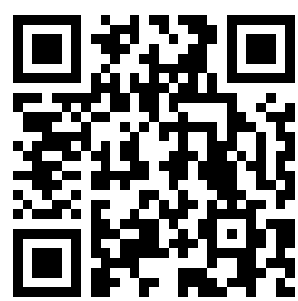

t of Emergency Medical Systems on Prehospital Cardiovascular Care

An Evaluation of Studies and an Inventory of Data Bases

National Highway Traffic Safety Administration, Washington, D.C. 20590 and
National Heart, Lung, and Blood Institute, NIH, Bethesda, MD 20205

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FOREWORD

The publication of this study correlates with the publication of the *Proceedings of the Conference on the Decline in Coronary Heart Disease Mortality* by the National Heart, Lung, and Blood Institute, National Institutes of Health (NIH), Bethesda, Maryland 20205. The conference completed its work and published the proceedings, in May 1979 under NIH Publication No. 79-1610. The proceedings are a 399 page publication with a 42-page appendix of statistics, figures, and tables prepared by the National Center for Health Statistics. Single copies are available free of charge from the Public Inquiries and Reports Branch; National Heart, Lung, and Blood Institute; Building 31, Room 4A21; National Institutes of Health; Bethesda, Maryland 20205. The publication number should be included in the request.

This Department of Transportation study was started following early conference reports that revealed steady decline in both cardiovascular and noncardiovascular deaths since about 1968. This decline coincided with the implementation of Standard 11 (entitled "Emergency Medical Service") of the Highway Safety Act of 1966 (amended), a prehospital program of upgrading field medical intervention and care in both cardiovascular and noncardiovascular medical emergencies. This study is intended to help the States in evaluating their own prehospital care systems.

PREFACE

The recent decline in cardiovascular mortality in the United States is slow but consistent and is in dramatic contradistinction to the marked, steady increase in cardiovascular mortality from World War II through the early 1970s. Many hypotheses have been proferred to explain this gratifying new trend: coronary risk factor reduction, public health education, high risk patient identification, the advent of coronary care units, improved medical technology, improved antianginal drugs (propanolol (Inderal®) in particular), increased use of antiarrhythmic drugs, and coronary artery bypass surgery. Some have attributed the decline in cardiovascular mortality rates to the introduction of prehospital mobile coronary care (MCC). Despite the many studies in each of these areas, there are no data to support any of these hypotheses. The ultimate explanation for this decline in cardiovascular mortality is probably a complex set of interactions among all these factors, superimposed over a set of yet undefined epidemiological phenomena.

It was from this vantage that the National Heart, Lung, and Blood Institute (NHLBI) and the Department of Transportation (DOT) let a request for Proposal (RFP) (No. ROI-140-7-2988) in the late spring of 1977. Under public and congressional pressure to expand MCC, especially in view of a possible relationship between MCC and a declining cardiovascular mortality rate, NHLBI and DOT responded with this RFP to ascertain the facts. The intent of the RFP was threefold:

(1) What do we know about the effectiveness of MCC?
   (a) How valuable, valid, and generalizable are the data on the effectiveness of MCC?
   (b) If MCC is effective, can the cost/benefit ratio of the system be optimized by targeting high-risk populations or concentrating programmatic efforts on elements of the MCC system that are particularly effective?
(2) Can a conceptual model for evaluating MCC be developed? In particular, can we define and identify a minimum data set that we would consider essential to any rational evaluation?
(3) Is our knowledge of MCC and the related methodological issues sufficient to enable us to design a sampling strategy for MCC evaluation? To what extent might such an evaluation rely upon existing data bases and how much additional Federal research initiative would be required to supplement present data collection activities?

In this report we have formulated an extensive response to these queries. Because this report is intended to provide factual background to facilitate upcoming decisionmaking by research administrators, legislators, and emergency

medical systems (EMS) operations officers, we have presented the data in great depth. We have purposefully limited our conclusions, preferring that the reader use the data to reach his or her own conclusions.

The report is organized according to the three tasks specified in the contract. In Chapter I, we review the clinical rationale for MCC, the historical perspective of the legislative mandate for these programs, and the general methodological problems in evaluating any EMS. In Chapter II (Task 1), we review the literature. We present our methodology followed by an overview of the literature. We then extensively analyze the 15 descriptive and experimental articles in the literature that present complete outcome data. Based on this review, we develop a series of estimates of MCC impact on each measurable component within the system. We conclude this chapter by updating the best presently available mode for MCC evaluation (by Dr. Shan Cretin) with our newly derived estimates of MCC impact. In Chapter III (corresponding to Task 2), we present a new model for EMS evaluation from both a theoretical and practical perspective. To emphasize the latter, we candidly report the "real world" problems of collecting the types of data required by the model based on our regional study of MCC on Cape Cod. In Chapter IV (corresponding to Task 3), we present alternative strategies and delineate one in its entirety for a national sample for MCC evaluation. The final chapter (Ch. V) contains our conclusions and recommendations. Appendix A is an annotated bibliography. Appendix B contains a glossary of terms for the lay reader, and Appendix C is a suggestion for standardized definitions of acute cardiovascular disease.

The answers to the questions raised in the RFP are of substantial consequence. The medical community, the NHLBI, and DOT are facing increased public and congressional pressure to get on with the business of providing prehospital MCC in all communities. Some have suggested doubling present expenditures by 1985. The data in this report offer the basis for a rational response.

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ABSTRACT

The decline in cardiovascular mortality in the United States over the past two decades has been dramatic. Many hypotheses have been proposed to explain this trend including, for example, public health education; the reduction of coronary risk factors; the advent of coronary care units; coronary artery surgery; and the subject of this study, prehospital mobile coronary care (MCC). The purpose of this study has been to learn more of the potential for prehospital coronary care as a factor in the decline. In particular, part of this study has involved a review of the literature currently available on MCC to assess its validity and universality with respect to the effectiveness of MCC. In addition, a conceptual model of MCC that may be very useful in its further evaluation has been developed and a minimum data set essential to any such evaluation effort has been identified. In addition, an extensive annotated bibliography has been developed of the 355 references on prehospital cardiovascular care that were derived from the literature review.

The report begins with a summary of the clinical rationale for prehospital coronary care and a review of the history of the prehospital coronary care system. The report then leads into the evaluation of the generic methodological problems of prehospital coronary care evaluation. The review of the literature notes the relatively limited number of adequate research publications in the field. These publications were analyzed in detail as well as abstracted, cross-referenced, and included as an annotated bibliography in the report. Of these articles, 132 used process and/or outcome measures. These articles were reduced to 51 sets of studies by combining multiple articles from the same system and researchers. This literature is analyzed in detail and also used to develop estimates of key components related to the impact of emergency medical systems including, for example, the proportion of patients with acute cardiovascular disease who use such systems. The report also discusses a model for the evaluation of MCC. In addition, it outlines a national sampling frame that could be useful in the future evaluation of such systems.

The authors conclude that the current data base is inadequate to provide a framework to assess the impact of prehospital cardiovascular care. The literature to date does not substantiate the hypothesis that MCC programs have substantially contributed to the decline in cardiovascular mortality rates. The authors conclude that there is great need for accurate estimates of MCC to aid in the long-term planning of this system.

I. BACKGROUND

The Clinical Rationale for Mobile Coronary Care (MCC)

MCC is a recent phenomenon—conceived of as a major technological advance in the secondary prevention of cardiovascular mortality, nurtured by the early successes of in-patient coronary care units (CCUs) in reducing mortality from myocardial infarction (MI), and generously supported by Federal funds ($475 million through fiscal 1977) as a response to the prevalence of cardiovascular mortality in middle-aged and elderly groups. The initial epidemiological studies of sudden cardiac death (SCD) suggested that two-thirds of all patients dying from MI died outside of the hospital prior to medical treatment. [282, 345, 346] Even more surprising was the fact that the majority of these patients, at post mortem examination, exhibited little evidence of pump failure as a predominant factor in their deaths.[349] The supposition was, therefore, that these patients were dying from life-threatening arrhythmias (LTAs), ventricular tachycardia (VT), and ventricular fibrillation (VF), in particular. This supposition has been borne out in subsequent in-hospital CCU and prehospital studies.[1, 12, 128, 186] The early reported successes of defibrillating patients from VT/VF in CCUs quickly translated into a prehospital strategy for reducing sudden death due to (MI). Pantridge, with his "flying ambulance squad" in Belfast, Northern Ireland, popularized the notion in 1966 with great zest and commitment.[242] His original reports documented potential LTAs in 80 percent of patients seen within the first hour after MI. Forty-four persons had bradyarrhythmias, 32 percent had ventricular arrhythmias (one-third of which were VF), and 7 percent had supraventricular arrhythmias. In these cases early intervention with defibrillation and/or drugs yielded a 5-percent prehospital mortality rate and a 10-percent in-hospital mortality rate.[1] The original hypothesis, that many patients with MI were dying from reversible arrhythmias and not from pump failure, appeared to have been empirically validated. Recent confirmatory studies suggest that actually less than 10 percent of out-of-hospital deaths from MI are "instantaneous," in which the patient dies immediately following the onset of symptoms; [343] this small group may, in fact, be dying from myocardial rupture, though this group has not been studied separately at autopsy.

Three basic types of interventions have emerged as the mainstays of MCC: cardiopulmonary resuscitation (CPR), cardioversion, and drugs. CPR is well described in the literature and its effectiveness is beyond doubt. [322, 353] A number of variations have been introduced to increase its use by ambulance attendants. A practical problem is that most ambulances are staffed by two attendants, one of whom must drive, and the usual division of the CPR ventilation function, with mouth-to-mouth resuscitation, and the perfusion function, by application of midsternal pressure, is not

feasible. The Red Cross and the American Heart Association (AHA) have introduced a one-person CPR program in which they suggest maintaining a rate of 80 per minute, with two insufflations of the lung every 15 strokes.[336] Some ambulance programs have introduced esophageal airways that facilitate ventilation, especially when CPR must be performed by one person. Other, more sophisticated, services have introduced endotracheal intubation, a method of ventillating the patient through the endotracheal tube with compressed oxygen modulated by a simple valve/this latter method being easily accomplished by one person performing CPR.

Cardioversion with mechanical defibrillators has become a mainstay in the treatment of post-MI arrhythmias.[351] Defibrillation has been made considerably easier by the introduction of new machinery, such as a "life pack" including a defibrillator and portable monitor, that has been marketed at reasonable cost. These portable defibrillators can be taken from the ambulance to the patient's bedside, even if the location is up a number of flights of stairs in an older dwelling, for immediate use upon the arrival of the ambulance team.[12]

As a method of intervention, drug use demonstrates the greatest variation in approaches around the country.[63] The three basic drugs are lidocaine for treatment of ventricular irritability, atropine for treatment of bradyarrhythmias, and epinephrine for asystole, cardiac arrest, and anaphylactic shock. Some ambulances carry bicarbonate for alkalinization to treat the acidosis following cardiac arrest, calcium chloride for its cardiotonic effect, digoxin for its block of the atrioventricular node in the presence of supraventricular arrhythmias, inderal for the treatment of supraventricular arrhythmias, and morphine as an analgesic. A few ambulances also have instituted the use of the vasopressors levophed and dopamine for the treatment of hypotension, and isuprel for the presence of a high degree of heart block nonresponsive to atropine. There have been a few attempts to develop a truly mobile coronary care unit (MCCU) where essentially all of the facilities of a CCU, including temporary pacing and swanganz catheterization, are available;[342] to our knowledge, none of these programs are operational at this time. The usefulness of these particular clinical interventions, well documented in the clinical literature and in the experience of CCUs, [190, 344] has been extrapolated to use in the prehospital situation. As is probable with any point-by-point extrapolation, controversy exists with respect to finding the most appropriate balance between technology, on the one hand, and effectiveness of patient care, on the other.

Entry of patients into the system emerges early from analytic studies as the rate-limiting step in the success of these prehospital programs.[281] Studies from cities throughout the world [115, 215] demonstrate that patients delay seeking medical help an average of 3 to 5 hours after the onset of their acute symptoms. Some research suggests that patients delay even longer on their second MI, indicating that the patients' knowledge of the problem may not be the determining factor in delay.[352] Studies have indicated that this delay is a form of denial.[134] Some patients refuse to believe that they are having symptoms, others attribute the symptoms to minor ailments, and some actually prepare for death and/or long hospital stays. They formalize their wills, pack a suitcase, or make arrangements for their pets to be cared for, etc. Public education campaigns have been launched by the AHA to inform the public of the significance of potential cardiac symptoms. Certain States, such as Vermont, have disseminated information about the ambulance system.[73]

The introduction of the "911" telephone system in many areas throughout the country has also facilitated the patient's access to the system.[111] In many cities, the "911" system connects all emergency departments, including police, fire, and ambulance. This permits an integrated approach to any emergency. Of course, this requires a sophisticated triage system to optimize the response of emergency vehicles to any particular situation. This is particularly important when a two-tiered ambulance situation exists; i.e., basic ambulance life support staff for routine calls and an advanced ambulance life support staff for true cardiac, trauma, and burn emergencies.[130] The decentralization of ambulances so that they are deployed throughout the city, usually attached to fire and/or police stations, has made the process of dispatch far more efficient. In most urban communities, response times of less than 10 minutes are standard. The two-way classification of emergency rooms (ERs) in an area by condition and severity has now been translated into a point-of-entry plan.[111] These plans insure that a patient is taken to a hospital that has both the staffing and the physical capacity to handle that particular problem at that particular level of severity.

In summary, a structure for an efficient and effective emergency medical services (EMS) system, especially for the cardiac patient, is in place. We have mobile technology, with vehicles modernized to provide adequate space and equipment for advanced medical interventions. Ambulance staffs are being trained and certified as basic emergency medical technicians (EMTs). Some EMTs are receiving advanced training as paramedics. Point-of-entry plans have been accepted by most communities because of the inherent staffing, legal, and economic advantages to hospitals, as well as the commitment to improve patient care. Most importantly, there exist the dollars, the legislative mandate, and the public support for EMS programs. There seems to be no substantive question as to whether or not we should continue to develop MCC programs. Rather, the question is how to maximize the efficiency and optimize the cost effectiveness of such systems. This requires attention to be focused on the five factors that appear to limit the effectiveness and increase the costs of present MCC programs. High-risk target populations likely to benefit from MCC should be identified. The public must be educated about the warning signals and symptoms of heart attacks, trained in CPR, and convinced of the importance of getting medical help rapidly following symptoms of MI. Protocols for dispatching vehicles must be developed and tested, and methods for quality control monitoring of ambulance staffs' performance on these vehicles need to be standardized and implemented.

Historical Perspective/Legislative Mandate

Prior to 1973, the U.S. Congress had a long track record of funding categorical programs for EMS. They included disaster relief, medical care for patients in motor vehicle accidents, burn centers, and transportation efforts, including both ambulances and helicopters.

In the *Journal of Emergency Care & Transportation* (6:105-107, November/December, 1977), Robert E. Motley of the Department of Transportation (DOT) succinctly and accurately summarized this era:

> The need for the development of the Emergency Medical Technician as a professional in the field of allied health was first identified in the September 1966 Report, *Accidental Death and Disability: The Neglected Disease of Modern Society,* developed by the National Academy of Sciences. At that time, 48 percent of the nation's ambulance personnel had standard Red Cross training or no formal training. Fifty-two percent had advanced Red Cross training. The majority of personnel were poorly paid technicians operating commercial or funeral director ambulance services or were volunteers. The turnover rate exceeded 40 percent annually.
>
> The Department of Health, Education, and Welfare (DHEW) established an Emergency Medical Services program in the Division of Accident Prevention in early 1960. The program lacked Departmental support or interest and was transferred by Congress to the U.S. Department of Transportation (DOT) with the passage of the Highway Safety Act of 1966. The Act mandated the establishment of Highway Safety Standards, one of which was Standard 11, "Emergency Medical Services." During the first two or three years, the efforts of DOT were directed to in-depth research on the recommendations and findings of the National Academy of Sciences' 1960 report. The first national training course directed to ambulance personnel was published by DOT in October 1969.
>
> A national EMT training program could not be put into effect without a State-organizational structure and authority. In 1966, only four States had an established EMS program or personnel identified as having an EMS responsibility; three were offering a formal State training program for ambulance personnel. Over the next 11 years, highway safety funds of between $9 and $15 million annually were spent on a matching grant basis in developing an effective prehospital system.

Discouraged with limitations of categorical programs and enthusiastic about early expected successes of MCC and trauma programs, the Congress in 1973 passed a comprehensive EMS program, P.L. 93-154. This program had five parts: Section 1201 provided funds for EMS system planning; Section 1202 mandated the implementation of planning programs; Section 1203 encompassed the broad spectrum of EMS operations beyond the planning phase, under which most present EMS funding falls; Section 1204 provided for an advanced system of prehospital coronary care and advanced ambulance staff training; and Section 1205 encompassed evaluation research. The Health Services Administration (HSA) administers all the programs under 1201, 1202, 1203, and 1204. The National Center for Health Services Research and Development (NCHSR) under the Human Resources Administration administers the funds from 1205. In 1976, these programs were updated and additional funds were put into these efforts.

Concomitantly, many States, such as Massachusetts, have developed their own ambulance laws and regulations.[348] These laws and regulations essentially address three generic topics: standards for systems, standards for staff, and standards for ERs. Included nationwide in most of these laws and regulations have been timetables for certifying all ambulance personnel at the basic 81-hour EMT course level. This is a course developed and published by DOT that trains ambulance personnel in the skills necessary for basic emergency medical care and transportation. At its conclusion, and under the aegis of each State, all candidates take a certifying national board examination. These certificates must be updated regularly with documentation of followup training.

The passage of these laws has brought about substantive changes in the organization of EMS throughout this country. Standards have been promulgated for the operation of the system. These include a single phone number providing access to all emergency services; a communications link among all emergency services, including dedicated phone lines for linkages with hospitals; a response time of less than 10 minutes in urban areas; and a geographically based point-of-entry plan to ensure the most appropriate use of ER facilities. The 81-hour EMT certification requirement has dramatically shifted ambulance services from a preponderance of voluntary and part-time staff to a full-time staff. Enforcement of standards for vehicles has encouraged more municipalities to provide ambulance services and has decreased the involvement of private ambulance companies in true emergency care, although private ambulance companies are still heavily involved in transport of patients between health facilities. These changes have served as the bedrock on which many precoronary care programs have been developed. These programs fall into four categories: (1) municipal ambulances staffed with 81-hour EMTs, (2) municipal ambulances staffed with advanced EMTs (paramedics), (3) dedicated cardiac ambulances with paramedics, and (4) MCCUs with nurses and/or physicians. All of these program approaches are coupled with some elements of public education.

Public education efforts are intended to inform citizens on how to access the EMS system. This is usually accomplished with advertisements and publicity related to the "911" number. Another measure is the AHA campaign to inform the public about risk factors, warning signals, and symptoms of cardiac disease. Here, the emphasis is on encouraging patient recognition of symptoms and response to these symptoms. In a number of States, this program has been called the "Heart-Watch" program. In Vermont, there was concern that this program would generate excessive concern on the part of the public, which would manifest itself as gross overuse of ambulances. The AHA has reported that ambulance usage in Vermont following the implementation of the heart-watch program increased by no more than 10 percent.[338] At the most sophisticated level of public education, there have been a number of community wide attempts to teach CPR. The best data regarding the effectiveness of CPR come from Seattle, Washington. There, the success of the ambulance paramedic program in resuscitating patients from VF increased by more than three fold in those situations in which the cardiac arrest was witnessed by a member of the public who was trained in CPR and instituted CPR properly.[192, 274] The unique circumstance in Seattle is that more than 20 percent of the 500,000 residents have been taught CPR[60]—an accomplishment that many civic leaders feel is not realistic in most metropolitan areas of the country. The AHA is now putting together a nationwide campaign to teach CPR.

Municipal ambulances staffed with basic EMTs are capable of instituting CPR and giving oxygen, either by nasal cannula or mask. The effectiveness of their CPRs is limited by the fact that, even with a response time of 4 minutes, the institution of CPR is sufficiently delayed that irreversible brain damage may have occured, especially in the elderly. There are some data to suggest that institution of CPR in children after an arrest may be successful as late as 6 to 7 minutes following the catastrophic event. The second limiting factor in CPR by EMTs and ambulances is the fact that it must be performed by one EMT in the back of the ambulance while the other is driving. The institution of oxygen therapy, which until 2 years ago had been based purely on anecdote, now has a strong scientific basis. Madias and Hood have shown that high-flow oxygen in cardiac patients definitely reduces infarct size and thereby preserves more myocardium, which should result in a better long term outcome.[347]

Probably the most prevalent plan for prehospital coronary care is the use of municipal ambulances staffed by paramedics. Paramedics, by definition,are 81-hour, EMT-certified staff who either are chosen or elect to go on to advanced training. Training programs range from 90 hours in Baltimore, Maryland, to more than 800 hours on Cape Cod, Massachusetts. DOT developed and published a national EMT-paramedic training course that consists of 500 to 800 hours of training. More and more communities use this course as the foundation for their training programs. The basic intent of paramedic training is to train the EMTs to use advanced technology for interventions in patients with critical problems. More than 70 percent of most courses revolve around cardiac problems, given the prevalence of cardiovascular disease (CVD) and the active involvement of cardiologists in developing these programs. In addition to basic life support skills, the paramedics are trained to interpret arrhythmias and intervene when appropriate. Interventions consist of defibrillation and/or drug treatment. All paramedic programs include airway management as an important part of the program—from basic airway management by head and neck maneuvers to, in some programs, esophageal intubation and endotracheal intubation. The use of drugs, requires that paramedics learn to be adept at starting intravenous fluids. These fluids are also used to provide hemodynamic support for patients in shock secondary to volume loss associated with trauma. Although the paramedic programs essentially cover the same basic clinical areas, the comprehensiveness of the teaching in each area varies greatly. For example, some programs teach arrhythmias in cardiologically simplistic terms, so that tachyarrhythmias can be distinguished from bradyarrhythmias, supraventricular arrhythmias from ventricular arrhythmias, and Premature Ventricular Contraction (PVC) from Premature Atrial Contraction (PAC). Other programs have very sophisticated arrhythmias teaching and the skills of the paramedics coming from some of these programs are at least equivalent to those of junior level medical house officers.[38] Some programs use straightforward, mandated protocols (if "a," do "b"), while others use complex branching algorithms. The operations of house staff vehicles, with their presumed greater independence, has only been minimally studied.[186] Almost all paramedic programs are supervised by physicians (usually cardiologists or ER physicians) or surgeons. There are very few paramedic programs in which the paramedic operates independently and only has his performance monitored in retrospect. Most programs provide some means of paramedic voice communication and electrocardiogram (ECG) telemetry with base hospitals.[219] The degree of independence for paramedics within this communication setup also varies greatly—from those programs in the field in which the paramedic uses the physician at the base hospital as a consultant on a "prn" (as-needed) basis, to programs where the physician at the base hospital monitors and diagnoses arrhythmias and orders specific interventions.

Dedicated cardiac ambulances differ from the municipal ambulances staffed by paramedics only with respect to the manner in which the ambulance is triaged to the patient. Some programs have the dispatcher make the triage decision based on the patient's initial complaint and/or assessment. Other programs use the cardiac ambulance as a backup to the basic ambulance when the EMT on board decides that a cardiac problem is present. A few programs dispatch the cardiac ambulances directly from the university center only after a series of highly discriminating triage decisions. These dedicated cardiac ambulance programs are the ones that tend toward the more sophisticated types of treatment protocols and tend to be the ones with the longer training programs. MCCUs staffed by physicians are essentially an anachronism. There is only one such program in the United States, and a recent controlled trial from England suggests that physicians on ambulances are no more successful than their paramedic counterparts.[139]

Other approaches to MCC have been attempted in a variety of situations. Under Dr. Boyd, the State of Illinois set up an MCC program that interlocks with the entire statewide system of emergency care.[339] A referral matrix has been established through which specialized referral centers provide medical backup (including ECG telemetry) to less specialized hospitals, which in turn support primary EMS providers over wide areas of the State. Dr. Rose in Oregon has developed a similarly comprehensive approach.[267] Carveth, who stations an MCC unit at a football stadium,[47] and Pace, using a similar approach in an office building,[234] have also reported some success in bringing their MCC programs a step closer to the potential patients.

Methodological Considerations in EMS Evaluation

The difficulties in directly developing the next step of an overall EMS strategy for prehospital coronary care derive from incomplete documentation and inadequate assessment of present EMS programs. The sheer number of critical input variables and wide variations in present programs that we outline in the literature review (Ch. II) have seriously impeded substantive and objective review. Evaluation problems have been further compounded by the great expectations raised by media coverage of MCC programs and the associated popularity among politicians and at the local community level. The problems with EMS research can be divided into four categories:[111] (1) an absence of standardized units of measurement and definitions, (2) a minimum of objective criteria for assessing the process of care, (3) statistically insensitive measurements for outcomes, and (4) the absence of proximate outcome measures to evaluate the effectiveness of specified interventions. Our literature review and development of MCC impact measures (Ch. II) in this report highlight these issues.

Standardization Most research reports do not identify the target population of the community in which the MCC service is provided and, in general, the denominators in most studies relate to that number of patients using the ambulance with a specified condition, under specified circumstances. There have been no serious attempts within the confines of the target population to define an at-risk population. Clearly, an ambulance with a catchment area including housing projects for the elderly serves a high-risk population.

The conditions themselves also are not specified in detail. Many reports dealing with patients with acute myocardial infarction (AMI) fail to specify the documentation for the diagnosis. In the case of MI, the standard clinical literature insists on there being historical, enzymatic, and ECG evidence for MI. Other studies include patients with ischemic heart disease (IHD), in which MI and the clinical spectrum of angina pectoris are included, but fail to specify whether the ischemic episodes are in fact acute exacerbations of underlying IHD or new onset of IHD. This is particularly important in that accelerated or crescendo angina and new onset angina clearly carry a worse prognosis from that of chronic IHD.[337] Even more misleading is the current practice of grouping all patients with cardiac conditions. In an analogous fashion, there are few examples in which severity of patient condition is specified. Occasionally, patients with AMI will be grouped into those with systolic blood pressure of more than 100. The use of the four-point ordinal Killip Classification for patients with MI[354] and the four-point ordinal New York Heart Association classification for patients with acute ischemic heart disease AIHD[341] would greatly enhance our ability to compare results across study settings.

Because of the multitude of relevant socioeconomic and historical variables, there has been almost no effort to standardize reporting across demographically disparate groups of patients. Those articles that do report the demography of the population usually examine the effect of each independent variable on the dependent variable by series of chi-square tests. Basic probability theory states that 5 out of 100 such chi-square tests will be positive by random chance alone at a $p = .05$ level of significance. Multiple regressive techniques permit simultaneous examination of multiple variables and can even quantitate their relative contribution to a given outcome variable. These analyses are restricted to routinely collected data, which are often incomplete and/or imprecise. For example, it is often difficult to ascertain the precise age of the patient. If standardized age groups were developed, almost all patients could be placed within an age group with a high degree of accuracy. Efforts to explain the average 3- to 5-hour delay in summoning an ambulance following an MI have been hampered by the lack of such a standardized approach. Measuring delay itself is an imprecise science,[284] and the source of information regarding the delay is usually not specified. When we have examined patients' ambulance records and hospital records and compared those results with those from patient interviews or next-of-kin interviews, there has been approximately 70 percent agreement among the three sources.[254] In an additional 20 percent of cases, two of the three sources agreed closely enough that we could place a patient within a half-hour time frame following his/her MI. In 10 percent of the patients, there was no agreement among the three sources.

All of these clinical, socioeconomic, and medical-historical variables operate to create case mixes. Case mixes must be controlled to compare the effectiveness of MCC programs in different areas of the country and must also be used to study the effectiveness of paramedics within a system. In comparing an MCC program with a routine ambulance program, Hampton found that careful study of case mix revealed that "low-risk cases were inadvertently selected for transport by the cardiac ambulance."[138] Statistics as to who the EMTs are, their backgrounds, their biases, their training, their length of experience, and their working situations are either missing or reported in such different fashion as to make cross-study comparisons impossible. The term paramedic is bantered about with little attention to defining the variables that go into making an EMT a paramedic. Comparisons between paramedics and EMTs not only exhibit these difficulties, but also do not account for the factors that determine whether an EMT will become a paramedic. Who makes the decision that an EMT will become a paramedic? In most areas around the country, there are a limited number of slots for EMTs in paramedic training programs. In Massachusetts, these slots are distributed on a geographic basis. Within each geographic region, the chief of the ambulance service (who is often also the fire chief) makes a decision as to which EMTs will become paramedics. On Cape Cod, Massachusetts, we found no overall difference between paramedics and EMTs with respect to their group scores on the national 81-hour EMT exam. However, because of confidentiality and lack of standardization, there are many variables, such as perceived competence in the field, that have not been explored and that may very well explain any differences in outcomes achieved by either group.

The vehicles used by EMTs and/or paramedics also vary from site to site and some standardization is required here as well. A simple example is that of a paramedic who rides on an ambulance equipped with only basic life support equipment and cannot apply his/her new technological skills—a situation that would be important to study in looking at the effects of education on the paramedic in terms of judgment, as opposed to skills and services rendered. Older ambulances not wide enough for adequate CPR probably limit the effectiveness of this technique more than any other variable. The system by which an EMS study is conducted is usually specified in the "Methods" section of research articles. The absence of standardized system typologies limits cross-system comparisons. At one extreme, there are so many differences among systems in their operational characteristics, staffing patterns, and population served that we are left with an infinite number of possible combinations and permutations. At the other extreme, systems are dichotomized into those with one-tiered versus two-tiered response. Some typology between these two extremes would obviously be far more useful.

Objective Criteria for Process Assessment There is a common intent to the paramedics' tasks and protocols, as mentioned in the literature review (Ch. II). However, there is enough variation in these tasks and enough difference of opinion by expert cardiologists about specific algorithms within general protocols that more precise definitions and objective criteria are necessary for cross-system comparisons of outcomes. One approach to this dilemma has been the attempt by some groups to develop uniform definitions and

standardized protocols. Uniform definitions are necessary and probably only require that someone take the time to methodically catalog them. However, it is improbable that attempts to develop and standardize protocols per se will have nationwide success because of the involvement in ambulance programs of so many different types of physicians. Physicians are unlikely to adhere rigidly to any protocol either in their formal paramedic teaching programs or in their direct interaction with paramedics in the field. A more logical approach would be to develop normative protocols that would define an acceptable range of responses/activities for specific diagnoses. This approach has been used by a number of medical audit groups because it reflects the basic mode of practice in this country.

Another important issue in developing objective criteria for process is to differentiate between symptom recognition, condition recognition, and diagnosis. This is more than a definitional problem in that the degree of precision required in assessing EMT or paramedic diagnostic accuracy carries a set of implicit tradeoffs; with increasing diagnostic specificity required, there is an inherent rise in the false negative diagnostic rate and a fall in the false positive diagnostic rate. Clinically, the problem is even more substantive; in some situations, very precise diagnoses are necessary to institute appropriate treatment, while in others, more general condition or symptom recognition is all that is needed to initiate appropriate treatment. Rather than making a specific decision to use symptom recognition, or condition recognition, or diagnosis, the degree of precision required in a diagnosis should be directly tied to the relevant treatment protocol. The failure of appropriate treatment to be highly correlated with correct diagnosis[45] has created uncertainty as to whether specified protocols[115] for specific diagnoses may be too arbitrary. If it is assumed that the EMTs and/or paramedics are well trained and reasonably adept, it is questionable whether they are exercising good clinical judgment in those situations in which they do not follow the correct diagnosis with the correct protocol. Measurements of process as they relate to proximal outcomes in the ER might provide insight into this unexplained paradox of appropriate treatment despite inaccurate diagnosis.

Meaningful Outcome Measures The standard approach to outcome measures for precoronary care is the use of mortality statistics. They are usually divided into prehospital mortality, mortality through hospital discharge, and 6-month mortality. A real counting problem exists in this simplistic approach. How are patients considered "dead on arrival" counted in the out-of-hospital mortality? There is little attempt to differentiate the patient with SCD who is clearly expired beyond resuscitation when the ambulance staff arrives from the SCD patient for whom CPR is appropriate. The SCD patient beyond CPR should obviously be included in the community statistics, but probably does not belong in the ambulance population statistics. Little attention has been given to the patient who dies en route, of whom there are very few, or to the patient who is pronounced dead in the ER shortly after arrival. Some studies count such deaths in the prehospital mortality group and others count these deaths in the in-hospital group. A patient who expires more than 12 hours following admission to the CCU is different and should be statistically treated as different from the patient who is alive when he/she arrives in the ER but expires within minutes after the arrival. As mortality statistics more and more distant from the initial event are included, contaminating variables come into play—the type of ER to which the patient is brought, the presence or absence of an active CCU or trained cardiological staff in the hospital, and the general facilities of the hospital.

Only a few studies have taken the additional step of examining the serious potential morbidity of prehospital resuscitation. There is some speculation that the prevalence of neurologically dysfunctional patients may be a real outcome of the present MCC strategy, with all of the inherent custodial costs to society that these patients present. The less dramatic morbidity of prehospital coronary care per se is almost never mentioned. All of the drugs used in prehospital coronary care, and defibrillation itself, carry their own morbidity. The incidence of fractured ribs with secondary pneumothoracies following CPR is well known. The patient whose accelerated idioventricular rhythm is abolished by the inappropriate use of lidocaine and who requires a temporary pacemaker in the ER or the CCU is another such example. Iatrogenically induced infections by intravenous lines started under less than ideal circumstances have not been studied.

Development of Physiological Parameters for Proximate Outcomes Outcomes such as mortality represent the composite of a complex series of events and interactions. One approach to ascertaining the effect of a given intervention is to measure early clinical or laboratory results subsequent to the intervention but prior to the ultimate outcome. These proximate outcome parameters measure the direct effort of the intervention and are less confounded by exogenous variables, such as which ER the patient is brought to, or what type of hospital the patient was treated at. In Boston, Massachusetts, arterial blood gases are being used to determine the effectiveness of ventilation and perfusion accomplished by CPR en route.[351] A parallel study is going on in Seattle, Washington.[340] The hypothesis in both studies is that low pH, low pO^2, and high pCO^2 levels upon arrival in the ER indicate that performance of CPR by the EMTs was inadequate to provide sufficient ventilation and perfusion, and reduced the possibility of survival. If monograms for these three arterial blood gas parameters could be developed, controlling for the time elapsed before the initiation of CPR, and the total time of CPR, standards for adequate CPR could be developed and used as a proximate outcome measure.

The concept of physiological parameters is sufficiently unique to warrant a more detailed discussion of arterial blood gases as an evaluation measure of CPR. The distribution of arterial blood acid-base levels (arterial pH) of cardiac arrest patients upon arrival at the ER provides a direct measure of the effectiveness of CPR performed by the EMT. Arterial pH values have the added advantage that the test is easily done and available, and that its interpretation has been standardized in the form of nomograms.

The CPR process has two components—ventilation and perfusion. Ventilation exchanges oxygen for the elevated levels of carbon dioxide that result from respiratory depression following a cardiac arrest. Perfusion is accomplished by externally massaging the heart, which

circulates oxygenated blood at near normal pH to the entire body. Perfusion reduces the levels of lactic acid (metabolic acidosis) that occur secondary to hypoperfusion during a cardiac arrest. The combination of ventilation and perfusion correct the underlying mixed respiratory-metabolic acidosis of cardiac arrest. Carbon dioxide (pCO_2) would only permit measurement of ventilation, oxygen levels (pO_2) would only reflect adequacy of perfusion, and lactate would only reflect the relative contribution of the metabolic acidosis. Arterial pH is in a sense a synthesis of the effects of ventilation/perfusion—the normal pH being 7.40. A minimum pH of 7.20 is the objective of CPR, because below that level marked cardiac and metabolic depression occur due to ineffective functioning of basic enzyme systems. Unacceptably low pH levels upon arrival in the ER would indicate that the EMTs are not providing adequate CPR and airway maintenance and are, thereby, reducing the probability of patient survival.

II. COMPREHENSIVE LITERATURE REVIEW (TASK 1)

The purpose of this chapter is to review the literature, to determine the impact of MCC as reported, and to discern a common framework for future studies. The first section of this chapter reports on the methodology used to conduct this literature review. The second section, reports on the general characteristics of the literature. All of the experimental articles reporting outcome are then analyzed. From these analyses, estimates of MCC impact are developed in terms of the community at large and the relevant subsets of the population of patients served by MCC programs. The chapter concludes with an analysis of the Cretin simulation model and updates that model with more current estimates of MCC impact.

Methodology

To define a denominator for the published literature review, two Medlar searches were run, reviewing these literature files, those of Dr. Thomas Willemain of MIT, and those of the University of Pennsylvania EMS research group. Each source was cross-referenced with the others and then with all EMS articles in 11 major clinical and health services research journals *(American Heart Journal, American Journal of Cardiology, American Journal of Public Health, Annals of Internal Medicine, British Heart Journal, British Medical Journal, Circulation, Health Services Research, Lancet, Medical Care, and New England Journal of Medicine).* Research assistants began abstracting articles and continued to enlarge the published literature denominator by tracing the appropriate references. Two additional literature searches were obtained, one from the American College of Emergency Physicians and another from the Smithsonian Scientific Information Exchange.

Unpublished reports were gathered by sending letters requesting information on current research to EMS researchers (see App. D) and with this assistance a file of major researchers in the field was assembled. Meetings were held with Dr. Willemain and Dr. Martin Keller of Ohio State University to obtain information on current data bases and ongoing research. In addition, Dr. M.W. Pozen (the principal investigator) visited Dr. Eugene Cayton at the University of Pennsylvania to further identify published and unpublished literature in the field. Dr. Mitchell (the coprincipal investigator), Dr. Sondik (the project officer), and Dr. David R. Boyd (the director of the Division of Emergency Medical Services) (DEMS) of the Department of Health, Education and Welfare (DHEW) also met to discuss ongoing evaluation work conducted by DEMS. Appendix E presents the forms used to record literature search data for analysis.

A total of 335 articles (both published and unpublished) on MCC were identified and reviewed. These 335 articles were

abstracted and tabulated along the following dimensions:

(1) Publication sources
(2) Organizational affiliation of the principal investigator in the study
(3) Sources of research funding
(4) Type of study conducted
(5) Type of MCC system studied
(6) Sampling frame and data collection methods
(7) Effectiveness measures analyzed
(8) Type of statistical analysis used

In addition, a one-paragraph summary was written for each article to be presented in the annotated bibliography.

All articles were categorized into two groups: outcome and other. Outcome studies are those that present primary data on the effectiveness of prehospital care. Because of the paucity of EMS studies reporting the outcomes of mortality and morbidity, this category was expanded to include studies that only employ process measures of care. The other studies category consists of literature reviews and strategies of emergency care that do not report original findings. A small but important group of other studies consists of simulations of emergency care based on secondary data.

The second stage of the literature review consisted of an indepth analysis of that subset of studies directly examining the effectiveness of prehospital coronary care. Out of the larger group of articles reviewed, 132 articles used process and/or outcome measures.

Three major components were examined in these studies:

(1) Derivation of estimates of the shifts in incidence and mortality of acute cardiovascular disease (ACVD) in the community studied. These rates were further disaggregated by diagnosis, severity, type of arrhythmia, and treatment.
(2) Delineation of MCC program, patient, and community variables expected to influence outcome.
(3) Examination of sample selection, data collection, study design, and data analysis procedures used.

Descriptive Findings

Three hundred thirty-five articles were abstracted. An additional 200 articles were read, but not abstracted, as they were only tangentially related to the study (e.g., letters to the editor, ambulance equipment, in-hospital CCUs, efficacy of drugs, etc.). Of the 335 articles, 132 directly examine the effectiveness of prehospital coronary care through process and/or outcome measures.

Sources of MCC Research Publication sources for research findings indicate how widely the results will be disseminated—*The New England Journal of Medicine* is more widely read than State medical journals, for example. The subject distribution of publication sources reviewed to date (355 studies) is as follows in table 1:

Table 1. Publication Sources for MCC Studies

Type of Journal	*Total (percent)*
Cardiology	16
General medical	36
Emergency	8
State medical	9
Other medical	9
Nursing	3
Health services research	8
Unpublished	11

Medical journals clearly predominate; over three-quarters (81 percent) of all articles reviewed were published in the clinical literature. Sixteen percent were found in traditional cardiology sources, while more than one-third were published in general medical journals with a national audience (e.g., *Annals of Internal Medicine* and *British Medical Journal).* The "other medical" category is composed of anesthesiology, pulmonary, and surgical journals.

An examination of the organizational affiliations of the principal investigators (Table 2) shows that a large share of EMS research has been conducted outside the United States. In particular, 36 percent of all outcome studies have been performed abroad, primarily in the United Kingdom. This is not surprising, since the pioneer MCC studies were conducted by Pantridge and his associates in Belfast, Northern Ireland. The majority of American studies reviewed were located in medical schools, usually in departments of cardiology, surgery, or anesthesiology. Other university-based studies generally came from social science departments or schools of engineering. The other category contains such diverse groups as regional medical programs and private corporations.

Table 2. Organizational affiliation of principal investigators conducting research

Organizational affiliation	Type of research (percent) Outcome studies	Other studies	Total (percent)
Medical school			
Cardiology:	11	3	7
Other	20	27	24
University (other than medical school)	5	7	7
EMS project/organization	6	1	2
Federal Agency	3	1	1
Hospital	9	10	10
Other	2	7	5
Outside United States	36	22	27
Not recorded	8	22	17
Total number of studies	132	204	335

As illustrated in Table 3, the majority of articles reviewed did not cite sources of funding for their research. When financial support was acknowledged, it was most likely to come from Federal grants, primarily from the National Heart, Lung, and Blood Institute (NHLBI) but not under PL93-154. (Most of the MCC research funded by NCHSR with 1205 funds has not yet been completed.)

Study Design Each article reviewed was categorized, by the type of study reported, into one of the following five groups:

(1) *Concepts/strategies:* These articles discuss new and improved ways to deliver emergency services. No findings are reported on the effectiveness of care provided.
(2) *Review/state of the art:* These articles are literature reviews that do not report original data.
(3) *Theoretical:* These studies present new findings based upon the manipulation of secondary data. This category is largely made up of modeling/simulation approaches and cost-benefit/cost-effectiveness studies.
(4) *Descriptive:* This group includes all nonexperimental studies of EMS systems.
(5) *Experimental:* These studies meet at least one of the following criteria: (a) use of random assignment, matching, or some other experimental study design and (b) multivariate statistical analysis.

The distribution of articles by study type is shown in Table 4. The majority of studies are either nonanalytic discussions of MCC (39 percent) or purely descriptive studies of effectiveness (47 percent). Only 2 percent of all articles reviewed met the criteria of an experimental study. The remaining discussion is based only on outcome studies reporting original data (i.e., the 132 studies in the descriptive and experimental groups).

Table 3. Sources of funding for MCC research

Funding organization	Type of research (percent) Outcome studies	Other studies	Total (percent)
Federal	19	15	17
Private foundation	7	5	6
Medical foundation/ medical society	3	1	2
Regional medical program	6	3	4
County heart or State heart association	5	2	3
Hospital	4	1	2
Other	9	3	6
Foreign	5	2	4
Not recorded	42	63	56
Total number of studies[a]	185	246	431

[a] Inflated numbers reflect multiple source of funding.

Table 4. Types of MCC studies conducted

Type of study	Type of research (percent) Outcome studies	Other studies	Total (percent)
Concepts/strategies	0	65	39
Review/state of the art	0	14	8
Theoretical	0	5	3
Descriptive	95	16	47
Experimental	5	0	3
Total number of studies	132	204	335

To evaluate the effectiveness of prehospital care, it is important to understand exactly what type of system is under study. It is notable in this regard that as many as one-half of all outcome studies reviewed fail to describe the triage mechanism used, while almost half do not mention the ambulance distribution plan. (See discussion of general EMS research problems in Ch. I.) Further, 16 percent of all studies specifically designed to assess the effectiveness of prehospital care fail to state who staffs the ambulances, as can be seen in the following list (compiled from 132 studies) of types of EMS systems:

Table 5. Types of MCC systems

EMS System	*Percent*
EMTs on ambulance	6
Paramedics on ambulance	23
Cardiac-dedicated ambulance	53
Unlicensed technicians on ambulance	2
Not recorded	16

A majority of articles are based on systems with cardiac-dedicated ambulances; these were primarily vehicles staffed by physicians and/or nurses in the early days of MCC. Of 31 studies evaluating paramedic performance, only 9 report the amount of advanced training received by paramedics. Only one-fourth of all articles reviewed provide mean response time; the median reported response time was 6.8 minutes.

Only a small number out of 132 MCC outcome studies (7 percent) focused on the entire community as the unit of analysis:

Table 6. Sampling frames used

Sampling frame	*Outcome studies (percent)*
Community	7
Ambulance system	72
Hospital/ER	9
Other	10
Not recorded	2

Almost three-fourths restricted their sampling frame to the ambulance system per se. Findings from these studies can only be generalized to those patients who access the system. (The category "other" refers to stationary CCUs in satellite settings, such as at factories or football stadiums.)

As seen in the following list of effectiveness measures used in MCC evaluation in 132 outcome studies, almost all studies collected outcome measures, and some of these examined process measures as well:

Table 7. Range of Effectiveness Measures used in MCC Evaluation

Effectiveness measures	*Outcome studies (percent)*
Process only	11
Outcome only	70
Both process and outcome	20

The remaining 11 percent restricted their effectiveness measures to process variables alone. Almost all studies of outcome examined mortality rates (99 percent), and a substantial number looked at morbidity rates as well. Only a very few studies measured morbidity alone, as can be seen in the following list based on 118 outcome studies:

Table 8. Type of Examination Used

Type of examination	*Outcome studies (percent)*
Mortality only	86
Morbidity only	1
Both mortality and morbidity	13

With one exception, the 132 studies reviewed employed unsophisticated statistical techniques, despite the richness of data they collected. The vast majority (70 percent) reported univariate statistics, such as means and percentages, with no attempt to test the significance of their findings; a few researchers reported bivariate statistics, generally chi-squares:

Table 9. Types of Statistical Analysis Used

Statistical analysis	*Outcome studies (percent)*
Single variable	70
Bivariate	17
Multivariate	2
None	9
Not recorded	2

Summary of Descriptive Findings This overview of the MCC literature demonstrates its limited scope. The absolute number of articles (n = 335) is small compared to other popular medical technological innovations. The extent of the medical and EMS administrative readership is unknown. Most of the 81 percent of articles in the clinical literature appeared in journals with restricted circulation, as opposed to highly prestigious and widely disseminated journals such as the *New England Journal of Medicine* or *Journal of the American Medical Association.* More importantly, physicians and EMS administrators are likely to miss the more objective and analytic articles that appear in the more specialized journals.

The research in the United States tends to come from medical academia that relate to the more highly sophisticated urban EMS systems. Increasing the breadth of MCC research in settings from which more general conclusions can be drawn will require increasing the proportion of studies emanating from EMS projects/organizations. Comments about funding sources will have to await more complete documentation (56 percent do not record a source).

Accurate assessment of the impact of MCC will require many more experimental studies in diverse settings. The descriptive work to date (47 percent of the articles) provides useful data on which estimates for many of the elements and hypotheses regarding their effects in MCC systems can be derived. Experimental studies will offer the "real world laboratories" for validating these estimates and testing these hypotheses. Such studies should be done in systems employing EMTs as well as paramedics, in that the 6 percent of articles reporting on EMTs grossly underrepresent their number (more than 80 percent of all ambulance personnel in the country are EMTs). Measuring the impact of MCC will require using the community as the unit of analysis, as opposed to the ambulance population. These studies will have to be increasingly sophisticated in design and use of multivariate analyses of both process and outcome measures to enhance our understanding of the complex set of interactive events in an MCC system.

