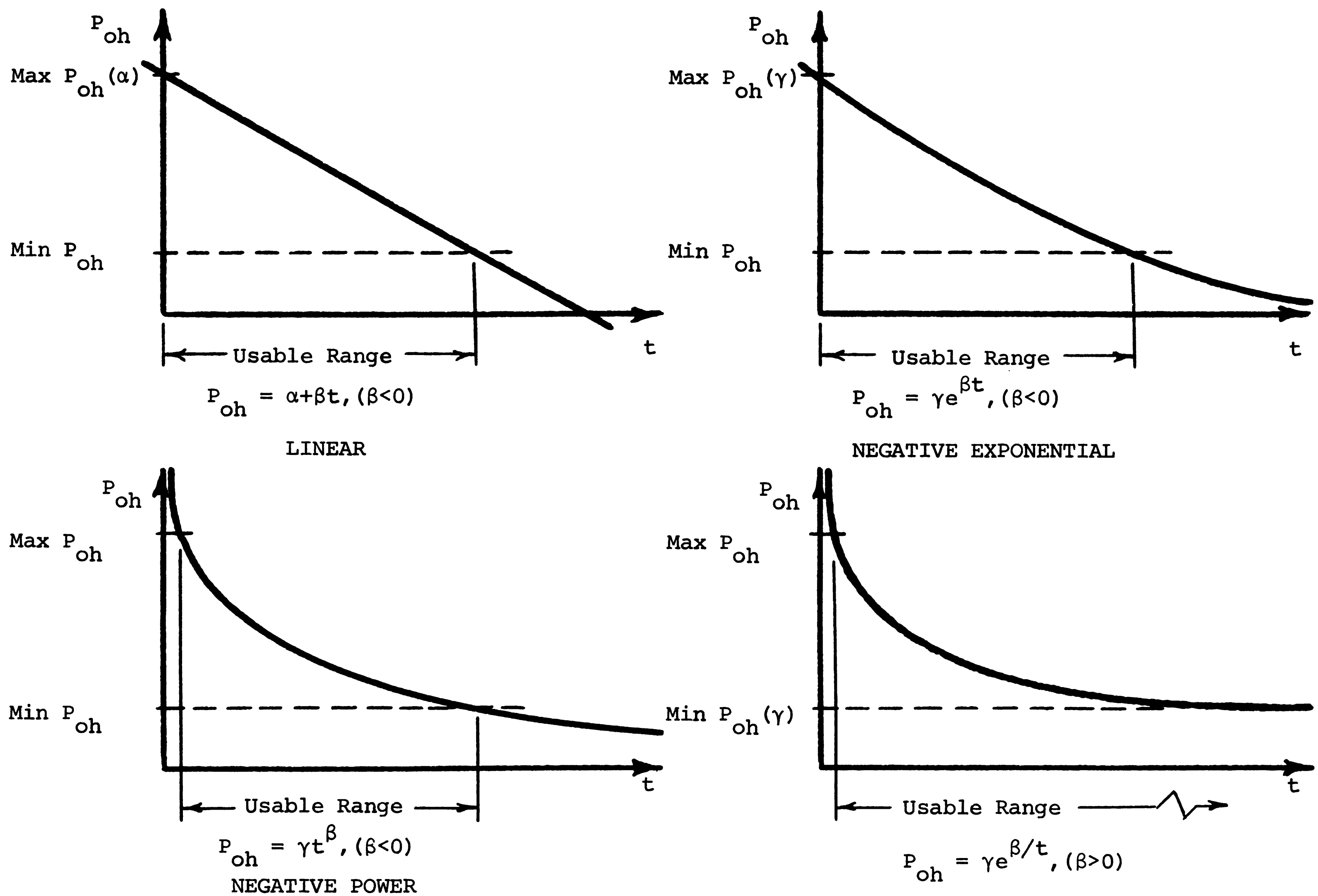

FIGURE VI-D-1

CANDIDATE FUNCTIONS FOR REPRESENTING THE RELATIONSHIP BETWEEN THE PROPORTION OF CRITICAL VICTIMS WHO SURVIVE AND THE ELAPSED TIME TO STABILIZING TREATMENT OR CARE injury to stabilizing treatment or care.

There typically was only one outcome for each observed elapsed time. Under such circumstances, two methods of curve fitting can be employed. The first is to use directly the zeros (victim died) and ones (victim lived), which represent the proportions (none or all) of the victims who survive, and the associated actual elapsed times. The second method is to aggregate the outcomes over designated intervals of elapsed times. The empirical proportions of victims who survived within each of the intervals of elapsed time and the midpoints of the intervals of elapsed time then are used as observed values of the dependent and independent variables respectively. The latter method was selected because the graphical plotting of the pairs of survival proportions and midpoints of intervals of elapsed time provided a basis for identifying the potential functional forms (kinds of mathematical relationships) which might fit the data.

It was necessary to define the intervals of elapsed times over which the medical outcomes would be aggregated in order to provide empirical proportions of victims who survived. The number of cases, which fell within an interval of a given duration, became smaller as the elapsed times grew longer. Therefore, intervals of four different durations were established as follows:

Elapsed Times (In Minutes)		Duration of Intervals (In Minutes)
From	To	
0	60	5
61	120	15
121	240	30
240	720	60

Since there was only one value of the dependent variable corresponding to each independent variable, there were no measures of the variances within sets. Therefore, the appropriateness of a given functional form to represent the relationships could not be tested by means of the conventional comparison of the variance of the observed values about the regression curve with the variance within sets. Instead, an examination was made of the differences between the observed and the predicted proportions of victims who survived divided by the standard deviation of observed values about the regression curve. If the hypothesized form of the relationship provides a good fit, these quantities ("normalized" differences) are distributed approximately normally with mean of zero and variance of one.

The empirically determined parameters for each function were tested in the conventional manner to determine whether or not they were statistically significantly different from zero at the 0.05 level of significance. The key parameter was β, which reflects the rate of change in the proportion of victims who survive as a function of the elapsed time. If this parameter is not statistically significantly different from zero, one cannot assume that the elapsed time to stabilizing treatment or care influences the proportion of victims who survive.

c. Results. The categories of illnesses and injuries, for which there were sufficient numbers of critical victims to attempt to parameterize the four forms of the regression curve, were: (F) Crushing, Perforation and Internal Injuries, (G) Poisonings and Overdoses, (K) Central Nervous System Injuries, (1) Hypertensive and Arteriosclerotic Heart Disease, and (2) Hypertensive and Arteriosclerotic Cerebro-Vascular Disease. The only one of these five categories, however, for which any of the β's were statistically significantly different from zero, was (1) Hypertensive and Arteriosclerotic Heart Disease.

For cardio-vascular diseases, the actual range of elapsed times to treatment or care, for which enough data were available to attempt curve fitting, was 5 to 105 minutes. The midpoints of the first and last intervals of elapsed time were 7.5 and 97.5 minutes respectively. Over this range, the β's for each of the convex functions were different from zero at the 0.05 level of statistical significance. The "normalized" differences between the observed proportions of victims who survived and their counterparts along the three regression curves were distributed in approximately normal manners with means close to zero and variances close to one. The "best fit", as measured by the residual differences, was provided by the negative power function.

The parameterized functions are:

$$P_{oh} = 0.66e^{-0.0069t} \quad \text{(Negative Exponential Function)}$$

$$P_{oh} = 0.89t^{-0.16} \quad \text{(Negative Power Function)}$$

$$P_{oh} = 0.49e^{1.7/t}$$

These functions are presented graphically in Figure VI-D-2. Interestingly the "best fit" negative power function lies between the other two functions over almost all of the range.

6. Illustrative Application of Predictive Model

The tentatively formulated "best-fit" equation, which relates the proportion of critically ill victims of hypertensive and arteriosclerotic heart diseases who survive to the elapsed time to stabilizing care as a negative power function, can be used to illustrate the procedure for the prediction of medical outcomes. As noted in Table VI-D-4, approximately 45% (71 out of 158 cases) of the critically ill victims of cardio-vascular disease came from a study that was designed to evaluate the medical benefits, operational characteristics and costs of mobile intensive care units (MICU's) manned by paramedics. Among other things, this study (See Section VII-A) showed that the survival rates of critically ill victims of cardio-vascular diseases were 66.1 and 46.7 percent for the victims who were handled respectively by the MICU's and by regular ambulances. The paramedics were able to begin

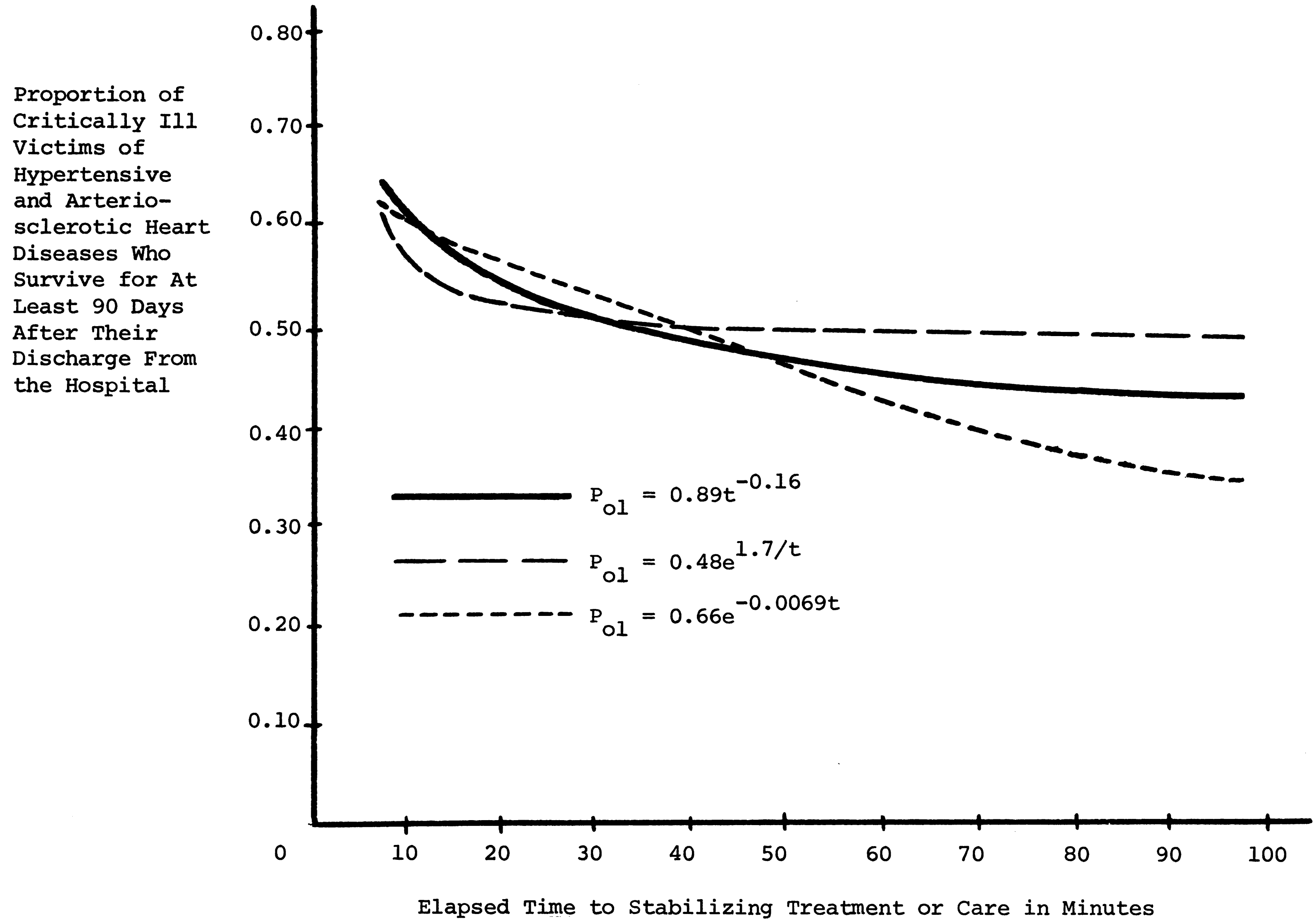

FIGURE VI-D-2

THE THREE PREDICTIVE EQUATIONS FOR THE PROPORTION OF VICTIMS OF HYPERTENSIVE AND ARTERIOSCLEROTIC HEART DISEASES WHO SURVIVE, WHICH HAD STATISTICALLY SIGNIFICANT PARAMETERS, (SHOWN OVER THE RANGE OF OBSERVED VALUES OF ELAPSED TIMES) the delivery of definitive stabilizing care at the scene while victims handled by the ambulance attendants had to wait for their arrival at the hospital to begin to receive such care. One might ask whether or not the results of this demonstration study could have been predicted in advance from the "best fit" regression equation developed in this Section and the distributions of elapsed times to definitive stabilizing treatment or care for victim's handled by the two kinds of emergency medical vehicles.

Tables VI-D-5 and VI-D-6 show the calculation of the predicted proportions of critically ill victim's of cardio-vascular disease who would survive when handled respectively by the MICU's and by the ambulances. Two methods were used to predict these proportions. The first was to compute the proportion of victims who would survive within each interval of elapsed time. These individual predictions were multiplied by the proportion of all victims falling within each interval of elapsed time and the resultant weighted predictions summed over all intervals of elapsed time. The second method was to merely compute the proportion of victims who would survive for the mean elapsed time to treatment or care. Since the predictive equation is nonlinear, the first method is the proper one. Because the nonlinearity is convex, the second method will underestimate the proportion of victims who survive.

The results show that the first method led a prediction that 60 percent of the victims handled by the MICU's survive. The actual percentage from the study was 66 percent. The first method also led to a prediction that 47 percent of the victims handled by the ambulances would survive. This figure is identical with the actual percentage of survivors found in the study. The slope of a convex function is steepest for small values of the independent variable. It is not surprising, therefore, that the second method, which had only the mean elapsed time, underestimated the predicted proportion more for the MICU's, which provided earlier stabilizing care, than for the ambulances.

The tentatively selected and parameterized model was able to be used to generate reasonable estimates of the results of the demonstration

TABLE VI-D-5

PREDICTION OF THE PROPORTION OF CRITICALLY ILL VICTIMS OF HYPERTENSIVE AND ARTERIOSCLEROTIC HEART DISEASES HANDLED BY MICU'S THAT WOULD SURVIVE

Midpoint of Time Interval in Minutes	Proportions of All Victims Treated in Time Interval	Proportion of Victims Who Would Survive as Predicted by Equation	Weighted Prediction of Proportion of Victims Who Would Survive
2.5	0.024	0.77[1]	0.0185
7.5	0.408	0.65	0.2652
12.5	0.216	0.59	0.1274
17.5	0.120	0.56	0.0672
22.5	0.048	0.54	0.0259
27.5	0.024	0.53	0.0127
32.5	0	-	-
37.5	0.024	0.50	0.0120
42.5	0.072	0.49	0.0353
47.5	0	-	-
52.5	0.024	0.47	0.0113
57.5	0.024	0.47	0.0113
67.5	0	-	-
82.5	0.024	0.44	0.0106
97.5	0	-	-
112.5	0	-	-
135.0	0	-	-
165.0	0	-	-

Predicted proportion of victims who would survive.	0.60
Predicted proportion of victims who would survive based only on mean time to treatment of 18.2 minutes and the equation.	0.56
Actual proportion of victims who survived in the demonstration study.	0.66

[1] This predicted value is an extrapolation for an interval of elapsed time that lay beyond the range of elapsed times used to parameterize the regression equation.

TABLE VI-D-6

PREDICTION OF THE PROPORTION OF CRITICALLY ILL VICTIMS OF HYPERTENSIVE AND ARTERIOSCLEROTIC HEART DISEASES HANDLED BY AMBULANCES THAT WOULD SURVIVE

Midpoint of Time Interval in Minutes	Proportions of All Victims Treated in Time Interval	Proportion of Victims Who Would Survive as Predicted by Equation	Weighted Prediction of Proportion of Victims Who Would Survive
2.5	0	-	-
7.5	0	-	-
12.5	0	-	-
17.5	0	-	-
22.5	0.083	0.54	0.0448
27.5	0	-	-
32.5	0	-	-
37.5	0.167	0.50	0.0835
42.5	0.250	0.49	0.1225
47.5	0.083	0.48	0.0398
52.5	0.083	0.47	0.0390
57.5	0	-	-
67.5	0	-	-
82.5	0.083	0.44	0.0365
97.5	0.083	0.43	0.0356
112.5	0	-	-
135.0	0.083	0.41[1]	0.0340
165.0	0.083	0.40[1]	0.0332

Predicted proportion of victims who would survive.	0.47
Predicted proportion of victims who would survive based only on mean time to treatment of 66.3 minutes and the equation.	0.45
Actual proportion of victims who survived in the demonstration study.	0.47

[1] These predicted values are extrapolations for intervals of elapsed time that lay beyond the range of elapsed times used to parameterize the regression equation.

study of mobile intensive care units. Since less than half of the data that were used to develop the equation came from that demonstration study, one can be encouraged to believe that the equation, in fact, has a general usefulness.

7. Discussion

The equation, which relates the proportion of survivors among critically ill victims of hypertensive and arteriosclerotic heart diseases to the elapsed time to stabilizing treatment or care, is a prototype of the entire set of such predictive models that would be required to evaluate alternative designs for systems of emergency medical services.

Clearly a great amount of additional data will be required to refine the equation for cardio-vascular diseases and to examine the nature of the relationship for other categories of illnesses and injuries. From *a priori* considerations, there are grounds for believing that the absence for other categories of β's that are statistically significantly different from zero reflects the actual independence of the proportion of surviving victims of the particular kind of illness or injury from the elapsed time to stabilizing treatment or care. For most of the categories, however, it is far more likely that the absences of statistically significant results were a consequence of inadequate sample sizes. Because of the relative infrequency of critically ill or injured victims in categories such as (D) Fractures and (3) Non-Traumatic Bleeding, a data base seven times larger than that generated by our two demonstration studies would be required simply to yield the same number of cases for each of these categories as was to establish the relationship for category (1) Hypertensive and Arteriosclerotic Heart Diseases. For categories such as (A) Burns, (4) Infections and (8) Obstetrical Complications, the comparable data base would need to be more than *thirty* times larger. The magnitude of such a data collection effort can be measured by the fact that seven organizations, which operated emergency medical vehicles and five hospitals, which operated 24 hours-a-day, seven days-a-week emergency rooms, collected data on all victims of medical emergencies who were transported by the emergency medical vehicles to the hospitals for more than a year in order to generate the reference data base for these projections.

The next step in the development of models for the prediction of medical outcomes would be to include a greater range of medical outcomes and considerations of alternative kinds of treatment and care and of differing levels of quality with which such treatment and care are delivered. Each such generalization increases the size of the data base that would be required to perform the analyses. What undoubtedly would be required to complete these tasks is a standardized data collection system for the nation as whole that would track emergency medical cases from the time that they arise to the time of their ultimate resolution.

E. ANALYSES OF THE RESULTS OF THE HOUSEHOLD SURVEY

The household survey, which is described in Section IV-C, was undertaken to begin to answer three questions:

- What images and perceptions do citizens have of emergency medical services?
- What factors influence bystander behavior in medical emergencies?
- What factors influence public responsiveness and support for changes and improvements in emergency medical services?

The answer to these questions are among the kinds of information that are needed by those seeking to design emergency medical service systems, which are responsive to the needs, knowledge and acceptable roles of users.

1. Households Interviewed

The primary objective, in selecting households to be interviewed, was to obtain data that was both representative and useful for analysis. The answers to the three questions being explored were expected to reflect the characteristics of the specific emergency medical services in the respondent's area of residence. Four areas, with identifiable differences in their emergency medical services, were chosen. These were the San Fernando Valley portion of the city of Los Angeles and the cities of Azusa, Pasadena and San Gabriel. Further, since it also was anticipated that socio-economic status influences a household's knowledge and use of emergency medical services, the sample was stratified by income and ethnicity in the San Fernando Valley and the city of Pasadena. In these areas, some census tracts were randomly selected on the basis of income and some on the basis of the ethnic composition. The median value of housing was used as the basis for stratification by income. The cities of Azusa and San Gabriel each had only three census tracts and there was no published data, by census block within census tracts. In these two cities, preliminary field work was undertaken to estimate the characteristics of census blocks and the selection of the sample of households was made randomly on the basis of these estimates. Table VI-E-1 summarizes the income and ethnicity characteristics of the households that were interviewed.

2. Images and Perceptions of Citizens

To understand and evaluate the effectiveness of different mixes and configurations of emergency medical services, it is necessary to understand how the citizenry perceives these services. What characterizes the citizens' views of the system? How do these views compare to the actual properties of the system? What roles do citizens see as appropriate for themselves and for public and private organizations? Do these perceptions differ for differing kinds of systems? The answers to these questions will identify knowledge, misperceptions and role expectations of the citizenry which should be taken into account in planning.

Three of the four separate and distinct areas, which were chosen for the survey, possess unique aspects in their systems for delivering medical services. In Pasadena, a physician accompanies each ambulance that responds to a medical emergency.[1] In San Gabriel, municipally operated services are free to residents.[2] In Azusa, there is a tendency to screen calls for an ambulance by dispatching a law enforcement officer, who goes to the scene to judge the seriousness of the injury or illness and decides whether or not to dispatch an ambulance. The San Fernando Valley was included primarily for the reason that

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[1]Since the period in which the survey was conducted, a shortage of physicians has caused some curtailment of this service and emergency medical paraprofessionals are replacing physicians.

[2]Since the period in which the survey was conducted, fees have been instituted for some of the services.

TABLE VI-E-1

SOCIO-ECONOMIC CHARACTERISTICS OF HOUSEHOLDS THAT WERE INTERVIEWED

Area (Sample Size)	Proportion of Households with Income Level in 1969						Proportion of Households with Ethnicity				
	<$4,000	$4,000 -5,999	$6,000 -9,999	$10,000 -14,999	$15,000 -24,999	≥$25,000	Black	Cau-casion	Chi-cano	Ori-ental	Other
Azusa (n = 183)	.16	.18	.30	.23	.09	.04	.02	.73	.25	-	-
Pasadena (n = 350)	.20	.14	.20	.22	.17	.07	.10	.82	.05	.03	-
San Fernando Valley (n = 748)	.10	.08	.23	.27	.21	.11	.06	.88	.04	.01	.01
San Gabriel (n = 178)	.16	.11	.26	.28	.13	.06	-	.71	.24	.04	.01
Total Sample (n = 1459)	.14	.11	.24	.25	.17	.09	.06	.82	.09	.02	.01

it had an emergency medical system that was somewhat "typical" for Los Angeles County.

A major dimension of the perception of citizens is the extent to which they accurately perceive the characteristics of the system that might influence their actions in the event of a medical emergency.

a. The EMS System. The typical EMS system consists of sets of providers, e.g., ambulances, emergency rooms, etc., of allocators, e.g., governmental agencies, and of potential users. Almost all such systems are a consequence of political jurisdictions, special interest groups and topsy-like growth. As a result, the systems are fragmented and much more loosely structured than fire and police departments, where a single, well-defined organization has geographical authority and responsibility. Tables VI-E-2 and VI-E-3 show the degree to which respondents thought that various entities have to do with the delivery of help or care in cases of medical emergencies. Since there was no significant area-to-area difference, the results are aggregated across all four areas. The results indicate that the boundaries of the EMS system are seen as fairly broad.

The top five entities, which were felt by 97% or more of the respondents to "definitely" or "probably" have to do with the delivery of help or care in medical emergencies were: fire department ambulances, hospital emergency rooms, police departments, highway emergency call boxes and public telephones. Fire department ambulances were ranked number one in each of the four areas even though it is only in the San Fernando Valley and the city of San Gabriel that the fire department operates the ambulance service. In the city of Pasadena, the ambulance service is municipally operated but not by the fire department and in the city of Azusa, a private ambulance company provides this service. In Azusa, private ambulance service ranked sixth in terms of the proportion of respondents judging

TABLE VI-E-2

PERCEPTIONS OF RESPONDENTS AS TO WHETHER OR NOT ENTITIES ARE PART OF THE EMERGENCY MEDICAL SYSTEM

Rank Order	Entity	Proportion of Respondents Who Believed That Entity "Definitely" or "Probably" Has to Do With Delivery of Help or Care in Medical Emergencies
1	Fire Department Ambulance	.99
2 (tie)	Hospital Emergency Room	.98
2 (tie)	Police Department	.98
2 (tie)	Highway Emergency Call Box	.98
5	Public Telephone	.97
6 (tie)	Private Individual with First Aid Training	.96
6 (tie)	Commercial Vehicle with Two-Way Radio	.96
8	Private Physician	.92
9	Private Ambulance	.90
10 (tie)	Neighbors	.88
10 (tie)	Outpatient Clinic	.88
12	Hospital Ward or Private Room	.83
13	People Near the Ill/Injured Person	.77
14 (tie)	Accident Insurance	.72
14 (tie)	Tow Truck	.72
16 (tie)	Taxi Cab	.70
16 (tie)	Medicare	.70
18	Government	.51

TABLE VI-E-3

PERCEPTIONS OF RESPONDENTS AS TO WHETHER OR NOT POTENTIAL ELEMENTS ARE PART OF THE EMERGENCY MEDICAL SYSTEM GROUPED BY CATEGORIES

Rank[1] Only of Category	Category	Rank Order Within Category	Entity	Proportion of Respondents Who Believe That Entity "Definitely" or "Probably" Has to Do With Delivery of Help or Care in Medical Emergencies
1	Communications	1	Highway emergency call box	.98
		2	Public telephone	.97
		3	Commercial vehicle with two-way radio[2]	.96
2	Medical facility	1	Hospital emergency room	.98
		2	Outpatient clinic	.88
		3	Hospital ward or private room	.83
3	Persons	1	Private individual with first aid training	.96
		2	Private physician	.92
		3	Neighbors	.88
		4	People near the ill/injured person	.77
4	Vehicles	1	Fire department ambulance	.99
		2	Commercial vehicle with two-way radio[2]	.96
		3	Private ambulance	.90
		4	Tow truck	.72
		5	Taxi cab	.70
5	Public Agencies	1	Police department	.98
		2	Government	.51
6	Medical Insurance	1	Accident insurance	.72
		2	Medicare	.70

[1] Rank of category is based on mean proportion of respondents who think that the entities in the category "definitely" or "probably" have something to do with delivery of help or care in medical emergencies.

[2] Included in two categories because it was identified as both a vehicle and a source of communications.

it to be "definitely" or "probably" having to do with the provision of emergency medical services.

Government was positively perceived by only about half of the respondents despite its significant involvement in the provision of emergency services. The ambulances are municipally operated in three of the four areas and in the fourth, Azusa, the private ambulance is under contract to provide emergency transportation in the area as part of the county's Emergency Aid Program. In three of the areas, hospitals are under contract to either the municipal or county government, or to both, to provide emergency room services. In the fourth, again Azusa, a hospital in a neighboring city is under contract to the county to provide emergency room services to residents of Azusa as well.

b. Ambulance Services. The number of suppliers of ambulance services varied markedly between the four areas. In Azusa, there is only a private ambulance company supplying such services while in the San Fernando Valley the Los Angeles City Fire Department and four private ambulance companies do so. Table VI-E-4 identifies the suppliers in each area and some characteristics of each service.

The County of Los Angeles, under its Emergency Aid Program (EAP), contracts with private ambulance companies to provide emergency transport. Such services are contracted for in all unincorporated areas of the county and within cities that have contracts with the county, which obligate the county to provide their emergency ambulance services. In areas, for which the county has the responsibility for providing emergency medical transport, the sheriff's department initiates the dispatching of the private ambulances that are under contract. The terms of the contracts require that the private ambulances and their crews meet a set of standards that specify the minimum levels of equipment and training. Further, the contracts require that all victims of medical emergencies, for whom the Sheriff's Department or the police

TABLE VI-E-4

SUPPLIERS OF AMBULANCE SERVICES AND SOME PROPERTIES OF THEIR SERVICES AS OF THE TIME OF THE SURVEY

Area	Number of Ambulances	Ownership of Ambulances	Assigned to Emergency Service?	Basic Charge for Patient Transport	Who Has to Pay for Transport?	Composition of Crew
Azusa	1	Private	Yes	$37	Those who can[1]	Driver and Attendant
Pasadena	1	City	Yes	$43	Those who can	Driver and Physician
	3	Private	No (Backup)	$37	Everyone	Driver and Attendant
San Fernando Valley	8	City	Yes	$37	Those who can	Two Rescue Firemen
	4	Private	No (Backup)	$37	Everyone	Driver and Attendant
San Gabriel	2	City	Yes	$30	Non-Residents[2]	Two Rescue Firemen
	1	Private	No (Backup)	$37	Everyone	Driver and Attendant

[1]Municipally operated ambulances and private ambulances, under contract to the County of Los Angeles (Emergency Aid Program) to provide emergency transport, will transport a victim without proof of one's ability to pay. If the victim is unable to pay and the ambulance is under County contract, the county reimburses the ambulance company.

[2]In the City of San Gabriel, non-residents with places of business in the city were not charged for ambulance services.

department of a city that is participating in the Emergency Aid Program has initiated the dispatch of an ambulance, will be transported without proof of their ability to pay. If the ambulance company is unable to collect from a person whom they have transported, the county reimburses the ambulance company a scheduled amount. The victim is transported to the emergency department of a hospital, typically the nearest, which also has an EAP contract.

Respondents to the survey were asked to name everybody, whom they could think of, who supplies ambulance services in their community. Table VI-E-5 shows the numbers of suppliers of ambulance services that were mentioned by respondents and the correctness of these responses. Depending upon the area, roughly 1/5 to 1/3 of the respondents could name no supplier. Some of the respondents named suppliers located outside of their city or, in the case of the San Fernando Valley, outside of that basin. These answers were treated the same as other answers under the assumption that such respondents viewed the "community" as larger than the area that was defined for the study. On the average, respondents were correct in their identifications roughly two-thirds of the time. The groups most frequently identified incorrectly as suppliers of ambulance services were law enforcement agencies, hospitals and funeral homes. Most likely, these errors reflected the nature of suppliers in communities in which these respondents previously resided.

For each supplier of ambulance services that was mentioned, whether correctly identified or not, the respondent was asked questions such as "who has to pay for the use of the ambulance, how much does it cost the users who have to pay, and what occupational titles describe the crew?" Table VI-E-6 presents the respondents' perceptions as to who has to pay for the use of ambulance services. Users of private ambulance services, which were not under contract to local or county government to provide primary emergency transport, were perceived accurately as having to pay by 85 to 98 percent of the respondents. In

TABLE VI-E-5

SUPPLIERS OF AMBULANCE SERVICES MENTIONED BY RESPONDENTS

	Area							
	Azusa		Pasadena		San Fernando Valley		San Gabriel	
Number of Suppliers of Ambulance Services Mentioned	Proportion of Respondents Mentioning This Number of Suppliers	Correctness Index[1]	Proportion of Respondents Mentioning This Number of Suppliers	Correctness Index	Proportion of Respondents Mentioning This Number of Suppliers	Correctness Index	Proportion of Respondents Mentioning This Number of Suppliers	Correctness Index
0	.18	N.A.	.21	N.A.	.31	N.A.	.21	N.A.
1	.58	.72	.16	.65	.21	.58	.16	.65
2	.15	.61	.22	.71	.21	.66	.22	.71
3	.08	.48	.25	.62	.18	.57	.25	.62
4	.01	.83	.11	.60	.06	.47	.11	.60
5	-	-	.05	.57	.03	.47	.05	.57
Total		.67		.65		.58		.69

[1]The correctness index is defined as the ratio: $\frac{\text{Correctly identified suppliers of ambulance services}}{\text{Total number of suppliers of ambulance service mentioned}}$

TABLE VI-E-6

PERCEPTIONS OF RESPONDENTS AS TO WHO HAS TO PAY FOR THE USE OF THE AMBULANCE SERVICE(S) THAT THEY CORRECTLY IDENTIFIED IN THEIR COMMUNITY

Area	Who Actually Has to Pay For Use of Given Service	Proportion of Respondents, Who Correctly Identified Suppliers of Ambulance Services, Perceiving Those Who Have to Pay for the Use of These Services as:					
		Everyone	No One	Only Those Who Can	Non-Residents	Don't Know	Other
Azusa	Only Those Who Can	.78	.01	.05	-	.15	.01
Pasadena	Everyone	.85	-	.15	-	-	-
	Only Those Who Can	.78	.06	.05	.01	.10	-
	Nonresidents	.56	.22	.05	-	.17	-
San Fernando Valley	Everyone	.91	.02	.02	-	.04	.01
	Only Those Who Can	.34	.27	.09	-	.28	.02
San Gabriel	Everyone	.98	.02	-	-	-	-
	Only Those Who Can	.87	.04	-	-	.09	-
	Nonresidents	.27	.21	.02	.22	.27	.01

contrast, none to 9 percent of the respondents correctly identified the fact that only those who can have to pay for the use of ambulances which are municipally operated or privately operated under contract to a municipality or the county. In the City of San Gabriel, only 22 percent of the respondents recognized that only nonresidents had to pay for the use of its municipally operated emergency ambulances.

Within the areas that were encompassed by the survey, three fees were charged for basic ambulance transport, namely 30, 37 and 43 dollars. Table VI-E-7 presents the perceived costs for users, who have to pay for the various services. In all cases the mean perceived cost was lower than the actual cost. The biggest underestimation was for the municipally operated ambulance in Pasadena where, with the presence of a physician as part of the crew, the basic charge was $43.

Respondents also were asked to identify the occupational titles of the crews of the ambulance services that they mentioned. Table VI-E-8 summarizes these perceptions. The only area, in which more than half of the respondents correctly identified the occupational title of an ambulance service, was in the San Fernando Valley, where rescue firemen man the ambulances of the Los Angeles City Fire Department. Perhaps most significant was the fact that in Pasadena only 21 percent of those who mentioned the municipally operated ambulance correctly perceived that the crew included a physician.

With regard to what, if anything, is required beyond merely calling to obtain an ambulance, it was found that a higher proportion of the residents of the City of Azusa, where there was a tendency to screen calls for an ambulance by first dispatching a law enforcement officer, perceived that a "law officer must come to the scene first" than any of the other study areas. The

TABLE VI-E-7

PERCEPTION OF RESPONDENTS AS TO WHAT THOSE, WHO HAVE TO, PAY FOR THE USE OF THE AMBULANCE SERVICE(S) THAT THEY CORRECTLY IDENTIFIED IN THEIR COMMUNITY

Area	Actual Basic Cost	Proportions of Respondents, Who Correctly Identified Suppliers of Ambulance Services Perceiving the Cost of the Use of These Services As:						
		$ 1-19	$20-29	$30-39	$40-49	$50-59	≥$60	Mean Cost
Azusa	$37	.07	.35	.32	.06	.15	.05	$34.85
Pasadena	30	.13	.50	.25	.12	-	-	28.13
	37	.08	.38	.31	.12	.09	.02	32.85
	43	.16	.45	.20	.17	.02	-	28.14
San Fernando Valley	37	.13	.43	.21	.08	.12	.03	31.68
San Gabriel	30	.27	.55	.18	-	-	-	22.73
	37	.04	.49	.38	.04	.04	.01	32.24

TABLE-VI-E-8

PERCEPTIONS OF RESPONDENTS AS TO THE OCCUPATION TITLE DESCRIBING THE LEVEL OF TRAINING OF THE CREWS OF THE AMBULANCE SERVICES THAT THEY CORRECTLY IDENTIFY IN THEIR COMMUNITY

Area	Actual Occupational Title of Crews	Proportions of Respondents, Who Correctly Identified Suppliers of Ambulance Service, Perceiving the Occupational Title of Crew Members As:					
		Attendant	Nurse	Physician	Rescue Firemen	Driver	Other
Azusa	Driver & Attendant	.44	.01	.05	.02	.27	.21
Pasadena	Driver & Attendant	.46	.03	.05	.05	.35	.06
	Rescue Firemen	.40	-	-	.13	.47	-
	Driver & Physician	.31	.02	.21	.15	.29	.02
San Fernando Valley	Driver & Attendant	.26	.03	.04	.34	.26	.07
	Rescue Firemen	.11	.03	.05	.53	.17	.11
	Driver & Physician	.39	-	.07	.15	.05	-
San Gabriel	Driver & Attendant	.48	.01	.02	.09	.33	.07
	Rescue Fireman	.17	.03	.03	.37	.31	.09

proportions of respondents, who perceived the existence of such screening, were 0.105 in Azusa and 0.056 (aggregated) in the other three study areas. This difference is statistically significant at the 0.01 level of significance.[1]

The perceptions of the citizenry with regard to ambulances can be summarized as follows:

(1) With regard to who provides ambulance services in a community:

- Depending upon the area, one-fourth to one-third of the respondents were unable to mention any provider of ambulance services.
- Approximately one-third of the organizations, which were thought by respondents to provide ambulance services, did not provide such services.

(2) With regard to who has to pay for the use of the various ambulance services in a community:

- Private ambulance services, for which everyone has to pay, were strongly so perceived.
- Private ambulance services that were under governmental contract and municipal ambulance services, for which only those who can have to pay, were correctly perceived by less than ten percent of the respondents.
- Municipal ambulance services, for which only those who are nonresidents have to pay, were correctly perceived by only about one-fourth of the respondents.

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[1] Welch, B.L., "The Generalization of Student's Problem When Several Different Population Variances are Involved," Biometrika, 34: 28-38, 1947.

(3) With regard to how much those who have to pay do pay for basic emergency transportation, the mean estimates in all areas for all mentioned ambulance services were low by from six to thirty-five percent.

(4) With regard to the occupational titles of the crews of ambulances, only about one-fifth of the respondents in Pasadena, where physicians are aboard the municipal ambulance, were aware of the physician's presence.

(5) With regard to the screening of requests for an ambulance, about one-fourth of the residents of Azusa, where it has occurred, perceived such screening. Although low, this proportion was statistically significantly higher than the comparable proportion of only about one in twenty in the other three areas.

c. Emergency Treatment Facilities. The number and nature of emergency treatment facilities varied markedly between the four areas. In Azusa, there is no facility which operates a 24 hour-a-day, physician-staffed, outpatient emergency department. In the San Fernando Valley, there are fifteen such facilities. Table VI-E-9 identifies the facilities which provide some level of emergency treatment in each area, and some characteristics of each.

One characteristic of hospitals that provide outpatient emergency services, namely who had to pay for the services, can be quite complex. The complexities arise because of contractual agreements between local governments and some hospitals, which define the terms under which certain kinds of emergency medical services are to be offered. For example, in addition to providing for ambulance services, the county's Emergency Aid Program provides for contracting with hospitals for certain emergency department services. The contracts with hospitals establish standards of equipment and staffing for the emergency department. The emergency department must be staffed, 24 hours a day, with a physician, nurses and other allied health personnel, and with the

TABLE VI-E-9

FACILITIES WHICH PROVIDE EMERGENCY TREATMENT SERVICES AND SOME OF THEIR PROPERTIES

Area	Number of Emergency Treatment Facilities	Kinds of Service	Hours Open Daily	Who is Eligible to Be Treated?	Eligibles Who Pay For Treatment Services	Is Physician Always Present During Hours of Operation?
Azusa	2	First aid[1]	<24	Walk-ins	Everyone	No
Pasadena	2	Basic[2]	24	Walk-ins	All but EAP	Yes
	1	Basic[2]	24	Walk-ins	Everyone	Yes
	1	Basic[2]	<24	Walk-ins	Everyone	Yes
	1	Basic[2]	24	Walk-ins	No one	Yes
San Fernando Valley	9	Basic	24	Walk-ins	All but EAP or city	Yes
	4	Basic[2]	24	Walk-ins	Everyone	Yes
	1	Basic[2]	24	Walk-ins	No one	Yes
	1	Basic[2]	24	Subscribers	No one	Yes
	7	Basic[2]	<24	Walk-ins	Everyone	Yes
	3	Basic[2]	<24	Subscribers	No one	Yes
	1	Standby[3]	24	Walk-ins	Everyone	No
	1	First aid	24	Walk-ins	Everyone	No
	2	First aid	24	Private patients	Everyone	No
	1	First aid	<24	Private patients	Everyone	No
	1	First aid	<24	Subscribers	No one	No
San Gabriel	1	Basic	24	Walk-ins	All but EAP	Yes
	1	First aid	24	Walk-ins	Everyone	Yes

[1]Hospital does not maintain regular outpatient emergency services but is equipped, prepared and staffed to initiate emergency resuscitative and life support procedures if indicated.

[2]Hospital maintains facilities for the provision of outpatient emergency services and has a physician plus nurses and other allied health personnel on the premises for emergency department services with the medical staff on call for specialty consultation and treatment.

[3]Hospital maintains facilities for the provision of outpatient emergency services and has a nurse and other allied health personnel with special training in emergency resuscitative and life support procedures on premises with physicians on call.

medical staff on call for specialty consultation and treatment. Further, the contracts require that a victim of a medical emergency, who is brought to the hospital by an ambulance whose dispatch was initiated by the Sheriff's Department or by the police department of a city that is participating in the Emergency Aid Program, will be treated without proof of his or her ability to pay. Again, if the victim is unable to pay, the county reimburses the hospital a scheduled amount.

A walk-in to an emergency department that is under an EAP contract is not covered by the provisions of the contract, except when his or her illness or injury is critical enough to require in-patient hospitalization and to prevent transfer to a county facility for hospitalization. If a person, who has become an in-patient through this provision of the Emergency Aid Program cannot pay for his or her hospitalization, the county again reimburses the hospital a scheduled amount. Indigent patients, who receive such public assistance, however, are transferred to a county hospital as soon as it is judged that they can be moved without serious risk to their health.

At the time of the survey, the City of Los Angeles had its own contracts with hospitals covering certain aspects of emergency outpatient services within its boundaries, including the San Fernando Valley. These contracts required the hospital to treat any victim of a medical emergency, without proof of ability to pay, who was transported to the facility by a municipally operated ambulance or, in the few areas in which such a mechanism was used, by a private ambulance that was under contract to the city. The contract with the hospital specifies that the charges to such patients could not exceed those in effect at the city's central receiving hospital. There was, however, no provision for the city to reimburse the hospital for emergency patients, who were treated under the terms of the contract but who could not pay for the services. The hospital had to absorb the costs for such patients.

Respondents to the survey were asked to name every place or organization in the community that provides emergency treatment for the general use of the public. Table VI-E-10 shows the numbers of providers that were mentioned by respondents and the correctness of these responses. Depending upon the area, roughly 1/5 to 1/3 of the respondents could name no provider. Frequently respondents named providers located outside of their city, or, in the case of the San Fernando Valley, outside of that basin. As was done in the case of ambulance services, these answers were treated the same as other answers. On the average, respondents were more than 90 percent correct in their identifications of providers of emergency treatment.

For each facility that was identified as a provider of emergency treatment, whether correctly identified or not, the respondent was asked the question, "who has to pay for emergency treatment?" Table VI-E-11 presents the perceptions of respondents as to who has to pay for treatment at the facilities which actually provide some form of emergency care. In all areas, except Pasadena, users of privately provided emergency services, which were not under contracts to a municipality and/or to the county to provide emergency treatment, were perceived accurately as having to pay by 83 to 90 percent of the respondents. In Pasadena, exactly half of the respondents correctly perceived that no one had to pay for treatment at the free clinic. The remainder of the respondents, who identified the free clinic, were split roughly 3 to 2 between those who thought that only those who can have to pay. In the San Fernando Valley, every respondent mentioning the Veterans Administration Hospital, correctly understood that those who are eligible to use the facility's emergency services do not pay.

With regard to hospitals, which had contracts for emergency medical services under the county's Emergency Aid Program or with the City of Los Angeles, there was no simple correct answer. Between 1

TABLE VI-E-10

EMERGENCY TREATMENT FACILITIES MENTIONED BY RESPONDENTS

Number of Suppliers of Emergency Treatment Mentioned	Area							
	Azusa		Pasadena		San Fernando Valley		San Gabriel	
	Proportion of Respondents Mentioning This Number of Facilities	Correctness Index[1]	Proportion of Respondents Mentioning This Number of Facilities	Correctness Index	Proportion of Respondents Mentioning This Number of Facilities	Correctness Index	Proportion of Respondents Mentioning This Number of Facilities	Correctness Index
0	.34	-	.24	-	.19	-	.21	-
1	.31	.96	.19	.99	.33	.95	.39	.99
2	.21	.71	.24	.97	.21	.93	.27	.95
3	.12	.86	.22	.91	.14	.93	.09	.83
4	.02	.81	.09	.83	.09	.91	.03	.88
5	-	-	.02	.90	.04	.96	.01	.90
Total		.86		.94		.94		.95

[1]The correctness index is defined as the ratio:

$$\frac{\text{Correctly identified emergency treatment facilities}}{\text{Total number of emergency treatment facilities mentioned}}$$

TABLE IV-E-11

PERCEPTIONS OF RESPONDENTS AS TO WHO HAS TO PAY FOR THE USE OF THE EMERGENCY TREATMENT FACILITIES THAT THEY CORRECTLY IDENTIFIED

Area	Who Actually Has to Pay For Use of Given Facility	Proportion of Respondents Who Thought that Those Who Had to Pay Were					
		Everyone	No One	Only Those Who Can	Non Residents	Don't Know	Other
Azusa	Everyone	.84	.06	.02		.06	.02
	All but EAP covered	.86	.03	.04	.01	.04	.02
Pasadena	Everyone	.57	.12	.14	.07	.10	
	No one	.29	.50	.21			
	All but EAP covered	.83	.03	.10		.04	
San Fernando Valley	Everyone	.83	.02	.06		.05	.04
	No one		.100				
	All but city or EAP covered	.82	.02	.09		.06	.01
San Gabriel	Everyone	.90	.03			.07	
	All but EAP covered	.84	.02	.01		.10	.03

and 10 percent of the respondents felt that only those who can have to pay for such services. For a victim who was brought to the hospital by ambulance, that had been dispatched at the initiation of the Sheriff's Department, or the police department of a city participating in the Emergency Aid Program, or the Los Angeles City Fire Department, this was the correct answer. Between 83 and 86 percent of the respondents felt that everyone had to pay for the use of such services. For the walk-ins and those brought to the hospital by an ambulance that was not dispatched by a public safety agency, this was the correct answer.

The level of household income influenced the respondent's perception as to who has to pay for treatment that is provided by emergency departments that are under contract to the county and/or city. For the survey, as a whole, the mean size of the households, of which the respondents were members, was between 3 and 4. The upper limit of household income of the "poverty level" for a non-farm family of four, as defined by the Bureau of the Census at the time of the survey, was $3,968. Therefore, the answers of respondents, who identified emergency departments that were under contract to the county or city, were examined in terms of income. Within each area, the proportion of responses that "only those who can have to pay" from among all responses was higher for respondents with household incomes within the poverty level (<$4,000), than for other levels of household income, e.g., $4,000 - $4,999, $6,000 - $9,999, etc. Aggregated across areas, the proportion of such responses for respondents within the poverty group was 12.9 percent. Although low, this figure was higher than the 8.4 percent of such responses for respondents from the group with household incomes that were above poverty level (≥$4,000), when aggregated across both areas and income levels. The difference between the two proportions of correct responses is statistically significant at the 0.01 level of significance. Such a difference may be explained by the actual experiences of respondents, with incomes that are at a poverty level, in connection with medical emergencies and from their use of the emergency departments of hospitals which are operated by the County of Los Angeles, as portals to the medical treatment system from non-urgent, general health problems.[1]

Respondents were asked if a physician was always present at the facility during the hours that it is open. There are three patterns of staffing which describe the presence of physicians in facilities, which are in the areas that were surveyed and which provide some level of outpatient services for medical emergencies:

- The facility has a licensed physician, who is assigned to the emergency department and is on the premises at all times that the facility is open (usually 24 hours a day).
- The facility has a registered or licensed vocational nurse, who is assigned to the emergency department and is on the premises at all times that the facility is open. A licensed physician is on call.
- The facility has no arrangement for the provision of outpatient emergency services by physicians. A registered nurse, licensed vocational nurse or emergency medical technician is on call from within the facility to render first aid.

Table VI-E-12 presents the perception of respondents as to whether or not a physician is always present in the emergency treatment facilities that they correctly identified. The results indicate that the large majority of respondents believed that a physician is always present in any facility which provides outpatient emergency services. For facilities in which physicians are only on call or not available at all for emergency treatment, the proportion of

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[1] Weinerman, E. R. and Edwards, H. R., op. cit.

TABLE VI-E-12

PERCEPTIONS OF RESPONDENTS AS TO WHETHER OR NOT A PHYSICIAN IS ALWAYS PRESENT IN THE EMERGENCY TREATMENT FACILITIES THAT THEY CORRECTLY IDENTIFIED

Area	At Facility Mentioned, A Licensed Physician Is Actually:	Proportion Of Respondents, Whose Perceptions As To Whether Or Not A Physician Is Always Present At Facility, Were:		
		Physician Definitely Or Probably Always Present	Uncertain As To Whether Or Not Physician Is Always Present	Physician Definitely Or Probably Not Always Present
Azusa	Always present	.89	.04	.07
	On call	.87	-	.13
	Not available	.83	-	.17
Pasadena	Always present	.92	.01	.07
	Not available	.75	.10	.15
San Fernando Valley	Always present	.91	.05	.04
	On call	.92	.04	.04
	Not available	.92	.05	.03
San Gabriel	Always present	.93	.03	.04
	Not available	.80	.12	.08

respondents who erroneously thought that they always had a physician present varied between the four areas from 75 - 91 percent.

Each respondent, who thought that a physician was not always on the premise of a facility that he or she had identified as providing emergency medical treatment, was asked "What happens when a seriously injured or ill person is brought to that facility and a physician is not present?" Table VI-E-13 summarizes the responses. Again, the respondents associated physicians with the rendering of emergency treatment. Depending upon the area, 76 to 89 percent thought that a physician would be called.

The perceptions of the citizenry of the four areas with regard to facilities which provide outpatient emergency treatment can be summarized as:

(1) With regard to who provides outpatient emergency treatment in a community:

- Depending upon the area, roughly one-fifth to one-third of the respondents were unable to mention any provider of outpatient emergency services.