Analysis of Outcome Articles

In this analysis, we have included all articles emanating from paramedic-staffed EMS systems that report outcome data for patients with ACVD. Most of the articles from Europe have been excluded because ambulances there are staffed by physicians. Fifteen articles met these criteria and they, in turn, can be subdivided into five basic types of studies:

(1) Descriptive—all patients transported by ambulance with ACVD:
   (a) Baltimore (Pozen)[253]
   (b) Tucson (Buck)[41]
(2) Descriptive—all patients transported by ambulance in cardiac arrest:
   (a) Los Angeles, early (Graf)[129]
   (b) Lincoln, Nebraska (Carveth)[51]
   (c) Brighton, England (Briggs)[38]
(3) Descriptive—all patients transported by ambulance in VF:
   (a) Seattle (Cobb)[60]
   (b) Miami, Florida (Nagel)[186]
   (c) Charlottesville, Virginia (Crampton)[71]
   (d) Los Angeles, recent (Diamond)[86]
   (e) Tampa (Amey)[13]
(4) Quasi-experimental:
   (a) Columbus, Ohio (Lewis)[183]
   (b) Illinois (Sherman)[278]
   (c) Seattle, recent (Eisenberg)[91]
   (d) Jacksonville, Florida (Richupan)[263]
(5) Randomized—all patients calling a central dispatch number for an ambulance with subsequent randomization: Nottingham, England (Hampton)[140]

This analysis will be approached on three levels. First, the validity and appropriateness of the methodology, given the intent of the article, will be discussed. For example, an article describing a set of events yielding an outcome must be examined with respect to definitions and completeness in its report of the relevant variables. An article attempting to demonstrate the effectiveness of an intervention has to meet the above criteria but should also discuss controlled studies for the important potentially confounding variables. Second, the outcomes in terms of their comparability to other studies and application to other settings will be discussed. Third, the implications for future studies of any

signficant methodological facets or secondary findings in these studies will be pointed out.

Descriptive Studies—All Patients Although many studies describe the population of patients transported by ambulance, few subdivide the population into clinically useful categories, i.e., the appropriate target population for MCC programs. Because the raison d'etre for prehospital coronary care lies in the rapid recognition and treatment of LTAs secondary to acute myocardial ischemic events, the appropriate subgroup of patients to be studied are those with AMI (ICDA 410), acute ischemic heart disease (AIHD) (ICDA 411), and cardiac arrest (ICDA 415). Many studies inappropriately exclude patients with AIHD (ICDA 411), because it is a difficult group to define from medical records. However, in the Baltimore study, the incidence of potential LTAs in patients with AIHD (ICDA 411) was not much lower than those with AMI.[253] Excluding these patients underestimates the correct denominator for MCC studies. The Baltimore study also points out that patients with ACVD in nontriaged ambulances represent only 2.3 percent of the total patients transported. Studies from nontriaged systems will require surveying large numbers of patients to identify the appropriate target groups.

The prehospital mortality rate for this group of patients with ACVD (excluding those in cardiac arrest and/or VF) appears low (2.3 percent through the time of admission to the CCU or 1 of 36 patients) in the Baltimore study. A few other studies report similarly low mortality rates for this group of patients both en route and in the ER[351] (This is one reason why data on this overall group of patients are excluded from most descriptive reports.) Another 11 of the 36 patients with ACVD without cardiac arrest and/or VF died during their hospital course, bringing the total mortality rate for this group to 36 percent. It seems advisable, in any evaluation of paramedic prehospital cardiac services, to follow all patients with ACVD at least through the time of hospital discharge. It is interesting to note that the mortality for this group at 3 months did not increase significantly from that found at hospital discharge, which, if applied generally, would eliminate the expense of postdischarge followup for short-term studies of paramedic programs.

For the subset of 22 patients in cardiac arrest and/or VF, the Baltimore study reports a 73 percent mortality rate by the time of hospital discharge. These data can be compared to those presented in the third part of this analysis (Table 10).

The Tucson report deals with 712 patients with a primary discharge diagnosis of AMI, 158 of whom used the EMS emergency vehicles.[41] Nineteen used the MCCU and 139 used ambulances staffed by EMTs. The mortality rate at the time of hospital discharge was 47.1 percent and 27.0 percent, respectively. It is not clear whether patients with AMIs who died prior to ambulance arrival or in the ER itself were included in this study, though the small number of patients carried by the mobile intensive care unit, (MICU) suggests that they were not. The difference in mortality between the patients cared for by the MICU versus those using regular emergency vehicles is almost certainly a function of the underlying severity of condition and not the ambulance per se.

The 19 patients using the paramedic staff MICU are too small a number for further analysis. The study does, however, reemphasize the important access issue within EMS: 41.8 percent (298 patients) with a final diagnosis of AMI came to the ER by their own means and 36 percent of the patients with a final diagnosis of AMI (256 patients) were directly admitted to the CCU via physician referral, entirely bypassing the prehospital EMS system as well as the ER. It is during this period of time that the highest incidence of potentially life-threatening and reversible arrythmias occur. This pattern of EMS use by patients with AMI is comparable to the 25 to 50 percent use range reported in the literature.[41, 252, 263, 283] Use of the emergency system appears to relate to the patients' distance from the hospital (the greater the distance, the more likely the patient is to use the ambulance) and a past history of MI, which often predisposes a patient to ambulance use. A number of these studies report that the patients' clinical severity does not influence this decision (except for the Buck study, in which "sicker" patients tended to use the ambulances more often than "less sick" patients).[41]

Table 10. Outcomes of treatment and observation for potential LTAs

Type of arrhythmia	Treatment				Observation			
	n	Died in ER	Died in hospital	Alive 3 months	*n*	Died in ER	Died in hospital	Alive 3 months
PVC	4	0	1	3	15	0	8	7
VT/VF	13	7	4	2	4[a]	0	0	4
Indioventricular	9	9	0	0	1	1	0	0
Sinus bradycardia	2	0	1	1	10	0	1	9
Totals	28	16	6	6	30	1	9	20

PVC = premature ventricular contraction.
[a] Short bursts of VT

Descriptive Studies—Patients in Cardiac Arrest The descriptive articles dealing solely with patients in cardiac arrest are from very different settings. The Los Angeles system is a second responder system in a large urban area. The advanced cardiac vehicle is dispatched once one of the first responder vehicles (basic EMT, police, sheriff, and/or fire) has ascertained that the patient is a potential cardiac problem. The Lincoln, Nebraska, system is also a second responder system, though there is an attempt to simultaneously dispatch the advanced cardiac vehicle (which must pick up a nurse at the CCU at the same time as the first responders are dispatched. The system in Brighton, England, is a nontriage, first responder system with at least one member of each ambulance crew trained as a paramedic.

As seen in Table 11 the mortality rates are high, ranging around 80 percent. It is interesting to note that the proportion of patients with ACVD in the three studies appear to be similar, regardless of the type of system, first responder or second responder. The low proportion of patients with ACVD in the second responder systems in Los Angeles and Lincoln is strikingly different from the 80 to 90 percent frequency of ACVD in patients cared for on strictly

TABLE 11. Patients in cardiac arrest

Ambulance data	Los Angeles (Graf[130])		Lincoln (Carveth[47])		Brighton (Briggs[38])	
	n	Percent	*n*	Percent	*n*	Percent
Number of ambulance patients	1,240	—	717	—	2,253	—
Patients per month	32	—	31	—	24	—
Rescue response time (minutes)	NR	—	NR	—	5	—
Patients with ACVD	472	[a]38	319	44	1,125	[a]50
Patients in cardiac arrest	186	[a]15	169	[a]24	207	[a]9
Patients in cardiac arrest—mortality rate (not surviving hospitalization)	151	[b]81	134	[b]79	180	[b]86

NR = not reported.
[a] Percent of ambulance patients.
[b] Percent of patients in cardiac arrest.

cardiac-dedicated vehicles, such as those used in Northern Ireland. This accounts in large measure for the very low frequency of patients in cardiac arrest seen by all three of the paramedic crews.

It is impossible to place any judgment on these outcome results, other than reporting them in this descriptive manner for a few principal methodological reasons.

The definition of arrest is not clear. In Los Angeles, no criteria were reported. In Brighton, circulatory arrest was defined very precisely as the presence of either asystole or VF upon arrival of the paramedics. Although a patient in cardiac arrest in either asystole or VF does not represent a diagnostic problem, there is clearly a subset of patients who are prearrest, as well as those who collapse from noncardiac causes, who may represent more of a diagnostic dilemma. In Lincoln, for example, of the 323 patients who had collapsed, 169 patients required resuscitation, 136 patients were responsive by the time the team arrived and did not require resuscitation, and 17 of the patients were declared dead by the paramedics and resuscitation was not attempted (1 patient missing). That 42 percent of patients (136 of 323 collapses) were responsive by the time the paramedics arrived in Lincoln and did not require resuscitation raises serious questions as to the accuracy of the diagnosis of "collapse." It is almost certain that the etiology of the "collapse" in the 136 patients was not AIHD. Though it is known that VF, as an etiology for "collapse," will spontaneously revert in a small proportion of patients to a more coordinated rhythm, there is no evidence that it occurs with this degree of frequency. The even more general definitional problem that is reported in the Lincoln article revolves around the number of patients whom the paramedics determine cannot be resuscitated, in that they have been dead for a long period of time. This is, in fact, the modus operandi in many systems, the legal aspects of which remain to be delineated. The decision to systematically exclude patients from resuscitative efforts will obviously influence both the denominator and the outcome data and produce "better" results.

Another methodologic point raised in these three studies revolves around both patient delay and ambulance response times. Only the Brighton study reports the median time from onset of symptoms to the ambulance being called, which was 65 minutes (131 minutes for those patients who called a general practitioner first, and 24 minutes for those patients who called the ambulance service directly). It does not report the median time of call for the subset of patients in arrest. Neither of the other studies reports this time either. The ambulance response time in Brighton is reported as 5 minutes and not reported in either of the other studies. Clearly, both are critical factors in successful outcome due to the well-understood inverse relation between outcome and the time from onset of arrest to the time of the beginning of CPR, a 4- to 6-minute lapse being the upper limit during which survival can be expected.

As seen in Table 11, none of the ambulance services were particularly busy, averaging 1 to 3 total patients per day and with a much smaller number of arrests per month. The two issues here relate to paramedic experience and skills: the number of patients a paramedic needs to be caring for on a regular basis to optimize his/her skills and the overall effect of experience. There do not appear to be too many patients, but we are unable to comment on whether they are seeing too few patients to maintain and improve their resuscitative skills.

Only the Brighton paper subdivides the patients in cardiac arrest into those with idioventricular versus those with VF rhythms. This is crucial to understanding outcome data. It is patently clear in the literature that almost no patients with idioventricular rhythms can be successfully resuscitated and discharged from the hospital.[3, 38, 86, 107] The proportion of patients in an idioventricular rhythm, of all those patients seen for cardiac arrest, is probably directly related to the total length of time elapsed from the time of arrest to the time of paramedic arrival, in that VF left untreated will almost certainly degenerate into an idioventricular rhythm. Therefore, with a larger proportion of patients in VF at the time of the paramedics' arrival (either due to rapid public response to seeking ambulance assistance and/or ambulance response time per se), the better the outcomes expected.

Descriptive Studies—Patients in VF The five studies included in this section all report on outcomes for patients treated with VF, though some of these articles also include

TABLE 12. Patients in VF

City	Patients Transported	Total events	Patients in VF	Study period (months)	Patients in VF per month	Median response time (means)	Patients in VF discharged alive	
							No.	Percent
Seattle, Washington	NR	NR	285	12	24	5	72	25
Miami, Florida	NR	NR	301	42	7	4	42	14
Charlottesville, Virginia	243	26	23	22	1	[a]15	5	22
Los Angeles, California	2,152	90	50	10.5	4.8	4	15	30
Tampa, Florida	NR	NR	296	12	25	5	68	23

[a] Mean.

less comprehensive data about other subsets of patients with ACVD transported in their system (Table 12.). It should first be noted that the five systems all have excellent reputations. We think that it is fair to say that these five cities represent "the best in the state of the art" of caring for patients in VF. Personal communication with the directors of these systems, the reputations of the systems, and their published results lead us to conclude that there are characteristics common to each of these five systems: efficient organization, good working relationships between the ambulance services and local governments, dedicated physician leadership with strong medical control, and adequate resources. In Seattle and Charlottesville, there have been major public relations campaigns to involve the community in the use of these services. Attesting to this fact is that 30 percent of all citizens in Seattle have now been trained in CPR and approximately one-third of the cardiac arrest patients seen by the Seattle paramedics have had CPR initiated by a citizen bystander. Nevertheless, the total number of patients seen in VF per month in any of these systems is small, and the percentage of patients in VF discharged from the hospital ranges from 14 to 30 percent, with an average of approximately 25 percent (Table 12).

Methodological problems similar to those outlined for the studies of cardiac arrest patients only are found in these studies. Additionally, these studies either implicitly or explicitly attempt to extrapolate this experience to the population at large and derive estimates of the number of lives that could be saved in a community were paramedic services uniformly available. None of the articles presents objective data to support these contentions. These types of projections assume that the experience with the present group of patients can be generalized to those who do not access the system at this point. It would seem obvious that, especially in well-popularized systems, the subset of patients who do not have access to the system are very different from those who do. These factors may be operative through the interaction of such variables as potential to access the system, the reluctance to seek medical assistance that increases delay, and increased clinical severity.

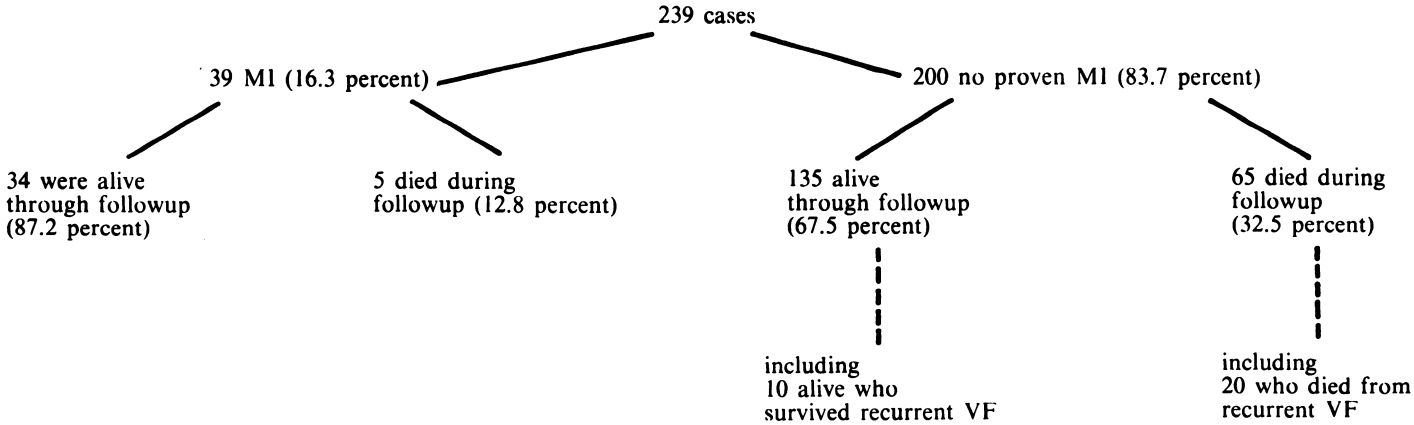
Further obscuring the potential benefits of paramedic systems is the lack of long-term followup regarding return to previous functional status of patients resuscitated from VF. In Seattle, the largest series of patients with the longest followup (4 years) was studied. Results were gathered for a subsample of 239 patients with prehospital VF who were successfully resuscitated, hospitalized, and discharged home, and for whom adequate followup data were available. As seen in Figure 1, long term survival for patients whose VF was secondary to an AMI was 87.2 percent, as compared to a 67.5 percent rate in the 200 patients who had no proven AMI. This more than twofold increase in mortality in patients without MI as an etiology for their VF is thought to be due to persistent ischemia. The conclusion is based on the fact that a subset of this group was found by coronary arteriography to have severe, three-vessel disease in every way comparable to the coronary anatomy of the patients whose VF was secondary to AMI.

Thirty of the 239 survivors of prehospital VF discharged home had a recurrent episode of VF. Ten (33 percent) survived. The study points out that the recurrence is usually early, with a median interval of 17 weeks from the initial event. Little is known about the functional status of these out-of-hospital survivors. The Miami study reports on 42 patients who were discharged following prehospital resuscitation from VF, of whom only 60 percent returned to their prearrest status. Twenty percent had mild, and 12 percent had severe, neurological deficit. In their series, the mean survival for discharged patients was 12.7 months.

The cost to society of these episodes of recurrent VF, neurological deficit, and post-VF medical care are unknown. The Miami group does raise the spectre of cost in general terms by discussing the shift of the locus of death from the prehospital environment to the hospital. In that study, 40 percent of the hospital deaths (24 patients) in those patients resuscitated from VF were dead within 1 day after admission to the hospital and 75 percent (44 patients) were dead within 1 week. Presumably, all would have died without incurring the cost of hospital admission if the paramedic program did not exist.

Quasi-Experimental Design Because legal, ethical, and political considerations essentially preclude the use of randomized trials to evaluate prehospital coronary care systems, a number of centers have employed quasi-experimental designs to address the same issue. Four case studies will be reviewed. Quasi-experimental designs attempt to take advantage of natural experiments. It is not the

FIGURE 1. Four-year followup of 239 episodes of resuscitation from prehospital VF (Seattle—Cobb 60).



purpose of this report to review the merits and potential hazards of quasi-experimental design; suffice it to say, that without the experimental advantage of randomization of patients to control for unexpected variation in potentially confounding variables, these studies require even greater attention and rigor in controlling for these potentially confounding variables. The studies, in turn, should be interpreted within the constraints imposed by the design and the ability of the researcher to measure and/or control for such variables.

The simplest quasi-experimental design is the "before-after." This type of design is essentially descriptive of the effects of an intervention but is unable to control for all the changes that one would expect in the absence of intervention or for those that occur unexpectedly over time. Such an approach appeared early in the literature of the Columbus, Ohio, group. They compared the 19-month experience of three MCCUs manned by paramedics over a 3-month period. They found the mortality rate for AMI was 20 and 30 percent, respectively. However, when they examined the clinical characteristics of the two populations, they found that the paramedic patients had a 58-percent incidence of arrhythmias as compared to 35 percent in the physician-monitored group, a 28-percent incidence of VT/VF/asystole in the paramedic patients versus 13.5 percent in the physician-treated patients, and a 25-percent incidence of shock or hypertension in the paramedic patients versus 14.5 percent in the physician-treated patients. They concluded that paramedics were equally as effective as physicians, though neither their data nor their analysis support this intuitive conclusion. More importantly, these results demonstrate the pitfalls of "before-after" designs; i.e., the change in case mix severity with time as the system becomes better known by the public.

A more sophisticated quasi-experimental design is the "multiple interrupted times—series design," which was employed by Sherman in a doctoral dissertation at Northwestern University, studying the Illinois MCC system. He examined four communities in the greater Chicago area that introduced similar MCC systems at different times over a 37-month period.[278] Using ambulance records, ER records, and death certificates, Sherman identified 1,796 patients who had probable prehospital MIs over the entire 65-month period. In Figure 2, the four times series are plotted, with the broken vertical lines in each figure indicating when the mobile intensive care service began in that particular community. Sherman used linear regression to determine whether the mortality rates decreased in each community. He demonstrated that in Community A and Community C there were statistically significant decreases in mortality from AMI, 42.6 to 24.2 percent in Community A and 38.2 to 25.4 percent in Community C. In Community D, the average mortality rate decreased from 28.4 to 21.9 percent, but the reduction was not statistically significant. In Community B, the mortality rate apparently increased after the introduction of the MICU. Sherman appropriately points out that this month-by-month type of analysis does not control for the varying number of cases per month, so he also aggregated his data in a before-after manner (Table 13) and found similar results.

Sherman also looked at 18 potentially confounding variables that might raise "plausible rival hypotheses" to explain these findings. By qualitative analysis he eliminated all but 8 of these, on the basis that the first 10 would only have the effect of increasing the mortality rate, which might cause one to "underestimate the effect of the mobile intensive care unit, but their effects would not be mistaken for a reduction resulting from an effective system." For some of these 10 variables, there are no data in either this study or others to support this contention. The analyses on the remaining eight variables leaves unanswered a certain number of "plausible alternate hypotheses" to explain the observed differences in the cardiovascular mortality rate. Although this approach is one of the most comprehensive reported to date, it fails to recognize the fundamental clinical complexity of the patient with AMI. The approach comparing four communities before and after the implementation of prehospital coronary care is realistic, but the unit of analysis must remain the individual patient in order to control for case mix differences in patient population. Moreover, the "before-after" design inherently does not permit for controlling of "historical effect;" i.e., shifts of exogenous but relevant variables.

A similar approach has been employed by the Seattle group recently.[91] That group had the opportunity to study two equivalent communities over the same period of time, one with paramedics available with prehospital coronary care

FIGURE 2. Monthly mortality rates before and after MICU implementation in the Chicago study

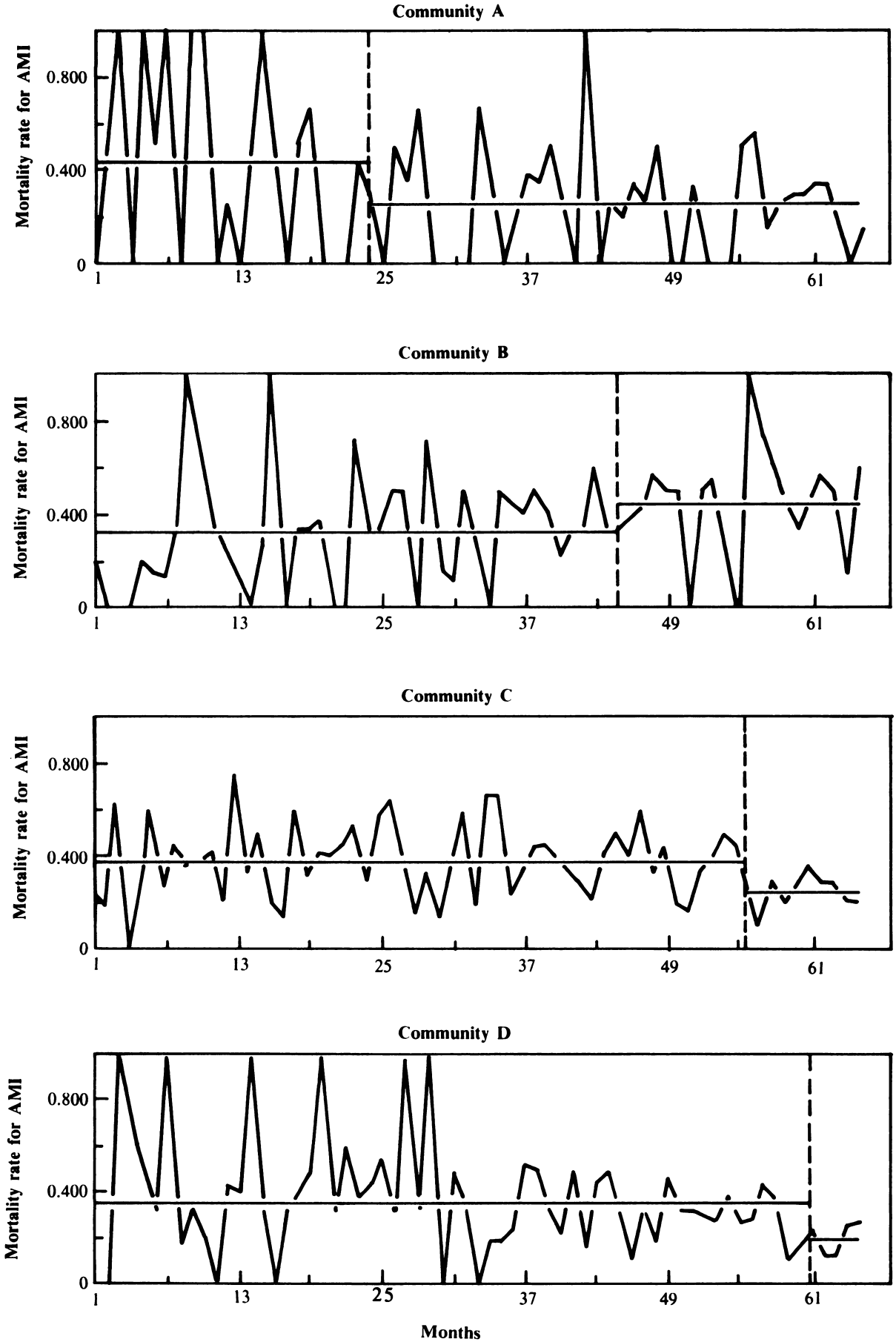


TABLE 13. Aggregated monthly mortality rates before and after MICU implementation in the Chicago study

Item	Community							
	A		B		C		D	
	Before	After	Before	After	Before	After	Before	After
Discharges	43	137	144	70	373	84	292	39
Deaths	30	43	65	55	225	31	154	11
Total cases	73	180	209	125	598	115	446	50
Mortality rate (percent)	41.1	23.9	31.1	44.0	37.6	27.0	34.5	22.0
Chi square (df = 1)	6.68		5.11		4.32		2.64	
Significance	[a].010		[a].024		[a].038		.104	

d.f. = degrees of freedom.
[a]Statistically significant at $p = .05$.

resuscitative capability and one staffed by EMTs with only basic life support available. They report on 333 out-of-hospital arrests, 123 treated by paramedics and 210 by EMTs. They report a 17.9-percent survival rate (22 patients) in the paramedic-treated group and a 4.8-percent survival rate (10 patients) in the EMT-treated group. Their data indicate that the communities clearly were not equivalent with respect to age and underlying primary heart disease rates. There is a similar lack of patient-by-patient control for potentially confounding variables such as etiology of arrest, age of patients, and length of time arrested prior to CPR in the two communities. Nevertheless, the findings are striking.

The fourth quasi-experimental study was done in Jacksonville, Florida.[263] It seriously attempts to control for 11 clinically significant variables on a case-by-case basis: shock, congestive heart failure, temporary pacemaker, age, past history of an MI, final primary diagnosis, hypertension, smoking, obesity, and vital signs (normal versus abnormal). All patients with AMI who used the prehospital coronary care system (staffed by EMTs, not paramedics) were compared with those patients who came to the hospital by other means. The researchers then controlled for these 11 potentially confounding variables and found no differences in survival rates between the two groups. Their initial comparison of the two groups, without controlling for these confounding variables, suggested a significant difference in outcome, favoring the patients who were cared for by the EMTs. Once the potentially confounding variables were taken into account, no statistical difference between the two groups could be ascertained. It is interesting that, when the subset of patients with shock was removed, and congestive heart failure controlled for, the EMT-treated patients did better than the nonambulance group. This finding suggests that there may be subsets of the population of patients with ACVD for whom the prehospital MCC system may be effective. None of the other control variables added any statistical utility.

This type of approach offers the most rational and potentially productive methodology for assessing the question of the effectiveness of paramedics. It would be even more useful to employ this approach comparing patients treated by paramedics versus those by EMTs in either similar communities or in the same community in a nontriaged system.

Randomized Trial There is only one randomized trial in the literature assessing the potential effectiveness of MCCUs. In Nottingham, England, 1,664 patients were randomly allocated to transport by the MCCU and 1,676 patients randomly allocated to routine transport.[140] There are serious questions about the randomization procedure because an equal number of patients were not randomized during that same time period. Nevertheless, no difference in the cardiovascular mortality rate was demonstrated between the two groups. No multivariate analyses of the data were performed and there do appear to be some differences between the two groups in the univariate analyses: an increase in the percentage of patients on the MCCU who had their attack at home, an increased cumulative percentage of patients using routine ambulances who called within the first hour after the onset of symptoms (though there appears to be no difference between the two groups during the first 30 minutes), a smaller number of patients with bona fide MIs in the routine ambulances, and a larger percentage of patients requiring resuscitation in the MCCU. These differences may have occurred by chance alone or they may have been due to poor randomization procedures. In any event, these differences certainly need to be controlled for on a patient-by-patient basis. Further, the overall mortality rate of 53 percent in the patients randomized to the MCCU versus the 62 percent mortality rate in those randomized to the routine ambulances is excessively high and only consistent with all MI patients having been in severe heart failure (Killip III, see App. C) or cardiogenic shock (Killip IV, see App. C). This raises serious questions about the generality of the patient data.

Summary of Analysis of Outcome Articles Despite the definitional and methodological problems enumerated in these 15 outcome studies, the results of the quasi-experimental studies tend to confirm the results of the descriptive studies. It appears that MCC programs do decrease the mortality rate for patients in cardiac arrest and, to a lesser degree, for patients with AMI. The extent of these improvements is difficult to quantitate in a comparative and general fashion because of study design problems. There is even less information available on other historical and clinical predictors of successful outcome. These will become increasingly important if it becomes necessary to selectively triage patients to paramedic units at the point of ambulance

dispatch. The absence of objective morbidity data precludes indepth cost/effectiveness studies at this time.

The consistency of the data in these articles, once definitions have been delineated, does offer us a rational basis for developing estimates of MCC impact. Because most of these estimates will of necessity be derived from descriptive studies, experimental studies for validation of these estimates should follow.

Estimates of MCC Impact

This section moves from an overview of the literature and methodological analysis of the articles to the data contained therein. The data have been organized across studies, carefully controlling for definition, to set forth estimates of MCC impact that represent the current state of the art.

Because the objective of prehospital MCC programs is to reduce ACVD mortality, the community is the appropriate unit of analysis. The rationale for this approach has been extensively reviewed in Chapter I. Assessing the impact of MCC programs involved a systematic disaggregation of cardiovascular death rates in the community and their associated outcomes, as reported in each study.

The target population was delineated in a stepwise fashion: (1) all persons with ACVD events in the community; (2) the subset of ACVD patients accessing the EMS system via ambulances; (3) the subset of transported patients with acute, as opposed to chronic, IHD; (4) delay factors; (5) the subset of transported patients with ACVD who experience potential LTAs; (6) the subset of patients with these potential LTAs who require advanced intervention; and (7) patients in cardiac arrest. Outcome measures (mortality and morbidity) have been evaluated both by diagnosis and type of arrhythmia.

The analysis of all components related to MCC impact was approached by an indepth review of all 118 primary data source articles that included "outcomes" as the dependent variable. Ten articles were excluded because the results were based on hospital, as opposed to prehospital, data. The remaining 102 articles were further reduced to 51 sets of studies by combining multiple articles emanating from the same system and researchers. The set of articles was then subdivided for analytic purposes into 22 reporting on total ambulance runs of cardiac-dedicated vehicles; 10 reporting on total ambulance runs of nondedicated vehicles; 5 reporting on a clinically defined population from cardiac-dedicated vehicles; and 14 reporting on a clinically defined population from nondedicated vehicles. First, the form shown in Appendix E was completed on each study. The articles were then reviewed with special attention to methodology; delineation of independent, process, confounding, and outcome variables; and statistical analysis. A third review involved an analysis of the articles from an epidemiological and clinical perspective. The study team then met to establish consensus on each criterion on the evaluation form. All the data available in the literature were reviewed to develop quantitative estimates for each component related to MCC impact. Whenever available, the estimates are reported in the text and tables and supporting evidence are included. The results of the analyses, following a stepwise approach, are outlined in the following pages.

Overall Incidence of Acute Cardiovascular Events in the Community Cardiovascular events in the community can be broken down into two groups, those patients dying from ACVD and ACVD among survivors. The primary source for data on patients dying from ACVD must be Public Health Department death certificates. Portland, Oregon, and Seattle report 1.5 deaths from primary heart disease per 1,000 population; Charlottesville reports 3.2 per 1,000 (Table 14). The next step is to break this group down into in-hospital versus out-of-hospital deaths. Approximately 45 percent die in-hospital and 55 percent die in the prehospital phase (Table 15). The in-hospital deaths then must be further subdivided into those patients who expire after prolonged hospitalizations (and for whom ACVD may have become a secondary diagnosis at the time) versus those who die directly from complications of their AIHD. It is also important to know the time interval from when the patient is first seen in the ER to the time of death. The Montgomery County report indicates that 75 percent of deaths occur within the first 2 days of hospitalization (Figure 3), Nagel found a slightly longer mortality time frame from patients resuscitated from VF by paramedics.[186] Clearly, those patients dying in the ER or shortly thereafter represent a different population of patients from those who expire further into their CCU course. The former group are more likely to have expired from arrhythmia-associated problems, for which MCC programs might have been helpful. The latter are almost

TABLE 14. Annual community cardiac mortality rates (Deaths per 1,000 population)

Location and principal investigator	Year	Etiology	Deaths (per 1,000)
Portland, Oregon, Rose[268]	1969	MI	1.37
King County, Washington, Eisenberg[92]	1976	Primary heart disease Primary heart disease Primary heart disease	1.35: paramedic area 1.97: EMT area 1.74: total area
Charlottesville, Virginia, Crampton[74]	1966-70	Coronary desease and 30-to-69-year-of-age cohort only	3.79
	1971	Coronary disease and 30-to-69-year-of-age cohort only	3.22
	1972	Coronary disease and 30-to-69-year-of-age cohort only	3.24

TABLE 15. In-hospital versus prehospital community mortality rates

Location and principal investigator	Year	Etiology	Deaths				
			Total	Prehospital No.	Prehospital Percent	In-hospital No.	In-hospital Percent
Southeastern Montgomery County, Maryland, Simon[283]	NR	[a]ACVD	167	138	82.6	[b]29	[b]17.4
Belfast, Northern Ireland, McNeilly[199]	1965-66	ASHD or CAD	998	596	60.0	402	40.0
Charlottesville, Virginia, Crampton[74]	1966-70	Coronary disease and 30-to-69-year-of-age cohort only	536	282	52.6	254	47.4
	1971	Coronary disease and 30-to-69-year-of-age cohort only	95	53	55.8	42	44.2
	1972	Coronary disease and 30-to-69-year-of-age cohort only	97	42	43.3	55	56.7

ASHD = arteriosclerotic heart disease; CAD = coronary artery disease.

[a]Sample is restricted to 35-to-75-year-old patients with no complicating malignant disease or other debilitating illness.

[b]The in-hospital sample is restricted to patients admitted to the one hospital in the study area.

certainly dying due to pump failure, given the successful track record of CCUs in treating potentially lethal arrhythmias. No one seriously expects that patients with pump failure will show better survival rates as a result of MCC programs. The out-of-hospital deaths require further subdivision into those dying as a result of last-stage CVD, with all of the sequelae, for whom MCC programs are unlikely to be useful, versus patients who are dying suddenly. The sudden death group should then be disaggregated by attended and unattended deaths. (See the section entitled "Cardiac Arrests" in this chapter.) It is clear that a person dying in his sleep has far less chance of being successfully treated than the persons who goes into arrest in a public place.

ACVD among survivors is more difficult to identify. Seven to 20 percent of all MIs are silent, and this subgroup by definition is not included in any study sample.[345] The remaining 75 to 80 percent of patients with ACVD can be readily identified through hospital-based discharge computer printouts of final diagnosis ICDA 410 to 415. Given the present medical and legal climate, the vast majority of symptomatic patients who seek medical assistance are admitted to a CCU. Our research indicates that only 2 percent of such patients are inappropriately discharged from the ER. Patients within each ICDA classification should be further reviewed using standard diagnostic criteria, since there is considerable interhospital viariation in assessing these diagnostic categories. Once the group of patients with ACVD who survive are identified, patients within each group need to be classified by severity. The four-point ordinal Killip Classification is a valid and readily applicable index for the ICDA 410 group, [344] though not routinely incorporated into hospital discharge computer printouts. We have no quantitative estimates for this category of patients because the majority do not use ambulances to reach the hospital and hospital discharge printouts do not disaggregate the two populations of survivors from ACVD.

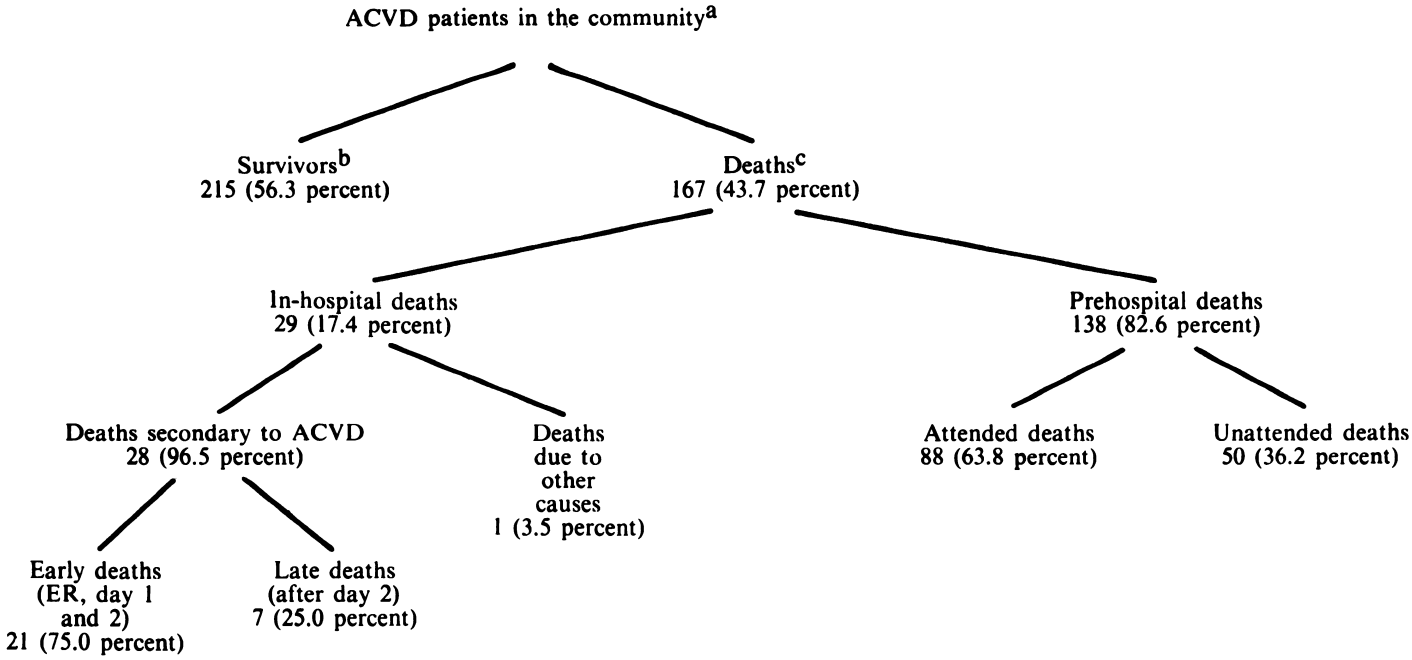
Patients With ACVD Who Seek Medical Assistance

The population of patients defined as having ACVD (see the preceding section) serves as a denominator for all subsequent analyses. We are then interested in identifying the proportion of patients with ACVD who seek medical assistance, broken down between those who use the emergency medical system and those who, on their own, seek medical assistance from their private physicians or from ERs.

The data relating ambulance use to the actual incidence of ACVD in the community are limited. The four studies undertaking this expensive and time-consuming analysis indicate that 31.0 to 57.5 percent of patients with MI use ambulances to reach the hospital; the remainder use private transportation, walk in, or arrive by other means (Table 16). In the Simon [283] and Buck [41] studies, only patient delay differentiated the ambulance users from nonusers. In Buck's study, ambulance users also were significantly sicker than nonusers, using a three-point ordinal scale: minor, major, and life threatening. Pozen, [252] however, was unable to demonstrate delay or severity (measured by presenting Killip Classification) as significant predictors for ambulance use. Rather, his group found that distance from the hospital of greater than 10 miles and a past history of an MI were the only discriminators between ambulance users and nonusers. None of the other three studies reported on distance and the Simon study found no difference between the groups with respect to previous history of an MI or previous history of angina pectoris. No difference in patients' sociodemographic and enabling characteristics in all four studies was found between the two groups. Recent legislation making it illegal in many States for police to transport patients to a hospital and increased public education may diminish this substantial rate of underuse.

Total Ambulance Runs Because of the data collection problems delineated in community-based data most studies

FIGURE 3. Community cardiac mortality data from Southeastern Montgomery County, Maryland.[283]



[a] Restricted to 35-to-75-year-of-age patients with no complicating malignant disease or debilitating illness.
[b] Survivors are only those survivors from ACVD admitted to the one hospital in the study area.
[c] Deaths include community out-of-hospital deaths and study hospital in-hospital deaths.

(32 of 51, or 63 percent) use total ambulance runs as their universe. The data are usually not standardized on a monthly or yearly basis. Sample sizes vary considerably: 8 with 100 to 199 runs, 7 with 200 to 499 runs, 5 with 500 to 599 runs, 11 with 1,000 to 3,999 runs, and 3 with more than 4,000 runs (Table 17). The wide difference in the sample sizes alone restricts meaningful statistical comparisons. Of the remaining 19 studies, 4 limit the universe to patients with MI, 11 to patients with cardiac arrest and/or VF, and 4 use incomplete combinations of the above (Figure 4).

Nevertheless, these studies reporting total ambulance runs can be analyzed within that context (as opposed to the community as a whole) if the data are disaggregated by diagnosis: all CVD and in particular, ACVD. Ideally, CVD would be subdivided into cardiac arrest (ICDA 415.8), AMI (ICDA 410), acute myocardial ischemia (angina pectoris) (ICDA 411), and chronic IHD (ICDA 412 to 414). The first two groups are categorized as ACVD. Each of these three subgroups has its own unique clinical and epidemiological characteristics and expected outcomes. AMI and cardiac arrest are relatively straightforward diagnoses and require only minimal interpretation by data collectors. Acute myocardial ischemia and chronic IHD, on the other hand, are less precise and require more interpretation, which explains their exclusion from 28 of the 51 studies under discussion.

The incidence of CVD in the 32 studies reporting total ambulance runs varies substantially, primarily as a function of type of ambulance system (Figure 4). Therefore, we further divided these studies into the 22 from cardiac-dedicated vehicles and the 10 from nondedicated vehicles. In the 22 studies of cardiac-dedicated vehicles using ambulance runs as the universe, 17 report some value for CVD (Figure 4). One of these includes the category "suspected CVD" by EMT or paramedic. The incidence of CVD on ambulance runs was 89.2 percent. From other work that has been done, categorization in this manner will overestimate patients with true CVD by at least 30 percent. In the other 16 studies, 7 report CVD rates of 44.5 to 88.0 percent, 6 split out ICDA 410/411 from ICDA 412 to 414 and report for the 410/411 patients a range of 47.3 to 82.1 percent, 6 report only the ICDA 410/411 cases, which range from 19 to 75.3 percent, and 3 report ICDA 410 alone as 16.1 to 33.3 percent.

In the 10 studies of non-cardiac-dedicated vehicles with total ambulance runs cited, 6 report some value for CVD, one includes patients with hypertensive CVD into the CVD category and reports a 4.1 percent CVD rate defined in this manner for MCC runs and 0.8 percent for regular ambulance runs. Four studies report a total CVD ambulance rate of 5.2 to 27.6 percent; one of those reports on ACVD per ambulance run (2.3 percent). One study reports on suspected ACVD, 36.1 percent. In both the dedicated ambulance studies and the nondedicated ambulance studies, it is obvious that the incidence data are more statistically reliable as the definitions of the population subsets become increasingly precise and narrow.

The incidence of ambulance patients with CVD in studies identifying the number of AIHD patients and the number of chronic IHD patients is presented in Table 18. The percentage of patients with CVD on cardiac-dedicated ambulances is generally 70 to 80 percent, except for studies in which the CVD sample excludes patients having acute ischemia without infarction (ICDA 411). The CVD incidence range in those studies is 41.4 to 54.7 percent of ambulance patients. The incidence of patients with chronic IHD (ICDA 412 to 414) on cardiac-dedicated ambulances ranges from 6.0 to 19.5 percent, whereas the majority (generally 55 to 65 percent, of patients on cardiac-dedicated ambulances have

TABLE 16. Ambulance use by patients with MI

Location and principal investigator	Time frame (months)	ACVD patients using ambulance (percent)	MI patients using ambulance (percent)
Southeastern Montgomery County, Maryland, Simon[285]	12	53	57.5
Cape Cod, Massachusetts, Pozen[252]	3	0	55.0
Jacksonville, Florida, Richupan[263]	18	0	31.0
Tucson, Arizona, Buck[41]	12	0	34.0

TABLE 17. Outcome studies reporting on total ambulance runs (distribution of sample sizes and identification of studies reporting on foreign systems and/or cardiac-dedicated vehicles)[a]

System characteristics	Sample size (100 to 199)	Estimated runs per month	System characteristics	Sample size (200 to 499)	Estimated runs per month	System characteristics	Sample size (500 to 999)	Estimated runs per month	System characteristics	Sample size (1,000 to 3,999)	Estimated runs per month	System characteristics	Sample size (>4,000)	Estimated runs per month
Foreign	198	NA	Cardiac-dedicated	225	28.1	Cardiac-dedicated	500	33.3	Cardiac-dedicated	1,973	54.8	Non-cardiac dedicated and domestic	4,580	381.7
Cardiac-dedicated	83	22.1				Foreign	770	128.0	Foreign	1,999	133.3			
	116	5.8		413	22.9		840	6.4		2,253	93.9		7,654	364.8
	134	11.2		200	NA		600	200		2,741	57.1		10,000	833.0
	189	94.5	Foreign	243	10.1		717	23		1,035	69.0			
	175	25.0		300	NA					1,240	38.7			
	165	6.9		320	26.7					3,581	67.5			
	170	42.5		382	382					1,379	57.4			
										1,755	97.5			
										2,152	179.3			
										3,950	329.0			

NA = not available.

[a]Total ambulance runs—31 studies report total runs and 2 of these studies report 2 different ambulance bases. (Lewis: physician staffed = 1.035 and nonphysician staffed = 600; Andrews: EMT staffed = 1,755 and paramedic staffed = 1,379.)

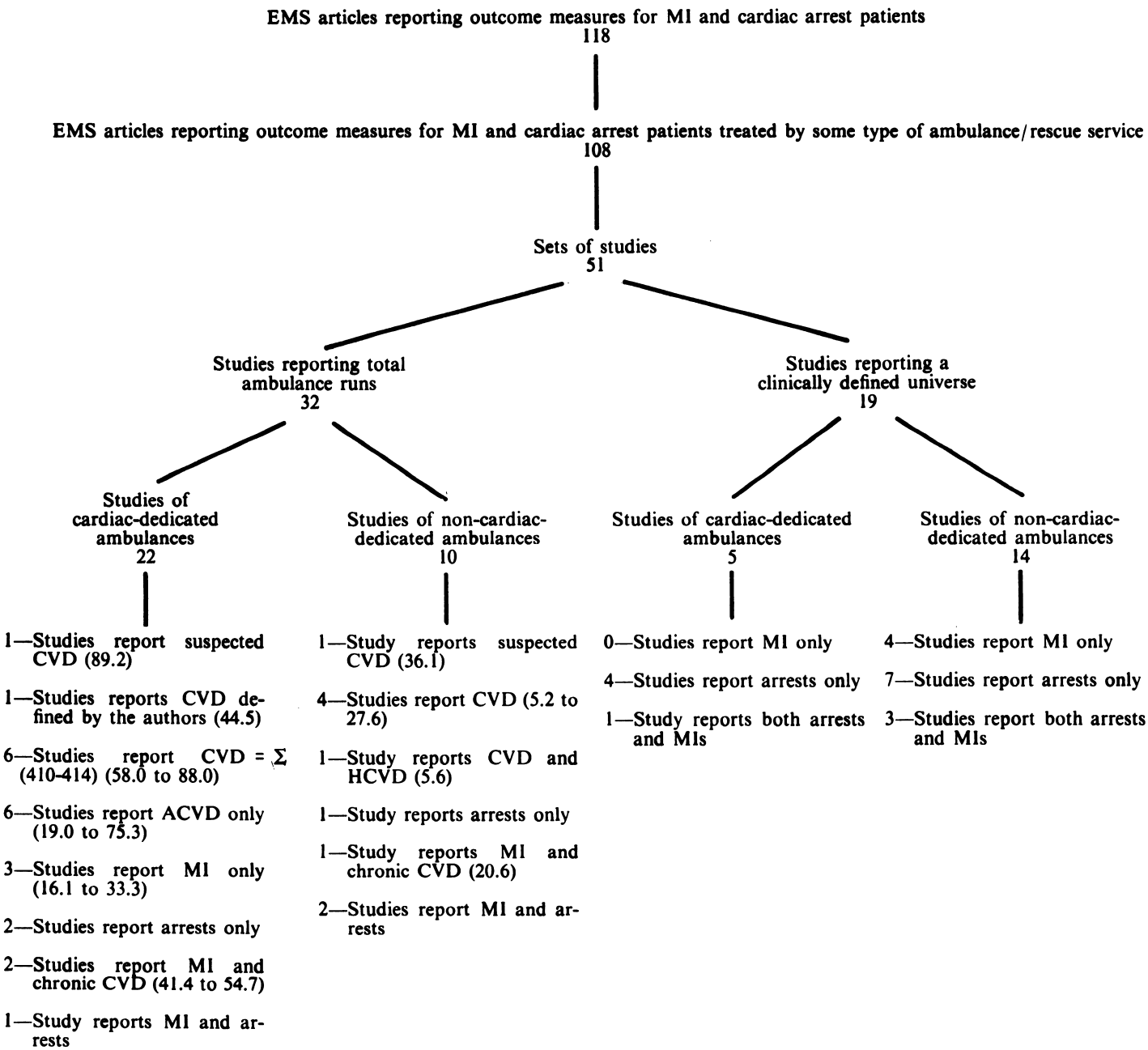
AMI or ischemia (ICDA 410/411). The percentage of ambulance patients with AMI (ICDA 410 only) varies considerably, even among studies of cardiac-dedicated ambulances only (Table 19). However, the MI incidence rates are 16.1 to 33.3 percent for the United States studies and 42.0 to 74.0 percent for the United Kingdom studies.