- The respondents, who did mention organizations that they thought provided outpatient emergency services, were highly accurate in their identification of providers of such services.

(2) With regard to who has to pay for the use of the various outpatient emergency facilities in a community:

- Privately provided emergency services, for which everyone has to pay, were generally so perceived.

TABLE VI-E-13

PERCEPTIONS OF RESPONDENTS AS TO WHAT A FACILITY WOULD DO WHEN NO PHYSICIAN WAS PRESENT AND A SERIOUSLY INJURED OR ILL PERSON WAS BROUGHT IN

Area	Proportion Of Respondents, Whose Perception As To What A Facility Without A Physician Present Would Do If A Seriously Ill Or Injured Person Is Brought In, Was:			
	Would Call Physician	Nurse Would Treat	Would Refuse Victim	Other
Azusa	.79	.13	-	.08
Pasadena	.76	.05	.14	.05
San Fernando Valley	.89	.08	-	.03
San Gabriel	.89	-	-	.11

- Emergency departments of hospitals that were under contract to the county or city to provide, without proof of ability to pay, treatment to victims of medical emergencies, who have been transported to them by ambulances that were dispatched at the initiation of a public safety agency, were perceived by 83 to 86 percent of the respondents as requiring everyone to pay.

- The emergency services provided by a veteran's hospital were correctly perceived, by everyone who mentioned them, as being free to those eligible for veterans' benefits.

- The emergency services, which were provided by a free clinic, were correctly perceived as being free by only half the respondents.

(3) With regard to whether or not a physician is always present when a facility is open to provide emergency treatment:

- Facilities, at which a physician always is present, were strongly so perceived.

- Facilities, at which a physician is on call rather than present, were perceived as always having a physician present roughly to the same degree as facilities that actually are staffed by a physician.

- Facilities, at which no physician-based emergency services are provided, were perceived as always having a physician present only slightly less frequently than those facilities that actually are staffed by a physician.

(4) With regard to what a facility would do if a seriously ill or injured person were brought in and a physician was not present:

- The dominant perception was that the facility would call a physician.

- In general, the minority perceptions were principally that a nurse would treat. Only in Pasadena, did the minority perceptions include refusal to treat the person.

d. Access to Emergency Medical Services. Among the important perceptions of citizens are those with regard to whether or not they think one can get medical treatment in their community for the kinds of illnesses and injuries for which people can be expected to use emergency services.

Table VI-E-14 presents these perceptions regarding their personal ability to get such treatment. In each area, the majority of the respondents felt that they could get emergency treatment, but the magnitude of the majority varied with both the area and with the nature of the illness or injury. For each of the five categories of illness or injury, Azusa had the lowest proportions of respondents who felt that they could get emergency treatment. In four out of the five categories, Pasadena, San Gabriel and the San Fernando Valley ranked first, second and third respectively in the proportions of respondents who felt that they could get emergency treatment.

For all four areas, the proportion of respondents who felt they could get emergency treatment was highest for a knife wound and lowest for indigestion. Neither the cost of emergency treatment nor the lack of medical insurance was seen as a major barrier to the receipt of emergency services. In Pasadena and San Gabriel, where the largest proportions of respondents felt that they could get emergency treatment, those who did not think that they could get such treatment based their view, for everything except a knife wound, largely on the belief that the condition was not a medical emergency. In Azusa and the San

TABLE VI-E-14

PERCEPTIONS OF RESPONDENTS AS TO WHETHER OR NOT THEY THINK THAT THEY PERSONALLY CAN GET MEDICAL TREATMENT IN THEIR COMMUNITY WHEN THEY NEED IT FOR VARIOUS ILLNESSES AND INJURIES

Kind Of Illness Or Injury	Proportion Of Respondents Whose Perception As To Whether Or Not They Could Get Emergency Treatment In Their Community Was:											
	Azusa			Pasadena			San Fernando Valley			San Gabriel		
	Yes	Don't Know	No	Yes	Don't Know	No	Yes	Don't Know	No	Yes	Don't Know	No
Sprained Ankle	.80	.08	.12	.95	.02	.03	.89	.04	.07	.94	.03	.03
Influenza	.81	.05	.14	.93	.02	.05	.88	.03	.09	.89	.03	.08
Knife Wound	.87	.06	.07	.97	.02	.01	.94	.02	.04	.98	.01	.01
Indigestion	.70	.09	.21	.91	.02	.07	.85	.04	.11	.89	.03	.08
Hernia (Males) or Female Troubles (Females)	.84	.03	.13	.94	.02	.04	.92	.02	.06	.91	.02	.07

Fernando Valley, however, the feeling that the condition was not a medical emergency was given as the reason, by a majority of those who thought that they could not get emergency treatment, only for influenza and indigestion. The principal reason for the other conditions was that there was no facility nearby at which they could get such treatment. In Azusa, this perception mirrors the fact that the nearest 24-hour basic emergency department is located in a neighboring community. In the San Fernando Valley portion of the City of Los Angeles, the picture is somewhat comparable. The area consists of approximately two dozen communities, e.g., Canoga Park, Encino, Granada Hills, North Hollywood, Pacoima, Sherman Oaks, Van Nuys, etc. As Table VI-E-9 shows, there were thirteen private hospitals, at the time of the survey, that provided 24-hour basic emergency services in the San Fernando Valley. Nine of these did so under contract to the City. The thirteen hospitals, however, were concentrated in only eight of the communities, so that the majority of the communities were served by a hospital in an adjacent community.

To examine the perceptions of the respondents as to what happens in their communities when the costs of emergency medical services are greater than the ability of the person who needs them to pay, another set of questions were asked. The majority of the respondents, in each area, felt that in such a situation the victim would be given proper emergency medical care in their community. A minority of about one in four or five, however, felt that the victim would not receive proper medical care.

Table VI-E-15 shows what respondents thought would happen to someone who is given emergency medical care and does not pay. Overall, the largest proportions felt that the person would be forced to pay by means of garnishment of income, lien

TABLE VI-E-15

PERCEPTION OF WHAT WILL HAPPEN TO SOMEONE WHO IS GIVEN EMERGENCY MEDICAL CARE IN THE COMMUNITY AND DOES NOT PAY

Action Taken Against Recipient Of Emergency Care Who Does Not Pay	Proportion of Respondents Who Thought What Would Happen To Recipient Of Emergency Care, Who Does Not Pay, Is:			
	Azusa	Pasadena	San Fernando Valley	San Gabriel
Nothing	.07	.14	.19	.04
Would Be Forced To Pay Through Lien On Property, Garnishment Of Income, etc.	.21	.22	.21	.27
Would Receive Public Assistance	.12	.08	.01	.13
Would Be Sued	.18	.14	.37	.07
Would Be Harrassed By Authorities	.03	.13	.13	.06
Other	.07	.08	.05	.07
Don't Know	.32	.21	.04	.36

on property, etc. There were some significant area-to-area differences. In the San Fernando Valley, for example, the largest proportion thought that the person would be sued, while at the same time, the proportion who thought that nothing would happen was the highest for any area.

The perceptions of the respondents with regard to access to emergency medical services can be summarized as:

(1) With regard to whether or not they personally can get emergency medical treatment in their community:

- Depending upon the area and nature of the illness or injury, 70 to 96 percent felt that they could.

- Those who thought that they could not get emergency care felt that it would be because the condition was not an emergency. Further, in Azusa, where there is no hospital that provides basic emergency services, and in the San Fernando Valley, where not every community has such a hospital, respondents noted that there was no nearby facility for treatment.

(2) With regard to persons who could not pay for needed emergency services:

- Roughly six out of ten thought that they would be given proper emergency medical care.

- Only a minority thought that after treatment, nothing would happen to such persons or that they would receive public assistance.

- The rest either did not know what would happen or thought that some kind of action would be taken to force or attempt to force such persons to pay.

e. Roles of Citizens. In addition to the perceptions of citizens as to the providers and characteristics of emergency medical services, it is necessary to know what roles citizens think that they are expected to perform and what roles they think are to be left to trained persons.

Respondents were asked to imagine that:

- You see a serious traffic accident while driving several blocks from home.
- You do not know any of the people involved.
- You can see that some of the people involved are injured.

Table VI-E-16 shows the respondents' perceptions of what public officials and medical people wanted them to do and what they think someone in their community would do in such a situation in terms of specific actions. The results show some interesting contrasts between what people thought it was wanted that they do and their expectations as to what someone in their community would do, all of which were statistically significant[1] at the 0.01 level.

Almost unanimously, respondents indicated that officials and medical people wanted them to report the emergency. Fourteen out of fifteen perceived that it was wanted that they volunteer to serve as a witness. Their perceptions as to actual behavior, however, indicated that 15 to 20 percent fewer of them felt that someone in their community would actually take such actions. Interestingly, there was only one other action, for which the proportion of respondents, who thought that someone in their community would take the action, was lower than the proportion who thought that officials and medical people wanted that action taken. This action was

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[1]Welch, B.L., op. cit.

TABLE VI-E-16

PERCEPTIONS OF RESPONDENTS AS TO WHAT PUBLIC OFFICIALS AND MEDICAL PEOPLE WANT THEM TO DO AND WHAT THEY THINK SOMEONE IN THEIR COMMUNITY WOULD ACTUALLY DO AT THE SCENE OF A SERIOUS TRAFFIC ACCIDENT

Action	Proportion of Respondents Whose Perceptions As To Whether Or Not					
	Public Officials And Medical People Want Them To Take Action Are:			Someone In Their Community Would Take The Action Are:		
	Probably Or Definitely Yes	Uncertain	Probably Or Definitely No	Probably Or Definitely Yes	Uncertain	Probably Or Definitely No
Report The Medical Emergency	.98	.01	.01	.83	.04	.13
Volunteer To Serve As A Witness	.93	.01	.06	.72	.04	.24
Wait Around For The Arrival Of The Public Agents	.87	.01	.12	.92	.01	.07
Volunteer What You Know About The Injured To Public Agents On Their Arrival	.86	.01	.13	.89	.01	.10
Stop At The Scene Of The Emergency	.73	.03	.24	.70	.05	.25
Direct Traffic At The Scene Of The Emergency	.61	.03	.36	.70	.03	.27
Volunteer To Aid The Public Agents In Helping The Injured	.59	.03	.38	.79	.02	.19
Drive The Injured To The Hospital	.10	.01	.89	.17	.02	.81
Just Stand Around And Look At The Victim Without Giving Any Help	-	-	-	.27	.04	.69
Take Advantage Of The Injured	-	-	-	.03	.02	.95

stopping at the scene. The action of stopping at the scene evoked some inconsistencies in the perceptions of respondents with regard to other actions that are conditional on first stopping at the scene. Higher proportions of respondents thought that public officials and medical people wanted people to "wait around for the arrival of the public agents," and to "volunteer what they know about the injured to public agents on their arrival" than to "stop at the scene of the emergency." The last action is clearly a prerequisite for the two former actions. Similarly, higher proportions of respondents felt that someone in their community would actually "wait around for the arrival of the public agents," "volunteer to aid the public agents in helping the injured," than that they would "stop at the scene of the emergency." Again, the last action is a prerequisite for the other actions. Such contradictions can arise from a number of causes such as the giving of conditional responses, namely, "If someone stopped, would official and medical people want him to (specific action)? or would he (specific action)?" The proportions of respondents who perceived officials and medical people as wanting the passerby to stop, or who perceived someone in their community as actually stopping, may have been depressed because it is the key decision in whether or not one gets involved.

For the actions, "wait around for the arrival of public agents," "volunteer what you know about the injured to public agents on their arrival," "direct traffic on the scene," "volunteer to aid public agents in helping the injured," and "drive the injured to the hospital," the proportions of respondents who felt that someone in their community would aid them were statistically significantly higher than the corresponding proportions of respondents who thought that public officials and medical people wanted them to be done. This reflects a positive view of the probable actions of the members of one's community. This positive view of other lay persons in the community also is reflected in the fact that only 27 percent of the respondents felt that people would "just stand around and look at the victim without giving any help," and only three percent thought that someone would "take advantage of the injured."

The only area in which a majority of the respondents perceived that public officials and medical people do not want citizens to act is that of driving the injured to the hospital. Further, roughly four out of ten felt that citizen's aid in assisting public agents in "helping the injured" or in "directing traffic at the scene" was not wanted.

The physician who is near or at the scene of a medical emergency, but without any patient-client relationship to the injured or ill person(s), poses a unique set of issues in terms of role. The respondents were asked two questions about their expectations of the behavior of a physician in such a situation:

- If a medical emergency occurred in a public place, where one of the persons who was present happened to be a medical doctor, would he identify himself as a doctor and try to help the victim?

- If a doctor, not on call, drives past the scene of an automobile accident, where no official assistance seems to have arrived, would he stop and try to help the victim?

Ninety percent of the respondents felt that in the first instance the physician difinitely or probably would identify himself as a doctor and try to help the victim. In the second situation, 86 percent of the respondents believed that the physician would stop his car at the scene of the automobile accident and again try to help the victim. The latter result is in conflict with the results of a survey[1] conducted among its members by the American Medical Association (AMA), in which approximately half of the respondents indicated that they would not stop and give aid to the victims of an automobile accident for fear of being sued for malpractice. Other surveys report similar findings.[2]

The risk of a legal suit against a physician, who aids the victim of a medical emergency, appears to be infinitesimal. There is no recorded instance of a court awarding compensation to a claimant in such a case. Attempts to improve the likelihood that a physician will assist the victim of a medical emergency have been focused mainly on the provision of legal immunity from such liability and information which reveals the true risk of such assistance of physicians. Approximately 40 states have now enacted "Good Samaritan" laws which offer varying degrees of immunity from liability to physicians giving aid in medical emergencies. The effectiveness of these laws in encouraging physicians to give assistance to victims, however, has been put in serious doubt by the AMA survey. The results also showed no significant difference in the responses of physicians in those states which had passed protective legislation and those states which had not.

The perceptions of the respondents with regard to roles can be summarized as:

(1) In the event of an automobile accident involving strangers:

- The primary roles that public officials and medical people want citizens to assume are to report the emer-

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[1] "1963 Professional Liability Survey," Journal of the American Medical Association, 189: 854-866, 1964.

[2] See, for example, Middlethon, W. R., Jr., "Florida's Proposed Good Samaritan Statute--It Does Not Meet the Problem," University of Florida Law Review, Vol. 17: 586-596, 1965 and the Medical Tribune and Medical News, Vol. 9, August 28, 1968, page 23.

gency, stop and wait for the arrival of public agents, and assist public agents who arrive on the scene by volunteering information and serving as a witness.

- Public officials and medical people do not want citizens to drive injured victims to the hospital.

- It was felt that people in the community in general will be helpful. In terms of reporting the medical emergency, stopping at the scene, and volunteering to serve as a witness; a smaller proportion of respondents thought that citizens in their communities would actually take such actions than thought that public officials and medical people wanted citizens to take them. Conversely, a larger proportion of respondents thought that citizens in their communities would wait at the scene for the arrival of public officials, volunteer what they know about the injured to public agents on their arrival, direct traffic at the scene, volunteer to aid the public agents in helping the injured, and drive the injured to a hospital than thought that public officials and medical people wanted these things done by citizens.

- About a quarter of respondents thought that people would stop at the scene and then just stand around and look without giving any help.

(2) With regard to the role of physicians who are at, or passing by the scene of a medical emergency:

- Nine out of ten felt that a physician, who is present at a public place where an emergency occurs, will give aid to the victim.

- Six out of seven felt that a physician, who drives by the scene of an auto accident, will stop and give aid to the victim(s). This perception is in conflict with the results of a survey conducted among AMA members.

3. Natures of Medical Emergency Situations and the Behavior of People Who Are Present

In recent years, there has been much concern with the behavior of persons at the scene of emergencies and their apparent unwillingness to help.[1,2,3,4,5,6] There has been little study of such phenomena in terms of real life emergency situations. The characterization of the natures of medical emergencies and knowledge of the behaviors of those present will be helpful in devising methods to increase the willingness of citizens to assist and to enhance their effectiveness when they do assist.

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[1] Darley, J., and Latane, B., "Bystander Intervention in Emergencies: Diffusion of Responsibility," Journal of Personality and Social Psychology, 10, 1968, pp. 377-383.

[2] Krebs, D., "Altruism: An Examination of the Concept and a Review of the Literature," Psychological Bulletin, 74, 1970, pp. 258-302.

[3] Latane, B., and Darley, J., "Group Inhibition of Bystander Intervention in Emergencies," Journal of Personality and Social Psychology, 9, 1968, pp. 215-221.

[4] Latane, B., and Rodin, J., "A Lady in Distress: Inhibiting Effects of Friends and Strangers on Bystander Intervention," Journal of Experimental Social Psychology, 5, 1969, pp. 189-202.

[5] Lerner, M., and Simmons, C., "Observer's Reaction to the 'Innocent' Victim: Compassion or Rejection?," Journal of Personality and Social Psychology, 4, 1966, pp. 203-210.

[6] Piliavin, I., Rodin, J., and Piliavin, J., "Good Samaritanism: An Underground Phenomenon?," Journal of Personality and Social Psychology, 12, 1969, pp. 289-299.

The structured interview that was used for the household survey examined these issues in terms of three kinds of actual situations which the respondents perceived as being medical emergencies. The first was the most recent situation in which the respondent was aware of an apparent medical emergency but did not stop and give assistance. The second was the medical emergency that the respondent was most knowledgeable about, in which the persons who helped or could have helped apparently did not know the victim(s). The third were all medical emergencies within the past four years in which at least one victim was a resident of the respondent's household.

a. Most Recent Medical Emergency that Respondent Did Not Stop and Give Assistance. The respondent was reminded that most of us have passed the scene of medical emergencies where something kept us from stopping to assist. The respondent then was asked to think back to the most recent time that he or she had done this. Table VI-E-17 summarizes the nature of the situation and reasons for the respondent's not stopping. Parts a. and b. of the table show that the majority of such instances occurred on freeways and that the respondent was either driving a vehicle or was a passenger in a vehicle.

Part c. of the table presents the reasons given by the respondents for their not stopping to help. Roughly two-thirds of all respondents gave the fact that other people had already stopped as their reason why they did not stop. The belief that public agents would take care of it and the opinion that it was too dangerous to stop at the site were each given as reasons for not stopping by slightly more than one-third of all respondents. In addition to the willingness to leave it to public agents to take care of, several other reasons were offered for not stopping to help that clearly appear to reflect a desire not to get involved. These included such things as "I was too busy to stop", "nothing I could do to help", "it was none of my business", "I have a weak stomach for such things" and "I thought

TABLE VI-E-17a

LOCATION OF THE MOST RECENT MEDICAL EMERGENCY THAT RESPONDENT COULD RECALL WHEN HE OR SHE PASSED BY WITHOUT STOPPING TO HELP

Kind of Location	Proportion of All Respondents for Which the Most Recent Medical Emergency That They Passed by Was in This Kind of Location
Freeway	.60
Business street	.22
Residential street	.13
Rural road	.03
Other	.02

TABLE VI-E-17b

RESPONDENT'S STATUS AT THE TIME OF THE MOST RECENT MEDICAL EMERGENCY THAT HE OR SHE PASSED BY WITHOUT STOPPING TO HELP

Status of Respondent	Proportion of All Respondents for Which This Was Their Status at the Time of the Most Recent Medical Emergency That They Passed by Without Stopping
Driving a vehicle	.58
Passenger in a vehicle	.36
Standing nearby	.03
Walking nearby	.03

TABLE VI-E-17c

REASONS GIVEN BY RESPONDENTS AS TO WHY THEY PASSED BY THE MEDICAL EMERGENCIES WITHOUT STOPPING TO HELP

Reason for Not Stopping	Proportion of All Respondents for Which This Was a Reason Given for Their Passing by the Medical Emergency Without Stopping
Other people had already stopped	.66[1]
Public agents would take care of it	.36
Too dangerous to stop	.34
Illegal to stop at site of emergency	.13
Too busy to stop	.06
Nothing I could do to help	.05
Site of emergency was on other side of roadway	.04
Others were in car that either I didn't want to involve or who themselves did not want to get involved	.03
Situation did not appear serious	.03
I wasn't driving	.02
It was none of my business	.02
I have weak stomach for such things	.02
Thought someone else would stop	.01
Other	.01

[1] Proportions do not sum to 1.00 because some respondents gave more than one reason for not stopping.

TABLE VI-E-17d

DIFFERENCES AT THE SCENES OR IN THE RESPONDENTS' SITUATIONS THAT WOULD HAVE CAUSED THEM TO STOP AT MEDICAL EMERGENCIES TO HELP

Difference That Would Cause Respondent to Stop	Proportion of All Respondents for Which This Was Difference That They Said Would Have Caused Them to Stop at Medical Emergency to Help
If no one else had been around	.76[1]
If there had been less traffic	.25
If I had been certain that it was a serious emergency	.21
If it had been legal to stop	.08
If public agents expected me to	.08
If I thought I could have helped	.06
If I had been driving	.04
If I had known first aid	.04
Nothing would have made me stop	.03
If I had been on same side of road as the emergency	.03
If I had known someone at the scene	.03
If I had been asked to	.01
If I had not had children with me	.01
If I had had previous emergency experience	.01
If someone had been with me	.01
If I had not been in a hurry	.01
Other	.02

[1]Proportions do not sum to 1.00 because some respondents gave more than one difference that would have caused them to stop.

someone else would stop."

Part d. of the table lists the differences at the scenes of the medical emergencies or in the respondents' situations that would have caused them to stop to help. Interestingly, approximately three out of four respondents said that they would have stopped to help if no one else had been around. This was offered as the kind of difference that would have caused them to stop and give assistance by more respondents than had given the fact that other people had already stopped as their reasons for not stopping. Only 3 percent of the respondents said that nothing would have made them stop.

b. Characteristics of the Medical Emergencies Mentioned by Respondents. The 1974 medical emergencies that were reported by the 1459 respondents in response to the survey questions about the medical emergencies, in which persons not known to the victim(s) were present or involved or in which members of their households were victims, are described in Table 18. Part a. shows the classification of these medical emergencies in terms of their natures or causes. In comparison with the data (See Section VII-A) which were gathered in connection with the mobile intensive care unit (MICU) demonstration, there are some interesting differences. The data from the household survey were for all victims, regardless of whether or not they went to a treatment facility, and if they went to such facility, regardless of the means of transportation. In the MICU demonstration, the data were for 3134 victims who were transported to Harbor General Hospital by an emergency medical vehicle. The proportions of injuries and illnesses that were reported in the household survey were .64 and .36 respectively. In the MICU demonstration the corresponding proportions were .58 and .42. One explanation for the higher proportion of injuries, which were reported in the household survey, was the frequent mentioning by respondents of

TABLE VI-E-18a

NATURE OR CAUSES OF MEDICAL EMERGENCIES MENTIONED BY RESPONDENTS

Kind of Incident	Number of Incidents		Proportion of All Incidents
Illness		702	.35
Accidents (non-traffic)			
Fall	406 (.53)[1]		
Lacerating household accident	115 (.15)		
Bite, clawing or sting	46 (.06)		
Recreational or sports injury	39 (.05)		
Running into object	33 (.04)		
Falling or dropped object	30 (.04)		
Slammed door	24 (.03)		
Fire or explosion	20 (.03)		
Stepped onto object	19 (.03)		
Industrial accident	14 (.02)		
Electrocution	1 nil		
Other	16 (.02)		
Subtotal		763	.39
Accidents (traffic)			
Auto, truck or bus	277 (.71)[2]		
Motocycle or scooter	50 (.13)		
Bicycle	25 (.06)		
Pedestrian	24 (.06)		
Other	14 (.04)		
Subtotal		390	.20
Assault		35	.02
Obstetrical		21	.01
Attempted suicide		15	.01
Psychiatric		6	nil
Other		42	.02
Total		1974	1.00

[1] Proportion of all non-traffic accidents

[2] Proportion of all traffic accidents

TABLE VI-E-18b

CATEGORIZATION OF MEDICAL EMERGENCIES MENTIONED BY RESPONDENTS IN TERMS OF THE KIND OF ILLNESS OR INJURY

Category of Illness or Injury	Number of Victims	Proportion of All Victims
Burns and heat injuries	36	.01
Fractures and dislocations	314	.14
Lacerations and penetrating injuries	668	.29
Crushing and perforating injuries	142	.06
Poisonings and overdoses	105	.05
Bites and stings	31	.01
Central nervous system injuries	33	.01
Minor injuries	186	.08
Hypertensive and arterosclerotic heart disease	202	.09
Hypertensive and arterosclerotic cerebro-vascular disease	38	.02
Nontraumatic blood loss	57	.03
Infection	129	.06
Influenza and prostration	9	nil
Convulsions	28	.01
Coma and metabolic disorders	282	.12
Obstetrical	36	.01
Respiratory dysfunction	10	nil
Psychiatric	5	nil
Unknown	17	.01
Total	2328	1.00

TABLE VI-E-18c

THE PROPORTION OF ALL INCIDENTS THAT WERE MENTIONED WHICH HAPPENED IN VARIOUS KINDS OF LOCATIONS

Kinds of Location	Proportion of All Incidents
Home or private yard	.61
Residential street	.11
School, recreational or sports area	.06
Business street	.06
Office, commercial building	.05
Freeway, turnpike, interstate highway	.02
Rural, open country	.02
Factory, construction site	.01
Rural road	.01
Hospital or convalescent home	.01
Other	.04

TABLE VI-E-18d

THE NUMBERS OF VICTIMS INVOLVED PER INCIDENT

Number of Victims per Incident	Proportion of All Incidents with This Number of Victims
1	.91
2	.05
3	.01
4	.01
5	.01
6 or more	.01

relatively minor injuries to their children who subsequently were driven to the pediatrician's office or emergency room in the family automobile.

In the household survey, 20 percent of all medical emergencies and 31 percent of those involving injuries were the result of traffic accidents. In the MICU demonstration, traffic accidents caused roughly one-third of all medical emergencies and slightly over half of those involving injuries. In addition to the effect of minor injuries to children that was mentioned above, victims of automobile accidents are more likely to be transported by an emergency medical vehicle than injury victims in general. In relation to the household survey, these two factors would act in the MICU demonstration to increase the proportion of traffic related incidents among medical emergencies of all kinds and among those that involved injuries.

Part b. of Table VI-E-18 reveals that the 1974 emergency medical incidents involved 2328 victims. This part of the Table shows the classification of the illnesses and injuries of these victims in terms of the classification system described in Section VI-C. A comparison with the illnesses and injuries of the victims handled in the MICU demonstration (See Tables VII-A-32 and 33) reveals some of the kinds of differences that were noted above. The categories of fractures and dislocations, lacerations and penetrating injuries, and minor injuries constituted one-half of all conditions of victims reported by respondents in the household survey but only 41 percent of the conditions of the victims that were handled as part of the MICU demonstration.

Part c. of the table shows that 61 percent of incidents leading to medical emergencies occurred in the home or its yard. Twenty percent of all incidents occurred on some kind of roadway. This figure is consistent with the figure for traffic accidents given in part a. of the table. Part d. of the table shows the relative frequencies with which the incidents involved multiple victims. Most frequently, incidents involving more than one victim were traffic accidents.

c. The Situation and Behavior of Persons at the Scene with Regard to What Treatment the Victim's Illness or Injury Required. For the medical emergencies, at which some of the people who helped or could have helped apparently did not know the victim(s), the respondents were asked to describe the situation and the behavior of those present in terms of several aspects. The first aspect examined was that of information about what treatment the victim's illness or injury required. Table VI-E-19 describes the situation and behavior of persons at the scene with regard to this aspect. Part a. of this table shows that, in roughly two-thirds of the incidents, there was felt to be enough knowledge at the scene in terms of what treatment the victim needed. In roughly half the incidents, information of this kind was given by people at the scene and, in almost all cases that such information was given, it was used.

Part b. of the table presents the kinds of information that would have been helpful in addition to that available at the scene and that was actually given by people who were present at the scene. The two most important kinds of information, as regarded what treatment the victim's condition required, were seen to be the severity of the illness or injury and general medical or first aid procedures. In roughly the same proportions of all incidents, at which information about the kind of treatment would have been

TABLE VI-E-19a

SITUATION AND BEHAVIOR OF PERSONS AT THE SCENE WITH REGARD TO WHAT TREATMENT THE VICTIM'S ILLNESS OR INJURY REQUIRED

Questions With Regard to What Treatment the Victim's Illness or Injury Required	Proportion of Incidents for Which Respondents Answered		
	Yes	Don't Know	No
Was there enough knowledge at the scene?	.68	.03	.29
Was any information given by people at the scene?	.48	.04	.48
Was information that was given at the scene used?	.96	nil	.04

TABLE VI-E-19b

INFORMATION AS TO WHAT TREATMENT THE VICTIM'S ILLNESS OR INJURY REQUIRED

Kind of Information	Proportion of Incidents at Which Information Would Have Been Helpful at the Scene	Proportion of Incidents at Which Information Actually Was Given at the Scene
Severity of illness or injury	.47	.48
General medical or first aid procedures	.40	.47
Whom to call regarding treatment	.02	nil
Possibility of contagion	.01	nil
Don't know	.10	.05

TABLE VI-E-19c

INFORMANTS WHO GAVE INFORMATION AT THE SCENE AS TO WHAT TREATMENT VICTIM'S ILLNESS OR INJURY REQUIRED

Kind of Informant	Proportion of Incidents at Which Information Was Given at the Scene
People who were present at the scene	.86
Victim(s)	.07
Doctor or nurse	.02
Fire department rescue squadman	.02
Law enforcement agent	.01
Other	.02

TABLE VI-E-19d

REASONS WHY INFORMATION GIVEN AT SCENE AS TO WHAT TREATMENT VICTIM'S ILLNESS OR INJURY REQUIRED WAS NOT USED

Reason Why Information Was Not Used	Proportion of Incidents For Which This Was Reason Information Was Not Used
Thought that decision should be left to public agents	.15
Recommended action did not seem necessary	.15
Victim refused to act on information	.10
Information did not seem correct	.10
Source of information was not trusted	.05
Recommended action seemed too risky for victim	.05
Other	.40

helpful or was actually given, these two respectively were seen as the kinds of additional information that would have been helpful and were reported as the kind of information that was actually given at the scene.

Part c. of the table shows that, in almost seven out of eight incidents at which information was given at the scene about what kind of treatment the victim required, it was given by lay people other than the victim(s). In only five percent of the cases was the information given by a doctor, nurse, fire department rescue squadman or law enforcement agent who came to the scene.

Part d. of the table shows, for the four percent of the incidents for which information was given at the scene as to what treatment the victim's illness or injury required but not used, why it was not used. Of the numerous reasons that were given, none was dominant. In about one incident out of seven, it was thought that the decision as to what treatment was required should be left to public agents. With an equal frequency, it was thought the recommended treatment did not seem necessary.

d. The Situation and Behavior of Persons at the Scene with Regard to Where Victim Should be Treated. The second aspect examined was that of information about where the victim should be treated. Table VI-E-20 describes the situation and the behaviors of persons at the scene with regard to this aspect. Part a. of this table shows that in roughly nine out of ten of the incidents, there was felt to be enough knowledge at the scene in terms of where the victim should be treated. In slightly more than half of the incidents, information of this kind was given by people at the scene and in almost all cases that such information was given it was used.

TABLE VI-E-20a

SITUATION AND BEHAVIOR OF PERSONS AT THE SCENE WITH REGARD TO WHERE VICTIM SHOULD BE TREATED

Questions With Regards to Where Victim Should Be Treated	Proportion of Incidents for Which Respondents Answered		
	Yes	Don't Know	No
Was There enough knowledge at the scene?	.89	.02	.09
Was any information given by people at the scene?	.54	.04	.42
Was information that was given at the scene used?	.96	.03	.01

TABLE VI-E-20b

INFORMATION AS TO WHERE VICTIM SHOULD BE TREATED

	Proportion of Incidents at Which Information	
Kind of Information	Would Have Been Helpful at Scene	Actually Was Given at the Scene
Location of medical facility	.30	.61
Severity of illness or injury	.19	.05
Emergency services offered at medical facility	.13	.14
Closeness of medical facility	.12	.14
Name, telephone numbers of victim's doctor	.08	.02
What ambulance or medical facility to telephone	.06	.02
Phone number of medical facility	.03	nil
Name of victim's insurance company	.02	-
Ease of admittance at medical facility	.01	.10
Hours of service at medical facility	.01	nil
Other	.05	.01

TABLE VI-E-20c

INFORMANTS WHO GAVE INFORMATION AT THE SCENE AS TO WHERE VICTIM SHOULD BE TREATED

Kind of Informant	Proportion of Incidents at Which Information Was Given At the Scene
People who were present at the scene	.79
Victim(s)	.07
Doctor or nurse	.05
Law enforcement agent	.04
Fire department rescue squadman	.02
Ambulance attendant	.01
Other	.02

TABLE VI-E-20d

REASONS WHY INFORMATION GIVEN AT SCENE AS TO WHERE VICTIM SHOULD BE TREATED WAS NOT USED

Reason That Information Was Not Used	Proportion of Incidents For Which This Was Reason Information Was Not Used
Victim refused to act on information	.22
Recommended action did not seem necessary	.14
Information did not seem correct	.07
Recommended action seemed too risky for victim	.07
Other	.50

Part b. of the table identifies the kinds of information that would have been helpful in addition to that available at the scene and that was actually given by people who were present at the scene. The location of a medical facility was seen as the most important kind of information in determining where the victim should be treated. Such information was given in 61 percent of all incidents at which information was given as to where the victim should be treated. It was mentioned as the kind of information that would have been helpful in 30 percent of all incidents for which additional information would have been helpful. Information about the emergency medical services offered at and the closeness of a medical facility were each given in roughly one out of seven incidents in which information was given. In the incidents for which additional information would have been helpful, the severity of the illness or injury was mentioned approximately one time in five.

Part c. of the table shows that, in almost eight out of ten incidents at which information was given at the scene regarding where the victim should be treated, it was given by lay people other than the victim(s). In 12 percent of the cases, the information was given by a doctor, nurse, fire department rescue squadman, law enforcement agent or ambulance attendant who came to the scene.

Part d. of the table indicates, for the one percent of the incidents for which information was given at the scene as to where the victim should be treated but not used, why it was not used. The most frequently given reason was that the victim refused to act on the information.

e. <u>The Situation and Behavior of Persons at the Scene with Regard to Danger</u>. The third aspect that was examined was whether or not the scene of the incident appeared safe for people. Table VI-E-21 describes the situation and the behavior of persons

TABLE VI-E-21a

SITUATION AND BEHAVIOR OF PERSONS AT SCENE WITH REGARD TO DANGER

Questions with Regard to Dangers	Proportion of Incidents for Which Respondents Answered Yes	Don't Know	No
Did scene of incident appear safe for people?	.89	.02	.09
If dangerous, what was needed to reduce danger present in vicinity?	.59	.04	.37
If what was needed to reduce danger present, was it used?	.79	.03	.18

TABLE VI-E-21b

NATURE OF DANGER AT SCENE

Kind of Danger	Proportion of All Incidents, the Scenes of Which Did Not Appear Safe, at Which This Danger Was Present
Physical hazard	.51
Vehicular traffic	.24
People	.06
Water or gasoline on pavement	.04
Debris on street	.04
Other	.11

TABLE VI-E-21c

WHAT WAS REQUIRED TO REDUCE THE DANGER AT THE SCENE OF THE MEDICAL EMERGENCY

What Was Most Needed to Reduce Danger	Proportion of All Incidents That Did Not Appear Safe at Which This Is What Was Most Needed to Reduce Danger
Presence of public agents	.28
Signal Device	.21
Something to clean up with	.20
Other citizens	.14
Tow truck	.06
Fire extinguishers	.05
Other	.06

TABLE VI-E-21d

REASONS WHY WHAT WOULD REDUCE DANGER AT SCENE WAS NOT USED WHEN IT WAS PRESENT IN VICINITY

Reason That What Would Reduce Danger Was Not Used	Proportion of Incidents at Which What Was Needed to Reduce Danger was Present at Scene But Not Used, for Which This Was the Reason
Thought action should be left to public agents	.36
Too busy assisting victim	.18
Did not realize scene was dangerous at the time	.18
No one present was capable of using what would reduce danger	.09
Other	.19

at the scene with regard to this aspect. Part a. of this table shows that in only 9 percent of all incidents was the scene judged not to be safe. For these incidents, what was needed to reduce the danger was felt to be present in the vicinity in roughly six out of ten instances. When what was needed to reduce the danger was present in the vicinity, it was used approximately eight out of ten times.

Part b. of the table displays the kinds of dangers that were present at the scene of incidents. For roughly half of the incidents at which some danger was present, the danger was in the form of a physical hazard, such as treacherous terrain, loose or falling materials, deep or swiftly moving water, etc. In approximately one-third of the cases, the danger was related to the scene of a traffic accident in the form of passing vehicles or debris, water or gasoline on the street or pavement. In 6 percent of the situations that were seen as dangerous, the danger was seen to be other people.

Part c. of the table displays what was needed most to reduce the various kinds of dangers. Most frequently, the presence of public agents was cited. Signal devices were associated with reducing the danger from vehicular traffic. Other citizens were mentioned as what was needed most in about one-seventh of the dangerous situations.

Part d. of the table exhibits the reasons why what was needed to reduce the danger at the scene was not used even though it was present in the vicinity. Again the principal reason cited was that the action should be left to public agents.

f. The Situation and Behavior of Persons at the Scene with Regard to Trapped Victims. The fourth aspect of incidents, at which persons who were present did not know the victim(s), was whether or not any victim was trapped. Table VI-E-22 sets forth the situations and the behaviors of persons at the scene in terms of this aspect. Part a. of the table presents the fact that in only five percent of the incidents were any victims trapped. When someone was trapped, what was needed to free him or her was present in the vicinity roughly eight times out of ten. When what was needed to free the person was present, it was used approximately nine times out of ten.

Part b. of the table lists the various things that were seen as being most needed to free the victim. In slightly over half of the instances when someone was trapped, other citizens were perceived as what was most needed. The rest of the list is comprised of tools, etc.

Part c. of the table presents the reasons why what could free a trapped victim was not used even though it was present in the vicinity. Again, the notion that the action should be left to public agents topped the list. Tied with it, however, was the belief that the action was too risky for the victim.

g. The Situation and Behavior of Persons at the Scene with Regard to Treatment of the Victim(s) at the Scene. The fifth aspect dealt with the need for and administration of first aid or medical care at the scene. Table VI-E-23 depicts the situations and the behaviors of persons at the scene with regard to this aspect. Part a. of the table shows that in about five out of eight instances, respondents judged that the victims needed treatment at the scene. In roughly two-thirds of the cases, when it was judged that the victim needed treatment at the scene, the necessary supplies and/or equipment were present in the vicinity. In those instances

TABLE VI-E-22a

SITUATION AND BEHAVIOR OF PERSONS AT SCENE WITH REGARD TO TRAPPED VICTIMS

Questions with Regard to Trapped Victims	Proportion of Incidents for Which Respondents Answered		
	Yes	Don't Know	No
Was any victim trapped?	.05	.03	.94
If a victim was trapped, was what was needed to free him or her present in vicinity?	.81	-	.19
If present in vicinity, was what was needed used to free trapped victim?	.89	-	.11

TABLE VI-E-22b

WHAT WAS REQUIRED TO FREE TRAPPED VICTIM

What Was Most Needed to Free Trapped Victims	Proportion of Incidents That Involved Trapped Victims, for Which This Is What Was Needed to Free Trapped Victim
Other citizens	.53
Crowbar	.13
Stick, lumber or rocks	.03
Saw	.03
Ax	.02
Rope	.02
Cutting torch	.02
Shovel	.02
Nothing	.02
Other	.18

TABLE VI-E-22c

REASONS WHY WHAT COULD BE EMPLOYED TO FREE TRAPPED VICTIM WAS NOT USED

Reason That What Could Free Trapped Victim Was Not Used	Proportion of Incidents That Involved Trapped Victims, for Which This Was Reason What Could Free Trapped Victim Was Not Used
Thought action should be left to public agents	.40
Action considered too risky for victim	.40
Too busy assisting victim	.20

TABLE VI-E-23a

SITUATION AND BEHAVIOR OF PERSONS AT SCENE WITH REGARD TO FIRST AID OR MEDICAL TREATMENT

Questions with Regard to First Aid or Medical Treatment	Proportion of Incidents for Which Respondents Answered		
	Yes	Don't Know	No
Did victim need first aid or medical treatment at scene?	.63	.04	.33
If victim needed first aid or medical treatment, were supplies or equipment needed present in the vicinity?	.66	.01	.34
If victim needed first aid or medical treatment and supplies or equipment were in vicinity, was victim given necessary care at the scene?	.54	.01	.45
If necessary care was given at scene, was giver at scene because public agency was contacted?	.24	-	.76

TABLE VI-E-23b

FIRST AID OR MEDICAL TREATMENT NEEDED AT SCENE BY VICTIM

First Aid or Medical Treatment Needed at Scene by Victim	Proportion of Incidents That Victim Needed First Aid or Medical Treatment at Scene, for Which This Was The Care That Was Needed
Control of bleeding	.29
Oxygen or assisted respiration	.18
Drugs or medication	.09
Ice pack or cold compress	.08
Treatment for shock	.07
Splinting	.06
Examination by physician	.03
Cardiac massage	.03
Covering with blanket	.03
Airway cleared	.02
Don't know	.02
Other	.10

TABLE VI-E-23c

SUPPLIES OR EQUIPMENT NEEDED TO GIVE FIRST AID OR MEDICAL TREATMENT REQUIRED BY VICTIM AT THE SCENE

Supplies or Equipment Needed To Give First Aid or Medical Treatment At The Scene	Proportion of Incidents That Victim Needed First Aid or Medical Treatment at the Scene, for Which This Was the Kind of Supply or Equipment Needed
Bandages	.22
Tourniquet material	.11
Ice pack or cold compress	.10
Oxygen or respirator	.10
Drugs or medication	.10
Blanket	.08
Antiseptic	.06
Nothing	.05
Don't know	.03
Other	.15

TABLE VI-E-23d

GIVER OF FIRST AID OR MEDICAL TREATMENT TO VICTIM AT SCENE

Person Giving First Aid or Medical Treatment at the Scene	Proportion of Incidents That First Aid or Medical Treatment Was Given at Scene, at Which Was Given by This Kind of Person
Relative, friend or bystander	.70
Ambulance attendant	.12
Rescue squadman	.09
Physician or nurse	.04
Another victim	.02
Law enforcement agent	.02
Other	.01

TABLE VI-E-23e

REASONS FIRST AID OR MEDICAL TREATMENT WAS NOT GIVEN VICTIM WHO NEEDED IT AT SCENE, OR, IF GIVEN AT SCENE BY DOCTOR, NURSE, AMBULANCE ATTENDANT OR RESCUE SQUADMAN, WHY NOT GIVEN BEFORE THE ARRIVAL OF THIS PROVIDER

Reason First Aid or Medical Care Was Not Given at Scene or Was Not Given at Scene Before Arrival of Professional Provider	Proportion of Incidents That First Aid or Medical Treatment Was Not Given at Scene to Victim Who Need It, for Which This Was Reason
Proper supplies or equipment not available	.38
Persons present did not know how to give treatment	.34
Thought treatment should be left to trained providers	.12
Too risky for victim	.04
Didn't think it was necessary at time	.04
Victim already dead	.02
Victim refused assistance	.02
Other	.04

that treatment was judged to be needed and the supplies and/or equipment to administer it were available, care was given a little more than half the time. In about a quarter of the instances that victims received treatment at the scene, it was given by someone such as an ambulance attendant, who came to the scene because a public agency was contacted.

Part b. of the table lists the kinds of care at the scene that the respondents thought the victim(s) needed. Most of the actions mentioned were of the kind that could be administered by anyone adequately trained in giving first aid. Only such things as the administration of drugs or medication, examination by physician, and cardiac massage cannot.

Part c. of the table shows the kinds of supplies and/or equipment needed to administer the kinds of care that were seen as being needed at the scene. Again, with the exception of oxygen or respirator and drugs or medications, everything mentioned would normally be available or could be improvised at the scene.

Part d. of the table identifies the kind of person(s) who actually gave first aid or medical treatment to the victim(s) at the scene. In 72 percent of the instances, when such care was given at the scene, it was given by a lay person.

Part e. of the table presents the reasons why care was not given to the victim(s) before the arrival of a health or allied health care professional, for those incidents when care at the scene was provided by such professionals. In over seventy percent of such instances, the reasons given were either that proper supplies or equipment were not available or that the lay persons who were present did not know how to give the necessary treatment.

h. <u>The Situation and Behavior of Persons at the Scene with Regard to the Kinds of Help for the Victim(s) That Could Only Be Gotten by Contacting Someone Away from the Scene</u>. The sixth aspect of medical emergencies, at which persons who did not know the victim(s) were present, that was examined was the need for help that could only be gotten by contacting someone away from the scene. Table VI-E-24 recapitulates the situations and the behaviors of persons at the scene with regard to this aspect. Part a. of the table reveals that in roughly nine out of ten incidents, the respondents perceived the victim(s) as needing help of this kind. In the same proportion, someone away from the scene actually was contacted when help that could be gotten only by such a contact was seen as being needed.

Part b. of the table shows the means of contacting help that were present in the vicinity of the medical emergency. Most prevalent were private and public telephones. Persons, who could be sent, were perceived as means of communication in 9 percent of the incidents.

Part c. of the table presents the kinds of help that were seen as being needed by the victim that could only be obtained by contacting someone away from the scene. Dominant was the need for medical treatment.

Part d. of the table identifies the means of communication that were actually used to contact help. Most commonly, a telephone was used and usually it was a private telephone.

Part e. of the table establishes the kinds of persons at the scene who contacted someone away from the scene to get help for the victim(s). Predominantly, the contact was made by someone at the scene when the medical emergency occurred. Of significance is the fact that in 6 percent of such contacts, the contact was made by someone who did not know the victim(s)

TABLE VI-E-24a

SITUATION AND BEHAVIOR OF PERSONS AT SCENE WITH REGARD TO CONTACTING HELP FOR VICTIM(S)

Questions with Regard to Contacting Help for Victims	Proportion of Incidents for Which Respondents Answered		
	Yes	Don't Know	No
Was help needed for victim that could only be gotten by contacting someone away from the scene?	.91	-	.09
If help was needed for victim, was someone contacted who was away from the scene?	.90	-	.10

TABLE VI-E-24b

MEANS OF CONTACTING HELP FOR VICTIM WHICH WERE PRESENT IN THE VICINITY OF THE MEDICAL EMERGENCY

Means of Contacting Help Which Were Present in the Vicinity	Proportion of All Incidents for Which This Means of Contacting Help Was Present in Vicinity
Private telephone	.69
Public telephone	.15
Sending someone	.09
Mobile radio	.02
Emergency call box	.02
Other	.03

TABLE VI-E-24c

KINDS OF HELP FOR VICTIMS THAT WAS NEEDED WHICH COULD ONLY BE GOTTEN BY CONTACTING SOMEONE AWAY FROM SCENE

Kind of Help Which Was Needed at Scene	Proportion of Incidents That Victim Needed Help That Could Only Be Gotten by Contacting Someone Away from Scene, for Which This Was The Kind of Help Needed
Medical treatment	.61
Transportation to treatment facility	.29
Notification of victim's relatives	.03
Law enforcement agents	.03
Extraction of trapped victim	.01
Other	.03

TABLE VI-E-24d

MEANS BY WHICH HELP WAS CONTACTED

Means of Contacting Help for Victim	Proportion of Incidents That Victim Needed Help that Could Only Be Gotten by Contacting Someone Away from Scene, for Which This Means of Contacting Help Was Used
Private telephone	.73
Public telephone	.10
Sending someone	.07
Mobile radio	.03
Emergency call box	.02
Other	.05

TABLE VI-E-24e

THOSE WHO CONTACTED SOMEONE AWAY FROM THE SCENE OF THE ACCIDENT TO GET HELP FOR THE VICTIM(S)

Who Made Contact with Someone Away from Scene to Get Help	Proportion of Incidents That Victim Needed Help That Could Be Gotten Only by Contacting Someone Away from Scene, for Which This Kind of Person Contacted Help
Relative, friend or bystander	.87
Someone aware of what had happened from a distance	.06
Law enforcement agent	.03
Other	.04

TABLE VI-E-24f

PERSONS AWAY FROM THE SCENE AND ORGANIZATIONS THAT WERE CONTACTED TO GET HELP FOR THE VICTIM

Person Away from Scene or Organization Contacted to Get Help for Victim	Proportion of Incidents That Victim Needed Help That Could Be Gotten Only by Contacting Someone Away from Scene, for Which This Kind of Person or Organization Was Contacted to Get Help
Physician	.20
Fire department	.19
Law enforcement agency	.17
Relative or friend	.16
Ambulance service	.11
Hospital emergency department	.11
Other	.06

TABLE VI-E-24g

REASONS WHY NO ONE AWAY FROM SCENE WAS CONTACTED TO GET HELP FOR VICTIM

Reasons Why No Contact Was Made with Someone Away From Scene to Get Help for the Victim	Proportion of Incidents That No Contact Was Made with Someone Away from Scene to Get Help for Victim Who Needed It, for Which This Was the Reason
Victim went or was taken directly to treatment facility	.39
Ignored available means of contacting help	.23
Victims condition didn't seem serious	.13
No means of contacting help	.11
Didn't know who to contact	.09
Other	.05

and was not at the immediate site when the medical emergency occurred.

Part f. of the table establishes the kinds of persons that were contacted. Six kinds of persons were named as the recipients of contacts for help; none was dominant. Four of the six were providers of health services, namely physicians, fire departments (rescue squads and ambulances), ambulance services and hospital emergency departments. Interestingly, in roughly one out of six instances when a contact was made, it was to a relative or friend of the victim. The diversity of contacts reflects the fragmentation of services in the County of Los Angeles and the absence of a universal emergency telephone number such as 911.

Part g. of the table lists the reasons why, when no contact to get help for the victim(s) was made with someone away from the scene. In roughly four out of ten instances, when no contact was made, it was because the victim went or was taken directly to a treatment facility. In almost one-quarter of such instances, no contact was made because available means of help were ignored by those present at the scene. In only 11 percent of the instances did respondents say that no contact was made because there were no means of contacting help.

i. <u>The Situations and Behavior of Persons at the Scene with Regard to the Transport of the Victim(s) to a Treatment Facility</u>. The seventh aspect that was examined was the transportation of the victim(s) to a treatment facility. Table VI-E-25 characterizes the situations and the behaviors of persons at the scene with regard to this aspect. Part a. of the table shows that in 94 percent of the incidents the victim or at least one of the victims was transported to a treatment facility.

TABLE VI-E-25a

SITUATION AND BEHAVIOR OF PERSONS AT SCENE WITH REGARD TO TRANSPORT OF VICTIM(S) TO TREATMENT FACILITY

Questions with Regard to Transportation of Victims	Proportion of Incidents for Which Respondents Answered		
	Yes	Don't Know	No
Was any victim transported to a treatment facility	.94	–	.06

TABLE VI-E-25b

KINDS OF DRIVABLE VEHICLES THAT WERE IN THE VICINITY OF THE MEDICAL EMERGENCY

Kind of Drivable Vehicle That Was in the Vicinity	Proportion of All Incidents for Which This Kind of Vehicle Was in the Vicinity
Parked private automobile(s)	.56
Ambulance	.23
Law enforcement agency vehicle	.07
Rescue squad vehicle	.05
Passing traffic	.05
Don't know	.06
Other	.02

TABLE VI-E-25c

KINDS OF VEHICLES THAT WERE USED TO TRANSPORT VICTIM(S) TO TREATMENT FACILITY

Kind of Vehicle Used to Transport Victim(s) to Treatment Facilities	Proportion of Incidents That Victim Was Transported to Treatment Facility, for Which This Kind of Vehicle Was Used
Private automobile	.77
Ambulance	.19
Law enforcement agency vehicle	.01
Other	.03

Part b. of the table delineates the kinds of drivable vehicles that were present in the vicinity of the medical emergency. Most commonly, parked private automobiles were referred to. Ambulances were called to the scene during 23 percent of the incidents.

Part c. of the table recounts the kinds of vehicles that actually were used to transport the victim(s) to a treatment facility. Most commonly, the transportation was by private automobile. In about eight out of ten of incidents when an ambulance came to the scene, it was used to transport one or more victims.

j. <u>The Situations with Regard to the Treatment of Victims at Health Care Facilities</u>. The eighth and final aspect that was explored was the treatment of the victim(s) at health care facilities. Table VI-E-26 recapitulates the situations with regard to this aspect. Part a. of the table shows that 6 percent of the victims taken to some kind of treatment facility were known by the respondents not to have received treatment.

Part b. of the table shows that 84 percent of the time the victim(s) were taken to a hospital emergency department. About one time in ten, however, the victim was taken to a physician's office.

Part c. of the table lists the reasons why victims were not treated at the health care facility to which they had been taken. Three reasons, which together account for almost 40 percent of the no treatments, give cause for concern in terms of the present operation of emergency services in the County of Los Angeles. These are refusal by the facility to treat the victim, the inability of the facility to provide the required level of care and the inability of the victim to demonstrate an ability to pay.

TABLE VI-E-26a

SITUATION WITH REGARD TO TREATMENT OF VICTIMS

Questions with Regard to Treatment of Victim(s)	Proportion of Incidents for Which Respondents Answered		
	Yes	Don't Know	No
Was treatment received at facility to which victim was taken?	.90	.04	.06

TABLE VI-E-26b

KIND OF FACILITY TO WHICH VICTIM WAS TAKEN

Kind of Treatment Facility to Which Victim Was Taken	Proportion of Incidents That Victim Was Transported to Treatment Facility, for Which This Was the Kind of Treatment Facility
Hospital	.84
Physician's office	.09
Clinic	.03
Other	.02
Don't know	.02

TABLE VI-E-26c

IF TREATMENT WAS NOT RECEIVED AT FACILITY, REASONS WHY IT WAS NOT

Reason Why Treatment Was Not Received at Facility	Proportion of Instances, When Treatment Was Not Received at a Facility, for Which Respondents Gave This Reason
Victim died enroute or at facility before treatment	.19
Facility refused to treat	.17
Victim was examined and no treatment was found to be needed	.17
Facility could not provide required level of care	.13
Victim could not demonstrate ability to pay	.09
Victim left because of anticipated length of delay until seeing physician	.06
Other	.19

k. <u>Summary of the Behavior of People at the Scene of Medical Emergencies</u>. The descriptions of the events surrounding medical emergencies, at which persons who helped or could have helped apparently did not know the victim(s), imply some things that are encouraging and some that are discouraging. On the encouraging side, the impression is given that people at the scene were generally knowledgeable and usually undertook actions on behalf of the victim(s). While it was perceived that there was not enough knowledge at three out of ten incidents about what treatment the victim required, at only one out of ten incidents was knowledge at the scene about where to take the victim for treatment seen as inadequate. Between 70 and 90 percent of the actions taken at the scene were undertaken by lay persons, including strangers. These actions ranged from giving information as to where the victim should be treated to such things as reducing the dangers that were present at the scene, freeing trapped victims, contacting help and transporting the victim to a treatment facility.

There are also disquieting aspects of the knowledge and behavior of persons at the scene of a medical emergency. With little exception, the major reason given, when no decision or action was taken by lay persons at the scene, was the view that the decision or action should be left to public agents. This, in fact, would be the correct procedure, with regard to those decisions and actions that involve significant risk to the victim or those seeking to help, when specialized knowledge, skills, equipment, etc., are not available. In many instances, however, this was not the case and the willingness to leave things to public agents probably was a rationalization for inaction in the specific instance or an expression of a general unwillingness to get involved.

The area in which the most significant gaps appeared was the care and treatment of the victim. In terms of care at the scene, the respondents judged, in almost two-thirds of all the incidents, that the victim required first aid or medical treatment at this stage. However, in only slightly more than one half of the incidents, when such care was judged to be needed and the associated supplies and equipment were available in the vicinity, were the victims given care at the scene. The extent to which this gap jeopardized the ultimate outcomes for the victims, of course, is unclear.

The implications of the experiences at treatment facilities are far clearer. In 6 percent of the instances that a victim was taken to a treatment facility, which was the case in 94 percent of all incidents, the victim did not receive treatment. In about one-quarter of such events, treatment was not received because the facility refused to treat, for unspecified reasons or because the victim could not demonstrate an ability to pay. In an additional one-eighth of such cases, the facility could not provide the required level of treatment. There presently are approximately 2,530,000 persons who annually get emergency treatment in facilities in Los Angeles County.[1] If the results of the household survey are extrapolated to the county as a whole, approximately 2,630,000 requests per year for emergency medical services are placed on treatment facilities. Of these, an estimated 41,000 would be refused treatment and 20,500 would require a level of care beyond that which the facility could provide.

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[1] An Overview of Emergency Medical Services in Los Angeles County, Los Angeles Countywide Coordinating Council on Emergency Medical Services, June 30, 1974, pp. 18-24.

4. The Role of the Citizen in the Evaluation and Improvement of Emergency Medical Services

As potential lay participants in medical emergency and potential consumers of emergency medical services, citizens have a role to play in the evaluation and improvement of the manner in which medical emergencies are handled. The household survey asked the respondents to make three kinds of evaluations. These were of the actions of private citizens and of the emergency medical system in specific medical emergencies, and, in general, of emergency medical services in their communities. The respondents also were asked whether or not they did anything to correct any deficiencies that they observed in the performance of the emergency medical system in specific instances or to bring about other changes that they desired in the emergency medical services in their communities.

Table VI-27 sets forth these evaluations and describes the behaviors of the respondents with regard to attempting to bring about changes. Part a. of the table shows that in roughly seven out of eight incidents lay persons at the scene, who knew that a medical emergency was occurring, did the things that the respondents felt that they should. In only slightly more than six out of eight of these incidents, however, did the emergency medical system do so. In only 15 percent of those incidents, in which the emergency medical system handled aspects poorly, did the respondents personally try to change the operation of the system. In addition to complaints about the performance of the emergency medical system in these specific instances, almost half of the respondents had other changes that they would like to see made in the emergency medical services of their communities. Only 8 percent of the respondents had attempted to do anything to bring these changes about.

Part b. of the table recounts the things that bystanders did wrong at the scene of the medical emergency, at which the people who helped or could have helped apparently did not know the victims and which the respondent knew the most about. The most frequent complaints were that people either just stood and looked or that they did not seem to know

TABLE VI-E-27a

PERFORMANCES OF LAY PERSONS WHO WERE PRESENT AT THE SCENES OF MEDICAL EMERGENCIES AND OF PROVIDERS OF EMERGENCY MEDICAL SERVICES

Questions with Regard to Performances of Private Citizens and of the Emergency Medical System	Proportion of Incidents for Which Respondents Answered Yes	Don't Know	No
For the medical emergency occurring during the past four years about which you know the most:			
Did private citizens, who knew that a medical emergency was occurring, do the things you felt they should do?	.87	.03	.10
Did the emergency medical system do the things you felt it should?	.78	.06	.16
If the emergency medical system handled aspects of the emergency poorly, did you personally try to change the operation of the system?	.15	.02	.83
Are there changes that you would like to see made in emergency medical services in your community?	.47	-	.53
If there are changes that you would like to see in the emergency medical services in your community, have you attempted to do anything to bring them about?	.08	-	.92

TABLE VI-E-27b

WHAT BYSTANDERS DID WRONG AT SCENE OF THE MEDICAL EMERGENCY THAT RESPONDENT KNEW THE MOST ABOUT

Behavior of Bystanders That Respondent Thought Was Wrong	Proportion of Incidents at Which Respondents Thought Bystanders Behaved Wrongly That This Was the Reason
People just stood and looked	.32
People didn't know what to do	.28
People refrained from or refused to give aid	.18
People gave harmful advice or aid	.11
People panicked	.09
Other	.02

TABLE VI-E-27c

CHANGES THAT WOULD IMPROVE THOSE THINGS THAT WERE HANDLED POORLY BY THE EMERGENCY MEDICAL SYSTEM DURING THE MEDICAL EMERGENCY ABOUT WHICH THE RESPONDENT KNEW THE MOST AND OTHER CHANGES THAT WERE DESIRED IN THE EMERGENCY MEDICAL SERVICES IN THE RESPONDENT'S COMMUNITY

Change in the Emergency Medical System	Proportion of the 1279 Changes That Respondents Wanted Made in Emergency Medical Services, Which Were of This Kind.
Cheaper or free emergency medical services	.19
More emergency treatment facilities	.14
Faster treatment at facilities	.13
More physicians and nurses on duty in emergency treatment facilities	.09
Eliminate need to prove ability to pay as condition for treatment	.08
Eliminate need for completion of paperwork as condition for treatment	.07
Increase citizens' knowledge of emergency medical systems	.05
Higher quality medical treatment	.04
More humane attitude on the part of emergency medical personnel	.04
Higher quality ambulance attendants	.04
Faster ambulance service	.03
Medical treatment facilities should be open and physicians available more hours of the day and night	.02
Every hospital should have emergency department	.02
Other	.06

TABLE VI-E-27d

KINDS OF ACTIONS THAT RESPONDENTS TOOK, OR WOULD TAKE, IF THEY ATTEMPTED, OR WERE TO ATTEMPT, TO BRING ABOUT CHANGES BECAUSE OF SPECIFIC INCIDENTS OR A DESIRE FOR IMPROVEMENTS IN THE EMERGENCY MEDICAL SERVICES IN THEIR COMMUNITIES

Kind of Action That Was or Would Be Taken	Proportion of All Actions of This Kind That Were Actually Taken	Proportion of All Actions of This Kind That Think Would Be Taken
No idea	N.A.	.43
Register complaint	.84	.41
Change to different provider	.10	nil
Sue provider	.03	.02
Circulate petition	-	.06
Organize community group	-	.04
Vote to elect different local politicians	-	.03
Other	0.3	.02

TABLE VI-E-27e

KINDS OF PERSONS OR ORGANIZATIONS THAT RESPONDENTS CONTACTED TO REGISTER A COMPLAINT OR THOUGHT THAT THEY WOULD CONTACT TO REGISTER A COMPLAINT, IF THEY HAD NOT ACTUALLY DONE SO

Kind of Person or Organization That Was Or Would be Contacted	Proportion of All Contacts to Register a Complaint That Were or Would be Made to This Kind of Person or Organization That Were Actually Made	Think Would be Made
No idea	N.A.	.54
Political representative	-	.27
Direct provider of service	.90	.10
Private individual	.07	.02
Governmental health agency	.03	.03
Media	-	.02
Civic organization	-	.01
Other	-	.10

TABLE VI-E-27f

REASONS WHY RESPONDENTS, WHO DID NOT ATTEMPT TO IMPROVE EMERGENCY SERVICES BECAUSE OF A SPECIAL INCIDENT OR A DESIRE TO IMPROVE SUCH SERVICES IN THEIR COMMUNITIES, SAID THAT THEY DID NOT DO ANYTHING

Reason Why No Attempt Was Made to Improve Emergency Medical Services in Respondents' Communities	Proportion of Respondents, Who Did Not Attempt to Improve Emergency Medical Services in Their Communities, That Gave This Reason for Their Inaction: When Change Was Aimed at Correcting Things That Were Not Handled Well by Emergency Medical System in a Specific Incident	When There Were Other Changes That Respondents Would Like to See Made in Emergency Medical Services
Feel that individual can't affect anything	.35	.14
Didn't care enough about it	.25	.13
Don't know	.13	.21
Didn't know how to go about it	.08	.18
System would retaliate against me	.06	nil
Never thought about it before	.03	.11
Don't have the ability to do it	.03	.02
Too busy to get involved	.02	.10
Hasn't affected me personally yet	.02	.09
Too much trouble	.02	.01
Government should correct it	.01	.01

what to do.

Part c. of the table lists the 1279 changes that the respondents felt would improve what the emergency medical system had handled poorly in specific incidents and the other kinds of changes that the respondents wanted to see in the emergency medical systems in their communities. The list covers most aspects of emergency medical services ranging from their costs and accessibility to the attitudes that their providers project.

Part d. of the table enumerates the kinds of actions that respondents took, if they attempted to bring about changes, or thought that they would take, if they had not actually attempted to bring about changes, because of the poor performance of the emergency medical system in a specific incident or a desire for improvements in the emergency medical services in their communities. Almost half of those who had done nothing stated that they had no idea what they would do to bring about a change. The vast majority, of those who actually did something, registered a complaint.

Part e. of the table depicts the kinds of persons or organizations that respondents contacted, if they registered a complaint about emergency medical services, or thought that they would contact to complain, if they had not actually done so. There are significant differences between those that the respondents actually contacted and those that respondents, who had done nothing thought that they would contact. More than half of those who did nothing stated that they had no idea whom they would contact to complain about aspects of emergency medical services. None of the respondents, who actually contacted someone, contacted one of their political representatives. Yet of the respondents who did not attempt to contact anyone, the largest proportion of those stating whom they would contact thought that they would contact one of their political representatives to register their complaints. Most frequently, nine times out of ten, those who contacted someone to register a complaint contacted the direct provider of the service in which they wanted some change made.

Part f. of the table lists the reasons that were given by respondents, who did not attempt to change emergency medical services because of poor performance in a specific incident or a desire to improve such services in their communities, as to why they did nothing. The most frequently given reasons for not seeking a change aimed at correcting things, which were not handled well in a specific incident, were that the individual cannot affect anything and not caring enough about it to do something. For other changes that the respondents would like to have seen made in emergency medical services, the largest proportion said that they did not know why they had done nothing to bring about these changes. The next largest proportion felt that they did not know how to go about attempting to get changes.

The examination of the deficiencies in emergency medical services revealed a rich agenda of things that the respondents wanted changed terms of what the respondents had done to help bring about these changes, the record is about as one might expect. If the deficiency was in terms of the manner in which the emergency medical system performed in a specific instance, respondents were twice as likely to take some kind of action than they were to take action when it was simply a change that they wanted to see in the emergency medical services of their community. By far, the most common action taken was to register a complaint to the direct provider of the service that the respondent wanted to see changed.

5. Estimates of the Utilization of Emergency Medical Services

As part of the household survey, each respondent was asked to identify and describe every medical emergency that had befallen a member of his or her household during the past four years. Each also was asked about nonemergent uses of emergency medical services by household members during the same time period. These data permitted estimations to be made of the utilization of various emergency medical services in the County of Los Angeles.

a. Utilization of Ambulances for Other Than Medical Emergencies. The uses of ambulances which, the respondent defined as being for nonemergency purposes, are depicted in Table VI-E-28. Part a. of the table reveals that about five percent of the households had made use of ambulances in the past four years for reasons other than medical emergencies. Part b. of the table presents the reasons why ambulances were used in these nonemergent situations. The most frequently given reason was that it was thought at the time that the victim was experiencing a medical emergency. Clearly, this kind of usage should be considered to be part of the emergency medical usage of ambulances. The other usages were the kinds of nonemergent transportation of patients, such as the movement from a hospital to home, for which ambulances typically are used.

b. Utilization of Hospital Emergency Departments and Emergency Clinics for Other Than Medical Emergencies. Nonemergent uses of emergency departments of hospitals and emergency clinics, as defined by the respondent, are described in Table VI-E-29. Part a. of the table shows that almost one-quarter of all households had made some use of hospital or clinical outpatient emergency services in the past four years for the treatment of illnesses and injuries that were not viewed as medical emergencies. Part b. of the table lists the reasons for such uses of these emergency treatment facilities. In roughly one-quarter of the instances, the victim was thought at the time to have a medical emergency. In almost half of the cases, however, an emergency department or clinic was used for reasons of access, namely it was open when other health care services were not available or the user did not have a regular physician, or convenience.

TABLE VI-E-28a

NONEMERGENCY USE OF AMBULANCES BY HOUSEHOLDS IN THE YEARS 1968-1971

Number of Times That Members of Respondent's Household Used Ambulances for Nonemergent Purposes in Four Years	Proportion of All Respondents, Who Reported This Frequency of Nonemergent Use of Ambulances by Members of Their Households
None	.954
1	.035
2	.008
3 or more	.003

TABLE VI-E-28b

WHY AMBULANCES WERE USED IN NONEMERGENCY SITUATIONS INSTEAD OF SOME OTHER MEANS OF TRANSPORTATION

Reason for Use of Ambulance	Proportion of Nonemergent Transports for Which This Reason Was Given
Victim was thought at the time to have medical emergency	.42
Patient transferred from one hospital to another	.23
Patient brought home after discharge from hospital	.17
Nonemergent patient taken to hospital by ambulance because no other form of transportation was available	.06
Other	.12

TABLE VI-E-29a

NONEMERGENT USE OF EMERGENCY DEPARTMENTS OF HOSPITALS AND EMERGENCY CLINICS IN THE YEARS 1968-1971

Number of Times Household Used Emergency Treatment Facilities for Nonemergent Purposes in Four Years	Proportion of Respondents Who Reported This Frequency of Nonemergent Use of Emergency Treatment Facilities by Their Households
None	.77
1	.13
2	.05
3	.02
4	.01
5 or more	.02

TABLE VI-E-29b

WHY EMERGENCY TREATMENT FACILITY WAS USED IN NONEMERGENT SITUATIONS INSTEAD OF SOME OTHER SOURCE OF TREATMENT

Reason for Use of Emergency Treatment Facility	Proportion of Nonemergent Visits to Emergency Facilities for Which This Reason Was Given
Weekend or off-hour place to go	.28
Victim was thought at the time to have a medical emergency	.26
Convenience	.14
Advised to do so by physician	.12
Has best care available	.08
Don't have regular physician	.05
Cheaper than going to physician	.01
Other	.06

c. Utilization of Various Emergency Medical Services. Since the sizes of the households, the years in which members of the household had their medical emergencies, etc. were know, it was possible to use the reports of medical emergencies for the respondents' households to estimate the utilization in 1971 of the various emergency medical services per 1000 population in Los Angeles County. Table VI-E-30 presents these utilization rates. The table also shows comparable rates of utilization in 1973 for the same services that have been estimated from totally separate data. The latter estimates were based upon surveys of:

- Municipally operated ambulance services, private ambulance companies and county and municipal rescue squads
- Hospitals that offer outpatient emergency services
- Clinics that offer outpatient emergency services
- Physicians in private practice (ten percent sample)

A comparison of the two sets of estimates show strikingly similar results. The estimated annual rates of incidents, to which at least one emergency medical vehicle was dispatched as distinct from the number of victims that might have been transported, were 38 and 39 per 1000 population. The estimated annual rates of utilization of hospital emergency departments, for both emergency and nonemergency purposes, were 334 and 343 per 1000. The annual rates of emergency visits to emergency clinics and to physician's offices were 7 and 4 per 1000 and 15 and 14 per 1000 respectively.

TABLE VI-E-30

ESTIMATED ANNUAL UTILIZATION RATES OF VARIOUS EMERGENCY MEDICAL SERVICES

Emergency Medical Service	Estimated Annual Usage in 1971 per 1000 Population Based Upon Data From Household Survey: Patient Defined Medical Emergency	Patient Defined Nonemergency	Total	Estimated Annual Usage in 1973 Per 1000 Population Based Upon Reports by Providers of These Services in the County of Los Angeles As a Whole[1]
Emergency Medical Vehicles (ambulances, mobile intensive care units, etc.)[2]	38[3]	3[4]	41	39[5]
Emergency departments of hospitals	195	139	334	343[6]
Emergency clinics	7	5	12	4[7]
Physician's offices	15	-	-	14[7]

[1] See An Overview of Emergency Medical Services in Los Angeles County, Los Angeles Countywide Coordinating Council on Emergency Medical Services, June 30, 1974.

[2] Usage of emergency medical vehicles is in terms of incidents which resulted in the dispatch of one or more emergency medical vehicles. As described in Section VII-A, more than one vehicle may be involved in a single incident with only one patient For example, in City of Long Beach the mobile intensive care units do not transport so an ambulance may be needed as well.

[3] Includes uses of ambulances that respondents' classified as nonemergency even though they were thought to have been emergencies at the time of their occurrence.

[4] Includes interhospital transfers, bringing home of patients after discharge from hospitalization, and transportation to hospital of nonemergent (by users own perception) patients because no other form of transportation was available.

[5] Does not include interhospital transfers, bringing home of patients after discharge from hospital, etc.

[6] Estimate of total emergency room visits, both emergency and nonemergency.

[7] What were classified (by physician or clinic) as emergency visits from among all visits.

6. Factors That Influence the Division of the Demands for Emergency Medical Services Among Alternative Sources and Between the Public and Private Sectors.

Analyses, by means of contingency tables and zero-one regression models, were undertaken in an attempt to identify what factors might be related to the decision to use one, from among a number of alternative sources, for emergency transportation and for emergency treatment. The factors examined included attributes of the victim, such as demographics, experience, and perceptions; the nature and severity of the injury or illness; situation variables, such as the time and location of the incident; and characteristics of the alternative sources themselves.

For the most part, these analyses were neither of forceful statistical significance nor particularly informative. The most successful was the examination of the decision to transport the victim by private ambulance rather than call for an ambulance. The coefficient of determination with five variables was only 0.23. Two variables were directly related to the use of a private automobile. These were that the medical emergency was the result of a traumatic injury and the belief that the household's health insurance coverage was adequate for medical emergencies. Three variables were inversely related to the use of a private automobile. These were the age of the victim, trauma that was the result of a traffic accident, and the number of times in the past four years that members of the household had used an ambulance for what was perceived to have not been an emergency. Thus, transport by private automobile was most common when the victim was young, had suffered a nontraffic injury and was a member of a household that had adequate health insurance and did not make nonemergency use of ambulances. The latter two factors suggest a degree of affluency that would be associated with the ownership of automobiles by the household and neighbors.

Parts a. and c. of Table VI-E-18 show that most of the incidents, which were reported by the respondents, had occurred in or near the home and were the result of falls. In fact, there were more falls reported than total traffic accidents. The victims of the majority of these falls were children. As might be expected if the mother had access to a private automobile, it was used to drive the injured child to an emergency room, clinic or physician's office. This kind of incident tended to dominate all others in the analysis of the use of private automobiles to transport the victim of a medical emergency.

Knowledge as to the factors, which influence the victim of a medical emergency or lay persons acting on his or her behalf to choose either the public or the private sector as the one from which to seek assistance, is required for the evaluation of alternative policies and system configurations. Such knowledge is needed to predict whether or not a specific policy or system configuration will shift demand between the public and private suppliers and, if so, in which direction and in what magnitude. It was hypothesized that the division of demand between the public and private sectors would be related to the same kinds of factors, as those that were examined above in connection with the decision to use one from among a number of alternative sources for a given kind of service without regard to whether it was classified as public or private.

The question of what factors influence or are related to the decision to utilize the public or private sector was examined by means of contingency tables and zero-one regression analyses. The results were largely inconclusive. The levels of statistical significance for the contingency tables and the coefficients of determination for the regression analyses indicated that the independent variables, which were being examined, explained very little of the division of demands between the two sectors.

The previously described misconceptions of the respondents, with regard to other properties of emergency medical services, provided grounds for having reservations about the capabilities of the respondents to properly classify providers in terms of their being public or private. Complexities such as a private ambulance company, which is under contract to a city or the county and dispatched at the initiation of a public safety agency, provide the bases for further confusion in the mind of the lay user of such a service. If a lay person calls the appropriate public safety agency requesting an ambulance and one operated by a private company that is under contract to provide service arrives, it most properly would be classified as public. If the lay person had called the private company directly and the same ambulance arrived, it most properly would be classified as private.

VII. DEMONSTRATION STUDIES BASED ON SELECTED MODIFICATIONS

A. MOBILE INTENSIVE CARE UNITS

As discussed in Section VI-D, there are only three design characteristics of emergency medical systems that affect the outcome of serious medical emergencies. These are: (1) the elapsed time between the occurrence of the injury or the onset of the illness and care or treatment; (2) the kind of care or treatment that is rendered; and (3) the quality with which the particular kind of care or treatment is rendered. Ideally, what is needed is the capability to bring appropriately trained personnel, equipment and supplies to the severely injured or ill victim in time to provide life sustaining care at the site of the incident and during transportation to the hospital.

In urban areas, it was common before World War II, for ambulances to be based at hospitals and to have physicians and surgeons in training as members of the crew. This permitted the then state-of-the-art of medical technology to be delivered to the site of the emergency. With the advent of World War II, the shortage of personnel led to the removal of the resident or intern from serving on urban ambulances and the ambulance was reduced to little more than a vehicle for transporting the victim.

In January 1966, Dr. J. F. Pantridge organized a mobile coronary care unit of physicians and medical attendants in Belfast, Northern Ireland.[1] This unit exported the medical practices developed in coronary care units to the site of coronary emergencies. The first mobile coronary care unit in the United States was started in New York City by

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[1] Pantridge, J.F. and J.S. Geddes, "A Mobile Intensive Care Unit in the Management of Myocardial Infarction," Lancet, 2:7510, August 1967, pp. 271-273.

Dr. W. J. Grace.[1] This unit was manned by an attending physician, resident physician, ECG technician, student-nurse, driver and driver's assistant. Since that time, a number of mobile coronary care units have been established in other cities. Some of these units are very expensive prototypes that have been designed specially for the purpose; others are ambulances that have been equipped with portable electrocardiographic and defibrillation equipment and with drugs and related medical supplies to treat heart attacks.

Whether a mobile coronary care unit utilizes a specialized vehicle or an ordinary ambulance, however, the concept of a special purpose unit that responds only to suspected heart attacks and is manned by physicians and/or coronary care nurses raises two important questions. The first is the appropriateness of a special purpose unit when there are many kinds of life threatening emergencies other than heart attacks. The second is the appropriateness of manning such vehicles with physicians and/or nurses when both are in short supply.

A special purpose unit creates two problems. First, the incident rate of heart attacks within a reasonable operating range of a mobile coronary care unit typically is not high enough to keep the unit utilized at a cost-effective level. The service area of such a unit can be extended to increase the rate of calls for suspected heart attacks. This can be done only at the cost of lengthening the response time to the scene. The second problem is that of identifying suspected heart attacks from among all other medical emergencies. Typically, neither the victim nor other persons at the scene are qualified to make a differential diagnosis. Thus, the unit is not called at times when it would be appropriate and it is forced to respond to calls for which it is inappropriate.

The use of physicians and/or nurses on emergency medical vehicle does not appear to be warranted. The survey of ambulance attendants

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[1] Grace, W.J. and J.A. Chadbonan, "The Mobile Coronary Care Unit," <u>Diseases of the Chest</u>, 55:6, June 1969, pp. 452-455.

performance that is described in Section VI-A indicated that the proportion of life threatening situations that would benefit from services of a physician is small. Further, the kinds of resuscitative and life supporting care needed in these critical cases largely can be performed by trained technicians. The military experience with paramedic personnel supports this view. Also in addition to being in short supply, most nurses are women. This creates additional problems because of environments to which emergency vehicles respond and the necessity for moving heavy patients, etc.

An attractive alternative to the special purpose vehicle that responds only to suspected heart attacks and is manned by physicians and/or nurses is a general purpose mobile intensive care vehicle that is manned by highly trained emergency medical technicians. Such a unit requires broadly trained technicians, specialized drugs and equipment and legislative sanction for the technicians to perform kinds of care not normally permitted to persons who are not licensed physicians or nurses. In 1967, Dr. E. L. Nagel of Miami, Florida began the evolution of a system of advanced mobile care for all kinds of medical emergencies utilizing fire department rescue vehicles and personnel.[1] The demonstrations of mobile intensive care units that were initiated in cooperation with Los Angeles County, and later with the City of Los Angeles, followed the philosophy of the Miami project, in that they were built upon existing fire department services and personnel and were to respond to all kinds of medical emergencies.

1. Los Angeles County Fire Department Rescue Squads

Emergency ambulance services are provided by the County of Los Angeles through its Emergency Aid Plan (EAP). Under EAP, the County presently negotiates contracts with 26 private ambulance firms. These

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[1] Nagel, E.L., Telemetry and Physician/Rescue Personnel Communication, National Highway Traffic Safety Administration, U.S. Department of Transportation, Doc. No. DOT HS-800 602, Washington, D.C., September 1971.

ambulance firms agree to provide 24 hour-a-day emergency coverage for specified areas and must meet the County's requirements in terms of equipment and personnel. They provide a total of approximately 140 ambulances at more than 60 locations throughout the County. The areas covered in this manner consist of the unincorporated portions of the County and 69 cities that subscribe to the County's EAP program. Dispatching of the contract ambulances can be authorized by a Los Angeles County Deputy Sheriff, a California Highway Patrolman or a police officer of a city that subscribes to the EAP. Fifteen cities in the County provide their own ambulance services. These cities are divided about evenly between those in which the service is provided by the city's own fire department and those in which the service is provided by a private ambulance company under contract to the city.

The Los Angeles County Fire Department has 27 rescue squad vehicles that are manned by firemen who have had 25 hours of training in the care and handling of the ill and injured. These rescue squads have a dual responsibility. They support fire fighting and provide rescue services. Historically, their rescue role primarily has been one of rescue, extrication and resuscitation. Most medical emergencies are responded to by the private ambulance companies under contract to the County. When a rescue squad is dispatched, it must call for a contract ambulance if transportation to a hospital is needed for any victim(s).

In early 1969, representatives of Harbor General Hospital, which is a Los Angeles County Hospital that is affiliated with the University of California, Los Angeles as a teaching hospital, the Los Angeles County Fire Department and the EMS Project began to explore the feasibility of a pilot program to train rescue squad firemen as mobile intensive care paramedics. The concept that evolved was one of training experienced rescue firemen to, roughly the equivalent of, what the Division of Medical Sciences, National Academy of Sciences - National Research Council (NAS-NRC) described as the Emergency Medical Technician Paramedic (EMT-2). Although no curriculum had been established for such personnel, NAS-NRC proposed that:

> They should be qualified to carry out, independently, or with the guidance and supervision provided by physicians through communication, such procedures as the giving of medication by hypodermic or intravenous routes, transfusion, decompression of tension pneumothorax, tracheal intubation, tracheotomy, defibrillation, mechanical external cardiac compression and control of hemorrhage.[1]

A proposal was developed for a pilot Mobile Intensive Care Unit (MICU) project to be conducted at Harbor General Hospital. It recommended that:

- Six County firemen, who were experienced as members of rescue squads, be trained as MICU paramedics.
- Upon completion of training, the team be stationed, with an appropriately equipped vehicle, on the hospital grounds to provide 24 hour coverage seven days per week for a six month period.
- A registered nurse be sent with the crew to perform defibrillation and to administer medications and intravenous solutions while modification was sought of the existing state statutes to permit the paramedics to perform such functions.
- Patients continue to be transported to the hospital by a contract ambulance.
- When necessary to continue advanced care, the nurse and a paramedic would accompany the patient in the ambulance to the hospital.

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[1] Division of Medical Sciences, National Academy of Sciences, National Research Council, Training of Ambulance Personnel and Other Responsible for Emergency Care of the Sick and Injured at the Scene and During Transport, Washington, D.C., March 1969.

With the support and sponsorship of County Supervisor Kenneth Hahn, within whose district Harbor General Hospital is located, the proposal was approved by the County.

A program for training mobile intensive care paramedics was designed by the staff of Harbor General Hospital under the leadership of Dr. Michael Criley. This prototype program called for 160 hours of instruction and clinical experience followed by several months of field internship accompanied by a nurse from the cardiac care unit. The total instructional and clinical time was divided evenly between advanced cardiac care and other forms of emergency care. The Project supported the development of the training program by supplying a resuscianne training dummy for practicing cardiopulmonary resuscitation, audio visual training equipment and packaged emergency medicine teaching program materials.

Six firemen, each with over two years of experience with a rescue squad, were selected for the initial class from among a number of rescue squad members volunteering for the program. They began their training on September 16, 1969. The first phase was didactic and clinical in nature. It was conducted on a two-day-a-week schedule. Typically, half of each day was devoted to lectures. There were homework assignments and a quiz each training day. The other half of the day consisted of a clinical experience in the emergency room, coronary care unit, cast room, inhalation theraphy unit, etc. Part of the clinical experience included working with an I.V. nurse and answering "Code Blue" (in-hospital emergencies) with the hospital's cardiac arrest team. This phase of the training program culminated in late November, 1969, when all of the trainees satisfactorily passed a comprehensive final examination.

On December 8, 1969, the team began operations as a mobile intensive unit stationed at Harbor General Hospital as part of County Fire Station 59, which is located on the hospital grounds. Figure VII-A-1 shows the location of the hospital. The unit was supplied with a station wagon, which was equipped with an electrocardiographic telemetry

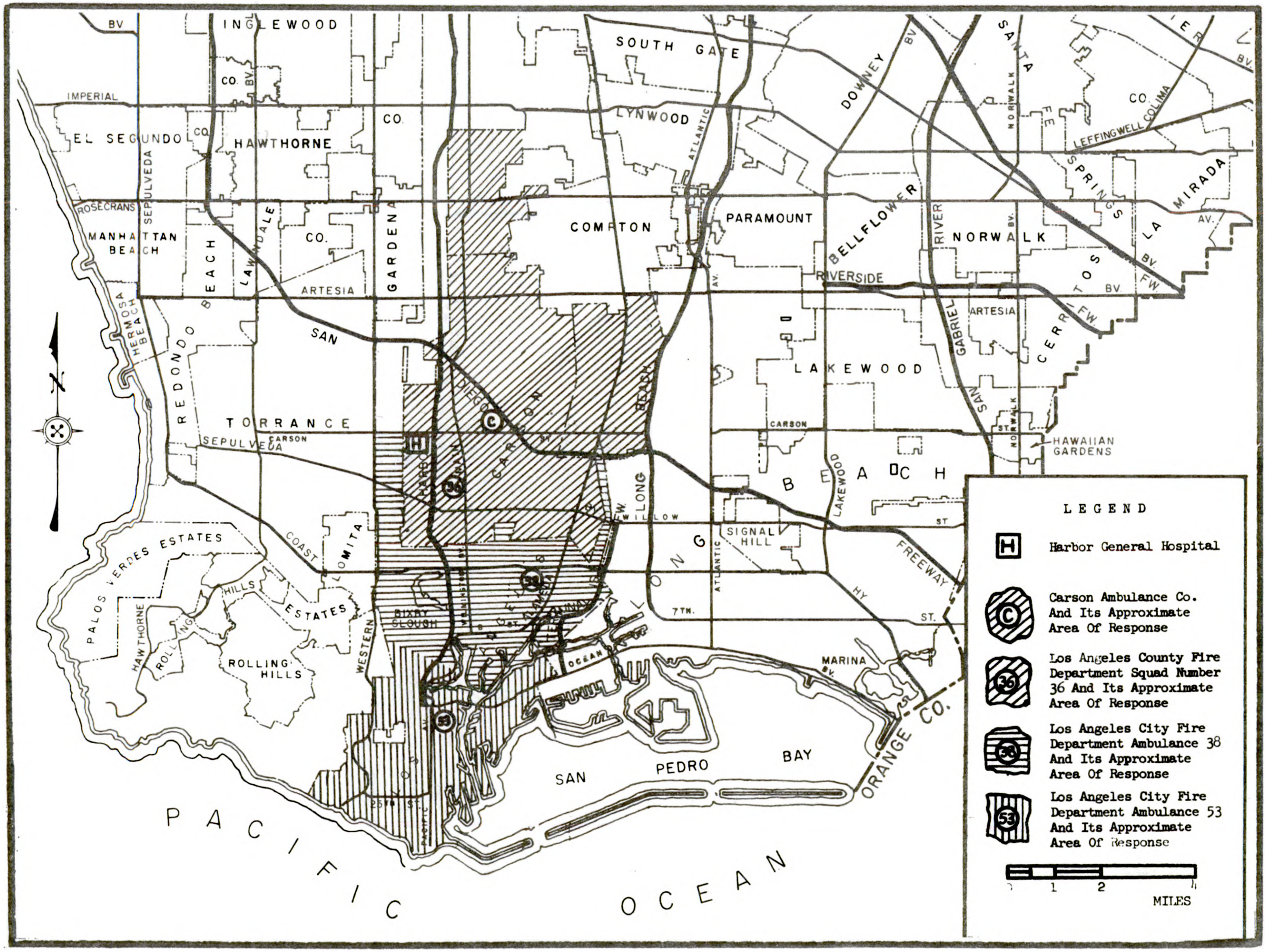

FIGURE VII-A-1. DEMONSTRATION AREA FOR THE STUDY OF MOBILE INTENSIVE CARE UNITS MANNED BY PARAMEDICS and voice communication system, portable oscilloscope, portable defibrillator, medication and related supplies. The Project supported the equipping of the vehicle by supplying a resuscitator and a suction unit. The dispatching procedure was modified so that the Sheriff's substation requested the Fire Department to dispatch the MICU rather than requesting the contract ambulance company serving the area to send one of its ambulances if there was reason to believe that the victim had suffered:

- myocardial infarction
- pulmonary insufficiency
- pulmonary edema
- asphyxia
- serious traumatic injuries

A second group of six Los Angeles County and six Los Angeles City rescue firemen began training in December 1969. Improvements were made in the training program for the second group based upon the actual field experiences of the first group when they began operating as an MICU team. The instruction and clinical experiences were related more closely to emergency medical care at the scene and in-transit. The first MICU was experiencing as many life threatening injuries as illnesses. As a consequence, the course content was expanded to include more advanced training in the care and handling of victims of traumatic injuries. The MICU paramedics were experiencing some difficulties with medical terminology when communicating by radio from the field with physicians at the hospital. For this reason, a section on medical terminology also was added to the second offering of the course.

When the second group of six County firemen completed their didactic and clinical training in March 30, 1970, the original six paramedics were shifted from the hospital based MICU to County Fire Station 36. Figure VII-A-1 shows the location of this fire station. They became the crew of a standard rescue squad truck which was equipped as a MICU vehicle. The second group of six County firemen were assigned to the hospital based station wagon MICU for their field internship. The two units were dispatched simultaneously through August 1970. The hospital based MICU training vehicle operated with a registered nurse who, in the absence of legislation permitting paramedics to function independently, provided the necessary on-scene and in-transit supervision of the care of the victim. Legislation concerning MICU paramedical training and practice was approved by the California Legislature and signed by the Governor on July 14, 1970. The firemen trained in the first and second training programs were certified under the provisions of this legislation as intensive care paramedics on August 14, 1970. Effective September 1, Rescue Squad 36 began functioning as a two man MICU. In addition to a portable telemetry and communication system, oscilloscope and defibrillator, the unit was equipped with medications, intravenous solutions and supplies. An inventory of these items is given in Appendix H. For purposes of on-going training, the hospital based MICU vehicle continued to be designated as unit 59. It was assigned a service area that overlapped that of Rescue Squad 36 and duplicated that of Rescue Squad 6, which was a regular unit not manned by paramedics.

The experience of the original MICU during its training and operational period with a registered nurse, indicated that more than the two paramedics are required for cases involving cardiopulmonary arrest. Through August 1970, the dual response of both Rescue Squad 36 and the hospital based training unit, which had aboard a registered nurse, assured that sufficient personnel were available in such cases. To assist the two man MICU paramedic teams with such cases after September 1970, additional measures were instituted. The ambulance personnel of the private ambulance company under contract to service most of the area within which Rescue Squad 36 responded, were given special training in assisting the paramedic team. In addition, the firemen of all engine companies that were located in the area served by Rescue Squad 36 were given similar training. When a call involved a possible cardiopulmonary arrest, an engine unit from the nearest fire station was dispatched in addition to Rescue Squad 36. If the engine unit arrived at the scene before Rescue Squad 36, the crew initiated whatever care they judged to be appropriate and within their capability while awaiting the arrival of the MICU. If the two MICU paramedics required help to initiate and perform the necessary on-scene care, the firemen from the engine unit provided this assistance. They applied ECG leads to the victim, cleared space around the victim, supplied adequate lighting, held I.V. bottles, etc. If required, the ambulance attendant provided similar assistance to the paramedic who accompanied the victim in the ambulance during his transport to the hospital.

2. City of Los Angeles Fire Department Rescue Squad

The City of Los Angeles is one of the 15 cities in the County of Los Angeles that provides its own ambulance service. With the exception of two areas in which private ambulance companies are under contract to provide ambulance service, the City Fire Department provides the ambulance services. Its fleet of 27 ambulances presently is manned by both firemen and non-firemen. The crewmen, who are not firemen, are the result of a decision, in early 1970, to transfer responsibility for ambulance service in the central section of the city from Central Receiving Hospital to the City Fire Department. Previously, Central Receiving Hospital had operated a fleet of 12 ambulances. These ambulances had been located at Central Receiving Hospital, Hollywood Receiving Hospital, Lincoln Heights Hospital and a number of city police stations. They had been dispatched through a communication center located at Central Receiving Hospital. When these units were transferred to the Fire Department, the ambulances were relocated at city fire stations (See Section IV-A-1.)

The Harbor City, Wilmington, San Pedro and Terminal Island sections of the City of Los Angeles are served by two City Fire Department ambulances, namely Rescue Ambulances 38 (RA 38) and 53 (RA 53). The location of these units are shown in Figure VII-A-1. These units mainly transport victims to Harbor General Hospital.

Shortly after the County's pilot MICU project was begun, the Project began discussions with the City of Los Angeles Fire Department to explore the feasibility of a pilot program to train the crew of one of its ambulance units in the Harbor General Hospital area as mobile intensive care paramedics. This would provide a different kind of MICU than the County's, in that it directly would transport victims to the hospital. An agreement was reached and half of the second group of MICU paramedics trained at Harbor General Hospital were six Los Angeles City Firemen.

Together with the second group of the six County firemen, the City firemen completed the didactic and clinical portion of the training program on March 30, 1970. They began their field internship in April 1970, by serving as added members of the County's MICU team based at Harbor General Hospital. Because it was not possible to have the City firemen relieved of their regular duties and be assigned full time to the MICU, their internship was extended over a longer period of time than that of the County firemen. The Project arranged with Harbor General Hospital to have a registered nurse, from among those riding with the hospital based MICU training unit, be stationed with the City paramedics four days a week (Thursday through Sunday) during the months of September and October 1970. These nurses were able to conduct refresher training between ambulance runs and to supervise the administration of medication and intravenous solutions and performance of defibrillation at the scene and in-transit to the hospital.

The six City firemen were fully certified as MICU paramedics at the end of October 1970. On November 1, 1970, they began operation as an ambulance MICU with two paramedics as the crewmen. Their vehicle was the regular spacious van type ambulance that the City Fire Department uses. The Project equipped the ambulance with the following paramedical equipment:

- portable telemetry and communication system
- portable oscilloscope
- portable defibrillator
- suction unit

The City supplied essentially the same medication and related supplies as were being used by the County's MICU. An inventory of these medications and supplies is given in Appendix H. The unit nominally continued to serve its prior service area. In actual practice, however, it was dispatched in Rescue Ambulance 38's service area in cases suspected to be very serious when the added time to the scene would be short. A measure of this modification in dispatching is provided by an examination of the proportion of cardiac calls to which each of the units was dispatched. In the three months prior to its becoming a MICU, 6.4% of all of RA 53's calls were for cardiovascular disease. During this same period, 6.5% of RA 38's calls were for this category of illness. During the first six months that RA 53 functioned as a MICU, the proportions of all calls that were for cardiovascular disease increased to 14.2% for RA 53, the MICU, and dropped to 3.9% for RA 38, the regular ambulance.

The City Fire Department, as had the County Fire Department, found that a two man paramedic crew needs additional trained personnel for cases involving cardiopulmonary arrest. Therefore, for a call within RA 53's response area, which involved a cardiopulmonary arrest, a procedure was adopted that was similar to that employed by the County. An engine unit from the nearest fire station was dispatched in addition to the MICU ambulance. Within the City Fire Department, there are no special rescue squads. Every engine unit functions in the dual capacity of its normal fire fighting role and as a fire rescue squad. All engine units are equipped with a resuscitator and other rescue equipment. Every firemen is trained in advanced first aid and cardiopulmonary resuscitation. In addition, the personnel of engine companies within RA 53's service area were trained to work with the MICU paramedics. If the engine unit arrived at the scene before RA 53, they initiated whatever care they judged appropriate and within their capability while awaiting the arrival of the MICU. If the two MICU paramedics required help to initiate and perform the necessary on-scene care, the firemen from the engine unit provided this assistance. When the paramedics were ready to transport a victim who required continuing care during transport to the hospital, one man from the engine unit served as the driver of the ambulance so that both paramedics were free to attend the victim.

3. <u>Legislation Regarding Mobile Intensive Care Paramedics</u>

From the inception of the pilot program, it was recognized by all parties that the California statutes would have to be modified to permit the paramedics to provide kinds of care that heretofore could be performed only by physicians or registered nurses. In January 1970, the Los Angeles County Board of Supervisors adopted a resolution urging the California Legislature to amend appropriate sections of the law to permit specially trained personnel to perform specific procedures. A bill was introduced to establish a pilot program to use mobile intensive care paramedics to render emergency medical care. This bill, the Wedworth-Townsend Paramedic Act, was approved by the California Legislature and signed by the Governor on July 14, 1970. This legislation is contained in Appendix D. It permits mobile intensive care paramedics, who have been trained in a certified training program, to do the following at the scene of an emergency, during transport to a hospital and in the hospital emergency department until responsibility for the victim is assumed by the regular hospital staff:

a. Render rescue, first-aid and resuscitation services
b. Perform cardiopulmonary resuscitation and defibrillation of pulseless, non-breathing victims
c. When in direct communication with and upon order of a physician or certified mobile intensive nurse:
   - administer intravenous saline or glucose solution
   - perform gastric suction by intubation
   - administer parenteral injections of any of the following classes of drugs:
      - antiarrhythmic agents
      - vagolytic agents
      - analgesic agents
      - aklakinizing agents
      - vasopressor agents

The broadening of this legislation continues to remain a problem. On the basis of data gathered from the pilot project, physicians and surgeons at Harbor General Hospital felt that changes should be made in the legislation. A meeting was held by the Committee for the Fire Rescue Paramedic Program at Harbor General Hospital on April 1, 1971. Based on a review of the experiences gained over a 15-month period, the physicians and surgeons attending indicated that the following additional drugs and procedures were necessary to enable MICU paramedics to render proper medical care:

- administration of parenteral injections of any of the following classes of drugs:
  - agents antagonizing the action of opiates
  - anticonvulsant agents
  - sedatives
  - diuretic agents
  - standard intravenous solutions for volume expansion
- administer an intracardiac injection of 1:10,000 epinephrine when there is no electrocardiographic evidence of a heart beat
- perform endotracheal intubation
- perform cutaneous incision for venipuncture
- remove blood for phlebotomy or blood chemical analysis
- institute rotating tourniquets

These measures are similar, but not identical, to those advocated by the National Academy of Sciences, National Research Council (NAS-NRC).[1] In contrast to the NAS-NRC recommendation, the physicians and surgeons at Harbor General Hospital did not include in their proposed legislation provisions for the paramedics to give transfusions,

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[1] Training of Ambulance Personnel, Guidelines and Recommendations of the Committee on Emergency Medical Services, National Academy of Sciences, National Research Council, March 1968, p. 18.

decompression of tension pneumothorax, tracheotomy, or mechanical external cardiac compression. Transfusions would require the refrigeration of blood, which presently is impossible on the MICU due to lack of refrigeration. The need for decompression of a tension pneumothorax was not encountered once in the first 15-months of operations. Instances of the need for a tracheotomy were so few as to be outweighed in the minds of the physicians and surgeons by the dangers inherent in the procedure. Mechanical external cardiac compression was regarded as inferior to manual massage as long as engine company firemen are dispatched to assist the paramedics when cardiopulmonary arrest is suspected. The mechanical units require time to properly adjust the pressure to be effective and to minimize the danger of physical injury to the victim. If, however, the two crewmen of the emergency medical vehicle did not have the assistance of engine unit crewmen, a mechanical external cardiac compression unit would be very useful. It would free the crewmen to perform other kinds of care. In summary, the physicians and surgeons proposed adding only those drugs and medical procedures that were warranted by the actual field experiences of the MICUs operating in conjunction with Harbor General Hospital.