Hospital discharge rates for ambulance patients with CVD are rarely reported for patients with diagnoses of ICDA 411 and 412 to 414. The hospital discharge rates of ambulance patients with MI (ICDA 410) are reported in 13 studies and range from 67.1 to 91.6 percent, with a median of 83.4 percent (Table 19).

Delay to Definitive Medical Care Delay has a number of components: the time from the onset of the warning signals to the time of the onset of the acute symptomatology; the time of the onset of the acute symptomatology to the time the patient seeks medical assistance, usually by telephone; and the time from the telephone request for assistance to the ambulance arrival in the patient's home. The latter is considered the onset of definitive medical care, in that the paramedic-staffed ambulance is capable of instituting definitive medical care in the field for the cardiac patient. None of the studies delineates the first time frame because prodromata are difficult to identify and the validity of these data would be highly questionable.

Five studies attempt to accurately define delay from onset of acute symptomatology to the call for an ambulance.[16, 38, 41, 140, 253] The data are presented in Figure 5, which demonstrates remarkable consistency among the studies: 50 percent of the patients seek help within 30 minutes of the onset of their symptoms, another 10 to 25 percent seek assistance within 1 hour from the onset of their symptoms (Figure 5). The rescue response times are delineated in Table 20. Geographically dispersed vehicles and paramedics have mean/median response times of less than 5 minutes; systems with one centrally dispatched coronary vehicle have mean/median response times of 10 minutes; and those systems in which the ambulance travels to the hospital to pick up the paramedic teams have mean/median response times of 15 minutes.

FIGURE 4. Frequencies of sample criteria (CVD, ACVD, MI and/or cardiac arrest in the 51 sets of outcome studies.)[a]



[a] Numbers in parentheses are percent ranges with total ambulance runs as denominators.

TABLE 18. Incidence of CVD[a] in ambulance patients

Study	Total ambulance runs	Ambulance patients with CVD ICDA (410 to 414)	Ambulance patients with AIHD ICDA (410 to 411)	Ambulance patients with chronic IHD ICDA (412 to 414)
	n	(percent)	(percent)	(percent)
Newcastle Upon Tyne, England, Dewar[85]	134	88.0	82.0	6.0
Dublin, Ireland, Gearty[107]	1,973	80.5	61.0	19.5
San Francisco, California, Uhley[303]	200	73.0	54.5	18.5
Perth, Australia, Robinson[265]	175	71.4	65.1	6.3
Hobart, Tasmania, Freeman[102]	320	70.0	60.3	9.7
Greensburg, Pennsylvania, Czachowski[79]	225	[b]54.7	[b]12.9	41.8
Los Angeles (County), California, Graf[129]	1,240	[b]41.4	[b]23.0	18.4
Baltimore County, Maryland, Pozen[253, c]	7,654	5.2	2.3	2.9
Holstebro, Denmark, Palm[236, c]	165	[b]20.6	[b]15.1	5.4

[a]This table only includes studies for which the CVD patient population can be strictly defined as the number of AIHD patients plus the number of chronic heart disease patients.

[b]Excludes cases of ICDA (411) because the study does not report a figure for this patient group.

[c]Studies report on patients treated in non-cardiac-dedicated ambulances.

TABLE 19. Incidence and outcomes for ambulance patients with AMI[a] (presented in ascending order of discharge rates)

Study	Cardiac = dedicated	Total ambulance runs *N*	Ambulance patients with AMI *n*	Ambulance patients with AMI (percent)	Ambulance patients with AMI discharged alive (percent)
Tucson, Arizona, Buck[41]	No	—	309	—	67.1
Chicago, Illinois, Sherman[278]	No	—	330	—	70.2
Columbus, Ohio, Lewis[183]	Yes	1,635	264	16.1	76.9
Jacksonville, Florida, Richupan[263]	No	—	1,410	—	79.0
Perth, Australia, Robinson[265]	Yes	175	97	55.4	79.4
Barnsley, England, Sandler[272]	Yes	500	[b]370	74.0	82.2
San Francisco, California, Uhley[302]	Yes	200	[c]36	18.0	83.4
New York, New York, Grace[126]	No	—	182	—	84.1
Belfast, Northern Ireland, Pantridge[3, d]	Yes	2,741	1,150	42.0	85.4
Sydney, Australia, O'Rourke[229]	Yes	116	69	59.5	87.0
Waynesboro, Virginia, Gorsuch[120]	Yes	198	66	33.3	87.9
Belfast, Northern Ireland, Walsh[309, d]	Yes	300	150	50.0	91.0
Montgomery County, Maryland, Grauer[131]	Yes	413	84	20.0	91.6

[a]Table only contains studies reporting hospital discharge data for AMI cases.

[b]Sandler's AMI cases include 34 probable and 37 possible MI cases.

[c]Uhley uses admission diagnoses (not discharge diagnoses) as criteria.

[d]Walsh's study is of the Ulster Hospital MCCU, while Pantridge's study is of the Royal Victoria Hospital MCCU.

The incorporation of data on patient delay provides a useful analytic framework for the patients in cardiac arrest, and, in particular, the subset of "potential save" patients in VF/VT or other LTAs. The percentage of patients in cardiac arrests found in VF or VT appears to be directly related to the mean/median rescue response time (Figure 6). As expected, the geographically dispersed vehicles find an average of 64 percent of patients in VF following cardiac arrest, whereas centrally dispatched coronary vehicles find only 33 percent of their patients in VF/VT (Figure 7).

Patients With Potential LTAs Of the patients with AIHD who are transported by ambulance, the proportion with acute potential LTAs needs to be identified, because MCC programs are primarily aimed at this subset. The

FIGURE 5. Cross-study comparison of patient delay times from onset of symptoms to call for ambulance

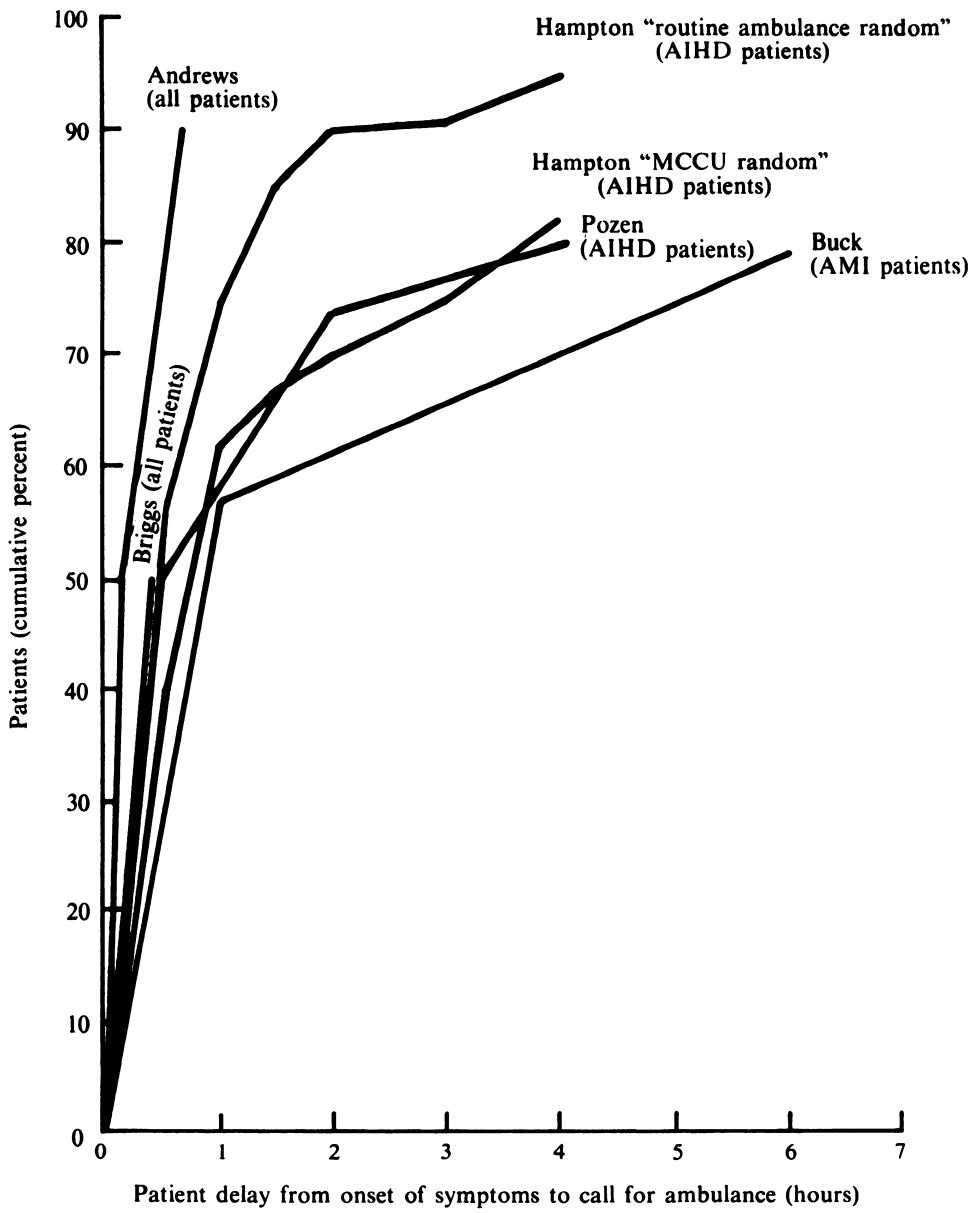


FIGURE 6. Cross-study comparison of the incidence of cardiac arrest cases in VF as a function of rescue response times.

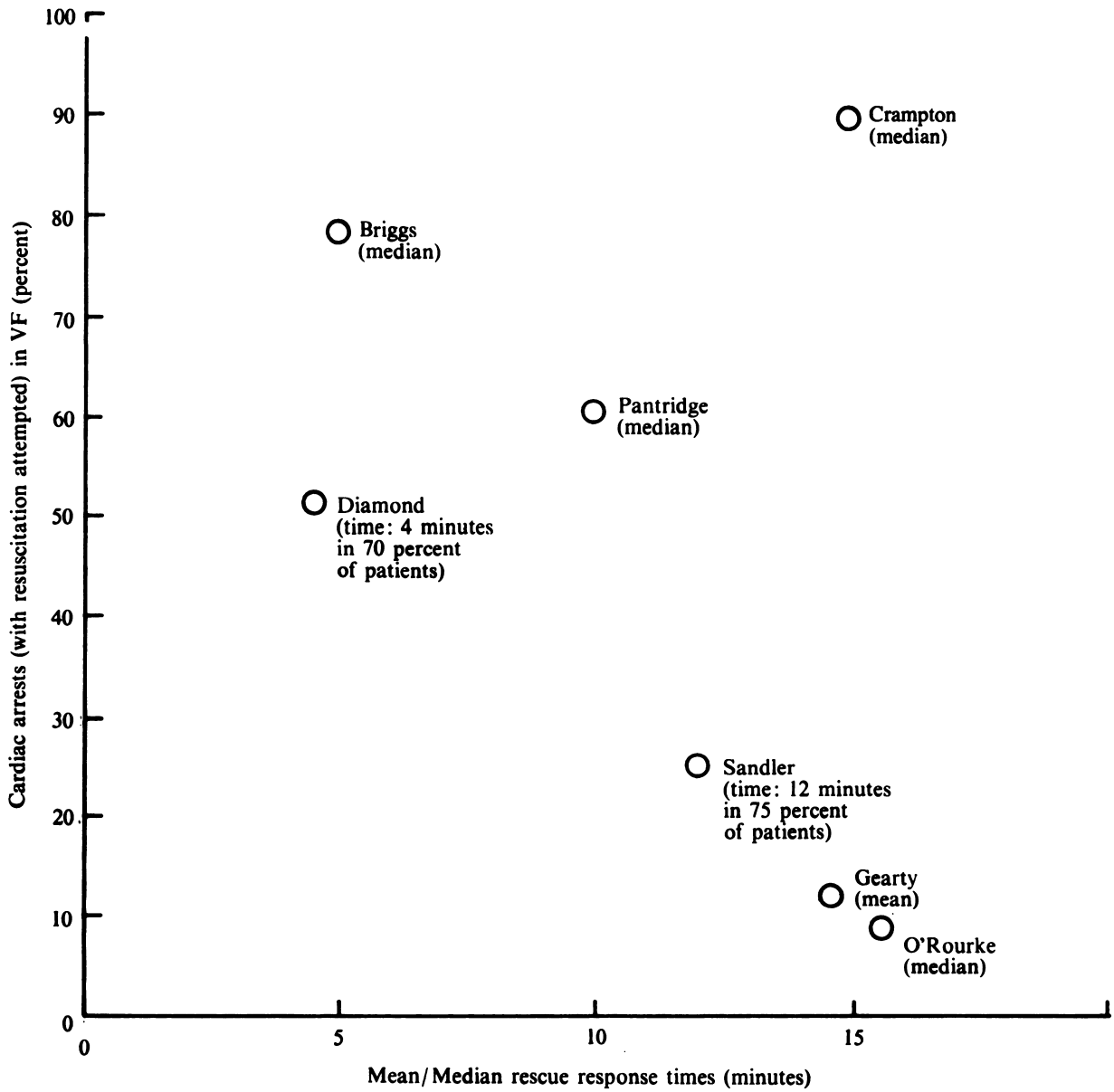
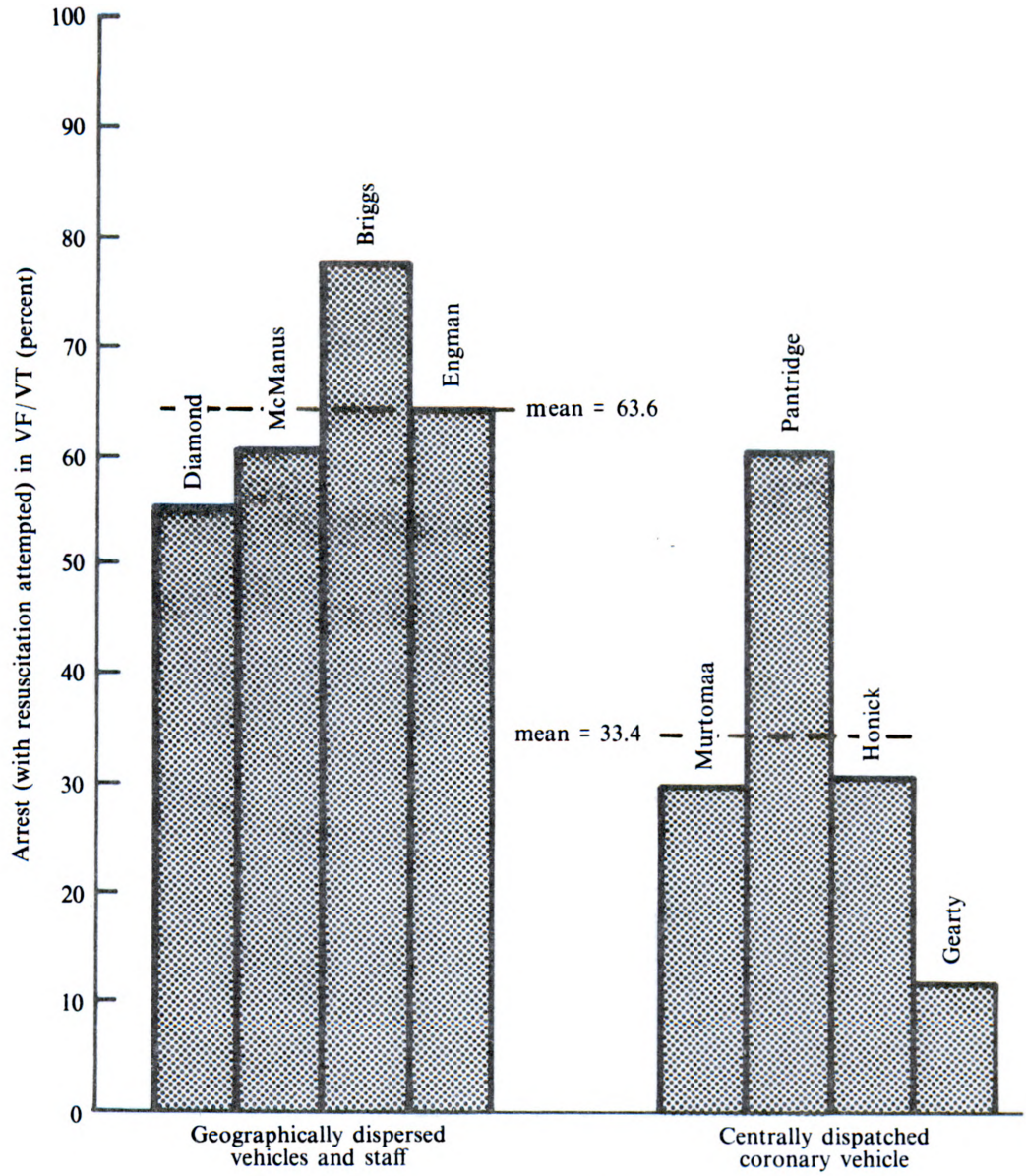


FIGURE 7. Comparison of the VF/VT incidence rates in cardiac arrest patients treated by one of several geographically dispersed vehicles or one centrally dispatched coronary vehicle.



critical LTA is VF. This group must be looked at independently, in that it has been designated as the tracer condition for evaluating the cardiac component of EMS by the DEMS of DHEW.

All studies agree that LTA includes straight line, idioventricular, VF, and VT. Most include PVCs of more than four per minute though some include any PVCs. All include sinus bradycardia (less than 60 beats per minute) though, in fact, only hemodynamically significant bradycardia between 40 to 60 beats per minute are treated per protocol. Supraventricular tachycardia (SVT) and atrial fibrillation/atrial flutter are potential LTAs under certain and unusual clinical circumstances that are rarely delineated as the basis for including patients with these arrythmias in the LTA category.

Despite these differences, controlling for case mix (ICDA 410-411), there is remarkable agreement about the overall incidence of LTAs: 30.2 to 51.5 percent in ambulance patients with documented ACVD (Table 21). The actual proportion of ACVD patients with LTA is somewhat smaller in that patients frequently have multiple arrythmias. The frequencies of specific arrythmias are approximately 8 percent for VF, 3 percent for VT, 20 percent for PVCs, 8 percent for sinus bradycardia, 5 percent for SVT, 8 percent for atrial fibrillation/atrial flutter, and 3 percent for high degree of heart block (Table 15).

It is important to note that incidence data on LTAs need to be based on all patients with ACVD because a substantial proportion of patients with ACVD apparently never have ECG rhythms recorded. It is unclear as to what kinds of arrhythmias are actually present in this nontransmitted group. One can speculate that the majority in this group may have normal sinus rhythm or sinus tachycardia that is just "too uninteresting" for the paramedic to record. On the other hand, the group may consist of critically ill patients, whom the paramedic decides to transport as quickly as possible to the nearest hospital, albeit inappropriately, without

TABLE 20. Mean/median rescue response times for 3 MCC systems

Geographically dispersed vehicles and paramedics			1 coronary vehicle centrally dispatched			Ambulance travels to hospital to pick up cardiac team		
Study	*n*	Mean/ median response times (minutes)	Study	*n*	Mean/ median response times (minutes)	Study	*n*	Mean/ median response times (minutes)
		Median			*Median*			*Median*
Miami, Florida, Nagel	301	<4.0	Tampa, Florida, Amey	125	<5.0	Barnsley, Sandler	500	<12.0
Los Angeles, California, Harbor General, Diamond	112	<4.0	New York, New York, Grace and Chadbourn	11	8.0	Charlottesville, Virginia, Crampton	103	15.0
Los Angeles County, California, Andrews	3,134	4.0	Belfast, Northern Ireland, Pantridge	NR	10.0	Perth, Australia Robinson	86	18.5
Brighton, England, Briggs	2,253	5.0	Belfast, Northern Ireland, Ulster Hospital, Walsh	300	13.0			
		Mean						
Baltimore, Maryland, Pozen	179	4.0	Nottingham, England, Hampton	456	<15.0			
					Mean			
Tucson, Arizona, Buck	NR	5.0	Bristol, England, Baskett	170	10.3			
Seattle, Washington Cobb	NR	5.0	Newcastle-upon-Tyne, England, Dewar	134	12.5			
Columbus, Ohio, Lewis	600	6.7	Dublin, Ireland, Gearty	1,204	11.6, 14.6			
			Melbourne, Australia, Luxton	200	14.0			
			Sydney, Australia, O'Rourke	116	15.6			
			Tasmania, Freeman	320	13.0			

TABLE 21. Incidence of LTAs in ACVD patients[a]

Study	[410411] *n*	Patients with LTAs *n*	Patients with LTAs Percent	No. of LTAS *n*	No. of LTAS Percent	Idioventricular percent	VF percent	VT percent	PVCs percent	Sinus bradycardia percent	A Fibrillation flutter percent	Complete heart block percent
Pozen[253]	179	58	32.4	58	32.4	5.6		9.5	10.6	6.7	—	—
Freeman[102]	[b]107	43	40.0	43	40.0	—	4.7	.2	[c]26.2	6.5	—	.9
Sandler[272]	370	—	—	172	47.4	—	2.7	2.2	15.4	8.6	7.3	2.9
Grace[126]	[b]182	—	—	84	46.2	—	11.5	3.8	12.1	9.3	4.4	2.2
Pantridge[3]	[b]284	—	—	195	68.7	—	9.8	3.5	24.6	26.4	3.9	—
White[319] (Brighton)	606	—	—	183	30.2	—	3.1	.2	7.4	2.7	7.9	3.3
Uhley[302]	146	—	—	57	39.0	—	0	—	[c]23.9	1.4	12.3	1.4
Robinson[265]	[b]97	—	—	50	51.5	—	3.1	0	[c]23.7	8.2	6.2	6.2
Kubik[170]	[b]185	84	45.4	84	45.4	—	4.3	1.6	[d]19.0	7.0	10.2	3.2
Anderson[14]	14	—	—	7	50.0	—	—	7.1	[c]35.7	7.1	—	—
Lambrew[171]	[f]269	46	17.1	56	20.8	—	.3	3.0	[c]7.4	—	7.8	2.2

[a]All percentages have ACVD as the denominator.

[b][410].

[c]No restriction on PVCs.

[d]PVCs > 6/minute and/or R on T. (PVC falling on or proximate to the preceding T wave)

[e]Chest pain group—includes patients with a history compatible with ischemic cardiac pain.

recording a rhythm. This group may even consist of patients with either straight line or slow idioventricular, agonal rhythms, who are being pronounced "dead" on the scene by the paramedics.

Proportion of Patients Receiving Advanced Interventions For each of the subsets of patients with potential LTAs, the proportion of patients receiving advanced interventions needs to be recorded. The paramedics' adherence to protocol needs to be defined. Because paramedic protocols vary greatly from one EMS system to another, a minimal, commonly accepted protocol for each LTA should be applied. It would also be important to estimate the amount of time the intervention requires, though it is rarely reported.

Five articles report on the effectiveness of lidocaine in reducing or abolishing PVCs. All studies concur that lidocaine is effective in suppressing PVCs in only approximately three-fourths of patients (Table 22).* Only one study reports on the effective control of supraventricular arrhythmias with any substantial sample size. Intravenous ouabain or an intravenous beta blocker are reported to be 100 percent effective in suppressing supraventricular ectopic arrhythmias (Table 23). In the six studies reporting on the use of atropine for bradycardia, the range of effectiveness is between 80 and 100 percent (Table 24). Patient outcomes within specific drug intervention categories are infrequently included in any of these studies. The effectiveness of CPR/defibrillation is discussed in the next section.

Cardiac Arrests Total arrests is defined as the number of all arrests (secondary to MI, CVD in general, or other causes). Ideally, arrests should include the distribution of patients found in VF/VT versus straight line/idioventricular rhythms. In this analysis, all studies reporting total arrests have been considered and then disaggregated into those reporting arrests secondary to ACVD, reporting arrests secondary to CVD, reporting the VF/asystole distribution, and reporting just VF cases. Usually, the definition is cardiac arrest without further specification. Not included in this group are a few studies with very unique circumstances and small numbers, such as paramedic teams located at football stadiums. As seen in Table 25, the incidence of cardiac arrest secondary to CVD of all ambulance runs is low, generally 5 to 10 percent. The arrest incidence rate increases if arrests due to all etiologies are included (Table 26).

The outcome that is of interest is the percentage of patients in cardiac arrest discharged alive, with the central nervous system (CNS) intact. Hospital discharge rates for cases of prehospital arrests due to CVD range from 6.7 to 30.8 percent (Table 25), and the median is 15.6 percent. Discharge rates for asystole cases are almost always 0 percent (Table 27). Discharge rates for arrest patients in prehospital VF are generally within 13.9 to 30.0 percent (Table 28), and the median for the rates reported within this range is 23.3 percent. Hospital discharge rates for samples of arrests not restricted to cardiac disease are generally lower than the rates reported for cardiac arrests due to CVD. The range, 5.2 to 20.7 percent, varies due to differences in the etiology of cardiac arrest samples (Table 26). Morbidity regarding CNS is rarely reported. Nagel reports that 12 percent of the patients discharged alive following resuscitation for prehospital VF had a severe CNS deficit.

Long-term survival rates for patients discharged alive following resuscitation from prehospital arrest are reported in five studies (Table 29). Seventy-five to 80 percent of the discharged patients survived the first year.

As discussed in the section on system delay, the time from onset of VF/arrest to the initiation of CPR is expected to affect patient outcome. Several studies disaggregate the patients receiving early resuscitation from those receiving late resuscitation efforts (Table 30). Eisenberg and Pantridge separate patients with CPR initiated within 4 minutes and those with CPR initiated after 4 minutes. Cobb, Crampton, and Lund use 5 minutes as the separation criterion. The differences in both the percentage of patients successfully resuscitated and the percentage of patients discharged alive consistently show that early initiation of CPR yields a two to three times higher survival rate. Patients receiving bystander-initiated CPR prior to the arrival of the trained ambulance crew also have a greater probability of surviving through hospital discharge (Table 31); patients receiving CPR prior to ambulance arrival had a discharge rate of 14.0 to 20.0 percent, while patients initially receiving CPR by the ambulance crew had a discharge rate of 0.0 to 14.4 percent.

Almost all of the studies reporting data on VF/asystole patients with resuscitation attempted fail to distinguish the percentage of patients receiving defibrillation attempts from those patients receiving CPR only. The proportion of ambulance patients receiving defibrillation (in systems with emergency personnel trained to defibrillate) is low (Table 32). Defibrillation is used in 7.1 to 10.6 percent of patients seen by cardiac-dedicated vehicles and in 0.2 to 1.8 percent of patients seen by regular ambulances.

Summary of Estimates of MCC Impact These data indicate that overall there is a 20 to 59.5 percent incidence of ACVD on ambulances with a 10 to 33 percent mortality rate through discharge. Outcomes appear to be limited in two ways: 50 to 75 percent of patients with ACVD bypass the EMS system, and 50 percent of patients with MI who use the ambulances still delay more than 30 minutes from the onset of prodromata.

Outcomes for patients in cardiac arrest should be subdivided into patients found in VF (a 23-percent survival rate through hospital discharge) versus those in asystole (a 0-percent survival rate). The role of experience and, conversely, attrition of skills of the paramedics/EMTs as a factor limiting effectiveness needs to be explored, because the incidence of patients on ambulances in cardiac arrest is less than 10 percent in cardiac-dedicated services and 2 percent in regular ambulance services.

In the next chapter the Cretin MCC effectiveness model is reanalyzed with the more current estimates of MCC impact.

*A recent editorial by Harrison (*Circulation* 58: 581-584, 1978) reinforces this point. He concludes that "Lidocaine may prevent primary VF even though it does not suppress all ectopic PVCs . . . the evidence does suggest that lidocaine is less effective in the first few hours after MI . . . most occurring in the first 12 hours after MI."

TABLE 22. Proportion of patients with PVCs receiving lidocaine and the reported outcomes

Study	Arrhythmia	Rx		Contractions suppressed		Died in hospital	
	n	*n*	Percent	*n*	Percent	No.	Percent
McManus[198]	NR	86		67	78	NR	
Sandler[272]	[a]119	65	54.6	54	83.1	NR	
Robinson[265]	23	NR		16	69.6	NR	
Pantridge[3]	96	66	68.8	47	71.2	NR	
Pozen[253]	19	4	21	NR		1	25

[a] Includes 8 cases of VT.

TABLE 23. Impact of drug therapies other than lidocaine and atropine for specific arrhythmias

		Arrhythmia		Rx		Responded to treatment		Died in ER		Died in hospital		Discharged from hospital	
Study	Drug	Type	*n*	*n*	Percent	*n*	Percent	*n*	Percent	*n*	Percent	*n*	Percent
Pozen[253]	Lidocaine	VT/fibrillation	17	1	5.9	NR		1	100	0		0	
	Defibrillation +/− lidocaine			12	70.6	NR		6	50	4	33.3	2	66.6
	Defibrillation +/− lidocaine	Idioventricular	10	3	30	NR		3	100	0		0	
Sandler[272]	IV Ouabain	A fibrillation	25	25	100	25	100						
	Practalol and/or oxprenolol	A tachycardia	23	23	100	23	100						
		Ectopic beats	13	13	100	10	76.9						
		Nodal tachycardia	4	4	100	4	100						
		A Flutter	2	2	100	2	100						
Grauer[131]	Metaraminol	Bradycardia	11	2	18.2	NR		0		0		2	100
	Lidocaine			5	45.4	NR		0		0		5	100
Robinson[265]	Atropine	Second degree block	3	3	100	3	100						
Czachowski[79]	Cardiac (unspecified)	PVCs	NR	4	—	NR		0		1	25	3	75
		PVCs with bradycardia	NR	3	—	NR		0		0		3	100

TABLE 24. Proportion of patients with sinus bradycardia receiving atropine and the reported outcomes

	Arrhythmia	RX		Improvement in conduction and blood pressure		Died in ED	Died in hospital		Discharged in hospital	
Study	*n*	*n*	Percent	*n*	Percent		*n*	Percent	*n*	Percent
McManus	NR	15		12	80					
Sandler[272]	32	32	100	32	100					
Grace[126]	17	17	100	17	100					
Robinson[265]	8	8	100	8	100					
Pozen[253]	12	2	16.7	NR		0	1	50	1	50
Grauer[131]	11	6	54.5	NR		0	0		6	100

TABLE 25. Incidence and outcomes of patients in cardiac arrests secondary to CVD (presented in ascending order of discharge rates)

Study	Cardiac dedicated (yes or no)	Total ambulance runs *N*	Patients with resuscitation attempted *n*	Total ambulance runs (percent)	Reached hospital alive after resuscitation attempt		Admitted to hospital after resuscitation attempt		Discharged alive after resuscitation attempts	
					n	Percent	*n*	Percent	*n*	Percent
Dublin, Ireland, Gearty[107], [a]	Yes	1,973	164	8.3	—	—	17	10.4	11	6.7
Aarhus, Denmark, Lysgaard[122]	Yes	840	197	23.4	108	54.8	—	—	14	7.1
Oslo, Norway, Lund[192]	Yes	—	631	—	—	—	—	—	70	11.1
Pittsburgh, Pennsylvania, Benson[30]	No	3,950	40	1.0	—	—	—	—	5	12.5
Brighton, England, Briggs[38]	Yes	2,253	207	9.2	66	31.9	—	—	27	13.0
Jacksonville, Florida, Waters[313]	No	382	26	6.8	14	53.8	5	19.2	4	15.4
Milwaukee, Wisconsin, McManus[198], [b]	No	4,580	276	6.0	95	34.4	—	—	43	15.6
Los Angeles, California, Diamond[86]	No	2,152	90	4.2	—	—	24	26.6	15	16.6
King County, Washington, Eisenberg[91]	No	—	495	—	—	—	141	28.5	87	17.6
Portland, Oregon, Rose[267]	Yes	—	210	—	81	38.6	—	—	38	18.1
Barnsley, England, Sandler[272]	Yes	500	16	3.2	6	37.5	—	—	3	18.7
Kiev, U.S.S.R., Zilberman[335]	Yes	—	139	—	43	30.9	—	—	29	20.9
Belfast, Northern Ireland, Pantridge[3]	Yes	2,741	155	5.7	55	35.5	—	—	38	24.5
Charlottesville, Virginia, Crampton[71], [c]	Yes	243	26	10.7	—	—	17	65.4	8	30.8

[a] Of 164 patients with resuscitation attempted, 144 were in asystole.

[b] Of 276 patients with resuscitation attempted, 10 were trauma cases.

[c] Of 26 patients with resuscitation attempted, 3 were in asystole and all 3 received CPR within 5 minutes and survived.

TABLE 26. Incidence and outcomes of patients in arrests for which the etiology is unspecified or specifically includes trauma and/or noncardiac disease (presented in ascending order or discharge rates)

Study	Cardiac dedicated	Total ambulance runs	Patients with resuscitation attempted	Total ambulance runs	Reached hospital alive after resuscitation attempt		Admitted to hospital after resuscitation attempt		Discharged alive after resuscitation attempt	
	Yes or No	*N*	*n*	Percent	*n*	Percent	*n*	Percent	*n*	Percent
Helsinki, Finland, Murtomaa[217], [a]	Yes	—	77	—	23	29.9	—	—	4	5.2
Baltimore, Maryland, Wilder[322], [b]	No	—	153	—	52	34.0	32	20.9	15	9.8
Holstebro, Denmark, Palm[236], [c]	No	165	79	47.9	—	—	—	—	8	10.1
Aarhus, Denmark, Lysgaard[122], [d]	Yes	840	28	—	16	57.1	—	—	3	10.7
Rochester, Minnesota, White[321], [b]	No	—	17	—	3	17.7	—	—	2	11.8
Los Angeles, County, California Graf[129], [c]	Yes	1,240	186	15.0	—	—	85	45.7	35	18.8
Lincoln, Nebraska, Carveth[51], [b]	Yes	717	169	23.6	80	47.3	—	—	35	20.7

[a] This MCCU provides CPR and intubation but not defibrillation.

[b] These studies include arrests secondary to cardiac disease and arrests secondary to trauma.

[c] These studies do not report the etiology of the arrests.

[d] Lysgaard's data in this table include arrests secondary to noncardiac disease.

TABLE 27. Incidence and outcomes of patients in prehospital asystole secondary to cardiac disease

Study	Total number of patients with resuscitation attempted *N*	Patients with resuscitation attempted in asystole *n*	All patients with resuscitation attempted (percent)	Reached hospital alive after patient in asystole		Admitted to hospital after patient in asystole		Discharged alive after patient in asystole	
				n	Percent	*n*	Percent	*n*	Percent
Barnsley, England, Sandler[272]	16	12	75.0	3	25.0	3	25.0	0	0.0
Los Angeles, California, Diamond[86]	90	40	44.5	—	—	3	7.5	0	0.0
Brighton, England, Briggs[38]	207	47	22.7	0	0.0	0	0.0	0	0.0
Belfast, Northern Ireland, Pantridge[3]	155	61	39.3	0	0.0	0	0.0	0	0.0
Dublin, Ireland, Gearty[107]	164	144	87.8	—	—	0	0.0	0	0.0
Milwaukee, Wisconsin, McManus[178]	[a]276	[b]104	37.7	23	22.1	—	—	6	5.8
Charlottesville, Virginia, Crampton[71]	26	3	11.5	3	100.0	3	100.0	[c]3	100.0

[a] Includes 10 trauma cases.

[b] Includes 35 patients with rhythm diagnosis of electromechanical dissociation.

[c] All three asystole patients received CPR within 5 minutes after onset of arrest.

TABLE 28. Incidence and outcomes of patients in prehospital VF secondary to cardiac disease

Study	Total number of patients with resuscitation attempted *N*	Patients with resuscitation attempted in VF *n*	All patients with resuscitations attempted (percent)	Reached hospital alive after patient in VF		Admitted to hospital after patient in VF		Discharged alive after patient in VF	
				n	Percent	*n*	Percent	*n*	Percent
Miami, Florida, Nagel[186]	—	301	—	199	66.1	101	33.6	42	13.9
St. Paul, Minnesota, Engman[94]	186	[a]119	64.0	—	—	—	—	18	15.0
Brighton, England, Briggs[38]	207	[b]160	77.3	66	41.2	—	—	27	16.9
Milwaukee, Wisconsin, McManus[198]	[c]276	167	60.5	69	41.3	—	—	35	20.9
Charlottesville, Virginia Crampton[71]	26	23	88.5	—	—	14	60.9	5	21.7
Tampa, Florida, Amey[13]	—	296	—	—	—	—	—	69	23.3
Seattle, Washington, Cobb[10,60]	—	285	—	—	—	—	—	72	25.3
Los Angeles, California, Diamond[86]	90	50	55.5	—	—	21	42.0	15	30.0
Belfast, Northern Ireland, Pantridge[3], [d]	155	94	60.6	55	58.5	—	—	38	40.4
Dublin, Ireland, Gearty[107]	164	[e]20	12.2	—	—	17	85.0	11	55.0
Barnsley, England, Sandler[272]	16	[f]4	25.0	3	75.0	3	75.0	3	75.0
Kiev, U.S.S.R., Zilberman[335]	139	[a]76	54.6	33	43.4	—	—	—	—

[a] Includes patients in VT.

[b] Includes VF after arrival of the ambulance.

[c] Includes 10 trauma cases.

[d] Of the VF patients, 49 percent received efficient resuscitation within minutes of arrest.

[e] All VF cases occurred after arrival of the ambulance.

[f] Includes VF in transit.

TABLE 29. Long-term survival rate of patients in prehospital arrest who are discharged alive

Study[a]	Long-term survival rate by length of followup period in months			
	3	12	24	43
Aarhus, Denmark, Lysgaard[122]	100.0	88.2	—	—
Seattle, Washington, Cobb[60]	—	80.0	72.0	—
Melbourne, Australia, Luxton[195]	—	77.0	—	—
Tampa, Florida, Amey[13]	—	[b]75.0	—	—
Miami, Florida, Nagel[186]	—	—	—	48.0

Note:
a) The studies by Amey, Nagel, and Cobb contain followup data on arrest patients in ventricular fibrillation only.
b) Lysgaard's arrest cases include arrests secondary to cardiac and non-cardiac disease.
c) The etiology of Luxton's arrest cases is not specified.
d) In Amey's study, followup data are only reported for twelve out of hospital ventricular fibrillation cases discharged alive; the 25% mortality rate includes cases of refibrillation as well as of deaths; average followup (not overall duration of followup) is used here and it is actually 11.6 months (not twelve months).

TABLE 30. Outcomes per unit time elapsed between anoxia time and initiation of CPR

Study	Patients receiving CPR *N*		Patients successfully resuscitated[a] (percent)		Patients discharged alive (percent)	
	Early resuscitation	Late resuscitation	Early resuscitation	Late resuscitation	Early resuscitation	Late resuscitation
King County, Washington, Eisenberg[91, b]	224	271	38.8	[c]19.9	29.0	[c] 8.1
Belfast, Northern Ireland, Pantridge[3, b]	130	25	41.5	4.0	[d]28.5	4.0
Seattle, Washington, Cobb[10, e, f]	168	51	39.3	15.7	14.3	7.8
Charlottesville, Virginia, Crampton[71, e]	13	13	77.0	54.0	61.5	0.0
Oslo, Norway, Lund[192, e]	153	407	—	—	33.3	4.7

[a] In the cases of Eisenberg and Crampton, the figures in this column reflect the percent of patients admitted to the hospital.
[b] Early resuscitation $\leq$ 4 minutes; late resuscitation $>$ 4 minutes.
[c] The difference in outcomes between patients resuscitated within 4 minutes and after 4 minutes is reported to be statistically significant at $p < .01$.
[d] The total number of patients discharged alive is given as 38, and Pantridge does not indicate whether the one patient successfully resuscitated following "late resuscitation" is among the 38 discharged alive. It was assumed here that the patient did survive through discharge. If not, the correct discharge percentages would be 29.2 and 0.0 percent.
[e] Early resuscitation $\leq$ 5 minutes; late resuscitation $>$ 5 minutes.
[f] Patients in VF only

Extending these studies to answer the queries we have raised requires not only financial support but also the solutions to many of the logistic problems inherent to these studies. In the latter part of the next chapter, the pragmatic issues involved in launching such studies are reviewed, based on experience obtained in studying MCC effectiveness in the Cape Cod, Massachusettes, region.

Analysis of Cretin Simulation Model

Shan Cretin developed a computer simulation method to assess the risk of death from MI.[76] This is an innovative approach in EMS evaluation; it has the advantage of allowing the analyst to alter different EMS system parameters. In this way, different programs can be simulated

TABLE 31. Comparison of outcomes for patients receiving bystander-initiated CPR versus CPR initiated by ambulance crew

Study	Patients receiving CPR		Patients admitted to hospital[a]		Patients discharged alive	
	By bystander *N*	By ambulance crew *N*	Patients with bystander-initiated CPR admitted to hopsital (percent)	Patients with ambulance crew-initiated CPR admitted to hospital (percent)	Patients with bystander-initiated CPR discharged alive (percent)	Patients with ambulance-crew initiated CPR discharged alive (percent)
King County, Washington, Eisenberg[91]	141	488	34.0	24.0	22.0	[b]12.9
Seattle, Washington, Cobb[10]	73	296	37.0	22.6	—	—
Milwaukee, Wisconsin, McManus[198]	19	257	63.1	32.2	31.6	14.4
Oslo, Norway, Lund[192]	75	556	—	—	36.0	7.7
Helsinki, Finland, Murtomaa[217]	29	48	—	—	14.0	[b].0

[a] Cobb reports successful resuscitation rates, not admission rates. The difference in outcome is significant at $p<.02$. McManus reports the number of patients reaching the hospital alive, not admission rates.

[b] Difference in outcomes between patients receiving bystander-initiated CPR and those not resuscitated until the ambulance arrived is reported to be statistically significant at $p < .01$.

TABLE 32. Proportion of ambulance patients receiving defibrillation attempts

Study	All VF or asystole patients *n*	Defibrillation attempted on VF or asystole patients (percent)	All MI patients *n*	Defibrillation attempted on MI patients (percent)	All CVD patients *n*	Defibrillation attempted on CVD patients (percent)	All patients *n*	Defibrillation attempted on all patients (percent)
Baltimore County, Maryland, Pozen[253]	29	51.7	—	—	—	—	7,654	0.2
Melbourne, Australia, Luxton[195]	52	11.5	—	—	—	—	—	—
Greensburg, Pennsylvania, Czachowski[79]	—	—	29	17.2	123	18.7	218	10.6
Bristol, England, Baskett[24]	—	—	—	—	47	6.4	170	1.8
Columbus, Ohio, Lewis[183]	—	—	—	—	—	—	[a]1,635	7.1

[a] Of the 1,035 patients seen by the heartmobile when it was staffed with a physician, 3.5 percent had defibrillation attempted. The remaining 600 patients were seen after paramedics replaced the physicians on this MCCU and 13.3 percent of these 600 patients had defibrillation attempted.

and outcomes compared at considerably reduced cost. The Cretin model contains two components, each of which can be analyzed:

(1) A general model of MI that describes the experience of an MI victim from the time of infarction until death
(2) A more detailed model of prehospital death that describes the probability of an MI patient dying prior to hospital admission.

Because it is of interest to evaluate the impact of EMS on prehospital coronary care, this analysis will be restricted to the second prehospital component. Other parameters from the overall model, such as in-hospital mortality rates, and probability of reinfarction, will not be reviewed. Instead, two key model estimates will be examined: the probability of cardiac arrest prior to ambulance arrival, or during transport, and the probability of prehospital death. Those

estimates were chosen for the following reasons:

(1) They are the primary output of the prehospital model.
(2) They drive the overall model of MI.
(3) They can be compared with recent empirical data not available to Cretin in 1974.

The Cretin model defines a cardiac arrest as VF secondary to an MI. Asystole is specifically excluded from consideration. To the extent that asystole is, in fact, an independent arrhythmia, estimates of the incidence of cardiac arrest will be biased downwards. The probability that a patient will die prior to hospital admission depends largely on whether the patient arrests. Thus, underestimates of the incidence of arrests should lead to underestimates of prehospital mortality rates as well.

By ignoring other LTAs, the model does not consider the full potential of an EMS system. The administration of cardiac drugs to patients in prehospital sinus bradycardia or with PVCs (greater than four per minute) may prevent the development of more serious arrhythmias later.

In developing parameter estimates for VF episodes, Cretin noted a number of confounding facts. Clinical input is required for two statistics: (1) the ratio of "early" (within the first few hours following an MI) to "late" VF episodes and (2) the percentage of MI patients who actually fibrillate. Early VF episodes are assumed to take place outside the hospital and are potential cases for emergency intervention. Late VF episodes will occur in the hospital CCU, where the probability of successful resuscitation is presumed to be much higher. Available empirical data often do not distinguish between early and late fibrillation; however, many of the latter patients are actually fibrillating for the second time. A number of sudden death victims may be early fibrillators who are not included in these statistics. The use of antiarrhythmic drugs may alter the observed incidence of VF, as well as its timing.

Output from the prehospital model is compared with results from studies of MCC programs to verify the VF parameters. The probability of arrest prior to ambulance arrival and during transportation was found in the prehospital model to approximate the results obtained by two Irish studies, Adgey and Pantridge in Belfast,[3] and Gearty et al. in Dublin.[107] (Cretin also reports that two early American studies yield similar probabilities of VF; see Graf et al., 1973,[129] and Nagel et al., 1970.[219] Based on the available published data, however, it has not been possible to reproduce these findings.) The Cretin model, as seen in Table 33, produces a probability of .14 that an MI patient will arrest prior to ambulance arrival and .029 that he will arrest en route, for a combined probability of prehospital VF of .169. This compares favorably with the probability of .151 found by Adgey and Pantridge, and .152 reported by Gearty et al. More recent studies, however, indicate that the incidence of prehospital VF is considerably higher, viz. .24 to .32. How can these differences be explained, and what are the current best estimates?

At the time Cretin developed her model, few studies of MCC had been conducted and only limited clinical data were available on the prehospital course of MIs. Besides, the major studies at that time had been conducted in Great Britain and Ireland, where the mode of emergency treatment differed considerably from that developed in this country. In particular, the Anglo-Irish emergency systems staffed their ambulances with physicians. This presents two potential problems for the Cretin model. First, results from the Dublin and Belfast studies may not be applicable to American programs, where emergency care is provided by paramedical personnel, not by physicians. Second, sampling and data collection methods used in the Belfast and Dublin studies may have influenced the reliability and validity of their findings. Because these two studies are landmarks in the prehospital coronary care literature and are frequently cited, they warrant a detailed discussion. The relevant points from each study will be reviewed separately.

Adgey and Pantridge (1972) describe the experience of an MCCU in Belfast from 1966 to 1969. Their ambulance was staffed with physicians who literally brought all the technology and expertise of the hospital CCU to the patient's side. Unlike American emergency programs, the ambulance

TABLE 33. Comparisons of Cretin model output with empirical data

Condition	Probability by study							
	Cretin[76]	Adgey and Pantridge[3]	Gearty et al.[107]	Pozen et al.[253]	Crampton et al.[73]	Diamond et al.[86]	Briggs et al.[38]	Carveth[48]
VF on arrival	.14	.15	.133	[a].20	[b] .32	.25	[c].22	[c].47
VF or asystole on arrival	—	—	—	[a].20	[b] .37	.45	[c].29	[c].47
VF en route	.029	.01	.019	[a].20	—	.045	[c].019	[c].47
VF or asystole en route	—	—	—	[a] .20	—	.06	—	[c].47
Prehospital death for MI patient in VF	.14	.12	.149	[a].20	.127	.18	[c] .14	[c]47
Prehospital death for MI patient in VF or asystole	—	—	—	.15	.127	.37	[c].21	[c].24

[a] Includes idioventricular VF cases that may not necessarily be MIs.

[b] Includes patients in VF (or asystole) enroute as well.

[c] Possible MI arrests; i.e., MI patients who collapsed and required resuscitation.

team remained with the patient for prolonged periods of time when necessary, until the patient's condition was stabilized; only then was the patient transported to the hospital. This procedure may increase the probability of VF episodes by extending the period of prehospital monitoring that the patient is "at risk" of arresting. The antiarrhythmic drugs available to the emergency team, on the other hand, should substantially reduce the incidence of VF.

Over the initial 4-year period, Adgey and Pantridge encountered 1,288 cases of possible AMI. Cardiac arrest occurred in 193 of these patients, or an incidence rate of 15 percent. As described by the authors, however, these 193 arrests included 99 cases of asystole. Thus, it appears that Cretin included both VF and asystole in the estimates she derived from Belfast.

Gearty et al. (1971) describes the experience of the Dublin cardiac ambulance service from December 1967 to November 1970. The ambulances were staffed by paramedics who had been trained in CPR and defibrillation. In 70 percent of the calls reported, however, a general practitioner was present either before the arrival of the ambulance or before its departure, and participated in the patient's treatment. Thus, for all intents and purposes, these cases resemble those of physician-staffed MCCUs.

Gearty et al. report diagnoses only for those patients who survived long enough to be admitted to the hospital. Because 89.6 percent of all cardiac arrest patients (147 out of 164) died prior to admission, it is not known whether these patients had, in fact, suffered an MI. It was not possible to accurately reproduce the Dublin estimates used by Cretin; in any event, it appears that these VF parameters include a large number of patients in asystole.

If Table 33 is reexamined, it is obvious that more recent studies report a higher incidence of VF than do the Belfast and Dublin studies. When patients in asystole are also included, the observed incidence of cardiac arrest is two to two-and-one-half times higher than that reported by Adgey/Pantridge and Gearty et al. and obtained by the Cretin model.

Why are these more recent estimates so much higher? First, in the American studies, the emergency medical system may be more accessible to the general public and a larger proportion of patients with MIs may be entering the EMS system. If so, a larger number of sudden deaths may have been included in these studies, thus raising the incidence rates of asystole and VF episodes. The Anglo-Irish studies tend to be very selective and to systematically exclude dead on arrival cases from their reported data. Entry of patients into the EMS system is carefully (and often slowly) triaged by physicians. Second, the American studies may include some sample selection biases that lead to overestimates of VF episodes. Briggs, for example, examines all arrests regardless of etiology. Thus, cardiac arrests secondary to an MI may represent only a subset of all arrests studies.

As expected, because the probability of cardiac arrest is higher in these other studies, so is the probability of prehospital death, ranging from .127 to .39. The Cretin model, in contrast, produces a prehospital mortality rate of .14 that compares favorably with those reported in the Belfast and Dublin studies. The .14 probability is obtained for an ambulance with "good" resuscitative capabilities; that is, with a defibrillator on board. An ambulance with "intermediate" capabilities; i.e., with a crew trained in CPR, gives a probability of prehospital death of .148. This difference is so small (less than 1 percent) as to be completely insignificant. It is also not realistic, given what is known about the relative effectiveness of CPR and defibrillation. Preliminary evidence from King County, Washington, suggests that cardiac arrests who receive prehospital defibrillation have significantly higher resuscitation and survival rates than do those who only receive CPR.

Why does the Cretin model produce essentially similar results for the two types of ambulance systems? The answer can be found by further examining the assumptions made in the prehospital model. (The incidence rates for VF are identical under the conditions of both good and intermediate resuscitative capabilities.)

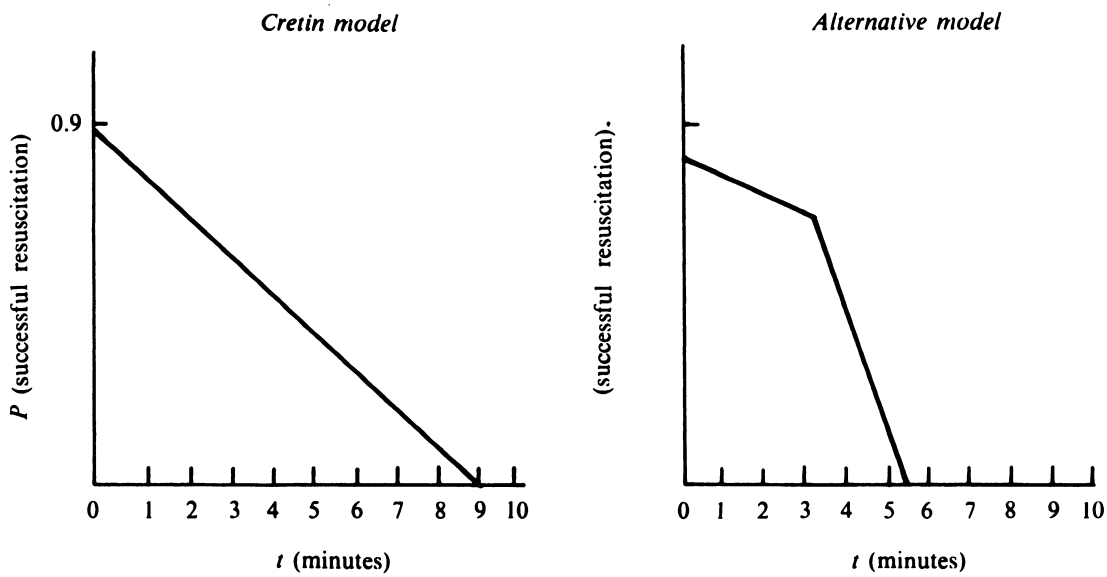
The probability of reaching the hospital alive is defined as the probability of successful resuscitation from VF. Because deaths due to pump failure are probably not amenable to any treatment, they are disregarded in this analysis.) Based on data from Adgey/Pantridge, the probability of successful resuscitation is assumed to be .9, if treatment is initiated immediately. Immediate resuscitation is possible only if the patient arrests in the presence of the ambulance crew. Estimates of the incidence of VF after ambulance arrival or in transit to the hospital suggest that these cases are quite infrequent, approximately 2 percent of all MIs. Immediate resuscitation might also be more likely in areas where a higher proportion of citizens have been trained in CPR. To date, all available data suggest that the .9 rate is overly optimistic.

Using this .9 successful resuscitation rate at time t_0, Cretin assumes that the probability of successful resuscitation is a monotonically decreasing function, falling to zero in 18 minutes in the case of ambulances with good capabilities. For ambulances with only intermediate capabilities, the probability of successful resuscitation falls to zero within only 9 minutes. These two assumptions are probably not valid, however, for several reasons. First, while the probability of resuscitation is undoubtedly higher with defibrillation, it cannot be assumed that the time available for successful resuscitation is longer. Second, 18 minutes is an excessively long time to expect successful defibrillation;* in the case of most adults, irreversible brain damage will begin to occur 4 minutes following the arrest. Third, all available evidence suggests that the probability of successful resuscitation is relatively high during the first 4 minutes; after this time, the odds decline drastically. The probability of leaving the hospital alive falls even more quickly for this group of patients.

A function with constant slope is not an appropriate mathematical form for the probability of successful resuscitation. An alternative functional form is shown in Figure 8; note the distinct kink at $t = 4$. The functional form

*A patient might be successfully defibrillated at a later point following his arrest, if he had previously received CPR. It is our understanding, however, that the Cretin model refers only to first responders.

FIGURE 8. Successful resuscitation from VF: Cretin model and alternative model.



used by Cretin has produced a substantial underestimate of prehospital mortality rates under both types of resuscitative capabilities. In addition, it has underestimated differential mortality rates between the two ambulance systems.

The Cretin model also assumes that the probability of dying in the hospital is invariant with respect to changes in the probability of prehospital death. This assumption may not be valid; the introduction of good resuscitative capabilities may have two opposing effects on in-hospital mortality rates. First, the use of paramedics may reduce hospital mortality, as more persons receive advanced interventions and are stabilized before arrival in the Emergency Department (ED). Second, hospital deaths may increase because more seriously ill persons reach the ED after rescue by paramedics. An ambulance system with good resuscitative capabilities may have the perverse effect of raising hospital mortality rates at the same time that it lowers prehospital mortality rates. Unfortunately, we lack empirical data to determine which effect will dominate.

It should be noted that Cretin's estimates of VF incidence and prehospital mortality are based on the assumption that all MI patients access the EMS system. Cretin initially sets the probability that an MI patient will use an ambulance at a probability of .5, a figure comparable to those found in other studies. When she proceeds to test the prehospital model, the probability of ambulance use is set at 1.0. Presumably this was done because Cretin was interested in observing the simulated mortality rates of the model only for patients who did access the EMS system. To examine the effects of an EMS system on overall mortality rates, however, one would need to use a probability of ambulance use closer to .5.

The Cretin model succeeds in providing comparative estimates of MI mortality under varying assumptions. These assumptions include patient delay time, age, and medical history; ambulance response and transit time; and the skill levels of the ambulance crews. Review of the literature indicates higher estimates of the probability of arrest and prehospital death than those employed by Cretin. The Cretin model also yields the counterintuitive finding of identical outcomes under basic and advanced life support systems. The reasons for these discrepancies are (1) the availability of more recent empirical data than was available to Cretin, (2) the difference in the organization of Anglo-Irish and American EMS systems, and (3) the unrealistic clinical assumptions in the Cretin model.

III. A MODEL FOR MCC EVALUATION (Task 2)

Based on the work presented earlier, a conceptual model was developed that details the various factors expected to influence EMS program effectiveness. Identification of relevant variables in the system is critical to the development of a data collection methodology for evaluating prehospital care. In addition to defining the optimal data set for evaluation purposes, the model contains directional hypotheses on the expected relationships between variables.

The conceptual model is described in the following section. The data requirements for EMS evaluation are derived from our model and are specified in detail in the section entitled "Data Requirements for EMS Evaluation."

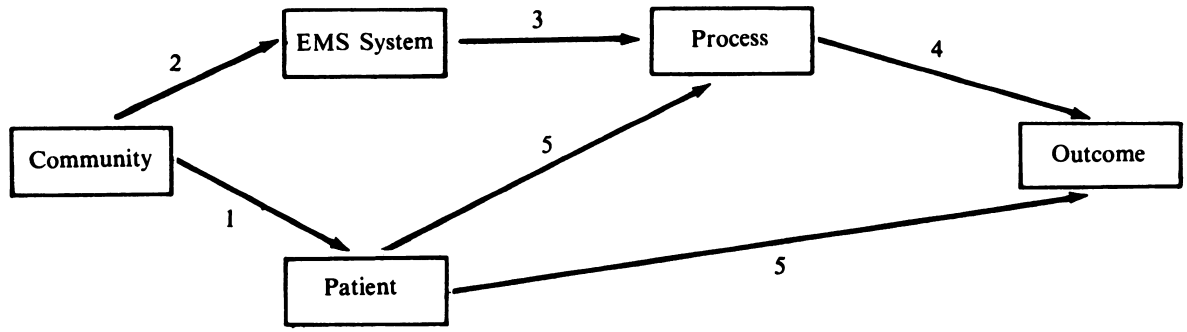
Conceptual Overview

Evaluation of the impact of an emergency medical system on prehospital cardiovascular care must focus on the community as the unit of analysis. The community can be conceptually defined as the geographic catchment area served by the emergency medical system. The community as the analytic unit permits the researcher to identify the population at risk, as well as the patients who actually enter the EMS system. Longitudinal evaluations and cross-EMS system comparisons become more feasible as exogenous variables influencing both the EMS system and the study population can be statistically controlled.

Community-based mortality rates also more completely capture differential outcomes of prehospital intervention. Examination of mortality rates associated with individual hospitals or ambulance services ignores that proportion of the population who either failed to summon help or called too late; e.g., sudden deaths. Because empirical evidence suggests that sudden deaths are not so unexpected, exclusion of this group may result in upwardly biased parameters for EMS effectiveness. Previous studies have shown that a substantial number of persons with AMI arrive at the ER by private transportation, despite the availability of an ambulance service. Exclusion of this patient population from EMS evaluation obviously would bias the estimated effects of prehospital intervention. Because patients also may be triaged to different hospitals, based on the perceived severity of their conditions, a community approach permits greater control of case mix differences.

Our conceptual model for EMS evaluation incorporates the major variables expected to influence EMS program effectiveness. A diagram, kept simple for presentation purposes, is shown in Figure 9. The model and the expected direction of influence for certain key variables will be discussed in this section. A more detailed discussion of the variables themselves will be presented in the following

FIGURE 9. Conceptual model for EMS evaluation.



section, including the hypothesized direction of each set of relationships. Where appropriate, plausible competing hypotheses will be presented, along with the potential bias that may be introduced if they are not recognized. The community in our schematization includes characteristics of the geographic area, the population, and medical resources. The EMS system incorporates program structure and organization and the input mix used to deliver prehospital services. Both patient characteristics and illness behavior are included in the patient. EMS performance refers to the process of care, including response times, and diagnostic and therapeutic accuracy. The effectiveness of EMS performance is captured by outcome measures in this model. EMS program costs are implicit in the training program and input mix.

The characteristics of the community (e.g., its socioeconomic status and population density) are expected to influence both the standard medical practices of that community and the type of EMS system developed and implemented. Rural areas, for example, may be more likely to use a network of volunteer EMTs. Population characteristics are hypothesized to influence two critical elements in EMS evaluation—need and demand. A high prevalence of risk factors in the community, such as hypertension and cigarette smoking, will increase the incidence of CVD ceteris paribus and, hence, the need for EMS. Other characteristics, such as participation in public education programs, may increase the patients' willingness to seek care and, thus, the demand for services.

Standard acceptable medical practice in the community will affect the duration and content of paramedic training programs. While the 81-hour EMT training course is established nationwide, community physicians are largely responsible for determining mandated treatment protocols for advanced EMT use. These mandated procedures vary widely in complexity across the country, ranging from symptom-related treatments to highly sophisticated arrhythmia-specific clinical algorithms. Similarly, members of the medical community will influence the input mix (personnel, ambulances, and equipment) used in the EMS system, both directly as technical advisors and consultants in the development of the system, and indirectly through the training program.

In our model, EMT performance refers to the process of care, what the EMT does and how he/she does it. Performance consists of three parts: symptom recognition, diagnosis, and treatment. Symptom recognition is the EMT's ability to identify signs and symptoms that form part of a distinct disease pattern, through obtaining the patient's past medical history, through clinical observation, and through empirical examination (pulse, blood pressure, etc.). Diagnosis is the EMT's ability to affix the medically correct label to the patient's condition. The EMT's ability to arrive at a correct diagnosis might alternatively be viewed as an outcome measure. The number of false negatives (i.e., patients incorrectly perceived as not experiencing an acute cardiac event) clearly would diminish the EMT's effectiveness. The number of false positives, however, would significantly add to total EMS program costs. The extent to which an EMT should be able to correctly diagnose is still an unresolved issue. On the one hand, it could be argued that EMTs do not need diagnostic acumen, that it is usually sufficient for the EMT simply to identify symptoms and provide the appropriate treatment. As prehospital cardiac interventions become increasingly more sophisticated, on the other hand, there may be a corresponding need for greater diagnostic ability.

EMT and paramedic performance (their ability to recognize symptoms, diagnose, and render appropriate treatment) is hypothesized to depend upon both the training received and the input mix deployed. The level of medical sophistication incorporated in the training program presumably will expand both the technician's level of competence and the range of therapeutic techniques he/she is legally permitted to employ. Similarly, the ambulance equipment available, especially cardiac drugs, defibrillators, and telemetry capabilities, will potentially raise the paramedic's effectiveness in treating CVD. The manpower mix deployed in a cardiac emergency also is hypothesized to affect the level of performance. The paramedic who is in communication with an ER physician via telemetry may gain valuable feedback and experience for future cardiac interventions. Similarly, basic EMTs riding with paramedics during a cardiovascular episode may acquire important diagnostic and clinical skills, even though they are not legally permitted to administer the treatments themselves.

While all treatments performed by EMTs are medically mandated procedures, some are discretionary (e.g., CPR) while others require prior authorization by a physician (e.g., defibrillation). Even in the latter cases, the EMT has considerable latitude in decisionmaking, as he is responsible for bringing the patient's status to the attention of the physician. The development of mandated procedures is no guarantee that the EMT will administer them. Previous studies have shown that, for clinical, environmental, or other unknown reasons, the EMT may correctly identify the medical problem but fail to treat it.

Finally, the patient's behavior (or that of significant others) is hypothesized to influence EMT/paramedic performance. EMTs appear to be more likely to perceive patients with socially deviant behavior (e.g., alcoholism, drug addiction, mental illness, etc.) as inappropriate transports. Yet these behaviors do not necessarily preclude concomitant CVD, and some of these conditions, such as drug overdose, may lead to cardiac arrest. The patients themselves may inhibit effective diagnosis and treatment through their interaction with EMTs—by failing to cooperate, to report symptoms, to detail past medical history, etc. In addition, family members or other individuals accompanying the patient may prevent paramedics from administering necessary intervention. Pozen et al. found that relatives sometimes insisted that paramedics immediately transport heart attack victims to the hospital rather than awaiting on-the-scene stabilization of the patient's condition.

The effectiveness of EMT performance can best be evaluated by patient outcome variables, as they more directly measure the success of prehospital intervention. Measures of patient outcomes include (1) mortality rates and (2) morbidity rates. False negative rates also can be measures of treatment effectiveness. While assessment of the EMT's diagnostic ability is a process measure, failure to recognize an acute cardiac event may result in failure to treat appropriately and a subsequent adverse outcome. Pozen et al. found, for example, that paramedics failed to transmit ECGs for 38 percent of all patients with AIHD. When those false negatives (inappropriately nontransmitted patients) were compared with true positives, the nontransmitted group was found to have 19 percent more Killip III and IV patients with an ensuing 22 percent higher 3-month mortality rate. Clearly, the mere presence of sophisticated technology does not ensure intervention. Although diagnostic ability is not included here as an outcome measure per se, our proposed outcome measures will capture any adverse effects produced by false negatives.

The credit for lives saved is difficult to attribute to prehospital care alone, due to the large number of competing explanatory variables. Nevertheless, reduction in mortality rates is the raison d'etre of prehospital cardiac care and must be examined in any EMS evaluation. Mortality rates can be used to assess the effectiveness of alternative paramedic programs as well as the impact of an entire EMS system. Mortality rates, however, must be adjusted for age and sex, and, in the case of heart attacks, possibly for other clinical varibles as well (e.g., type of arrhythmia and previous cardiac history).

First, survival rates of cardiac patients transported by ambulance can be compared across groups of emergency medical personnel with different levels of training. Such comparisons must be carefully controlled for case mix differences, however. In EMS systems with a two-tiered dispatch system, for example, patients may be selectively triaged to ambulance teams, depending upon perceived severity of illness. Mortality rates also can be measured at different points in the treatment process: the time interval chosen clearly will influence the rates themselves. Effectiveness can be measured, for example, by the proportion of patients reaching the ER alive, by the percentage surviving hospitalization, and by the more traditional 1-month, 6-month, and 1-year survival rates. The relationship between prehospital care to outcome becomes increasingly subject to extraneous factors as the time period increases.

Second, changes in overall cardiac-related mortality rates in a given community can be evaluated. Because these rates incorporate both in-hospital and out-of-hospital rates, they measure not only the effectiveness of prehospital interventions but also the extent of entry into the EMS system. Reduction in out-of-hospital deaths, for example, might reflect improved EMT performance, improved system response time, and the effects of consumer education. If out-of-hospital mortality is offset by corresponding increases in hospital deaths, the value of improved EMS effectiveness becomes ambiguous. In any event, adequate evaluation of changes in community death rates attributable to a specific EMS system must be based on either pretest-posttest design or, preferably, comparison with a suitable control group.

Morbidity rates measure outcomes for those cardiac patients who have survived the acute event. Morbidity can be operationally defined in many ways (including functional status, bed disability days, and return-to-work rates) and at different followup periods (6 months after the emergency, 1 year, etc.). An EMS system may have the perverse effect of increasing cardiac morbidity rates, however, as more patients are salvaged in the community but never regain their previous levels of functioning.

Patients may also indirectly influence their own outcomes through their interactions with EMTs. More importantly, however, patients directly affect their own mortality or morbidity by deciding to enter the EMS system. Empirical evidence has shown that, despite the presence of acute symptoms, a substantial subset of patients wait for several hours or more before calling medical assistance. Patient delay in seeking emergency medical care for AMI is hypothesized to lower their probability of an optimal outcome. Some patients will never enter the EMS system alive—they will become victims of sudden death. Nevertheless, many experience warning symptoms and would be potentially "salvageable" if they sought emergency care.

Data Requirements for EMS Evaluation

The data elements required for controlled evaluation of the effects of prehospital coronary care are derived from the model presented. The discussion in this section will be organized around the relationships implicit in the arrows shown in Figure 9:

(1) Influence of community characteristics on the potential patient population; i.e., variables expected to alter the prevalence of CVD and the need for EMS services
(2) Influence of community characteristics on the type of EMS system developed
(3) Influence of the EMS system on process measures; i.e., variables expected to improve response times and diagnosis/treatment accuracy
(4) Impact of EMS system performance on patient outcome
(5) Impact of patient characteristics on outcome

Variables subsumed under each set of relationships are shown in Table 34. Many of these variables undoubtedly will be difficult to measure and hold constant in evaluation of

EMS programs. Nevertheless, it is important that they be identified, and some attempt made to assess their potential impact. Researchers must consider all reasonable competing hypotheses that might account for observed differences in prehospital cardiac mortality rates.

Influence of Community Characteristics on Potential Patient Population Community characteristics consist of those variables hypothesized to influence need and demand for EMS in the aggregate. The following data elements need to be collected:

(1) Prevalence of major cardiac risk factors in the population—this includes cigarette smoking, high cholesterol, hypertension, and diabetes. Is there any evidence of an unusually high (low) prevalence of these risk factors?
(2) Age and sex distribution of the community—elderly and male populations will raise the demand for emergency services. Current trends in increased life expectancy will tend to age all communities, increasing the person-years at risk for developing CVD. Does this age-sex distribution shift with seasonal variations (e.g., tourism, migrant farm labor, etc.)?
(3) Distribution of race and socioeconomic status in the community—socioeconomic status is best measured by family income and education, but can be approximated by number of welfare recipients and/or Medicaid eligibles. The influence of the racial composition of a community is indeterminate because, while whites experience higher MI rates, there is a greater prevalence of hypertension among blacks. Similarly, the relationship between CVD and socioeconomic status is undefined. (High socioeconomic status is hypothesized to raise the demand for services, to the extent this variable incorporates education, income, and health insurance coverage.)
(4) Incidence and mortality rates from CVD in the community (including MI, angina pectoris, sudden death, etc.)—the number of MI patients who recover and return to the community is hypothesized to influence the incidence of acute cardiac events. As this number grows, the pool of potential MI patients increases. Additional increases in the local incidence of acute cardiovascular events (as opposed to the decline nationwide) are hypothesized in turn to raise the demand for EMS. Such increases in cardiovascular mortality locally may generate greater public awareness of the problem and encourage use of the EMS system.

Influence of Community Characteristics on the Type of EMS System Developed Any unique characteristics of the community that might affect the type of system implemented and its operation should be noted. Population density and the local medical community are the two primary variables. The population density of the catchment area will influence the input mix deployed in cardiac emergencies. Advanced life support systems staffed by full-time paramedic professionals and cardiac-dedicated ambulances will be more often found in large metropolitan areas. Rural and more sparsely populated regions are hypothesized to use a network of part-time volunteer EMTs and paramedics. This characteristic may also have an indirect effect on EMS performance, if a low incidence of life-threatening events results in attrition of paramedic skills.

Certain characteristics of the local medical community are hypothesized to influence the extent of medical control placed on the EMS system. Systems with a high degree of medical control are expected to use detailed clinical algorithms in paramedic treatment protocols, to mandate physician contact via telemetry, and to conduct quality reviews of paramedic/EMT performance. The characteristics of local physicians leading to medical control are not known, but probably are based on such factors as specialty medical interest groups, region of the country, previous EMS experience, and medical school affiliation.

Changes in the local practice of medicine are also hypothesized to affect mortality rates, independent of the EMS system. This includes the innovation of new resources such as a CCU, or improved ERs, and the diffusion of new technology into the community; e.g., routine use of cardiac antiarrhythmic drugs for high-risk patients.

Influence of the EMS System of Process Measures The following variables are hypothesized to decrease response times in a cardiac emergency:

(1) The use of a "911" system (what triage protocols are employed? Is there an attempt to identify a priori high-risk citizens for whom paramedic units are routinely dispatched?)
(2) Geographically dispersed staff and ambulances
(3) Multitiered ambulance system
(4) Point-of-entry plan for the differential use of hospitals that depends upon the availability of the full range of cardiovascular services at each participating hospital—in theory, patients with ACVD should only be transported to such hospitals

The following variables are hypothesized to improve the diagnosis and treatment of persons experiencing acute cardiovascular events:

(1) The use of paramedics. The added training received by a paramedic will expand both his level of competence and the range of interventions he is permitted to employ.
(2) Paramedic training program with emphasis on cardiac care. Because paramedics may vary in the length and sophistication of their training, those with more intense training are hypothesized to be better clinicians. (There is obviously a point at which the marginal impact of additional training is zero, but no data are available on the effectiveness of incremental levels of training.)
(3) Wider range of medical interventions that the paramedic is permitted to employ. It is particularly important to distinguish the paramedic who can administer drugs and IVs from the advanced EMT who is only allowed to defibrillate.
(4) Full-time emergency personnel. The full-time EMT or paramedic is hypothesized to experience more opportunities for using and improving his skills.
(5) Availability of ambulance equipment; i.e., cardiac drugs, defibrillators, and telemetry capabilities.
(6) A high degree of medical control. In some EMS systems, paramedics operate very independently, relying upon treatment protocols and radio communications; physicians act solely in a backup capacity. In other systems, however, the physician interacts directly with the

* For evaluation purposes, it will be impossible to disentangle the paramedic's assessment of the patient's condition from the physician's diagnosis.

TABLE 34. Data items for EMS evaluation

1. *Influence of community characteristics on potential patient population:*			
a. Variables expected to increase prevalence of CVD and need for EMS:			
— High prevalence of major risk factors	N	3	2
— Elderly population	N	1	1
— Males	N	1	2
— Race?	N	1	2
— Socioeconomic status?	N	2	2
b. Variables expected to increase demand:			
— Increased number of MIs returning to community	N	1	1
— Increased incidence of acute cardiovascular events	Y	1	1
— Increased out-of-hospital mortality	?	2	1
— Increased in-hospital mortality	?	1	1
2. *Influence of community characteristics on type of EMS system developed:*			
a. Low population density will lead to use of part-time and volunteer staff	N	1	1
b. Certain characteristics of local medical community will lead to more medical control	N	3	2
3. *Impact of EMS system on process measures:*			
a. Variables expected to lower response times:			
— Use of "911" system	Y	1	1
— Geographically dispersed vehicles	Y	1	1
— Multitiered system	Y	1	1
b. Variables expected to improve diagnosis/treatment accuracy:			
— Use of paramedics	Y	1	1
— Sophisticated training program	Y	1	1
— Full-time personnel	N	1	1
— Availability of ambulance equipment	Y	1	1
— Medical control	N	2	1
— Mandated refresher courses	N	1	1
4. *Impact of EMS system on patient outcome:*			
a. Variables expected to lower out-of-hospital mortality:			
— Use of paramedics	Y	1	1
— Citizen CPR training	Y	1	1
b. Variables expected to lower in-hospital mortality:			
— Use of paramedics	N	1	1
— Fewer paramedic saves in community	N	1	1
c. Variables expected to lower morbidity:			
— Faster response time	N	1	1
— Use of paramedics	N	1	1
— Higher mortality rates out of hospital	N	1	1
5. *Impact of patient characteristics on outcome:*			
a. Variables exptected to increase entry to the EMS system:			
— Lower socioeconomic status	N	2	2
— Introduction of paramedics	N	1	1
— Severe symptoms/acute onset	N	3	2
b. Variables expected to lower mortality: less delay	Y	2	1

Key: Secondary Estimates: Are estimates on this relationship available from secondary data: Y = Yes, N = No.
Feasible: How feasible is data collection? 1 = easy, 2 = moderate, 3 = difficult.
Essential: How essential is this information for EMS evaluation? 1 = very, 2 = preferable, 3 = not critical.

[a] Secondary estimates: Are estimates on this relationship available from secondary data? Y = Yes; N = No.

[b] Feasible: How feasible is data collection? 1 = easy; 2 = moderate; 3 = difficult.

[c] Essential: How essential is this information for EMS evaluation? 1 = very; 2 = preferable; 3 = not critical.

paramedics, reading ECGs and participating in the therapeutic decisions. Under medical control, diagnosis and treatment become a joint physician—EMT/paramedic decision and is hypothesized to be more accurate.*

(7) Mandated refresher courses. In areas with a low incidence of LTAs or other cardiac problems requiring specialized training, paramedics may experience considerable attrition of their skills. Studies of open heart surgery teams, for example, have demonstrated an inverse relationship between the number of operations performed and mortality rates; a minimum number of operations appear to be necessary to maintain highly specialized skills. While minimal experience levels for effective paramedic performance have not yet been determined, they must be considered as part of any EMS system evaluation. Retraining courses are hypothesized to offset the attrition of paramedic skills due to infrequent use.

Impact of EMS System Performance on Patient Outcome Out-of-hospital cardiac mortality rates are hypothesized to decline as a function of two factors within the EMS system:

(1) The use of paramedics.
(2) Citizen CPR training programs (Since the time frame for successful resuscitation is so short, bystander-initiated CPR is hypothesized to be a necessary complement for many "saves.")

As prehospital cardiac interventions have become more sophisticated, the attendant risks of these advanced interventions increase. Accordingly, the use of paramedics may have some detrimental effect on the morbidity and mortality rates.

Advanced life support techniques may have two opposing effects on in-hospital mortality rates. First, the use of paramedics may be hypothesized to reduce hospital mortality, as more persons receive advanced interventions and are stabilized before arrival in the ER. Second, hospital deaths may increase because more seriously ill persons reach the ER after rescue by paramedics. Both hypotheses are reasonable, and we cannot determine *a priori* the net effect of paramedics on hospital mortality in the short run.

Faster response times and the use of paramedics are both hypothesized to reduce cardiac morbidity rates. There is a reasonable competing hypothesis, however, that advanced interventions will increase morbidity over the short run. More marginal patients may be salvaged in the community by paramedics, but these patients may never be able to regain premorbid levels of functioning due to residual neurological deficits. An absence of empirical data prevents us from determining the net effect.

Impact of Patient Characteristics on Outcome Clearly, even the best of programs will not work if patients do not readily access the EMS systems. It is important to recognize that hospital or ambulance-based studies may yield a distorted view of overall program impact. Do delay times vary significantly between persons presenting in the ED by ambulance and those arriving by other means?

Patients are hypothesized to improve their chances for a successful outcome by seeking emergency assistance as soon as possible. The following variables are expected to influence entry into the EMS system:

(1) Socioeconomic status. Low income persons, lacking private transportation, may be more likely to summon an ambulance.
(2) Perceived severity of disease. Persons experiencing an acute onset, or perceiving their symptoms as more serious, will more often use the ambulance. People in less distress may use private modes of transport.
(3) Introduction of advanced life support systems. The publicity surrounding paramedics will encourage persons to call an ambulance who otherwise would visit their physician or travel on their own to the ED.

To a small extent, patients also indirectly influence their outcome by their interaction with EMTs and paramedics.

Pragmatic Issues in Data Collection Necessary for EMS Evaluation

On Cape Code, Massachusetts, a clinical evaluation is being conducted to compare the effectiveness of EMTs versus paramedics in rendering emergency prehospital cardiac care (Grant No. 1 RO1 HS 02536). The principal evaluation measure is patient outcome expressed as ER and hospital mortality rates. The Cape Cod region has also provided a laboratory in which to test the feasibility of assessing the community and patient components of the model. In this section, we will present an analysis of the availability and quality of these data elements in the Cape Cod system from January 1, 1976, to August 15, 1977.

Overview of EMS Data Collection on Cape Code

Area Discription
Cape Cod is a 394.04-square-mile region consisting of 20 towns, each of which provides EMS services to its residents. Ambulances are located in town fire stations and EMTs and paramedics are responsible to the town fire chief. Three community hospitals—Cape Cod Hospital in Hyannis, Falmouth Hospital in Falmouth, and Tobey Hospital in Wareham—are the exclusive providers of inpatient emergency medical care in the region.

Data Sources
The sampling frame was designed to first capture all documented MIs, as defined by hospital discharge diagnoses of AMI (ICDA 410) or AIHD (ICDA 411), and cardiac arrests cared for by EMTs or paramedics. In addition, we decided to include all noncardiac patients whom the EMTs and paramedics had identified and/or treated as cardiac patients (false positive diagnoses). A sampling strategy was devised based on a combination of EMT and paramedic diagnoses, symptom recording and treatment, ER physician diagnoses, and hospital discharge diagnoses. The data sources selected enable the researcher to identify study patients and to examine the process and outcome of prehospital cardiac care. Specifically, these data sources are the ambulance run form and the Emergency Department record.

The ambulance run form is the form on which the EMT or paramedic records the clinical details of the run. Ambulance personnel usually record the working diagnosis, the patient's symptoms, the clinical data (e.g., blood pressure and pulse rate), and the treatment rendered. These forms provide data for evaluation of the process of care, patient labeling ("diagnosis"), and symptom recognition. They are on file by calendar date in individual fire stations and are almost always available. The completeness of the data recorded ranges from 20 to 100 percent; this variation can be seen both across towns and within towns. As of November 1977, a regional ambulance recording form was introduced on Cape Cod. Prior to that date, each of the 20 towns on the Cape had its own individual form. It has not yet been possible to fully evaluate the effect of the new form on the overall quality of data and patient symptomatology. In addition, a tendency has been observed on the part of the EMTs and paramedics to more appropriately specify conditions and avoid specific diagnoses. The remaining 9 months of data collection will be examined to determine the direction of these trends.

The Emergency Department record is filled out by the ER physician for all patients who enter the ERs of any of the three hospitals on the Cape. It provides an ED diagnosis, clinical data, and patient outcome; i.e., whether the patient died, was admitted, or was discharged. It is 99 percent available. For the small number of patients who die in the ED, there is much variation (between 20 and 100 percent) in the amount of clinical data recorded. Important information that is often missing for these patients includes past medical history, patient medications, and ED, ECG or rhythm strip. These data are probably not recorded because 50 percent of study patients who die in the ED are essentially dead on arrival and the physician pronounces them dead within 5 to 10 minutes of ER arrival time.

Data Collection Procedures

Data collection for this project is a massive undertaking. To sample the patients identified as cardiac cases by the EMTs and paramedics, all ambulance run forms for the entire Cape must be reviewed. Because there is no centralized EMS data bank for the area, all ambulance run forms must be reviewed on an individual basis by the research assistants. This entails traveling to the fire stations in each of the 20 towns on Cape Cod and manually sifting through ambulance run forms. Travel between fire stations takes a minimum of 20 minutes and can take over 1 hour, depending upon starting point and traffic conditions. For the period between January 1, 1976, and August 15, 1977, the research assistants reviewed 21,090 ambulance run forms to identify 3,180 eligible study patients (Figure 10). At the time the sample is selected, all ambulance ECGs available at the fire stations are Xeroxed for the principal investigator to read. This is a time-consuming task, because only five fire stations on the Cape have Xerox machines, and the research assistants have to leave the fire stations to find a Xerox machine (town halls or libraries are frequently used).

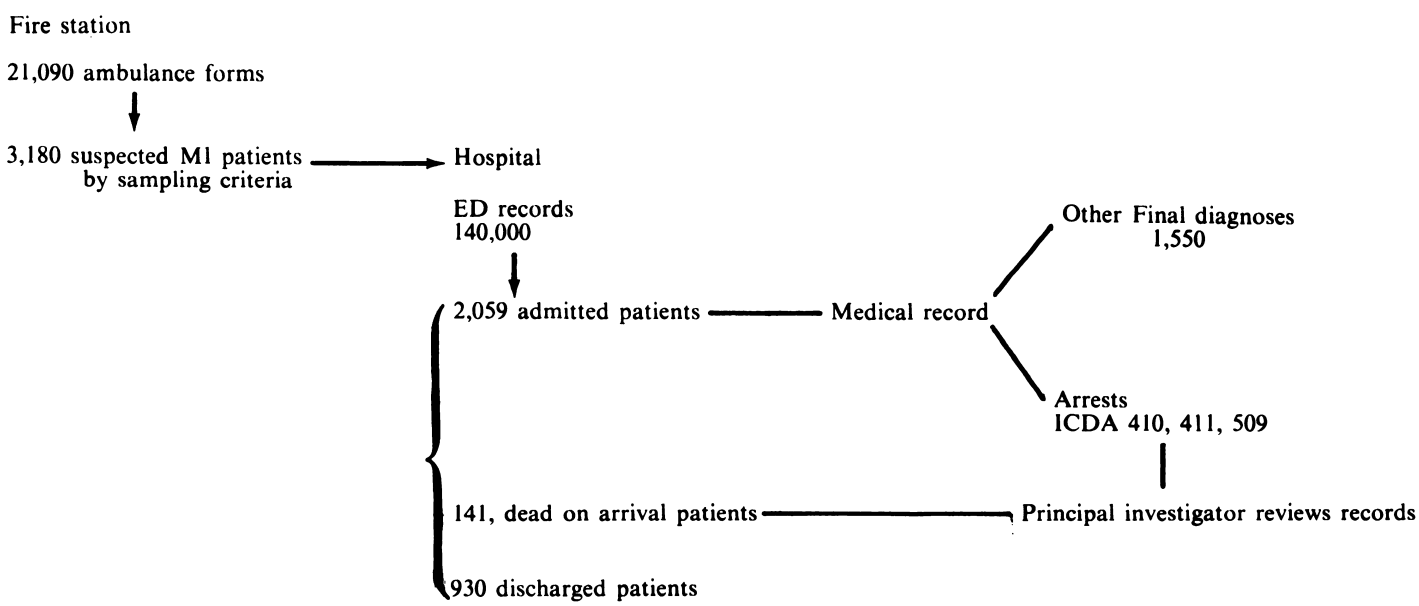
After the ambulance run forms are sampled, the research assistants return to the hospitals where they manually review all ED records. During this process, they obtain an ED diagnosis for those patients whom they identified at the fire stations, and they also identify patients who arrived at the ED by ambulance, were admitted to the hospital with a cardiac ischemic diagnosis, but were not identified at the fire station. This process serves to both identify false negative patients (those incorrectly diagnosed by EMTs or paramedics), as well as to check for research assistant error. For the January 1, 1976, to August 15, 1977, period, the research assistants had to review approximately 140,000 ED sheets to verify the accuracy of our sample selection. The EMT/paramedic false negative rate was 3 percent; the research assistant error rate was 5 percent.

Final (discharge) diagnoses are then obtained on all admitted patients (2,059 for the period defined above) using hospital patient record printouts at Cape Cod Hospital (large numbers of patients at this hospital prevented the pulling of a medical record on each patient) and by reviewing hospital records of all patients at Tobey and Falmouth hospitals. The medical records of all patients who die in the ED who have a final diagnosis of AMI (ICDA 410), AIHD (ICDA 411), or cardiac arrest (ICDA 415.8) are reviewed. These records are first reviewed by a specially trained research assistant and then by the principal investigator, who goes to all three hospitals, personally reviews the charts, reads all pertinent ECGs, and assigns a final diagnosis either by Killip Classification or New York Hospital IHD classification. For the January 1, 1976, to August 15, 1977 period, the entire data collection process took 6½ months to complete by four persons working full time and two persons working part time.

Quality of Data Collected

To assess the overall quality of the data currently on file, we have prepared a summary table of certain key variables for which large amounts of data were missing. The problem of missing data is almost exclusively related to our use of ambulance run forms as data sources. Data obtained from ER and hospital records are usually 95 to 99 percent complete.

Figure 10. Diagram of data collection procedures (figures based on January 1, 1976, to August 15, 1977)



Our data on ambulance items (Table 35) illustrate the type of data problems that we have encountered. The times that the ambulance was dispatched, arrived at the scene, left the scene, and arrived at the hospital are necessary to determine response times. Response time is a critical variable when examining patient outcomes with respect to cardiac arrest because survival rates are inversely correlated with it. Complete time data needed to compute response times were missing for about 50 percent of our sample, although the time of dispatch is generally available (Table 35). Our town-by-town breakdown of the data demonstrates the variation in the quality of the data recorded around the Cape. Patterns of missing information clearly cluster in certain towns. Because response times are so critical, we employed alternative data sources (e.g., police and fire radio logs) to obtain times. However, in three towns with almost 100 percent missing data on ambulance run forms, these alternative data sources were not available, as the information had been recorded on tapes that had been subsequently destroyed.

TABLE 35. Summary of missing operational time data, January 1, 1976, to October 31, 1977

Town	Dispatch	Scene	Leave	Hospital
TOTAL MISSING				
total percent missing	174/3,662 (4)	1,467/3,662 (40)	2,101/3,662 (57)	1,941/3,662 (53)
Data not available from alternative source				
A	8/622	31/622	621/622	621/622
B	0/167	81/167	167/167	167/167
C	5/53	53/53	53/53	53/53
Clusters				
D	1/468	464/468	465/468	466/468
E	1/147	147/147	147/147	147/147
F	4/384	188/384	147/384	10/384
G	1/171	39/171	102/171	59/171
H	1/108	86/108	83/108	84/108
I	94/259	86/254	29/259	14/259
Minor data problems				
J	5/143	71/143	70/143	72/143
K	1/171	4/171	4/171	1/171
L	7/85	22/85	20/85	28/85
M	6/20	19/20	20/20	20/20
N	8/35	35/35	35/35	35/35
O	7/259	29/259	20/259	29/259
P	2/361	4/361	7/361	24/361
Q	8/71	26/71	26/71	26/71
R	4/38	7/38	6/38	5/38
S	5/34	11/34	14/34	15/34
T	6/65	64/65	64/65	64/65

Clinical and treatment data were also often unavailable (Tables 36 and 37). Blood pressures, pulse rates, neurological status, and skin condition went unrecorded for over 50 percent of the sample. These clinical observations are necessary for cardiac diagnosis and their omission makes it impossible to analyze severity of patient condition. ECGs are mandated for our entire sample since presumably, it consists entirely of cardiac patients. Yet the paramedics recorded the rhythms on only 41 percent of all patients who had ECGs taken.

TABLE 36. Summary of missing clinical data, January 1, 1976, to August 15, 1977

Variable	Frequency missing	Percent missing
Pulse attempted	1,522/3,180	48
Pulse recorded	1,901/3,180	60
Blood pressure:		
Attempted/recorded	1,700/3,180	54
Recorded systolic	1,701/3,180	53
Recorded diastolic	1,740/3,180	55
Skin	3,029/3,180	95
Neurological	2,880/3,180	90
Rate of respiration	2,593/3,180	81

TABLE 37. Summary of missing ECG data, January 1, 1976, to October 31, 1977

Type of data	Frequency	Frequency missing	Percent missing
ECG taken	1,202/3,662	2,460/3,662	67
ECG rhythm recorded by paramedic	491/1,202	711/1,202	59
Rhythm strips available to be read by principal investigator	411/1,202	891/1,202	66

If data were not recorded, it was necessary to assume that tasks were not performed. Our brief survey of missing data indicated that the quality of EMS on Cape Cod is poor. But, based on extensive conversations with EMTs, paramedics, and ER physicians, as well as personal observations, we have reason to believe that essential clinical and treatment procedures were obtained. In the haste of emergency treatment, vital signs were monitored, but simply not recorded.

EMTs and paramedics have articulated a general dissatisfaction with filling out forms. They see themselves as men of action and the forms as unnecessary paperwork. Researchers should be aware of this attitude when contemplating the use of various data sources for EMS evaluation.

Availability of Data Elements

Variables Expected To Increase Prevalence of CVD and Need for MCC Service

High Prevalence of Major Cardiac Risk Factors in the Community
These data are not available on Cape Cod (or anywhere) because they are not informational items routinely recorded by Public Health Departments or hospitals. A substitute for this information can be derived by measuring the number of patients discharged from the 3 hospitals over the past 10 years with diabetes or hypertension as primary, secondary, or tertiary diagnoses. However, this measure would be incomplete because it would exclude other cardiac risk factors (smoking and high cholesterol), as well as those with hypertension and diabetes who are never hospitalized.

Community Characteristics.
Age and sex distribution, racial composition, income, and educational level. These data are readily available for the Cape from the U.S. Census Bureau. In addition, Philip B. Herr and Associates, a Boston-based urban planning firm, prepared a report entitled, "Development Projections for Cape Cod," for the Cape Cod Planning and Economic Development Commission. This report updates the 1970 Census information and makes projections to the year 2000. The Herr report analyzes population shifts, income and employment distribution, and land use. All variables analyzed are listed separately by each of the 20 towns on the Cape. The most characteristic feature of the Cape Cod community is the influx of tourists it receives during the summer months, when the population increases by a factor of 2.9. The other characteristic that Herr details at length is the rapidly expanding retirement community that is developing on the Cape and increasing the size of the winter population. In 1975, 21 percent of the population of Cape Cod was aged 65 and over, and this group is increasing at a rate of between 3 and 5 percent per year.

Variables Expected To Increase Demand

Mortality Rates for ACVD in the Community
The Massachusetts Public Health Department has computerized all death certificate information. Mortality rates for all residents can be computed by town of death or residence at death. These data can be broken out on a town-by-town basis according to any timespan desired. The diagnosis scheme used is ICDA classification. Other distributions, such as ICDA classification by age and sex, may also be obtained.

Incidence Rates
These must be computed by the individual researcher. The three hospitals on Cape Cod use the hospital discharge PAS system and rates can be computed by summing the number of MIs per month, per year, etc. The ICDA classification is used and the data are readily available.

Community Characteristics

Population Density
These data are easily obtained from the U.S. Census Bureau and the Cape Cod Economic and Planning Commission. As noted earlier, the Cape Cod population increases by a factor of 2.9 in the summer.

Number of Acute Cardiac Runs per EMT or Paramedic.
These figures can only be obtained through an extensive research project that entails counting up the number of runs per individual, per month and per year. These are a fairly gross index of experience, however, because they do not take into account all the noncardiac runs in which the EMTs and paramedics participate. These figures would be considerably more difficult to obtain because they would entail counting every ambulance run that takes place on the Cape.

The following description of the EMS and medical community on Cape Cod is based upon 2 years' experience with the system, including personal observations as well as extensive conversations with the EMS area coordinator, the physicians in charge of EMT and paramedic training, the ED physician, and the EMTs and paramedics.

Cape Cod Medical Community
Medical care on Cape Cod is provided almost exclusively by private physicians, who admit to one of three small community hospitals. None of the three hospitals has outpatient facilities, although there are currently some groups who are trying to introduce a system of institution-based ambulatory care to the Cape.

EMS System
EMS is provided on a town-by-town basis. Each town has at least one Class I ambulance, usually 1 or 2 Class II vehicles, a group of 81-hour trained EMTs, and 1 to 4 paramedics who staff the vehicles. The vehicles are located at the town fire station and 80 percent of the EMTs and paramedics on the Cape were originally firemen. There are no point-of-entry rules, as proximity to a hospital is straightforward and usually determines use. There has been no centralized effort to geographically disperse vehicles, although some towns have entered into mutual aid agreements. The only attempt at regionalization has been the introduction, in 1976, of a "911" system. However, most people seeking assistance still call their local fire station and ambulances are dispatched directly from that point. Ambulances do notify the "911" dispatcher that they are on the road, however, as they need the intervention of the dispatcher to patch them through to the hospitals. There appear to be no specified "decision rules" for the dispersal of ambulances, although it is increasingly becoming the practice to send a paramedic (if available) and a Class I vehicle if an MI is even vaguely suspected. The persons who make the decision vary from town to town. They are usually the fire station dispatchers, or sometimes the "911" dispatchers. It would be very costly and time consuming to determine exactly who the decisionmakers are because the process would involve monitoring the radio logs of all 20 towns to determine whether "911" came on the air before or after calls were received, and analyzing what the callers said.