During the internships of the 18 trainees, the nurses who accompanied the paramedics had utilized a number of the drugs suggested above to treat victims. For example, a number of cases of pulmonary edema failed to improve after oxygen therapy and the application of tourniquets. The conditions of these victims were improved markedly by the infusion on-scene of furosemide, which is a potent diuretic agent. Victims with seizures or who were combative were managed effectively with anticonvulsant agents and sedatives. Despite the otherwise successful resuscitation of cardio-pulmonary arrests, there was persistent anoxia with the associated risk of permanent damage to the brain. These cases of severe anoxia would have been alleviated by endotracheal intubation. Some difficulty has been experienced in successfully starting I.V.'s. Failures generally are due to collapsed veins. In this event, a cutaneous incision can be made to accomplish the venipuncture. In critical cases, in which whole blood transfusion and/or surgery are likely, a substantial amount of time may be saved by having the paramedics remove a sample of blood during the transport of the victim to the hospital so that crossmatching or other blood chemical analyses can be begun immediately when the MICU arrives at the hospital.

In June 1971, the California Legislature amended the Wedworth-Townsend Paramedic Act. The amendment requires each county conducting a pilot program, under the provisions of the Act, to submit a report to the Legislature and to the State Department of Public Health not later than 30 days from the first calendar day of the Legislature's 1974 regular session. The report is to evaluate the competency and effectiveness of performance of paramedics in their duties and may include recommendations relating to extensions of or modifications to the paramedic program. It, therefore, can be anticipated that there will be no additions to the procedures that paramedics are authorized to perform before the end of 1974.

At the present time, there is no state wide curriculum nor are there state wide examining boards or certifying agencies for mobile intensive care paramedics as there are for physicians, nurses and therapists. The Wedworth-Townsend Paramedic Act authorizes the board of supervisors of each county to designate the county health officer or the county director of hospitals as the officer empowered to certify a training program for mobile intensive care paramedics. In the County of Los Angeles, the Board of Supervisors has designated the Director of Hospitals as the certifying officer.

4. The Harbor General Hospital Training Program for Mobile Intensive Care Paramedics

The Los Angeles County training program for mobile intensive care paramedics was begun in 1969 as a pilot program. It is now well established as the Paramedic Training Branch of the Los Angeles County Department of Hospitals. The program has a permanent director and a core faculty based at the Paramedic Training Facility at Harbor General Hospital.

The training program has been expanded in two dimensions since its inception. The first dimension is in the nature of the training itself. The two pilot groups of 18 firemen, 12 from the County and six from the City Fire Departments, received a total of 180 hours of classroom, laboratory and direct clinical instruction. This period of instruction was followed by a field internship on a hospital-based MICU vehicle accompanied by a cardiac care unit nurse. Because of the time that elapsed before the Wedworth-Townsend Paramedic Act was enacted into law, the field internships for the pilot groups were six to nine months in duration.

Subsequent groups of trainees have received a total of over 300 hours of classroom and laboratory instruction and of direct clinical experience which takes two months. The composition of the didactic and clinical phase of the training of the sixth group of trainees, who began their training on August 16, 1971 and completed their field internship on February 22, 1972, is presented in Appendix C. The didactic and clinical phase totalled 374 hours. This time was divided as follows:

Didactic	187.5 hours
Discussion, quizzes and homework review	38.5 hours
Clinical experience	136 hours
Examinations	12 hours

Following the passing of a written examination of the didactic and clinical phase, a three month internship is served. This consists of a combination of clinical experience in the hospital and of answering emergency calls on the hospital-based MICU vehicle accompanied by and under the supervision of certified MICU paramedic. Trainees who satisfactorily complete the training program are certified, under the provision of the Wedworth-Townsend Paramedic Act, by the Los Angeles County Director of Hospitals.

The second dimension, in which the program has expanded, is in terms of the geographical areas that are represented. Beginning with the third group of trainees, which began training in August 1970, the graduates of the program have largely become crewmen of MICU vehicles that operate with a base hospital other than Harbor General. They have been a mixture of Los Angeles County Firemen from rescue squads in other areas of the County, firemen from the cities of Inglewood, Redondo Beach, Beverly Hills, and civilians from a private ambulance company and from the Pasadena City Emergency Service. The physicians at Harbor General Hospital who were responsible for the initiation and development of the paramedic training program established a policy that such trainees should be instructed by both the core faculty, that is based at Harbor General Hospital, and by faculty from the hospital with which the team will work. From their personal experiences, these physicians believed that much of the success of the pilot program was due to the fact that the paramedics had been trained at the hospital to which, as certified paramedics, they subsequently brought most of their patients. The inclusion of faculty, from other hospitals, permits the building of comparable levels of rapport between the paramedics and the staffs of these hospitals. The staff of the hospital becomes familiar with both the capabilities and limitation of the paramedics. This knowledge enables the hospital staff to utilize the information from and give instructions to the paramedics via radio communication while the latter are rendering care on-scene and enroute to the hospital. The mutual understanding gained during the training period significantly contributes to smoothly functioning teamwork between the hospital and the paramedics when the MICU becomes operational.

A total of 474 mobile intensive care paramedics have been trained and certified under the auspices of the paramedic training branch of the Los Angeles County Department of Health Services. At present, there are 56 mobile intensive care units, which are manned by teams of two paramedics each, in operation within the county. Thirty-two of these are operated by fourteen cities and 24 by the county itself. The county's capacity for producing new paramedics recently has been increased to 230 per year by the initiation of new training programs at Pasadena City College and Queen of Angels Hospital.

5. <u>Bases for the Analyses and Evaluation of Mobile Intensive Care Units</u>

The operational characteristics and effectiveness of the two kinds of mobile intensive care units manned by paramedics were studied in relation to two ambulance organizations which transport victims of medical emergenices to Harbor General Hospital. These ambulance organizations were the private ambulance company, which is under contract to the County to serve roughly the same area as the County's Rescue Squad 36 (MICU), and Los Angeles City Fire Department Rescue Ambulance 38, which services the harbor area of the City of Los Angeles together with Rescue Ambulance 53 (MICU). The decision to limit the comparison to the two MICUs and to ambulances that mainly brought victims to Harbor General Hospital provided a means to control the nature and quality of hospital care as a variable. This decision, however, did introduce a problem. It has been noted that a specific request had been made to the County Sheriff's dispatchers and a predilection was present on the part of the City Fire Department dispatchers to dispatch their respective MICUs to suspected heart cases and certain other categories of serious illnesses or injuries. These changes in dispatching practices caused the proportions of calls, which fell into the various categories of injuries and illnesses and into the categories of severity, namely dead on arrival at scene, threat to life or no threat to life, to be somewhat different for the MICUs and the ambulances.

As noted previously, the two kinds of MICUs differed operationally in that the City Rescue Ambulance transported victims to the hospital while the County's Rescue Squad did not. The procedure for the County's Rescue Squad, in cases involving victims who require in-transit care during their transport to the hospital, was for one of the paramedics with the necessary portable equipment and supplies to ride in the contract ambulance to the hospital with the victim(s). Such a run was categorized as a MICU case because it was felt that the essential difference between the MICUs and the ambulances was the ability of the mobile intensive care paramedics to deliver advanced life supporting care. Despite this procedural difference, the data for the two kinds of MICUs were aggregated. Such an aggregation was deemed appropriate because, in serious cases, the on-scene time of the County's Rescue Squad (MICU) was sufficiently long to permit a contract ambulance to be called and to arrive at the scene before the paramedics are ready to have the victim(s) transported to the hospital. Once the paramedic and his equipment and supplies were aboard the contract ambulance, the configuration was roughly comparable to the City's Rescue Ambulance (MICU). For these reasons, it seemed appropriate for most analyses to eliminate from consideration the fact that the County's Rescue Squad (MICU) was dependent upon a private contract ambulance for the transportation of victims.

The data for the analyses and evaluations that follow were gathered in the manner and with the forms described in Section IV-D-3. The data included from the four units were for emergency medical incidents that occurred during the following inclusive periods:

County Rescue Squad 59/36[1] (MICU)	December 1969 - May 1971
Contract Ambulance Company	December 1969 - May 1971
City Rescue Ambulance 38	April 1970 - May 1971
City Rescue Ambulance 53 (MICU)	November 1970 - May 1971

The data encompassed all activities from the onset of symptoms of the illness or the occurrence of injury through 90 days after discharge from the hospital in serious cases. Emergency medical incidents occurring after May 1971 were not tracked in order to make it possible to complete the file for each case 90 days after hospital discharge. A total of 3134 case histories were completed. Of these, 1975 were handled by ambulances and 1379 were handled by MICUs.

6. Analyses of Operating Characteristics of Mobile Intensive Care Units

The operating characteristics of interest in the evaluation of mobile intensive care units are the times for the various activities

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[1]From December 1, 1969 - March 30, 1970, the paramedics manned unit 59, which was based at Harbor General Hospital; after March 30, 1970, they manned unit 36, which was based at County Fire Station 36.

and the kinds of care rendered on-scene and enroute to the hospital.

a. Times for Activities. The temporal profiles of activities from the occurrence of injury or onset of symptoms of illness to the initiation of treatment at the emergency room are presented in Table VII-A-1. For mean times, the cases that were judged by the emergency room physician or surgeon to have involved a significant threat to life have been differentiated from those involving no threat to life. The time distributions of all activities were highly skewed toward long time durations. Thus, while the mean delay between the occurrence of incident and a request for the dispatching of an emergency medical vehicle was between roughly 20 and 25 minutes, the median time, namely the time interval encompassing the shortest half of all such delays, roughly was between 8 and 8-1/2 minutes. The 90th fractile values for notification indicate that, in one case out of ten, the delay was greater than roughly 37 to 39 minutes.

Several aspects of the temporal profiles are worthy of note. The first is the length of the elapsed time from the onset of symptoms of illness or the occurrence of injury until the victim begins to receive treatment in the emergency room. Despite the fact that the study was conducted within suburban and industrial sections of a greater metropolis area, the average victim did not begin to receive hospital care for 70 to 80 minutes. Half of the victims still have not begun to receive treatment at the hospital after roughly 50 minutes have elapsed and 10 percent have not begun to receive it after roughly two hours. By way of comparison, the average victim handled by an ambulance in the Antelope Valley portion of the County of Los Angeles, where data was collected by the Project in connection with the helicopter demonstration, begins to receive treatment in roughly 60 minutes. In the Antelope Valley, the mean travel time to the scene and the mean time to transport the victim to the hospital are longer than the corresponding times for ambulances in the area served by Harbor General Hospital. However, these increases in time are more than offset in the Antelope Valley by the reduction in the delay at the emergency room before treatment is begun

TABLE VII-A-1

TIMES IN MINUTES FOR ACTIVITIES FROM OCCURRENCE OF INJURY OR ONSET OF ILLNESS TO INITIATION OF TREATMENT AT EMERGENCY ROOM

MOBILE INTENSIVE CARE UNITS

Activity	Mean Duration		Cumulative Elapsed Time: Mean		Cumulative Elapsed Time: All Cases	
	No Life Threat	Life Threat	No Life Threat	Life Threat	Median	90th Fractile
1. Notification	24.3	22.3	24.3	22.3	8.1	37.2
2. Dispatching	0.4	0.2	24.7	22.5	8.3	38.0
3. Travel to Scene	4.6	4.9	29.3	27.4	12.1	42.1
4. On Scene	14.6	18.1	43.9	45.5	29.3	65.8
5. Transport to Hospital	9.4	9.7	53.3	55.2	38.8	76.1
6. Delay at Emergency Room	24.9	16.6	78.2	71.8	52.9	115.1

AMBULANCES

Activity	Mean Duration		Cumulative Elapsed Time: Mean		Cumulative Elapsed Time: All Cases	
	No Life Threat	Life Threat	No Life Threat	Life Threat	Median	90th Fractile
1. Notification	20.4	24.9	20.4	24.9	8.4	39.3
2. Dispatching	0.3	0.3	20.7	25.2	8.7	39.8
3. Travel to Scene	4.1	4.0	24.8	29.2	12.2	44.7
4. On Scene	6.4	6.4	31.2	35.6	18.6	52.4
5. Transport to Hospital	8.1	8.6	39.3	44.2	27.1	61.4
6. Delay at Emergency Room	30.5	34.6	69.8	78.8	48.5	123.8

by a physician or surgeon. Harbor General Hospital is a large metropolitan hospital whose Emergency Department handles very large numbers of patients per day. By comparison, the four Antelope Valley hospitals cooperating in our study were small and their emergency departments handle far fewer patients per day.

The second aspect of significance is the substantially greater amount of time spent on-scene by the mobile intensive paramedics than by the ambulance attendants. This certainly was expected. The MICU notifies the hospital by radio of each dispatch and by the time the MICU reaches the scene of the incident, a physician is standing by at the hospital radio waiting for a report from the MICU. Once at the scene, the intensive care paramedics evaluate the nature and severity of injury or illness and communicate this information by radio to the physician at the hospital. If the victim's condition is serious, the paramedics report vital signs and symptoms and any history they can obtain. Depending upon the kind of illness or injury, the paramedics may attach electrodes and transmit an electrocardiogram to the hospital. The physician who communicates with the paramedics and receives the telemetered electrocardiogram has an appreciation of the capabilities and limitations of the paramedics. Although the physician retains the final authority as to the care of the victim, he relies heavily upon the paramedics. Because they are actually with the victim, the paramedics can make physical examinations to substantiate preliminary diagnoses. A common example arises when an electrocardiogram is transmitted to the hospital. Artifacts can be introduced into the ECG pattern by the transmission process itself. Some of these artifacts alter the ECG wave form in a manner that mimics certain kinds of cardiac arrhythmias. The paramedics can confirm or deny the existence of such arrhythmias from their observations of the same ECG on their own oscilloscope. The paramedics also discuss and make recommendations as to the nature of care to be given on-scene. When the administration of drugs, intravenous solutions or cardioversion are judged to be applicable and important in the management of the illness or injury, an attempt is made to stabilize the seriously ill or injured victim at the scene before transporting him or her to the hospital. In contrast, the procedures that the ambulance attendants are trained and authorized to perform are more limited. In the absence of being able to initiate advanced life supportive care at the scene, the ambulance attendants rush seriously ill or injured victims to the hospital where such care can be initiated in the emergency room.

One consequence of the MICUs spending more time at the scene than ambulances was that the service time,[1] namely the time interval from the beginning of the travel of the emergency medical vehicle to the scene through and including the transfer of the victim into the care of the staff of the emergency room was longer for the MICUs than for the ambulances. The mean service times, averaged across all cases, were 29.7 and 18.9 minutes respectively for the MICUs and the ambulances. The mean service time is an important determinant of the mean response time,[1] namely the mean time interval from the dispatch of the emergency medical vehicle to its arrival at the scene of the emergency. Other factors held constant, the greater the mean service time is, the greater will be the mean response time. The connection between the two time intervals is provided by the "wait for available emergency medical vehicle" component of the response time. The greater the mean service time is, the more likely it is that a given emergency medical vehicle or set of emergency medical vehicles will be busy, namely occupied in one of the components of service time, when a call for service is received. If the emergency medical vehicle or vehicles serving an area are busy when a call for service is received, there will be delay in the response time in the form of "wait for available emergency medical vehicle." From this it follows that the number of emergency medical vehicles, which are required to provide a given mean response time, increases with the mean service time. Therefore, a larger fleet of MICUs will be required, because of their greater mean service time, than of ambulances to provide a given mean response time in the same service area.

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[1] see Figure IV-A-1.

The third aspect is that the mean time to travel to the scene is roughly one-half the mean transport time to the hospital. This difference resulted from three factors. First, the mode of travel to the scene is always "red light and siren" while the mode of transportation to the hospital varies from "no warning device," a condition under which normal traffic laws are followed, to "red light and siren." Second, distances to the scenes of emergencies are shorter on-the-average than distances from the scene to the hospital. Finally, the time for transport to the hospital includes the physical transfer of the patient into the care of the hospital staff.

The final aspect worthy of note is the delay between the time at which the patient is delivered to the hospital and the time at which treatment actually is begun by a physician or surgeon. This delay at the emergency room is significantly shorter for victims handled by the MICUs than for those handled by the ambulances. For victims, with a life threatening condition, the mean delay of 16.6 minutes for victims handled by the mobile intensive paramedics is approximately one-half the mean delay of 34.6 minutes experienced by victims handled by ambulance attendants. The difference in the amount of delay at the emergency room is the result of the hospital having been alerted by radio as to the nature and severity of the illness or injury for victims handled by a MICU. As a consequence, the emergency room is already familiar with the case and prepared to expedite the handling of seriously ill or injured victims. Furthermore, in cases of victims of heart attacks, the paramedics are authorized to bypass the emergency room and take the victim directly to the coronary care unit. In contrast, victims brought to the emergency room by an ambulance must first be evaluated by the triage nurse, who may or may not be free when the victim arrives. Next, the victim waits until a physician or surgeon is free to see him. At times, all available emergency room personnel are busy with other seriously ill or injured victims. In such instances, the risk to the victim of a delay may be minimized by the care already given by the paramedics. For example, a newly arrived victim handled by a MICU, who otherwise would be in danger of hemorrhagic shock, already would have had an intravenous route established and would be receiving an appropriate solution to maintain his circulating volume until an emergency room surgeon was free.

The effect of the reduction in the delay at the emergency room, when a victim was handled by a MICU, was to offset the additional time spent by the paramedics to provide care at the scene. On-the-average, treatment by a physician or surgeon of a victim, with a life threatening condition and who was handled by a MICU, was initiated 71.8 minutes after the onset of symptoms of the illness or occurrence of the injury. The comparable mean time to treatment at the emergency room for a victim transported by an ambulance is 78.8 minutes. Thus, the average victim with a life threatening condition who was handled by a MICU not only began to receive advanced care at the scene after 27.4 minutes but he or she began to receive treatment at the emergency room within a slightly shorter cummulative elapsed time than those handled by an ambulance.

b. Kinds of On-Scene and In-Transit Care. The major differences between the kinds of care that could be rendered by the mobile intensive care paramedics and by well trained ambulance attendants were the abilities of the former to administer:

- defibrillation
- intravenous solutions
- specified classes of drugs

In order to determine how frequently these advanced forms of life supportive care were performed by the paramedics and whether or not there were other differences in the patterns of care, an analysis was made of the kinds of care that were rendered by the paramedics and by the ambulance attendants. In addition, an analysis was made of the modes in which victims were transported to the hospital. Three modes of transportation were employed. The first was "no warning device," in which the emergency medical vehicle was driven to the hospital under normal traffic rules. The second was "red light," in which the emergency medical vehicle employed its red light to proceed to the hospital more quickly while observing traffic controls at intersections. The third was "red light and siren" in which the emergency medical vehicle employed all its warning devices and was driven to the hospital as quickly as possible without regard to speed limits and traffic controls at intersections.

The kinds of care and modes of transportation to the hospital were related to the category in injury or illness and the severity or medical outcome. The analyses were restricted to the 15 categories of injury or illness in which there were life threatening cases. Table VII-A-2 through VII-A-16 present the results for the mobile intensive care units and Table VII-A-17 through VII-A-30 present those for the ambulances. The kinds of care given by the mobile intensive care paramedics and by the ambulance attendants were compared for each category of injury or illness that involved life threatening cases. The care given to victims who were dead, namely pulseless and breathless, at the time that the emergency vehicle arrived at the scene was examined separately.

Burns and heat injuries. With the exception of one victim, who was handled by the paramedics and who received I.V. fluids during transport to the hospital, care by both paramedics and ambulance attendants was limited to bandaging.

Electrical injuries. All three victims in this category of injury were handled by the paramedics. The two victims who were alive when the MICU arrived at the scene, were administered I.V. fluids, one at the scene and the other while enroute to the hospital. Both also received oxygen. The victim who eventually died in the hospital received artificial respiration during his transport to the hospital.

Fractures and dislocations. Most of the care given to victims in this category was rendered at the scene by both paramedics and ambulance attendants. The care most frequently rendered was splinting. Paramedics and ambulance attendants splinted 57.1 and 41.1 percent of all victims that they handled respectively. Other kinds of care that are associated typically with traumatic injuries such as control of bleeding, bandaging and handling the

TABLE VII-A-2

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF BURNS

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival at Scene (N=0)	No Threat to Life (N=9)[1]	Threat to Life But Survived[2] (N=))	Died on Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=9)
On-Scene Care									
None or Minor		7(77.8)[4]							7(77.8)
Clear Airway									
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen									
Cardiac Massage									
Control Bleeding									
Bandage		2(22.2)							2(22.2)
Splint									
Backboard									
Defibrillation									
Drug(s) or IV Fluid									
Transportation to Hospital									
No Warning Device		2(22.2)							2(22.2)
Red Light									
Red Light & Siren		7(77.8)							7(77.8)
In-Transit Care									
None or Minor		8(88.9)							8(88.9)
Clear Airway									
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen									
Cardiac Massage									
Control Bleeding									
Bandage									
Defibrillation									
Drug(s) or IV Fluid		1(11.1)							1(11.1)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-3

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF ELECTRICAL INJURIES

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival at Scene (N=1)[1]	No Threat to Life (N=1)	Threat to Life But Survived[2] (N=0)	Died on Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=1)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=3)
On-Scene Care									
None or Minor						1(100.0)			1(33.3)
Clear Airway									
Artificial Respirat.	1(100.0)[4]								1(33.3)
Resuscitator									
Airway Tube	1(100.0)								1(33.3)
Oxygen		1(100.0)							1(33.3)
Cardiac Massage	1(100.0)								1(33.3)
Control Bleeding									
Bandage									
Splint									
Backboard									
Defibrillation	1(100.0)								1(33.3)
Drug(s) or IV Fluid	1(100.0)	1(100.0)							2(66.7)
Transportation to Hospital									
No Warning Device									
Red Light									
Red Light & Siren	1(100.0)	1(100.0)				1(100.0)			3(100.0)
In-Transit Care									
None or Minor	1(100.0)								1(33.3)
Clear Airway									
Artificial Respirat.						1(100.0)			1(33.3)
Resuscitator									
Airway Tube									
Oxygen		1(100.0)							1(33.3)
Cardiac Massage						1(100.0)			1(33.3)
Control Bleeding									
Bandage									
Defibrillation									
Drug(s) or IV Fluid		1(100.0)				1(100.0)			2(66.7)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-4

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF FRACTURES AND DISLOCATIONS

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival at Scene (N=0)[1]	No Threat to Life (N=66)	Threat to Life But Survived[2] (N=2)	Died on Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=69)
On-Scene Care									
None or Minor		16(23.8)[4]							16(22.8)
Clear Airway		4(5.9)	1(50.0)					1(100.0)	5(7.1)
Artificial Respiration									
Resuscitator									
Airway Tube		1(1.4)							1(1.4)
Oxygen		1(1.4)	1(50.0)						2(2.8)
Cardiac Massage									
Control Bleeding		12(17.9)	1(' 50.0)					1(100.0)	13(18.5)
Bandage		20(29.8)	1(50.0)					1(100.0)	22(31.4)
Splint		38(56.7)	1(50.0)					1(100.0)	40(57.1)
Backboard		10(14.9)	2(100.0)						12(17.1)
Defibrillation									
Drug(s) or IV Fluid									
Transportation to Hospital									
No Warning Device		24(36.4)	1(50.0)					1(100.0)	26(37.8)
Red Light		1(1.)							1(1.4)
Red Light & Siren		41(62.)	1(50.0)						42(60.8)
In-Transit Care									
None or Minor		58(87.9)	1(50.0)						59(85.5)
Clear Airway		1(1.4)						1(100.0)	1(1.4)
Artificial Respiration									
Resuscitator		1(1.4)							1(1.4)
Airway Tube									
Oxygen		1(1.4)	1(50.0)						2(2.8)
Cardiac Massage									
Control Bleeding		6(8.9)						1(100.0)	7(10.1)
Bandage		5(7.4)							5(7.1)
Defibrillation									
Drug(s) or IV Fluid									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-5

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF LACERATIONS AND PENETRATING INJURIES

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=2)[1]	No Threat to Life (N=111)	Threat to Life But Survived[2] (N=10)	Died On Scene or In Transit (N=1)	Died in Emergency Room (N=1)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=126)
On-Scene Care									
None or Minor		6(5.4)		1(100.0)					7(5.5)
Clear Airway	1(50.0)[4]	12(10.8)	1(10.0)						14(11.0)
Artificial Respirat.									
Resuscitator	1(50.0)								1(0.7)
Airway Tube	1(50.0)								1(0.7)
Oxygen	1(50.0)	4(3.6)							5(3.9)
Cardiac Massage	1(50.0)	1(0.9)							2(1.4)
Control Bleeding	1(50.0)	56(50.4)	5(50.0)		1(100.0)			1(100.0)	64(50.8)
Bandage	1(50.0)	79(91.1)	9(90.0)					1(100.0)	90(71.4)
Splint		7(6.3)							7(5.5)
Backboard		38(34.2)							38(30.0)
Defibrillation									
Drug(s) or IV Fluid	1(50.0)	5(4.5)						1(100.0)	7(5.5)
Transportation to Hospital									
No Warning Device		46(41.4)	6(60.0)						52(41.2)
Red Light		1(0.9)							1(0.8)
Red Light & Siren	2(100.0)	64(57.6)	4(40.0)	1(100.0)	1(100.0)			1(100.0)	73(58.0)
In-Transit Care									
None or Minor	1(50.0)	73(65.7)	3(30.0)	1(100.0)				1(100.0)	79(62.7)
Clear Airway		4(3.6)	1(10.0)						5(3.9)
Artificial Respirat.									
Resuscitator	2(100.0)		1(10.0)						3(2.3)
Airway Tube	1(50.0)		1(10.0)						2(1.4)
Oxygen		2(1.8)							2(1.4)
Cardiac Massage	1(50.0)								1(0.7)
Control Bleeding	1(50.0)	29(26.1)	4(40.0)		1(100.0)				35(27.7)
Bandage		17(15.3)	1(10.0)						18(14.3)
Defibrillation									
Drug(s) or IV Fluid	1(50.0)	2(1.8)	2(20.0)						5(3.9)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-6

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF CRUSHING, PERFORATION AND INTERNAL INJURIES

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival at Scene (N=2)[1]	No Threat to Life (N=12)	Threat to Life But Survived[2] (N=6)	Died on Scene or In Transit (N=1)	Died in Emergency Room (N=0)	Died in Hospital (N=1)	Died After Hospital Discharge (N=0)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=23)
On-Scene Care									
None or Minor	2(100.0)[4]	5(41.7)				1(100.0)			8(34.3)
Clear Airway		2(16.6)	1(16.6)	1(100.0)					4(17.4)
Artificial Respiration									
Resuscitator									
Airway Tube			1(16.6)	1(100.0)					2(8.7)
Oxygen		1(8.3)	1(16.6)	1(100.0)					3(13.0)
Cardiac Massage									
Control Bleeding		4(33.3)	1(16.6)	1(100.0)				1(100.0)	7(30.4)
Bandage		4(33.3)	5(83.3)					1(100.0)	10(43.5)
Splint			1(16.7)						1(4.4)
Backboard		1(8.3)	2(33.3)	1(100.0)					4(17.4)
Defibrillation									
Drug(s) or IV Fluid		1(8.3)	1(16.6)						2(8.6)
Transportation to Hospital									
No Warning Device		3(25.0)				1(100.0)			4(17.4)
Red Light		1(8.3)							1(4.3)
Red Light & Siren	2(100.0)	8(66.3)	6(100.0)	1(100.0)				1(100.0)	18(78.3)
In-Transit Care									
None or Minor	2(100.0)	9(75.0)	3(50.0)			1(100.0)			15(65.3)
Clear Airway		1(8.3)	2(33.3)	1(100.0)					4(17.3)
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen		1(8.3)	1(16.6)	1(100.0)					3(13.0)
Cardiac Massage									
Control Bleeding		1(8.3)	1(16.6)	1(100.0)				1(100.0)	4(17.3)
Bandage		2(16.7)						1(100.0)	3(13.0)
Defibrillation									
Drug(s) or IV Fluid		1(8.3)							1(4.3)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-7

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF POISONINGS AND OVERDOSES

Number of Victims in Each Category of Severity or Medical Outcome

Activity	Dead on Arrival At Scene (N=4)[1]	No Threat to Life (N=117)	Threat to Life But Survived[2] (N=38)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=1)	Died in Hospital (N=2)	Died After Hospital Discharge[2] (N=1)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=163)
On-Scene Care									
None or Minor	1(25.0)	71(60.6)	6(15.7)		1(100.0)				79(48.6)
Clear Airway	2(50.0)[4]	16(13.6)	9(23.6)			1(50.0)	1(100.0)		29(17.8)
Artificial Respirat.	1(25.0)		2(5.2)						3(1.8)
Resuscitator	1(25.0)		4(10.5)				1(100.0)		6(3.6)
Airway Tube	2(50.0)	3(2.5)	6(15.7)			1(50.0)	1(100.0)		13(8.0)
Oxygen	3(75.0)	30(25.6)	18(47.3)			1(50.0)			52(31.9)
Cardiac Massage	3(75.0)					1(50.0)			4(2.5)
Control Bleeding									
Bandage									
Splint									
Backboard			1(2.6)						1(0.06)
Defibrillation	2(50.0)					1(50.0)			3(1.8)
Drug(s) or IV Fluid	2(50.0)	19(16.2)	19(50.0)			2(50.0)	1(100.0)		43(26.4)
Transportation to Hospital									
No Warning Device		48(41.0)	8(21.0)						56(34.4)
Red Light		5(4.2)	2(5.2)						7(4.3)
Red Light & Siren	4(100.0)	64(54.7)	28(73.6)		1(100.0)	2(100.0)	1(100.0)		100(61.3)
In-Transit Care									
None or Minor	2(50.0)	91(77.7)	8(21.0)		1(100.0)				102(62.6)
Clear Airway		11(9.4)	9(23.6)			1(50.0)	1(100.0)		22(13.4)
Artificial Respirat.	2(50.0)		2(5.2)			1(50.0)			5(13.1)
Resuscitator	1(25.0)	1(1.0)	3(7.8)			2(100.0)			7(4.2)
Airway Tube			2(5.2)			1(50.0)			3(1.8)
Oxygen	1(25.0)	19(16.2)	16(42.1)			1(. 50.0)			37(22.7)
Cardiac Massage	1(25.0)					2(100.0)			3(1.8)
Control Bleeding									
Bandage									
Defibrillation									
Drug(s) or IV Fluid		13(11.1)	16(42.1)			2(100.0)	1(100.0)		32(19.6)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-8

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF SUFFOCATIONS, ASPHYXIATION, DROWNING AND STRANGULATION

Activity	Number of Victims in Each Category of Severity or Medical Outcome								
	Dead on Arrival At Scene (N=4)[1]	No Threat to Life (N=5)	Threat to Life But Survived[2] (N=7)	Died on Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=17)
On-Scene Care									
None or Minor		3(60.0)[4]	1(14.2)						4(23.5)
Clear Airway	2(50.0)	1(20.0)	4(57.1)					1(100.0)	8(47.0)
Artificial Respirat.	3(75.0)								3(17.6)
Resuscitator	2(50.0)		1(14.2)						3(17.6)
Airway Tube	3(75.0)		1(14.2)						4(23.5)
Oxygen	3(75.0)	1(20.0)	3(42.8)					1(100.0)	8(47.0)
Cardiac Massage	4(100.0)		1(14.2)						5(29.4)
Control Bleeding									
Bandage									
Splint									
Backboard			1(14.2)						1(5.9)
Defibrillation	1(25.0)		1(14.2)						2(11.7)
Drug(s) or IV Fluid	1(25.0)	1(20.0)							2(11.7)
Transportation to Hospital									
No Warning Device		3(60.0)						1(100.0)	4(23.5)
Red Light			2(28.5)						2(11.8)
Red Light & Siren	4(100.0)	2(40.0)	5(71.4)						11(64.7)
In-Transit Care									
None or Minor		4(80.0)	3(42.8)						7(41.1)
Clear Airway	1(25.0)	1(20.0)	2(28.5)						4(23.5)
Artificial Respirat.	3(75.0)								3(17.6)
Resuscitator	2(50.0)		1(14.2)						3(17.6)
Airway Tube	2(50.0)		1(14.2)						3(17.6)
Oxygen	2(50.0)		1(14.2)					1(100.0)	4(23.5)
Cardiac Massage	4(100.0)		1(14.2)						5(29.4)
Control Bleeding									
Bandage									
Defibrillation			1(14.2)						1(5.8)
Drug(s) or IV Fluid	2(50.0)		1(14.2)						3(17.6)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-9

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF CENTRAL NERVOUS SYSTEM INJURIES

Number of Victims in Each Category of Severity or Medical Outcome

Activity	Dead on Arrival at Scene (N=3)[1]	No Threat to Life (N=35)	Threat to Life But Survived[2] (N=10)	Died On Scene or In Transit (N=1)	Died in Emergency Room (N=1)	Died in Hospital (N=1)	Died After Hospital Discharge[2] (N=2)	Unknown Medical Outcome[3] (N=2)	Total for All Victims (N=55)
On-Scene Care									
None or Minor		19(54.2)	2(20.0)	1(100.0)				1(50.0)	29(52.7)
Clear Airway	1(25.0)[4]	3(8.5)	5(50.0)		1(100.0)	1(100.0)	1(50.0)	1(50.0)	13(23.6)
Artificial Respirat.	2(50.0)		1(10.0)						3(5.4)
Resuscitator	1(25.0)		1(10.0)						2(3.6)
Airway Tube	1(25.0)		2(20.0)			1(100.0)		1(50.0)	5(9.0)
Oxygen	1(25.0)	1(2.8)	1(10.0)				1(50.0)	1(50.0)	5(9.0)
Cardiac Massage	2(50.0)		1(10.0)						3(5.4)
Control Bleeding	1(25.0)	6(17.0)	2(20.0)		1(100.0)	1(100.0)	2(100.0)		13(23.6)
Bandage	3(75.0)	11(31.4)	2(20.0)		1(100.0)	1(100.0)	2(100.0)		20(36.4)
Splint		8(22.9)	2(20.0)				2(100.0)		12(21.8)
Backboard		7(20.0)					2(100.0)		9(16.4)
Defibrillation			1(10.0)						1(1.8)
Drug(s) or IV Fluid	1(25.0)	3(8.5)	2(20.0)		1(100.0)				7(12.7)
Transportation to Hospital									
No Warning Device	1(33.1)	17(48.5)						1(50.0)	19(34.6)
Red Light		2(5.7)							2(3.6)
Red Light & Siren	2(66.7)	16(45.7)	10(100.0)	1(100.0)	1(100.0)	1(100.0)	2(100.0)	1(50.0)	34(61.8)
In-Transit Care									
None or Minor	1(25.0)	28(80.0)	4(40.0)	1(100.0)					34(61.8)
Clear Airway	2(50.0)	3(8.5)	5(50.0)			1(100.0)	1(50.0)	1(50.0)	13(23.6)
Artificial Respirat.	2(50.0)		2(20.0						4(7.2)
Resuscitator	1(25.0)		1(10.0)						2(3.6)
Airway Tube	1(25.0)							1(50.0)	2(3.6)
Oxygen			1(10.0)					1(50.0)	2(3.6)
Cardiac Massage	2(50.0)		1(10.0)						3(5.4)
Control Bleeding	1(25.0)	1(2.8)	3(30.0)				1(50.0)	1(50.0)	6(10.9)
Bandage		2(5.7)					1(50.0)	1(50.0)	4(7.2)
Defibrillation									
Drug(s) or IV Fluid		4(11.4)	3(30.0)		1(100.0)			1(50.0)	9(16.3)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] P- -centage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-10

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF HYPERTENSIVE AND ARTERIOSCLEROTIC HEART DISEASE

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival at Scene (N=92)[1]	No Threat to Life (N=76)	Threat to Life But Survived[2] (N=37)	Died on Scene or In Transit (N=7)	Died in Emergency Room (N=0)	Died in Hospital (N=5)	Died After Hospital Discharge[2] (N=7)	Unknown Medical Outcome[3] (N=25)	Total for All Victims (N=249)
On-Scene Care									
None or Minor	2(2.1)[4]	3(3.9)	1(2.7)				1(14.2)		7(2.8)
Clear Airway	55(59.7)	5(6.5)	5(13.5)	5(71.4)		4(80.0)	1(14.2)	7(28.0)	82(32.9)
Artificial Respirat.	42(45.6)	1(1.3)	1(2.7)	2(28.5)		1(20.0)		2(8.0)	49(19.6)
Resuscitator	60(65.2)	1(1.3)	3(8.1)	3(42.8)		3(60.0)		4(16.0)	74(29.7)
Airway Tube	57(61.9)		3(8.1)	3(42.8)		2(40.0)	1(14.2)	4(16.0)	70(28.1)
Oxygen	68(73.9)	41(53.9)	25(67.5)	6(85.7)		4(80.0)	3(42.8)	19(76.0)	166(66.6)
Cardiac Massage	78(84.3)		2(5.4)	5(71.4)		3(60.0)		3(12.0)	91(36.5)
Control Bleeding									
Bandage									
Splint									
Backboard	17(18.4)		2(5.4)	2(28.5)				2(8.0)	23(9.2)
Defibrillation	45(48.9)		3(8.1)	2(28.5)		3(60.0)		4(16.0)	57(22.8)
Drug(s) or IV Fluid	63(68.4)	39(51.3)	26(70.2)	4(57.1)		3(60.0)	5(71.4)	20(80.0)	160(64.2)
Transportation to Hospital									
No Warning Device	12(13.1)	54(71.1)	15(40.5)	1(14.2)		1(20.0)	5(71.5)	10(40.0)	98(39.3)
Red Light	1(1.0)								1(0.4)
Red Light & Siren	79(85.9)	22(28.9)	22(59.5)	6(85.7)		4(80.0)	2(28.5)	15(60.0)	150(60.3)
In-Transit Care									
None or Minor	10(10.8)	14(18.4)	3(8.1)					1(4.0)	28(11.2)
Clear Airway	18(19.5)	3(3.9)	1(2.7)	3(42.8)		1(20.0)			26(10.4)
Artificial Respirat.	30(32.6)			3(42.8)				2(8.0)	35(14.0)
Resuscitator	42(45.6)		1(2.7)			3(60.0)		1(4.0)	47(18.8)
Airway Tube	14(15.2)		1(2.7)	1(14.2)		2(40.0)		3(12.0)	21(8.4)
Oxygen	63(68.4)	26(34.2)	15(40.5)	5(71.4)		4(80.0)	3(42.8)	15(60.0)	131(52.6)
Cardiac Massage	65(70.6)		2(5.4)	6(85.7)		2(40.0)		1(4.0)	76(30.5)
Control Bleeding									
Bandage									
Defibrillation	5(5.4)		1(2.7)						6(2.4)
Drug(s) or IV Fluid	48(52.1)	23(30.2)	26(70.2)	3(42.8)		3(60.0)	4(57.1)	11(44.0)	118(47.3)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-11

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF HYPERTENSIVE AND ARTERIOSCLEROTIC CEREBRO-VASCULAR DISEASE

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival at Scene (N=2)[1]	No Threat to Life (N=26)	Threat to Life but Survived[2] (N=8)	Died on Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=10)	Died After Hospital Discharge[2] (N=1)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=48)
On-Scene Care									
None or Minor		9(34.6)	1(12.5)			1(10.0)			10(20.8)
Clear Airway	1(50.0)[4]					3(30.0)			4(8.3)
Artificial Respirat.	1(50.0)								1(2.0)
Resuscitator	1(50.0)					1(10.0)			2(4.0)
Airway Tube	1(50.0)	2(7.6)							3(6.2)
Oxygen	1(50.0)	14(53.8)	4(50.0)			8(80.0)	1(100.0)		28(58.3)
Cardiac Massage	1(50.0)					1(10.0)			2(4.0)
Control Bleeding	11(50.0)								1(2.0)
Bandage									
Splint									
Backboard									
Defibrillation									
Drug(s) or IV Fluid	1(50.0)	7(26.9)	4(50.0)			6(60.0)		1(100.0)	19(39.5)
Transportation to Hospital									
No Warning Device	2(100.0)	20(77.0)				2(20.0)		1(100.0)	25(52.1)
Red Light									
Red Light & Siren		6(23.0)	8(100.0)			8(80.0)	1(100.0)		23(47.9)
In-Transit Care									
None or Minor	2(100.0)	14(53.8)	4(50.0)						20(41.6)
Clear Airway						3(30.0)			3(6.2)
Artificial Respiration									
Resuscitator						1(10.0)			1(2.0)
Airway Tube		3(11.5)	1(12.5)						4(8.3)
Oxygen		8(30.7)	3(37.5)			6(60.0)	1(100.0)		18(37.5)
Cardiac Massage									
Control Bleeding									
Bandage									
Defibrillation									
Drug(s) or IV Fluid		4(15.4)	3(37.5)			6(60.0)		1(100.0)	14(29.1)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-12

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF NONTRAUMATIC BLOOD LOSS

Number of Victims in Each Category of Severity

Activity	Dead on Arrival at Scene (N=0)[1]	No Threat to Life (N=11)	Threat to Life But Survived[2] (N=4)	Died on Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=3)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=2)	Total for All Victims (N=20)
On-Scene Care									
None or Minor		5(45.3)[4]	3(75.0)					1(50.0)	9(45.0)
Clear Airway						2(66.6)			2(10.0)
Artificial Respiration		4(36.3)	1(25.0)			2(66.6)		1(50.0)	7(35.0)
Resuscitator						1(33.3)			1(5.0)
Airway Tube						2(66.6)			2(10.0)
Oxygen		3(27.2)				3(100.0)			6(30.0)
Cardiac Massage									
Control Bleeding		2(18.1)	1(25.0)						3(15.0)
Bandage									
Splint									
Backboard									
Defibrillation									
Drug(s) or IV Fluid		2(18.1)	1(25.0)			3(300.0)		1(50.0)	7(35.0)
Transportation to Hospital									
No Warning Device		6(54.5)	2(50.0)			1(33.3)		2(100.0)	11(55.0)
Red Light		3(27.3)	2(50.0)						5(25.0)
Red Light & Siren		2(18.1)				2(66.7)			4(20.0)
In-Transit Care									
None or Minor		7(63.6)	2(50.0)					1(50.0)	8(40.0)
Clear Airway			1(25.0)			1(33.3)			2(10.0)
Artificial Respiration		2(18.1)							2(10.0)
Resuscitator						1(33.3)			1(5.0)
Airway Tube									
Oxygen		2(18.1)				2(66.6)			4(25.0)
Cardiac Massage									
Control Bleeding		2(18.1)							2(10.0)
Bandage									
Defibrillation									
Drug(s) or IV Fluid		1(9.0)	2(50.0)			3(100.0)		1(50.0)	5(25.0)

[1] Number of Cases

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-13

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF INFECTIONS

Activity	Number of Victims in Each Category of Severity or Medical Outcome								
	Dead on Arrival At Scene (N=1)[1]	No Threat to Life (N=17)	Threat to Life But Survived[2] (N=1)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=19)
On-Scene Care									
None or Minor		12(70.7)							12(63.2)
Clear Airway	1(100.0)[4]	1(5.9)							2(10.5)
Artificial Respirat.	1(100.0)								1(5.3)
Resuscitator									
Airway Tube									
Oxygen		5(29.4)	1(100.0)						6(31.6)
Cardiac Massage	1(100.0)								1(5.3)
Control Bleeding									
Bandage									
Splint									
Backboard									
Defibrillation									
Drug(s) or IV Fluid		1(5.9)	1(100.0)						2(10.5)
Transportation to Hospital									
No Warning Device		10(58.8)							10(52.7)
Red Light									
Red Light & Siren	1(100.0)	7(41.2)	1(100.0)						9(47.3)
In-Transit Care									
None or Minor	1(100.0)	16(94.3)							17(89.4)
Clear Airway		1(5.9)							1(5.3)
Artificial Respirat.									
Resuscitator									
Airway Tube									
Oxygen		1(5.9)	1(100.0)						2(10.5)
Cardiac Massage									
Control Bleeding									
Bandage									
Defibrillation									
Drug(s) or IV Fluid		1(5.9)	1(100.0)						2(10.5)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-14

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF COMA, FAINTING, DEHYDRATION AND METABOLIC DISORDERS

Number of Victims in Each Category of Severity or Medical Outcome

Activity	Dead on Arrival at Scene (N=3) [1]	No Threat to Life (N=215)	Threat to Life But Survived [2] (N=8)	Died on Scene or In Transit (N=1)	Died in Emergency Room N=0)	Died in Hospital (N=0)	Died After Hospital Discharge [2] (N=0)	Unknown Medical Outcome [3] (N=2)	Total for All Victims (N=229)
On-Scene Care									
None or Minor	1(33.3)[4]	102(47.4)	1(12.5)	1(100.0)					105(45.8)
Clear Airway		20(9.3)	2(25.0)					1(50.0)	23(10.0)
Artificial Respirat.								1(50.0)	1(0.4)
Resuscitator	1(33.3)	1(0.5)							2(0.8)
Airway Tube		22(10.2)						1(50.0)	1(0.4)
Oxygen	1(33.3)	67(31.1)	4(50.0)						5(2.2)
Cardiac Massage								1(50.0)	1(0.4)
Control Bleeding									
Bandage									
Splint									
Backboard		1(0.5)							1(0.5)
Defibrillation									
Drug(s) or IV Fluid		49(22.7)	7(87.5)						56(24.5)
Transportation to Hospital									
No Warning Device	1(33.3)	154(11.6)	4(50.0)					1(50.0)	160(69.8)
Red Light		5(2.3)							5(2.3)
Red Light & Siren	2(66.7)	56(26.1)	4(50.0)	1(100.0)				1(50.0)	64(30.9)
In-Transit Care									
None or Minor	2(66.6)	144(66.9)							146(64.0)
Clear Airway	1(33.3)	9(4.1)						1(50.0)	11(4.8)
Artificial Respirat.								1(50.0)	1(0.4)
Resuscitator	1(33.3)								1(0.4)
Airway Tube	1(33.3)	3(1.3)						1(50.0)	4(1.7)
Oxygen	1(33.3)	41(19.0)	3(37.5)	1(100.0)					46(20.1)
Cardiac Massage	1(33.3)							1(50.0)	2(0.8)
Control Bleeding									
Bandage									
Defibrillation									
Drug(s) or IV Fluid		40(18.6)	4(50.0)						44(19.2)

1 Number of Cases.

2 90 days after discharge from hospital.

3 Victim was taken to a hospital that did not cooperate in the demonstration.

4 Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-15

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF OBSTETRICAL COMPLICATIONS

Activity	Number of Victims in Each Category of Severity or Medical Outcome								
	Dead on Arrival At Scene (N=0)[1]	No Threat to Life (N=13)	Threat to Life But, Survived[2] (N=1)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=14)
On-Scene Care									
None or Minor		10(76.9)[4]							10(71.4)
Clear Airway									
Artificial Respirat.									
Resuscitator									
Airway Tube									
Oxygen		1(7.7)							1(7.1)
Cardiac Massage									
Control Bleeding		1(7.7)							1(7.1)
Bandage									
Splint									
Backboard									
Defibrillation									
Drug(s) or IV Fluid		3(23.1)	1(100.0)						4(28.6)
Transportation to Hospital									
No Warning Device		7(53.8)	1(100.0)						8(57.2)
Red Light									
Red Light & Siren		6(46.2)							6(42.8)
In-Transit Care									
None or Minor		10(76.9)							10(71.4)
Clear Airway									
Artificial Respirat.									
Resuscitator									
Airway Tube									
Oxygen		3(23.1)							3(21.4)
Cardiac Massage									
Control Bleeding		2(15.4)							2(14.3)
Bandage									
Defibrillation									
Drug(s) or IV Fluid		1(7.7)	1(100.0)						2(14.3)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-16

KINDS OF CARE AND MODES OF TRANSPORTATION TO HOSPITAL PROVIDED BY MOBILE INTENSIVE CARE UNITS TO VICTIMS OF RESPIRATORY DYSFUNCTION

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival at Scene (N=1)[1]	No Threat to Life (N=73)	Threat to Life But Survived[2] (N=10)	Died on Scene or In Transit (N=0)	Died in Emergency Room (N=1)	Died in Hospital (N=4)	Died After Hospital Discharge[2] (N=1)	Unknown Medical Outcome[3] (N=4)	Total for All Victims (N=94)
On-Scene Care									
None or Minor		19(26.0)	3(30.0)			1(25.0)			23(24.4)
Clear Airway	1(100.0)[4]	12(16.4)	1(10.0)			1(25.0)			15(15.9)
Artificial Respiration						1(25.0)			1(1.0)
Resuscitator						1(25.0)			1(1.0)
Airway Tube						1(25.0)			1(1.0)
Oxygen	1(100.0)	42(57.5)	7(70.0)			3(75.0)		4(100.0)	57(60.6)
Cardiac Massage	1(100.0)					1(25.0)			2(2.1)
Control Bleeding									
Bandage									
Splint									
Backboard						1(25.0)			
Defibrillation	1(100.0)								1(1.0)
Drug(s) or IV Fluid		22(30.1)	6(60.0)		1(100.0)	1(25.0)		3(75.0)	34(36.2)
Transportation to Hospital									
No Warning Device		49(67.1)	5(50.0)			1(25.0)	1(100.0)	3(75.0)	59(62.7)
Red Light		2(2.7)							2(2.1)
Red Light & Siren	1(100.0)	22(30.2)	5(50.0)		1(100.0)	3(75.0)		1(25.0)	33(35.1)
In-Transit Care									
None or Minor	1(100.0)	37(50.6)				1(25.0)			2(2.1)
Clear Airway		5(6.8)	1(10.0)			1(25.0)			7(7.4)
Artificial Respiration									
Resuscitator									
Airway Tube		10(13.6)				1(25.0)			11(11.7)
Oxygen		16(21.9)	8(80.0)			2(50.0)		3(75.0)	21(22.3)
Cardiac Massage									
Control Bleeding									
Bandage									
Defibrillation									
Drug(s) or IV Fluid		16(21.9)	5(50.0)		1(100.0)	1(25.0)	1(100.0)	3(75.0)	27(28.7)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-17

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF BURNS

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=0)[1]	No Threat to Life (N=10)	Threat to Life But Survived[2] (N=0)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=1)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=11)
On-Scene Care									
None or Minor		8(80.0)[4]							8(72.7)
Clear Airway									
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen									
Cardiac Massage									
Control Bleeding									
Bandage		2(20.0)				1(100.0)			3(27.3)
Splint									
Backboard									
Transportation to Hospital									
No Warning Device		3(30.0)							3(27.3)
Red Light									
Red Light & Siren		7(70.0)				1(100.0)			8(72.7)
In-Transit Care									
None or Minor		7(70.0)							7(63.6)
Clear Airway									
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen									
Cardiac Massage									
Control Bleeding									
Bandage		3(30.0)				1(100.0)			4(36.4)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-18

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF FRACTURES AND DISLOCATIONS

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=0)[1]	No Threat to Life (N=175)	Threat to Life But Survived[2] (N=3)	Died On Scene or In Transit (N=1)	Died in Emergency Room (N=0)	Died in Hospital (N=1)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=180)
On-Scene Care									
None or Minor		91(52.0)[4]							91(50.5)
Clear Airway		3(1.7)							3(1.6)
Artificial Respiration									
Resuscitator									
Airway Tube		1(0.5)							1(0.5)
Oxygen									
Cardiac Massage									
Control Bleeding		17(9.7)	1(100.0)						18(10.0)
Bandage		39(22.2)	2(66.7)	1(100.0)		1(100.0)			43(23.9)
Splint		73(41.7)				1(100.0)			74(41.1)
Backboard		38(21.7)	1(33.3)						39(21.6)
Transportation to Hospital									
No Warning Device		131(74.8)	1(100.0)						132(73.3)
Red Light		1(0.6)							1(0.6)
Red Light & Siren		43(24.6)	2(66.7)	1(100.0)		1(100.0)			47(26.1)
In-Transit Care									
None or Minor		158(90.3)				1(100.0)			159(88.3)
Clear Airway		3(1.7)							3(1.6)
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen		2(1.1)							2(1.1)
Cardiac Massage									
Control Bleeding		7(4.0)	1(33.3)						8(4.4)
Bandage		17(9.7)	2(66.7)	1(100.0)					20(5.6)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-19

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF LACERATIONS AND PENETRATING INJURIES

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=7)[1]	No Threat to Life (N=346)	Threat to Life But Survived[2] (N=17)	Died On Scene or In Transit (N=1)	Died in Emergency Room (N=1)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=1)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=374)
On-Scene Care									
None or Minor	3(42.8)[4]	67(19.3)	2(11.7)						72(19.2)
Clear Airway	2(28.5)	2(0.5)							4(1.0)
Artificial Respirat.									
Resuscitator									
Airway Tube	1(14.2)								1(0.2)
Oxygen			1(5.8)						1(0.2)
Cardiac Massage	1(14.2)	1(0.2)							2(0.4)
Control Bleeding	1(14.2)	130(37.5)	5(29.4)	1(100.0)					137(36.6)
Bandage	1(14.3)	232(67.0)	12(70.6)		1(100.0)		1(100.0)		247(65.9)
Splint		7(2.0)							7(1.9)
Backboard	1(14.3)	17(4.9)	1(5.9)						19(5.1)
Transportation to Hospital									
No Warning Device		243(70.3)	5(29.5)		1(100.0)		1(100.0)	1(100.0)	251(67.1)
Red Light		1(0.3)							1(0.3)
Red Light & Siren	7(100.0)	102(29.4)	12(70.5)	1(100.0)					122(32.6)
In-Transit Care									
None or Minor	3(42.8)	266(76.9)	6(35.2)		1(100.0)		1(100.0)		277(74.1)
Clear Airway	2(28.5)			1(100.0)					3(0.8)
Artificial Respirat.	1(14.2)								1(0.2)
Resuscitator	2(28.5)								2(0.4)
Airway Tube	2(28.5)								2(0.4)
Oxygen		2(0.5)	2(11.7)						4(1.0)
Cardiac Massage	3(42.8)								3(0.8)
Control Bleeding		49(14.1)	2(11.7)						51(13.6)
Bandage	1(14.3)	65(18.8)	8(47.1)					1(100.0)	75(20.1)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-20

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF CRUSHING, PERFORATIONS AND INTERNAL INJURIES

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=3)[1]	No Threat to Life (N=23)	Threat to Life But Survived[2] (N=14)	Died On Scene or In Transit (N=2)	Died in Emergency Room (N=0)	Died in Hospital (N=2)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=45)
On-Scene Care									
None or Minor		4(17.3)[4]	4(28.5)						8(17.7)
Clear Airway	2(66.6)			2(100.0)					4(8.8)
Artificial Respirat.									
Resuscitator									
Airway Tube	1(33.3)			1(50.0)					2(4.4)
Oxygen									
Cardiac Massage									
Control Bleeding	1(33.3)	3(13.0)	3(21.4)			2(100.0)		1(100.0)	10(22.2)
Bandage	1(33.3)	8(34.8)	7(50.0)	1(50.0)		1(50.0)		1(100.0)	19(42.2)
Splint		8(34.8)	4(28.6)	2(100.0)		2(100.0)			16(35.5)
Backboard	1(33.3)	5(21.7)	5(35.7)	1(50.0)		2(100.0)			14(31.1)
Transportation to Hospital									
No Warning Device		15(65.2)	6(42.8)						21(46.7)
Red Light									
Red Light & Siren	3(100.0)	8(34.7)	8(57.1)	2(100.0)		2(100.0)		1(100.0)	24(53.3)
In-Transit Care									
None or Minor	1(33.3)	17(73.9)	3(21.4)						31(68.8)
Clear Airway	1(33.3)		1(7.1)	1(50.0)		1(50.0)			4(8.8)
Artificial Respirat.	1(33.3)								1(2.2)
Resuscitator									
Airway Tube									
Oxygen		1(4.3)	2(14.2)	1(50.0)					4(8.8)
Cardiac Massage	1(33.3)								1(2.2)
Control Bleeding			2(14.2)	1(50.0)		1(50.0)		1(100.0)	5(11.1)
Bandage		1(4.3)	4(28.5)	1(50.0)				1(100.0)	7(15.5)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-21

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF POISONINGS AND OVERDOSES

Activity	Number of Victims in Each Category of Severity or Medical Outcome								
	Dead on Arrival At Scene (N=1)[1]	No Threat to Life (N=173)	Threat to Life But Survived[2] (N=30)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=1)	Died in Hospital (N=1)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=207)
On-Scene Care									
None or Minor	1(100.0)[4]	157(90.7)	23(76.6)		1(100.0)	1(100.0)			183(88.4)
Clear Airway		13(7.5)	5(16.6)					1(100.0)	19(9.1)
Artificial Respirat.								1(100.0)	1(0.4)
Resuscitator			1(3.3)					1(100.0)	2(0.8)
Airway Tube		4(2.3)	1(3.3)					1(100.0)	6(2.8)
Oxygen		8(4.6)	1(3.3)					1(100.0)	10(4.8)
Cardiac Massage									
Control Bleeding									
Bandage									
Splint									
Backboard		4(2.3)						1(100.0)	5(2.4)
Transportation to Hospital									
No Warning Device		134(77.4)	14(46.6)		1(100.0)	1(100.0)		1(100.0)	151(72.1)
Red Light		2(1.1)							2(1.0)
Red Light & Siren	1(100.0)	37(21.3)	16(53.3)						54(26.1)
In-Transit Care									
None or Minor		155(89.6)	17(56.6)			1(100.0)			173(83.6)
Clear Airway	1(100.0)	10(5.7)	2(6.6)					1(100.0)	14(6.7)
Artificial Respirat.	1(100.0)	7(4.0)	8(26.6)		1(100.0)			1(100.0)	18(8.6)
Resuscitator	1(100.0)	2(1.1)	4(13.3)					1(100.0)	8(8.6)
Airway Tube	1(100.0)	3(1.7)							4(1.9)
Oxygen	1(100.0)	13(7.5)	5(16.6)					1(100.0)	20(9.6)
Cardiac Massage									
Control Bleeding									
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-22

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF SUFFOCATIONS, ASPHYXIATION, DROWNING AND STRANGULATION

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=0)	No Threat to Life (N=3)	Threat to Life But Survived[2] (N=1)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=4)
On-Scene Care									
None or Minor		1(33.3)[4]	1(100.0)						2(50.0)
Clear Airway		1(33.3)							1(25.0)
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen		1(33.3)							1(25.0)
Cardiac Massage									
Control Bleeding									
Bandage									
Splint									
Backboard									
Transportation to Hospital									
No Warning Device		2(66.6)							2(50.0)
Red Light									
Red Light & Siren		1(33.3)	1(100.0)						2(50.0)
In-Transit Care									
None or Minor		1(33.3)							1(25.0)
Clear Airway		1(33.3)							1(25.0)
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen		1(33.3)	1(100.0)						2(50.0)
Cardiac Massage									
Control Bleeding									
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-23

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF CENTRAL NERVOUS SYSTEM INJURIES

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=8)[1]	No Threat to Life (N=70)	Threat to Life But Survived[2] (N=13)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=1)	Died in Hospital (N=2)	Died After Hospital Discharge[2] (N=2)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=96)
On-Scene Care									
None or Minor	1(12.5)[4]	53(75.7)	5(38.4)						59(61.5)
Clear Airway	5(62.5)	1(1.4)	4(30.7)		1(100.0)		2(100.0)		13(13.5)
Artificial Respirat.	3(37.5)								3(3.1)
Resuscitator	4(50.0)					1(50.0)			5(5.2)
Airway Tube	4(50.0)		1(7.6)						5(5.2)
Oxygen	4(50.0)								4(4.1)
Cardiac Massage	4(50.0)								4(4.1)
Control Bleeding	4(50.0)	7(10.0)	4(30.7)			2(100.0)			18(18.7)
Bandage	1(12.5)	18(25.7)	8(61.5)				1(50.0)		28(29.1)
Splint	1(12.5)	1(1.4)	1(7.7)			1(50.0)			4(4.2)
Backboard	1(12.5)	12(17.1)	3(23.1)						16(16.7)
Transportation to Hospital									
No Warning Device		49(70.0)	4(30.7)				1(50.0)		54(56.3)
Red Light									
Red Light & Siren	8(100.0)	21(30.0)	9(69.2)		1(100.0)	2(100.0)	1(50.0)		42(43.7)
In-Transit Care									
None or Minor		68(97.1)	8(61.5)						76(79.1)
Clear Airway	6(75.0)	1(1.4)	4(30.7)		1(100.0)		2(100.0)		14(14.5)
Artificial Respirat.	1(12.5)								1(1.0)
Resuscitator	7(87.5)					1(50.0)	1(50.0)		9(9.3)
Airway Tube	3(37.5)				1(100.0)				3(3.1)
Oxygen	4(50.0)		2(15.4)		1(100.0)				7(7.2)
Cardiac Massage	5(62.5)					1(50.0)			6(6.2)
Control Bleeding	3(37.5)	1(1.4)	3(23.0)			1(50.0)	2(100.0)		10(10.4)
Bandage	1(12.5)	3(4.3)	1(7.6)		1(100.0)		1(50.0)		7(7.3)

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-24

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF HYPERTENSIVE AND ARTERIOSCLEROTIC HEART DISEASE

Number of Victims in Each Category of Severity or Medical Outcome

Activity	Dead on Arrival At Scene (N=12)[1]	No Threat to Life (N=20)	Threat to Life But Survived[2] (N=7)	Died On Scene or In Transit (N=2)	Died in Emergency Room (N=1)	Died in Hospital (N=5)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=47)
On-Scene Care									
None or Minor	1(8.3)[4]	11(55.0)	3(42.8)			3(60.0)			18(38.2)
Clear Airway	7(58.3)			1(50.0)		1(20.0)			9(19.1)
Artificial Respirat.	3(25.0)		1(14.2)						4(8.5)
Resuscitator	6(50.0)	1(5.0)		1(50.0)		1(20.0)			9(19.1)
Airway Tube	8(66.7)			1(50.0)		1(20.0)			10(21.2)
Oxygen	5(41.6)	8(40.0)	3(42.8)		1(100.0)	2(40.0)			19(40.4)
Cardiac Massage	9(75.0)		1(14.2)	1(50.0)		1(20.0)			12(25.5)
Control Bleeding									
Bandage									
Splint									
Backboard	2(16.7)								2(4.3)
Transportation to Hospital									
No Warning Device		15(75.0)	5(71.5)			4(80.0)			24(51.1)
Red Light									
Red Light & Siren	12(100.0)	5(25.0)	2(28.5)	2(100.0)	1(100.0)	1(20.0)			23(48.9)
In-Transit Care									
None or Minor		7(35.0)	2(28.5)			4(80.0)			13(27.6)
Clear Airway	3(25.0)		1(14.2)			1(20.0)			5(10.6)
Artificial Respirat.	3(25.0)		1(14.2)						4(8.5)
Resuscitator	11(91.6)			1(50.0)		1(20.0)			13(27.6)
Airway Tube	1(8.3)		1(14.2)			1(20.0)			3(6.3)
Oxygen	6(50.0)	9(45.0)	4(57.1)	1(50.0)	1(100.0)	1(20.0)			22(46.8)
Cardiac Massage	10(83.3)			2(100.0)		1(20.0)			13(27.6)
Control Bleeding									
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-25

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF HYPERTENSIVE AND ARTERIOSCLEROTIC CEREBRO-VASCULAR DISEASE

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=1)[1]	No Threat to Life (N=6)	Threat to Life But Survived[2] (N=3)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=1)	Died in Hospital (N=4)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=15)
On-Scene Care									
None or Minor	1(100.0)[4]	5(83.3)	3(100.0)		1(100.0)	4(100.0)			14(93.3)
Clear Airway									
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen		1(16.6)							1(6.7)
Cardiac Massage									
Control Bleeding									
Bandage									
Splint									
Backboard		1(16.7)							1(6.7)
Transportation to Hospital									
No Warning Device		6(100.0)	2(66.7)			2(50.0)			10(66.7)
Red Light						1(25.0)			1(6.6)
Red Light & Siren	1(100.0)		1(33.3)		1(100.0)	1(25.0)			4(26.7)
In-Transit Care									
None or Minor		5(83.3)	3(100.0)			1(25.0)			11(74.3)
Clear Airway						2(50.0)			2(13.3)
Artificial Respirat.									
Resuscitator	1(100.0)								1(6.6)
Airway Tube									
Oxygen		1(16.6)			1(100.0)	1(25.0)			3(20.0)
Cardiac Massage									
Control Bleeding									
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-26

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF NONTRAUMATIC BLOOD LOSS

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=0)[1]	No Threat to Life (N=9)	Threat to Life But Survived[2] (N=3)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=2)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=14)
On-Scene Care									
None or Minor		5(55.5)[4]	3(100.0)			2(100.0)			10(71.4)
Clear Airway		1(11.1)							1(7.1)
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen									
Cardiac Massage									
Control Bleeding		4(44.4)							4(28.5)
Bandage									
Splint									
Backboard									
Transportation to Hospital									
No Warning Device		9(100.0)	3(100.0)			2(100.0)			14(100.0)
Red Light									
Red Light & Siren									
In-Transit Care									
None or Minor		8(88.8)	2(66.6)			2(100.0)			12(85.7)
Clear Airway									
Artificial Respiration									
Resuscitator									
Airway Tube									
Oxygen			1(33.3)						1(7.1)
Cardiac Massage									
Control Bleeding		1(11.1)							1(7.1)
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-27

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF INFECTIONS

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=1)[1]	No Threat to Life (N=21)	Threat to Life But Survived[2] (N=0)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=1)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=23)
On-Scene Care									
None or Minor		20(95.4)				1(100.0)			21(91.3)
Clear Airway	1(100.0)[4]								1(4.3)
Artificial Respirat.									
Resuscitator	1(100.0)								1(4.3)
Airway Tube									
Oxygen		1(4.8)							1(4.3)
Cardiac Massage									
Control Bleeding									
Bandage									
Splint									
Backboard									
Transportation to Hospital									
No Warning Device		19(90.5)				1(100.0)			20(87.0)
Red Light									
Red Light & Siren	1(100.0)	2(9.5)							3(13.0)
In-Transit Care									
None or Minor		19(90.5)							19(82.8)
Clear Airway	1(100.0)								1(4.3)
Artificial Respirat.									
Resuscitator	1(100.0)								1(4.3)
Airway Tube	1(100.0)								1(4.3)
Oxygen		2(9.5)				1(100.0)			3(13.0)
Cardiac Massage									
Control Bleeding									
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-28

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF COMA, FAINTING, DEHYDRATION AND METABOLIC DISORDERS

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=1)[1]	No Threat to Life (N=126)	Threat to Life But Survived[2] (N=6)	Died On Scene or In Transit (N=1)	Died in Emergency Room (N=0)	Died in Hospital (N=3)	Died After Hospital Discharge[2] (N=1)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=139)
On-Scene Care									
None or Minor		116(92.0)[4]	4(66.6)	1(100.0)		3(100.0)	1(100.0)		125(89.9)
Clear Airway		4(3.1)	1(16.6)						5(3.5)
Artificial Respirat.									
Resuscitator	1(100.0)								1(0.7)
Airway Tube	1(100.0)								1(0.7)
Oxygen		8(6.3)	1(16.6)						9(0.6)
Cardiac Massage	1(100.0)								1(0.7)
Control Bleeding									
Bandage									
Splint									
Backboard		1(.01)	1(16.7)						2(1.4)
Transportation to Hospital									
No Warning Device		112(88.9)	4(66.7)			1(33.3)			117(84.2)
Red Light									
Red Light & Siren	1(100.0)	14(11.1)	2(33.3)	1(100.0)		2(66.7)	1(100.0)	1(100.0)	22(15.8)
In-Transit Care									
None or Minor		112(88.8)	4(66.6)			2(66.7)	1(100.0)	1(100.0)	120(86.3)
Clear Airway		3(2.3)	1(16.6)						4(2.8)
Artificial Respirat.									
Resuscitator	1(100.0)								1(0.7)
Airway Tube				1(100.0)					1(0.7)
Oxygen		13(10.3)	1(16.6)			1(33.3)			15(10.7)
Cardiac Massage	1(100.0)			1(100.0)					2(1.4)
Control Bleeding									
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-29

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF OBSTETRICAL COMPLICATIONS

	Number of Victims in Each Category of Severity or Medical Outcome								
Activity	Dead on Arrival At Scene (N=0)[1]	No Threat to Life (N=21)	Threat to Life But Survived[2] (N=3)]	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=0)	Died in Hospital (N=0)	Died After Hospital Discharge[2] (N=0)	Unknown Medical Outcome[3] (N=0)	Total for All Victims (N=24)
On-Scene Care									
None or Minor		20(95.3)[4]	3(100.0)						23(95.8)
Clear Airway		1(4.8)							1(4.2)
Artificial Respirat.									
Resuscitator									
Airway Tube									
Oxygen		1(4.8)							1(4.2)
Cardiac Massage									
Control Bleeding									
Bandage									
Splint									
Backboard									
Transportation to Hospital									
No Warning Device		12(57.1)	2(66.7)						14(58.3)
Red Light									
Red Light & Siren		9(42.9)	1(33.3)						10(41.7)
In-Transit Care									
None or Minor		18(85.7)	3(100.0)						21(87.5)
Clear Airway		2(9.5)							2(8.3)
Artificial Respirat.									
Resuscitator		1(4.8)							1(4.2)
Airway Tube									
Oxygen									
Cardiac Massage									
Control Bleeding		1(4.8)							1(4.2)
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

TABLE VII-A-30

KINDS OF CARE AND MODE OF TRANSPORTATION TO HOSPITAL PROVIDED BY AMBULANCES TO VICTIMS OF RESPIRATORY DYSFUNCTION

Number of Victims in Each Category of Severity or Medical Outcome

Activity	Dead on Arrival At Scene (N=0)[1]	No Threat to Life (N=34)	Threat to Life But Survived (N=4)	Died On Scene or In Transit (N=0)	Died in Emergency Room (N=1)	Died in Hospital (N=1)	Died After Hospital Discharge[2] (N=2)	Unknown Medical Outcome[3] (N=1)	Total for All Victims (N=43)
On-Scene Care									
None or Minor		23(67.6)[4]	4(100.0)				1(50.0)		28(65.1)
Clear Airway		1(2.9)							1(2.3)
Artificial Respiration		1(2.9)							1(2.3)
Resuscitator		1(2.9)							1(2.3)
Airway Tube		1(2.9)							1(2.3)
Oxygen		10(29.4)			1(100.0)	1(100.0)	1(50.0)	1(100.0)	14(32.5)
Cardiac Massage									
Control Bleeding									
Bandage									
Splint									
Backboard									
Transportation to Hospital									
No Warning Device		28(82.3)	4(100.0)		1(100.0)		2(100.0)		35(81.4)
Red Light									
Red Light & Siren		6(17.6)				1(100.0)		1(100.0)	8(18.6)
In-Transit Care									
None or Minor		15(44.1)	3(75.0)		1(100.0)		1(50.0)		20(46.5)
Clear Airway		1(2.9)							1(2.3)
Artificial Respiration		1(2.9)							1(2.3)
Resuscitator		2(5.8)				1(100.0)			3(6.9)
Airway Tube		1(2.9)							1(2.3)
Oxygen		18(52.9)	1(25.0)				1(50.0)	1(100.0)	21(61.8)
Cardiac Massage									
Control Bleeding									
Bandage									

[1] Number of Cases.

[2] 90 days after discharge from hospital.

[3] Victim was taken to a hospital that did not cooperate in the demonstration.

[4] Percentage of the number of cases in the category of severity or medical outcome.

victim with a backboard also were rendered by both paramedics and ambulance attendants. There was no use of advanced life support care, such as I.V. solutions to forestall possible hemmorhagic shock, by the paramedics in handling the two victims in life threatening condition.

Lacerations and penetrating injuries. Most of the care given to victims in this category was rendered at the scene by both paramedics and ambulance attendants. The kinds of care most frequently rendered were bandaging and control of bleeding. Paramedics and ambulance attendants bandaged 71.4 and 67.1 percent and controlled bleeding in 50.8 and 36.6 percent of all of the victims that they handled respectively. Two of the 12 victims with life threatening conditions who were handled by the paramedics were given I.V. solutions enroute to the hospital.

Crushing, perforation and internal injuries. Most of the care given to victims in this category was rendered on-scene by both paramedics and ambulance attendants. The kinds of care most frequently rendered were bandaging, control of bleeding and splinting. Paramedics and ambulance attendants bandaged 43.5 and 42.2 percent, controlled bleeding in 30.4 and 27.2 percent, and splinted 17.4 and 35.5 percent of all victims that they handled respectively. One of the eight victims, with life threatening conditions who were handled by the paramedics, was given I.V. fluids enroute to the hospital.

Poisoning and overdoses. The paramedics rendered more care at the scene and ambulance attendants rendered almost equal care at the scene and enroute to the hospital. More than 80 percent of the victims who were handled by ambulance attendants receive no or only minor care. More than half of the victims who were handled by the paramedics receive some sort of significant care. All care rendered by the ambulance attendants was associated with maintenance of ventilation, namely clearing the airway, artificial respiration, administration of oxygen, etc. A major portion of care rendered by the paramedics also was concerned with maintenance of ventilation. Such care was used far more frequently by the paramedics than by the ambulance attendants. For example, the paramedics cleared airways in 18.5 percent of all victims that they handled and ambulance attendants in only 9.1 percent of the cases that they handled. There was an even greater disparity in the use of oxygen. Paramedics administered oxygen on-scene and enroute to the hospital to 33.1 and 23.3 percent respectively of the victims that they handled. The corresponding percentages for victims handled by ambulance attendants were 4.8 and 9.6 respectively. The paramedics made substantial use of I.V. fluids and drugs. Of the 42 life threatening cases handled by the paramedics, 22 or 52.3 percent received such care on-scene and 19 or 45.3 percent received it enroute to the hospital. Three of the life threatened victims were defibrillated.

Suffication, asphyxiation, drowning and strangulation. Most of the care given to victims in this category was rendered on-scene by paramedics and enroute to the hospital by the ambulance attendants. All care rendered by the ambulance attendants was associated with the maintenance of ventilation, namely clearing the airway and giving of oxygen. The paramedics also administered care associated with maintenance of ventilation. In addition to clearing the airway and giving of oxygen, they administered artificial respiration and employed airway tubes and resuscitators. Of the victims in a life threatening condition who were cared for by paramedics, one required extensive life supportive care. He was given cardiac massage and drugs or I.V. fluids and was defibrillated on-scene and defibrillated again enroute to the hospital.

Central nervous system injuries. Most of the care given to victims in this category was rendered on-scene by both the paramedics and ambulance attendants. The care rendered encompassed the entire spectrum that could be provided by both kinds of emergency vehicle crewmen. The kinds of care most frequently given were bandaging, control of bleeding, clearing the airway, splinting and use of a backboard during handling. With the exception of roughly equal use of a backboard, the paramedics provided these kinds of care on-scene to a higher proportion of the victims whom they handled than did the ambulance attendants. Both the paramedics and ambulance attendants administered closed chest cardiac massage to victims in life threatening conditions. One of the 16 life threatened victims was given cardiac massage enroute by ambulance attendants. Cardiac massage was administered once on-scene and to three victims with life threatening conditions enroute by paramedics. The paramedics also gave advanced life supportive care. One victim with a life threatening condition was defibrillated on-scene. I.V. solutions and/or drugs were administered three times on-scene and four times enroute to victims with life threatening conditions.

Hypertensive and arteriosclerotic heart disease. Most care given to victims in this category was rendered on-scene by paramedics and enroute to the hospital by ambulance attendants. On-scene, all of the kinds of care that are associated with the maintenance of ventilation were provided to a higher proportion of the victims handled by the paramedics than of those handled by ambulance attendants. Enroute to the hospital, this also was the case for each kind of such care except the clearing of the airway and the use of the resuscitator, which the ambulance attendants performed more frequently. The paramedics defibrillated eight of the 56 victims, with life threatening conditions, on-scene and one enroute. The paramedics also administered I.V. fluids and/or drugs to 38 victims with life threatening conditions on-scene and continued this kind of care for 36 of these victims enroute to the hospital. I.V. fluids and/or drugs were also administered on-scene to 51.3 percent of the victims with no threat to their life and this care was continued enroute for 30.2 percent of these victims.

Hypertensive and arteriosclerotic cerebro-vascular disease. Most of the care given victims in this category was rendered on-scene by paramedics and enroute to the hospital by ambulance attendants. The ambulance attendants gave care to only one victim on-scene. He or she received oxygen but was not in a life threatening condition. Enroute to the hospital, the ambulance attendants gave the kinds of care that are associated with the maintenance of ventilation to all but one of the eight victims with life threatening conditions whom they handled. In contrast, the paramedics administered oxygen on-scene to 13 and enroute to the hospital to 10 of 19 victims with life threatening conditions. The paramedics also administered I.V. fluids and/or drugs on-scene to 10 of the victims with life threatening conditions and continued this care enroute to the hospital for nine of these victims.

Nontraumatic blood loss. Most of the care given victims in this category was rendered on-scene by both paramedics and ambulance attendants. The ambulance attendants gave no care on-scene to the five victims with life threatening conditions and only administered oxygen to one of these victims enroute to the hospital. They controlled bleeding on-scene for four of the victims with no life threat and enroute for one of these victims. The paramedics administered care on-scene associated with maintenance of ventilation for more than half of the seven victims with life threatening conditions whom they handled. They controlled bleeding on-scene for one of these victims. The paramedics administered I.V. fluids and/or drugs on-scene to four victims with life threatening conditions and to five of these victims while enroute to the hospital.

Infections. Most of the care given victims in this category was rendered on-scene by the paramedics and enroute by the ambulance attendants. The ambulance attendants gave no care on-scene to the one victim with a life threatening condition. He was given oxygen enroute to the hospital. The administration of oxygen was the only kind given by ambulance attendants to victims with no life threat. The clearance of the airway and the administration of oxygen were the only kinds of conventional care given by the paramedics. The paramedics also administered drugs and/or I.V. fluids to the one victim who was in a life threatening condition.

Coma, fainting, dehydration and metabolic disorders. Care given in this category was rendered about equally on-scene and enroute to the hospital by both paramedics and ambulance attendants. The ambulance attendants gave no care or only minor care to 89.9 percent and 86.3 percent of the victims on-scene and enroute respectively. They gave care associated with maintenance of ventilation to a small proportion of the victims they handled. They gave cardiac massage enroute to one victim who died before reaching the hospital. The paramedics care on-scene and enroute to the hospital also was largely that associated with maintenance of ventilation. Seven of the eight victims with life threatening conditions were administered I.V. fluids and/or drugs on-scene and this care was continued enroute to the hospital for four of these victims.

Obstetical complications. Care was divided approximately evenly between that given on-scene and that given enroute for both the paramedics and the ambulance attendants. The conventional kinds of care rendered by both kinds of crewmen were limited to the maintenance of ventilation, namely clearing the airway, administration of oxygen and use of the resuscitator. The ambulance attendants gave no care or only minor care to the three victims with life threatening conditions. The care given by the paramedics to the one victim that they handled who had a life threatening condition was limited to the administration of I.V. fluids.

Respiratory dysfunction. Most of the care given in this category was rendered on-scene by paramedics and enroute to the hospital by ambulance attendants. The care by both kinds of crewmen of emergency medical vehicles was focused on the maintenance of ventilation largely through the administering of oxygen. The paramedics administered I.V. fluids and/or drugs both on-scene and enroute to the hospital to half of the sixteen victims with life threatening conditions.

Dead on arrival at scene. Both the paramedics and ambulance attendants attempted to resuscitate the majority of victims who were pulseless and breathless when the emergency medical vehicle arrived at the scene. These attempts included both ventilation and closed chest massage. In addition, the paramedics attempted to establish a heart beat and control arrhythmias through the use of drugs. In the event that a heart beat was established but went into acute fibrillation, cardioversion was attempted by electrical countershock defibrillation. In a few cases, the paramedics were successful at resuscitating a "dead" victim.

In summary, with regard to the kinds of care rendered, several generalizations can be made. First, the mobile intensive care paramedics tended to make relatively greater use of conventional kinds of care than the ambulance attendants. Second, the paramedics gave most of the care on-scene before transporting the victim to the hospital. The ambulance attendants also tended to give most of the care on-scene in cases of injuries. In cases of illnesses, the pattern varied with category of illness. The more serious the illnesses, the greater was the tendency of the ambulance attendants to speed the victim to the hospital and give care enroute. This is understandable since they lacked the training and authority to render advanced life supportive care.

Table VII-A-31 summarizes the employment of the various modes of transport to the hospital for the aggregation of all categories of illness and injury involving a threat to life. Because of the diagnostic training given to the paramedics and the fact that they were in voice communication with physicians at the hospital, it was anticipated that better diagnoses and more accurate assessments of severity would be made when the victim was handled by a MICU rather than by an ambulance. From this, it would be reasonable to hypothesize that the appropriate mode of transport to the hospital would be employed more frequently by the MICUs than by the ambulances. This appears to be the case for victims who were dead on arrival (D.O.A.) at the scene. When there is no hope of resuscitation, there is no purpose in speeding to the hospital and one would expect a proportion of D.O.A. transports to be made with no warning device on the

TABLE VII-A-31

EMPLOYMENT OF EACH MODE OF TRANSPORTATION TO HOSPITAL FOR THE AGGREGATION OF ALL CATEGORIES OF ILLNESS AND INJURY INVOLVING THREAT TO LIFE

Mode of Transportation to Hospital	Number of Victims in Each Category of Severity or Medical Outcome					
	Dead on Arrival at Scene		No Threat to Life		Threat to Life	
	MICU (N=115)	Amb. (N=34)	MICU (N=787)	Amb. (N=1037)	MICU (N=196)	Amb. (N=146)
No Warning Device	16(3.9)[1]	0	443(56.3)	778(75.0)	55(28.1)	68(46.6)
Red Light	1(0.9)	0	20(2.5)	4(0.4)	6(3.1)	2(1.4)
Red Light and Siren	98(85.2)	34(100.0)	324(41.2)	255(24.6)	135(68.8)	76(52.0)

[1] Percentage of victims in given category of severity or medical outcome who were handled by specified kind of emergency medical vehicle.

vehicle being employed. All D.O.A. transports by ambulances were made with red light and siren. About 85.0 percent of the D.O.A. transports by the MICUs were made with red light and siren. It was anticipated that a smaller proportion of victims with no threat to life would be transported with red light and siren by MICUs than by ambulances. This was not the case. The MICUs transported 41.2 percent of such victims in a red light and siren mode while the ambulance companies transported only 24.6 percent in this mode. There was some uncertainty in the a priori expectation with regard to victims with life threatening conditions. First, other things being equal, it would be expected that a higher proportion of such victims would be transported in the red light and siren mode by MICUs than by ambulances. Second, however, to the extent that the paramedics were able to stabilize the victims before transporting them to the hospital, the need for transporting them in the red light and siren mode would be eliminated. The actual data indicates that 68.8 percent of victims with a life threatening condition were transported in the red light and siren mode by the MICUs and 52.0 percent were transported in this mode by the ambulances.

7. Effectiveness and Cost of the Mobile Intensive Care Units

As discussed in Section III-B, the ultimate criteria by which an existing potential emergency medical system or subsystem should be evaluated are its effectiveness, namely the medical outcomes for victims of medical emergencies who come from the population or geographical area that it serves, and its costs.

a. Medical Outcomes. As discussed in Section VI-D, the range of possible medical outcomes is broad. The most appropriate measure of medical outcomes for emergency medical systems is the survival rate among the victims that are served. Subjectively for most people, life or death dominates the other dimensions of medical outcomes.

A number of alternatively defined means of calculating the survival rate could be used to evaluate the effectiveness of the patterns of care provided by the crews of the two kinds of emergency medical vehicles. Two dimensions were critical. The first was the population of victims that was to be taken as the base. The second was the point in time or in the sequence of events at which the survival rate was to be determined.

With regard to the population of victims, two aspects were considered. The first was the level(s) of severity of illness or injury to be included in the population of victims, for which MICUs and ambulances are compared. For the present study, a decision was made to restrict the reference population to those victims who were alive when the unit arrived at the scene and who had a life threatening condition. The reasons for this decision were two-fold. First, these victims constituted the group whose members were either going to live or die. Second, the inclusion in the reference population of victims, who did not have a life threatening condition, would have distorted the observed survival rates for MICUs and ambulances to the extent that there were differences in the proportion of victims with life threatening condition in the two populations of victims.

The second aspect of the reference population of victims that was considered was the composition of injuries and illnesses within the populations served by MICUs and by ambulances. A decision was made to compare the survival rates between MICUs and ambulance on the basis of both the individual categories of illnesses and injuries and on the basis of a normalized mix of illnesses and injuries. The normalized mix was simply that produced by aggregating the victims with a life threatening condition who were handled by MICUs and ambulances.

With regard to the point in time or in the sequence of events at which the survival rate was to be determined, a decision was made to use two points. The first was the point at which responsibility for the victim was assumed by the staff of the emergency room. The survival rates defined at this point reflected the extent to which the crews of MICUs and ambulance were able to sustain the life of victims with life threatening conditions until they could be delivered to the hospital where definitive treatment could be rendered. The second point was 90 days after the discharge of the victim from the hospital. Only those victims who died as a direct result of the specific medical emergency were considered in determining the survival rate of this point in time. Although arbitrarily defined, this period of time was sufficiently long to provide a reasonable estimate of the long term survival rate directly associable with a specific emergency medical incident. The survival rates defined at this point reflected the extent to which the care provided on-scene and enroute to the hospital by the crews of the MICUs and ambulances contributed to both the short and long term survival of victims with life threatening conditions.

Tables VII-A-32 and VII-A-33 present the kinds of medical emergencies and their outcomes for victims handled respectively by the MICUs and by the ambulances. The relative proportions of the different kinds of injuries and illnesses differed substantially among victims handled by the MICUs and by the ambulances. In general, the MICUs handled mostly illnesses and the ambulances mostly injuries. Excluding the category of "Unknown," the MICUs handled 65.9 and 34.1 percent illnesses and injuries respectively. The comparable percentages for the ambulances were 23.5 percent illnesses and 76.5 percent injuries. This was largely the result of the previously mentioned policies that guided the dispatcher at the Sheriff's substation when, in response to a call for an ambulance, he decided whether to request the County's MICU or a private ambulance under contract to the County. The kinds of incidents that occurred in the area of the County served by Rescue Squad 59/36 (MICU) and the private ambulance company and those that occurred in the area of the City served by rescue ambulances RA 53 (MICU) and RA 38, were very similar. For example, traffic related accidents comprised 30.0 and 31.5 percent of the runs in the County and City service areas respectively. Within the City's service area traffic related accidents were almost evenly divided between RA 53 (MICU) and RA 38 (ambulance); the percentages were 30.9 and 31.8 respectively. Within the County's service area, however, the policy of dispatching Rescue Squad 59/36 (MICU) primarily for cases suspected to require cardiopulmonary resuscitation lead to a very different division. The percentages of traffic related accidents were 10.0 and 50.9 for Rescue Squad 59/36 and the private ambulance company respectively.

TABLE VII-A-32

KINDS OF MEDICAL EMERGENCIES AND THEIR OUTCOMES FOR VICTIMS HANDLED BY MOBILE INTENSIVE CARE UNITS

Category of Illness or Injury	Total Number of Victims	Number Dead on Arrival (D.O.A.) at Scene	Number with Unknown Severity/ Outcome[1]	Number with No Threat to Life	Number with Threat to Life	Number with Threat to Life Who Through 90 Days After Hospital Discharge: Survived	Died	Number Alive When Unit Arrived Who Died Within 90 Days As A Direct Result of Specified Injury or Illness: On Scene Or In Transit	Emergency Room	Hospital	Post Hospital
A. Burn	9 (0.7)[2]	0 (0.0)[3]	0 (0.0)[3]	9 (100.0)[4]	0 (0.0)[4]	( )[5]	( )[5]	( )[6]	( )[6]	( )[6]	( )[6]
B. Cold	0 (0.0)										
C. Electrical	3 (0.2)	1 (33.3)	0	1 (50.0)	1 (50.0)	0 (0.0)	1 (100.0)	0	0	1 (100.0)	
D. Fractures	69 (5.0)	0	1 (1.4)	66 (97.0)	2 (3.0)	2 (100.0)	0 (0.0)				
E. Lacerations	126 (9.1)	2 (1.6)	1 (0.8)	111 (90.2)	12 (9.8)	10 (83.3)	2 (16.7)	1 (50.0)	1 (50.0)		
F. Crushing	23 (1.7)	2 (8.7)	1 (4.3)	12 (60.0)	8 (40.0)	6 (75.0)	2 (25.0)	1 (50.0)		1 (50.0)	
G. Poisoning	163 (11.8)	4 (2.5)	0 (0.0)	117 (76.5)	42 (23.5)	38 (90.5)	4 (9.5)		1 (25.0)	2 (50.0)	1 (25.0)
H. Bite	0 (0.0)										
J. Suffocation	17 (1.2)	4 (23.5)	1 (5.9)	5 (41.7)	7 (58.3)	7 (100.0)	0 (0.0)				
K. C.N.S.	55 (4.0)	3 (5.5)	2 (3.6)	35 (70.0)	15 (30.0)	10 (66.7)	5 (33.3)	1 (20.0)	1 (20.0)	1 (20.0)	2 (40.0)
L. Minor Injury	121 (8.8)	0	0	121 (100.0)	0 (0.0)						
1. Cardio-Vasc.	249 (18.0)	92 (36.9)	25 (10.0)	76 (57.6)	56 (42.4)	37 (66.1)	19 (33.9)	7 (36.8)	0	5 (26.4)	7 (36.8)
2. Cerebro-Vasc.	48 (3.5)	2 (4.2)	1 (2.1)	26 (57.8)	19 (42.2)	8 (42.1)	11 (57.9)	0	0	10 (90.9)	1 (9.1)
3. Bleeding	20 (1.4)	0	2 (10.0)	11 (61.1)	7 (38.9)	4 (57.1)	3 (42.9)	0	0	3 (100.0)	0
4. Infections	19 (1.4)	1 (5.0)	0	17 (94.4)	1 (5.6)	1 (100.0)	0 (0.0)				
5. Flu, etc.	1 (0.1)	0	0	1 (100.0)	0						
6. Convulsions	5 (0.4)	0	0	5 (100.0)	0						
7. Coma, etc.	229 (16.6)	3 (1.3)	2 (0.9)	215 (96.0)	9 (4.0)	8 (88.9)	1 (11.1)	1 (100.0)	0	0	0
8. Obstetrical	14 (1.0)	0	0	13 (92.9)	1 (7.1)	1 (100.0)	0 (0.0)				
9. Respiratory	94 (6.8)	1 (1.1)	4 (4.3)	73 (82.0)	16 (18.0)	10 (62.5)	6 (37.5)		1 (16.7)	4 (66.7)	1 (16.7)
10. Minor Illness	54 (3.9)	0	0	54 (100.0)	0						
11. Emotional	44 (3.2)	0	0	44 (100.0)	0						
Unknown	16 (1.2)	4 (25.0)	5 (31.3)	7 (100.0)	0						
TOTAL	1379 (100.0)	119 (8.6)	45 (3.3)	1019 (83.9)	196 (16.1)	142 (72.4)	54 (27.6)	11 (20.4)	4 (7.4)	27 (50.0)	12 (22.2)

[1] Victim was taken to a hospital that did not cooperate in the demonstration.

[2] Percentage of victims in all categories.

[3] Percentage of victims in this category.

[4] Percentage of victims in this category (excluding D.O.A. and unknown severity/outcome).

[5] Percentage of victims with life threat in this category.

[6] Percentage of victims who died in this category.

TABLE VII-A-33

KINDS OF MEDICAL EMERGENCIES AND THEIR OUTCOMES FOR VICTIMS HANDLED BY AMBULANCES

Category of Illness or Injury	Total Number of Victims	Number Dead on Arrival (D.O.A.) at Scene	Number with Unknown Severity/ Outcomes[1]	Number with No Threat to Life	Number with Threat to Life	Number with Threat to Life Who Through 90 Days After Hospital Discharge: Survived	Died	Number Alive When Unit Arrived Who Died Within 90 Days As A Direct Result of Specified Injury or Illness: On Scene Or In Transit	Emergency Room	Hospital	Post Hospital
A. Burn	11 (0.6)[2]	0 (0.0)[3]	0 (0.0)[3]	10 (90.9)[4]	1 (9.1)[4]	0 (0.0)[5]	1 (100.0)[5]	( )[6]	( )[6]	1 (100.0)[6]	( )[6]
B. Cold	0										
C. Electrical	0										
D. Fractures	180 (10.2)	0	0	175 (97.2)	5 (2.8)	3 (60.0)	2 (40.0)	1 (50.0)	0	1 (50.0)	0
E. Lacerations	374 (21.3)	7 (1.9)	1 (0.3)	346 (93.0)	20 (5.4)	17 (85.0)	3 (15.0)	1 (33.3)	1 (33.3)		1 (33.3)
F. Crushing	45 (2.6)	3 (6.7)	1 (2.2)	23 (56.1)	18 (43.9)	14 (77.8)	4 (22.2)	2 (50.0)	0	2 (50.0)	0
G. Poisoning	207 (11.8)	1 (0.5)	1 (0.5)	173 (84.4)	32 (15.6)	30 (93.8)	2 (6.2)	0	1 (50.0)	1 (50.0)	0
H. Bite	1 (0.0)	0	0	1 (100.0)	0						
J. Suffocation	4 (0.2)	0	0	3 (75.0)	1 (25.0)	1 (100.0)	0 (0.0)				
K. C.N.S.	96 (5.5)	8 (8.3)	0	70 (79.5)	18 (20.5)	13 (72.2)	5 (27.8)	0	1 (20.0)	2 (40.0)	2 (40.0)
L. Minor Injury	418 (23.8)	0	0	418 (100.0)	0						
1. Cardio-Vasc.	47 (2.7)	12 (25.5)	0	20 (57.1)	15 (42.9)	7 (46.7)	8 (53.3)	2 (25.0)	1 (12.5)	5 (62.5)	0
2. Cerebro-Vasc.	15 (0.9)	1 (6.7)	0	6 (42.8)	8 (57.2)	3 (37.5)	5 (62.5)	0	1 (20.0)	4 (80.0)	0
3. Bleeding	14 (0.8)	0	0	9 (64.3)	5 (35.7)	3 (60.0)	2 (40.0)	0	0	2 (100.0)	0
4. Infections	23 (1.3)	1 (4.3)	0	21 (95.5)	1 (4.5)	0 (0.0)	1 (100.0)	0	0	1 (100.0)	0
5. Flu, etc.	6 (0.3)	0	0	6 (100.0)	0						
6. Convulsions	5 (0.3)	0	0	5 (100.0)	0						
7. Coma, etc.	139 (7.9)	1 (0.7)	1 (0.7)	126 (92.0)	11 (8.0)	6 (54.5)	5 (45.5)	1 (20.0)	0	3 (60.0)	1 (20.0)
8. Obstetrical	24 (1.4)	0	0	21 (87.5)	3 (12.5)	3 (100.0)	0 (0.0)				
9. Respiratory	43 (2.4)	0	1 (2.3)	34 (81.0)	8 (19.0)	4 (50.0)	4 (50.0)	0	1 (12.5)	1 (12.5)	2 (25.0)
10. Minor Illness	47 (2.7)	0	0	47 (100.0)	0						
11. Emotional	47 (2.7)	0	0	47 (100.0)	0						
Unknown	9 (0.5)	6 (66.7)	0	3 (100.0)	0						
TOTAL	1755 (100.0)	40 (2.3)	5 (0.3)	1564 (91.5)	146 (8.5)	104 (71.2)	42 (28.8)	7 (16.6)	6 (14.3)	23 (54.8)	6 (14.3)

[1] Victim was taken to a hospital that did not cooperate in the demonstration.

[2] Percentage of victims in all categories

[3] Percentage of victims in this category.

[4] Percentage of victims in this category (excluding D.O.A. and unknown severity/outcome).

[5] Percentage of victims with life threat in this category.

[6] Percentage of victims who died in this category.

The proportions of cases, which involved a threat to life, differed markedly between the various kinds of injuries and illnesses. The proportion of cases, which the victim already was dead when the emergency medical vehicle arrived at the scene, also differed markedly between the various kinds of injuries and illness. These differences in concert with the fact that the proportion of each kind of injury or illness differed between the MICUs and the ambulances, led to corresponding differences in the proportion cases that involved a threat to life and those in which the victim was dead on arrival of the emergency medical vehicle at the scene. Among victims who were alive at the time that the emergency medical vehicle arrived at the scene and the severity of whose condition was known, 16.1 and 8.5 percent of those handled by the MICUs and by the ambulances respectively had life threatening conditions. 8.6 and 2.3 percent of all of the victims handled by the MICUs and by the ambulances respectively were dead when the unit arrived at the scene.

The large differences, between the categories of injuries and illness in terms of the numbers of victims with life threatening conditions, created problems in testing the statistical significance of the observed differences in survival rates between victims handled by the MICUs and by the ambulances. First, the sample size of victims with life threatening cases was simply too small for the differences in survival rates within most categories of injury or illness to be statistically significant. Second, these variations in sample size necessitated the use of three different statistical tests. For each of the three tests, the null hypothesis was that the proportion of victims who survived (or died) was the same whether the victims were handled by the MICUs or by the ambulances. It should be noted that the proportion surviving is equal to the survival rate (expressed as a percentage) divided by 100. For categories in which the sample sizes were small, two way classification tests were used to test null hypothesis. When the combined sample size of victims handled by MICUs and ambulances was twenty or less, Fisher's Exact Test, which considers the observed proportions in a 2 X 2 classification table to be estimates of the parameters of two binomial populations, was used to obtain the probability necessary to test the null hypothesis. To carry out Fisher's Exact Test, it is necessary to determine the sum of the probabilities of all possible proportions with the same marginal totals that are more divergent than those observed. Because this is a laborious process even with a computer, the Chi-Square approximation, incorporating Yates continuity correction, was employed when the combined sample size of victims handled by the MICUs and ambulances was greater than 20. Finally, when the combined sample size was greater than twenty and the product of the observed proportion of victims, who survived or who died (whichever quantity was smaller), multiplied by the number of victims was greater than five for both the MICUs and the ambulances, a normal approximation was used. Fisher's Exact Test and the Chi-Square Test are "one-tailed" tests of the null hypothesis that the observed proportions in a two-way classification table are independent. Since there was no _a priori_ reason to expect that the proportion of survivors among victims handled by MICUs would be less than that among victims handled by ambulances, a one-tailed test was used as well for the normal approximation; exceptions will be noted specifically.