EMT Paramedic Training
The National DOT EMT-P course is given regularly at Cape Cod Community College and there are mandated hours of retraining. The paramedic course follows the national model. In 1975, the Robert Wood Johnson Foundation provided funds to underwrite the course, as well as to regionalize EMS on Cape Cod. The first course, in 1975, was an intensive, 400-hour, 12-week course. The course time has since been reduced, although it is unclear to what extent. The paramedics are trained to set up IVs, give drugs, defibrillate, and take and interpret ECGs. There were 20 paramedics in

the first class and 20 in each of three subsequent classes, making a total of 80 paramedics on the Cape. Only one refresher course has been given since 1975. Although there is nominal medical control built into the system, actual medical control is largely a function of who is on duty at the ED. If one of the two physicians who trained the paramedics is on duty, interaction takes place. Although the paramedics are provided with detailed treatment protocols, they will not treat the patient (with the exception of CPR) unless instructed to do so. Often they will be told to simply transport. Assessment of the degree of medical control is, at this point, based on the observations of researchers.

Impact of Patient Characteristics Upon System
The ability to measure patient delay is closely tied to the question of EMS system use. To determine who uses the system, the medical records of all patients with acute ischemic events must be reviewed. This entails pulling a medical record on all patients listed as having been discharged from the hospital with a diagnosis of ICDA 410 or 411. For the January 1, 1976, to August 15, 1977, period previously cited this would entail reviewing 650 additional records. This is a costly and time-consuming process and often the variable affecting use and delay cannot be clearly determined from the medical record. For further discussion of this problem see Pozen, Berezin, Modne, et al. "Ambulance utilization by patients with acute myocardial infarction," *American Journal of Public Health* 68: 568-572, June 1978. 351

Summary of Practical Issues in MCC Evaluation Our experience of Cape Cod suggests that collection of complete data sets on all MCC patient is expensive and probably impractical with ordinary data collection procedures.

We have identified three general types of MCC data sets and the pragmatic issues associated with collecting them. First, there is the *ambulance data set*. These include patient identification, EMT/paramedic diagnostic categorization, and ambulance operations data, such as run times. These data are almost always available. Collection can be facilitated by using a standardized reporting form. It is interesting to note that, although space for the EMT/paramedic treatment plan is routinely included in these forms, it is not completed in the majority of cases. We can only speculate as to why. EMTs/paramedics may be unwilling to commit their treatment plan to writing for fear of being wrong, because of malpractice considerations, or merely because they perceive themselves as being too busy.

The second data set combines the ambulance data set with the emergency room data set, yielding proximate outcomes against which the EMTs'/paramedics' diagnoses and treatment plans can be compared. If hospitalization data and summaries are added, a more accurate diagnostic picture is obtained. ER and discharge data are almost always available. Matching these data to the ambulance data sets is time consuming and costly. This need not be the case, were these forms routinely coupled in the ER. Our data suggest that the combination of these two forms results in four cases of suspected ACVD by EMTs/paramedics, yielding two cases of suspected ACVD by ER physicians, which in turn will yield one case of ACVD at time of hospital discharge diagnosis.

The third data set is an expanded clinical data set incorporating variables such as medical history, drug history, vital signs, clinical signs of congestive heart failure, ECG, and morbidity associated with ACVD. These data are extremely difficult to collect and are completely available in less than 25 percent of cases. Unless the research effort is totally integrated into routine ambulance and ER procedure, it is unlikely that these data can be obtained. Any rational evaluation plan needs to consider these issues because, without this latter data set, multivariate process/outcome analyses discussed in earlier chapters are unrealistic.

IV. DEVELOPMENT OF A NATIONAL SAMPLE FOR EMS EVALUATION (TASK 3)

Task 3 was to identify potential data sources for future MCC evaluation based on the data set defined in chapter III. The need for MCC evaluation, considering both the costs and scope of the MCC system, is apparent. In this section, the three logical approaches to this evaluation are considered: (1) an evaluation employing the data routinely generated by the EMS areas through the DEMS/DHEW, (2) an evaluation based on current MCC research projects, and (3) an evaluation based on a national sampling frame of EMS areas.

We explored deriving an MCC data base nationwide from the DEMS/DHEW. Their information system has fallen substantially behind. The information enclosed represents the sum total of data available for the 309 EMS areas throughout the country (through the courtesy of Val Artz, Evaluation Specialist, DEMS). The 50 States and territories are subdivided into EMS areas that correspond to regions (single county for highly populated areas and multicounty units for less densely populated areas). Of the 309 EMS areas, 6 represent U.S. territories and 35 have not applied funds—leaving 268 EMS areas that are supposed to be collecting and reporting data.

As indicated in Table 38, the availability of MCC data from the EMS areas is sparse. This table is derived from the total number of 1977 funded areas reporting abstracted information at the end of 1977 to the DEMS. The first four categories ("theoretical" through "research with quantitative outcomes") are derived from a group of competitive abstracts submitted for the Seattle EMS conference. The other two categories ("adequate" and "inadequate") are culled from abstracts submitted for the January report of DEMS. Funded areas responding to both abstract calls have been counted only once, and have been placed in one of the first four categories of the table. The 11 areas reporting quantitative information are too small a number for any meaningful analysis.

The second approach, of using ongoing MCC research, has been covered extensively in Chapter II of this report. Essentially, the ongoing research is located primarily in academic medical centers, in large urban areas, and in EMS areas generally judged to be advanced well beyond the norm for EMS areas, with respect to organization, training, and communications. Therefore, the presence or absence of a medical center was included in the development of a national sampling strategy.

Table 38. Availability of EMS data in the United States

Data	1202 (Planning)	1203 (BLS)	1204 (ALS)	*Total*
n	89	119	60	[a]268
Theoretical	—	1	2	3
Proposed research	—	1	—	1
Descriptive	1	8	7	16
Research (with no quantitative outcomes)	1	0	1	2
Research (with quantitative outcomes)	—	5	6	11
Adequate	3	7	9	19
Inadequate	3	5	4	22
Total reporting	8	36	29	73
Percent reporting	9	30	48	27
Number of any quantitatively useful estimates[b]	4	20	22	46
Percent of any quantitatively useful estimates	4	17	37	17

ALS = advanced life support; BLS = basic life support.

[a] Total EMS areas 309
U.S. territories (i.e., Puerto Rico, Virgin Islands, Guam, etc.) -6
Areas not funded (1977) -35
Funded EMS areas 268

[b] Calculated by adding the categories "Descriptive," "Research with quantitative outcomes," and "Adequate."

The objective of a national sampling strategy is to maximize the external validity of any EMS evaluation. Findings on the effects of MCC in one geographic area must be applicable to other areas of the country; i.e., the EMS system selected for evaluation must be representative of the Nation as a whole.

A stratified sample design that will both ensure national representation and permit comparative evaluation of alternative MCC delivery systems is proposed. The primary sampling unit will be the EMS system area. An EMS area will be operationally defined as the geographic area served by an organized EMS system, as mandated by P.S. 93-154. While the actual development of EMS areas has been left to the discretion of individual States, they generally are regional (single-county or multicounty) units. As discussed earlier, in Chapter I, the use of a community, or EMS area, as the primary unit of analysis is essential in measuring the total impact of prehospital care on CVD.

Four stratification variables are proposed: (1) geographic area, (2) urban/mixed/rural, (3) type of MCC system, and (4) presence of an academic medical center. Geographic area of the country and an urban/rural designation are standard sampling criteria designed to ensure a nationally representative sample. Because MCC systems are expected to vary considerably across different parts of the country and among urban, mixed, and rural regions, the use of these two stratification variables will minimize within-cell variance and permit greater control over exogenous factors influencing EMT performance. The urban/mixed/rural trichotomy also ensures that rural EMS areas are not under-represented in the sampling frame. In both P.L. 93-154 and P.L. 94-573, Congress has demonstrated particular concern over the delivery of EMS in rural parts of the country.

Geographic areas are traditionally defined, for sampling purposes, as the four Census divisions of the country: (1) Northeast, (2) North Central, (3) South, and (4) West. The Census division is sufficiently sensitive to capture variations in costs, demographic characteristics, and other factors that influence the demand for and supply of EMS across the country.

Within each of the four Census divisions, EMS areas will be designated as urban, mixed, or rural. On other areas of research, the urban/mixed/rural designation of the primary sampling unit has usually been defined by whether or not it constitutes a Standard Metropolitan Statistical Area, as defined by the U.S. Census. In this study, however, the primary sampling units (EMS areas) will be generally larger (multicounty) geographic areas. Some of the EMS areas are centered around an urban city and many include only that county where the city is located. Other areas may include the whole State or a large portion of it. To determine whether an EMS area is urban, mixed, or rural, all of the following factors must be considered:

(1) Number of urban cities (50,000 or more population) in an area
(2) Volume of nonurban land space (in the form of counties) surrounding an urban center
(3) Population of nonurban counties

We have attempted multiple definitions and have found that the following definitions best describe the EMS area designations:

Urban

(1) Area containing only a city of 150,000 or more population.
(2) Area containing one large city (150,000 or more) with only contiguous counties that may be called suburban or semirural.
(3) Area containing two or more medium-sized cities of 50,000 or more, with contiguous counties of suburban or semi-rural nature.

Mixed

(1) Area containing one or two large urban cities (150,000 or more) surrounded or bordered by rural counties of at least twice the land space in those cities.
(2) Area containing medium-sized city or cities (50,000 or more) surrounded or bordered by rural counties of at least twice the land space in those cities.

Rural

(1) Area containing small cities (less than 50,000) and rural counties.
(2) Area that is totally rural with only small towns as a locus.

The third stratification variable is the type of system implemented in the EMS area. We have decided to use the DEMS/DHEW taxonomy of EMS systems for prehospital cardiac care:

(1) Basic (81-hour) EMTs on ambulances
(2) Paramedics on ambulances.

These two types of systems are described in the Overview (Chapter I). The prehospital coronary care program of any given EMS area will be classified based on the type of system in operation: EMS areas with a multitiered ambulance system will be categorized by the system most frequently used for cardiac emergencies. This taxonomy permits controlled comparisons of the effects of different modes of emergency care delivery on CVD; e.g., between communities with paramedics on standard ambulances and communities with EMTs on standard ambulances.

Of course, a more detailed taxonomy of EMS systems could examine effectiveness even more closely; e.g., the effects of different levels of paramedic training. The large number of strata thus introduced and the resulting small cell sizes, however, would inhibit useful comparisons. The proposed sample design already consists of a 48-cell matrix: 4 (census areas) x 3 (urban/mixed/rural) x 2 (MCC system types) x 2 (medical school present/absent.)* This sampling methodology best answers the primary evaluation question, "What is the effect of emergency medical systems on prehospital cardiovascular care?" as well as a second implicit research question, "What is the effect of *different types* of systems on prehospital care?" Other important research issues, such as the incremental effectiveness of advanced paramedic training, must first await the answer to the two preceding, more basic questions.

Both the research and nonresearch data collection activities will be allocated across the possible 48 cells in our sample design. The classification of data bases by our four stratification variables is quite straightforward. Our current Boston-based study, "Confirmation Parameters to Assess EMTs' Decisions," for example, would fall into the cell defined by (1) Census Division—Northeast, (2) urban location, (3) type of MCC system—basic EMTs on ambulances, and (4) academic medical center present. We anticipate that the exhaustive inventory described will yield sufficient data bases to fill the matrix.

Within each cell, it was anticipated that the existing data collection activities could be classified as meeting one of three criteria: (1) those data bases that meet the basic data set requirements specified in Task 2, (2) those that meet the basic requirements with minor modifications to their current data collection efforts, and (3) those data bases where extensive modifications to existing reporting systems are required. We had hoped to identify not only which EMS areas require major modifications in their EMS data collection systems, but to suggest ways in which changes in their reporting systems could be introduced. The limited data available from the DEMS and research funding considerations have made this set of goals unrealistic. Table 39 lists EMS areas.

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*The stratification variables will probably yield a somewhat smaller matrix, however, due to the number of cells with no EMS areas meeting the criteria. In some parts of the country, for example, no rural areas may have a medical school.

Table 39. EMS areas

Area No.	Area name	Designation	EMS status	Medical school
	Northeast			
Connecticut				
01	Bridgeport	U	None	Absent
02	New Haven	U	None	Present
03	Norwich	R	BLS	Absent
04	Hartford	M	BLS	Present
05	Waterbury	M	BLS	Absent
Maine				
01	Portland	M	BLS	Absent
02	Lewiston	R	BLS	Absent
03	Augusta	R	ALS	Absent
04	Bangor	R	BLS	Absent
05	Presque Isle	R	BLS	Absent
Massachusetts				
01	Springfield	M	BLS	Absent
02	Worcester	M	ALS	Present
03	Lawrence	U	BLS	Absent
04	Boston	U	ALS	Present (3)
05	Fall River/Brockton	M	BLS	Absent
06	Lynn	U	BLS	Absent
New Hampshire				
01	Hanover	R	ALS	Present
02	Concord	R	Planning	Absent
03	Portsmouth	R	Planning	Absent
New Jersey				
01	Paterson	U	BLS	Absent
02	Newark	U	BLS	Present
03	Trenton	R	BLS	Absent
04	Cambden	M	BLS	Absent
New York				
01	Buffalo	M	BLS	Present
02	Rochester	M	BLS	Present
03	Syracuse	M	BLS	Present
04	Binghamton	R	None	Absent
05	Albany	M	Planning	Present
06	White Plains	U	BLS	Absent
07	New York City	U	BLS	Present (7)
08	Mineola	U	BLS	Present
Pennsylvania				
01	Erie	R	BLS	Absent
02	Pittsburgh	M	BLS	Present
03	Altoona	R	Planning	Absent
04	Bellefonte/Williamsport	R	Planning	Absent
05	Binghamton, New York		(bi-State area, see New York)	
06	Avoca	M	BLS	Absent
07	Allentown	U	BLS	Absent
08	Philadelphia	U	BLS	Present (5)
09	Camp Hill	M	BLS	Present
Rhode Island				
01	Providence	M	BLS	Present
Vermont				
01	Burlington	R	None	Present
02	Newport	R	None	Absent
03	Brattleboro	R	BLS	Absent
04	Rutland	R	BLS	Absent
05	Montpelier	R	BLS	Absent
	North Central			
Illinois				
01A	Rockford	R	ALS	Present
02	Chicago	U	ALS	Absent
02B	Peoria	R	ALS	Present
03A	Springfield	M	ALS	Present

Table 39. EMS areas (Continued)

Area No.	Area name	Designation	EMS status	Medical school
	North Central (Continued)			
03B	Champaign	M	ALS	Present
04	Edwardsville	R	ALS	Present
05	Marion	R	ALS	Present
06	Chicago (city limits)	U	ALS	Present (6)
Indiana				
01	Ft. Wayne	M	BLS	Absent
02	Indianapolis	M	BLS	Absent
03	Evansville	R	Planning	Present
Iowa				
01	Waterloo	R	Planning	Absent
02	Sioux City	R	BLS	Absent
03	Carroll/Pocahontas	R	Planning	Absent
04	Indianola	M	Planning	Absent
05	Oakdale	M	BLS	Present
06	Omaha, Nebraska	(bi-State area, see Nebraska)		
07	Davenport	U	Planning	Absent
Kansas				
01	Hill City	R	BLS	Absent
02	Garden City	R	BLS	Absent
03	Wichita	R	Planning	Present
04	Topeka	R	Planning	Absent
05	Joplin, Missouri	(bi-State area, see Missouri)		
06	Kansas City, Missouri	(bi-State area, see Missouri)		
07	St. Joseph, Missouri	(bi-State area, see Missouri)		
Michigan				
01	Detroit	U	BLS	Present (2)
02	Lansing	M	Planning	Present
03	Kalamazoo	R	BLS	Absent
04	Grand Rapids	M	ALS	Absent
05	Flint	U	Planning	Absent
06	Midland/Saginaw	U	ALS	Absent
07	Petoskey	R	Planning	Absent
08	Marquette	R	Planning	Absent
South Dakota				
01	Pierre	M	BLS	Present
02	Rapid City	M	BLS	Absent
Wisconsin				
01	Madison	M	Planning	Present
02	Milwaukee	U	Planning	Present
03	Oshkosh	U	Planning	Absent
04	Green Bay	M	BLS	Absent
05	Eau Claire	R	None	Absent
06	Wausau	R	Planning	Absent
07	Hayward	R	BLS	Absent
Minnesota				
01	Grand Forks	R	BLS	Absent
02	Duluth	M	BLS	Present
03	Moorhead	R	BLS	Absent
04	St. Cloud	R	BLS	Absent
05	St. Paul	U	BLS	Present
06	Mankato	R	BLS	Absent
07	Rochester	R	Planning	Present
Missouri				
01	St. Joseph	R	BLS	Absent
02	Kirksville	R	BLS	Absent
03	Kansas City	M	ALS	Present (2)
04	Jefferson City	R	Planning	Present
05	St. Louis	M	Planning	Present (2)
06	Joplin	R	BLS	Absent
07	Springfield	M	BLS	Absent
08	Poplar Bluff	R	Planning	Absent
Nebraska				
01	Gering	R	ALS	Absent
02	North Platte	R	BLS	Absent
03	Kearney	R	BLS	Absent

Table 39. EMS areas (Continued)

Area No.	Area name	Designation	EMS status	Medical school
	North Central (Continued)			
04	Lincoln	M	BLS	Absent
05	Norfolk	R	BLS	Absent
06	Omaha	R	ALS	Present (2)
07	Sioux City, Iowa		(bi-State area, see Iowa)	
North Dakota				
01	Bismarck	R	ALS	Absent
02	Minot	R	ALS	Absent
03	Grand Forks	R	ALS	Present
04	Fargo	R	ALS	Absent
Ohio				
01	Cincinnati	M	Planning	Present
02	Dayton	M	BLS	Absent
03	Lima	R	None	Absent
04	Toledo	R	ALS	Present
05	Columbus	M	None	Present
06	Cambridge	R	None	Absent
07	Wooster	R	Planning	Absent
08	Akron	M	Planning	Absent
09	Cleveland	M	ALS	Present
10	Youngstown	U	Planning	Absent
	South			
Alabama				
01	Decatur	R	BLS	Absent
02	Tuscaloosa	R	ALS	Absent
03	Birmingham	M	BLS	Present
04	Gadsden	R	Planning	Absent
05	Montgomery	R	BLS	Absent
06	Mobile	R	Planning	Present
Arkansas				
01	Fayetteville	R	ALS	Absent
02	Newport	R	ALS	Absent
03	Forest City	R	ALS	Absent
04	Ft. Smith	R	ALS	Absent
05	Arkadelphia	R	ALS	Absent
06	Little Rock	U	ALS	Present
07	Hope	R	ALS	Absent
08	Pine Bluff	R	Unknown	Absent
Delaware				
01	Dover	M	BLS	Absent
District of Columbia				
01	Washington, D.C.	U	ALS	Present (3)
Florida				
01	Panama City	M	ALS	Absent
02	Gainesville	R	BLS	Present
03	Jacksonville	U	ALS	Absent
04	Tampa	U	BLS	Present
05	Orlando	U	BLS	Absent
06	Winterhaven	R	BLS	Absent
07	W. Palm Beach	U	BLS	Absent
08	Ft. Lauderdale	U	BLS	Absent
09	Miami	U	BLS	Present
Georgia				
01	Rome	R	None	Absent
02	Gainesville	R	None	Absent
03	Atlanta	U	ALS	Present
04	La Grange	R	None	Absent
05	Macon	M	Planning	Absent
06	Augusta	R	BLS	Present
07	Columbus	M	Planning	Absent
08	Albany	R	BLS	Absent
09	Brunswick/Waycross	R	Planning	Absent

Table 39. EMS areas (Continued)

Area No.	Area name	Designation	EMS status	Medical school
	South (Continued)			
10	Athens	R	BLS	Absent
11	Chattanooga, Tennessee	(bi-State area, see Tennessee)		
Kentucky				
01	Mayfield	R	BLS	Absent
02	Hopkinsville	R	BLS	Absent
03	Owensboro	R	BLS	Absent
04	Bowling Green	R	ALS	Absent
05	Louisville	M	BLS	Present
06	Florence	M	BLS	Absent
07	Lexington	M	ALS	Present
08	Campbellsville	R	ALS	Absent
09	Ashland	R	BLS	Absent
Louisiana				
01	New Orleans	M	BLS	Present (2)
02	Baton Rouge	R	Planning	Absent
03	Thibodaux	R	BLS	Absent
04	Lafayette	R	BLS	Absent
05	Lake Charles	R	None	Absent
06	Alexandria	R	Planning	Absent
07	Shreveport	M	BLS	Present
08	Monroe	R	Planning	Absent
Maryland				
01	Cumberland	M	BLS	Absent
02	Hagerstown	M	BLS	Absent
03	Baltimore	M	ALS	Present (2)
04	Salisbury	M	ALS	Absent
05	Metropolitan Washington	(tri-State area, see Washington, D.C.)		
Mississippi				
01	Clarksdale	R	Planning	Absent
02	Tupelo	R	BLS	Absent
03	Jackson	M	Planning	Present
04	Hattiesburg	R	ALS	Absent
05	McComb	R	BLS	Absent
North Carolina				
01	Black Mountain	R	Planning	Absent
02	Winston-Salem	U	BLS	Present
03	Charlotte	U	BLS	Absent
04	Louisburg/Raleigh Durham	U	Planning	Present (2)
05	Fayetteville	R	None	Absent
06	Greenville	R	Planning	Absent
Oklahoma				
01	Shawnee	R	BLS	Absent
02	Lawton	R	BLS	Absent
03	Enid	R	BLS	Absent
04	Tulsa	U	BLS	Absent
05	Oklahoma City	U	BLS	Present
South Carolina				
01	Greenville	M	ALS	Absent
02	Columbia	M	ALS	Absent
03	Florence	R	None	Absent
04	Charleston	M	BLS	Present
Tennessee				
01	Johnson City	R	Planning	Absent
02	Knoxville	M	BLS	Absent
03	Chattanooga	M	Planning	Absent
04	Nashville	M	None	Present (2)
05	Jackson	R	BLS	Absent
06	Memphis	U	BLS	Present
Texas				
01	Amarillo	R	ALS	Present
02	Lubbock	R	Planning	Present
03	Wichita Falls	R	Planning	Absent
04	Arlington	M	BLS	Present
04	Fort Worth	M	ALS	Absent
05	Texarkana	R	BLS	Absent

Table 39. EMS areas (Continued)

Area No.	Area name	Designation	EMS status	Medical school
	South (Continued)			
06	Tyler	R	Planning	Absent
07	Abilene	R	ALS	Absent
08	El Paso	R	Planning	Absent
09	Midland	M	ALS	Absent
10	San Angelo	R	Planning	Absent
11	Waco	M	Planning	Absent
12	Austin	M	BLS	Absent
13	Bryan	R	BLS	Absent
14	Lufkin	R	Planning	Absent
15	Beaumont	M	BLS	Absent
16	Houston	M	Planning	Present (3)
17	Victoria	R	Planning	Absent
18	San Antonio	M	ALS	Present
19	Laredo	R	Planning	Absent
20	Corpus Christi	M	Planning	Absent
21	McAllen	M	BLS	Absent
22	Sherman	R	Planning	Absent
23	Belton	R	BLS	Absent
24	Uvalde	R	Planning	Absent
Virginia				
01	Charlottesville	M	ALS	Present
01	Fredericksburg	M	Planning/ BLS	Absent
02	Metropolitan Washington	(tri-State area, see Washington, D.C.		
03	Lynchburg	M	BLS	Absent
03	Roanoke	M	BLS	Absent
04	Richmond	M	Planning	Present
05	Norfolk	M	ALS/BLS	Present
06	Johnson City, Tennessee	(bi-State area, see Tennessee)		
West Virginia				
01	Bluefield	R	Planning	Absent
02	Huntington	R	BLS	Absent
03	Charleston	R	BLS	Absent
04	Parkersburg	R	Planning	Absent
05	Fairmont	R	ALS	Present
06	Martinsburg	R	Planning	Absent
07	Wheeling	R	Planning	Absent
	West			
Alaska				
01	Fairbanks	R	BLS	Absent
02	Barrow	R	None	Absent
03	Kotzebue	R	BLS	Absent
04	Nome	R	Planning	Absent
05	Bethel	R	Planning	Absent
06	Dillingham	R	Planning	Absent
07	Anchorage	M	Planning	Absent
08	Juneau	R	BLS	Absent
Arizona				
01	Phoenix	U	BLS	Absent
02	Tucson	M	BLS	Present
03	Flagstaff	R	BLS	Absent
04	Kingman	R	None	Absent
05	Window Rock	R	ALS	Absent
California				
01	Eureka	M	ALS	Absent
02	Redding	R	BLS	Absent
03	Sacramento	M	ALS	Present
04	Berkeley	U	BLS	Absent
05	San Mateo	U	ALS	Present (2)
06	Alameda	U	ALS	Absent
07	San Jose	U	BLS	Absent
08	Modesto	M	Planning	Absent
09	Bakersfield	U	None	Absent
10	Salinas	R	Planning	Absent

Table 39. EMS areas (Continued)

Area No.	Area name	Designation	EMS status	Medical school
	West (Continued)			
11	Santa Barbara	U	BLS	Absent
12	Los Angeles	U	ALS	Present (2)
13	Santa Ana	U	BLS	Present
14	San Diego	M	ALS	Present
15	Riverside	M	BLS	Present
Colorado				
01	Denver	M	BLS	Present
02	Pueblo	M	BLS	Absent
03	Grand Junction/Montrose	R	ALS	Absent
04	Ft. Collins	R	ALS	Absent
05	Colorado Springs	M	BLS	Absent
Hawaii				
01	Honolulu	U	ALS	Present
02	Hilo	R	Planning	Absent
Idaho				
01	Lewiston	R	BLS	Absent
02	Boise	R	ALS	Absent
03	Idaho Falls	R	ALS	Absent
Montana				
01	Missoula	R	ALS(1A) BLS(2)	Absent
02	Great Falls	R	BLS	Absent
03	Billings	R	BLS	Absent
New Mexico				
01	Albuquerque	U	BLS	Present
02	Roswell	R	Planning	Absent
03	Las Cruces	M	Planning	Absent
Nevada				
01	Carson City	R	Planning	Absent
02	Reno	M	BLS	Present
03	Tonopah	R	Planning	Absent
04	Las Vegas	U	BLS	Absent
Oregon				
01	Portland	M	BLS	Present
02	Eugene	R	ALS	Absent
03	Bend	R	ALS	Absent
Utah				
01	Salt Lake City	M	ALS	Present
02	Ogden	M	ALS	Absent
Washington				
01	Spokane	M	ALS	Absent
02	Olympia	M	ALS	Absent
03	Bellingham	R	ALS	Absent
04	Vancouver	R	ALS	Absent
05	Wenatchee	R	ALS	Absent
06	Silverdale	R	BLS	Absent
07	Seattle	M	BLS	Present
08	Richland	R	BLS	Absent
Wyoming				
01	Cody	R	BLS	Absent
02	Sheridan	R	BLS	Absent
03	Cheyenne	R	BLS	Absent

M = mixed; R = rural; U = urban.

V. SUMMARY

Specific Conclusions and Recommendations

Each chapter in this final report is a self-contained, referenced entity. We have purposely avoided value judgments, preferring to present the data in such a fashion that the reader might reach his/her own conclusions. We have also delineated the methodological constraints on the data, as well as the findings themselves, so that the reader can place the policy implications of the data into appropriate perspective.

Nevertheless, in a report of this size, it is useful to delineate conclusions and related recommendations.

Task 1 The purpose of this task was to develop a comprehensive review of the literature in the area of prehospital coronary care.

In Chapter I, we present a factual summary of the clinical rationale for prehospital coronary care, the development of related technology and training of paraprofessional ambulance staff, and the effectiveness-limiting factors of patient access/public responsiveness. Starting from this vantage, we then unfold a theme that runs throughout the entire report:

> While two-thirds of patients with MI still die before they reach or seek medical care, there remains an essential need for an effective prehospital coronary care system. Under ideal circumstances, it appears that MCC programs can reduce the present excessive prehospital mortality rate from cardiac disease and, more specifically, the associated LTAs. The public, political, and fiscal commitment to implementing these programs is evident. The technology and training programs are sophisticated enough to enable efficient implementation of programs. What remains is for the medical and EMS community to develop a consensus as to the most appropriate, rational, and cost-effective strategies for implementing these programs. These decisions need to be based on the data generated from evaluation of existing paramedic programs and alternative strategies addressing the same problem.

The second part of Chapter I is an extensive historical review of the development of the prehospital coronary care system, in which we describe the entire range of ambulance-based approaches to prehospital coronary care. The last third of the chapter is an indepth review of the generic methodological problems in prehospital coronary care evaluation. Particular attention is paid to issues of standardization, objective criteria for process assessment, meaningful outcome measures, and development of physiological parameters as proximate outcome measures.

We point out the lack of commonality of definition across studies and the absence of severity indices being incorporated into these definitions. This is difficult to accept when the cardiological community (and the New York Heart Association, in particular) have developed acceptable and prognostically valid measures for severity of both MI and congestive heart failure. Only with the adoption of standardized definitions incorporating severity, can case mix indices be developed that permit us to compare results across multiple sites. Similar problems exist with definitions of EMS process measurements. In the area of outcome measurement, most studies have restricted outcome to overall mortality rates. We delineate a framework for disaggregating these mortality rates to render them more valid outcome measures for any given set of prehospital interventions.

In Chapter II we present our detailed analysis of the literature. We review our methodology for the literature search that yielded 335 articles, both published and unpublished, on MCC. These articles were all abstracted and are incorporated into our cross-referenced, annotated bibliography at the end of this report. Of this group of articles, 132 articles used process and/or outcome measures. These articles were further reduced to 51 sets of studies by combining multiple articles emanating from the same system and researchers. The 51 sets of articles were then used to develop the estimates of MCC impact in this chapter.

Our overview of the literature revealed the following:

(1) There are a limited number of research publications in the field.
(2) The publications are found in numerous types of medical journals, primarily in the general medical (36 percent) and cardiology (16 percent) literature.
(3) Thirty-one percent of all principal investigators in the area of MCC research are based at medical schools, 27 percent are outside this country, and the remainder are distributed among a variety of organizations. Very little research emanates from the Federal Agencies directly responsible for EMS research.
(4) Fifty-six percent of the funding sources for MCC research are not recorded. According to those articles reporting on sources of funding, the Federal Government supports 39 percent of MCC research. The remaining research is funded from a wide variety of sources.
(5) Only 39 percent of the articles report outcomes. The remainder are "state of the art," anecdotal experience, or public relations articles.
(6) Of the articles reporting outcomes, 53 percent emanate from studies of cardiac-dedicated vehicles, which are almost exclusively used in Europe. It is difficult to generalize from the results of studies done in Europe, given the substantial differences in the overall medical care system between continents. Only 23 percent of the 132 articles deal with paramedics.
(7) The ambulance system (72 percent), as opposed to the community, is almost exclusively the sampling frame used in most reports.
(8) Twenty percent of the studies reporting outcome also report process variables, rendering it impossible to ascribe the effect of any outcome to a prehospital intervention in the remainder.
(9) Morbidity as an outcome is rarely reported.
(10) Of the 132 outcome studies, only 2 percent of the articles employ multivariate analysis, which is necessary to control for and explain the complexity of clinical events involved in prehospital coronary care.

In our analysis of the outcome articles, we review 15 articles emanating from paramedic-staffed MCC systems. These articles report outcome data for patients with ACVD. Our emphasis here is on reviewing these conclusions. We found that:

(1) Mortality from ACVD measured in the ER grossly underestimates the mortality rates through hospital discharge. Little change in mortality rate is seen between hospital discharge and 3-month followup.
(2) Fifty to 75 percent of patients with ACVD still arrive at hospitals by their own means and bypass EMS systems.
(3) The mortality rate from the cardiac arrest, prehospital phase remains high, 79 to 83 percent.
(4) Patient delay, and not ambulance response time or excessive demand on the ambulance system, appears to be the limiting factor in achieving better outcomes.
(5) The results from patients in VF when found in cardiac arrest are somewhat better documented. The mortality rate is reported in the 70 to 75 percent range even from EMS systems with outstanding reputations for efficient organization.
(6) A number of studies employing quasi-experimental design suggest that paramedic programs have a favorable effect, though various methodological problems and the uniqueness of the systems limit generalizations.
(7) Essentially no valid, randomized trial with paramedics versus EMTs has been carried out.

In the next section on "Estimates of EMS Impact," we review the literature in an attempt to develop the best estimates for all the key components related to EMS impact:

(1) The incidence of acute cardiovascular events in the community: 1.5 deaths from primary heart disease per 1,000 population
(2) Proportion of patients with ACVD in the community who use the EMS system: 25 to 50 percent
(3) Incidence and outcomes for patients with ACVD who use ambulances: 20 to 59.5 percent incidence of ACVD on ambulances, with a 10 to 33 percent mortality through hospital discharge
(4) The measures of delay to definitive care: 50 percent in less than 30 minutes; 75 percent within 1 hour
(5) Proportion of patients with potential LTAs: 30 to 52 percent
(6) Proportion of patients receiving advanced intervention: 50 percent of patients with LTAs
(7) Incidence, outcome, and definitive treatment data on patients in cardiac arrest: a 5 to 10 percent incidence of arrest in ambulance patients with a 23 percent survival rate through hospital discharge of patients found in VF and 0 percent for those found in asystole

In the last section of this chapter, we reanalyze the simulation model developed by Dr. Shan Cretin. Dr. Cretin has based her data on the earlier reports on prehospital cardiac care programs emanating from Europe. We critique

some of the assumptions on which the model is based and update that model with more current data applicable to this country.

Task 2 Chapter III, which corresponds to Task 2, conceptualizes a model for MCC system analysis. We review the theory and assumptions involved in such a model and the data requirements for the model. In the last part of this chapter, we detail our experience from research on Cape Cod involving a sophisticated, regional EMS system employing both paramedics and EMTs. We explore the data collection strategies for that system and the availability of data elements. We find that although EMS and ED records are generally available (95 to 99 percent), half of the records are incomplete with respect to essential clinical, demographic, and ECG information. Accurate data on EMS system response are available also in only 50 percent of the cases.

Task 3 Chapter IV corresponds to Task 3—development of a national sample for MCC evaluation. These following approaches are discussed:

(1) Use of routinely collected EMS system data
(2) Use of current MCC research results
(3) Use of a national sampling frame

The paucity of data available through EMS systems is outlined. The bias introduced by the use of current research is quantitated in Chapter I and commented on here. We conclude that a sampling frame should be developed along four strata:

(1) Region—North, North Central, South, West
(2) Location—urban/mixed/rural
(3) MCC system—basic life support/advanced life support
(4) Medical center affiliation—present/absent

The 302 EMS areas of the country are categorized by each of the four strata. This categorization, the first of its type, will facilitate sampling for any future national study design.

General Conclusions and Recommendations

DOT, in conjunction with the NHLBI, generated the request for proposal for this contract to examine the effectiveness of MCC programs (as reflected in the literature) for two distinct purposes. First, they were interested in defining the role of MCC programs as one possible explanation for the recent decline in national cardiovascular mortality rates. Second, they desired a current state-of-the-art report on MCC programs in order to develop the most rational and cost-effective strategies to guide the continued development of MCC programs.

The data in this report do *not* support the contention that MCC programs have substantially contributed to the decline in cardiovascular mortality rates in this country. We have reached this conclusion based on three lines of evidence:

(1) The decline in cardiovascular mortality rate antedated the advent of MCC programs in this country. The decline in cardiovascular mortality rate became apparent in 1970, though the enabling legislation for MCC programs was not passed until 1973.
(2) Currently, only 73 of the 297* DHEW EMS project regions in the country have advanced life support sytems that include MCC programs. These systems vary in their level of sophistication, but, more importantly, they serve only a small proportion of the American citizenry (probably less than 10 percent) at this time.
(3) The data presented in this report suggest that the principal effectiveness of MCC programs relates to the subset of patients found in cardiac arrest in the rhythm of VF. There appears to be a decline in mortality rate for this subset from approximately 85 to 75 percent. Even if we make a series of extremely optimistic assumptions, the net effect is quite small:

- Assume: 50 percent of the 297 EMS regions had MCC programs.
- Then: 50 percent of the 1,000,000 patients with AMI (500,000) patients would have MCC programs available to them.
- Assume: 50 percent of these 500,000 patients with access to the medical care system would use the MCC ambulance programs.
- Then: 250,000 patients would be treated annually by MCC units.
- Assume: 10 percent of these 250,000 patients would be found in cardiac arrest.
- Then: 25,000 patients in cardiac arrest would be treated annually by MCC units.
- Assume: 75 percent of these 25,000 patients would have been witnessed arrests and/or have received citizen-initiated or EMS-initiated CPR within 5 minutes of the arrest (18,750) patients.
- Assume: 75 percent of these 18,750 patients would be found in VF as opposed to idioventricular rhythm (14,063).
- Then: 33 percent of these 14,063 patients would survive through hospital discharge; 4,688 patients would have been "saves" of the MCC system.

The estimate of MCC impact that we have developed from our literature search also suggests that our current data base is inadequate to provide a rational framework for the continued development of MCC programs in the United States. Relative to the considerable fiscal input to date in MCC programs, process and outcome measures of care are limited. Even among those programs routinely reporting information, the range of estimates of MCC impact is so wide that their usefulness is minimal. The excessive range for many of these estimates also raises serious questions about the quality and generality of currently available data.

We assume that MCC programs have become a permanent fixture of medical care in this country. If that be the case, then the need for accurate estimates of MCC impact parameters for long-term planning is self-evident. Although the DEMS/DHEW data base can serve to improve the management efficiency of these programs and efforts of the research establishment are needed to develop and test new MCC methodologies, neither provides the necessary data for planning and system development. We propose, in Chapter IV, a sampling strategy for an ongoing national MCC evaluation. We conceive of this evaluation effort as a sampling strategy that would provide a series of

representative "wet laboratories" around the country, in which the performance of MCC programs would be monitored in an ongoing fashion and innovations could be tested in a controlled, prospective manner. Alternatively, and less usefully in our opinion, the operations and outcome data from these representative regions could be compiled to provide an overview, along with serial status reports on MCC programs in the country. Either type of evaluation should incorporate present DEMS/DHEW data collection efforts and academic research studies, wherever possible. It is also clear that this effort needs to be a cooperative venture undertaken by at least four agencies: DOT, DEMS (under the Health Services Administration), NCHSR, and NHLBI. The exemplary cooperation between two of these Agencies in the support and direction of this contract augers well for such an undertaking.

While CVD, with all of its social, psychological, and economic implications, remains among the most prevalent of chronic conditions in this country, there will be continued public and legislative pressures for improving the care of these patients. MCC programs offer one remedy for this complex public health problem. These programs are expensive and will become even more expensive. Therefore, programmatic and research efforts need to be directed at optimizing the benefits of MCC programs in the most cost-efficient manner.

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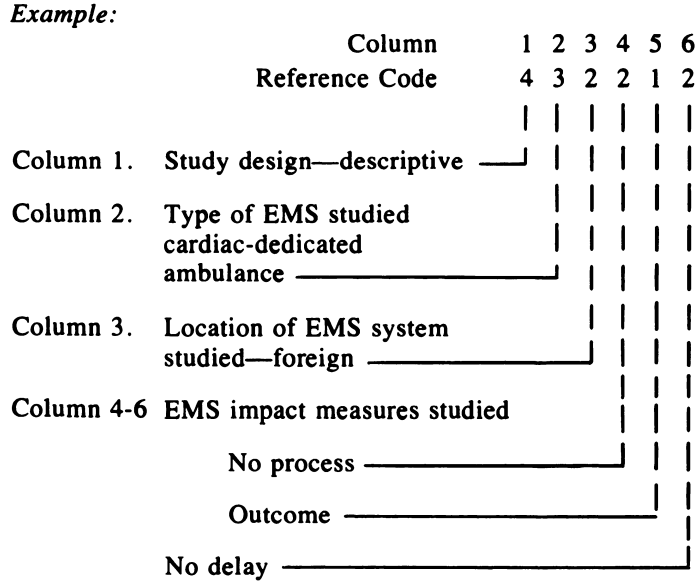
* Although there are 309 designated DHEW EMS project regions, 12 of these overlap among States. Therefore, we designate the net number of EMS regions as 297.

Appendix A ANNOTATED BIBLIOGRAPHY

The annotated bibliography contains the 335 articles originally abstracted with a brief summary written for each article. The bibliography is intended as an independent paper and contains a cross-reference system that distinguishes (1) articles of the same study type, (2) articles reporting on the same kind of emergency medical services (EMS) systems, (3) domestic versus foreign studies, (4) studies with process measures, (5) studies with outcome measures, and (6) studies with delay measures. The lists of articles (by reference numbers) that correspond to the appropriate categories follow the bibliography. The six-number code following each bibliographic entry coincides with the cross-reference categories as explained in this introduction. For example, the first entry, Adgey et al is coded 432212. The 4 in column 1 means that the article is a descriptive study. The 3 means that the article is a cardiac-dedicated ambulance. The 2 in the third column indicates a foreign study. The 2 in column 4 indicates that the article does not use process measures. The 1 in column 5 indicates the use of outcome measures in the study. Finally, the 2 in the last column means that the article does not report delay measures.

Example:



Explanation of Cross-Reference Codes

Column 1: Study Design

Each article reviewed was categorized by type of study into one of the following five groups:

(1) *Concepts/strategies.* These articles discuss new and improved ways to deliver emergency services. No findings are reported on the effectiveness of care provided.

(2) *Review/state of the art.* These articles are literature reviews that do not report original data.

(3) *Theoretical.* These studies present new findings based upon the manipulation of secondary data. This category is largely made up of modeling/simulation approaches and cost-benefit and cost-effectiveness studies.

(4) *Descriptive.* This group includes all nonexperimental studies of EMS systems.

(5) *Experimental.* These studies meet at least one of the following criteria: (a) use of random assignment, matching, or some other experimental study design and (b) multivariate statistical analysis.

Column 2: Type of EMS System Studied

Each article containing descriptive or experimental research was categorized according to the following types of systems:

(1) *Emergency medical technicians (EMTs) on ambulances.* These are ambulances staffed with personnel having completed only the 81-hour basic EMT training.

(2) *Paramedics on ambulances.* These are ambulances staffed with personnel trained in advanced life support who have completed more than 81 hours of emergency medical training. Included in this category are nurses and respiratory technicians.

(3) *Cardiac-dedicated ambulances.* These ambulances are dispatched exclusively for suspected or definite cardiac cases. These vehicles are frequently staffed with physicians.

(4) *Unlicensed technicians on ambulances.* These ambulances are staffed by personnel not trained as basic EMTs. This category is applicable in cases of articles reporting on EMS systems prior to legislation requiring licensing of ambulance personnel.

(9) *Not recorded.* This category applies to those studies of ambulance systems that do not report the type of personnel staffing the ambulances.

(0) *Not applicable.* This category applies to research studies with community- or hospital-based study populations of cardiac patients. Articles not classified as either "descriptive" or "experimental" are also included in this group.

Column 3: Location of EMS System Studied

Each article was categorized by the location of the EMS system studied. In cases of articles not reporting on an EMS system, the location is designated by the principal investigator's affiliation:

(1) *Domestic.* These articles involve EMS systems located in the United States.

(2) *Foreign.* These articles involve EMS systems located outside the United States. Only those foreign articles emanating from European countries and published in English were included in our literature review.

Columns 4-6: EMS Impact Measures Used

Each article containing descriptive or experiemental EMS research was categorized to indicate the use of process measures:

(1) *Process.* These articles contain process measures of coronary care such as correct diagnosis and appropriate treatment by emergency personnel.

(2) *No process.* These articles do not employ process measures to evaluate coronary care. All articles not classified as either "descriptive" or "experimental" studies are also included in this category.

Each article containing descriptive or experimental EMS research was categorized to indicate the use of outcome measures:

(1) *Outcome.* These articles report primary data in terms of mortality, morbidity, or both.

(2) *No outcome.* These articles do not report mortality or morbidity data from the EMS system studied. All articles that are not classified as either "descriptive" or "experimental" studies are also included in this category.

Each article containing theoretical, descriptive, or experimental research was categorized to indicate the use of delay measures:

(1) *Delay.* These articles study system and/or patient delay in the treatment of prehospital coronary care.

(2) *No delay.* These articles do not contain delay measures. Articles classified as either "concepts/strategies" or "review/state of the art" literature are also included in this category.

1. **Adgey, A. J., I. P. Clements, H. G. Mulholland, et al., "Acute Phase of Myocardial Infarction, *Minnesota Medicine* 59:347-353, May 1976.**

   This article reports on the 4 years' experience with the Belfast mobile coronary care unit (MCCU). Of 3,861 MCCU calls, 24 percent had acute myocardial infarction (AMI) and 33 percent had other acute ischemic heart disease. A sample of 294 first-hour patients was selected for the study of arrythmia incidence within the first, second, third, and fourth hour following onset of myocardial infarction (MI). Fifteen and one-half percent of these 294 MI patients had ventricular fibrillation (VF) within the first few hours. Of the 55 total patients who had VF, 18.2 percent were discharged alive. The authors suggest from their results that early coronary care diminishes the incidence of shock and pump failure, hence reducing further the mortality from AMI.

   432212

2. **Adgey, A. J., and J. F. Pantridge, "Monitoring Requirements in Patients With Acute Myocardial Infarction," *Post Graduate Medicine* 46:380-387, June 1970.**

   The majority of deaths from MI occur soon after the onset of symptoms. This article describes the MCCU in Belfast. It allows intensive care to commence in the patient's own home or at the site of infarction and thus reduces the interval between the onset of symptoms and the initiation of intensive care. Monitoring is continued during transport and following admission to the hospital coronary care unit (CCU). The major impact of therapy on the mortality from AMI will result from the detection and correction of rhythm disturbances.

   102222

3. **Adgey, A. J., and J. F. Pantridge, "The Prehospital Phase of Treatment for Myocardial Infarction," *Geriatrics* 27:102-110, May 1972.**

   The prognosis for AMI is best if treatment is initiated early after the onset of symptoms. The MCCU allows coronary care to reach patients soon after the onset of symptoms. The authors describe and give results of the MCCU in Belfast. From their study of 447 patients with MI in 1969, they report that mortality can be reduced to 12.3 percent; and among patients 70 years or younger, to 10.5 percent. Among those 70 years or younger seen within 1 hour, the mortality

rate was 8.6 percent. Adgey reports the 1-year survival rate as 89 percent for 111 patients seen within the first hour of onset of MI and discharged alive. Also, for 193 cardiac arrest patients, mortality rates were analyzed with respect to time to resuscitation.

432211

4. **Adgey, A. J., M. E. Scott, S. D. Allen, et al., "Management of Ventricular Fibrillation Outside Hospital," *Lancet* 1:1169-1171, June 14, 1969.**
Fifty-five of 126 patients with cardiac arrest outside hospitals had resuscitative measures initiated within 4 minutes of the onset of arrest. Forty-eight of the 55 had VF. Thirty-nine of the 48 survived. Resuscitative measures were initiated by members of an MCCU in 14 patients and by other individuals in 25. Twenty-seven patients left the hospital, and the majority of these were well at the time of follow-up. Among 71 patients with no cardiopulmonary resuscitation (CPR) in 4 minutes, asystole was present in 58 and VF in only 13. This suggests that in the absence of immediate CPR, VF may change to asystole. Thus these findings indicate the value of training medical and lay personnel in resuscitation methods, provided an MCCU is available.