For each category of injury or illness, in which one or more victims who were alive at the time that the emergency medical vehicle arrived at the scene died before reaching the emergency room, Table VII-A-34 presents the results of the testing of the statistical significance of the observed difference between MICUs and ambulances in terms of their survival rates at the time of arrival at the emergency room. It was recognized by physicians and surgeons at Harbor General Hospital that, in a limited number of specific cases, the kinds of advance life supportive care that the paramedics delivered on-scene or enroute was directly responsible for the survival of victims whose prognoses in the absence of such care would have been death before reaching the hospital. Despite these instances, there was no category of injury or illness, for which the observed survival rates to the emergency room was statistically different for victims handled by the MICUs and by the ambulances. It is reasonable to presume

TABLE VII-A-34

STATISTICAL TESTS OF SIGNIFICANCE OF DIFFERENCES IN SURVIVAL RATES UPON ARRIVAL AT EMERGENCY ROOM

Category of Illness or Injury	Survival Rate Upon Arrival at Emergency Room		Differences in Survival Rates (MICU - Amb.)	Statistical Test That Was Employed To Test Null Hypothesis	Level of Significance[1]	Decision on Null Hypothesis that Survival Rates Are Equal for MICU and Ambulances
	MICU	Amb.				
D. Fractures	100.0	80.0	+20.0	Fisher's Exact Test	0.71	Accept
E. Lacerations	91.7	95.0	- 3.3	Corrected Chi Square	0.70	Accept
F. Crushing	87.5	88.9	- 1.4	Corrected Chi Square	0.58	Accept
K. C.N.S.	93.3	100.0	- 6.7	Corrected Chi Square	0.97	Accept
1. Cardio-Vasc.	87.5	86.7	0.8	Corrected Chi Square	0.72	Accept
7. Coma, etc.	88.9	90.9	- 2.0	Fisher's Exact Test	0.81	Accept

[1] Probability that a difference in empirical survival rates at least as large as that observed will occur due to sampling error when the true survival rates are equal.

that three considerations contributed to the absence of any statistically significant differences. First, there well may be categories of injuries and illness, which involve threats to life but for which the kinds of advanced care that can be given by the paramedics do not affect the short term survival rate. Second, from Table VII-A-1, the mean period of time, during which victims in life threatening conditions were in the care of ambulance attendants was only 15.0. Even within categories, such as "crushing, perforation and internal injuries" and "hypertensive and arteriosclerotic heart disease," only a fraction of the victims with life threatening conditions would have required advanced care such as the administration of I.V. fluids or countershock defibrillation within a span of fifteen minutes to prevent irreversible hemorrhagic shock or "electrical death" respectively. Third, the number of cases was too small for the statistical tests to be discriminantly powerful. Of the total 3,134 cases that were handled by the MICUs and the ambulances, only 342 were judged to pose a serious threat to life. If these had been divided evenly among the fifteen categories of injuries and illness, which involved cases with life threatening conditions, each category would have contained only twenty-three cases. In combination, the last two considerations would mask any real differences in survival rates to the emergency room.

For each category of injury or illnesses, in which one or more victims who were alive at the time that the emergency medical vehicle arrived at the scene died within 90 days after discharge from the hospital, Table VII-A-35 presents the results of the testing of the statistical significance of the observed difference between MICUs and ambulances in survival rates 90 days after hospital discharge. The only category for which the observed difference in survival rates was statistically significant at the 0.10 level was "hypertensive and arteriosclerotic heart disease." It had been expected that the major consequence of the capabilities of the paramedics to render advanced care to victims of myocardial infarctions, arrythmias and pulmonary edemas would be sustain the lives of those victims who otherwise would die before reaching the emergency room. As previously noted, however, the survival rates to the emergency room for MICUs and

TABLE VII-A-35

STATISTICAL TESTS OF SIGNIFICANCE OF DIFFERENCES IN SURVIVAL RATES 90 DAYS AFTER DISCHARGE FROM HOSPITAL

Category of Illness or Injury	Survival Rate 90 Days After Hospital Discharge		Differences in Survival Rates (MICU - Amb.)	Statistical Test That Was Employed To Test Null Hypothesis	Level of Significance[1]	Decision on Null Hypothesis that Survival Rates Are Equal for MICU and Ambulances
	MICU	Amb.				
D. Fractures	100.0	60.0	+ 40.0	Fisher's Exact Test	0.48	Accept
E. Lacerations	83.3	85.0	- 1.7	Corrected Chi Square	0.91	Accept
F. Crushing	75.0	77.8	- 2.8	Corrected Chi Square	0.91	Accept
G. Poisonings	90.5	93.8	- 3.3	Corrected Chi Square	0.94	Accept
K. C.N.S.	66.7	72.2	- 5.5	Corrected Chi Square	0.61	Accept
1. Cardio-Vasc.	66.1	46.7	+ 19.4	Normal Approximation	0.08	Reject
2. Cerebro-Vasc.	42.1	37.5	+ 4.6	Corrected Chi Square	0.82	Accept
3. Bleeding	57.1	60.0	- 2.9	Fisher's Exact Test	0.69	Accept
4. Infections	100.0	0.0	+100.0	Fisher's Exact Test	0.33	Accept
7. Coma, etc.	88.9	54.5	+ 34.4	Fisher's Exact Test	0.12	Accept
9. Respiratory	62.5	50.0	+ 12.5	Corrected Chi Square	0.89	Accept

[1] Probability that a difference in empirical survival rates at least as large as that observed will occur due to sampling error when the true survival rates are equal.

ambulances, namely 87.5 and 86.7 percent respectively, were roughly equal. This suggests that it is possible to keep victims with low or no cardiac output alive until they reach the emergency room by means of cardiopulmonary resuscitation (CPR), namely assisted ventilation and closed chest heart massage. The significant difference in the long term survival rates between victims handled by MICUs and by ambulances, suggests that the level of cardiac output that can be achieved by CPR is not sufficient to maintain enough coronary artery perfusion to limit the damage to this heart muscle. As an apparent consequence, there is a greater chance of death due to pump failure. Conversely, the kinds of advanced care that the paramedic can render, namely, I.V. fluids and drugs to maintain blood pressure and drugs and defibrillation to convert arrhythmias to normal sinus rhythms, can establish and maintain adequate coronary artery perfusion. Apparently, early restoration of normal perfusion limits the amount of damage that is done to the heart muscles and thus reduces the likelihood of subsequent death due to pump failure.

The observed survival rates 90 days after hospital discharge for the category "coma, fainting, dehydration and metabolic disorders" were 88.9 and 54.5 percent respectively for victims handled by the MICUs and by ambulances. Because of the small number of life threatening cases in this category, only a total of twenty, the level of significance of this large observed difference was 0.12. This level of significance indicates that observed for the twenty victims could happen only about one time out of eight if there was no real difference in the survival rates for victims handled by MICUs and by ambulances 90 days after discharge from the hospital.

A large proportion of the victims with life threatening conditions in this category were suffering from diabetic shock. The advanced care given by paramedics in such cases was the administration of insulin. Although of less statistical significance than that for the category of heart disease, the data suggest that the advanced care rendered by the paramedics enhanced the victims chances for long term survival. Again early restoration of physiological stability apparently limits the deterioration of the victim.

Two of the three considerations, which were noted in connection with survival rates to the emergency room, can be presumed to account for the absence of statistically significant differences in the survival rates of victims handled by the MICUs and by the ambulances for other categories of injuries and illnesses 90 days after discharge from the hospital. The first is the possibility that the kinds of advanced care, which can be rendered by the paramedics, have little or no effect on the long run survival rates of victims in some categories of illnesses and injuries. For example, in a study of surgically-treated acute subdural hematoma, the ten percent, who survived after removal of the blood clot, were distinguishable from the 90 percent who died largely, if not entirely, in terms of the severity of the extent of the original injury to the brain.[1] The second is the fact that the number of cases was too small for the statistical tests to be discriminantly powerful.

To offset the problem of small sample size, three categories of injuries, namely "fractures," "lacerations and penetrating injuries," and "crushing, perforation, and internal injuries," were examined together as a group. These categories of injuries were chosen because they all involve the potential for high rates of blood loss. In such cases, the most effective course of treatment at the scene and enroute to the hospital is the control of the hemorrhage if possible, maintenance of adequate airway and oxygenation, and the maintenance of the circulating volume. It is in terms of the last kind of care, through the ability of paramedics to administer I.V. fluids to augment the circulating volume of blood, that the MICUs differed from the ambulances. The number of cases involving a threat to life for the aggregation of the three categories totalled 65. The difference in survival rates 90 days after hospital discharge for victims handled by MICUs and by ambulances and the level of significance of this difference is shown in Table VII-A-38. The long term survival rate was slightly higher for victims handled by the paramedics

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[1] Echlin, F.A., S.V.R. Sordillo, and T.Q. Garvey, "Acute, Subacute and Chronic Hematoma," Journal of the American Medical Association, 161:14, August 1956, pp. 1345-1350.

but this difference was not statistically significant. In part the absence of a significant difference may be explained by Table VII-A-4, 5 and 6. These tables indicate that I.V. fluids were administered to only three of the victims, with life threatening conditions, all of whom survived. Since the paramedics had been trained to manage hemorrhagic shock, and were in voice communication with the hospital, only the conditions of these three victims apparently required I.V. fluids. Therefore, it can be presumed that the kind of advanced care the paramedics could render was appropriate to roughly only 14 percent of the victims with life threatening conditions. The effectiveness of this kind of advanced care would be swamped, in terms of the long term survival rate for victims in the three categories who were handled by the MICUs, by the outcomes for the remaining 86 percent of the cases, which were independent of the ability of the paramedic to administer I.V. fluids.

Because of the considerable differences in the composition of the kinds of injuries and illnesses handled by the MICUs and by the paramedics, it is difficult to make an overall comparison of the effectivenesses of the two kinds of emergency medical services. Perhaps the best overview is provided by projecting the observed survival rates to estimate what the outcomes would have been if all 342 cases involving a threat to life had been handled by either the MICUs or the ambulances. The projected survival rates upon arrival at the emergency room and 90 days after hospital discharge are shown in Tables VII-A-36 and VII-A-37 respectively. The projected overall survival rates to the emergency room were 94.4 and 95.0 for the MICUs and the ambulances respectively. As Table VII-A-38 shows, this difference is not statistically significant. The projected survival rates 90 days after hospital discharge were 74.5 and 67.5 percent for the MICUs and the ambulances respectively. This projected difference would be an absolute increase of seven percent and a relative increase of ten percent in the survival rate. It is statistically significant at the 0.03 level.

TABLE VII-A-36

HYPOTHETICAL OUTCOMES UPON ARRIVAL AT EMERGENCY ROOM IF ALL LIFE THREAT CASES HAD BEEN HANDLED BY EITHER MICU OR BY AMBULANCE

Category of Illness or Injury	Total Life Threat	Survival Rate to Emergency Room		Number Surviving		Number Dying	
		MICU	Amb.	MICU	Amb.	MICU	Amb.
A. Burn	1[1]		100.0		1.0		0
B. Cold	0						
C. Electrical	1[2]	100.0		1.0		0	
D. Fractures	7	100.0	80.0	7.0	5.6	0	1.4
E. Lacerations	32	91.7	95.0	29.3	30.4	2.7	1.6
F. Crushing	26	87.5	88.9	22.8	23.1	3.2	2.9
G. Poisoning	74	100.0	100.0	74.0	74.0	0	0
H. Bite	0						
J. Suffocation	8	100.0	100.0	8.0	8.0	0	0
K. C.N.S.	33	93.3	100.0	30.8	33.0	2.2	0
L. Minor Injuries	0	0	0				
1. Cardio-Vasc.	71	87.5	86.7	62.1	61.6	8.9	9.4
2. Cerebro-Vasc.	27	100.0	100.0	27.0	27.0	0	0
3. Bleeding	12	100.0	100.0	12.0	12.0	0	0
4. Infections	2	100.0	100.0	2.0	2.0	0	0
5. Flu, etc.	0						
6. Convulsions	0						
7. Coma, etc.	20	88.9	90.9	17.8	18.2	2.2	1.8
8. Obstetrical	4	100.0	100.0	4.0	4.0	0	0
9. Respiratory	24	100.0	100.0	24.0	24.0	0	0
10. Minor Illness	0						
11. Emotional	0						
TOTALS	341 [3]			321.8	323.9	19.2	17.1
AS A PERCENTAGE OF TOTAL LIFE THREAT CASES				(94.4)	(95.0)	(5.6)	(5.0)

[1] Applies only to ambulance.

[2] Applies only to MICU.

[3] Reduced by one to compensate for fact that there was one life threatening case in Category A which was handled by an ambulance, and one life threatening case for Category C which was handled by a mobile intensive care unit.

TABLE VII-A-37

HYPOTHETICAL OUTCOMES 90 DAYS PAST HOSPITAL DISCHARGE IF ALL LIFE THREATENING CASES HAD BEEN HANDLED BY EITHER MICU OR BY AMBULANCE

Category of Illness or Injury	Total Life Threat	Survival Rate 90 Days After Hospital Discharge		Number Surviving		Number Dying	
		MICU	Amb.	MICU	Amb.	MICU	Amb.
A. Burn	1[1]		0		0		1.0
B. Cold	0						
C. Electrical	1[2]	0		0		1.0	
D. Fractures	7	100.0	60.0	7.0	4.2	0	2.8
E. Lacerations	32	83.3	85.0	26.7	27.2	5.3	4.8
F. Crushing	26	75.0	77.8	19.5	20.2	6.5	5.8
G. Poisoning	74	90.5	93.8	67.0	69.4	7.0	4.6
H. Bite	0						
J. Suffocation	8	100.0	100.0	8.0	8.0	0	0
K. C.N.S.	33	66.7	72.2	22.0	23.8	11.0	9.2
L. Minor Injury	0						
1. Cardio-Vasc.	71	66.1	46.7	46.9	33.2	24.1	37.8
2. Cerebro-Vasc.	27	42.1	37.5	11.4	10.1	15.6	16.9
3. Bleeding	12	57.1	60.0	6.9	7.2	5.1	4.8
4. Infections	2	100.0	0	2.0	0	0	2.0
5. Flu, etc.	0						
6. Convulsions	0						
7. Coma, etc.	20	88.9	54.5	17.8	10.9	2.2	9.1
8. Obstetrical	4	100.0	100.0	4.0	4.0	0	0
9. Respiratory	24	62.5	50.0	15.0	12.0	9.0	12.0
10. Minor Illness	0						
11. Emotional	0						
TOTALS	341[3]			254.2	230.2	86.8	110.8
AS A PERCENTAGE OF TOTAL LIFE THREAT CASES				(74.5)	(67.5)	(25.5)	(32.5)

[1] Applies only to ambulance.

[2] Applies only to MICU.

[3] Reduced by one to compensate for fact that there was one life threatening case in Category A which was handled by an ambulance, and one life threatening case for Category C which was handled by a mobile intensive care unit.

TABLE VII-A-38

STATISTICAL TESTS OF SIGNIFICANCE OF DIFFERENCES IN SURVIVAL RATES FOR AGGREGATED AND HYPOTHETICAL OUTCOMES

Category of Illness or Injury	Survival Rate 90 Days After Hospital Discharge: MICU	Survival Rate 90 Days After Hospital Discharge: Amb.	Differences in Survival Rates (MICU - Amb.)	Statistical Test That Was Employed To Test Null Hypothesis	Level of Significance[1]	Decision on Null Hypothesis that Survival Rates Are Equal for MICU and Ambulances
D+E+F 90 Days After Hospital Discharge	81.8	79.0	+2.8	Corrected Chi Square	0.95	Accept
Hypothetical for All Life Threats in All Categories Upon Arrival at Emergency Room	94.4	95.0	-0.5	Normal Approximation	0.78[2]	Accept
Hypothetical for All Life Threats in All Categories 90 Days After Hospital Discharge	74.5	67.5	+7.0	Normal Approximation	0.03	Reject

[1] Probability that a difference in empirical survival rates at least as large as that observed will occur due to sampling error when the true survival rates are equal.

[2] Two-tailed test used.

The projected difference in survival rates 90 days after hospital discharge undoubtedly is a conservative figure. First, for reasons explained aobve, the MICUs tended to be dispatched to the more serious cases. The proportion of cases with life threatening conditions for the MICUs was almost twice that for the ambulances, namely 16.1 to 8.5 percent respectively. Among the cases with life threatening conditions, members of the medical and nursing staffs of Harbor General Hospital, who have been involved, have expressed the opinion that those handled by the MICUs tended to be more serious. To the extent that this was true, the expected survival rate during the pilot study would have been lower for victims handled by the MICUs than for those handled by the ambulances. Second, the study covered the initial phases of the MICU program. During this period, the program admittedly stressed the care of coronary and related illnesses. As the program has evolved, considerably more attention has been devoted to the care of traumatic injuries. Dispatching policies also have been altered so that the County MICUs are responding to a substantially higher proportion of the cases that involve serious traumatic injuries. Physicians and nurses, who work closely with the paramedics, believe that the combination, of greater emphasis of and exposure to the care of serious injuries, has enhanced the abilities of the paramedics to render appropriate care in such cases. To the extent that this was true, the expected survival rates, among victims who were handled by MICUs, would have been lower during the pilot study than at present.

b. Costs. The monetary cost to provide mobile intensive care units to serve an area is a combination of the incremental fixed and operational costs. Both kinds of costs will be functions of the design of the MICU subsystem and of the existing emergency medical system, to which the MICU subsystem is being added.

The incremental fixed costs include equipment and the training of personnel. In the pilot study, both of these categories of costs were influenced by the design of the MICU subsystem and by the existing emergency medical system. Both the County and City of Los Angeles chose to utilize existing vehicles for their MICUs. The County used its fire rescue vehicles and the City used its rescue ambulances. The choice of future replacements for these existing vehicles undoubtedly will be influenced by their roles as MICUs. Table VII-A-39 shows the costs of the kinds of equipment that were added in the conversion of the County's rescue units and the City's rescue ambulance to MICUs. The costs of establishing a communication and telemetry base station at a Harbor General Hospital are given in Table VII-A-40.

The cost of providing the initial training of a paramedic to the point of his certification has been estimated by the Director of Paramedic Training for Los Angeles County to be $1370. Relative to the total number of firemen in a large fire department, such as that of the County or of the City of Los Angeles, the number of rescue firemen, typically six, who are in training at any given time, has been very small. It was been possible for these fire departments to provide backup personnel from the existing ranks to carry out the normal duties of the paramedics-in-training. For smaller fire departments, this would not be the case. Similarly if larger numbers of paramedics were to be in training at the same time, even the large fire departments would reach a point where it ceases to be possible to absorb the normal duties of the trainees without additional personnel or overtime. Therefore, the fixed cost of creating a fire department MICU has been estimated under the conservative assumption that additional personnel must be hired or existing personnel paid overtime to perform the normal duties of the paramedic trainees. Incremental fixed costs for personnel are incurred during training in this case.

The incremental operating costs are of three kinds. First, medical expendables are required by the paramedics in addition to those first aid aupplies that are used in providing regular rescue squad or ambulance services. Second, repairs and modifications must be made to the additional items of equipment that are used by the paramedics. Third, it is anticipated that approximately 80 hours per year of retraining will be required per paramedic. The cost associated with this retraining was estimated in the same way as the cost of the

TABLE VII-A-39

COST OF ADDITIONAL EQUIPMENT FOR A SINGLE MOBILE INTENSIVE CARE UNIT

1 each CARDIAC TELEMETRY UNIT - Biocom Model 3502 Biophone (including battery, spare battery, battery charger, antenna, handset, cable acoustic coupler)	$ 2,770.00
1 each PHYSIOLOGICAL MONITOR - Datascope Model 850	1,100.00
1 each DEFIBRILLATOR - Resuscitron Model 680 (including extra paddles)	1,705.00
1 each SUCTION UNIT - Laerdal	147.00
SUBTOTAL	$ 5,722.00

TABLE VII-A-40

COST OF COMMUNICATION AND TELEMETRY SYSTEM AT BASE HOSPITAL

1 each ANTENNA - Phelps Dodge Model 201-509	$ 85.00
1 each TRANSCEIVER - General Electric Model 4ER42G11 - single frequency, with carrier operated relay, with 117V AC power supply without channel guard	442.00
1 each REMOTE CONTROL UNIT - with handset, General Electric Deskon MC31ABS11 (with option 5196)	188.00
1 each DEMODULATOR for 117V AC operation	550.00
1 each AMPLIFIER - 2 channel, including power supply for 117V AC	55.00
1 each TAPE DECK - Sony Model TC160	200.00
1 each STRIP CHART RECORDER - Mechanics for Electronics, Model M-20C-AHA	475.00
1 each TELEPHONE COUPLER for recorder	20.00
1 each TELEPHONE INSTRUMENT with push-to-talk handset	
INSTALLATION	400.00
TOTAL COST OF ESTABLISHING BASE STATION	$ 2,415.00

initial training, namely that the paramedic duties of those undergoing retraining cannot be absorbed without additional personnel or overtime.

It is estimated that on-the-average three MICUs will operate in conjunction with each base hospital. The useful life of the additional items of equipment that are used by the paramedics is estimated to be five years. It was assumed that any discounting of future dollars, in terms of their present worth, would be offset by the rising costs of goods and services due to inflation. It further was assumed that there would be no replacement of paramedics. This is a reasonable assumption for the first years of the program if appropriate career ladders are created for paramedic personnel within the fire departments. Firemen are long term career personnel and turnover is very small. In the absence of such career ladders, however, losses can be anticipated as ambitious paramedics become eligible to take examinations for more advanced non-paramedic positions within the fire departments.

From the above premises, the incremental cost of a single mobile intensive care unit operated by the County or City of Los Angeles was estimated. The results are presented in Table VII-A-41. The estimated total incremental cost of introducing and operating a single MICU over the first five year period would be $56,197.00. On an annualized basis this would amount to $11,239.40. Aggregated across the MICUs and ambulances, the 342 life threatening cases, among the 3134 total cases handled in the pilot study, reflected a total of 4.4 years of operation of the emergency medical vehicles. At $11,239.40 per year, the cost of handling these cases with MICUs instead of fire rescue units and ambulances would have been roughly $49,450 (4.4 years X $11,230.40). It was projected in Table VII-A-37 that the number of victims from among the 342 with life threatening conditions, who would have survived at least 90 days after hospital discharge, would have been 254 and 230 if all of these cases had been handled respectively by MICUs or by ambulances. Thus, the approximate cost of the projected saving of 24 additional lives, which it is anticipated

TABLE VII-A-41

INCREMENTAL COSTS FOR A MOBILE INTENSIVE CARE UNIT

FIRST YEAR		
Equipment		
MICU (from Table VII-A-39)	$ 5,722.00	
Base Hospital (from Table VII-A-40)	805.00[1]	
		$ 6,527.00
Initial Training[2]		
Tuition ($1370 per man)	$ 9,248.00	
Replacement Personnel (480 hours per man)	18,014.00	
		27,262.00
Operating Costs		
Medical Expendables (drugs, I.V. fluids, etc.)[3]	$ 1,200.00	
Equipment Modification and Repair[4]	800.00	
		2,000.00
TOTAL FIRST YEAR COST		$ 35,789.00
SECOND THROUGH FIFTH YEARS		
Operating Costs		
Medical Expendables[3]	$ 1,200.00	
Replacement Personnel During Retraining	3,002.00[2]	
Equipment Modification and Repair[4]	900.00	
TOTAL YEARLY COST		$ 5,102.00
FIVE YEAR COSTS		
First Year	$ 35,789.00	
Subsequent Years ($5,102.00 X 4)	20,408.00	
TOTAL FIVE YEAR COST		$ 56,197.00
ANNUALIZED COST		$ 11,239.40

[1] Prorated cost based on three MICUs per base hospital.
[2] Training costs are based on a team of six paramedics per MICU and three backup paramedics per every four MICUs to fill in for vacations, sick leaves, etc.
[3] For inventory of these items, see Appendix H.
[4] Does not include equipment currently used in regular fire rescue or ambulance services.

would have resulted if all life threatening cases had been handled by MICUs instead of by ambulance, was $49,450 or $2060 per life.

A significant proportion of the cost of the first five years was contributed by the initial training of the paramedics. To the extent that career ladders are developed and firemen serve as paramedics for more than five years, the prorated cost per year of the initial training would drop. Such a drop would lead to a reduction in the total cost of providing MICU services. To the extent that the paramedic phase of firemen's careers exceed five years, the total cost of each MICU was overstated in the above analysis.

As the County and City expand their MICU services, they may have to increase the number of emergency medical units that they operate. Such increases in fleet sizes would be for the purpose of maintaining existing response times in the face of the increase in the mean service time per call that occurs when an emergency medical unit is converted from a regular rescue unit or ambulance to a MICU. The size and geographic location of a fleet of MICUs, to provide a desired level of response times, could be determined easily through the use of the computerized ambulance location logic model described in Section IV-A-1. To the extent that additional MICUs are added to the system to compensate for the increase in the mean service time, the total cost of each MICU was understated in the above analysis.

8. The Los Angeles County Paramedic Program and Disasters

At approximately 6:00 A.M. on February 9, 1971, an earthquake occurred in Southern California. The epicenter of the earthquake was north of the San Fernando Valley, a suburb of the City of Los Angeles.

The most seriously affected area in terms of injuries, fatalities, and property damage was the northern San Fernando Valley. Two hospitals, Olive View and San Fernando Veterans, which are located in the northern foothills of the San Fernando Valley, sustained extensive structural damage. Numerous injuries and fatalities resulted among the staff and patients of these two hospitals. Two teams of two paramedics each were dispatched from Harbor General Hospital to assist with the on-scene care and evacuation of the injured at the San Fernando Veteran's Hospital. Working with the few supplies not destroyed at the Veteran's Hospital and the equipment carried on the MICU, the paramedics attempted to treat as many patients as possible but quickly exhausted their supplies. Half an hour after the first team of paramedics arrived, a group of physicians and surgeons from Harbor General Hospital were flown in by helicopter.

The paramedics were involved in the care of 108 victims during the aftermath of the earthquake. Their performance affirmed the value of a broadly conceived paramedic program. The training and experience of the paramedics permitted them to provide effective care for victims with traumatic injuries. Working together with the paramedics in the field for the first time, the physicians and surgeons praised the paramedics for their knowledge, skill, and professional judgment.

Medical personnel from many diverse sources contributed to the treatment of victims of the earthquake. Such care was rendered, however, under conditions of disorder and a lack of adequate supplies and equipment. As a result of this experience, Harbor General Hospital has developed a disaster team composed of four physicians and surgeons, three paramedics and a radioman. One of the doctors serves as the team leader and is responsible for organizing the triage site and coordinating the efforts of the team. The remaining three doctors and the three paramedics form three subteams for the delivery of care to victims. The radioman provides a communication link and assists the leader and other members of the team as needed. His radio is tuned to the Hospital Emergency Administrative Radio (HEAR) System, which was created and operated by the Hospital Council of Southern California.

Medical supplies were in short supply during the aftermath of the earthquake. To provide adequate supplies during the crucial first few hours following any future disaster, a list of essential items that would be needed by the Disaster Team was developed. The list was too extensive to be transported by helicopter as a single kit. Therefore, the list was divided into three field kits that contained the kinds of items that would be required for the care of: (1) burns; (2) traumatic injuries; and (3) cardiopulmonary arrest. The composition of each field kit is given in Appensix I. These specialized kits are each transportable by helicopter. The nature of any future disaster will dictate the priorities with which the field kits will be transported to the scene.

In the event of future disasters, the Disaster Team will be dispatched immediately. The team and its field kits will travel to the scene by helicopter or ground vehicles, whichever is appropriate. It is anticipated that the Disaster Team will be able to function in a far more effective manner than was possible following the earthquake of February 1971.

9. Discussion

The pilot study provided an initial data base, from which the effectiveness of mobile intensive care units could be judged. Preliminary estimates were made of the survival rates of victims with life threatening conditions who had been handled by MICUs and by ambulances. Based upon these estimates, a comparison of the effectiveness of the MICUs and of the ambulances revealed some unexpected findings. The kinds of advanced care that the paramedics administered, largely were designed to keep the patient alive until he or she could be delivered to a hospital. It, therefore, had been anticipated that the major effect of this care would be reflected in survival rate to the emergency room. During the course of the study, individual cases indeed were documented in which the reasoned medical judgment was that the patient would not have survived to the hospital without the kind of advanced care that the paramedics rendered and which could not have been rendered by ambulance attendants. Such cases, however, apparently represented only a small fraction of all life threatening cases. No statistically significant difference was found between the MICUs and the ambulance in terms of the survival rates to the emergency room, whether examined by individual categories of injury or illness or in terms of the hypothetical outcomes that could have been expected if all cases involving a threat to life had been handled by the crews of one or the other of the two kinds of emergency medical vehicles.

The empirical differences in survival rates 90 days after hospital discharge between victims handled by the MICUs and those handled by the ambulances were statistically significant for the categories of "hypertensive and arteriosclerotic heart disease" and "coma, fainting, dehydration and metabolic disorders" at the 0.08 and 0.12 levels respectively. Since the program initially stressed the management of coronary problems and this kind of advanced care was based on principles that have been proven effective in coronary care units, it is not surprising that the survival rate for victims handled by paramedics was significantly higher than that for victims handled by ambulance attendants. Apparently the major influence of the kinds of advanced care that the paramedics rendered was derived from the early stabilization of victims. For victims of acute coronary disease, and possibly for victims of comas and metabolic disorders, the apparent effect of such early stabilization was to alter the probability for long term survival. Assuming that the observed differences are representative of true differences in the survival rates for these categories of illness, a larger sample size would be needed to demonstrate statistical significance at the generally accepted 0.05 level.

For other categories of illnesses and injuries, the smaller observed differences in survival rates also may indicate correctly true differences in the outcomes that can be expected from the two kinds of emergency medical services. However, in order to be shown to be statistically significant, such small differences would require sample sizes that are many times larger than those generated by the pilot study.

The pilot study encompassed two kinds of MICUs, namely those which did and did not transport victims. The County's MICU, which did not transport victims, had to request the dispatch of an ambulance, whenever a victim needed to be transported to the hospital. The City's MICU, which utilized an ambulance type vehicle, directly transported the victims that it handled. A comparison between the two kinds of MICUs, as the comparison between MICUs and ambulances, must consider both effectiveness and cost. There is no inherent basis for any differences between the kinds of MICUs in terms of their medical effectivenesses. Both units employed paramedics who were trained and equipped similarly.

The cost analysis of the MICUs, which was presented earlier, considered only those aspects that were related directly to the conversion of existing services into a MICU. These aspects were: (1) training of personnel; (2) additional equipment and supplies and (3) base station communication equipment. It did not consider the differences between the two configurations that were employed in the pilot study nor between these configurations and other alternative ways in which mobile intensive care services could be delivered. Between the configurations employed by the County and the City, the difference in costs would depend upon the proportion of calls which would require an ambulance, if the MICU did not transport victims, and the costs associated with the involvement of two vehicles whenever a transport was required.

The operational consequences and their associated costs for both the MICU and the supporting ambulances, of an MICU not transporting victims, are predictable in general terms. Prior to its conversion to a MICU, the County Fire Rescue Squad had been dependent on an ambulance for the transport of any victim, whom it handled initially. As an MICU, the rescue squad was dispatched to certain kinds of incidents to which ambulances previously had been dispatched. From our study of public ambulance services in the City of Los Angeles, which was described in Section V.C., the number of calls, in which no one was transported because: (1) no victim(s) could be located; (2) the victim was treated by the ambulance attendants and released at the scene; or (3) the victim refused treatment and/or transportation to the hospital, was found to be in the range of 10-15 percent of all calls. To serve a comparable population, therefore, the paramedics manning MICUs, which did not transport victims, would have to request the dispatch of an ambulance in about 85-90 percent of their calls.

In specific terms, the operational consequences of alternatives, such as a MICU not transporting victims, could best be explored through the use of the computerized simulator that was described in Section IV.B. From the results of such a simulation, the difference in costs between MICUs, which transport victims and which do not, could be predicted accurately.

B. HELICOPTER AMBULANCE STUDIES

Helicopter ambulance studies were conducted in three distinct phases:

(1) a response time study in which a helicopter was dispatched to emergency incidents in tandem with ambulances that serviced a suburban area; the helicopter did not land, but estimated probable landing difficulties;

(2) a landing feasibility study to assess the operational potentialities of helicopters, in a suburban/urban environment, in a variety of controlled landing site conditions;

(3) a patient retrieval demonstration to assess the operational efficiency and medical effectiveness of helicopter ambulances in a rural environment.

The overall objective of these demonstrations was to examine the feasibility of integrating helicopters into the emergency rescue transportation system both to supplement and to complement ground rescue ambulances.

Information obtained from the helicopter demonstrations provided operating data for the development of both the analytical and simulation models (see Section V). Combining demonstrations and analytical studies enabled the Project staff to identify alternative system configurations of ground transportation, air transportation and care elements; these alternative configurations could then be used in both research studies and field studies.

1. Response Time Study

The first helicopter study was a three-week operation designed and conducted in conjunction with the Los Angeles City Fire Department (LACFD) Helicopter Patrol. Helicopters were dispatched to emergency medical incidents in tandem with ground ambulances; response times were recorded and estimates were made of probable landing difficulties. (No landings were attempted in this demonstration.) The specific objectives of the study were as follows:

(1) to assess the potential for improving transportation time to and from emergency incidents in a suburban setting;

(2) to assess potential benefits, hazards, or limitations of helicopter operations in suburban areas;

(3) to provide preliminary operating data for development of the helicopter transportation portion of the analytical and simulation models;

(4) to develop an understanding of helicopter operations in emergency medical service situations.

a. Description of Environment and System. At the time of the study, the main LACFD Rescue Ambulance operation was conducted in the San Fernando Valley area of the Los Angeles basin, and the region under study was that portion of the Valley within the city's jurisdiction. The area covers 235 square miles and contains a population of over 1,000,000 people. It is served by 50 miles of freeway and 2,700 miles of surface streets.

Ambulance service in the Valley was first provided by the LACFD in 1956. There are eight rescue ambulances, located at fire stations, which are dispatched through the Fire Department Dispatch and Communication Center.

When an ambulance call comes into LACFD directly or into any law enforcement agency in the Valley area, the call is transferred to the Dispatch Center. A dispatcher pinpoints the exact location of the incident, determines from the status board the nearest available Rescue Ambulance and dispatches it. Depending on the origin and nature of the call, the dispatcher may also contact law enforcement agencies or other Fire Department units. In certain types of calls, such as those in which a drowning is reported, the nearest firefighting unit may be dispatched, since most units carry resuscitation equipment and all LACFD firemen are trained to the Advanced First Aid level of the Red Cross program.

If patient transport is required, the Rescue Ambulances take the victim to the nearest of eight hospitals under contract to the city to provide emergency services on a 24-hour basis, including the presence of at least one doctor and a registered nurse in the emergency room.

For purposes of this study, four Bell JetRanger helicopters were integrated into the existing system. The heliport from which the helicopter patrol operates is located at approximately the geographic center of the Valley. Activities in which the helicopter patrol participated during the year 1966-1967 included:

Activities	Flight Hours
fire fighting, aerial photography, transportation of personnel and equipment	269
non-fire-department aerial photography	269
pilot proficiency and training	365
emergency (including search and rescue)	72
inspection, reseeding, etc.	101
demonstrations and drill	41
maintenance	101

Initially the JetRanger was not equipped with "litter kits" (these subsequently became available). The helicopters did possess a well-integrated communication capability, which enabled direct voice contact with the dispatch center, other departmental surface vehicles, and the Los Angeles Police Department, and indirect contact with the County Sheriff.

b. Operational Methodology. During periods of operation, a helicopter was dispatched from the heliport in tandem with any one of the eight rescue ambulances. An EMS Project staff member recorded the desired data, photographed the incident scene, and had the pilot indicate the nearest potential landing site.

For a period of three weeks, the helicopters were on call for three hours a day, usually in the late afternoons and early evenings. On the tandem dispatches, the helicopter dispatch time, takeoff time, and arrival time on-scene were recorded. For the rescue ambulance, the dispatch time, arrival time on-scene, departure time from scene, and arrival time at the hospital were recorded.

It was estimated that during the three-week study period, approximately 180 incidents would occur and that in order to develop time distributions for the helicopter and the rescue ambulance it would be necessary to obtain records for at least half the calls.

The incident data were to be classified by traffic and nontraffic emergencies, by transport and nontransport responses, and by the presence of hazards or obstructions to a potential landing.

c. Modifications to the Operational Plan. Emergency calls received after sunset were responded to by the Bell 47G3B, since the JetRanger was grounded at night owing to a mechanical problem; therefore, day and night response times were handled separately.

Data were obtained on 85 out of approximately 200 incidents that occurred during the study. That information on only 40% of the cases could be collected stemmed primarily from interactions between the primary mission of the helicopters and their study mission:

- the helicopters were required for fire suppression and transport of personnel and equipment;
- after study missions, helicopters were sometimes diverted immediately to other activities;
- emergency incidents sometimes occurred simultaneously;
- some calls were completed by the rescue ambulance prior to the arrival of the helicopter;
- some calls were lost owing to activities at the communications center.

d. Results. A ground unit--either a police car, ambulance, or both--arrived on the scene before the helicopter in 80% of the cases (see Table VII-B-1). In the traffic incidents, this occurred in 84% of the cases, and in the nontraffic incidents, this occurred in 71% of the cases.

Although no actual landings were attempted, potential landing hazards were identified as well as possible solutions.

Potential hazards to helicopter and crew in landing attempts include:

- wires or unknown (unlighted) obstructions or rough terrain;
- gusty winds;
- low visibility;
- uncontrolled access to landing area.

Potential hazards to personnel in the landing zone include:

- debris blown by rotor wash;
- injury from physical contact with the aircraft.

These hazards may be reduced by providing:

- voice communication (and hand signals) with ground personnel;
- controlled access to the landing zone;
- high-intensity lights on the aircraft and/or ground units.

On the basis of the presence of potential hazards, the estimates shown in Table VII-B-2 were made. As might be expected, it was estimated that difficulties would arise more frequently at night than during the day--42% versus 23%. Because ground units were more frequently present at traffic incidents than at nontraffic incidents, it was estimated that there would be a lower percentage of potentially hazardous landings in such cases--23% versus 39%.

TABLE VII-B-1

FREQUENCY OF ARRIVAL OF GROUND UNITS PRIOR TO THE HELICOPTER

TRAFFIC INCIDENTS

	Day	Night	Total
No Patient Transport	20/26 - 77%	4/4 - 100%	24/30 - 80%
Patient Transport	23/26 - 88%	4/5 - 80%	27/31 - 87%
TOTAL	43/52 - 83%	8/9 - 89%	51/61 - 84%

NONTRAFFIC INCIDENTS

	Day	Night	Total
No Patient Transport	7/12 - 58%	1/2 - 50%	8/14 - 57%
Patient Transport	6/7 - 86%	3/3 - 100%	9/10 - 90%
TOTAL	12/19 - 68%	4/5 - 80%	17/24 - 71%

ALL INCIDENTS

	Day	Night	Total
No Patient Transport	27/38 - 71%	5/6 - 84%	32/44 - 73%
Patient Transport	29/33 - 88%	7/8 - 88%	36/41 - 88%
TOTAL	56/71 - 79%	12/14- 86%	58/85 - 80%

TABLE VII-B-2

POTENTIALLY HAZARDOUS LANDINGS

	Day	Night	Total
Traffic Incidents	9/47 - 19%	5/14 - 36%	14/61 - 23%
Nontraffic Incidents	6/19 - 32%	3/5 - 60%	9/24 - 39%
TOTAL	15/66 - 23%	8/19 - 42%	28/85 - 27%

An assessment of the rescue ambulance and helicopter response time was made and is shown in Table VII-B-3.

It was noted that the helicopter required an average of 3.0 minutes for warm-up prior to takeoff, as compared to a nominal dispatch delay for the rescue ambulance.

All response times for the rescue ambulance were measured under Code 3 conditions, i.e, with red lights and siren. There was no significant difference in response time between traffic and nontraffic incidents for either the rescue ambulance (4.4 versus 3.9 minutes) or the helicopter (3.8 versus 4.2 minutes). The helicopter took longer on the average to locate nontraffic incidents than did the rescue ambulance (4.2 versus 3.9 minutes). This is probably accounted for by the fact that the pilots had less experience than did the ambulance drivers.

The amount of time spent on-scene by the ambulance was generally less for traffic than for nontraffic incidents, regardless of whether or not a patient was transported. As would be expected, more time is spent on-scene for those incidents requiring patient transport since some time is required for stabilizing and loading a patient.

The mean retrieval time from the incident scene to the hospital was 7.8 minutes. Aggregating response, on-scene, and transport times for all cases, the overall mean service time for the rescue ambu-

TABLE VII-B-3

RESCUE AMBULANCE/HELICOPTER RESPONSE TIME SUMMARY[1]

	Traffic Incidents		Non-Traffic Incidents		All Incidents	
	Ambulance	Helicopter	Ambulance	Helicopter	Ambulance	Helicopter
Departure/Takeoff Delay	0.3	3.0	0.3	3.0	0.3	3.0
Response Time to Scene	4.4	3.8	3.9	4.2	4.3	3.9
On-Scene Time	6.4	N/A	9.9	N/A	7.2	N/A
(When no patient is transported)	(3.5)		(8.2)		(5.8)	
Retrieval Time to ER	8.5	N/A	6.4	N/A	7.8	N/A

[1]Figures in the table are mean values in minutes; the overall service time for the rescue ambulance from dispatch to arrival at hospital is 19.3 minutes with a standard deviation of 6.5 minutes.

lance from dispatch to arrival at the hospital was 19.3 minutes with a standard deviation of 6.5 minutes. It should be noted that because of helicopter takeoff delay time, the mean difference in response time for those cases involving patient transport is in favor of the ground ambulance by 2.2 minutes (i.e., 4.5 versus 6.7 minutes).

e. Implications. Owing to the fixed takeoff delay time of helicopters and the dispersed deployment of ambulances in San Fernando Valley, helicopter response times are, on the average, longer than those of the rescue ambulances. Therefore, it would be operationally inefficient to regularly dispatch a helicopter as an air ambulance to emergency incidents in this or similar types of service areas.

However, the fact that demand for ambulance services tends to increase markedly during periods of high traffic density, combined with the occurrence of emergencies in limited access areas, may indicate the desirability of utilizing helicopters on a backup basis.

For incidents requiring landings in streets or congested areas, traffic would need to be halted. This indicates that a landing study should be conducted to determine the extent of the ground support necessary for safe landings and to determine actual landing problems.

After the landing study, further helicopter studies would be aimed toward those areas in which ambulance response times to emergency incidents exceed 15 minutes from the time of dispatch to the time of arrival on-scene.

2. Helicopter Landing Feasibility Study

In this study, a systematic series of helicopter landings were carried out in suburban areas of the San Fernando Valley of Los Angeles under a variety of controlled landing-site conditions. No ambulance operations were involved in this demonstration. The purpose was to evaluate the operational feasibility of helicopter landings in a suburban environment. This experiment, in conjunction with that described in Section VII-B-1, was designed to help prepare for an experimental air ambulance service in which helicopters were to be used on a limited basis to supplement ground ambulances.

a. Demonstration Description and Plan. Between December 18 and December 23, 1969, the Los Angeles City Fire Department Bell Jet-Ranger helicopter performed 12 landings at simulated emergency incidents. A helicopter was requested by means of a radio call from the landing site to the Fire Department communications center. Dispatch was made by the center and pilots had no advance knowledge of site location. Police and Fire Department ground personnel and equipment were on site throughout the simulated incident to provide vehicle and pedestrian control. In this experimental situation, a Helicopter Patrol Captain was present at each landing and takeoff to give the pilot radio and visual instructions about landing hazards, landing approach, touch-down location, and takeoff precautions. Each helicopter crew consisted of a pilot and a rescue attendant; a photographer and an EMS Project data collecter participated as observers.[1]

Sites were selected to include various combinations of the following characteristics:

- location type (residential, commercial, etc.)
- touch-down location (two-lane road, four-lane road, median strip, parking lot)
- level or sloping terrain
- landing surface (dirt, grass, pavement, etc.)
- potential hazards present (trees, wires, poles)
- pedestrian and vehicular traffic

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[1] A motion picture film of this demonstration was prepared for the U.S. Department of Transportation.

Eight landing sites were selected from aerial photographs and on-site inspections. For comparative purposes, landings were made at four of the eight sites by day and night, yielding a total of 12 flights. All site locations were approved by the Los Angeles City Fire and Police Departments. Landing data were collected by observers on site and in the helicopter. Samples of the data collection forms that were used are shown in Figures VII-B-1 and VII-B-2.

The information obtained was used to evaluate the effects of landing site characteristics, environmental factors, and operational procedures on helicopter operations.[1] The most significant parameters of the demonstration are listed below:

- weather
- visibility
- dispatch instructions
- navigation
- air-ground communication
- pedestrian and traffic control
- landing hazards

In addition, aerial and ground photographs of each landing and tape recordings of air/ground communications were obtained.

b. Results. Factors common to all 12 landings are described below:[2]

- weather was clear and visibility good (day and night);
- police and fire personnel were able to control vehicle and pedestrian traffic; at no time did traffic present a problem;

---

[1]The problem of transporting a patient from an inaccessible location to the helicopter will be studied in future demonstrations.

[2]A thirteenth landing was accomplished at night at the site of an oil well fire in a mountainous area in north Los Angeles without ground assistance.

EMS PROJECT — LOS ANGELES CITY HELICOPTER LANDING DEMONSTRATION-AIR — FILLED OUT BY____________

(1) DATE ____________ (2) PILOT ____________

(3) TIME DISPATCH RECEIVED:__________M

(4) LOCATION OF H/C AT DISPATCH:
STATION 90 ☐ OTHER: ______

(5) INFORMATION GIVEN AT DISPATCH:
(A) LOCATION CADASTERAL ☐ OTHER RESPONDING AGENCIES ☐
(B) REPORTED LOCATION: ____________________
____
(C) OTHER DISPATCH INFORMATION: ____________________
____

(6) TIME OF DEPARTURE:__________M

(7) TAKEOFF DELAYS:
NONE ☐ YES, SPECIFY:________________
____

(8) WEATHER:
(A) CLEAR ☐ OVERCAST ☐ FOG ☐ RAIN ☐ OTHER: ________
(B) APPROXIMATE VISIBILITY:_______MILES
(C) APPROXIMATE WIND VELOCITY:_____MPH
(D) LIGHT ☐ TWILIGHT ☐ DARK ☐

(9) PROBLEMS IN LOCATING INCIDENT:
VISIBILITY ☐ DARKNESS ☐ COMMUNICATIONS ☐
UNFAMILIAR AREA ☐ INCORRECT INSTRUCTIONS ☐ OTHER: ______
____

(10) WAS THERE COMMUNICATION WITH THE GROUND SUPPORT:
NO ☐ YES, SPECIFY WITH WHOM: ______
____

(11) WHAT INFORMATION DESCRIBING THE LANDING SITE WAS GIVEN:________________
____

(12) WAS THE INFORMATION ADEQUATE FOR LANDING PURPOSES:
YES ☐ NO, NEEDED:________________
____

(13) DESCRIBE THE LANDING SITE:
____
____
____

(14) THE LANDING WAS:
ROUTINE ☐ MODERATELY DIFFICULT ☐ DIFFICULT ☐ VERY DIFFICULT ☐

(15) LANDING PROBLEMS:
WEATHER ☐ VISIBILITY ☐ WIND ☐ WIRES ☐
TREES ☐ COMMUNICATIONS ☐ CAR TRAFFIC ☐ PARKED CARS ☐
FLYING DEBRIS ☐ PEDESTRIAN TRAFFIC ☐ OTHER: ________
____
____

(16) WHAT WAS THE DELAY IN TIME CAUSED BY LANDING PROBLEMS: APPROX.______MIN.

(17) COULD LANDING CONDITIONS HAVE BEEN IMPROVED:
NO ☐ YES, SPECIFY:________________
____
____

(18) WERE ANY PROBLEMS ENCOUNTERED DURING TAKEOFF FROM SITE:
NO ☐ YES, SPECIFY:________________
____
____
____

(19) GENERAL COMMENTS:________________
____
____
____
____

FIGURE VII-B-1

DATA COLLECTION INSTRUMENT--AIR

EMS PROJECT | LOS ANGELES CITY HELICOPTER LANDING DEMONSTRATION-GROUND | FILLED OUT BY ____________

(1) DATE: ____________ (2) LOCATION: ____________________

(3) DESCRIPTION OF LANDING SITE:

(A) RESIDENTIAL ☐ COMMERCIAL ☐

(B) INTERSECTION ☐ NON-INTERSECTION ☐

(C) NO. OF LANES ______;______ NO. OF LANES ______

PARKING LOT ☐

(4) TOPOGRAPHICAL CHARACTERISTICS:

DIRT MEDIAN ☐ DIRT SHOULDER ☐

UNUSUAL CHARACTERISTICS: ____________________

____

(5) POTENTIAL HAZARDS:

LARGE TREES ☐ WIRES ☐ POLES ☐

BUILDINGS ☐ PARKED CARS ☐ ☐

OTHER: ____________________

____

(6) WIND VELOCITY_____MPH

TURBULENCE: YES ☐ NO ☐

(7) LANDING ASSISTANCE:

(A) NO. OF: FIREMEN ____ POLICEMEN ____

OTHERS: ____________________

(B) SPECIAL LANDING AIDS:

LIGHTS ☐ FLARES ☐

OTHER: ____________________

(8) TIME:

(A) DISPATCH STATION NOTIFIED__________M

(B) HELICOPTER LANDED__________M

(9) SPECIAL TRAFFIC CONTROL DEVICES:

BARRICADES ☐ ROPES ☐

OTHER: ____________________

____

(10) NUMBER OF:

(A) PEDESTRIANS IN AREA________

(B) VEHICLES RESTRAINED________

(11) WAS THERE MORE THAN ENOUGH ASSISTANCE TO ASSURE A SAFE LANDING:

YES ☐ NO ☐

(12) WHAT LANDING ASSISTANCE COULD HAVE BEEN DELETED: ____________________

____

(13) COULD LANDING CONDITIONS HAVE BEEN IMPROVED:

NO ☐

YES, BY: ____________________

____

____

(14) WAS FLYING DEBRIS A PROBLEM:

NO ☐

YES, TO:

PEDESTRIANS ☐ VEHICLES ☐ STRUCTURES ☐

(15) WHAT INFORMATION WAS GIVEN TO THE HELICOPTER:

NONE ☐ NAVIGATION ☐ HAZARD WARNINGS ☐

SPECIFY: ____________________

____

(16) ADDITIONAL COMMENTS: ____________________

FIGURE VII-B-2

DATA COLLECTION INSTRUMENT--GROUND

- ground-to-air communications consisted of identification of touch-down spot, approach instructions, wind information, and hazard warnings;
- takeoff was uneventful in all cases.

A summary of the 12 landings is presented in Table VII-B-4.

c. Conclusions and Recommendations. Incident site location caused no significant delay in any of the cases. The rescue attendant performed as a navigator for those cases in which the pilot was not familiar with the incident location. Darkness did not seem to make navigation more difficult in the four night incidents.

Direct ground-air communication is required for urban helicopter operations. The Los Angeles City Fire Department helicopters, surface units (including Rescue Ambulances), and communications center are directly linked by an integrated communications system operating on four separate frequencies in the 33-megacycle band. For this demonstration, however, ground-to-air communication between the helicopter and the helicopter patrol truck was accomplished on an ultra-high frequency so as not to interfere with normal Fire Department operations. Generally, if these simulated incidents were emergencies, any Fire Department surface unit could communicate directly with the helicopter. Additionally, the helicopter could carry a walkie-talkie, which would permit direct communication with police department surface units.

Communication between landing site personnel and the pilot seemed essential in those landings where wires, virtually invisible from the air, were a landing hazard. Ground-air communication permitted identification to the pilot of hazards in all cases. Communication was also necessary to inform the pilot of the touch-down spot when it was not identifiable from the air.

Wires were the only serious landing hazard. This is particularly true of wires in unexpected locations--e.g, wires diagonally across a median were not noticeable from the air. Positioning a

TABLE VII-B-4

HELICOPTER LANDING SUMMARY

LANDING NUMBER	SITE DESCRIPTION	TIME	LANDING HAZARDS	EQUIPMENT ON SCENE[1]	PERSONNEL USED IN VEHIC. AND PEDEST. CONTROL[2]	PEDESTRIANS IN AREA	VEHICLES RESTRAINED
1	Adjacent to residential intersection	Night	Overhead signals, light poles	Police car	5	25-35	50-60
2	Grass median of four-lane street	Day	Wires, signs	Police car, Two fire trucks	8	25-30	20-30
3	Same site as Landing #2	Night	Wires, signs	Police car, Two fire trucks	8	25-30	60-70
4	Small residential street	Day	Trees, light poles	Police car, Two fire trucks	5	30-40	None
5	Same site as Landing #4	Night	Trees, light poles	Police car, Two fire trucks	5	15-20	3
6	Commercial intersection	Day	Trees, overhead traffic signals	Police car, fire truck	4	60-70	40-50
7	Four-lane road with dirt shoulder	Day	Wires, poles, trees	Police car, Two fire trucks	4	10-20	35-45
8	Small intersection in foothills	Day	Trees, street lights	Police car, Two fire trucks	4	5-10	5-10
9	Same site as Landing #8	Night	Trees, street lights	Police car	4	10-15	15-20
10	Residential "T" intersection	Day	Trees, wires, poles	Police car, Two fire trucks	4	15-20	15-20
11	Parking lot in commercial district	Day	Wires	Police car, Three fire trucks	4	20-25	5
12	Same site as Landing #11	Night	Wires	Police car, Two fire trucks	4	10-15	None

NOTES: [1]A helicoptor patrol truck, performing no pedestrian or vehicle control function, was present at each landing site. A fire chief's vehicle and an ambulance were present at several landings.

[2]These figures indicate the number of men directly involved in pedestrian and vehicle control. Additional personnel were present as observers.

vehicle underneath such wires made it easier to describe their location to the pilot. In both day and night operations, trees and poles made some landings difficult; however, they were visible from the air and presented no real danger.

Ground personnel must be aware of all wires in the landing area; at night, this requires the use of spot lights or flares. The landing light of the Bell JetRanger was not adequate for night wire detection. In general, a high-intensity light attached to the helicopter to aid in detecting landing hazards is necessary for flexibility in night operations.[1]

To provide vehicle control, fire engines blocked traffic lanes at several landings. However, at four landings--three involving heavy traffic--fire engines were not employed and no problems resulted. It is concluded from this demonstration that one man with the aid of flares at night, can effectively stop traffic in one direction on a street. A team of four men could control vehicle traffic at almost all locations in this suburban region. Such a team could be provided by the dispatch of one fire unit, or one police unit and one fire unit, since the ground unit would arrive on-scene ahead of the helicopter in 80% of the cases (refer to Section VII-B-1).

Pedestrian control was not a problem. The presence of police and fire equipment prior to the landing did attract bystanders. When these people were informed of the touch-down location by loudspeaker, they remained at a safe distance. In one situation the helicopter remained at the scene for a few minutes and bystanders drifted toward the aircraft for a better look. One man positioned near the tail rotor to protect pedestrians would be desirable if the

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[1] Gutherie, C. Robert, Aerial Surveillance Methods of Crime Prevention: Evaluation, Institute for Police Studies, Department of Criminology, California State College, Long Beach, U.S. Department of Justice Grant 198 (S022), May 1968.

helicopter were to remain on the site of an emergency with its engine running.

3. A Patient Retrieval Demonstration

The feasibility of using helicopters as air ambulances has been well demonstrated both in the U.S. and abroad. However, the EMS Project showed in its response time study (see Section VII-B-1) that despite its speed and ability to fly to a destination in a straight line, a helicopter, on the average, cannot reach the scene of a medical emergency in an urban or suburban area ahead of a ground ambulance dispatched simultaneously from a well-deployed fleet of vehicles.

Furthermore, in highly developed areas, the presence of poles, overhead wires, tall buildings, and heavy street traffic tend to delay or preclude a helicopter landing, unless a trained controller is at the scene to point out obstacles, control traffic, and guide the helicopter by means of hand signals and/or direct voice communications (see Section VII-B-2)

Taking these factors into account, it appeared that helicopter ambulances had their greatest potential in rural areas, where the response time of conventional ambulance services was relatively long and where the presence of open areas would permit unassisted helicopter landings and takeoffs.

Rural areas are also characterized by a relatively small population base. Thus the frequency of occurrence of medical emergencies was projected to be relatively low within the area serviced by helicopter. This infrequent demand for emergency ambulance transport, coupled with the high initial investment cost and recurring operating costs of a helicopter, indicated that it might be uneconomic to operate a helicopter solely as an air ambulance in a rural environment. Therefore, helicopters whose presence in rural areas had been justified for other purposes (i.e. fire suppression, highway surveillance, forestry, etc.) were sought. In this way, the medical and operational benefits of the secondary role need only be balanced against the incremental cost of operation.

The primary goals of such a demonstration were:

- to determine if significant reductions in response time to emergency medical incidents could be achieved by helicopters; to study the medical benefits of such reductions;
- to determine if helicopters could be effective as air ambulances in terms of their physical, operational, and economic characteristics in a basically rural environment.

a. Methodology. A Bell 206A Jet Ranger helicopter, operated by the Los Angeles County Fire Department, was used for the demonstration. The helicopter was outfitted with radios on loan from the Los Angeles County Sheriff's Department and the California Highway Patrol, which provided the communications links with the cooperating agencies.[1] A conversion kit was installed in the JetRanger to allow two litters to be carried inside the helicopter cabin, in addition to the pilot and the medical attendant. The Los Angeles County Fire Department used the Jet Ranger for forest surveillance, work-crew transfer and to assist in forest fire-fighting operations, in addition to its role as an air ambulance. Eight men (two helicopter pilots and six rescue firemen were sent to an 80-hour emergency medical training session at Harbor General Hospital prior to initiating the demonstration service.

The demonstration area known as the Antelope Valley-Newhall area covers about 2200 square miles of predominantly high desert plains and low mountainous terrain. Although mostly rural, the area does include several cities and small towns. The total population serviced at the time of the demonstration was approximately 120,000. Figure VII-B-3 portrays the demonstration area.

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[1] A more detailed version of the helicopter ambulance communications and operational protocol is presented in Appendix E.

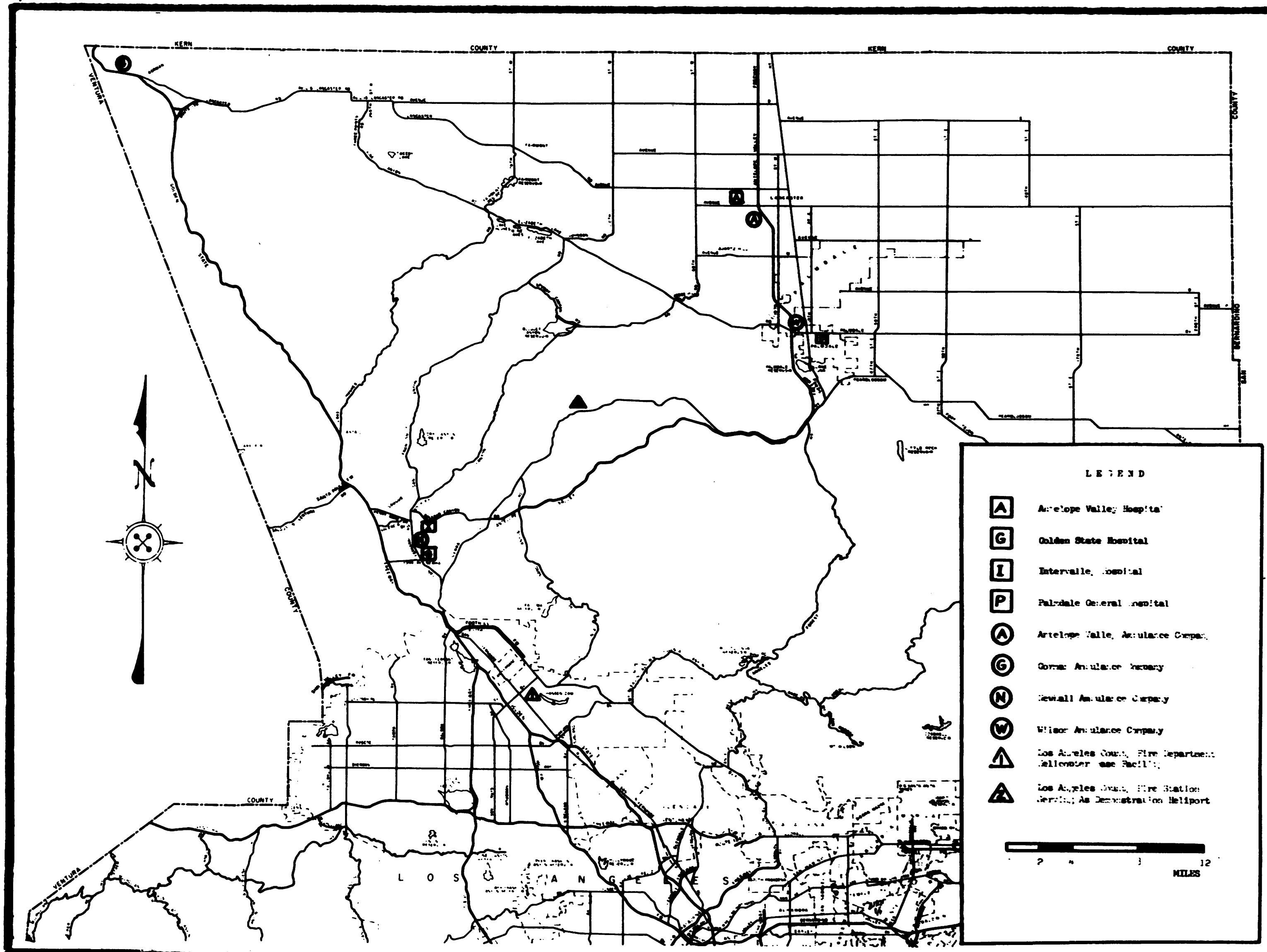

FIGURE VII-B-3. DEMONSTRATION AREA (ANTELOPE VALLEY - NEWHALL) FOR THE STUDY OF A SECONDARY ROLE FOR HELICOPTERS AS AIR AMBULANCES.

The area is served by four private hospitals, each with 24-hour emergency facilities and by four private ambulance companies under contract to the County of Los Angeles. Each ambulance company had at least one vehicle and crew available, 24 hours per day.

During the demonstration, the helicopter was based at a Fire Department station near the geographical center of Antelope Valley. From this station, the response time of the helicopter to any point in the area was estimated to be within 25 minutes, including an allowance for cold-engine starts. The helicopter was seldom dispatched to the three larger towns, where conventional ambulance response times were relatively short, and where the need to land a helicopter was infrequent. The incidents to which the helicopter responded were those for which the estimated response time of a conventional ambulance was 15 minutes or more.

The helicopter was dispatched between noon and 8:00 p.m. on Fridays, Saturdays, and Sundays, for approximately 13 months.[1] The demonstration was funded jointly by the Project and the County. Data were recorded by the Sheriff's dispatcher, the helicopter medical attendants, and by hospital personnel to document all aspects of the emergency, including elapsed times for incident detection and reporting, the response time of the helicopter, the type and severity of the injury, the care administered at the scene, transportation time to the hospital, and ultimate medical outcome.[2] On weekdays and during weekend periods when the helicopter was not dispatched, these same data were recorded for incidents served by conventional ambulance for the purpose of enlarging the data base.

b. <u>Results.</u> During the course of the demonstration, the helicopter was either deployed or scheduled for deployment as an air ambulance

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[1]During non-daylight-saving months, the helicopter was deployed from 10:00 am to 6:00 pm.

[2]The data forms utilized included those discussed in Section V and the Pilot Report shown in Figure A-11.

on 180 of 401 days, which were predominantly weekends and/or holidays. The frequency of emergency incidents was higher on these days (7.6 per day vs. 5.8 per day), as had been projected.

In general, the helicopter was used for a greater proportion of life-threatening cases (26.7% more) than were the surface ambulances. The air ambulance was considered instrumental in saving five patients (two traffic accident victims, two cardiac victims, and one industrial accident victim) and was successful in transferring 12 patients, 6 of whom were considered to have life-threatening injuries, from the demonstration area hospitals to hospitals with a broader range of medical capabilities.

During the 180 days of the demonstration, 1374 emergencies occurred that involved patient transport. The helicopter was dispatched to 118 (8.6%) of them. This figure represents 32.4% of 366 incidents in which time to arrival was estimated to be greater than 15 minutes (i.e., the criterion of helicopter dispatch). One hundred and fifty-two of these (41.6%) occurred while the helicopter was on duty. This result occurred because dispatching personnel sometimes omitted to call the helicopter (mainly in the early period of the demonstration).

Of the 118 emergency calls 63.5% resulted in the transporting of patients--a total of 88 persons; 29.8% resulted in the helicopter being preempted by the ground ambulance (owing to delayed dispatching) and returned while enroute (see Table VII-B-5). The remaining 6.7% of the calls would not have yielded more patients for the helicopter. However, the 35 preempted missions would have resulted in the transport of 41 more patients.[1] Of the 87 cases[2] which involved patient transport, 54% resulted from vehicle accidents (see VII-B-6). Of

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[1] There were 12 emergency hospital transfers in addition to the 88 emergency patients transported.

[2] There were 75 emergency transport missions and 12 emergency transfer missions.

TABLE VII-B-5

BREAKDOWN OF HELICOPTER AMBULANCE CALLS

Patient Transport Cases	Number of Flights	Number of Patients	Percentage
One patient	63	63	53.4
Two patients	11	22	9.3
Three patients	1	3	0.8
SUBTOTAL	75	88*	63.5
Non-Transport Cases			
Returned en route	25**		21.4
Arrived at scene, but transport occurred by ground amb.	10**		8.4
Refused transport	3		2.5
Dead on arrival	2		1.7
Helicopter unable to land	2		1.7
Lack of working room in helicopter	1		0.8
SUBTOTAL	43		36.5
TOTAL	118*		100.0

*In addition, there were 12 cases in which emergency patients were being transferred to other hospitals, bringing the total number of missions to 130 and the total number of patients to 100.

**The helicopter was preempted by the ground ambulance owing to delayed dispatching.

TABLE VII-B-6

INCIDENT TYPES INVOLVING PATIENT TRANSPORT

Type	Number	Percentage
Traffic Accidents	47	54.0%
Injuries	20	23.0%
Illnesses	14	16.1%
Other	6	6.9%

TABLE VII-B-7

PATIENT PROGNOSIS PRIOR TO
TREATMENT BY THE MEDICAL ATTENDANT

Nature of Injury	Percentage	
No Threat to Life or Recovery Within Eight Hours	31%	
Life-Threatening Injury	27%	
(Within 15 Minutes)		(15%)
(Within 30 Minutes)		(2%)
(Within 60 Minutes)		(0%)
(Within Two Hours)		(6%)
(Within Four Hours)		(2%)
(Within Eight Hours)		(2%)
Permanent Disability	3%	
Delayed Recovery	31%	
Insufficient Medical Data	8%	
	100%	

the patients involved in these cases, 27% had sustained injuries judged to be life-threatening by our consulting physician (see Table VII-B-7).

That the helicopter was used to transport the more seriously injured victims is borne out by the 49.5% patient admission rate--twice that for emergency patients transported by conventional ambulances in the area.

The typical air ambulance run covered approximately 51 miles from takeoff to landing at the helicopter station. On the average, distance to the scene was 19 miles and median time to arrival on scene was approximately 15 minutes from the time of dispatch. Elapsed service times for the air ambulance are shown in Tables VII-B-8. It should be noted that virtually all of these calls required more than 15 minutes for the surface ambulance response (which was the helicopter dispatching criterion). Overall, only 26.7% of all calls responded to by surface ambulances in this area result in more than a 15-minute response time.

If we compare service times for surface and air ambulances, we see that the helicopter effected three improvements. It reduced average time from dispatch to the scene by 6.3 minutes, or 30.1%. It reduced time from dispatch to the scene and then on to the hospital by 9.1 minutes, or 22%. Finally, it influenced a reduction in average waiting time at the hospital of 7.7 minutes, or 68.8%.[1] In sum, the average reduction from dispatch to time of treatment in the hospital was 16.8 minutes, a net shortening of service time by 31.9%. Table VII-B-9 displays the relevant figures in greater detail.

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[1] It should be noted that the reduction in waiting time after arrival at the hospital was due at least in part to the fact that the hospital was given advance notification of the helicopter's arrival and of the nature of the patient's injuries; this stemmed from the use of radio communication equipment, rather than from an inherent superiority of the helicopter. Some allowance should be made for this factor in the net reduction.

TABLE VII-B-8

AIR AMBULANCE SERVICE TIMES

Time Interval	Mean Time (Minutes)	Cumulative Mean Time From Dispatch (Minutes)
Dispatch to lift-off	2.3	2.6
Response to scene		
(average distance 19 miles)	12.0	14.6
On-scene care	8.3	22.9
Retrieval to hospital		
(average distance 15 miles)	9.4	32.3

Cumulative Time to Arrival On-Scene

50% of calls responded to within 15 minutes

90% of calls responded to within 26 minutes

Cumulative Time to Arrival at the Hospital

50% of all patients arrived within 33 minutes

90% of all patients arrived within 53 minutes

TABLE VII-B-9

GROUND AMBULANCE SERVICE TIMES
FOR CALLS GREATER THAN FIFTEEN MINUTES

Time Segments	Mean Time (Minutes)	Median Time (Minutes)	90th Percentile
a. Sums to:			
Arrival on Scene (Dispatch + Response)	20.9	19	28
Arrival at Hospital (Dispatch + Response + On-Scene + Retrieval)	41.4	39	56
b. Interval:			
Retrieval to Hospital	14.6	12	26

Comparative Service Times of Ground Ambulance
and Air Ambulance

Time from Dispatch to:	Ambulance	Helicopter	Diff. in Minutes	Percentage Change
Arrival on Scene				
Mean	20.9	14.6	6.3	30.1
50th Percentile	19	15	4	21.1
90th Percentile	28	26	2	7.1
Arrival at Hospital				
Mean	41.4	32.3	9.1	22.0
50th Percentile	39	32	7	17.9
90th Percentile	56	53	3	5.4
Treatment in Hospital*				
Mean	52.6	35.8	16.8	31.9
50th Percentile	46	35	11	23.9
90th Percentile	94	61	33	35.1

*Waiting time in the emergency room is included with time to arrival at the hospital.

This comparison should be interpreted as a potential area of improvement in emergency ambulance service in this community and not as a criticism of existing service, since 50% of all calls are responded to by ground ambulance within 10 minutes (see Table VII-B-10). Given the cost and utilization of the air ambulance, careful planning is required before the use of helicopters as air ambulances is arbitrarily decided upon.

Table VII-B-11 shows that the helicopter was (1) called on ambulance missions 47.8% of the time, (2) not called or unavailable 38.8% of the time, and (3) called for nonambulance missions 13.4% of the time. The helicopter was used for joint purposes (i.e., ambulance and fire, ambulance and administration) 13.9% of the time; however, the aircraft had to be reconfigured when used for water drops since water tanks are not carried during ambulance runs. This requires base station availability of the water tanks or else necessitates returning to the County heliport for them. When the helicopter is used for administrative purposes, the litter kit can be readily stowed away on board or at the base station.

Analysis of the demonstration cost data (see Table VII-B-12) shows that the initial cost (2a)[1]--$15,658.74--greatly affects the average cost per mission (3a)--$141.78--since it accounts for $120.45 while the variable cost of operation per mission is only $21.33 (3b). Actually, the average variable cost per ambulance mission is $11.67 (3b), which includes flight hour costs and first aid consumables.

The high initial-cost-per-mission figure is partially accounted for by two factors: "dry runs," in which the helicopter was dispatched and then returned en route before completing its mission, and cases in which the helicopter should have been dispatched (because the incident met the 15-minute criterion), but was not. Projected

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[1] Section references to Table VII-B-12 are indicated in parentheses throughout the following discussion. Initial cost consisted of purchase and installation of litters, medical equipment, medical malpractice insurance, and personnel training.

TABLE VII-B-10

CONVENTIONAL AMBULANCE SERVICE TIMES FOR ALL EMERGENCY CALLS

Time Interval	Mean Time (Minutes)	Cumulative Mean Time From Dispatch (Minutes)
Dispatch to Departure	1.5	1.5
Response to Scene	10.5	12.0
On-Scene Care	6.8	18.8
Retrieval to Hospital	9.4	28.2

Cumulative Time to Arrival On-Scene

50% of calls responded to within 10 minutes

90% of calls responded to within 21 minutes

Cumulative Time to Arrival at the Hospital

50% of all patients arrived within 24 minutes

90% of all patients arrived within 45 minutes

NOTE: This table is based on all data gathered on the days on which the helicopter was deployed.

TABLE VII-B-11

UTILIZATION OF THE LOS ANGELES COUNTY FIRE DEPARTMENT HELICOPTER

Mission Types	Number of Days	Percentage
None	61	33.9
Ambulance Only	61	33.9
Ambulance and Administrative	18	10.0
Ambulance and Fire	7	3.9
Administrative Only	14	7.8
Fire Only	10	5.6
Not Deployed	6	3.3
Maintenance	3	1.6

NOTE: This summary is for only those 180 days on which the helicopter was deployed or scheduled for deployment as an air ambulance. The helicopter was deployed on some holidays in addition to weekends.

TABLE VII-B-12

COST ANALYSIS OF THE AIR AMBULANCE DEMONSTRATION

1. Operational Data*

(a) 75 emergency flights involving patient transport

12 inter-hospital transfers

43 dry runs

130 air ambulance flights

(b) 51 miles per emergency flight involving patient transport

(c) .53 flight hours/emergency transport flight (12 minutes to scene, 9.4 minutes to hospital, 10.7 minutes to base)

1.1 flight hours/inter-hospital transfer

.4 flight hours/dry run (12.0 minutes to and from incident)

.4 flight hours/day for deployment to base

(d) 171 days deployed as air ambulance

9 days not deployed or out for maintenance

180 days potentially available as air ambulance

(e) 138.7 flight hours on ambulance runs

-39.8 flight hours emergency transports (.53 X 75)

-68.4 flight hours for deployment from heliport to base (.4 X 171)

-13.3 flight hours for patient transfer (.4 X 171)

-17.2 flight hours for dry runs (.4 X 43)

87.3 flight hours for non-air ambulance purposes

226 total flight hours on days helicopter deployed

(f) .81 flight hours per day on air ambulance missions (138.7 ÷ 171)

.76 ambulance missions per day (130 ÷ 171)

*Additional Air Ambulance Operational Performance Data are shown in Table VII-B-13.

TABLE VII-B-12 (Cont'd)

2. Incremental Costs of Service (13 months)

(a) Initial Costs (one-time charges)

o Emergency Care Training (2 pilots and 6 attendants)	$ 2,589.01
o Litter Kit (including installation)	3,913.30
o Medical Equipment	935.83
o Medical Malpractice Insurance ($7,590.62/year)	8,220.60
Subtotal of initial costs	$15,658.74

(b) Variable Costs

o Allowance for airframe parts (scheduled and unscheduled replacements), for engine replacement parts, and for engine overhaul	$14.60/hour*
o Consumables (fuel and oil)	4.58/hour*
Subtotal of helicopter cost	$19.18/hour
o Helicopter Ambulance Flight Hour Cost (138.7 X 32.85)	$2,660.27
o First aid consumables (not involved in helicopter transfers) . . .	113.00
Subtotal of variable costs	$2,773.27

(c) Total Incremental Costs $18,432.01

3. Prorated Costs of Demonstration

(a) For Mission Flown

Total Incremental Costs	$18,432.01
Total Missions Flown	130
Cost per Mission	$ 141.78

*No labor cost was included because all maintenance was performed by existing personel. The hourly cost for services and supplies ($14.60/hour) was based on a three year average for the County since overhaul costs and scheduled inspection costs are only included in hourly costs for the year in which they occurred. Bell Helicopter Company in their manufacturer's specifications dated November 1971 estimate comparable costs to be $25.17/hour and $7.68/hour.

TABLE VII-B-12 (Cont'd)

3. Prorated Costs of Demonstration (contd.)

(b) By Mission Type

(1) Initial Cost $15,658.74

Prorated over 130 flights. . . . . $ 120.45

(2) Variable Costs . . . . $ 2,773.27

Deployment Flights Hour Costs (68.4 X $19.18). . . . . . $ 1,311.91

Patient Transfer Flight Costs (13.3 X $19.18). . . . . . $ 255.10

Patient Transport Flight Costs (39.8 X $19.18 + $113). . $ 876.36

Dry Run Flight Costs (17.2 X $19.18) . . . . $ 329.90

(3) Per Mission Costs

Mission Type	Initial Cost	Variable Cost	Total Cost
Deployment	N/A	$ 7.67	$ 7.67
Transfer	$120.45	$21.10	$181.78
Transport	$120.45	$11.67	$132.12
Dry Run	$120.45	$ 7.67	$128.12
Average	$120.45	$21.33	$141.78

(c) By Patients Carried

Total Incremental Cost $18,432.01

Total Patients 100

Cost per Patient. . . . . $ 184.32

4. Projected Costs of Service

(a) Projected Costs Including Preempted Dry Runs* and Non-Dispatches

(1) Number of dry runs resulting in patient transport. 35

Number of patients involved in transport 41

*Runs on which helicopter dispatched later than ambulance whereby helicopter would have transported patients.

TABLE VII-B-12 (Cont'd)

(a) Projected Costs Including Preempted Dry Runs and Non-Dispatches (contd.)

(2) Number of calls exceeding 15 minutes on which helicopter not dispatched 34

Number of patients involved in transport 37

(3) Total projected emergency cases (130 + 34) 164*

Total projected patients (100 + 41 + 37) 178*

(4) Additional variable costs for projected cases

- Flight Time [(23.1 X $19.18]. . . . . $ 443.06

- First Aid Consumables (78 X 1.28) . . . . $ 100.15

Total Variable Cost . . . .$ 543.21

(5) Total Incremental Cost (18,432.01 + 543.21) $18,975.22

(6) Cost per projected number of cases (18,975.22 ÷ 164). . . .$ 115.70

(7) Cost per projected number of patients (18,975.22 ÷ 178). . .$ 106.60

(b) Projected Costs - 7 Day a Week Operation**

(1) Initial Costs $15,658.74

(2) Projected Missions

Patient Transport Cases 264

Non-transport Cases (Dry Runs). 21

Patient Transfer Cases 23

Total Missions 308

(3) Projected Patients

Patients Transported 309

Patients Transferred 23

Total Patients 332

(4) Prorated Initial Costs

Cost per Mission . . . . $ 50.84

Cost per Patient . . . . $ 47.16

*Includes 12 transfers.

**This analysis is a projection of costs if helicopter had been scheduled for deployment throughout the 13 months everyday instead of weekends only.

TABLE VII-B-12 (Cont'd)

(b) Projected Costs - 7 Day a Week Operation (contd.)

(5) Projected Variable Costs . . . . $ 4,303.98

Deployment flight hour costs* (50.8 X 19.18). . . . . . $ 974.34

Patient transfer flight costs (25.3 X 19.18) . . . . . . $ 485.25

Patient transport flight costs (139.9 X 19.18) . . . . . $ 2,683.28

Dry run flight costs (8.4 X 19.18) . . . . $ 161.11

(6) Projected Per Mission Costs

Mission Type	Initial Cost	Variable Cost	Total Cost
Deployment	N/A	$ 7.67	$ 7.67
Transfer	$50.84	$21.10	$71.94
Transport	$50.84	$11.67	$62.51
Dry Run	$50.84	$ 7.67	$58.51
Average	$50.84	$13.97	$64.81

(c) Projected Costs - Second Year, 7 Days a Week**

(1) Initial Costs***

o Emergency Care Retraining Costs . . . . $ 1,152.00

o Medical Malpractice Insurance . . . . $ 8,220.60

Subtotal of Initial Costs . . . . $ 9,372.60

(2) Prorated Initial Cost

Cost per Mission . . . . $ 30.48

Cost per Patient . . . . $ 28.23

(3) Variable Costs** . . . . $ 4,303.98

(4) Total Projected Incremental Cost $13,676.58

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*Helicopter would be based at station regularly or semi-regularly and fly to heliport for maintenance which would thereby reduce deployment flight hours.
**Assuming same patient load as in 4 (b) and same time period.
***Since all litter kit and medical equipment costs were amortized the first year, the only second year costs are for training and insurance

TABLE VII-B-12 (Cont'd)

(c) Projected Costs - Second Year, 7 Days a Week (contd.)

(5) Projected Per Mission Cost

Mission Type	Initial Cost	Variable Cost	Total Cost
Deployment	N/A	$ 7.67	$ 7.67
Transfer	$30.48	$21.10	$51.58
Transport	$30.48	$11.67	$42.15
Dry Run	$30.48	$ 7.67	$38.15
Average	$30.48	$13.97	$44.45

5. Summary Comparison of Air Ambulance and Ground Ambulance Service Costs for the Average Helicopter Emergency Run*

Air Ambulance Utilization	Air Ambulance Cost Per Run	Ground Ambulance Cost Per Run (Public Rate**)	Percent Change
Actual Demonstration	$141.78	$48.83	+190.4
Demonstration including preemptions and non-dispatches	$115.70	$48.83	+136.9
Projected 7 day a week operations during demonstration	$ 64.81	$48.83	+ 32.7
Projected 7 day a week operations for second year	$ 44.45	$48.83	- 9.9

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*Average miles to the hospital from the incident for the ground ambulances was 15 miles.

**If patient can not pay bill, the County Emergency Aid Program office reimburses operator at a special rate.

	Public Rate	EAP Rate
Initial Fee	$30	$27
Mileage Rate	$1/mile	$1/mile (after five miles)
Nite Rate	$5	—
Second Patient	½ cost of first patient and bill is split between the two.	$9 (flat rate for each additional patient and total is split for bookkeeping purposes.)

TABLE VII-B-12 (Cont'd)

6. Other Non-Service Demonstration Costs

Data Acquisition	$10,202.65
(Data collection costs from ambulance companies and hospitals; mileage to gather data; data forms)	
Pilot and Attendant Overtime	$ 1,164.54
(Extraordinary adjustment of crew schedules to fit needs of demonstration during first two months)	
Reimbursement of Los Angeles County	$ 830.40
Emergency Aid Program Contract Ambulances (for patients transported by helicopter rather than ground ambulance)	
TOTAL:	$12,197.59

TABLE VII-B-13

AIR AMBULANCE OPERATIONAL PERFORMANCE SUMMARY

1. Helicopter Location at Dispatch	
Airborne	10.3%
On Ground	89.7%
2. Helicopter Delayed at Dispatch	
Reconfiguration	1.3%
None	98.7%
3. Weather Conditions	
Overcast and/or Rain	9.2%
Clear	91.8%
4. Time of Mission	
Night	5.7%
Day	94.3%
5. Wind Conditions	
None	23.0%
0 - 10 M.P.H.	28.4%
10 - 20 M.P.H.	38.3%
Over 20 M.P.H.	10.3%
6. Difficulties Locating Incident	
None	91.9%
Visibility	1.2%
Area Unfamiliar	1.2%
Inadequate Information	5.7%

TABLE VII-B-13 (Cont'd)

7. Landing Problems at Incident	
None	77.0%
Obstacles (wires, terrain)	16.0%
Automobile Traffic	4.6%
Crowd	1.2%
Air-Ground Coordination	1.2%
8. Landing Assistance	
None	70%
Radio	12%
Traffic Control	11%
Crowd Control	7%
9. Delayed in Landing at Incident	
None	98.7%
Yes (Air-Ground Coordination)	1.3%
10. Distance Landed from Incident	
Within 100 feet	73.4%
Between 100-300 feet	18.7%
Between 300-600 feet	1.6%
Over 600 feet (eg. hitting accident, skiing accident)	6.3%
11. Units at Incident prior to Helicopter	
Public Agency (squad car, fire unit, forestry service)	79.0%
Ambulance	3.9%
None	17.1%

TABLE VII-B-13 (Cont'd)

12.	Pilot Assistance at Scene Outside Aircraft	
	Assist in Treatment and/or Transport	59.8%
	Guard Aircraft and/or Keep Area Clear	12.6%
	Traffic Control	1.2%
	None required	24.1%
	Not indicated	2.3%
13.	Delayed at Incident	
	No	92.0%
	Yes, distance from patient	2.3%
	Yes, equipment problem	1.2%
	Yes, coordination	1.2%
	Yes, other	33%
14.	Hospital Notified of Time of Arrival	
	Yes	97.7%
	No	2.3%
15.	Hospital Notified of Type of Injury	
	Yes	94.3%
	No	5.7%
16.	Landing Problems at Hospital	
	None	94.0%
	Obstacles	2.4%
	Traffic Control	2.4%
	Crowd Control	1.2%
17.	Improvement of Helicopter Landing Site	
	Not necessary	95.4%
	Yes	4.6%

TABLE VII-B-13 (Cont'd)

18. Suggested Improvements by Helicopter Crew

None	93.1%
More Working Space in Helicopter	2.3%
Communication Equipment to enable Air-Ground Coordination with All Units	4.6%

costs of service were recomputed on the assumption that complete runs had been made in these two cases (4a), which reduced the average cost per ambulance mission to $115.70. This represents a $26.08 (21.7%) reduction in the prorated initial cost.

A further reduction in the prorated service costs could have been achieved through the scheduled deployment of the helicopter on a seven-day-a-week basis rather than a three-a-day-a-week basis during the demonstration period (4b). This could be accomplished without interfering with the helicopter's primary mission, since the average number of ambulance missions per day would be less than one and the average length of service times (from dispatch to departure from hospital) would be less than 40 minutes.

The reduced costs of operation on this basis indicate that the average cost per mission would have been $64.81 (4b), which reflects a reduction of $76.97 (63.1%) in the prorated initial cost.

In addition, the litter kits[1] and medical equipment are one-time purchases and these costs were charged off across the runs occurring during the first 13 months of operation. If the helicopter were operated for an additional 13 months, assuming the same demand for ambulance service (4c), the average cost per ambulance mission would be reduced to $44.45, which reflects a reduction of $97.33 (80.8%) in the prorated initial cost.

The ground ambulance cost per mission (5) is $48.83, and it would appear that the air ambulance could effect a 9.9% decrease in that figure. However, we must make due allowance for the degree of inaccuracy in our serial extrapolation, so it is probable that this difference is not significant. Still, the costs of air and ground ambulances, if both were fully implemented, would clearly be comparable.

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[1] When the existing helicopters depreciated and were replaced, the new helicopters would include litters as an option already installed.

c. <u>Conclusions</u>. The helicopter ambulance could provide improved emergency service to emergency victims who are located 15 minutes or more from the nearest ground ambulance, which would include a 30.1% decrease in time to arrival on-scene and a 22% decrease in arrival time at the most appropriate (rather than merely the closest) hospital. This service could be offered at a cost comparable to present ground ambulance costs if the helicopter were made available daily and its use continued beyond the demonstration period.

Air ambulance service could be used in other outlying areas of the county, having potentially long response times (15 minutes or more) in emergencies--for example, the Malibu area of the county, which presently has no hospital[1] and during the warm weather months incurs approximately 60-70 emergencies (primarily on the weekends). If the injury/illness in these cases is serious enough to warrant transport to the hospital in Santa Monica, service time may require an hour or more.

It cannot be stressed too strongly that these findings strictly depend on (1) the helicopter having another function against which the procurement and other fixed costs of operation can be offset, (2) demand for emergency service continuing at indicated levels, and (3) no expansion of ground ambulance service or deployment patterns that would effectively reduce the time to arrival on scene.[2] If one or all of the foregoing conditions were not met, then the economies of operation would change significantly and the medical benefits be diminished.

With respect to the latter, if paramedical personnel (equivalent of EMT II) were used instead of the present attendants (equivalent of EMT I), then medical benefits could still be derived by seriously

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[1]There is only a field office available presently.

[2]The effect of changes in (2) and (3) could be explored by use of the simulation model (see Section IV-B).

injured patients in areas of the county in which the arrival time at the hospital would exceed the arrival time of the helicopter.

C. COMMUNITY IMPACT

Several activities of the Project resulted in the modification of some of the existing emergency medical services in the County of Los Angeles. These changes were introduced as part of either the MICU or helicopter demonstration studies or as an application of the analytic and simulation techniques that were developed by the Project. In particular, the demonstrations were designed to generate permanent community interest in the improvement of emergency medical services.

The benefits that accrued from these experimental modifications were such that the sponsoring communities or jurisdictions have continued or even expanded them. Table VII-C-1 summarizes the major impacts of these Project activities and the subsequent developments that have flowed from them.

VII-C-1

DIRECT IMPACTS OF PROJECT ACTIVITIES

Area of Direct Impact	Project Activities: (A) MICU Demonstration	(B) Helicopter Demonstration	(C) Analytic and Simulation Techniques
1. Communications	X	X	X
2. Legislation	X		
3. Public Information	X	X	
4. Telemetry	X		
5. Training	X		
6. Transportation	X	X	X
7. Treatment	X		X

1. Establishment of County Paramedic Training Program (5-A)[1]

After the first groups of firemen had been trained and certified as

[1] The designation (5-A) denotes an impact from Table VII-C-1 on area 5, namely training, of EMS Project activity (A), namely the MICU demonstration, which led to community action.

paramedics (Emergency Medical Technician-II) for the MICU study at Harbor General Hospital, the County Department of Hospitals, in conjunction with the County Fire Department, decided to explore the feasibility of establishing a continuing program for the training of additional paramedics and retraining of certified paramedics.

During discussions of how best to continue the training activities it was decided that an individual with extensive experience in the training of paramedical personnel should be hired to direct this activity for the County of Los Angeles. In the fall of 1970, the County of Los Angeles hired a former Army Colonel, Gaylord Ailshie, who had been responsible for The training of Army paramedical personnel at Fort Sam Houston, Texas. Following Colonel Ailshie's appointment as Director of Paramedic Training, plans were developed for establishing a permanent training program. On July 1, 1971, a $250,000 matching fund grant from the U.S. Department of Transportation was awarded to Los Angeles County to train approximately 90 firemen as paramedics over a two-year period.

In addition to the paramedic training center at Harbor General Hospital, a second such facility was created at the Los Angeles County/University of Southern California Medical Center. To date, 474 paramedics have been trained and certified in Los Angeles County. An additional 104 paramedics currently are in training at the two facilities.

2. Expansion of Mobile Intensive Care Units (1-A, 4-A, 6-A and 7-A)

With the establishment of a permanent paramedic training program, it has been possible For the County and City of Los Angeles to expand their MICU programs. In addition, a number of cities have been able to initiate MICU programs of their own. At present, there are 56 mobile intensive care units operating within the County of Los Angeles. Table VII-C-2 describes these.

A critical problem, which remains unsolved in the County of Los Angeles, is the absence of an efficient operational design for the MICU's. The operational designs for the rescue squad and the ambulance

TABLE VII-C-2

MOBILE INTENSIVE CARE UNITS PRESENTLY IN SERVICE IN LOS ANGELES COUNTY

Jurisdiction	When Unit (Or First Unit) Went Into Service	Number of MICU's in Service	Can MICU Transport Victims?[1]
Arcadia	October 1973	1	Yes
Beverly Hills	January 1972	1	Yes
Culver City	June 1973	1	Yes
El Segundo	May 1974	1	Yes
Gardena	December 1972	1	No
Inglewood	July 1972	3	Yes
Long Beach	November 1972	4	No
Los Angeles (City)	October 1970	10	Yes
Los Angeles (County)	December 1969	24	No
Los Angeles Sheriff's Emergency Service Detail[2]	February 1973	2	Yes
Manhattan Beach	July 1972	1	Yes
Monrovia	November 1972	1	Yes
Pasadena	April 1972	2	Yes
Redondo Beach	January 1972	2	Yes
Torrance	November 1972	1	No
Santa Fe Springs	July 1974	1	Yes

[1]Some units with transport capability only transport critically ill or injured patients. Others are transported, after examination and treatment at the scene of the MICU paramedics, by ambulance

[2]Carries out rescue operations in remote and difficult access areas; can be helicopter airlifted or can operate as mountain or desert rescue unit.

type MICU's, which were intended for experimental purposes (see Section VII-A), have been proliferated with little change. The original operational designs contained procedures and safeguards, which were appropriate to experimental units. Based upon the more than four years of experience that have been acquired, however, the entire mode of operation of the MICU's needs to be examined. A new operational design is required that appropriately balances the risks and benefits to patients, reflects the availabilities of resources such as the number of radio telemetry channels, and integrates the MICU's more fully into emergency medical services as a total system.

3. Modification of Wedworth-Townsend Act (2-A)

The Wedworth-Townsend Act of 1970 (see Appendix D) enabled trained paramedical personnel to administer intensive care at the scene of medical emergencies. This Act was amended to extend the types of treatments that may be administered by paramedical personnel to include

- Administer intravenous volume expanding agents
- Perform pulmonary ventilation by use of esophageal airway
- Obtain blood for laboratory analysis
- Apply rotating tourniquests
- Administer parenterally, orally or topically any of the following classes of drugs or solutions:

    Narcotic antogonists
    Diuretics
    Anticonvulsants
    Ophthalmic agents
    Oxytocic agents
    Antihistaminics
    Bronchodilators
    Emetics

Further amendments are contained in a bill presently before the California Legislature. These amendments would:

- Increase the training requirements of mobile intensive care paramedics to 200 hours of didactic training, 100 hours of clinical experience and a field internship of at least 200 hours, from the previously required 290 hours.
- Authorize waiver of portions of the training program for a person who has had medical training and passes a performance examination.
- Permit paramedics to assist in child birth.

A critical issue that needs to be examined objectively is what kinds of care and treatment, if any, from among those that paramedics presently can perform at the scene only when in direct communication with and upon the order of a physician or a certified MICU nurse, paramedics should be permitted to perform under standing orders without any direct communications.

4. Redeployment of the City of Los Angeles Fire Department Ambulances (6-C)

In 1969, the City of Los Angeles Fire Department assumed responsibility for operating thirteen additional City ambulances. The Fire Department asked the EMS Project to recommend optimum locations for these ambulances. The objective was to balance ambulance itilization under the constraint of a mean response time of five minutes or less. The CALL model (see Section V-A) was used to more optimally locate the thirteen ambulances.

5. Continuation of the County Helicopter Ambulance Service (1-B, 6-B)

Following the completion of the helicopter ambulance demonstration, which was conducted in the rural, northern part of Los Angeles County, the County Fire Department, with the approval of the Board of Supervisors, has continued this service on Fridays, Saturday, and Sundays.

A modification of the helicopter ambulance service is now under consideration. It is the replacing of the medical attendant by a certified paramedic with the appropriate medical and telemetry equipment. In addition to upgrading care at the scene and in-transit, this would facilitate the transportation of critically ill or injured victims from local community hospitals to one of the major hospitals elsewhere in the County. If this modified service is instituted, it will probably be made available on a seven-day-a-week basis.

6. Continuation of The Los Angeles City Helicopter Ambulance Backup (C-B)

A Los Angeles City Fire Department helicopter was equipped by the Project with a litter kit. While primarily used for fire suppression, this helicopter and several others, which the city Fire Department subsequently purchased with litter configurations, are used as backup for the Fire Department's fleet of ground ambulances. Their principal uses have been the retrieval of critically ill or injured persons from areas of the city that have become inaccessible to ground ambulances due to flooding, fire, etc., and in minor and major disasters. During the 1971 earthquake, for example, these helicopters:

- evacuated patients
- transported medical teams
- transported medical supplies and equipment

7. Public Information (3-A, 3-B)

During the course of the Project, the demonstrations have received media coverage including television, newspapers, and magazines.

a. Mobile Intensive Care Demonstration. Prior to the inception of the MICU demonstration, each household and business in the demonstration area received an information pamphlet describing the warning signs of a heart attack and telling how to obtain service from the MICU. Figure VII-C-1 reproduces this informational material.

Sponsored by

The Los Angeles County Harbor General Hospital

The Los Angeles County Fire Department

UCLA Emergency Medical Services Program

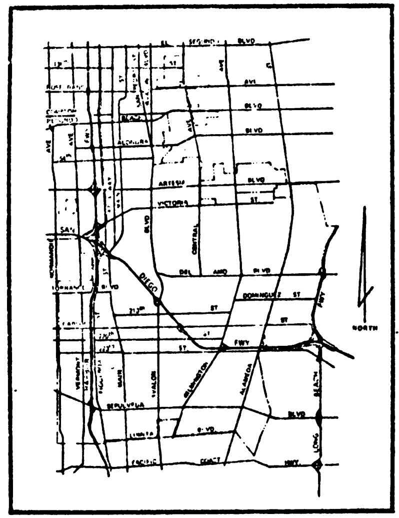
A Program Utilizing

– Mobile Intensive Care

– Paramedics of the Los Angeles County Fire Department

The Rescue Heart Unit - a program sponsored by the County of Los Angeles under a Resolution introduced by Supervisor Kenneth Hahn;

LOS ANGELES COUNTY FIRE DEPARTMENT
AREA MAP



Shown above is the area served by the Rescue Heart Unit of the Los Angeles County Fire Department.

EMERGENCY SERVICE TELEPHONE NUMBER

638-6121

HOW TO GET EMERGENCY CARE

OF A HEART ATTACK

READ THIS and LIVE

KEEP this by your phone

FIGURE VII-C-1. MICU INFORMATION PAMPHLET

HEART ATTACK

EARLY Warning Signal

BIG ATTACKS may have a small amount of PAIN

A pressure or tightness or squeezing in the center of the chest.

This may follow exertion, a meal, or anger – or nothing.

The discomfort lasts for several minutes – it may travel to the arm, neck, or jaw.

This may NOT be "indigestion."

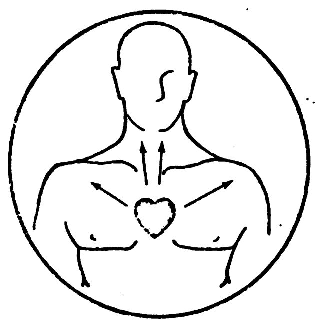
LATE Warning Signal

The chest discomfort may be more severe and crushing.

However, it has lasted over five minutes.

Perspiration of the brow may be present.

A feeling of faintness or shortness of breath may follow.

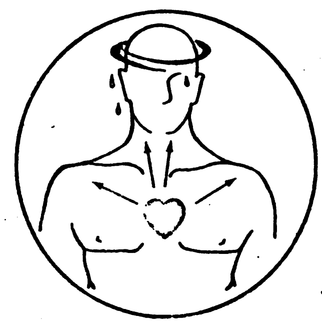


WHAT TO DO

Don't Waste Valuable Time
Call Your Physician

or

Have someone drive you to the nearest hospital that has an EMERGENCY ROOM and a CORONARY CARE UNIT.



WHAT TO DO

DON'T STALL—ACT NOW!!
Call the RESCUE HEART UNIT

They have the training, the medicines, and the electronic equipment to save most heart attack victims – if you phone promptly.

(See Phone Number on Other Side)

YOU ARE IN A HIGH RISK GROUP IF YOU HAVE:

1. A personal or family history of heart problems
2. High blood pressure
3. Over weight
4. Long history of smoking
5. Diabetes

YOU SHOULD KNOW

2/3 of all heart attack deaths occur before hospitalization.

1/2 of these deaths may be preventable if you call your

RESCUE HEART UNIT PROMPTLY

Under a new State Law introduced by Senator Wedworth and Assemblyman Townsend, our area is permitted to have special trained Paramedics (Rescue Heart Unit) who can give emergency heart care.

This involves special portable heart monitors, sending the EKG by radio to the hospital heart station, and giving special medicines after radio consultation from experts.

If hospitalization is indicated, you will be taken to the hospital of your choice.

FIGURE VII-C-1 (Cont'd). MICU INFORMATION PAMPHLET

All local television news programs featured segments describing the paramedic program initiated at Harbor General Hospital. In the fall of 1970, the ABC television network featured a documentary on heart attacks that included a five-minute segment featuring the MICU demonstration. On January 15, 1972, the NBC television network featured a two-hour pilot program for the series "Emergency" that was based upon the MICU program at Harbor General Hospital. The series became a weekly network program later that month.

b. Helicopter Demonstrations. Each of the three helicopter demonstrations was given extensive coverage in both the local and countywide newspapers. The local newspapers have featured continuing coverage of the progress of the helicopter ambulance service in north Los Angeles County.