432211

5. **Aleman, P. J., "Organization of Clinical Resuscitation," *Acta Anesthesiologia Scandinavia,* supplement 29:293, 1968.**
This article gives a report on a system for emergency resuscitation at the Dijnzigt Hospital in Rotterdam, Holland, that was planned in 1961. After reviewing the system, Aleman believes the most important points are that (1) patients should be resuscitated at the place where cardiac arrest occurs, (2) all medical, nursing, and ambulance staff should be trained to give artificial ventilation and external cardiac compression, (3) equipment for artificial ventilation should be available everywhere in the hospital, (4) crash carts of electrocardiograph (ECG) monitor, defibrillator, drugs, etc., should be accessible within a few minutes, and (5) a specialist trained in resuscitation should be alerted by means of a central alarm and be able to reach the site in a short time

102222

6. **Allen, R. T., G. H. Milly, and E. P. Visco, "Analysis of Emergency Support System," *Journal of the Association for Advancement of Medical Instrumentation*. 4:133-135, July/August 1970.**
The general structure of emergency coronary care systems is described. The systems are viewed as flows involving a series of interrelated functions. Such a view permits the isolation of critical modes for the collection of data significant to quantitative analysis. Such analysis is necessary for the development of models representing the performance (cost and benefit) of the system.

101222

7. **Al-Naaman, Y. D., and M. M. Al-Omeri, "Cardiac Arrest Between Prophylaxis and Treatment," *Journal of Cardiovascular Surgery* 12:161-162, May/June 1971.**
The main thrust of the article is prevention of "cardiac arrest" or "circulatory arrest" (a term the authors feel defines emergency procedure more accurately). The authors claim that "disturbed rhythm starts in the cellular membrance and prophylaxis should aim at this level" using polarization solution to avoid arrhythmias and to restore the disturbance in the Krebs cycle at the cellular level.

102222

8. **Alonzo, A. A., "The Impact of Physician Consultation on Care-Seeking During Acute Episodes of Coronary Heart Disease," *Medical Care* 15:34-50, January 1977.**
This study sample consists of 262 patients admitted to one hospital during 1 year with admission diagnoses of acute coronary heart disease. The article classifies the time delays from onset of symptoms to hospital admission into five categories to look at the impact of a medical evaluation phase (MEP) (i.e, patient calling a physician) upon mortality (in-hospital). It reports that the incidence of the MEP is not a significant factor on mortality. It also determines the factors significant to a patient deciding whether to contact a physician before going to the hospital. The article also evaluates (based on patient interviews and interview of others) the average time delay in the six alternative paths for a patient to take in getting to the hospital.

401211

9. **Alonzo, A. A., A. Simon, and M. Feinleib, "Prodromal of Myocardial Infarction and Sudden Death," *Circulation* 52:1056-1062, December 1975.**
A sample of 160 hospitalized ACI patients and 138 individuals (both in 25 census tracts in southeastern Montgomery County, Maryland) who died prior to hospitalization from acute coronary heart disease were studied, using retrospective interviews, to determine the incidence and duration of prodromal symptoms and action taken to cope with the symptoms. Seventy percent of the in-hospital subsample (IHS) and 64 percent of the out-of-hospital sample (OHS) reported prodramata. The OHS reported a significantly longer median duration of symptoms than the IHS (29 versus 10.5 days). Sixty-seven percent of the IHS reported new or accelerated anginal symptoms as the most frequently occurring symptom in contrast to 35 percent for the OHS. Twenty-seven percent of the IHS and 36 percent of the OHS consulted a physician about symptoms. Individuals in both subgroups, especially chronically diseased patients, considered their symptoms manageable. Patients with a high risk of MI and sudden death were significantly more likely to have consulted physicians during the prodromal phase than low-risk patients. A clearly delineated prodromal syndrome is needed so that both lay and medical communities can effectively respond to and intervene during the prodromal phase of AMI and sudden coronary death.

401221

10. **Alvarez, H., and L. A. Cobb, "Experiences with CPR Training of the General Public." *Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC),* (Dallas: American Heart Association, Inc., 1975).**

Emergency Cardiac Care (ECC), **(Dallas: American Heart Association, Inc., 1975).**
A descriptive study of tiered coronary cardiac mobile unit system (Medic I) with the Medic II system (a program that trained Seattle citizens in CPR methods) in Seattle, Washington, is described. Because the evaluation of Medic II was then ongoing and incomplete, this is an incomplete comparison of these two programs. The study shows (1) an increase of 15 percent in the number of citizens who initiated CPR, (2) an increase of 10 percent of resuscitation attempts by citizens for VF patients who became long-term survivors, (3) an increase of 10 percent of resuscitation of VF patients who then survived after hospitalization using a Medic I unit. The study reports on a random sample of 42 high school students 1 year following a CPR course. All knew, as determined by written test, when to initiate CPR and 50 percent had the necessary practical skills to perform CPR satisfactorily.

According to the authors the improvement is due to citizens awareness and involvement in CPR, training of primary response (fire department) personnel, and rapid response (2 to 5 minute) dispatch of fire engines.

421112

11. **Alvarez, H., R. H. Miller, and L. A. Cobb, "Medic I: The Seattle Advanced Paramedic Training Program,"** ***Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)*** **(Dallas): American Heart Association, Inc., 1975.**
This article describes the development and content of a curriculum for the training of appropriately selected paramedic personnel in the management of out-of-hospital medical emergencies in Seattle. Medic I, Seattle's mobile intensive/coronary care system, is based on the use of paramedic personnel for the delivery of near-physician level out-of-hospital emergency care.

101222

12. **Alvarez, H., R. Willis, and L. Cobb, "Sudden Cardiac Death: Physiologic Observations and Therapeutic Implications,"** ***American Journal of Cardiology*** **31:116, 1973.**
This abstract reports that 83 (13 percent) of 659 patients with VF on arrival of the MCCU were resuscitated, hospitalized, and discharged to their home. In the last 6 months of the study, 26 of 148 patients with VF (18 percent) were resuscitated and discharged.

431212

13. **Amey, B. D., E. E. Harrison, and E. Straub, "Sudden Cardiac Death: A Retrospective and Prospective Study,"** ***Journal of the American College of Emergency Physicians*** **5:429-433, June 1976.**
Since the inception of the MCCU, patients with sudden cardiac death saved by paramedics can be studied retrospectively and prospectively. Forty-eight cases of sudden cardiac death found in VF were successfully resuscitated in Tampa, Fla., between October 1972 and July 1975. Only 32 percent had an MI. Most survivors were N.Y. Heart Association Class I or II. All Class IV survivors with severe congestive heart failure died within 45 days. All Class II survivors had angina as the limiting factor. Of all patients with VF, 23 percent survived. Eighty percent of survivors were Class I or II and have returned to prior status. No clear-cut symptom complex was indentified.

421212

14. **Anderson, G., S. Knoebel, and C. Fisch, "Continuous Prehospital Monitoring of Cardiac Rhythm,"** ***American Heart Journal*** **82:642-646, November 1971.**
Fourteen MI or acute coronary insufficiency patients (sample not delineated with respect to location) were monitored by continuous ECG telemetry system. All except two of these had arrhythmias. Asystole or VF may appear with little forewarning. Thus it is theoretically sound to extend the concepts of CCU monitoring to prehospitalization monitoring. It is necessary, however, to obtain an exclusive frequency for continuous telemetry.

491222

15. **Anderson, G. J., S. Knoebel, C. Fisch, et al., "Continuous Prehospitalization Monitoring of Cardiac Rhythm,"** ***American Heart Journal*** **8:723-724, May 1972.**
This report describes and documents the usefulness and application of a continuous ECG telemetry system. ECG monitoring is by means of telemetry and simultaneous voice communications. ECG telemetry is a useful tool in the prehospital phase in the detection of arrhythmias in patients with coronary heart disease. This system may reduce the incidence of early death.

101222

16. **Andrews, R. B., L. E. Davis, J. R. Bettman, et al.,** ***Methodologies for the Evaluation and Improvement of Emergency Medical Services Systems—Final Report*** **(Washington, D.C.: U.S. Department of Transportation, July 1975.)**
This report includes a study comparison of two mobile intensive care units (MICUs) staffed by paramedics and two regular ambulances (that do not provide adavanced life support) operating in Los Angeles County between December 1969 and May 1971. The MICUs treated 1,379 patients of which 249 were victims of hypertensive and arteriosclerotic heart disease. The ambulance made 1,755 runs, including 47 runs for hypertensive and arteriosclerotic heart disease patients.
The study is intended to determine the effectiveness of MICUs by comparing MICU with regular ambulance survival rates to the Emergency Room (ER) at discharge, and after 90 days following discharge. Excluding those cardiac patients who were dead on arrival at site and those without a life-threatening condition, the authors found that 90-day survival rates are significantly different for MICU (66.1 percent) and ambulances (46.7 percent).

421211

17. **Anthony, J., and L. Semeraru, "A Mobile Emergency Cardiac Care Unit: Analysis of Initial Data," *Connecticut Medicine* 39:797-800, December 1973.**
This study analyzes the data of the first 550 runs by a mobile system of emergency cardiac care instituted at St. Mary's Hospital in Waterbury, Conn. The program began in December 1972.
Approximately 58 percent of the calls were for suspected acute cardiovascular disease, whereas 38 percent were for other assorted acute illness. Less than 5 percent were for nonemergencies. In 93 percent of the cases, the MICU rendered some form of treatment.

431222

18. **Askanas, A., S. Rywik, B. Szczypiorowski, et al., "The Registration Program of Cases of Recent Myocardial Infarction Conducted Within the Framework of Medical Care of the Warsaw Emergency Service," *Cor et Vasa* 12:169-177, 1970.**
This article reports findings regarding the 5,178 (covered by registration) Warsaw inhabitants in whom ambulance physicians suspected acute coronary insufficiency within a 1-year period. Of those hospitalized, the diagnosis of acute coronary insufficiency was confirmed in 1,428. Of the 3,302 patients with known catamnesis the authors also report the mortality rates prior to arrival of physician, during emergency service care, and in the hospital of acute coronary insufficiency or other reasons.

432112

19. **Backer, P., "Copenhagen Emergency Service," *British Medical Journal* 2:423-424, May 1968.**
This article describes an emergency service system implemented to relieve the general practitioner so that he may have leisure time. The system provides the public with a simple, rapid system of effective emergency treatment administered by well-qualified doctors.

102222

20. **Baker, R., and J. M. Waters, "Cardiac Experience, Jacksonville Rescue Branch, February 1973," *Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).**
Response was made to 255 calls involving patients having breathing or cardiac difficulty. Of these, 169 (66.3 percent) were evaluated on the scene as possible cardiac; 136 (80.5 percent) of these were successfully treated in the field or delivered alive to the hospital. Cardiopulmonary resuscitation, including defibrillation and cardiac drugs, was employed 11 times. Four of these patients were pronounced dead in the field; five were dead on arrival at the hospital despite continual CPR; two died after arrival at the hospital. There were no long-term survivors in February, though past experience would have indicated 17 long-term survivors.

421212

21. **Baker, R. M., J. M. Waters, "Use of General Duty Ambulances as Mobile Coronary Care Units," *Journal of the Florida Medical Association* 57:22-23, November 1970.**
This article reports on a preliminary study of a first aid branch of the fire department of Jacksonville, Fla., a city with a population greater than 512,000 and an area of 842 square miles. It has 63 fire department men with more than 200 hours of training. In 6 months, there were 8,209 requests for help. Of these, five hundred five presented symtpoms suggestive of heart attacks and were treated by rescue crews as coronary patients. In 88 cases, CPR was used.

441222

22. **Barber, J. M., D. M. Boyle, N. Chaturverdi, et al., "Mobile Coronary Care," *Lancet* 2:113-114, July 1970.**
This article describes an MCCU from the Ulster Hospital, Dundonald, Belfast. The MCCU is staffed by the in-hospital CCU staff and uses ordinary ambulance service.

102222

23. **Barber, J. M., D. McC. Boyle, M. Walsh, et al., "Delay Times in Acute Ischemic Heart Disease," *British Heart Journal* 35:8612, August 1973.**
The early mortality of MI requires rapid intensive management. Mobile coronary care (MCC) aims to reduce the total delay time between onset of symptoms and intensive care conditions. Patients are admitted via an MCCU and conventionally. This group studied (1) the effect on patient delay time of age, sex, position of infarct, extent of infarct, severity of infarct as judged by a coronary prognostic index, previous ischemic heart disease, cigarette smoking, diabetes mellitus, hypertension, time of initiation of intensive care, and day of admission; (2) the patient's reasons for delaying (studied by means of a questionnaire); and (3) the impact of the mobile unit on delay times. The results suggest that patient delay time depends on time of day at which symptoms start and on the severity of the infarct. Of patients delaying more than 30 minutes, 55 (56 percent) of 99 realized their pain was cardiac in origin. Of these, 21 (38 percent) considered early treatment to be important. During the first 2 years, total delay time was shortened for mobile unit patients (due to a reduction in doctor delay time). Patient delay time and mobile unit delay did not change. Delay times remained unaltered for conventional admissions.

492221

24. **Baskett, P. J., "Urban Mobile Resuscitation: Training and Service," *British Journal of Anaesthesiology* 48:377-385, 1976.**
The establishment of a mobile resuscitation unit based on a district general hospital in Bristol, England, is described. The unit is manned by hospital-trained ambulance men and by an anesthesiologist when necessary. The training of the ambulance men, organization of the service, and some results are discussed.

Of the total of 170 cases seen by ambulance during "a recent four month period," 28 percent (47) had cardiac disease. Of the 47, use of special equipment was described as follows: in 17 cases arterial pressure and ECG equipment was used; in 12 intravenous (IV) cannulation; in 6, IV drugs; in 2, laryngoscopy and intubation; in 3, intermittent positive pressure ventilation (IPPV); and in 3, defibrillation. The value of the mobile resuscitation unit was estimated to be as follows for these heart disease patients: (1) definitely valuable for 64 percent (30) and (2) possibly valuable for 21 percent (10). Of those described in categories (1) and (2) 85 percent (34) survived and were able to leave the hospital. The lives of 5 percent (2) had definitely been saved while the lives of 30 percent (12) had possibly been saved. The authors recommend the establishment of such a unit in association with an urban district general hospital for the immediate care of all patients who suddenly become seriously ill, regardless of the cause of their illness or accident.

432212

25. **Bastnagel, G., P. J. Cristiano, and R. Achelli, "Hospital, Community Establish EMS System," *Hospitals* 48:59-62, August 1974.**
This article describes the establishment and implementation of a jointly operated hospital-community EMS program in Southfield, Michigan, with Providence Hospital. It describes the establishment of the program, training of paramedics (fire and rescue squad personnel), the communications system, costs, and the results of this planning. In a 90-day period since the beginning of the program, 10 lives had been "saved."

101222

26. **Baum, R. S., H. Alvarez, and L. A. Cobb, "Survival After Resuscitation from Out-of-Hospital Ventricular Fibrillation," *Circulation* 50:1231-1235, December 1974.**
During the first 3 years of operation of a comprehensive system for the management of out-of-hospital medical emergencies, 146 patients were resuscitated from VF, hospitalized, and discharged home. The diagnosis of acute transmural MI associated with the episode of VF was confirmed in only 17 percent of the patients. The presence of myocardial necrosis, based on either evidence of a new transmural infarction or LDH-isoenzyme, criteria was established in 49.5 percent of the patients. During the followup period, averaging 418 days, 43 of the 146 patients died. Thirty-four of the 43 deaths occurred suddenly outside the hospital. Patients whose aborted sudden cardiac death was associated with acute transmural infarction had a morbidity rate of 14 percent after 2 years of followup. In contrast, patients without evidence of acute myocardial necrosis had a high mortality rate of 47 percent at 2 years.

It is concluded that (1) out-of-hospital VF is common and treatable, (2) the phenomenon of sudden cardiac death should not be equated with AMI, and (3) patients resuscitated from VF without associated AMI are prone to sudden cardiac death—most likely from VF.

431212

27. **Beck, C. S., "Reminiscences of Cardiac Resuscitation," *Review of Surgery* 27:77-86, March/April 1970.**
Dr. Beck reviews important progressive milestones with respect to the heart (period 1924-69) demonstrating how the realization came about that it is a life-giving powerhouse. He shows how electrical failures were accidentally discovered to be connected with VF and the falsity of the theory of more blood to be replaced by the theory of redistribution of available blood. Treatment techniques went from the introduction of defibrillation in 1937; to open-heart in-hospital resuscitation in 1956; to out-of-hospital open chest procedures; to closed chest resuscitation; to the first CCU begun in 1962 by Dr. Hughes Day at Bethay Hospital, Kansas City; to, in 1963, CPR training for nonparamedical personnel.

201222

28. **Bell, B. D., "Mobile Medical Care to the Elderly: An Evaluation," *Gerontologist* 15:100-103, April 1975.**
This article represents an evaluation of a statewide mobile program of health care delivery to older rural persons. From its beginning in November 1973 through April 1974, 2,738 individuals (mean age 69.5 years) were processed. The data indicate significant incidences of high blood pressure (31.0 percent), heart trouble (29.9 percent), and eye problems (17.3 percent). In addition, 12.8 percent of the population exhibited ailments serious enough to warrant referral.

401222

29. **Bensen, P. P., and C. B. Wright," Better Pre-hospital Emergency Services Through Emergency Care, Inc." *The Journal of the Maine Medical Association* 65:63, 8 March 1974.**
This article describes the development of Emergency Care, Inc. (Maine), originally planned for prehospital coronary care, but now broadened to all emergency calls that require hospital attention.

101222

30. **Bensen, D. M., G. Esposito, J. Dirsch, et al., "Mobile Intensive Care by Unemployable Blacks Trained as Emergency Medical Technicians (EMTs) in 1967-69," *Journal of Trauma* 12:408-421, May 1972.**
This is a personnel study of newly trained EMTs (unemployable blacks) who staffed the Freedom House Enterprises (FHE) hospital based MICU. Of the 44 blacks who entered the class, 39 finished the course and passed the Level I examination.

The service results for those who were hired as EMTs are discussed briefly. Of the 3,950 patients transported (not including transfers from one care facility to another), the EMTs treated 40 arrests. Five of these 40 (12.5 percent) survived to be discharged.

4111112

31. **Benson, D. M., and C. Stewart, "Inadequacy of Prehospital Emergency Care," *Critical Care Medicine* 1:130-134, May/June 1973.**
This survey evaluates emergency care in the city of Pittsburgh. Of 214 patients needing prehospital care,

44 percent came to the emergency department by private cars, 26 percent by ambulance, 16 percent by FHE MICU, and 13 percent by private ambulance. Twenty-three percent arriving by private cars, 21 percent transported by private ambulance, 37 percent by police ambulance, and 88 percent by FHE MICU were adequately managed during the prehospital phase. The FHE MICU provided adequate care in 88 percent of their cases, but only handled 16 percent of all patients. Similar levels of performance probably exist in most urban, suburban, and rural areas of the country. A concerted effort to upgrade the ambulance services and their paramedical staffs should be made to provide adequate prehospital care to reduce morbidity and mortality of critically ill patients.

491122

32. Benson, D. M., and C. H. Wecht, "Conflagration in an Ambulance Oxygen System," *Journal of Trauma* 15:536-540, June 1975.
This article presents a case report illustrating one of the potential problems associated with installed ambulance oxygen systems.

101222

33. Beyers, B. G., "The Air Transport of Patients," *South African Medical Journal* 49:856-858, May 1975.
This article describes air transport of patients including the specific problems and shortcomings that must be dealt with to insure the best service. Beyer discusses the change in atmospheric pressure, skin disturbances, and patients' fear. He also mentions specific problems in the aircraft with certain illnesses.

102222

34. Bondurant, S., "Problem at the Pre-hospital Phase of Acute Myocardial Infarction," *American Journal of Cardiology* 24:612-616, November 1969.
Advances in management of the prehospital phase of MI consist of various means of foreshortening the prehospital care phase to allow earlier application of established techniques of arrythmia control. Perfection of the present system of coronary care will leave substantial residual mortality—about 30 percent of all deaths in the first 6 hours—consisting of patients who die so suddenly that no triage or revival system can expect to help. The best approach to gain better results is through further investigation with the purpose of earlier identification of the episode and improved prophylaxis and therapy.

No single MCCU system will be most effective in every setting.

101222

35. Boyd, D. R., "Efforts to Improve Emergency Medical Services: The Illinois Experience," *Journal of the American College of Emergency Physicians*, pp. 209-217, May 1977.
This article reviews some of the clinical impact studies of the early Illinois Trauma/EMS Program. The author responds to the criticisms of Snack and Thall (of the Illinois EMS program, its effectiveness, documentation, and some implied correlatives of the early efforts in Illinois and the current national EMS program) and clarifies and reinforces some of the commentary by Willemain.

101222

36. Boyd, D. R., W. A. Pizzano, T. Romano, et al., "Regionalization of Trauma Patient Care: The Illinois Experience," *Surgery Annual* 7:25-52, 1975.
This article reviews the regionalization of injured trauma patients in Illinois, the Illinois trauma system, the program concepts, subsystem components, and trauma registry clinical data to describe the dynamics of the trauma EMS care system.

The authors believe that trauma patient care, because of its complex requirements, provides an excellent model from which to design a basic emergency health care delivery system—one that can be expanded to include all types of emergency medical problems.

Surgeons should take a leadership role in regional and areawide trauma EMS planning and implementation in their local communities.

101222

37. Brantigan, J. W., "Should You Let That Patient Fly?" *Medical Times* 100:80-85, October 1972.
This article is directed to doctors who must decide whether a patient with advanced ischemic heart disease can use an airplane (e.g., to visit a medical center several hundred miles away). The author states two main altitude effects that cause virtually all medical difficulties in flight: (1) decrease in available O_2 at flight altitudes and (2) expansion of trapped gas, thus lowering alveolar pO_2. The doctor must determine whether the patient can travel by any other means because a commercial aircraft is neither a hospital nor an ambulance. If not, then the doctor should call for the assistance of the medical department of the airline involved.

101222

38. Briggs, R. S., P. M. Brown, and M. E. Crabb, "The Brighton Resuscitation Ambulance: A Continuing Experiment in Prehospital Care by Ambulance Staff," *British Medical Journal* 2:1161-1165, November 1976.
Two ambulances from the existing fleet in Brighton and one in Hove are equipped with portable defibrillator-oscilloscope units. Selected attendants have been trained to defibrillate patients and to perform endotracheal intubation and administer IV atropine and lidocaine for carefully defined indications. In 1974 and 1975 the ambulances responded to 2,253 calls that were considered possible emergencies. Retrospective analysis showed that half of these were for patients with MI, coronary insufficiencies, or angina. The median ambulance response time is reported to be 5 minutes. Attempts at resuscitation were made in 207 patients with circulatory arrest, of whom 160 had VF. Coordinated rhythm was restored at least transiently in 66 patients, and 27 of them survived to leave the hospital. Sixteen of these survivors were in VF before the ambulance arrived. The delay preceding hospital admission was reduced, 50 percent of the patients were admitted within 2 hours of the onset of major symptoms.

432111

39. **Briggs, R., P. Brown, D. Southall, et al., "Pre-hospital Coronary Care Provided by Ambulancemen,"** ***British Heart Journal*** **38:530, May 1976.**
This article reports the results of a setup with special portable equipment carried on coronary ambulances staffed by paramedics. One hundred patients were carried, approximately 42 with AMI or coronary insufficiency. More than 90 percent of rhythm diagnoses were interpreted correctly by the ambulance men. Atropine was given 68 times and lidocaine 41 times and in all but one instance the indications were entirely as laid down. Fifteen patients were resuscitated successfully to be discharged from the hospital alive. Fourteen of these had VF and in six cases cardiac arrest had occurred before the ambulance arrived.

432112

40. **Brown, G., "The Immediate Care of Seriously Ill and Injured Persons,"** ***The Medical Journal of Australia*** **1:465-468, March 1974.**
The author presents evidence from different studies with respect to (1) availability of doctors in an emergency; (2) the role of ambulance officers with respect to IV, respiratory obstruction, acute coronary care, communications, and transport; (3) reception at hospital; and (4) the role of the public. Studies show that ambulances should have access to a medical officer. Also, ambulance officers are usually at the scene first so they need special training. For acute coronary occlusion care, patients need early skilled treatment. Finally, communications are important to speed up hospital reception.

The author concludes that "the presence of highly skilled, adequately equipped personnel at the side of the acutely ill and seriously injured patient will save lives and eliminate morbidity."

202222

41. **Buck, G. L., P. F. Brimmer, L. T. Putzier, et al., Acute Myocardial Infarction: The Victim and the Event,"** ***Emergency Medical Services (EMS) Research: Effectiveness of Emergency Care (Final Report)*** **Springfield, Virginia: National Technical Information System, 1976.**
Part of the evaluation report of the Emergency Medical System in the Tucson Metropolitan Statistical Area, this section evaluates the extent to which those patients with AMI use the Emergency Medical System. Although the sample size for mortality vs. transportation method figures is not stated, the results reported indicate that those AMI patients who arrive at the emergency facility by MICU are most likely to die in-hospital, those arriving by ambulance are next most likely to die. The authors indicate that because there is such a variation in patient delay, methods of seeking care, and other characteristics of AMI victims, AMI is a "poor tracer condition to be used in evaluating the effectiveness of an EMS system."

421211

42. **Callen, I. R., P. Zopolsky, L. Y. Yako, et al., "Achieving a Lower Mortality in the Prehospital Phase of Acute Myocardial Infarction,"** ***Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)*** **(Dallas: American Heart Association, Inc., 1975).**
This article discusses the first 3 years' experience of the Edgewater Hospital (Chicago) MCCU established in 1969. The service is unique in that only patients of the attending staff of the Edgewater Hospital have access to it. The 322 calls made by the MCCU were retrospectively analyzed for patient diagnoses. Forty-seven percent had proven MI and 34 percent had coronary insufficiency but not clear-cut infarction. Only 8 percent had no demonstrable disease. The MCCU experienced no deaths in transit and 11 percent of the 322 patients were dead at the time of arrival of the MCCU.

431212

43. **Cameron, M., F. Wilkinson, and S. R. Hampton: "Follow-up of Emergency Ambulance Calls in Nottingham: Implications for Coronary Ambulance Service,"** ***British Medical Journal*** **1:384-386, February 1975.**
Information about patients in ambulance records was linked with that in patients' hospital records in an attempt to make the most efficient use of an MCCU for patients suspected of having an MI. Two hundred and forty-eight emergency calls made by the public in one week for an ambulance and 115 emergency calls in a 3-week survey of patients described as having collapsed show that the quality of information given to the ambulance center is poor. The existing special services all apparently restrict their ambulances to calls made by general practitioners or to cases where there is some special reason for the telephone operator to believe that a heart attack has occurred. This study suggests that there is no point in sending a coronary ambulance in response to an emergency call for a patient with anything other than a collapse, and if the operator can elicit a history without chest pain it looks as if it is unprofitable to dispatch an MCCU.

432122

44. **Campion, B. C., J. W. McBride, P. Sukhum, et al., "Implementation of an Expanded Emergency System,"** ***Minnesota Medicine*** **59:124-129, February 1976.**
This article describes the St. Paul Minnesota emergency system including its implementation and the problems involved in bringing this system into reality.

101222

45. **Cannon, J. F., "Emergency Medical Technician Performance: A Clinical Trial," Unpublished Paper, Department of Epidemiology and Public Health, Yale University, New Haven, 1974.**
In this study, Cannon evaluates the performance of EMS during the time he titles "Phase I" and defines as "the time between the initial injury and the patient's arrival at a medical facility." Cannon presents an analysis of appropriate treatment by EMTs with a sample base of 3,000 cases observed during the study period.

Cannon uses EMT diagnoses for the sample criteria, and emergency room physician diagnoses as the standard for comparison. The caseload is broken out in terms of fractures; lacerations; heart, lung and airway emergencies; and arrests. Cannon found that

of the 141 fracture cases, only 50.4 percent were treated appropriately. Of the 476 cases with lacerations, only 66.6 percent were dressed. Of the 271 cases involving heart, lung, and airway diagnoses, and requiring treatment, only 51.3 percent received oxygen and ventilation. Finally, of the 92 arrests, 25 percent had resuscitation attempted. Appropriate treatment is defined as that treatment mandated by the 81-hour EMT course.

511122

46. Carter, W. H., "Pre-hospital Coronary Care in West Virginia," *The West Virginia Medical Journal* 70:287-289, November 1974.

The author discusses the history and development of pre-hospital coronary care worldwide in general and West Virginia in particular. Certified ambulance paramedics in West Virginia recently started successful definitive cardiac care in ambulances. Success of this system requires cooperation of State and local medical societies, the State Health Department, the State and local heart association, local hospitals, and the local government. Structure of any local program must be geared to the local needs and resources.

101222

47. Carveth, S. W., "Eight-year Experience with a Stadium-based Mobile Coronary Care Unit," *Heart and Lung* 3:770-774, September/October 1974.

This article describes a life-support unit developed at the Nebraska football stadium in 1966. By the end of the 1973 football season, 18 spectators had experienced a cardiac or a pulmonary emergency while attending a game. Four of the 18 had moderate to severe chest pain without cardiovascular collapse. Four who developed a cardiopulmonary emergency were successfully resuscitated but died in 1 to 7 days of a stroke. One had a transient cerebral ischemic episode and was told to see her physician. Nine had a cardiac arrest secondary to a later documented AMI. Eight of these were successfully resuscitated. Three of the eight died 6 months to 2 years later; and 5 survived.

421212

48. Carveth, S. W., "Heart of the Community," *Nebraska Medical Journal* 59:108-109, April 1974.

Carveth cites statistics with respect to the effects of the CCU on acute MI patient (in-hospital) survival, annual death from heart attacks (in the United States), and out-of-hospital resusciation attempts, then states, ". . . if widespread public education in CPR together with community organization of emergency care systems were accomplished throughout the Nation, many lives could be saved." He summarizes the seven resolutions passed by the Nebraska Heart Association 1972 Annual Meeting to promote widespread use of CPR and encourage other communities to use the resources of the Heart Association to develop emergency care systems within their own communities.

201222

49. Carveth, S. W., "Standards for Cardiopulmonary Resuscitation and Emergency Cardiac Care," *Journal of the American Medical Association* 227:796, February 1974.

At the first CPR conference in 1966, the CCU emerged as succeeding in the reduction of in-hospital mortality from MI from 40 percent to between 15 and 20 percent. Carveth emphasized the need to focus on prehospital deaths using a stratified system of cardiac care that begins with CPR in the street and embraces every subsequent level of cardiac care. Formal evaluations, however, of physician competency have demonstrated a critical lack of proficiency in basic life support. The American Medical Association (AMA) (to date) has planned new training programs.

201222

50. Carveth, S. W., T. Burnap, J. Bechtel, et al., "Training in Advanced Cardiac Life-Support," *Journal of the American Medical Association* 235:2311-2315, May 1976.

This article explains the development of a training program in Advanced Cardiac Life Support and reports the initial results of this new training, testing, and certification course.

The current results after four 12-hour training courses indicate that 604 of the people who took the course were certified. The results reinforce the concept that those persons interested in certification in advanced life-support must obtain the precourse material and must prepare for the course if these skills are to be learned to a high level of proficiency.

491122

51. Carveth, S. W., D. C. Olson, and J. Bechtel, "An Emergency Care System—Lincoln Mobile Heart Team," *Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).

Four hundred and seventy patients were seen and treated by an MCCU between March 1, 1971, and February 28, 1973, in Lincoln, Nebraska. Ten percent of the total patients seen were described as nuisance calls. Two hundred and twenty-five patients had collapse symptoms. This included 116 patients who required resuscitation and 93 patients who were responsive by the time the team arrived and did not require resuscitation. Sixteen of the 225 patients were dead when the team arrived. Seventy-two of the 116 patients who required resuscitation had MI; of these, 27 were successfully resuscitated. Forty-five of the 116 were successfully resuscitated; of these, 23 left the hospital alive.

431212

52. Carveth, S. W., D. Olson, and J. Bechtel, "Emergency Medical Care System," *Archives of Surgery* 108:528-530, April 1974.

The objective of the Lincoln, Nebraska, emergency care system was the provision of an effective method by which a collapsed person could be rapidly and efficiently placed in a modern stratified system of emergency care. Using national statistics, it was estimated that over 300 people collapsed and died each year in the Lincoln area. Between March 1, 1971, and September 30, 1973, 717 patients were treated by this emergency care system; 323 had collapsed and 169 of these required resuscitation. Of the 169 patients who required resuscitation, 50 (52/

105) percent of those with MI were successfully resuscitated; 44 percent (28/64) of those with drug intoxication, alcohol ingestion, or syncope from heart bloc or aortic stenosis were successfully resuscitated. Twenty percent (34/169) who required resuscitation left the hospital alive. It is estimated that once the public is thoroughly trained in basic life support, this 20 percent might well be increased to 50 percent survival for all patients now dying outside the hospital.

431212

53. **Cassidy, P. J., and P. A. Wilson, "Operational Research in the London Ambulance Service: Simulation of Total Service,"** ***GLC Research and Intelligence Unit Quarterly Bulletin*** **No. 9, December 1969.**

This article reports a study in progress that plans to answer questions pertaining to communication facilities, levels of staff, size, composition of vehicle fleet, locations of stations, and the organizational and control strategies. The study uses a simulation model.

102222

54. **Chapman, W. E., "Electronics in Medical Practice,"** ***Postgraduate Medicine*** **49:55-56, May 1970.**

The author describes trends of mobile electronic units for monitoring patients at three different sites. These units have several practical advantages for both physician and patient. They help the physician care for patients sooner and more effectively in emergencies; in nonemergency situations they permit the physician to obtain data on patients and to care for those who are unable to go to clinical laboratories.

101222

55. **Chaturverdi, N. C., G. Shivalingappa, B. Shanks, et al., "Myocardial Infarction in the Elderly,** ***Lancet*** **1:280-282, February 1972.**

One hundred and five patients, aged 71 and older, with MI treated at the Ulster Hospital in Belfast are reviewed. Mortality in the hospital and at 3 months is compared with total delay time and mode of admission. The findings show that for those patients admitted by the MCCU and receiving coronary care within 4 hours of the onset of symptoms, the hospital mortality rate was 18 percent, and for those admitted through the casualty department within 4 hours, the hospital mortality rate was 21 percent. The author's findings were not significant, but indicate that a shorter delay time (less than 4 hours) yields a lower hospital and long-term mortality rate and that the MCCU hospital mortality rate (22 percent) and long-term mortality rate (24 percent) is lower than for casualty admissions (38 and 41 percent mortality, respectively).

432211

56. **Cleveland, H. C., D. B. Bigelow, D. Bacon, et al., "A Civilian Air Emergency Service: A Report of its Development, Technical Aspects, and Experience,"** ***Journal of Trauma*** **16:452-463, June 1976.**

Rapid transit of the seriously and critically ill by helicopter offered a natural solution to the problems involved in conventional land transportation in the Rocky Mountains near Denver, Colorado. In October 1972 an air emergency service was initiated by a private institution without any special funding. This article describes the development, technical problems, medical aspects of the patients, and their transportation by this system. In 27 months, 2,650 patients have been transported by helicopter (85 percent) or fixed-wing plane.

101222

57. **Cobb, L. A., "Pre-hospital Coronary Care: The Role of a Rapid Response Mobile Intensive/Coronary Care system,"** ***Singapore Medical Journal*** **14:451, September 1973.**

This article describes a 2-year descriptive research study begun March 1970 in Seattle, Washington, in a cooperative effort involving Harborview Medical Center, The Seattle Fire Department, and the University of Washington, with one MCCU to provide rapid response to people in life-threatening emergencies. During the first 2 years of operation, the MCCU was dispatched to 4,891 patients, 511 of whom had VF when first seen. Ninety-two persons received life-saving therapy prior to hospital admission and were consequently discharged from the hospital. Fifty-seven of these long-term survivors were unconscious and had VF upon arrival of the emergency aid units, and eight developed VF after the arrival of the paramedical personnel. The average age of people with VF was 57 years. Therapy included CPR, defibrillation, endotracheal intubation, and drug administration. The vast majority with VF had underlying coronary artery disease, although less than 50 percent could be diagnosed as having AMI on the basis of ECGs and LDH isoenzymes during the postresuscitation hospitalization.

431212

58. **Cobb, L. A., and H. Alvarez, "Medic I: The Seattle System for the Management of Out-of-Hospital Emergencies,"** ***Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)*** **(Dallas: American Heart Association, Inc., 1975).**

This article reviews the initial 3-year experience with an out-of-hospital EMS system manned by highly trained paramedic personnel. The system is stratified and provides for primary response by EMTs as well as secondary response by advanced paramedics.

The immediate resuscitation rate has increased significantly from 34 percent in the first 2 years to 44 percent in the 3d year. The percent of patients saved has increased from 11 percent in the first 2 years to over 20 percent in the 3d year, also a significant difference. In the 3 years of the program, 202 lives have been saved. Of 900 patients in VF at the time of arrival of the unit, 121 were long-term survivors.

431212

59. **Cobb, L. A., H. Alvarez and M. Kopass, "A Rapid Response System for Out-of-Hospitals Cardiac Emergencies,"** ***Medical Clinics of North America*** **60, March 1976.**

This article describes several aspects of the initial 5 years' experience with a stratified out-of-hospital emergency medical care system. Methods and implementation described include (1) use of

established emergency care system (fire department), (2) hospital-based communication and direction, (3) extensive paramedic training, (4) community-wide involvement, and (5) easy patient access to the MICC system. The system is broadly based: it serves the city of Seattle and responds to all medical emergencies. The effectiveness of the system is mostly dependent on paramedical personnel supported by a rapid mean response time of 3 minutes and 75,000 local citizens trained in CPR. Cost is a major factor. Careful use of resources will result in a reasonable budget; thus, the major hurdle is political. A large population to service is needed to establish and maintain a good cost/effectiveness ratio. Seattle has the population and only a single government entity is involved.

101222

60. Cobb, L. A., R. Baum, H. Alvarez, et al., "Resuscitation From Out-of-Hospital Ventricular Fibrillation: Four Years Follow-un," *Circulation* 52:223-235, December 1975.

In 51 months, 234 patients with out-of-hospital VF were successfully resuscitated, hospitalized, and discharged to their homes. Patients surviving an episode of primary VF (VF not associated with AMI) showed a 2-year mortality rate greater than three times that of survivors from VF associated with acute transmural infarction. Recurrent out-of-hospital VF was common, and a pattern of early recurrence was noted, with a medium interval of 17 weeks in 34 documented cases. Ten patients were counted as long-term survivors from second episodes of out-of-hospital VF, one of whom survived a third episode. Coronary anatomy and VF were studied in 29 survivors of primary VF. Of the 29 patients, 23 had coronary disease and 17 were considered "operable." Exercise testing and left ventricular function studies were normal or minimally abnormal in approximately half of these patients.

431212

61. Cobb, L. A., R. D. Conn, and W. E. Samson, "Prehospital Coronary Care: The Role of a Rapid Response Mobile Intensive/Coronary Care system," *Circulation* 44:45, 1971.

This is an abstract of Cobb's Seattle study of patients served by the Seattle MI/CCU in its first year of operation. The sample includes 225 patients found to be in VF at the time of arrival of the unit. The outcome measures reported are morbidity (to the extent that none of the long-term survivors had severe brain damage) and a combined mortality figure of in-hospital and preadmission deaths. Of the 225 in VF, 31 were subsequently discharged. This study was presented as evidence that an "MI/CCU staffed exclusively by paramedics is one feasible approach to decrease out-of-hospital coronary deaths."

431212

62. Cobb, L., R. Conn, W. Samson, et al., "Early Experiences in the Management of Sudden Death with a Mobile Intensive/Coronary Care Unit," *Circulation* 41 and 42:111-144, October 1970.

In the first 3 months of service, the staff of a mobile intensive/coronary care unit (MI/CCU) attended 76 patients having sudden unexpected circulatory arrest. The unit was dispatched simultaneously with one of nine rapid response fire department aid cars located throughout Seattle. Resuscitation was initiated by aid car personnel, usually within 2 to 5 minutes of dispatch.

VF was diagnosed in 54 of the 76 patients (71 percent). In 18 patients with VF, effective heart rate and blood pressure were restored. Six of these survived and are ambulatory; and 4 weeks after VF, one has impaired but improving intellect. In five of the six survivors, a single d.c. shock was effective in removing VF. AMI evolved in three survivors, and previously suspected heart disease was present in five.

The early results from this rapid response system suggest that most instances of sudden cardiac arrest are probably caused by VF associated with ischemic heart disease, although AMI may not be detected even after resuscitation. In this early experience, therapy was effective in about 1 of every 10 patients with VF.

431212

63. Cole., L., J. Sims, S. Otterbein, et al., "Prehospital Cardiac Care: Illusion of Consensus," *Journal of the American College of Emergency Physicians* 6:552-555, December 1977.

To address the questions of standard practice for various arrhythmias, what an EMT should do in the field, what are the drugs of choice, and how good is EMT performance, clinical algorithms were developed to assess EMT performance.

Algorithms translate standard operating procedures into branching decision logic, forcing yes/no choices at every step. There exists a lack of consensus on what constitutes appropriate prehospital cardiac care. This stems from unproven medical advances, newness of paramedic roles, and variations in EMS systems across the country.

101222

64. Collins, J., "Organization and Function of an Accident Flying Squad." *British Medical Journal* 2:578-580, July/September 1966.

This article describes the history, set up, and implementation of the Derbyshire flying squad with respect to equipment, transport, staff, methods of calls, major accidents, communications network with hospitals, incoming help request calls, and cost. The "flying squad" is basically a resuscitation service that sees speed as being of vital importance with respect to getting to an accident. This service uses police personnel as adjuncts.

102222

65. Cooper, J. K., K. Steel, and J. P. Christudoulou, "Mobile Coronary Care—A Controversial Innovation," *New England Journal of Medicine* 906-907, October 16, 1964.

Several issues need to clarified before general implementation of MCCUs can be recommended. The first MCCUs must receive critical and fair evaluation. MCCUs offer an exciting option; however, they must be part of a total integrated approach. Because of the basic emergency facilities in some communities without mobile units, it is possible that implementation of other improvements would

result in essentially the same lifesaving benefit as a mobile unit but without the associated cost.

101222

66. **"Coronary Care On The Way. New Ambulance for Barnsley,"** ***Nursing Mirror*** **130:37, February 27, 1970.**
This article describes a new mobile coronary care ambulance system in Barnsley.

102222

67. **"Coronary Care: Prompt Action Saves Lives,"** ***Medical Journal of Australia*** **1:605-606, May 17, 1975.**
It is estimated that the possibility of saving many lives exists if patients can be brought to special coronary care facilities earlier. A number of possible solutions have been instituted in an attempt to achieve this aim. One of the most important is the education of the general public and the second is the development of the coronary care ambulance concept.

101222

68. **Craddock, G. B., T. E. Bean, and R. Crampton, "Version of Arrhythmia,"** ***Journal of the American Medical Association*** **229:1420, September 1974.**
This article discusses the incorporation of thympversion (and "bumpversion") into new revised standards for CPR. The authors feel that thumpversion will become appropriate prehospital treatment in cardiac arrhythmias.

201222

69. **Crampton, R. S., "Prehospital Emergency Care in the Commonwealth."** ***Virginia Medical Monthly*** **101:97-100 (editorial) February 1974.**
Four systems (Charlottesville and Albenarle County, Waynesboro, Haysi, and Virginia Beach) provide prehospital treatment for MI and sudden but reversible coronary death caused by arrhythmias. Results appear to be favorable. Two-thirds of the patients with prehospital cardiac arrest caused by AMI that were treated with prompt CPR survive to resume active life. One long-term followup of patients with AMI indicates an 86-percent survival rate 2 years after correction of VF outside the hospital.

101222

70. **Crampton, R. S., R. F. Aldrich, and J. A. Gascho "Reduction of Prehospital, Ambulance and Community Coronary Death Rates by the Community-Wide Emergency Cardiac Care System,"** ***American Journal of Medicine*** **58:151-165, February 1975.**
After the initiation of prehospital CPR and emergency cardiac (ECC) care, annual community rates for coronary death in people under 70 during ambulance transport fell by 62 percent and for prehospital coronary death, 26 percent. In cardiac arrest caused by AMI, prompt successful prehospital correction of VF and asystole yielded long-term survival in two-thirds of the cases. Community lives saved yearly were 15.2 per 100,000 people aged 30 to 69 and 6.4 per 100,000 people in the total population. According to the article annual community rates for coronary death as a cause of death fell by 15 percent and coronary death per 1,000 people fell by 17 percent. Crampton states that of the present frequency of coronary death during ambulance transport (9 to 22 percent of prehospital coronary death according to his and other surveys) suggests that prehospital CPR and ECC components need improvement. Crampton concludes that prehospital CPR and ECC have cheaply and effectively expedited and abbreviated hospitalization for AMI and lowered community death rates from coronary artery disease; adoption of this system throughout the United States and the western world seems justified.

431212

71. **Crampton, R. S., R. Aldrich, R. Stillerman, et al., "Reduction of Community Mortality from Coronary Artery Disease After Initiation of Prehospital Cardiopulmonary Resuscitation and Emergency Cardiac Care."** ***Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC) American Heart Association*** **193-195, Dallas 1973.**
This descriptive study was done between March 1, 1971, and December 31, 1972, in the Charlottesville-Albermarle, Virginia area with an EMT-staffed municipal MCCU serving a community of 80,000 over 745 square miles. The sample studied was a subset of 71 patients with AMI. The 15 patients in the sample with AMI had prehospital CPR ECC interventions begun before or during ambulance transport to the hospital. Ten of the 15 (67 percent) resumed active life after 13 CPRs, 7 cardiac defibrillations, 2 thumpversions and 3 tries at fist pacing; 84 percent of the CPR ECC interventions were required before and during ambulance transport (that is 21 out of 25 interventions). "The initiation of rapid prehospital CPR-ECC was associated with a significant fall in community rates for prehospital coronary death, ambulance transport death, coronary disease as a cause of death, and coronary death per 1,000 population. The frequency of ambulance transport deaths, which constituted 10 percent to 22 percent of prehospital and 8 percent to 13 percent of all coronary deaths in this and other surveys, further emphasizes the need for upgrading the quality of prehospital CPR-ECC in the community."

431212

72. **Crampton, R. S., R. Michaelson, R. Aldrich, et al., "Prehospital Care for Myocardial Infarction,"** ***New England Journal of Medicine*** **291:418, August 1974.**
The authors review findings of several salient studies made within the last 6 years. These studies show that (1) in hospital systems with EMS community mortality caused by AMI decreased 15 percent versus 3 to 5 percent with CCUs only; (2) calculations for regional CCUs preclude influence of prehospital care in 8 to 10 percent of hospital mortality rate; (3) quality of care rather than prehospital period is more important; (4) CCU admissions in specific communities increased from 36.3 to 75.0 per month after mobile units were added; and (5) the family doctor should be included in rural coronary care systems.

The authors conclude that the quality of prehospital care of AMI, even though applied briefly during

contact with the ambulance system, may definitely influence prehospital and hospital mortality and morbidity and the need for and use of CCU beds.

201222

73. **Crampton, R. S., S. P. Michaelson, A. Wynbeek, et al. "Reduction of Pre-hospital, Ambulance, and Hospital Coronary Death by the Pre-hospital Emergency Care System: A Rationale for Training Emergency Medical Technicians, Nurses, and Physicians,"** ***Heart and Lung*** **3:742-747 September/October 1974.**

The authors describe the Charlottesville-Albemarle Rescue Squad System and report the results of a 3 year experience with this system. The authors state that during the 3 years, the prehospital coronary death rate fell 26 percent and the ambulance coronary death rate fell 62 percent. Hospital mortality for patients with AMI managed in the pre-hospital setting was lowered significantly to 8.8 percent, and only 5 percent had cardiogenic shock. Provision of pre-hospital cardiac care saved at least 5.8 lives per 100,000 population each year.

431212

74. **Crampton, R. S., J. R. Miles, J. A. Gascho, et al., "Amelioration of Prehospital and Ambulance Death Rates from Coronary Artery Disease by Pre-hospital Emergency Cardiac Care,"** ***Journal of the American College of Emergency Physicians*** **4:19-23, January/February 1975.**

This article reports the hospital mortality rates of 119 patients transported by the Charlottesville, Virginia, CPR-ECC system from March 1, 1971, to December 31, 1973. It is descriptive research with percentage reportings and chi-squared statistical tests. Of the 119 patients, 13.4 percent died. Of 20 patients under 70 years of age, 60 percent resumed a normal active life. "Prompt CPR-ECC . . . accounted for the significant fall in ambulance deaths in 1972," but not in 1971 or 1973. In the cohort 30 to 69 years of age, 13.4 lives per 100,000 people were saved by prehospital CPR-ECC annually.

431212

75. **Crampton, R. S., R. Stillerman, J. A. Gascho, et al., "Pre-hospital Coronary Care in Charlottesville and Albermarle County,"** ***Virginia Medical Monthly*** **99:1191-1196, November 1972.**

This article describes prehospital coronary care in Charlottesville and Albermarle County. The system discussed uses existing volunteer and hospital personnel. During a 1-year period, 96 calls from the community were answered. Subsequently 51 patients (53.1 percent) entered the hospital CCU, of whom 22 (21.9 percent) had AMIs, and 13 (15.6 percent) had coronary insufficiency. VF was removed outside the hospital in four cases and two have since returned to work. Two of the 22 AMI patients died, indicating a hospital mortality rate of 9.5 percent. A 15.3-percent reduction in coronary artery disease deaths per 1,000 people in the community was recorded.

431212

76. **Cretin, S., "A Model of the Risk of Death from Myocardial Infarction," Technical Report No. 09-74 for Operations Research Center, Massachusetts Institute of Technology, Cambridge, Massachusetts, November 1973.**

Cretin develops a computer simulation method to assess the risk of death from MI. Her model contains two components: (1) a general model of MI that describes the experience of a MI victim from the time of infarction until death and (2) a detailed model of prehospital death that describes the probability of an MI patient dying prior to hospital admission. Output from the prehospital model is compared with results from studies of mobile coronary care programs to verify the VF parameters.

301222

77. **Croog, S. H., D. S. Shapiro, and S. Levine, "Denial Among Heart Patients,"** ***Psychosomatic Medicine*** **35:385-397, September/October 1971.**

Among 345 men (specific location omitted) ages 30 to 60 years under treatment for approximately 3 weeks after a first MI, 20 percent were classified as denying that they had had a heart attack. "Deniers" and "nondeniers" of the heart attack were compared with regard to (1) whether there were social and psychological correlates of the clinical response, and (2) other areas to which denial was generalized. A third area examined was the temporal aspect; i.e., the manifestation of the denial over time.

Findings obtained from three interviews over a period of a year suggest an association between denial and ethnic background. Generalization of denial of the heart attack appeared in such findings as a tendency to disavow negative traits, minimizing of symptoms, and minimizing the effects of the attack on life in general and on work in particular. One association of relevance to physicians was the tendency for "deniers" to resist medical advice related to work, rest, and smoking. Differences in response between the "deniers" and "nondeniers" were noted 1 month after discharge from the hospital and 1 year postinfarction, suggesting persistence of denial.

491222

78. **Crowley, R. A., F. Hudson, E. Scanlan, et al., "An Economical and Proved Helicopter Program for Transporting the Emergency Critically Ill and Injured Patient in Maryland,"** ***Journal of Trauma*** **13:1029-1038, December 1973.**

This article reports on a medical evacuation program that has been functioning in Maryland for over 3 years. The system feeds into the University of Maryland Center for Trauma. The program's evaluation is described, and the use of State agencies renders the operation economical.

Between April 1969 and December 1972, over 1,000 patients were transported.

101222

79. **Czachowski, R. E., D. E. Reed, and D. S. Parrucci, "The Effectiveness of Mobile Coronary Care in a Non-Urban Setting,"** ***Journal of the American College of Emergency Physicians*** **5:501-504, July 1976.**

Two hundred twenty-five patients in Greensburg, Pennsylvania, received care from an MCCU staffed by coronary care nurses from the hospital CCU. One hundred twenty-six patients were eventually diagnosed as coronary disease cases while 99 were released with a noncardiac diagnosis. Eight lives were definitely saved: three for the long term (discharged

from hospital) and five short term (died in hospital). Seven other lives were possibly saved: six for the long term and one short term.

431212

80. Czawa, S. J., and C. G. Drury, "An Evaluation of Emergency Medical Technicians" (Buffalo: Research and Evaluation Unit, Emergency Medical Services Project, Lakes Area Regional Medical Program, Inc., 1975).

The study involves EMTs in Erie County. A greater emphasis on CPR and splinting fractures is needed and reflected by the caseload. The authors found that the teaching skills of instructors should be upgraded and doctors should be better briefed so that their teaching is more consistent. Further, the ER observation part of the course needs organizing to achieve more clearly understood roles between EMTs and emergency room staff.

Findings show that written exams are not good predictors of an EMT's future performance. Diagnostic accuracy of the EMTs was consistent with emergency department physicians in 92 percent of all cases. The treatment given by EMTs were judged as being appropriate in 89 percent of the cases.

The authors conclude that EMT training in Erie County is effective.

511122

81. Daberkow, S. G., "Location and Cost of Ambulances Serving a Rural Area," *Health Services Research* 12:299-311, Fall 1977.

Concentrating on the EMS ambulance system in a rural northern California environment with seasonal fluctuations in the population, a location model is used to determine the most efficient number and location of ambulance facilities. The model incorporates response time and service time standards into the analysis, and indicates the tradeoff between cost and various time standards. The financial feasibility of individual facility locations is then analyzed. The results indicate that the use of volunteer services appears to be necessary in areas with low population density and infrequent need for an ambulance.

301222

82. Dalen, J. E., "Pre-hospital Coronary Care," *American Journal of Public Health* 67:512-514, June 1977.

In the author's review of two reports by Pozen et al. in the *American Journal of Public Health* 67:512-514, June 1977, and the Emergency Medical Services in Seattle, he concludes that citizen involvement is vital if EMS aimed at providing pre-hospital care for citizens with acute ischemic heart disease is to be successful.

101222

83. Dembo, D. H., and L. Scherlis, "Standards for Cardiopulmonary Resuscitation and Emergency Care—Medicolegal Considerations," *Maryland State Medical Journal* 23:69-70, May 1974.

This article proposes four areas in which standards should be set for CPR and emergency care: (1) in the area of initiation and termination of resuscitation efforts, it sets forth standards for the physicians and the nonphysicians; (2) with respect to orders not to resuscitate, the article tells when CPR should be contraindicated; (3) with respect to conference* recommendations for advanced life support, a 24-hour-per-day plan is necessary for each hospital; and (4) with respect to conference recommendations on necessary legislative action, the article specifies whom should be certified for CPR, and offers qualified immunity recommendations.

101222

84. DePasquale, N. P., and M. S. Bruno, "Prevention of Sudden Cardiac Death," *Heart and Lung* 2:851-856, November/December 1973.

Because the CCU cannot lower mortality by a large percentage, the main thrust of prevention of sudden cardiac death must be directed toward prevention of the fatal rhythm disturbance rather than the correction of the disturbance once it has occurred. Secondary prevention should be concerned with early detection of patients with heart disease, avoidance of delays in reaching the hospital (i.e., MCCUs, life-support units, cardiac observation stations, and elimination of patient and physician delay), and elimination of cardiac arrhythmias that may precipitate VF.

101222

85. Dewar, H. A., J. P. K. McCollum, and M. Floyd, "A Year's Experience with a Mobile Coronary Resuscitation Unit," *British Medical Journal* 4:226-229, October 1969.

This article relates the experience of an MCCU during its first year of operation in Newcastle upon Tyne. The sample of 134 calls is divided according to diagnosis: 62 percent were MI cases, 20 percent had coronary pain, and 6 percent were diagnosed as other cardiac.

The study attempts to evaluate the usefulness of the unit by determining the number of patients who benefitted "definitely," "substantially," or "appreciably" from the MCCU treatment. The study also reports mean delay times for the following intervals: (1) from symptom onset to call for physician, (2) from call for ambulance to ambulance arrival, (3) from ambulance arrival to departure for the hospital, and (4) from departure with patient to arrival at hospital.

432211

86. Diamond, N., J. Schooferman, and J. W. Elliott, "Factors in Successful Resuscitation by Paramedics," *Journal of the American College of Emergency Physicians* 6:212-216, February 1977.

The out-of-hospital reports of 2,152 consecutive paramedic fire rescue responses were reviewed. Examination of emergency department records and outcome was conducted in all cardiopulmonary arrests (120), major trauma (59) or nontraumatic hemorrhage (9), and one-half of the patients (95 of 199) with chest pain or possible MI. The predominant age group was 50 to 70, and men

*National Conference on Cardipulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC), National Academy of Sciences, Washington, D.C., May 1973.

outnumbered women by 4 to 1. Arrival at the scene was in 5 minutes in over 70 percent of the cases. Of the 120 patients with cardiopulmonary arrest, 30 responded to CPR, 24 entered the CCU, and 16 (13 percent) were discharged alive.

421212

87. **Duggan, J. J., and M. C. Barrett, "A Community Approach to Coronary Care,"** ***Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)*** **(Dallas: American Heart Association, Inc., 1975).**

This article describes the introduction of prehospital coronary care in Syracuse, New York. Of the first 518 runs, 40 percent were for patients with acute coronary disease and 60 percent of the calls were clearly appropriate.

101222

88. **"Early Care of the Acute Coronary Suspect: Bethesda Conference Report,"** ***American Journal of Cardiology*** **123:603-618, April 1969.**

This article reports on the Bethesda Workshop Conference. The conference recommended studies for the development of knowledge in several areas: (1) sequence of events leading to sudden death, (2) patient behavior, (3) professional response, (4) availability of medical services, (5) effectiveness of emergency treatment, (6) effectiveness of MICUs, (7) legal status of nurses and paramedics, (8) improved diagnostic techniques, and (9) development of less toxic drugs. The conference recommended a mobilization of health resources and also education of both patients and members of the medical profession.

101222

89. **Easley, R. M., and A. J. Moss, "Fixed Life Support Station in an Industrial Location,"** ***Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)*** **(Dallas: American Heart Association, Inc., 1975).**

This article describes a satellite intensive CCU equipped with adequate material for resuscitation and life support, at the Eastman Kodak Company in Rochester, New York. The authors also attempt to find out if the unit made a significant difference in prehospital mortality by comparing a comparable number of on- and off-duty employees ($n = 65$ and $n = 98$, respectively) with sudden cardiovascular death or definite or probable MI. It appears that satellite units, although effective for occasional patients, do not significantly reduce the major impact of sudden death in patients with ischemic heart disease.

491212

90. **"The Economics of Highway Emergency Ambulance Services,"** ***Northwest Medicine*** **68:333-338, April 1969.**

This article reviews the Dunlap Report, which is divided into two parts. The first is a survey of existing administrative and operational practices. The second is the development of guidelines for the design and analysis of ambulance systems. An analysis of the use of the helicopter is included.

101222

91. **Eisenberg, M., L. Berger, and A. Hallstrom, "Paramedic Programs and Cardiac Mortality: I. Factors Associated With Successful Resuscitation from Cardiac Arrest." unpublished (University of Washington affiliation).**

The article reports on an experimental study that compares outcomes of EMT-treated patients with paramedic-treated patients. Eisenberg's patients came from 81-hour EMTs (cannot defibrillate). The paramedic patient sample came from the Seattle suburbs that are designated to receive care from paramedics.

Eisenberg studies only the out-of-hospital cardiac arrest incidents receiving CPR from either a paramedic or an EMT. Trauma incidents are not included. Outcomes in terms of hospital admissions and hospital discharge (alive) are compared with respect to type of emergency personnel rendering treatment, bystander-initiated CPR, and initiation of CPR within 4 minutes of collapse. The latter two factors were determined to be statistically significant with respect to both hospital admission and hospital discharge.

521111

92. **Eisenberg, M., L. Berger, and A. Hallstrom, "Paramedic Programs and Cardiac Mortality: II. Impact on Community Mortality," unpublished (University of Washington affiliation).**

This article reports on community cardiac mortality rates in suburban Seattle from April 1976 to March 1977. Community mortality rates in the suburban area of Seattle receiving emergency care from EMTs are compared with those of the suburban area of Seattle receiving paramedic emergency care. Eisenberg identified 1,053 deaths caused by acute cardiovascular disease, 750 of which occurred in the EMT served area. The annual heart disease mortality rate for the 12 months was 17.4 per 10,000 in the combined study area, 19.7 per 10,000 in the EMT area, and 13.5 per 10,000 in the paramedic area. Reduction in community cardiac mortality was 6.8 percent in the paramedic area and 1.3 percent in the EMT area.

521212

93. **"Emergency Medical and Health Services in Pennsylvania, Present Status Recommendations for Improvement,"** ***Pennsylvania Medicine*** **4:43-70, June 1971.**

The first section of this article is a summary of the data collected by the Commission on Emergency Medical Services. The second section presents recommendations.

101222

94. **Engman, F. J., B. C. Campion, J. W. McBride, et al., "Mobile Coronary Care in Management of Prehospital Cardiac Arrest,"** ***Minnesota Medicine*** **59:833-835, December 1976.**

The first full year's operations of the St. Paul expanded emergency system, which includes MCC, is described. A total of 199 patients with out-of-hospital cardiac arrest were seen with data available on 186 patients: 34.4 percent survived to reach the hospital after treatment by paramedic personnel in voice and telemetry contact with physicians at St.

Paul-Ransey Hospital and Medical Center; 12.4 percent survived to leave the hospital. Of patients with tachyarrhythmias, 16.9 percent survived while only 1.9 percent with bradydysrhythmias lived.

421212

95. Erhart, L. R., A. Sjogren, U. Salve, et al., "Pre-hospital Phase of Patients Admitted to a Coronary Care Unit," *Acta Medica Scandinavica* 196:41-46, July/August 1974.

The interval between onset of chest pain and admission to a Stockholm CCU has been investigated in 137 patients, 42 percent of whom were in the CCU within 3 hours of onset of symptoms. The main part of the interval was patient delay: 30 percent of calls for help were within 30 minutes, yet many waited 3 hours or more. Of those seeking help within 30 minutes, 85 percent were in the CCU within 3 hours of onset of symptoms. Almost one-half of the patients sought help by calling the Central Health Information Center, and 84 percent of the patients were sent to the hospital without first being seen by a physician. The subsequent diagnosis (i.e., AMI versus non-AMI), did not affect the delay. Factors in the past medical history of patients associated with a shorter delay were previous CCU care and a visit to the doctor within the past year. Delay was also shorter for patients not at home at the onset of symptoms and for those who encountered a positive attitude when calling for medical help. For unknown reasons, there were significantly more patients with anterior infarctions among those with a short delay. Sex, age, and self-diagnosis did not affect the delay.

492221

96. Estell, D. A., and S. N. Smock, "Blind Defibrillation Outside the Hospital," *Journal of the American College of Emergency Physicians* 5:512-514, July 1976.

Blind defibrillation, defibrillation of an unconscious, pulseless adult without electrocardiogram verification of arrhythmias, allows early definitive treatment of cardiac arrest victims. Basic EMTs have the ability to perform blind defibrillation in a pre-hospital setting, and place an esophageal obturator airway. When basic EMTs are performing a blind defibrillation, there should be a standard operating procedure involving diagonsis, defibrillation, CPR, and reevaluation.

101222

97. Fahey, M. F., "The Establishment of Decentralised Accident Teams in Christchurch," *New Zealand Medical Journal* 82:191-193, September 24, 1975.

This article describes the organization, method of operation, and evaluation of decentralized medical accident teams established in Christchurch, New Zealand. The results from a 5 year study of accidents attended by the author, establish a need for these units.

102222

98. Findeiss, J. C., "Protocols for On Site Critical Care by the EMT-Paramedic," Findeiss, J. (ed.), *Emergency Management of the Critical Care Patient* (New York: Stratton, pp. 227-261, 1975).

An article about protocols established for on-site critical care by EMTs—paramedics in EMS in Dade County, Florida. Fourteen protocols have been established and are enumerated in the article, including protocols for (1) EMT on-site care, (2) CPR, (3) trauma, (4) chest pain, (5) coma, (6) toxicology, (7) shock, and (8) dysrhythmia. These protocols were developed to expedite and standardize the care rendered in the Dade County EMS system.

101222

99. "First Aid to Acute Myocardial Infarction," *British Medical Journal* 1:356-367, February 1976.

The article discusses a safe guide to intervention for the MCCU. The author states that the patients to save are those who die from arrhythmia at the start of their attack, and it is these patients that the MCCU may help.

102222

100. Flax, P., T. Larke, and G. Wulser, et al., "The Mechanics of Widespread Training of Cardiopulmonary Resuscitation: A Community Project Implemented by Volunteers," *American Heart Journal* 91:123-125, January 1976.

This article describes the mechanics of instituting a program of widespread community training in CPR. It concludes that it is possible to successfully accomplish such a program with motivated volunteer personnel.

The CPR committee of the Marin County Heart Association initiated a program in 1973 to train its citizens in the basic life support measures of CPR. The project was implemented by volunteer personnel. The project trained two nonprofessional groups: ninth grade students and citizens who had an interest in CPR, ususally because of a probable association with "high risk" individuals.

101222

101. Flexer, M., "What Potential for Helicopters in EMS?" *Hospitals* 49:60-63, February 1975.

The article describes two federal programs: (1) projects of the Department of Transportation established in 1966 and (2) the Military Assist to Safety and Traffic program begun in 1970. The results of these programs have proved the usefulness of the helicopter as an emergency ambulance in rural areas but not in urban areas.

201222

102. Freeman, J. W., and M. G. Loughhead, "A Coronary Care Ambulance Controlled by Radio Telemetry," *Medical Journal of Australia* 1:132-134, February 1975.

This article describes an MCCU that relies upon radiotelemetry so that trained ambulance officers can defibrillate patients and administer intravenous injections under direct instructions from a hospital physician.

Results from 1 year's experience with the MCCU are analyzed to determine the percentage of requests made by the public as opposed to a physician. Of the 320 calls answered by the MCCU, 33 percent had proven AMI; 60 percent of the MI patients had the MCCU requested by a member of the public. In

addition, 60 percent of all cardiac calls (final diagnosis) were requested by a member of the public.

Delay times are also recorded for response time from receipt of the call to the arrival of the ambulance and for the time from the establishment of radio contact to the arrival at the assessment area.

432211

103. Frey, R., F. W. Ahnefeld, E. L. Navel, et al., "Mobile Intensive Care Units and Advanced Emergency Care Delivery Systems," *Journal of the American College of Emergency Physicians* 4:60-65, January/February 1975.

This article relates recommendations for (1) planning and organization of the EMS system, (2) communications, (3) treatment at the scene and during transportation, (4) continuing life support in the hospital, (5) data acquisition and evaluation of the system, (6) training, (7) the emergency cardiac system, (8) disaster preparedness and care, and (9) research and innovations.

101222

104. Fry, J., and J. B. Dillane, "Acute Coronary Deaths," *Journal of the Royal College of Physicians* 14:44-49, July 1967.

The author studies the patients encountered in 17 years of his practice (1949-66) who died from direct effects of coronary heart disease. The 97 who died within 24 hours of the onset of symptoms constitute the study sample. The findings reported are that 71 percent of the 38 patients for whom resuscitation might have been successful died within the final hour. The authors conclude that there is a need for mobile ECC.

402222

105. Gambier, D. M., "Advances in Acute Coronary Care," *Journal of the Royal College of General Practitioners* 20:90-97, August 1970.

This article discusses whether any of the principles of treatment developed in the intensive care unit could reasonably be applied to treatment of patients either at home or before admission to the CCU. He believes that some forms of treatment can. Gambier also attempts some evaluation of attempts made to bring intensive care out of the hospital to the patient.

102222

106. Gambier, D. M., "Advances in Acute Coronary Care—Part 2," *Journal of the Royal College of General Practitioners* 20:153-162, September 1970.

This article reviews the Belfast and Newcastle upon Tyne MCCUs. The author looks at the Edinburgh study and death from MI occurring in his own and the practices of his partners (1966-69), and concludes the following: MICUs have demonstrated that cardiac resuscitation outside the hospital is a practical proposition. The speed by which patients are brought under intensive care remains the crucial factor in success or failure. Geographical and traffic problems will limit the development of such units. Where conditions are favorable, MICUs offer the patient the best chance of survival. Whether MICUs are available or not, avoidable patient delays occur before treatment is instituted. The timely use of lidocaine, atropine, steroids, oxygen, and external cardiac massage may reduce the high mortality rate from AMI.

102222

107. Gearty, G. F., N. Hickey, G. J. Bourne, et al., "Pre-hospital Coronary Care Service," *British Medical Journal* 3:33-35, July 1971.

This study shows that resuscitation of a limited number of patients with primary ventricular fibrillation is an important benefit of MCC.

The Dublin cardiac ambulance service operates two specially equipped ambulances from a private ambulance station; five metroplitan hospitals provide coronary care beds on a rotating system. The service covers an area of 450 square miles and a population of 800,000. The ambulances are staffed solely by trained ambulance personnel. During the first 3 years, 1,973 patients were transported to the hospital. Primary ventricular fibrillation was encountered in 20 patients and successfully treated in 17. No deaths occurred in the ambulance.

Over 98 percent of the patients were transferred uneventfully to the hospital, so a medical team from the hospital on duty was called on 30 occasions only. A feature of the Dublin service is the low cost of a standard ambulance call—about £ 7.50.

432211

108. Geddes, J. S., "Instant Intensive Care for Myocardial Infarction," *Nursing Times* 64:1614-1616, November 29, 1968.

This article emphasizes that early treatment at the patient site can prevent many deaths resulting from arrhythmias. The need for MCCUs is stressed. The author describes the Belfast system and reports a few results to support the system.

102222

109. Geomet Inc., *Impact Evaluation of Emergency Medical Service Projects: Vol. 1, Methodological Studies on Patient Outcome and Cost Analysis; An Executive Summary* (Springfield, Virginia: National Technical Information Service, July 1975).

This theoretical study considered patient outcome evaluation through a multivariate analytical model that would test associations of system process variable with measures of outcome. Process measures involved were delay times and level of care at all phases of EMS. Outcome measures were the patient's condition at each stage of care and postcare mortality and morbidity. A field trial was performed, using emergency arrivals at a large urban medical center and a small rural hospital. Objectives included testing data collection procedures and investigating specific means for parameterizing process and outcome. Patients were selected for the study from selected days and shifts and the intention was to choose the more serious and urgent conditions. The report concentrates on interview data and on investigating the use of functional scales in outcome measurement.

301222

110. Ghent, W. R., "Ontario's Ambulance Service, DOA?," *Canadian Medical Association Journal* III: 1265, 1268, December 1974.

The author talks about the leadership role Ontario

has played in developing an ambulance service (more recently under the aegis of the Ministry of Health). Four types of service were recognized in 1966 in the first Ambulance Act: private service, volunteer service, municipal service (police and firemen), and hospital-based service (Ministry of Health). Private owners were brought into the system several years ago. British Columbia is developing a provincial ambulance service based on the Ontario experience.

202222

111. Gibson, G., "Emergency Medical Services: The Research Gaps," *Health Services Research* 9:6-21, Spring 1974.

The author evaluates 24 research presentations on EMS at the American Public Health Association meetings in November 1973. He categorizes each paper according to type of research presented (basic, applied, project description, project evaluation) and its subject matter (EMS needs, EMS structure, Demand/Process, Outcomes). The research problems within each category are discussed and the underdeveloped research areas, particularly those dealing with outcomes of EMS, are noted. The article makes recommendations for general strategy for expanding research in this area, including the need to delineate better variables and processes of EMS need, structure, or demand to use as independent variables to explain outcome. The author makes note of problems in isolating the independent effect of an individual EMS factor in patient outcome. The author also indicates a need for more descriptive detailed data on EMS-related condition outcomes and more concentration on developing appropriate methodologies. Problems with funding agencies exist and they sould insist on outcome evaluation of projects and careful monitoring of projects to reward good evaluation and penalize sloppy evaluation.

101222

112. Gibson, G., "Evaluative Criteria for Emergency Ambulance Systems," *Social Science and Medicine* 7:425-454, 1973.

Although agencies have developed minimum standards for emergency ambulance services, systematic criteria for program evaluation are lacking. In particular, sensitivity and specificity indexes are required to evaluate the extent of inappropriate ambulance use and of unmet need. The present study has examined over 50 evaluative surveys of emergency ambulance service in the United States and abroad in an attempt to develop suitable evaluative criteria. Using data from the recent University of Chicago survey of EMS (which monitored over 3,000 Police and Fire Department ambulance runs, surveyed ambulance companies in Cook County, Illinois, and secured interviews and clinical data on 5,000 emergency department patients), evaluative criteria are proposed and applied to the Chicago emergency ambulance system. The measures are also applied to ambulance data secured from 25 U.S. cities. The measures include ambulance availability and use rates, process criteria (such as response times, and incidence of first aid), disposition criteria (quality of receiving hospitals), and criteria for unmet need. Total availability (ambulances per 100,000 population) ranged from 13.52 (Kansas City) to 1.78 (Newark); total use (ambulance runs per 1,000 population per year) varied from 90.4 (St. Paul) to 13.3 (Kansas City). Applying the proposed Ambulance Sensitivity Index and the Ambulance Specificity Index to the Chicago situation indicated that although 84 percent of ambulance cases were "true" emergencies, only 38 percent of emergency department cases in clinical need of ambulance transportation actually received it.

301121

113. Gibson, G., "Guidelines for Research and Evaluation of Emergency Medical Services," *Public Health Reports* 89:99-111, March/April 1974.

This paper outlines several methodologies and formats for securing and presenting baseline evaluation data on the preintervention state of EMS in a service area and impact evaluation data to measure the nature of change brought about by intervention. Methodologies and data formats are presented to analyze resources, patients needs, use and outcomes of EMS.

101222

114. Gibson, G., E. R. Prehar, and J. L. Wagner, "Evaluative Measures and Data Collection Methods for Emergency Medical Services Systems." *Public Health Reports* 92:315-321, July/August 1977.

This article suggests methods for collecting data (for example, hospital, public safety, and ambulance forms; telephone surveys; and available EMS project data) and reports evaluative measures for EMS systems. The list of evaluative measures given are organized according to EMS components as specified in the Emergency Medical Services Systems Act. Evaluation involves manpower, training, communication, facilities and critical care units, and public safety agencies.

101222

115. Gillum, R. F., M. Feinleib, J. R. Margolis, et al., "Delay in the Prehospital Phase of Acute Myocardial Infarction," *Archives of Internal Medicine* 136:804-806, July 1976.

Prehospital delay is considered to be an important cause of out-of-hospital coronary mortality. Behavior of patients and physicians in response to the symptoms of MI or impending out-of-hospital death was studied for 107 consecutive acute coronary events in Framingham, Massachusetts. Delay caused by inappropriate patient behavior was the most important component of total delay. Delay related to patient/physician contact occured in two-thirds of the MI cases, and in half of these the delay was more than 30 minutes. Office visits and inappropriate triage by nurses and receptionists were important factors in physician delay. Travel to hospital facilities was a relatively minor component in overall delay; however, 60 to 75 percent of out-of-hospital deaths occur so rapidly that their prevention by reduction of prehospital delay seems impossible. An educational program for the public as well as physicians as a strategy for reduction of delay may be of benefit in preventing some of the out-of-hospital deaths.

401221

116. **Goldstein, S., and A. J. Moss, "Sudden Death and Pre-hospital Phase of Acute Myocardial Infarction," *Chest* 61:600-602, June 1972.**
Mobile units are of major importance to individual patients resuscitated, although their effect is relatively small when compared to the overall problem of sudden death. These units provide safe transportation to the hospital for AMI patients and resuscitate a certain number of patients in transit, but most patients who initiate the call are on the descending limb of the mortality curve because of patient delay. The most impressive effect of these units is their ability to resuscitate certain patients when they have succumbed suddenly in the community and outside the hospital. Three approaches seem necessary for the successful reduction of the major factor in the mortality of coronary heart disease: (1) high risk patients need to be identified so therapeutic programs may be developed, (2) new approaches (like the MICU and fixed life support stations) to the therapy of sudden death as a specific disease entity must be developed, and (3) the community must be educated about early response to the symptoms of coronary heart disease.
101222

117. **Goldstein, S., A. J. Moss, and W. Greene, "Sudden Death in Acute Myocardial Infarction," *Archives of Internal Medicine* 129:770-774, May 1972.**
Factors affecting hospitalization delay and sudden death were studied in 98 patients with AMI in an industrial population. History of heart disease and misinterpretation of symptoms as recurrence of angina delayed arrival at hospital. In 19 of 22 patients who died suddenly, there was a history of a previous MI or angina. The same factors that delayed hospital arrival are associated with sudden death. The use of a fixed satellite industrial CCU shortened arrival time when symptoms began while the patient was at work but had an adverse effect when symptoms occurred when the patient was not at work. The unit did not reduce sudden death mortality.
491211

118. **"A 'Good' Place To Have A Heart Attack," *International Journal of Occupational Health and Safety* 44:34-37, May/June 1975.**
This article describes the WE Indianapolis Works emergency system for cardiac care. The personnel include a physician, a nursing staff, and 300 employees who have received CPR training from the Marion County Heart Association. The article discusses the communication system with the hospital, the special ambulance, and the critical first minutes.
101222

119. **Gorry, A. G., and D. W. Scott, "Cost-Effectiveness of Cardiopulmonary Resuscitation Training Programs," *Health Services Research* 12:30-41, Spring 1977.**
cost-effectiveness of programs to train large numbers of citizens in CPR. The model determines the probability of interventions for various numbers of trained citizens and for several allocation strategies and patterns of population density. The key factors are the maximum distance from which a person with CPR training could intervene in an emergency, the cost of training, and the loss of skill with time. The model is used to analyze possible training efforts in Houston, Texas. Although it is not considered in the model, the authors suggest that the type of person trained in CPR probably matters as does the relationship between the distribution of emergencies and the distribution of the population.
301222

120. **Gorsuch, T. L., C. Nichols, E. Driver, et al., "Mobile Pre-hospital Coronary Care in Waynesboro, Virginia," *Virginia Medical Monthly* 101:121-125, February 1974.**
This article describes a MCCU using nurses from the in-hospital CCU and regular members of the local rescue squad. The system requires no equipment not already in use except a portable drug box.

In its 15-month operation, the mortality rate of AMI patients dropped from 20 percent after the implementation of in-hospital CCU care to 12 percent for those patients receiving care from the mobile CCU. Of 198 calls answered by the MCCU, 33.3 percent had proved AMI. Of the 66 AMI patients, 4.5 percent died before admission and 7.6 percent died in the CCU.
431212

121. **Gotsman, M., and V. Schrire, "Acute Myocardial Infarction—An Ideal Concept of Progressive Coronary Care," *South African Medical Journal* 42:829-832, August 1968.**
This article is an examination of progressive coronary care and the particular application of the principle of providing several related services with different nursing and medical requirements according to the degree of risk and bedfastness of the patient. (In AMI the risk of death is highest in the first few hours, then symptom onset and risk decreases exponentially with time.) This concept defines three types of care: (1) intensive care, (2) standard inpatient nursing care, and (3) convalescent medical care. Emergency care is considered to be the responsibility of the "Flying Squad—Mobile Ambulance." Adequate care under this type of system requires a policy of progressive treatment, with a staff of trained coronary-care nurses, continuous medical care from the doctors, and appropriate electronic monitoring equipment.
102222

122. **Gotzche, H., and A. Lysgaard, "Cardiac Arrest in Heart Disease: With Special Reference to Survival Results in a Regular Emergency Service in Hospital Wards and an Urban District," *Acta Anaesthesiologica Scandinavica*, supplement, 29:217, 1968.**
This study involved 449 "cardiac patients" on which resuscitation had been attempted for several acute episodes. Of these, 44 patients were found not to have had cardiac arrest, which gives a total of 405 heart-disease patients with cardiac arrest, 361 outside the hospital and 44 in the hospital wards.

Survival rates were 13 percent out of hospital and 16

percent in the hospital for patients with acute coronary occlusion. Survival rate for those without coronary disease was 10 percent. Survival rate was 2 to 3 percent for the rest of the series as a whole (5/256), and for the group having coronary sclerosis without acute coronary occlusion outside the hospital (3/113), the long-term survival rate was 6 percent for the total sample.

492212

123. Grace, W. J., "The Mobile Coronary Care Unit and the Intermediate Coronary Care Unit in the Total Systems Approach to Coronary Care," *Chest* 58: 363-368, October 1970.
A system of patient care is described in which the patient with AMI is under the umbrella of continuous ECG monitoring outside the hospital; in the ER; in the CCU; and, finally, in a mobilization unit referred to as the intermediate CCU.

101222

124. Grace, W. J., "Out-of-Hospital Care for Cardiac Emergencies: Prevention of Sudden Death in the Community," *Heart and Lung* 3:733-735, September/October 1974.
This article is an introduction to a symposium on sudden death outside the hospital. Grace states that something can be done about sudden death, and that most sudden deaths are due to arrhythmias, not shock.

Because most victims of lethal arrhythmias and AMI never reach the hospital, the techniques of the in-hospital CCU must be applied outside the hospital. This out-of-hospital medical care must be combined with intensive educational programs.

101222

125. Grace, W. J., "Prehospital Care and Transport in Acute Myocardial Infarction," *Chest* 63:469-472, April 1973.
The patient is the source of the greatest delay to entering the medical care system. Even if the patient decides to enter the system early, two problems remain: poor communication and lack of out-of-hospital support systems. The development of the 911 emergency phone number and out-of-hospital CCUs are effective ways of circumventing these problems.

This article explains a community-wide system involving out-of-CCU mobile and fixed life support stations.

101222

126. Grace, W. J., and J. A. Chadbourn, "The First Hour in Acute Myocardial Infarction," *Heart and Lung* 3:736-741, September/October 1974.
This article describes a mobile CCU in New York City and reports its results. The hospital mortality of patients treated outside the hospital within 1 hour of the onset of symptoms with subsequently proven AMI was 8.6 percent. The findings showed a 21.7 percent hospital mortality in patients treated outside the hospital 1 hour or more after the onset of symptoms with subsequently proven AMI.

431211

127. Grace, W. J., and J. A. Chadbourn, "Mobile Coronary Care Unit," *Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).
The authors describe an MCCU that covers about four square miles of lower Manhattan. Of 70 patients attended to by the MCCU within 1 hour after the onset of chest pain, there were five deaths, a mortality rate of 7.1 percent.

431212

128. Grace, W. J., and J. A. Chadbourne, "The Mobile Coronary Care Unit," *Diseases of the Chest* 55:452-455, June 1969.
St. Vincent's Hospital and Medical Center in New York undertook an MCCU project. The experience indicates that such a project is feasible. The problems to be solved are mainly those of communication and more efficient use of the team by better identification of calls and isolation of the patient population.

The team is able to mobilize quickly from the hospital to the emergency site. Of 52 arrhythmias cases, only two could not be effectively dealt with. Of 161 calls, 37 were unnecessary. Of 161 calls, there was only one unequivocal case of a life saved.

431112

129. Graf, W. S., S. S. Polin, and B. L. Paegel, "A Community Program for Emergency Cardiac Care. A Three Year Coronary Ambulance-Paramedic Evaluation," *Journal of the American Medical Association* 226:156-160, October 8, 1973.
Of 1,240 transported patients, 70 percent were hospitalized. Forty-four percent of the hospitalized patients had AMI; and of this group, 32 percent had serious life-threatening arrhythmias prior to hospitalization. There were 35 long-term resuscitations. Patients were treated by Fire Department paramedics in about the same manner as those treated by CCU nurses and with similar results. Skilled personnel using an ordinary ambulance performed as well as those using the elaborate ambulance. An intensive local publicity program markedly increased the use of the program without any increase in unjustified calls. The average call for help was about half as long when the fire rescue paramedic was called rather than when a physician was called.

Twenty-two percent of the transported patients died: 10 percent at the patient location, 6 percent in the CCU, 3 percent in the ER, 2 percent upon arrival at the ER, 1 percent in a non-CCU bed, and 0.3 percent in the ambulance. A 24-percent mortality rate was experienced by paramedics and an 18-percent mortality rate by nurses, but the authors found that the paramedics had a higher risk population of patients.

431111

130. Graf, W. S., S. S. Polin, and B. L. Paegel, "Emergency Cardiac Care in Los Angeles," *Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).
In the 2 years and 9 months that the coronary ambulance/paramedic program of the Los Angeles

County Heart Association has been in operation, 1,240 patients were transported. Of these, 70 percent were hospitalized, and 44 percent of the hospitalized patients had AMI. Of this group, 32 percent had a serious or life-threatening arrhythmia prior to hospitalization. Patients were treated by Fire Department paramedics in about the same manner as those treated by CCU nurses, and with similar results. The mortality rate for patients treated by paramedics (24 percent) was slightly higher than for those patients treated by nurses (18 percent), but paramedics saw patients with both a higher incidence of collapse and arrhythmias. The difference in type of vehicle (regular ambulance or coronary care ambulance) did not alter the mortality rate.

431112

131. Graver, L. E., B. S. Gershen, M. M. Orlando, et al., "Bradycardia and Its Complications in the Prehospital Phase of Acute Myocardial Infarction," *The American Journal of Cardiology* 32:607-611, October 1973.

To explain the mechanisms of sudden death in the prehospital phase of AMI, records of 84 patients with AMI transported by the MCCU of Montgomery County, Maryland, were studied. Twenty patients had bradycardia; 10 received no pharmacologic therapy other than narcotic drugs. All 20 survived transportation and hospitalization, whereas 7 of the 64 patients without bradycardia died. Ten had systolic blood pressure values of 90 millimeters of mercury or less, and bradycardia was an associated finding in five. Thus, in suburban-metropolitan populations of the United States, bradycardia occurs frequently during the prehospital phase of AMI. Although the overall incidence of hypotension is low by the time a patient calls for medical aid, hypotension is not common in patients with bradycardia. The therapeutic implications of these observations depend on an elucidation of the natural history of AMI with bradycardia in the presence and absence of hypotension.

Results reported in this article do not indicate whether bradycardia with or without hypotension significantly contributes to the high mortality rate that occurs during the prehospital phase of AMI and whether increasing heart rate with atrophine will reduce mortality.

431112

132. Griffiths, A. H., "Communication to Support the Urban Emergency Cardiac Care System." *Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).

This article describes the communications necessary to support the ECC system. The communications system that will provide adequate support for ECC should be able to adequately support EMS as a whole.

101222

133. Griggs, T. R., M. Barringer, B. Klaur, et al., "Impact of Medical Training on Ambulance Dispatching," *Journal of the American College of Emergency Physicians* 6:47-49, February 1977.

This study done with 76 calls received for EMS in Chapel Hill, North Carolina, was designed to assess the ability of trained individuals to screen calls for EMS to allow for safer or more appropriate responses. The degree of urgency of calls, as judged by ambulance dispatchers (for Police Department ambulances) and a panel of physicians, was compared to estimates of the severity of the patient's illness or injury. Physicians were more likely to designate calls as emergencies than were dispatchers. Neither physicians nor dispatchers were able to discriminate between the severely ill and those without severe problems. The EMTs were better able to assess severity and degree of urgency than were physicians or dispatchers. A tentative conclusion is that rapid response by an EMS system will be based upon the caller's descriptions of the situation rather than medical assessment of patient condition.

411122

134. Hackett, T. P., and N. H. Cassem, "Factors Contributing to Delay in Responding to the Signs and Symptoms of Acute Myocardial Infarction," *American Journal of Cardiology* 24:651-658, November 1969.

With a sample of 88 patients randomly selected from a population of 100 patients who had been admitted to a CCU (location not given) with a diagnosis of suspected or proven AMI, the investigators examined the delay time between the onset of symptoms and arrival of the patient at a medical facility for examination. They found (1) no significance between ward and private patients with regard to delay time, so all patients were grouped together; (2) no significant relationship with regard to time delay and 10 chosen variables (such as age, sex, previous MI, and presenting symptoms); (3) delay times tended to decrease as symptom severity increased; (4) a significant relationship between symptom source and delay; (5) the role of a second person in initiating the help-seeking decision was found to be significant; and (6) physicians caused or contributed to patient delay in 12 percent of the cases. In addition, denial was not found to be significantly related to symptom displacement (especially to the gastrointestinal and pulmonary systems) and to the influence of another person on delay.

401221

135. Hall, F., "Coronary Care in this Community," *Royal Society of Health* 2:87-88, April 1973.

This article discusses the design and implementation of the coronary care ambulance service in the county borough of Barnsley. The author, the Chief Fire and Ambulance Officer of the county, describes the unique design of the coronary ambulance, the training of the medical staff, and the process of calling for the ambulance service. In its first 2 years of operation, the service was rendered to 851 patients, 50 percent of whom resided outside the county borough of Barnsley. Hall concludes that the development of this service was a worthwhile undertaking.

102222

136. Hamilton, W., "System Analysis in Emergency Care Planning," *Medical Care* 12:152-162, February 1977.

The use of EMS has risen substantially in recent years, and the need for better organized systems of emergency transportation, communication, and treatment has become increasingly evident. This paper reviews the role of systems analysis techniques in the planning and evaluation of community emergency services. The actual application of an emergency system model is described as part of a comprehensive study of emergency care delivery in the urban area of Philadelphia, Pennsylvania (with 2 million people in 129 square miles). This computer simulation model, called the "emergency system simulation model" (ESSIM) simulates emergency occurrences, transportation, and treatment over time using Monte Carlo techniques to reflect variations in system workload and performance. (This is accomplished by selecting appropriate parameter values at each stage of the simulation process using historical data.) Selected results with regard to the decrease in the ER load and redistribution of emergency system loads, illustrate the implications of proposed system configurations and the potential benefits of similar efforts in other communities.

301222

137. Hamilton, W. R., Mittelstaedt, and J. Thomas (eds.), *Federal Assistance for Medical Service Systems: A Program Guide*, Publication No. 75-08, (Philadelphia: Leonard Davis Institute, August 1975).

This booklet contains several case studies of several sites that are developing "regionalized" EMS systems. Case studies of these regions, chosen to represent a broad spectrum of organizational and funding arrangements, are providing the basis for a series of more detailed investigations into specific economic problems such as service, pricing and charge policies, and alternative financing arrangements. These broad spectrum studies and hence initial contacts with several prospective study sites revealed that, while regional planners availed themselves of State aid and private support, several opportunities for Federal assistance were being lost because of lack of information about the variety of Federal programs potentially applicable to EMS systems planners.

101222

138. Hampton, J. R., "Importance of Patient Selection in Evaluating a Cardiac Ambulance Service," *British Medical Journal* 1:201-203, 1976.

This describes an experimental study conducted in Nottingham that was intended to determine whether mortality rates are lower in a cardiac ambulance with trained technicians than in regular ambulances, and whether there is evidence of selection in the type of patient carried by the cardiac ambulance. The cardiac ambulance was made available at random shifts of each day throughout the study year. The control group consisted of the patients with arrests when the cardiac ambulance was not on duty. Overall mortality (51 percent) was identical in the group brought to the hospital when the cardiac ambulance was available and in the group of arrests when it was not.

532111

139. Hampton, J. R., M. Dowling, and C. Nicholas, "Comparison of Results from a Cardiac Ambulance Manned by Medical or Non-Medical Personnel," *Lancet* 1:526-529, March 1977.

During a 20-month period a "cardiac" ambulance was manned on alternate days by specially trained ambulance personnel only, or by such personnel and a doctor. The presence of the doctor did not lead to any reduction in the mortality of patients with heart attacks.

Although transport to the hospital by the cardiac ambulance was associated with a low prehospital mortality, this was balanced by a high prehospital mortality in the group of patients brought to the hospital by the routine ambulance at times when the special vehicle was manned but for some reason was not used. There was evidence of unintentional selection of low-risk cases for transport by the cardiac ambulance. The number of lives saved by this special service was too small to cause any significant reduction in the overall mortality from heart attacks in Nottingham.

432112

140. Hampton, J. R., and C. Nicholas, "Randomised Trial of a Mobile Coronary Care Unit for Emergency Calls," *British Medical Journal* 1:118-121, April 1978.

This article describes an experimental research study designed as a trial of an MCCU. To determine the value of the MCCU in noncardiac as well as cardiac emergencies, 6,223 of the "911" calls for medical emergencies received at the ambulance control center were considered for random dispatch of the MCCU or a routine ambulance. Calls not considered included those for children or traffic accidents (routine ambulance sent) and cases in which either a physician requested the MCCU or the controller was given information that prevented him from justifiably choosing the type of ambulance at random. A routine ambulance responded in 2,583 of the 6,223 cases because the MCCU was not available. Of the remaining patients, 1,664 were randomly allocated to transport by the MCCU and 1,676 received routine ambulance transport. Hampton reports the category of the emergency for both the randomized and nonrandomized groups. Of the 1,664 patients selected at random for the MCCU, 4.8 percent had acute ischemic heart disease and 45 percent of these died in the prehospital phase. Of the 1,676 randomly allocated to the rountine ambulance 3.2 percent had acute ischemic heart disease and 47 percent were dead before arrival at the hospital. The overall mortality rate (through the time of discharge) of the 80 cardiac patients selected at random for the MCCU was 53 percent, and the 53 cardiac patients selected at random for routine ambulances had a mortality rate of 62 percent.

592111

141. Henderson, A. H., "Management of Myocardial Infarction," *The Practitioner* 215:415-422, October 1975.

Henderson outlines the overall aims and principles involved in the management of MI. He discusses prevention of early arrhythmia death and minimization of infarct size as the two main

objectives in reducing high mortality. In terms of prehospital care, Henderson believes that selective therapy with potentially dangerous drugs needs expert medical supervision. When such therapy is not immediately available, effective resuscitation can still be provided early by a simplified (and more economical) version of an MCCU using specially trained ambulance staff.

102222

142. Hershberg, P. I., and S. Alexander, "Prevention and Treatment of Sudden Cardiac Death," *Medical Clinics of North America* 56:625-631, May 1972.

The majority of deaths occurring from AMI occur outside the hospital. To lower mortality, a major effort must be made in several areas.

Prevention and patient education are the best approaches. The MCCU may be useful, particularly in densely populated areas, but it will only have limited application to the problem of sudden cardiac death until the major delay in the institution of effective therapy, patient indecision, is overcome.

101222

143. Hill, J. D., and J. R. Hampton, "Mode of Referral to Hospital of Patients with Heart Attacks: Relevance to Home Care and Special Ambulance Services," *British Medical Journal* 2:1035-1036, October 30, 1976.

Out of 1,250 consecutive patients brought to the hospital with heart attacks, 956 (76 percent) were at home when their symptoms began. Of these 687 (61 percent) called their general practitioner and the remainder were brought to the hospital by an ambulance summoned by a member of the public. Of the 294 patients who were away from home when the attack occurred, 291 were brought to the hospital by ambulance. Of these, only 70 (24 percent) were attended by a general practitioner. Patients for whom the ambulance was called by a general practitioner had had their symptoms significantly longer and had significantly lower prehospital and hospital mortalities than those for whom ambulances were summoned by members of the public. Special "cardiac" ambulances appear to be inappropriate for patients who have been seen by a general practitioner. For this reason, group home care may well be as effective as hospital admission.

492222

144. Hillman, L. L., W. M. Carroll, and M. S. Hobbs, "Mobile Coronary Care, A Survey Amongst General Practitioners," *Medical Journal of Australia* 2:264-267, August 11, 1973.

In Perth the MCCU that has been operating since 1969, has transported only 15.6 percent of the patients admitted to the hospital with MI in a 13-month period. This study determines the general practitioner's attitude to, and the use of, the mobile service. One hundred eighty-nine questionnaires were distributed to practitioners within the operational area of the unit. The response rate was 95.5 percent.

Practitioners were divided into two groups according to whether they use the service routinely (50.3 percent) or not (48.1 percent). Factors such as age of the patient and severity of the infarction influenced the routine users less than the nonroutine users. Nonroutine users were less inclined to refer patients to CCUs and more inclined than routine users to treat patients at home. The main advantages of the MCCU were considered to be availability of the defibrillator, early cardiac monitoring, and access to antiarrhythmic drugs; however, many practitioners stressed the operational difficulties associated with the service.

Suggestions are made for the improvement of the MCCU.

432122

145. Hirschman, J. G., S. R. Nussenfeld, and E. L. Nagel, "Mobile Physician Command. A New Dimension in Civilian Telemetry-Rescue Systems," *Journal of the American Medical Association* 230:255-258, October 14, 1974.

This article describes the Miami emergency care system. This system, first to make regular use of Radiotelemetry of ECGs to hospital-based physicians, now also employs physicians who, while moving freely about in their normal professional practices, supplement and occasionally replace the hospital physician. This is accomplished by belt-carried walkie-talkie radio, which frees the system from dependence on the hospital base station and elevates the level of care.

101222

146. Holloway, R. M., "New York City's Experience in Improving Ambulance Service," *Health Services Report* 87:455-550, May 1972.

New York City Health and Hospitals Corporation and the New York City Department of Hospitals have attempted to minimize increased ambulance cost while maximizing increased services. Following an analysis of the operation of the existing ambulance service, a number of steps were taken. Control and administration of the ambulance service were centralized, and ambulances were redeployed temporarily and geographically without additional cost. Having nurses screen calls does incur some expense as does training ambulance technicians; however, the cost benefit would appear to be great. To keep costs down, ambulances are selected on the basis of function rather than style and appearance.