Local television stations featured coverage of both the helicopter response time study and the landing feasibility study. The latter study was discussed in an article in Aviation Week[1] and the EMS Project produced a short documentary film on this demonstration.

8. Los Angeles Countywide Coordinating Council on Emergency Medical Services (C-1, C-6, and C-7)

The Los Angeles Countywide Coordinating Council on Emergency Medical Services grew out of a two day conference, which was held in June 1972 and brought together 500 participants from all parts of the county. Fifteen workshops identified problems and made recommendations with regard to emergency medical services in the county[2]. The Council was organized to undertake the planning of a countywide EMS system. It is a coalition of county and municipal governments, providers, associations, health care professional associations,

[1] Himmel, Nieson S., "Interest in Air Ambulance Use Increases, "Aviation Week & Space Technology, March 24, 1969.

[2] Proceedings, Countywide Conference on Emergency Medical Services, in Los Angeles, California, June 19-20, 1972.

community groups, and individuals. It maintains an independent role and and is not the creature of any particular organization or group of organizations. It exists only for the purpose of planning and the final choice of a system and its implementation will be joint responsibility of the participating organizations.

The Council has developed a "socio-technical" approach[1] to planning which was based upon the work of the Project. This approach encompasses both an ordered set of planning tasks and a planning process, which involves the active participation of individuals, organizations and political jurisdictions. The set of planning tasks draws heavily on both the analytic and simulation techniques that were developed by the Project and are described in Chapters IV and V. Similarly, the planning process is based upon the approach to action research that is described in Chapter III.

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[1] Andrews, R. B., Brill, J. C. and Horowitz, L., "A Socio-technical Approach to the Planning of Emergency Medical Services" Journal of The American College of Emergency Physicians, 1973, pp 416-421.

VIII - CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

A large amount of data and experience were generated by the many and varied activities of the Project. From these, a number of inferences can be drawn. These relate to the present state of emergency medical services, the shortcomings of most attempts to improve emergency medical services, methodologies for the improvement of emergency medical services, and the major findings of selected demonstrations.

1. The Present State of Emergency Medical Services

Our society is in the midst of fundamental changes. Continuing advances in technology, shortages of natural resources, rising expectations of individuals, and reappraisals by individuals of their roles and their relationships to society and to its institutions are producing dislocations and mismatches. Strong forces have emerged that demand fundamental changes; these in turn have kindled counterforces that call for the maintenance of the status quo. There is probably no area in which the dissonance is greater than that of health care. Since they are one of the few portals to health care that are available to everyone, emergency medical services are among the storm centers.

Some of the major elements that contribute to the dislocations and mismatches, which presently characterize much of emergency medical services, are briefly recapped below:

a. The Knowledge of Lay Persons with Regard to the Natures of Medical Emergencies and What to Do to Assist the Victim. The decision that an illness or injury requires prompt attention is most commonly made by the victim or by a relative or acquaintance acting on his or her behalf. The consequence is that the demand for emergency medical services is defined by laymen in the absence of an accurate evaluation. At one extreme, apparently minor complaints, which are harbingers of life-threatening conditions, are ignored.

At the other extreme, a high level of apprehension on the part of the victim, his or her relatives or acquaintances, in relation to a relatively minor illness or injury, results in a demand for emergency medical services.

The results of the household survey showed that roughly thirty percent of the respondents reported that at the medical emergency, with which each respondent was the most familiar, there was not enough knowledge about what treatment the victim required. In about half of such instances, it was indicated that this was because the severity of the victim's illness or injury could not be judged at the scene by lay persons. In almost two-thirds of all the medical emergencies, the respondents believed that the victim required care at the scene. In only about forty percent of the instances, when such care was judged to be needed and the supplies and equipment to give it were available in the vicinity, was care given at the scene by lay persons. One of the major reasons that was offered to explain why care was not given at the scene was that no one present knew how to give it.

On the other hand, the household survey revealed that most lay persons at the scene of a medical emergency had some general kinds of knowledge and usually attempted to assist the victim. Between seventy and ninety percent of all actions taken at the scene were undertaken by lay persons, including strangers. Their actions ranged from providing information to such things as reducing the dangers that were present at the scene, freeing trapped victims, contacting help and transporting the victim to a treatment facility.

With little exception, the major reason given, when no decision or action was taken by lay persons at the scene, was the view that these should be left to public agents.

b. The Knowledge and Perceptions of Consumers of Emergency Medical Services. Most people are infrequently faced with medical emergencies. Those that have established sources of primary health care have little occasion to develop an accurate understanding of the emergency medical services in their communities and of how to use them properly.

The household survey provided ample evidence of the ignorances and misconceptions of most citizens in these matters. Roughly thirty percent of all those who were surveyed were unable to mention a single organization that they thought provided ambulance services in their communities. Among the organizations that the other respondents identified as providers of ambulance services, one-third did not provide such services. Similarly, roughly one-third of the respondents were unable to identify any facility that they thought provided outpatient emergency medical services in their communities. Facilities which were correctly identified and at which physicians were merely on call or which didn't offer any physician-based emergency treatment, were thought by a majority of respondents to always have a physician present to provide emergency treatment.

Others view the situation differently. Outpatient services in this country have long been associated with public assistance. Originally, such services were adjuncts to hospitals and were staffed by practitioners, who donated their time as charitable public services, or served as teaching facilities for physicians in training. The culturally and/or economically disenfranchised came to use emergency medical services as one of their few portals to ambulatory care. Still others, because of their kinds of employment or other activities, have come to use emergency medical services as a place to go for ambulatory services at night and on weekends, when other sources of care are closed.

c. <u>State of the Art in the Care of the Critically Ill and Injured</u>. Advances in pathophysiology, bioengineering and critical care practice have provided the means for saving and supporting the lives of the victims of many kinds of critical illnesses and injuries. Specialized kinds of in-patient intensive care units have exhibited more growth in recent years than any other category of community hospital services. This rapid growth reflects two trends. First, the availability of sophisticated procedures for diagnosis, life support, and definitive therapy. Second, a growing awareness that concentrating critically ill and injured patients in units under the care of teams of full-time, specialized health professions and allied health personnel improves their prognoses. We are still in the initial stages of the development of methods for exporting these kinds of care to the scenes of medical emergencies to make advanced kinds of life support available at earlier stages in the courses of medical emergencies.

d. State of the Arts in Support Function. The core function in emergency medical services is the stabilization or maintenance of life of the critically ill and injured and the appropriate disposition of noncritical persons, who enter the system for a variety of reasons. The performance of this function depends more heavily, than other kinds of health care, upon supportive communications and transportations. The states of the art for these functions have also advanced rapidly in recent years. There are few technological constraints to satisfying the communicative and transportative requirements of almost any alternative approach for organizing and performing the core treatment function. The constraints in choosing appropriate means for performing these support functions are largely economic.

e. Organization of Emergency Medical Services. Historically, providers have determined the kinds, manners and places of health care, including emergency medical services. Existing emergency medical services have evolved as a consequence of political jurisdictions, special interest groups, historical accidents, and unplanned growth. They continue to operate disjointly and autonomously, some under private, others under public ownership. Each organization performs one or more of the functions in the total spectrum of activities. Such fragmentation has several important consequences:

- Fractionated components lack any common set of objectives and any overall management function to guide their efforts. In life threatening situations, the victim, or those acting on his or her behalf, would like to be able to turn to a single source for help, such as the law enforcement agency or the fire department that one turns to in other kinds of emergencies. Each such public safety agency has a single management structure, which plans, organizes, staffs, directs and controls its activities. Within their geographical jurisdictions, such agencies control the resources that are required to deal with the emergencies that fall within their area of concern.

- Fractioned components at best can only suboptimize, that is, with regard to the limited objectives of only one of a set of interacting activities. In such instances, there typically are differing objectives for each component, some of which are incompatible with those of other components. The resources collected and utilized by one component are not balanced with those of the other components with which it interacts. Resources tend to be wasted through underutilization of facilities, whose overcapacities not infrequently are the result of the competitive buildup of facilities, equipment and functions.
- Fractionated components require the user of emergency medical services to provide a high degree of "self-management" to deal with the different entities in a manner that satisfies his or her health needs.

The fractioned providers of interdependent emergency medical services are faced with ever increasing demands for their services. These demands are being placed by a comingling of critically ill and injured persons and those who do not require immediate attention. The net result of all of their activities is usually not satisfactory in terms of what it is now possible to deliver in the way of life-supportive care for the critically ill and injured and appropriate dispositions of others. Yet any significant improvements are likely to be possible only in ways that cut across several providers. About the only mechanism that exists, for introducing innovations under such circumstances, is voluntary cooperation, something that is difficult to attain.

2. The Shortcomings of Most Attempts to Improve Emergency Medical Services

Attempts have and continue to be made to improve emergency medical services. While almost all have been well-intended, few have been able to demonstrate the hoped for results. In many cases, it has been impossible to make anything but a subjective evaluation of their results because no or inadequate data, which measure their performances, have been collected. Most have suffered from one or more of the following weaknesses.

a. Lack of a Conceptual Framework for Emergency Medical Services. Without a conceptual framework, it is difficult to develop and evaluate alternative approaches for improving emergency medical services. Lacking such a conceptual framework, an attempt at improvement tends to become an exercise in the improvement of existing elements and arrangements rather than the exploration of fundamentally different options. It is unlikely that the "tuning" of what presently exists, in the way of services, will generate the degree of improvement that is both required and attainable.

b. Lack of a Methodology for Predicting the Performance of the System as a Whole. Without a methodology for predicting the performance of the alternativies that are under consideration, it is difficult to identify the tradeoffs among the different options and to make value judgments as to a preference among them. The predictions should be in terms of the consequences for both the patient and the system. In the absence of these kinds of data, the choice of the "best" approach for improving emergency medical services tends to become that advocated by a dominant individual or group.

c. Isolated Improvement of Only One Aspect of Emergency Medical Services. Focusing on only one aspect of emergency medical services frequently results from the lack of a conceptual framework or the lack of predictive methodology or both. Whether the result of parochialism or ignorance, the net effect on the performance of the system as a whole most likely will be an improvement that is substantially less than could be achieved by a comparable economic investment on other aspects of the system. An all-too-common example is the attempt to improve a supportive function, such as communications or transportation, without an adequate examination of the effects on the emergency medical services as a whole and on the core treatment function in particular.

d. Failure to View the Improvement of Emergency Medical Services as a Social as Well as a Technical Process. Not only must a host of technical questions be solved by a variety of specialists, but the process itself, by which improvement is sought, must involve the substantial participation of the concerned constituencies in the identification and solution of problems. The knowledge, concerns and priorities of users, providers, politicians and administrators are essential to the development and choice of the "best" approach. The familiarity of such constituencies with the considerations and decisions, which led to the selection of a specific alternative, are essential to their support during its implementation. Any plan for the improvement of emergency medical services, which has not had a direct and on-going involvement of these constituencies, will most likely be politely received and shelved to gather dust alongside others of its genre.

3. Methodologies for the Improvement of Emergency Medical Services

A procedure is proposed by which a large number of potential alternative systems for the delivery of emergency medical care can be explored and evaluated quickly and inexpensively. The procedure requires several kinds of methodologies.

a. Models for Predicting the Nature and Distribution of the Demands for Emergency Medical Services. As a first step toward satisfying this need, the use of linear multiple regression models for predicting demand was demonstrated. Both the demand per census tract for ambulances and for treatment in a hospital emergency department were examined. The independent variables characterized the differences in the census tracts in terms of socio-cultural variables, economic variables, land use variables, and properties of the emergency medical services themselves.

The coefficients of determination[1], for the regression equations for total demand per census tract and aggregated across all kinds of medical emergencies, were 0.93 and 0.69 respectively for ambulances and emergency departments. Regression analyses, which examined separately the demands for service associated with specific categories of medical emergencies, proved to be far more successful than their counterparts, which examined the proportions of total demand that were associated with the same categories. For the number of emergency department visits originating from a census tract per year, the coefficients of determination were the highest for the category of minor injuries. They were 0.78 and 0.16 respectively for the separate examination and for the partitioning of the total number of emergency department visits. The coefficients of determination were the lowest for the categories of abdominal injuries and of ingestion of poisons, drugs, narcotics, etc. For abdominal injuries, the coefficients of determination were 0.30 and 0.09 respectively for the separate and the partitioning analyses; for ingestions they were 0.38 and 0.03.

The separate examination of a different set of categories proved comparably successful in the analysis of the demands for ambulance service that were generated by different kinds of medical emergencies. The coefficients of determination for the number of ambulance calls, per year per capita in a census tract, ranged from 0.87, for the category of illnesses (exclusive of

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[1] Square of the multiple regression coefficient; this quantity represents the proportion of the variation in demand among census tracts that is "explained" by the independent inviables.

cardiac and ingestion), to 0.44, for ingestion of poisons, drugs, narcotics, etc.

Three issues, with regards to the prediction of the demands for emergency medical services, were identified on which work remained to be done at the conclusion of the Project. Preliminary investigations were made by the Project of all three.

(1) Nonlinear Regression Analyses. The question of whether or not nonlinear analyses would contribute to the predictability of the demand for emergency medical services was investigated in depth as an extension of, but separate from, the Project.

The Los Angeles Countywide Coordinating Council on Emergency Medical services examined, by nonlinear multiple regression analysis, the relationship between the number of incidents in the county during 1973, which resulted in the dispatch of one or more emergency medical vehicles, and the same kinds of descripters of areas and their population that were examined by the Project in its linear multiple regression analyses of demand.[1]

For this analysis, the county was divided into 127 geographical areas. The actual number of incidents during the year per 1,000 residents varied among the 127 areas from a low of 16.0, in one largely residential community, to a high of 1,068.0, in an industrial area that experienced a daily influx of thousands of non-resident workers. The resulting nonlinear multiple regression equation had a coefficient of determination of 0.92 with only four independent variables. In comparison, the Project's corresponding linear multiple regression equation, for the annual per capita ambulance demand by census tract in the city of

[1] An Overview of Emergency Medical Services in Los Angeles County, Los Angeles Countywide Coordinating Council on Emergency Medical Services, June 30, 1974, pp. 128-137.

Los Angeles, required 32 variables to attain an equivalent coefficient of determination. This difference suggests that nonlinear regression equations for predicting the demands for emergency medical services are likely to be more efficient than linear ones in terms of the number of independent variables that are required for a given level of predictability.

(2) The Effects of Aspects of an Emergency Medical System Upon the Demand for Its Service. Aspects of an emergency medical system can be expected to influence the demand for its services. The ability to make predictions of such effects is a necessary part of the overall process of identifying and estimating the magnitudes of the differential consequences of a set of alternative approaches to the improvement of emergency medical services.

The linear regression analysis of the demand per capita for public ambulance service in the City of Los Angeles included three characteristics of the existing services:

- The response time in minutes from the call for an emergency ambulance to its arrival at the scene.
- The presence or absence of a mechanism for screening incoming calls on medical grounds to decide whether or not to dispatch an emergency ambulance.
- The presence or absence of a fee for the use of an emergency ambulance.

In each case, the effect on the utilization of ambulances per capita was in the direction that one would anticipate. In census tracts with long response times or with a mechanism for screening requests for an ambulance, the utilization was lower. When a fee was introduced for the use of an ambulance, the average demand per capita was lowered throughout the city as a whole.

Data collected in areas of the country in which mobile intensive care units have been introduced tend to indicate that the introduction of such services increased the demand per capita above that of the ambulance-only services that preceded them. This question is still under study by groups in the county.

The only information that was gathered during the Project, which related a characteristic of an emergency department to the demand in a census tract for its services, was the location of the hospital. The coefficient in the regression equation for the rectilinear distance in miles from the centroid of the census tract to the nearest hospital with an emergency department was negative and significance at the 0.10 level. A negative sign indicates, as would be anticipated, that demand was inversely related to the distance to the hospital. Other characteristics of emergency departments, such as the time that one has to wait to be seen by a physician and the attitudes of the staff toward patients, etc., also would be expected to influence their utilization and need to be investigated.

(3) The Factors That Influence the Division of the Demands for Emergency Medical Services Between the Public and Private Sectors and Among Alternative Sources for a Given Kind of Service. To evaluate alternatives for improving emergency medical services, a prognostication is needed as to whether or not a specific alternative will shift demand between the public and private suppliers and, if so, in which direction and in what magnitude. For example, when, as described above, a fee was introduced in the City of Los Angeles for use of emergency ambulances, whose dispatches were initiated by a health or public safety agency of the city, demand per capita was lowered throughout the city. The data indicated that one component of demand, which was reduced drastically

by the fee, was that for victims of industrial accidents. Apparently with the introduction of the fee, industrial firms made other arrangements to transport their workers, who became seriously ill or were injured on the job, to treatment facilities. This constituted a shift of demand from the public to the private sector.

There are many other factors that can be expected to influence the decision to select either the public or private sector as the one from which to seek assistance. The household survey examined a number of these including demographics, experiences and perceptions of the lay persons involved, the nature and severity of the injury or illness, situational variables, and characteristics of the services provided by the sectors. Difficulties were encountered because respondents were not highly accurate in their perceptions as to whether a given provider was public or private and because the classification of what was public and what was private was not itself unambiguous. As a consequence, the results of the analyses of this facet of demand were neither highly statistically significant nor informative.

The evaluation of alternatives also requires a prognostication as to whether or not a specific alternative will shift demand among the alternative sources of a given kind of service, without regard to whether such sources were classified as public or private. The data gathered by the household survey permitted estimates to be made of how the total demand was divided among the alternative sources of transportation and of treatment in Los Angeles County.

Analyses, which were similar to and employed the same kinds of factors as those described in connection with the study of the division of demand between the public and private sectors, were made to examine possible determinants of the division among the alternative sources of services. Some success was achieved in defining the kind of incident that was likely to result in the victim's transport to a treatment facility by private automobile. Beyond this, the results again were neither highly statistically significant nor informative.

b. Models for Predicting the Operational Characteristics of Alternative Approaches to the Improvement of Emergency Medical Services. Two methods were developed and demonstrated for the prediction of the operational characteristics of alternative systems for the delivery of emergency medical services.

When feasible, direct analysis is the quickest and least expensive method of predicting the operational characteristics of any proposed system. The computerized ambulance location logic (CALL) model, which was developed, is an example of such an analytical tool. Given the geographical pattern of incidents that result in medical emergencies, and policies for dispatch and retrieval that can be mimicked by the model, it can be used in two ways. First, the ambulance response model part of CALL can be used to estimate the distributions of response times for alternative configurations of emergency medical vehicles. Second, the optimum seeking search routine portion can be used, in combination with the ambulance response model, to determine the set of locations for emergency medical vehicles that minimizes the average response time.

While highly flexible, there are combinations of system configurations and complex combinations of policies for dispatch, on-scene care, retrieval, etc., which CALL cannot mimic closely. For such situations, an extremely flexible computerized simulation package was developed. It consists of two separate models and an analysis program. The incident generation model creates a representative stream of incidents, which lead to medical emergencies, and simulates the detection, recognition and reporting of these incidents. The incident generator permits the pattern of demands to be easily altered to reflect the effects on demand, of different considerations, including the design of the EMS system itself. The dispatch, allocation and retrieval model simulates almost any combination of policies governing the dispatch, on-scene and in-transit care and retrieval for almost any configuration of emergency medical vehicles and treatment facilities. The analysis program permits the user to analyze practically any and all aspects of the simulated system and to generate reports that are tailormade to the need.

The next step in model development would be to link the CALL or simulation models for the extrafacility portions of emergency medical services with comparable models for the intrafacility activities. Models of the latter kind have been developed.[1] However, little, if any, experience has been gathered in the joint use of the two kinds of models.

c. Models for Relating the Nature of Medical Emergencies and the Operational Characteristics of an EMS System to Medical Outcomes. At best, the operational characteristics of any proposed system for the delivery of emergency medical services are only surrogates for the medical outcomes that might be projected for its users. Operationally it may be possible to reduce the average time, from the request for help until a specified level of care can be delivered at the scene by the crew of an emergency medical vehicle, by X minutes at a cost of Y dollars per year. Without a means of estimating the difference that this reduction will make in the numbers of victims of medical emergencies per year who will die, suffer permanent functional impairment, etc., it is difficult if not impossible to judge whether or not to spend the Y dollars per year.

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[1] For example see Hare, R. R. and Wemple, A. B., Model for the Analysis of Emergency Medical Service Systems, Technical Report 555, Operations Research, Inc., May 1970 and Baum, M. A., Primary Health Care Delivery Simulator, Report MTP-361, The Mitre Corp., November 1971.

As a first step toward satisfying the need for a means of translating the operational characteristics of any proposed EMS system into the expected medical outcomes for the victims that it will care for, a generalized model was formulated. The model represents the probabilities of various medical outcomes as a function of the kind of illness or injury and its severity, the elapsed time from onset of symptoms or occurrence of injury to treatment, and the kind and quality of treatment.

The first attempt, to classify illnesses and injuries and to quantify the model in terms of a classification scheme, was by means of structural interviews. Forty-eight medical and surgical practitioners were asked to perform three tasks. First, the selection of a category of illness or injury from his field of specialization that can lead to medical emergencies and its structuring in terms of the most and least severe conditions. Second, the identification of the alternative treatments for each condition. Third, the subjective assessment of the relationship between medical outcomes and the elapsed time and kind of treatment. On the average, each participating physician judged two major categories so that almost one hundred responses were obtained covering 22 categories of injuries and 16 of illnesses. No common viewpoints emerged in terms of the criteria that were employed to judge severity, the severities assigned to specific conditions, or the relationships between medical outcomes and the elapsed times to treatment and kinds of treatment for given conditions.

The next attempt was empirical and employed a reduced form of the model, in which medical outcomes were limited to survival, for 90 days after discharge from the hospital, and death. Further, because of inadequacies of data collection, the kinds and quality of treatment were not differentiated and severities were limited to threat to life or not. From the results of the interview survey of physicians and other classification systems, a physician, who had worked with the Ad Hoc Committee on Injury Scaling of the American Medical Association and on the development of a qualitative method of scaling injuries for the United States Public Health Service, developed a classification scheme with 22 categories of injuries and illnesses. The aim was to group injuries and illnesses into sets, which were thought *a priori* to have relationships, between survival rates and elapsed times to definitive life supportive care, that were similar.

Data were drawn from those that were collected as part of the demonstration of mobile intensive care units and of a secondary role for helicopters as air ambulances. Of the almost 6000 victims, who were tracked during these demonstrations, 699 or 11.9 percent had significant threats to their lives. Although sixteen of the categories contained at least one victim with a significant threat to life, only five of the categories had a sufficient number of critical victims to permit an attempt to parameterize the reduced form of the model. Only one of these five, namely, hypertensive and arteriosclerotic heart disease, had a rate at change, in the proportion of victims who survive for 90 days after discharge from the hospital as a function of the elapsed time to definitive life supportive care, that was statistically significantly different from zero. For this category, three kinds of functions were statistically significant. Of the three, a negative power function had the "best fit" as measured by the residual variation about the curve.

The "best fit" equation, for hypertensive and arteriosclerotic heart diseases, was applied to the demonstration of mobile intensive care units to illustrate the procedure for the prediction of medical outcomes. Among other things, this demonstration had shown that the survival rates, 90 days after discharge from the hospital, were 66 and 47 per 100 victims of heart disease who were handled respectively by the MICU's and by regular ambulances. Using the distributions of elapsed times to defintive life supportive care, at the scene for the MICU's and at the hospital for regular ambulances, the survival rates were predicted by the equation to be 60 and 47 per 100 victims respectively. Since less than half of the data that were used to develop the equation came from the MICU demonstration, the closeness of the predicted and observed survival rates suggest that the equation has a general usefulness. In a prospective study, of course, the distributions of elapsed times to treatment would be generated by the CALL or simulation model.

The results of the empirical study of the relationship between medical outcomes and elapsed times to treatment, suggest that conventional medical diagnostic classifications of disease are not the suitable taxonomic framework for evaluating alternative systems for the delivery of emergency medical services. Diagnostic classifications are simply too numerous and difficult, if not impossible, to aggregate into groupings without obscuring the natures of life threatening mechanisms.

As the result of these difficulties, which from the Project's experience appear to be inherent in any classification system that is based on conventional diagnostic descriptions, the Los Angeles Countywide Coordinating Council on Emergency Medical Services has explored other taxonomies for critical illnesses and injuries. The most promising approach appears to be one that is based upon the pathophysiologic states that pose actual or potential threats of death. Death ultimately means demise on a cellular level. The cessation of cellular metabolism occurs as a result of the cessation of either respiration or circulation, or both, on a regional or local level. A task force of the Countywide Coordinating Council under the direction of Dr. James Brill, Director of Emergency Services, UCLA Hospital, has defined eleven pathophysiologic states of circulation and respiration.[1] This taxonomy is currently being tested. It appears

[1] Los Angeles Countywide Coordinating Council on Emergency Medical Services, op. cit., pp. 61-63 and 146-153.

extremely promising for the evaluation of the criticality of a victim's condition and for the determination of life-sustaining measures and their priorities as well as for the examination of the influences of the time to treatment and kind of treatment on the medical outcome.

4. Major Findings of Selected Demonstrations

a. Communications between Emergency Medical Vehicles and Emergency Departments of Hospitals. As a preliminary to the demonstration study of mobile intensive care units, a demonstration study was conducted of the communications between the crew of an ambulance and the emergency department to which it was transporting the victim(s). Two kinds of modifications, of the then existing communication link, were made. The first was in the type of voice communication link. Four different communication links were examined, namely one-way radio (ambulance to emergency department), two-way radio (direct), two-way radio (indirect with the telephone switchboard operator at the hospital relaying messages between the ambulance and the emergency department) and two-way mobile telephone. In each case, the crew of the ambulance transmitted a partially coded message. The code permitted a description of the nature and severity of each victim's illness or injury. The crew of the ambulance and the staff of the emergency department described and evaluated each voice transmission on data forms in terms of the quality of the transmission itself and the medical uses made of the information that was transmitted. In addition, each transmission was recorded by means of a voice-actuated tape recorder at the hospital.

The results indicated that the quality of transmission was judged to be the poorest for the one-way radio. With one-way radio, it became necessary for the ambulance dispatchers to place a telephone call to the emergency department and repeat the message of the ambulance crew whenever the victim's condition was judged to be an "emergency". Unique kinds of difficulties were encountered with the mobile telephone because of its "party-line" nature. The ambulance crew was unable to get the mobile operator roughly 10 percent of the time and it was almost as common to reach the mobile operator only to be told that there were no open lines. Roughly 4 percent of the time, when communications with the emergency department had been established with the mobile telephone, the call was interrupted by physicians with mobile telephones in their private cars who claimed involvement in medical emergencies of their own.

Roughly one-quarter of the transmissions in suburban areas and three-quarters of those in rural areas resulted in the emergency department making advanced preparations to receive the victim. In terms of emergency department personnel, only nurses and inhalation therapists were mobilized in the suburban hospital. In the rural hospitals, laboratory and x-ray technicians and orderlies were mobilized as well. A major limitation on the extent of advance preparations that could be made at the emergency department was the length of time between notification and the arrival of the ambulance. In the rural area, this interval was almost twice as long as in the suburban area.

Aside from advance preparations in the emergency department, there was little use of voice communications in support of care and treatment. For three victims of poisoning, physicians in the emergency departments did use two-way voice communications to obtain more information. On no occasion did a physician order or advise the crew of an ambulance to give any specific kind of care to a victim. Clearly, the use of two-way voice communication to improve the level of diagnosis and of care prior to arrival of the victim at the emergency room had to await the advanced training of crewmen and the removal of medicolegal constraints.

The second kind of modification, of the then existing communication link, was the addition of the telemetry of electrocardiograms from the ambulance to the emergency department. The results revealed that approximately 90 percent of the electrocardiographic tracings showed aberrations that could not have been present in the actual electrical variations that are caused by the functioning of the heart. These could have been caused by the movements of skeletal muscles, improper electrode placement or the radio and/or telephone links of the transmission process. Only three tracings were totally illegible. Of the remainder, about three out of four were judged by the consulting cardiologist to be legible enough for diagnostic purposes.

Using only the electrocardiograms that were transmitted from the ambulance, the consulting cardiologist judged that nineteen of the total 56 victims had some sort of heart disorder. Four of these were judged to be critical. For three of these four, the diagnoses that were in the hospital records were comparable to those made from the transmitted ECG's, within the limits of normal diagnostic variation. The hospital records for the remaining fifteen, who were judged non-critical, indicated that eleven were treated as cardiac cases with diagnoses similar to those made from the transmitted ECG's. The hospital records of the 37 patients, whose transmitted ECG's were judged to show no heart disorders, revealed only one case where a heart disorder might be involved. Clearly, a great potential was demonstrated for the diagnostic use of electrocardiograms that are transmitted from the scene or while the victim is enroute to the hospital emergency. Again, however, the use of this diagnostic potential, to initiate advanced kinds of care in the field for critical victims of heart disorders, had to await the advanced training of crewmen and the removal of medicolegal constraints.

b. Physician on the Ambulance. Surgical residents, with recent and extensive experience in an emergency department, were assigned to ride an ambulance to examine several aspects of the care that was being delivered by ambulance attendants. These included the specific kinds of care that ambulance attendants were delivering, how well such care was being delivered, and the kinds of care that ambulance attendants were not performing that more highly trained personnel could deliver in the field with beneficial effects on medical outcomes.

The observations of the physicians showed several things. First, in about one-eighth of all cases, attendants performed acts that were judged not to have been necessary. These included the unwarranted use of a stretcher, blanket or oxygen. In no case, however, were these unnecessary acts judged to have impaired treatment or harmed the victim. The average number of actions per victim, which the observers believed should have been performed, was about four. About 15 percent of the actions deemed necessary were not performed. More than half of these were omissions in checking the victim's vital signs. Similarly, the kind of action which most frequently was scored low in terms of the quality of performance was the examination of the victim. These deficiencies were in terms of poor procedures for the checking of pulse rate and blood pressure and inadequate physical examinations of injured parts of the body. The kinds of mis-handling of victims that have been reported by some other studies of ambulance attendants, such as failure to immobilize injured parts of the body, were not witnessed.

In about eleven percent of the cases, the physicians felt that additional kinds of care, which at the time only physicians could have administered, would have been beneficial to the victim. In only a few cases, however, did the physician-observer have to intercede himself because he felt that a failure to do so would have endangered the victim. In the most serious such instances, the physician-observer was credited with saving the life of a victim by the performance of a tracheotomy.

In summary, ambulance attendants tended to perform well and up to the level of their training. While a doctor's special abilities were seldom deemed to have been necessary, the failure to have been able to provide advanced kinds of care when needed would have seriously jeopardized the lives of the few critical victims. The results of this demonstration were important in the design of the demonstration of mobile intensive care units, which were manned by paramedics.

c. Mobile Intensive Care Paramedics. Eighteen firemen, twelve from the county and six from the city of Los Angeles, were initially trained in two groups as MICU paramedics (Emergency Medical Technicians-II). Their training consisted of 160-180 hours of didactic training and clinical experience which was followed by a field internship while accompanied by an experienced coronary care nurse. Because of the time that elapsed before the state enacted enabling legislation for pilot paramedic programs, the field internships for these initial trainees lasted six to nine months. This extensive field experience was supplemented by additional didactic and clinical experience so that the first two groups, in actuality, received as much, if not more, training than subsequent groups of trainees, whose didactic and clinical preparation before the field internship totalled 362 hours.

Two kinds of mobile intensive care units, each with two-man paramedic crews, were started. The county's units used the regular rescue squad vehicles of its fire department. These could not be used to transport victims to the hospital. When a victim required monitoring and/or advanced care enroute, one of the paramedics, with the necessary portable equipment and supplies, rode with the victim in the ambulance to the hospital. The unit that was initiated by the City of Los Angeles, however, used the regular van-type ambulance of its fire department.

This unit could transport victims directly to the hospital.

During the demonstration, a total of 3,134 victims were handled by the first two mobile intensive care units and by the two ambulances that were selected for comparative purposes. All four units transported almost all of the victims that they handled to a large metropolitan hospital. Data were collected on each victim from the onset of noticeable symptoms of illness or the occurrence of injury through discharge from the emergency department or ninety days after discharge from the hospital when they were admitted as an inpatient.

One of the significant products of this demonstration was the creation of temporal profiles of the sequence of events from the beginning of a medical emergency through its conclusion. The time distributions of all activities were highly skewed toward long time durations. Thus, while the mean delay, from the onset of noticeable symptoms of illness or the occurrence of injury to the initiation of a request for the dispatch of an emergency medical vehicle, was 22 minutes, the median delay was between 8 and 8½ minutes. The 90th fractile for this interval was 38 minutes.

Several aspects of the temporal profiles are worthy of note. The first is the length of the elapsed time from the onset of noticeable symptoms of illness or the occurrence of injury until the victim begins to receive treatment from a physician in the emergency department. Despite the fact that the study was conducted within suburban and industrial sections of the greater Los Angeles metropolitan area, on-the-average a victim did not begin to receive physican care for about 70 minutes. By way of comparison, in the rural Antelope Valley where 2,740 victims were similarly tracked in connection with the helicopter demonstration, on-the-average, victims, who were transported by helicopter or ambulance, began to receive treatment from a physician in roughly 60 minutes. The compositions of the total intervals were different between the MICUs and ambulances within the metropolitan area and between the metropolitan and rural areas. Under all circumstances, the mean delay, from the onset of noticeable symptoms of illness or the occurrence of injury to the initiation of a request for the dispatch of an emergency medical vehicle, was roughly 20 minutes. There was a delay of about one minute between notification and dispatch of the vehicle. Travel times to the scene averaged around 4 and 10 minutes respectively in the metropolitan and rural areas. The times spent at the scene averaged roughly 6 and 10 minutes respectively for ambulances and MICUs. Travel times from the scene to the emergency department of the hospital averaged about 9 minutes for both kinds of vehicles and in both areas. Finally, the delays at the hospital from arrival to treatment by a physician averaged roughly 12 minutes for hospitals in the rural Antelope Valley and 22 and 32 minutes at the large metropolitan hospital for victims, who were transported by MICU's and by ambulances respectively.

The second aspect of note of the temporal profile is the substantially greater amount of time that was spent, on-the-average, at the scene by the mobile intensive care paramedics than by the ambulance attendants. Paramedics make a much more thorough physical examination of victims than do ambulance attendants. When the treatment that is required by a critically ill or injured victim is within the training of the paramedics, an attempt is made to stabilize the victim before his or her transport to the hospital.

The third aspect is that the delay in the emergency department of the metropolitan hospital was less for victims transported by MICUs than for those transported by ambulances. The MICUs were in radio communication with the hospital from the field so that the emergency department was alerted as to the nature and severity of the victim's illness or injuries.

Further, among the victims handled by MICUs, the delay in the emergency department was one-third less for those with a threat to life than for those who were not critical.

Several conclusions can be drawn from the temporal profiles. First, the elapsed time to the initiation of definitive life supportive care is reduced by 50 to 65 percent, when such care can be delivered at the scene by the crew of the emergency medical vehicle. Second, in the absence of a crew that is trained in advanced kinds of care, only about 30 to 40 percent of the total elapsed time to definitive treatment is associated with the emergency medical vehicle, namely, dispatch, travel to the scene, on-scene activities and travel to the emergency department. The rest of the time is occupied by the delay from the onset of noticeable symptoms of illness or occurrence of injury to the initiation of a request for an emergency medical vehicle and the delay at the hospital from arrival to initiation of treatment by a physician. Third, a consequence of the MICUs spending more time at the scene than ambulances is that a larger fleet of MICUs is required than ambulances or rescue units to provide the same mean response time in a specified service area. This is because the lengthening of the service time makes it more likely that a given MICU will be busy when a call for service is received. Finally, the delay between the victim's arrival at the emergency department and the initiation of treatment at an emergency department is less when the crew of the emergency medical vehicle is in radio contact with the emergency department and has professional credibility.

A comparison was made of the survival rates among victims with life threatening conditions for each category of illness or injury in which one or more victims, who were alive at the time that the emergency medical vehicle arrived, died sometime before 90 days after release from the hospital. There was no category of illness or injury, for which the observed survival rates to the emergency department was statistically different for victims handled by the MICUs and by the ambulances. It is reasonable to presume one or a combination of several considerations contributed to this result. First, there may be categories of illnesses and injuries for which either the kinds of advanced care that could be given by the paramedic did not affect the short term survival rate, or the kinds of care rendered by paramedics and by ambulance attendants were equally effective in the short term. Second, the mean period of time in which victims were in the care of ambulance attendants was only 15 minutes. Only a fraction of the victims with life threatening conditions in some categories would probably require advanced care, such as the administration of intravenous fluids, within a span of 15 minutes to prevent death. Third, in most categories, the number of cases was too small for the statistical tests to be discriminatively powerful.

The only category of illness or injury, for which the observed difference in the survival rates 90 days after discharge from the hospital was statistically significant at the 0.10 level between victims whose conditions were initially life threatening, was "hypertensive and arteriosclerotic heart disease." The survival rates were 66 and 47 percent for the victims who were handled by the MICUs and by the ambulances respectively. This suggests that while it is possible to keep victims with low or no cardiac output alive until tney reach the emergency room by means of cardiopulmonary resusitation, in which all the ambulance crewmen as well as paramedics had been trained, the cardiac output that is achieved is not sufficient to maintain enough coronary artery perfusion to limit the damage to the heart. As an apparent consequence, there is a greater chance of death later due to "pump-type" failure of the heart. The kinds of additional care that the paramedic can deliver, however, include intravenous fluids and drugs to maintain blood flow and drugs and defibrillation to convert arrhythmias to almost normal sinus rhythms. These procedures can establish and maintain adequate coronary artery perfusion and, in so doing, apparently limit the amount of damage that is done to the heart.

The total incremental cost of replacing a rescue vehicle or ambulance with a mobile intensive care unit was estimated to be roughly $56,000 for the first five years. This figure included the initial training and periodic retraining of paramedics, purchase and maintenance of equipment for the base hospital and the vehicle, and medical expendables. Based upon this cost and the projected difference in survival rates for the handling of victims by MICU's and ambulances, it was estimated that mobile intensive care units cost $2,060 per life saved.

d. Secondary Helicopter Role as an Air Ambulance. A helicopter demonstration was undertaken to examine the feasibility of integrating helicopters into the emergency transportation system to supplement and complement ground ambulances. It was conducted in three phases:

- A response time study in which a helicopter was dispatched to emergency incidents in tandem with the ambulances which served an urban/suburban area; the helicopter did not land, but estimated probable landing difficulties.
- A landing feasibility study to assess the operational potentialities of helicopters in an urban/suburban environment under a variety of controlled landing site conditions.
- A patient retrieval demonstration to assess the operational efficiency and medical effectiveness of helicopter ambulances in a rural environment.

The results of the urban/suburban response time study showed that a ground unit arrived on the scene before the helicopter, which was dispatched simultaneously, in 80 percent of cases. From conditions at each potential landing site, it was judged that difficulties would have been encountered in landing on 42 percent of the night flights and 23 percent of the day flights. It was judged, however, that these difficulties could have been reduced by communications with ground personnel, ground control of people and vehicles in the landing zone and high intensity lights.

On the basis of these first two studies, it was demonstrated that it was feasible for helicopters to navigate during either day or night to the scene of a medical emergency and land. However, despite its speed and ability to fly to a destination in a straight line, a helicopter, on the average, could not reach the scene of a medical emergency in an urban or suburban area ahead of a ground ambulance which had been dispatched simultaneously from a deployed fleet.

The results of response time and landing feasibility studies in urban/suburban areas suggested that helicopters had their greatest potential as ambulances in rural areas. In rural areas, the response times of ground ambulances are relatively long and the open areas permit more unassisted helicopter landings. Rural areas also are characterized by a relatively small population base. Thus, the frequency of occurrence of medical emergencies is relatively low. This infrequent demand for emergency medical transport and the high initial investment cost and recurring operating costs of a helicopter suggested that it probably would be uneconomical to operate a helicopter solely as an air ambulance in a rural environment. Therefore, it was concluded that helicopters, whose presence in rural areas had been justified for other purposes, should be sought. In this way, the medical benefits of a secondary role as an air ambulance need only be balanced against the incremental costs of operation.

The area that was selected for the patient retrieval demonstration was the Antelope Valley-Newhall portion of the County of Los Angeles. At the time of the demonstration, it had a population of approximately 120,000 in an area of about 2,200 square miles. A fire surveillance helicopter of the County Fire Department was placed on standby from noon to 8:00 p.m. on Fridays, Saturdays and Sundays for a 13 month period. Prior to the initiation of the service, the helicopter crewmen attended the first portion (80 hours) of the paramedic training program.

As an air ambulance, the helicopter was dispatched to those incidents for which the estimated response time of the nearest ground ambulance was 15 minutes or longer. As a basis for comparison and to provide an optional mode of transportation in case any victim refused to be flown, ground ambulances were always dispatched simultaneously with the helicopter. The helicopter retrieved 88 patients and was considered instrumental in saving the lives of five. It was used to transfer twelve patients, six of whom had life threatening injuries, from small hospitals in the rural area to large urban hospitals. Of all of the cases transported, the reviewing physician judged 27 percent to have had life threatening injuries or illnesses. The proportion of critical cases was higher for the helicopter than the ground ambulances. As a result, the inpatient admission rate was twice as large for those transported by the helicopter as those transported by ground ambulance.

Since the helicopter was available for a secondary role as an air ambulance only three days a week, ground ambulances had to respond alone on the other four days each week to medical emergencies. This permitted a comparison of the temporal profiles for the helicopter and ground ambulances, for those medical emergencies that involved a travel time to the scene for ground ambulances of 15 minutes or longer. The comparison revealed several significant advantages for the helicopter. The mean times from dispatch to arrival at the scene and at the hospital were respectively 30 and 22 percent shorter for the helicopter than for the ground ambulance. Interestingly, the waiting time to treatment by a physician in the emergency department of the hospital was only about one-third as long for victims transported by the helicopter. This large difference most probably was due to the advanced notification of the emergency department by the helicopter crew via radio, of the expected arrival time and the nature of the patient's illness or injury.

No significant interference was encountered between the helicopter's primary role of fire surveillance and its secondary role of air ambulance. The average number of ambulance flights was less than one per day and the average time away from the primary role for each air ambulance mission was only about 40 minutes.

An analysis was made of the incremental costs and the potential utilization of the helicopter, as an air ambulance in the rural area for the retrieval of victims who would be 15 minutes or more from the nearest ground ambulance. The results indicated that the service could be offered at a total incremental cost comparable to present charges for the use of a ground ambulance if the helicopter was made available for this secondary role daily. This result is dependent on: (1) the helicopter having a primary function, in this case that of fire surveillance, which justifies its procurement and other fixed costs of operation and (2) demands for its use as an air ambulance of the level experienced in the demonstration.

B. RECOMMENDATIONS

1. The Planning Process

a. The Need for a Holistic View of Emergency Medical Services. In planning for the improvement of emergency medical services, it is essential that they be viewed as a whole, even if they presently are fragmented. It is also essential that all of those in the community or region, who are engaged in the effort to improve emergency medical services for the area, have a common understanding of these services. Understandably, when users, health professionals, provider organizations, administrators and politicians first get together in such an effort, each will tend to see emergency medical services from only their own point of view. The first step for such constituencies to begin the planning process and to begin their own group process of learning to work together, is to have as their initial agenda the joint development of a shared holistic view. The identification of issues, problems, expectations and values and the melding of these diverse inputs into a common understanding must precede any discussion of how to "solve" the problem.

b. Use of Analytic and Synthesizing Methodologies. In the process of planning for the improvement of emergency medical services, a variety of fundamentally different options, for the system as a whole and for each of its components, should be considered.

Regression analyses of the kinds examined by the project, can be used to investigate the factors that can be expected to influence the demands for the various services in the future. These should be based upon the demand per capita not the absolute demand. This will prevent population *per se* from dominating the analyses. On a per capita basis, the anticipated future changes in the natures of the populations and attributes in each subarea can be used to predict the future changes in per capita demand in each subarea over the planning horizon. The product of the per capita demand and the expected size of the population in each subarea in each future time period, which is being examined, will generate the pattern of future absolute demands.

Caution, of course, must be exercised in making interpretations of the independent variables in any regression analysis. The existence of stochastic interdependence between demand, as the dependent variable, and the independent variables does not necessarily indicate a causal influence of any of the independent variables on demand. Independent variables frequently are surrogates for the actual causal mechanisms that could not or were not included. Spurious relationships may arise in many other ways.

The specific predictive equations that were presented in this report were developed for areas of the County of Los Angeles. It is doubtful that they are applicable to other areas.

Once future levels of demand have been predicted, tools, such as the CALL model for emergency medical vehicle deployment and the simulation package, can be used to predict many of the important quantifiable operational characteristics of the alternative means that are under consideration for the delivery of emergency medical services. These models permit a large number of alternatives to be examined and evaluated quickly and relatively inexpensively.

c. Treatment As The Core Function. The raison d'être of emergency medical services is the stabilization or maintenance of life of the critically ill or injured and the treatment of other appropriate disposition of nonemergent persons who enter the system. It is essential that the first "design" choice made, during the planning for the improvement of services, be of the approach to be used for the delivery of patient care. The supportive functions, such as transportation and communications, exist only to facilitate and make possible patient care. The requirements for the supportive functions must be derived from the choice of the kinds of patient care and how these are to be delivered.

d. Use of Pilot Studies. Pilot studies are frequently utilized as part of the process of improving emergency medical services. Ideally, they should be the result of a substantial amount of preceding planning and analyses, which examined a large number of options and narrowed the candidates down to a few alternatives or a single choice. It is important to gather data during a pilot study, which can resolve the questions for which the pilot study was initiated. Further, pilot studies are excellent sources for the identification of unanticipated, often indirect, consequences.

Pilot studies often utilize procedures, such as special safeguards for patients, which are appropriate for experimental situations but which may not be required in regular operations. Usually the activity, which was the subject of the pilot study, must be modified from the form used during the pilot study to produce a good operation design. In Los Angeles County, for example, the mobile intensive care units manned by paramedics are an unfortunate example of the failure to do this. The experimental units, which were designed for the demonstration, have been proliferated without sufficient planning as to how they might best be integrated into the rest of emergency medical system and with the necessary support services, particularly communications. As a consequence, while they have measureably improved the level of emergency medical services, the full potential of mobile intensive care units have not been realized and avoidable difficulties are being encountered.

e. The Choice of The "Best" Method for the Delivery of Emergency Medical Services. The choice of the preferred design concept to be used, for the delivery of emergency medical services in a given locality or region, should be based upon the identification and consideration of all the important attributes that are expected to characterize each of the alternatives that are under consideration. There are too many significant dimensions to permit their being represented by a single criterion or simplistic set of criteria.

In the course of this project, some indices of cost-effectiveness, such as the cost per patient transport and the cost per life saved, were developed. These are useful but not sufficient measures for choice.

There are other equally important aspects such as the consequences for health professionals, in terms of roles, statuses, career ladders, etc. There are similar aspects of importance for provider organizations, administrators and politicians. These kinds of qualities of the options can be quantified only in terms such as their "dollar equivalents" or "utilities." The diversities between and among the value systems of the many constituencies, which have a stake in the choice, appear to be too great for such translations to be useful. Further, value systems frequently are too volatile to make these kinds of conversions meaningful. Time and again one witnesses shifts in the previously stated priorities or relative "weightings" given to criteria when new information becomes available. This is particularly true when the new information is in the form of the "package" of qualities that can be obtained from new options.

In our opinion, the knowledges, concerns and priorities of users, health professionals, provider organizations, administrators and politicians can best be brought to bear on the choice of a design concept by a collective decision process. Such a process requires that the constituencies have all of the relevant information about the alternatives that can reasonably be provided. If they have been participating throughout the planning process, they share a rich understanding of emergency medical services, of the crucial issues and of the chief concerns of the other parties. If they have a willingness to do so, they have all of the ingredients necessary to hammer out a solution that all or a majority can support.

2. Need for Continuing Development of Methodologies and Techniques

During the course of this project, a number of methodologies were applied and several techniques were developed. Others have developed some similar and some different "tools" of these kinds. While the tool kit is now quite serviceable, it needs to be improved and expanded so that better information can be provided at lower costs to those seeking the improvement of emergency medical services. From our vantage point two topics need to be given the highest priorities.

a. The Linking of Simulation Models for the Extrafacility and the Infacility Portions of Emergency Medical Services. To be most useful for planning purposes, simulation models must be flexible enough to be able to mimic almost any reasonable proposal. To provide such flexibility, the simulators are complex and require a great deal of computer capacity. The highly flexible simulation model for the extrafacility EMS activities, which was developed by the project, utilizes much of the available capacity of a very large computer system when applied to a complex situation.

This is so even though the programming of the simulator has been improved, from a computing efficiency standpoint, continually over the years. It is highly unlikely, at the present state of programming and of computers, that an equally flexible simulation model can be developed that would encompass both the extrafacility and infacility portions of EMS activities and still fit on a computer. Therefore, work needs to be done on the appropriate joint use of highly flexible simulators for these two interrelated sets of EMS activities.

b. Models for the Prediction of Medical Outcomes. In order to convert the operating characteristics (such as the lapsed times to treatment and the kinds of treatment) of any proposed mode of organizing and delivering emergency medical services into the expected medical outcomes, predictive models are required. The experience of the project strongly suggests that a taxonomy for the natures and severities of critical illnesses and injuries will be required that is different from conventional diagnostic classifications or groupings thereof. The most promising candidate is a pathophysiologic approach in terms of the fundamental disfunctions which pose threats to life or of permanent disabilities. There is an urgent need to develop a taxonomy that can be standardized on a nationwide basis. The adoption and use of an appropriate such classification scheme would permit the tracking of medical emergencies from the onset of noticeable symptoms or the occurrence of injury to their ultimate conclusions. Applied on a nationwide basis, sufficient data could be collected to establish the relationships between controllable design variables and medical outcomes, on a basis that is representative of the population of victims.

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