101222

147. Holmdahl, M. H., and I. Werner, "Experience with Heart-Lung Resuscitation in Coronary Infarction," *Acta Anaesthesiologica Scandinavica* 11:129-137, 1967.

This is a descriptive study that reviews 31 patients (two patients were admitted twice) admitted to the intensive care unit of University Hospital in Upsala, Sweden. Of 33 cases of resuscitation, there were 15 instances of successful resuscitation after which the patient was discharged from the hospital with intact function of the central nervous system. In all of these, successful resuscitation was started immediately when arrest occurred, in the presence of a nurse or doctor. In contrast, the patients who never regained consciousness suffered cardiac arrest under conditions that did not allow resuscitative effort immediately. In seven of these cases, resuscitation was outside the hospital, and in three, arrest occurred at night.

One case, in which a second cardiac arrest occurred during ambulance transport, demonstrated that resuscitation can be successfully performed by a competent ambulance staff.

The data show a need for a CCU where patients can be continually watched.

402212

148. Honick, G. L., "Experience with a Nurse-Staffed Ambulance," *Heart and Lung* 3:748-752, September/October 1974.

This study relates the experience of an MCCU in Oklahoma City over a 4-year span. There were 3,581 runs made by the MCCU, of which 32.9 percent were patients with acute IHD; 755 patients had AMI. The final diagnosis of all 3,581 cases is listed.

Honick reports the outcome of those patients requiring resuscitation efforts. One hundred seventy were in VF when the MCCU arrived, and 60.6 percent were admitted to the hospital alive. Honick's other tracer group of resusciation patients contains those with asystole complete heart block or slow idioventricular rhythm on arrival of the unit. Ninety-three of these patients were admitted to the hospital, but 289 were either dead at the site of arrest or dead on arrival at the hospital.

431212

149. Honick, G. L., T. Nagel, and A. Daniels, "A Nurse Staffed Mobile Coronary Care Unit," *Journal of the Oklahoma State Medical Association* 63:505-509, December 1970.

A mobile CCU of St. Anthony's hospital in Oklahoma City staffed by two nurses and a driver of the emergency vehicle is described. The MCCU commenced operation in October 1969, and its operation is explained in depth. Also, an analysis of the first 400 MCCU calls is included in the article. The cardiac diagnosis breakdown is as follows: 12 percent were dead on arrival at the site, 20 percent of the patients had AMI, 20 percent had coronary insufficiency and angina pectoris, and 8 percent had congestive heart failure. No process or outcome measures are included in the article.

431222

150. Humphries, J., "Treatment of Non-Traumatic Cardiac Emergencies," *Postgraduate Medicine* 55:159-165, January 1974.

This article tells what emergency measures for cardiac arrest should be performed in rapid sequence and should be interrupted only if the patient recovers consciousness. In sudden loss of consciousness, the patient should be placed in supine position. If the patient stays unconscious and has no carotid pulse, then CPR should be started. The author suggests first delivering a strong blow to the chest to terminate asystole VT or VF. Further treatment of cardiac emergencies depends on the initial response of the patient to resuscitation, ECG, and the total clinical picture.

101222

151. "Immediate Care by Doctors and Ambulancemen," *Injury* 6:1-2, 1974.

This editorial suggests that there is an increasing demand for official support for EMS in Great Britain. The author offers a proposal for planning a comprehensive emergency medical system, which would be an ambulance control system. After 2 years of successful operation, a system would be eligible to apply for financial support from the State. Anyone could establish a new scheme. Also, the State should be encouraged to survey existing emergency services to identify parts of the city in which ambulances take more than 20 to 30 min. to reach the patient and to urge, in such cases, that urgent steps be taken. The aim for a new integrated service would be to create in each area a successful comprehensive accident and emergency service.

202222

152. Irwin, E., "Equipment," *Emergency Medical Services* 5:60-64, May/June 1976.

This article reviews problems existing in ambulance electrical systems and discusses objectives for design of ambulance electrical systems. The article also provides appropriate interpretations of the federal specifications.

101222

153. Irwin, E., "Equipment," *Emergency Medical Services* 5:60, July/August 1976.

This is the second part of an article that appeared in the May/June issue of *Emergency Medical Services*. It discusses how to accomplish the design, in achieving the objectives for ambulance electrical systems, and how to comply with federal specifications. Some common sense operating practices are recommended, and solutions to the problems of ambulances are discussed; finally, sample specifications to accomplish the objectives are presented.

101222

154. Isler, C., "Dial 911 for the Coronary Ambulance," *RN* 32:48-51, August 1969.

This article reviews the MCCU at St. Vincent's Hospital: its inception and system. Isler relates a coronary ambulance run. She states that it is too early to draw any conclusions.

101222

155. James, D. R., "Obstetric Flying Squad Service—A Defense," *British Medical Journal* 1:217-219, January 22, 1977.

Eighty-one calls made by the obstetric flying squad in West Berkshire were assessed on the basis of a suggestion that patients would do as well, if not better, if they were brought straight to the hospital by ambulance rather than await the arrival of the flying squad. Of the 81 responses, 36 were made to general practitioner maternity units and 45 were made to patients' homes. In both situations, the flying squad was still considered to be of great value. Although a slower method (17-minute difference) than an emergency ambulance call, it represents a much safer method of transporting an obstetric patient in an emergency.

492121

156. Jarmon, R. G., "Cardiac Telemetry Exercise Program," *Journal of the College of Emergency Physicians* 6:50-52, February 1977.

To train cardiac consultants who interpret ECG

rhythm strips from the field, a series of prerecorded telemetered rhythms and discussions that can be sent into telemetry consoles was designed. The patterns represent cardiac arrhythmias, as well as equipment problems. Patterns of "arrhythmia resusci anne" were selected and modified and sent through ambulance radios. The signal was recorded on a standard tape recorder and the monolog was dubbed. The physician is asked to interpret the pattern and give instructions to the ambulance attendant. The answers and response times are recorded by the technician running the taped exercise. At the end of the quiz, the rhythms are replayed along with a discussion of each pattern.

101222

157. Jarvis, D., and S. Kushnir, "Mobile Coronary Care Team's Efforts to Save Patients from Premature Death," *Hospital Topics* 49:49, March 1971.

This article is mainly a description of the procedures (input) encountered by the Edgewater hospital (Chicago, Illinois) ICCU-MCCU, primarily with respect to the equipment, the nursing personnel, and the guidelines for treatment in the MCCU. However, the article does report the mortality figures for the 140 patients the MCCU responded to in its first 15 months of service; 114 were transferred from the ICCU and discharged to their homes.

431212

158. Jergadeesan, K., M. K. Visweswaran, and I. Sheriff, "Mobile Intensive Coronary Care Ambulance," *Journal of the Indian Medical Association* 64:105-106, February 16, 1975.

This paper expresses the various important factors and problems faced by an MICCU in India.

One problem indicated is the difficulty in transporting a patient from the second or third floor of his/her home.

The comparison of mortality rates, during the first 24 hours after infarction for the period 1969-72 and 1972-74, showed a marked reduction of 36 percent.

492212

159. Jones, E. L., A.F. Peters, and R. M. Gasior, "Early Management of Battle Casualties in Vietnam," *Archives of Surgery* 97:1-15, July 1968.

This report deals with the experiences of the mobile army surgical hospital. Knowledge gained from WW II and the Korean conflict added to the quality of medical care available in Vietnam. Reduction in mortality and morbidity has been due to improved surgical techniques.

Advances in helicopter evacuation directly from the injury site and availability of whole blood gave an opportunity to treat those who would never have made it to a medical facility.

401222

160. Kahn, A. J., "Cardiac Care Units," *Journal of the Arkansas Medical Society* 71:137-138 (editorial) August 1974.

This editorial presents the point of view that CCUs are worth their expense yet they are only one link in a chain of care for patients with MI. There is also a need for better education for the public about medical first aid and vans large enough to permit the continuation of cardiac resuscitation en route to the hospital.

101222

161. Kamaryt, P., J. Minarik, and P. Miklis, "Total Delay Between First Appearance of Symptoms In and Hospitalization of Patients with Acute Myocardial Infarction," *Cor et Vasa* 14:1-8, 1972.

This article reports that the longest component of the total delay between onset of symptoms and hospitalization in patients with AMI is the delay caused by the patient. Median patient delay is reported to be 13 hours and 20 minutes. Of the 430,000 people in the city of Brno, 28 of 96 hospitalized with proven AMI died and another 26 died outside of the hospital.

402211

162. Kassapoff, I., W. Whaley, W. Walter, et al., "Stadium Coronary Care—A Concept in Emergency Health Care Delivery," *Journal of the American Medical Association* 221:397-99, July 1972.

Over a 5-year period in two Altanta-based stadiums, emergency "life support stations" were established. Of total attendence at football games during those 5 years (9,076,724 fans) 13 documented episodes of apparent SCD occurred. Three or 23 percent, were salvaged, yet these 13 patients represented only 0.00014 percent of the total number of fans in two stadiums for football seasons for those 5 years (1966-70).

Kassanoff also delineates eight cases of suspected AMI that occurred during the 1970 season. Of these eight, one patient experienced pain only and did not have a proven AMI. The other seven patients had syncope and/or cardiac arrest, five of whom required resuscitation. Of these five, two were successfully resuscitated and discharged alive from the hospital. The two syncope patients not requiring resuscitation did have a proven AMI.

431212

163. Keller, G. B., and M. D. Keller, "Concept of Sensitivity and Specificity in the Evaluation of Emergency Medical Services," *Social Science and Medicine* 7:861-864, 1973.

Sensitivity is a measure of the proportion of individuals requiring a given service who actually receive it. The term "true positives" is a measure of how well the system detects the actual cases requiring care.

Specificity is a measure of the proportion of individuals who do not require service and who indeed do not receive it. The term "true negatives" is a measure of how well the system avoids the inclusion of unnecessary cases.

The authors propose a model to calculate sensitivity and specificity. This calculation may be carried out for the following sequence of steps: an EMS call, dispatch of ambulance, transport of patient to facility, treatment, and hospitalization.

101222

164. Keller, M. D., R. R. Lanese, T. N. Chirikos, et al. *A Study of the Impact of Mobile Coronary Care Units,*

Department of Preventive Medicine, College of Medicine, The Ohio State University, June 1978.
This study reports on the impact of MCCUs in Columbus, Ohio. It specifically concerns the outcomes of patients with AMI. Keller et al. compares the characteristics of AMI patients who use MCCUs with those who do not, in terms of decision variables and subsequent outcomes. The nonusers were matched for age, sex, and race with the users and were identified from the population of cardiovascular emergency patients who entered the study hospital by means other than the MCCU. Of 551 MCCU users, 290 had a confirmed AMI (53 percent), and 119 were classified as "other cardiac emergency" (21.6 percent). The major factor that determined MCCU use was severity of the illness. Mortality prior to hospital admission, in-hospital, and within 6 months after the onset of AMI is presented. The MCCU users had a hospital mortality rate of 17.2 percent and the nonusers had a hospital mortality rate of 1.5 percent.

531211

165. Kernohan, R. J., and R. B. McGuhen, "Mobile Intensive Care in Myocardial Infarction," *British Medical Journal* 3:178-180, July 20, 1968.
In the first 6 months of its existence, a rural mobile intensive care unit (MICU) was used to admit 146 patients, 95 with definite or probable MI, to the local district hospital. The average interval between receipt of a call and the start of intensive care was less than 30 minutes.

Capital cost involved in converting an ambulance and in providing equipment was £1,579. Running cost of the ambulance and staff for 6 months was £3,111. Cost per ambulance call was £19. The authors believe that the reduction in mortality of AMI which can be achieved by MCCUs justifies the cost.

432221

166. Kleinman, J., R. Weiss, M. Tanner, et al., "Emergency Medical Services in the City of Boston" (Boston: Harvard Center for Community Medical Care, December 1972).
Data (March 4-12, 1972) collected from 11 hospital ERs in the 15 districts of Boston were examined to determine the number of people and types of patients using those ERs. Of all visits, 15 percent were classified as emergent, and 57 percent as urgent. Age and sex were determinants in ER use, as was geography in influencing which emergency facility was used. Of all ambulance patients, 35 percent were emergencies, suggesting a triage system. Three percent of the total cases had chest pain. Of these, 15 percent used ambulances or police transport, suggesting the use of ambulances with cardiac equipment. The study recommends goal specification and cooperative planning among components of the entire medical system in the city. Level-of-services planning needs to be done on a geographic basis.

401222

167. Knight, A. L., "First Aid for Suspected Myocardial Infarction," *Journal of Occupational Medicine* 15:364, April 1973.
This article states that any health service department in any industry has an obligation to reduce risk by providing immediate care for an employee suspected of having an AMI. From this premise the author describes a procedure that can be instituted.

101222

168. Kossman, C. S., "Changing Views of the Spectrum and Management of Atherosclerotic Coronary Artery Disease," *Advances in Internal Medicine* 21: 363-389, 1976.
This article discusses the spectrum of atherosclerotic coronary artery disease: clinical, temporal, pathologic, pathologic after bypass graft, and angina without coronary artery disease. Kossman also discusses the management of atherosclerotic coronary artery disease, precoronary care, preinfarction care, prehospital care, hospital care, and posthospital care.

In terms of the MICU he states that the number of long-term survivals after defibrillation by an MICU in 14 different geographic areas is 18 percent. MICUs are a necessity if the rate of sudden death is to be lowered. But, the cost and relative overall inadequacy of reaching individuals in time necessitates continued study and evaluation of this method.

101222

169. Kubik, M. M., "Mobile Coronary Care Units," *The Practitioner* 216:303-306, March 1976.
This article describes a strategy study in which the author states that MCCUs decrease mortality. Kubik reports the concept of an MCCU and the need for educating the public. He concludes that perhaps the future will bring a simple safe drug that will diminish the postinfarction electrical instability; but until then, MCC remains the most efficient approach.

102222

170. Kubik, M. M., B. K. Bhowmick, J. Stockes, et al., "Mobile Cardiac Unit: Experience from a West Midland Town," *British Heart Journal* 36:238-241, March 1974.
This article describes the organization, staffing, and equipment of an MCCU in a West Midland district. Two hundred eighty calls were made in the first 18 months of the existence of the MCCU. Thirty-seven (13.2 percent) of the patients were dead at the time of arrival of the team; 185 (66.1 percent) of the cases were due to MI; 133 of the MI cases were treated for various complications; 12 cases were resuscitated outside of the hospital. The majority of cases, 152 (82.1 percent) had the benefit of intensive care within 4 hours after the onset of chest pain. The unpredictability of early postinfarction arrhythmias with the risk of sudden and preventable death is emphasized, and the role of an MCCU in their prevention and treatment is described.

432121

171. Lambrew, C. T., "The Experience in Telemetry of the Electrocardiogram to a Base Hospital," *Heart and Lung* 3:756-764, September/October, 1974.
This article describes the experience of the Nassau County Police ambulance system and telemetry operation. Lambrew's approach is one of a process study on the impact of telemetry in revealing significant arrhythmias in all types of patients. Of 9,000 patients monitored during the first 21 months of the operation, 19 percent had chest pain consistent

with cardiac ischemia, 48 percent had illnesses other than chest pain, 30 percent were trauma cases, and the remaining 2 percent were unclassified. Significant arrhythmias were found in 22.9 percent of the chest pain cases, 8.7 percent of other illnesses, 4.2 percent of the trauma cases, and 8.8 percent of the unclassified. VF as the initial rhythm was identified in 8.1 percent of the chest pain cases and 9.8 percent of the unclassified. Cardiac arrest en route to the hospital occurred only in 19 cases, 17 of which belonged in the cardiac pain category. The author finds his results to indicate the importance of monitoring noncardiac patients because there is a likelihood of arrhythmia incidence in those patients, as well as in patients complaining of chest pains.

Lambrew reports that the incidence of cardiac arrest en route to the hospital in patients with chest pain decreased from 5.1 to 1 percent after the introduction of the telemetry operation. Also, 11.5 percent of all the patients requiring defibrillation were discharged alive from the hospital.

421112

172. Lambrew, C. T., "Telemetry Command in an Integrated Emergency Care System," ***Proceedings of the National Conference on Studies for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)*** **(Dallas: American Heart Association, Inc., 1975).**

Between March 1, 1971, and November 30, 1972, 9,000 patients were monitored. This article reports the incidence of arrhythmias according to diagnosis, the incidence of VF or standstill as initial rhythm according to diagnosis, and cardiac arrest or clinical deterioration according to diagnosis. Nine hundred eight patients (10.1 percent) had significant arrhythmias. The findings confirm the author's expectation as to the incidence of arrhythmias early in the course of AMI, in the patient with chest pain and would support the requirement that vehicles and personnel responding to calls for help from such patients and transporting them to the hospital be prepared to defibrillate at the scene of the incident or en route to the hospital, or prevent progression to cardiac arrest through early drug therapy of arrhythmias. These data also show that although arrhythmias occur with greatest frequency in patients with chest pain, they may complicate any acute illness or injury, suggesting that telemetry of the ECG, when extended to any acutely ill or injured patient, may be of value in the care of that patient.

421222

173. Lambrew, C., W. Schuchman, and T. Cannon, "Emergency Medical Transport Systems: Use of ECG Telemetry," ***Chest*** **63:477-482, April 1973.**

This article describes a rapid-response, widely deployed emergency medical transport system using trained nonprofessional personnel (paramedics) supervised and evaluated by physicians through a patient communications system incorporating ECG telemetry. This has been developed within the framework of existing resources at relatively low cost. Analysis of the course and of the telemetered ECG of 1,000 randomly selected patients in New York's Nassau County in this 8½ month prospective study (in 1971) indicates that clinical deterioration and death as well as LTAs occur in a significant number of patients en route to the hospital (mean transit time = 7.4 minutes). These occurrences are not confined to patients with AMI. Such a system is feasible and justified to reduce prehospital morbidity and mortality in patients with acute illness or injury through arrhythmia control (especially drug therapy) and CPR.

421121

174. Larson, R. C., ***Urban Emergency Service Systems: An Interative Procedure for Approximating Performance Characteristics*** **(New York City: Rand Institute, January 1974).**

Larson analyzes two procedures for approximating performance of emergency systems (e.g. police, fire, and ambulance). He describes easy procedures performed with a hand calculator or with easy-to-program algorithm with TV servers, which only require N equations (instead of 2_N). Larson derives a procedure (P'_{ij} approximate method) for estimating such events as travel times and frequencies of cross-district dispatches. Both procedures rely on dispatch probabilities with regard to use and availability factors. Analysis of error characteristics of these two approximation procedures shows greater accuracy with larger values of N's and greater accuracy for systems in which units are similar in their volume of service demands and area. Computer assistance is necessary for larger values of N.

301222

175. LeBordais, E., "Taxi or Treatment: The Ambulance Controversy," ***Dimensions in Health Services*** **52:14-16, March 1975.**

The author poses the question: Are emergency ambulances worthwhile? LeBordais attempts to give the advantages and disadvantages regarding Canadian ambulance services in 10 Canadian provinces with regard to paramedical training, dead patients, dead calls, red light runners, small communities, and the financial bind. The author concludes that because ambulance attendents and drivers are so often the first to arrive at a medical distress area, they form an important link in the provision of emergency care. This link must be recognized by the establishment of appropriate regulations and guidelines in each province.

202222

176. Lehman, J. S. Jr., and P. F. Basch, "Acute Myocardial Infarction in an American Traveler in China," ***Archives of Internal Medicine*** **136:804-806, July 1976.**

This article describes the occurrence of an MI in an American traveler in China and the state of the art of cardiology in the People's Republic of China. The American traveler had an AMI that was complicated by VT and congestive heart failure. Medical personnel were rapidly mobilized and an improvised CCU was created around the patient. He survived because of the organization, training, and skill of the Chinese medical staff.

102222

177. Lemmi, H., C. Hubbert, and A. Faris, "The Electroencephalogram After Resuscitation of Circulatory Arrest," ***Journal of Neurology and Psychiatry*** **36:997-1002, 1973.**

A sample of 31 patients at Baptist Memorial Hospital of Memphis, Tennessee, were studied after resuscitation from cardiac arrest. (Selection criteria are not mentioned except that the patients had been resuscitated after cardiocirculatory arrest and they were selected over a 12-month (dates not given) period.) Case studies of patients with normal or mildly abnormal (Category I) and severly abnormal (Category II) electroencephalograms (EEGs) are presented. All patients in Category II died. In the patients in Category I, EEGs showing no improvement or worsening indicated a fatal prognosis and possibly reflected deteriorating cardiac function caused by the basic disease process.

401212

178. Lennon, M., "Coronary Care in Belfast," *Nursing Times* 67:921-924, July 1971.

The author describes both the MCC system in Belfast and the work of a district nursing sister whose time is devoted to following up all of the MCCU patients after discharge.

102222

179. Lewis, A. J., G. E. Ailshie, and J. M. Criley, "Long-Term Survival Following Pre-hospital Resuscitation from Ventricular Fibrillation," *Proceedings of the National Conference on Studies for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).

This study attempts to determine the long-term effectiveness of attempted resuscitation following VF by an Los Angeles County paramedic team prior to hospitalization. In 32.1 percent of 137 patients with documented VF, there was restoration of a superventricular rhythm that was present when the patient arrived at the hospital. There were 32 (23.4 percent) short-term survivors who succumbed during the period of hospitalization. Twelve (8.8 percent) patients survived the period of hospitalization and are considered long-term survivors. Central nervous system damage was noted in two of the long-term survivors.

421212

180. Lewis, A. J., G. Ailshie, and M. Criley, "Pre-hospital Cardiac Care in a Paramedical Mobile Intensive Care Unit," *California Medicine* 117:1, October 1972.

The article is a descriptive study of the operation of three MICUs in Los Angeles County. The sample consists of 843 patients seen between December 1969 and November 1970. Of the 843 patients, 30 percent complained of symptoms of a potential cardiac nature but only 19 percent were found to have a definite cardiac disease.

The authors also report 24-hour mortality rates according to type of arrhythmia in those patients with arrhythmias. Seventy-five percent of the patients with VF died within 24 hours of treatment by the MICU. The same percentage of patients with idioventricular rhythm had a 24-hour mortality rate, and 80 percent of asystole patients were dead within the first 24 hours following contact with the MICU.

The authors conclude that deaths can be prevented by using this system, but most calls were noncardiac in nature and, therefore, a cardiac-dedicated unit is not justified on the basis of cost effectiveness.

421212

181. Lewis, A. J., and J. M. Criley, "An Integrated Approach to Acute Coronary Care," *Circulation* 50:203-205, August 1974.

The authors cite ECC within Los Angeles County to show how "Efforts to reduce the staggering mortality during the early hours of AMI involve much more than the development of mobile intensive or mobile coronary care units. The system developed is a continuum, beginning with the patient and his recognition for care, or with the lay consultant who urges prompt medical attention or even begins CPR. The next phase involves the institution of definitive therapy at the earliest possible moment, usually prior to hospitalization by an MICU. Finally, the hospital to which the patient is taken must be capable of continuing expert, definitive therapy in the emergency department and coronary care unit."

201222

182. Lewis, R. P., "Approach to Sudden Death Outside the Hospital," *Heart and Lung* 2:862-866, November/December, 1973.

This article reviews the MCCU system in Columbus, Ohio, and compares the results of the system manned by fire rescue squad personnel and the earlier system manned by physicians. The results show that the fire rescue squad personnel were as effective in resuscitation of both VF and other types of cardio-pulmonary arrest as were the physicians. The other physician/nonphysician staff measures included sudden death incidence rates, MI incidence rates, CPR incidence rates, and the total number of long-term survivors.

431112

183. Lewis, R. P., "The Columbus Experience with Mobile Emergency Care," *Proceedings of the National Conference on Studies for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc. 1975).

This article compares the operation of a heartmobile staffed by a physician for 15 months ("before") with the operation of three rescue squad vehicles staffed by paramedics for 3 months ("after"). "Before" and "after" measures include monthly patient load, incidence of sudden deaths and patients in VF, incidence of AMIs, arrhythmia incidence and survival rate, correct diagnoses of AMI by the MCCU staff, mortality of AMI, and rescue response time. The "before" period experienced a 17.5 percent incidence of AMI and a 20 percent mortality rate for AMI patients. The MICU without the physician experienced a 13.8 percent incidence of AMI and a 30 percent mortality rate for AMI patients.

431112

184. Lewis, R., and J. U. Warren, "Effect of Atropine on Bradyarrhythmias in the Pre-hospital Phase of Acute Myocardial Infarction," *Circulation* 8, supplement 4:191, 1973.

Fifty-four patients with documented AMI seen by an MCCU had inital bradyarrhythmia. Fifty-eight

percent were seen within 1 hour of onset of symptoms. Thirty-three (61 percent) received atropine. The hospital mortality was lower for the treated group (21 percent) than the untreated group (24 percent). These data indicate the efficacy of atropine in improving heart rate and blood pressure in the majority of patients with AMI and bradyarrhythmia. The lower mortality of the treated but higher risk group suggests early atropine treatment may lower mortality when bradyarrhythmia is present in AMI.

431212

185. Liberthson, R. R., E. L. Nagel, J. C. Hirshman, et al., "Pathophysiologic Observation in Pre-hospital Ventricular Fibrillation and Sudden Cardiac Death," ***Circulation*** **41:790-798, May 1974.**

To better understand prehospital sudden cardiac death, two groups were studied: one group was monitored by rescue squads during attempted rescue and defibrillated from prehospital VF and hospitalized or autopsied. Histories were collected and either clinical or autopsy diagnoses were obtained.

On the day of VF one-fourth reported new symptoms preceding collapse by more than 30 minutes, one-fourth reported symptoms lasting 1 to 30 minutes, and one-half collapsed instantaneously or within 1 minute of acute symptoms. A history of MI was present in 41 percent and agina pectoris in 54 percent. Twenty-seven percent reported new or changing symptoms within 4 weeks.

In defibrillated survivors, ECG changes of AMI or ischemia were nearly three times more frequent than changes detected histologically in SCDs, and in the former involved predominantly the anterior wall in contrast to the inferior wall in most autopsied deaths. Acute coronary lesions occurred in 58 percent of the SCDs autopsied. The SCD population may be subgrouped into those having MI, myocardial ischemia, and no detectable myocardial change. When rescuers were able to monitor prehospital SCDs, VF was found in the majority of cases. However, 28 percent did have other rhythms. An educational program directed toward community, physician, and high-risk patients could bring some of those who would acutally die from MI to earlier medical attention.

491221

186. Liberthson, R., E. Nagel, J. Hirschmann, et al., "Pre-hospital Ventricular Defibrillation," ***New England Journal of Medicine*** **219:317-321, August 1974.**

Analysis of the subsequent course of subjects with prehospital VF detected by mobile units with unlicensed technicians in Miami, Florida, in a 42-month study (April 1970 through September 1973) was done. Of the 301 subjects, 199 had successful defibrillation (66 percent). Of these 98 died before admission. Of the 101 who were hospitalized, 42 were discharged alive. Among hospitalized patients, VF or VT recurred in 57 percent, and in most patients within 24 hours. AMI was diagnosed in 35 percent, and ischemia in 32 percent. In 17 percent no acute myocardial changes evolved. Congestive heart failure was present in 63 percent, cardiogenic shock in 25 percent, and pulmonary complications in 42 percent. Of the 42 discharged, 60 percent returned to prearrest status but 28 percent had a mild and 17 percent had severe neurological defects. Of the hospital deaths, 40 percent occurred within 1 day and 75 percent within 1 week. Mean survival for discharged patients was 12.7 months. Regardless of arrhythmia prophylaxis, 28 percent died suddenly after discharge.

441212

187. Lilley, W., "The Ambulanceman," ***Nursing Times*** **72:647-649, April 1976.**

W. Lilley, an ambulanceman, explains what is entailed in his work and suggests how ambulancemen and nurses could work together more closely for the benefit of patient. He feels that nurses and ambulancemen should fully understand each other's functions.

Lilley describes the ambulanceman's training and his function on cardiac care ambulances.

102222

188. Linhart, J. W., and W. Likoff, "Stratified Coronary System Developed," ***Pennsylvania Medicine*** **76:40-42, June 1973.**

Two main problems that should be attacked by therapy with regard to heart disease patients are the lack of improvement in prognosis of patients with cardiogenic shock and congestive heart failure and the death of many MI patients before hospital arrival.

The article explains the need for a system of stratified coronary care that would be regional and well organized for maximal use of scarce manpower and facilities. The implementation would involve a multidisciplinary committee to organize this coordinated medical effort, especially for rapid entry into the system provided by emergency life support systems. The article also emphasizes CCUs and regional conference centers that will assist communities in planning their stratified care system.

201222

189. Lown, B., M. D. Klein, and P. I. Hershberg, "Coronary and Precoronary Care," ***American Journal of Medicine*** **46:705, May 1969.**

This article discusses coronary and precoronary care. In terms of precoronary care, the author outlines a few areas from which to develop a system of precoronary care.

101222

190. Lown, B., and W. Ruberman, "The Concept of Precoronary Care," ***Modern Concepts of Cardiovascular Disease*** **39:97-102, May 1970.**

The authors review numerous studies with respect to mechanisms of sudden death, population at risk from sudden death, acute MI group, and sudden instantaneous death. Recommendations include a unified plan to reduce sudden death that involves a precoronary care unit, MCCUs especially for early arrival of a paramedical team with the goal of promptly stabilizing heart rhythm, and ER improvements.

201222

191. Luger, G. W., and W. Kolsters, "Preliminary Experience with a Mobile Corouary Care Unit (Cardulence)," *Folia Medica Neerlandica* 14, 1971.

This article reports the diagnoses made by the MCCU physician based on patient complaints and ECGs during a 15-week trial of an MCCU operating from two different hospitals (one at a time; i.e., alternating weeks). In 39 of 74 patients there was an ECG consistent with ischemic or fresh MI, but final diagnoses for the patients transported by the MCCU were not obtained. In 35 of the 39 ECG consistent cases, the patient's chief complaint was chest pain. In 25 of the other cases, the chief complaint was chest pain. The major decision was whether to transport.

432222

192. Lund, I., and A. Skulberg, "Cardiopulmonary Resuscitation by Lay People," *Lancet* 2:702-704, October 1976.

The survival rate in 75 of 631 patients with cardiac arrest in whom resuscitation was started outside the hospital by lay people was 36 percent. Only 8 percent survived when attempts at resuscitation were delayed until the arrival of the ambulance team, which included an anesthesiologist and a specially trained nurse.

Seventy (11 percent) of 631 survived to be discharged from the hospital. Fourteen of the 70 who were discharged had brain damage; 2 of the 14 were initially resuscitated by lay people.

These data show the importance of time of cessation of circulation to initiation of resuscitation for the chances of survival after resuscitation. The findings support the idea that lay people should be taught and encouraged to perform CPR.

422112

193. Lund, I., and A. Skulberg, "Resuscitation of Cardiac Arrest by Doctor-Manned Ambulance Service in Oslo (Experiences with a Doctor-Manned Ambulance Service in Oslo). *Proceedings of the National Conference on Studies for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).

This article presents the experience with a physician-staffed MICU ambulance in Oslo. Of 1,263 cardiac arrests, resuscitation was attempted in 78 percent of the cases and in 408 cases (41 percent) circulation was restored. Of the patients on whom resuscitation was attempted, 9.8 percent were discharged alive.

This article divides the 1,263 patients into cardiac, accident, drowning, and other patients and gives the resuscitation rates for the separate groups. Of those cardiac etiology cases that received resuscitation attempts, 8.5 percent were discharged alive from the hospital. Followup of 97 patients showed 18 patients dead after 8 months and 6 with cerebral damage. At 24 months, 79 patients were alive and 14 had cerebral damage.

422212

194. Lund, I., and A. Skulberg, "Resuscitation of Cardiac Arrest Outside Hospitals: Experience with a Mobile Intensive Care Unit Oslo," *Acta Anaethesiologica Scandinavica*, supplement 29:217+, 1968.

This study evaluated an MICU that has been in operation for 5½ years in Oslo, Norway. The patient population was 1,263 persons with cardiac arrest or VF subdivided into cardiac conditions (n = 1,129), accidents (n = 59), drownings (n = 14, and unknown (n = 61). Ninety-eight percent of the patients who would have died had only conventional methods been used were able to leave the hospital after having been resuscitated by the ambulance crew. If one considers only those patients on whom resuscitation was initially successful, 23.8 percent were long-term survivors.

422212

195. Luxton, M., P. Thomas, H. Richard et al., "Establishment of the Melbourne Mobile Intensive Care Service," *Medical Journal of Australia* 1:612-615, May 1975.

A mobile intensive care ambulance service has been instituted in Melbourne. Initially, service was manned by doctors and ambulance officers, but was subsequently staffed by two specially trained officers. Over a 27-month period, 52 patients have been successfully resuscitated from VF or asystole. One half of the patients had a definite AMI and another 16 had probable but not proven MI. Of the 52 patients, 31 survived to leave the hospital. Five of 21 discharged patients for which there is followup data were dead within 1 year.

422212

196. McCann, J. P., and J. R. Burnett, and F. M. G. Holmstrom, "Potentials of the Aeromedical Evacuation System in the Overall Treatment Process for the Seriously Ill Patient," *Aerospace Medicine* 41:323-328, March 1970.

A broad-based study of the current worldwide military Aeromedical Evacuation System (AES) and its civilian counterpart in the United States has revealed that its growth and exploitation is being influenced by both major advances in medical and transport technology and by our changing concepts of mortality in general. AES along with other modes of mobile medical service is vastly improving its capability of bringing treatment to the patient rather than merely moving the untreated patient to a facility for treatment. With a more enlightened use of the medical, operational, and economic potentials of AES, much can be done to increase its value, both to the patient and to the nation.

101222

197. MacMahon, A. G., "The Mobile Medical Squad," *South African Medical Journal*, pp. 1915-1919, September 1974.

This article is a concepts/strategy article describing the planning and implementation of the first professional mobile accident unit in South Africa. It began operation on February 14, 1973. It is based on the system described by Snook in England in 1972, with minor modifications dictated by local factors. The specific organization, methods of operation, and problems attached to the scheme are discussed.

102222

198. McManus, W. F., D. Tresch, and J. C. Darin, "An Effective Pre-hospital Emergency System," *Journal of Trauma* 17:304-310, April 1977.

McManus describes a dual response system (Milwaukee) with the capabilities of rapid response, patient extrication, basic life support, advanced life support, radio communication, and transportation, which provides appropriate care for injured and acutely ill patients.

Of 4,580 ambulance runs, the distribution of disease was 25 percent cardiac, 35 percent trauma, and 40 percent medical-surgical. There were 276 arrest patients with resuscitation attempted (10 were trauma cases). Of the arrest patients 60.5 percent were in VF and of these 21 percent were discharged alive. Twenty-five percent of the arrests were in asystole and of these 6 percent were discharged alive. Electrical/mechanical dissociation was found in 12.7 percent of the arrests and the remaining 1.8 percent were unknown.

The authors report 14.4 paramedic "saves" per 100,000 population per year.

421212

199. McNeilly, R. H., and J. Pemberton, "Duration of Last Attack in 998 Fatal Cases of Coronary Artery Disease and Its Relation to Possible Cardiac Resuscitation," *British Medical Journal* 3:139-142, July 1968.

All the deaths attributed to Coronary artery disease (CAD) and occurring in Belfast during one year were studied. The frequency distributions of the cases by interval between onset of the last attack and death were given for those not admitted to a hospital, for those admitted to a hospital, and for those already in a hospital for some other cause of illness. Sixty percent of all the deaths occurred outside the hospital. This indicates that the problem of CPR in CAD is, to a considerable extent, an extra-hospital problem. Twenty-seven percent of the men and 22 percent of the women died within 5 minutes, but the median period of survival was 3 hours and 30 minutes for men and 6 hours and 18 minutes for women.

The median time interval from onset of the attack to sending for medical aid was 1 hour and 17 minutes for men and 1 hour and 6 minutes for women, and from summoning medical aid to sending for the ambulance, 59 minutes for men and 1 hour and 26 minutes for women. Ninety-six percent of the ambulance journeys were made in less than 20 minutes.

It was found among men but not among women that the duration of survival tended to be longer in older patients and in second or subsequent attacks.

Of the 596 who did not gain admission to a hospital, 229 (23 percent of all the 998 patients) were known to have survived for more than one-half hour after the onset of the fatal attack, 182 (18 percent) survived for more than 1 hour, and 143 (14 percent) survived for more than 2 hours. It is among these that there would appear to be the special scope for the cardiac ambulance, providing that medical aid is sought and the ambulance is summoned without delay.

402211

200. Mailloux, J. R., "Center Runs Information Network," *Hospitals* 47:60-62, September 1973.

This Article gives information about the establishment and implementation of the Medical and Health Care Information Center for the Burlington, Vermont, community and for the whole State. The center polled physicians in the State to determine needs and used releases to newspapers to inform the public of the Center. The goal is to try to guide callers and to explain what can be done, but not to make their decisions for them. The center provides names of specialists, works closely with the hospital's emergency department, and is connected by the statewide ambulance radio network (since 1971) to 60 ambulances.

The center has performed valuable services such as improving patient care (especially emergency care), improving the relationship of the hospital with the community and the medical staff, and pinpointing and reporting gaps in the health care system.

101222

201. Marcus, H., and R. S. Crampton, "Rural Mobile Coronary Care," *Virginia Medical Monthly* 101:126-128, February 1974.

This article describes a rural MCCU in the town of Haysi, Virginia. It is staffed by three nurses and a rescue squad. The EMS system provides transportation to the local hospital, a 1-hour drive.

Transportation with the MCCU is now safer. The Haysi system demonstrates that general practitioners in a rural setting using local resources can inexpensively provide and use a MCCU.

101222

202. Mattox, K. L., "Public Entry into Emergency Medical Services Systems," *Journal of the American College of Emergency Physicians* 5:128-131, February 1976.

The problems of public access to EMS systems can decrease the effectiveness of emergency care. Much of the public is unable to recognize signs of serious illness such as MI and does not know how to obtain emergency medical help. In addition, emergency facilities and personnel are used for more nonemergency care than for true emergency cases. Suggestions for the improvement of public access to emergency medical care include the use of telephones for triage and for providing information, ambulatory centers for nonemergency care, physician extenders such as paramedics or midwives, and improved systems of alerting emergency personnel that an emergency exists.

101222

203. Mausner, J. S., S. C. Benes, and I. W. Gabrielson, "A Study of Volunteer Ambulance Squads," *American Journal of Public Health* 66:1062-1068, November 1976.

A study of all 37 ambulance squads in two Pennsylvania counties (Lehigh and Northampton), an area known to be served largely by volunteer units, was made by personal onsite interviews in 1973. The objective was to determine the structure and function of the squads and to devise preliminary estimates of effectiveness as a base for regional planning. Topics examined include population and geographic area served, amount and training of personnel, vehicles, equipment, recordkeeping,

finances, communications capabilities, and squad organization. The 34 volunteer squads were found to vary greatly in resources and sophistication. Training varied from 10 hours to EMT level.

The rural squad in particular tended to be underfinanced, to have low call loads, and to have a delayed response. The advantages and disadvantages of maintaining volunteer services in rural areas are discussed, and some possible approaches to the problem of providing high quality services in rural areas are outlined.

411221

204. Mitchell, H. W., "Ambulances and Emergency Care," ***American Journal of Public Health*** **55:1717-1724, November 1965.**

The author believes that ambulance service has not received the attention it deserves. He discusses the various phases of the problem: (1) epidemiology—kinds of injuries and illnesses that require ambulance transportation and emergency care; (2) the present pattern of ambulance and emergency services; (3) geographic and logistic problems; (4) economic problems; and (5) suggestions as to the role of the public health agency in helping to see that the community has adequate emergency medical care services, including good ambulance transportation.

101222

205. "The Mobile Coronary Care Unit," ***Journal of the Medical Society of New Jersey*** **68:71-72, January 1971.**

This editorial reports on a study being done with an MCCU by L. Schwartz, M.D., Professor of Medicine and Director of Clinical Cardiology, New Jersey College of Medicine and Dentistry at the Martland Hospital in Newark. During one year 325 calls were received. Of these, forty-two (or 13 percent) canceled or were crank calls. Little other data are given.

201222

206. "Mobile Coronary Care Units," ***World Health Organization Chronicle*** **25:79-82, February 1971.**

It is estimated that the overall mortality from MI is about 40 percent, and that some two-thirds of the deaths occur outside the hospital. MCCUs may provide a means of reducing this high death rate.

101222

207. "Mobile Units Found to Reduce Mortality Rates," ***Geriatrics*** **26:24, March 1971.**

This article relates a few of the MCCU studies reported at the Annual Scientific Session of the AHA.

201222

208. "Modified Coronary Ambulance," ***Medical Journal of Australia*** **2:1182-1183, December 1969.**

The majority of deaths from MI occur within the first hour. A great number of these cases die outside the hospital usually because of VF. Pantridge and Geddes have shown that the number of early mortalities can be reduced by use of a special coronary ambulance.

After consideration of resources available, it was agreed to institute a modified coronary ambulance to cover the eastern suburbs of Sydney, the casualty services for which are mainly supplied by three hospitals.

102222

209. Moseley, V., "First Aid Training is Vital for Effective Emergency Medical Services," ***Journal of the South Carolina Medical Association*** **71:227-228, July 1975.**

The major argument of this article is that because EMTs, nurses, and doctors are usually not at the scene of an accident, the public needs to have training and knowledge of first aid, with clear guidelines for action to reinforce this knowledge when an accident occurs. The author provides a number of different ways in which this information can be furnished.

101222

210. Moss, A. J., and S. Goldstein, "The Pre-hospital Phase of Acute Myocardial Infarction," ***Circulation*** **41:737-742, May 1970.**

A prospective interview study of the hospital arrival time (HAT) was obtained on 160 patients, ages 28 to 87 years, who were admitted with AMI to CCUs in two Rochester community hospitals. The median time between the onset of acute coronary symptoms and the patient's arrival in a hospital emergency department was 3½ hours. The distribution of the HAT was trimodal: Group I (early arrivals): less than 4 hours from onset of symptoms, median was 2 hours, $n = 89$; Group II (mid-arrivals): 4 to 14 hours from onset of symptoms, median was 6 hours, $n = 45$; Group III (late arrivals): greater than 14 hours, median was 27 hours, $n = 26$. Three intervals of time were defined: a decision time, an unaccounted for time, and a transportation time. In the entire population, the decision time consumed the major portion (51 percent) of the HAT, and the unaccounted for time consumerd 35 percent of HAT. The transportation time, whether by ambulance or car, averaged 25 minutes (14 percent of HAT, and it made up a diminishing percentage of the HAT in the longer arrival groups. The HAT in Groups I, II, and III and the decision time in groups I and II were scrutinized with regard to demographic data, past medical history, prehospital factors, and hospital course. The findings suggest that the psychologic makeup of the patient is a major factor in the decisionmaking process and, thus, in the duration of the HAT.

401221

211. Moss, A. J., and S. Goldstein, "Symposium on the Pre-Hospital Phase of Acute Myocardial Infarction," ***Archives of Internal Medicine*** **129:713, May 1972.**

The authors state that mobile ambulances have not had a major impact on AMI since most of the prehospital deaths from AMI are sudden and occur within the first hour of acute symptomatology. Proper case identification becomes the key to success in this condition.

101222

212. Moss, A. J., S. Goldstein, W. Greene, et al., "Pre-Hospital Phase of Ventricular Arrhythmias in Acute Myocardial Infarction," ***Archives of Internal Medicine*** **129:756-762, May 1972.**

During the past 28 months, 60 patients with suspected AMI were admitted to a prehospital

satellite industrial CCU. During patient stabilization, clinical data, blood studies, and continuous electrocardiographic tape recordings were obtained. Thirty-three of 60 patients had AMI, and the median arrival time at the satellite CCU was 45 minutes. Seventy-seven percent of the patients had one or more ventricular premature beats (VPBs) on the 78±11-minute ECG tape, and 36 percent of the AMI patients developed major ventricular arrhythmias within 24 hours of the initial obervation. Closely coupled VPBs and elevated cortisol levels were reliable prehospital precursors of serious ventricular arrhythmias. Early prehospital arrival, atrial bradycardia, frequent VPBs, hypertension, elevations of growth hormone or nonesterified fatty acid, and decreased insulin levels were found not to be significant indicators of subsequent ventricular arrhythmia.

401221

213. **Moss, A. J., B. Wynar, and S. Goldstein, "Delay in Hospitalization During the Acute Coronary period,"** ***American Journal of Cardiology*** **24:659-665, November 1969.**

This study evaluates the factors that influence the time intervals and time delays during the prehospital phase of AMI. Sixty-four patients with definite or probable AMI admitted to a CCU were interviewed with regard to the time intervals and time delays during the pre-hospital phase of their acute illness. The average time interval between the onset of symptoms and the patient's arrival in the hospital emergency department was 306 minutes, and this time was subdivided into a decision time of 200 minutes (65 percent), 77 minutes (25 percent) of unaccounted time, and 29 minutes (10 percent) of transportation time. The decision time was longer in those patients who arrived by car rather than by ambulance, increased progressively with age, and was twice as long for women as for men. It was three times longer when the symptom occurred on a weekend as opposed to a weekday, and it was generally longer when the symptom occurred during the daylight than when it occurred at night.

Since the transportation time made up less than 10 percent of the prehospital period, the value of a MCCU must be questioned. In terms of priorities, emphasis should be placed on first reducing the decision time and the time unaccounted for. This might be done by a sophisticated public and professional education program.

401221

214. **Mulcahy, R., "Intensive Coronary Care: Current Status and Future Prospects,"** ***Cardiovascular Clinic*** **2:82-101, 1971.**

Mulcahy emphasizes the practical aspects of acute coronary care and the application of such care in small hospitals and clinics. He begins by discussing prehospital coronary care and two mobile units that have been functioning in Dublin for 2 or more years. These units have been successful.

Mulcahy continues the article by discussing the in-hospital CCU, management and treatment of patients, and future prospects of coronary care.

102222

215. **Mulcahy, R., D. Murnaghan, S. Healy, et al., "Recent Trends in Acute Coronary Care,"** ***Journal of the Irish Medical Association*** **62:387-389, November 1969.**

This study examined a hospital-based sample of patients with MI (128 admissions, only 124 patients because there were four readmissions) in a six-bed CCU in Dublin, Ireland. The time frame of the study is April 1968 to June 1969. Findings reveal that 18 of 124 patients admitted with an MI to the CCU (14. 5 percent) died immediately. Pump failure was the cause of 83.3 percent of these deaths. With respect to age, 49 of the 124 admissions (39.5 percent) were in the 60 to 69 year cohort and 7 of the 18 deaths (38.9 percent) were in the 60 to 69 year cohort. The authors compare their results with the mortality rate of 30 percent generally reported for the times before "modern coronary care." The improvement is attributed in this article to control of primary arrhythmias, better treatment of heart failure, and better prevention of embolic complications.

402212

216. **Murtomaa, M., and K. Korttila, "The Beginning of Resuscitation by Laymen; Mobile Intensive Care Unit and Emergency Room,"** ***Anaesthetist*** **23:398-402, September 1974.**

The results of CPR undertaken by an MICU at Meilahti Hospital, Helsinki, were compared with the results from an ER at the same hospital. Of the MICU patients 5 percent (77) were later discharged from the hospital. The discharge rate in the ER was 7 percent (175 patients). Of the MICU patients, those on whom resuscitation had been started by laymen before the arrival of the MICU had a significantly better survival rate ($p < 0.01$). Of the ER patients, the prehospital start of resuscitation by laymen did not increase the survival rate. The results suggest that resuscitation started by laymen is more effective if it is continued by an MICU team at the same place as compared with the transportation of the patient to the hospital in an ordinary ambulance.

432112

217. **Murtomaa, M., and K. Korttila, "Experience of Cardiopulmonary Resuscitation Outside Hospital by a Mobile Intensive Care Unit,"** ***Resuscitation*** **3:211-214, 1974.**

This article is a comparison of preadmission and in-hospital mortality rates during 6 months before and after the incorporation of an MICU in Helsinki, Finland. During the first 6 months, the sample considered consists of the 175 patients resuscitated in the ER of Helsinki University Hospital; during the second 6 months the sample is the 77 patients who received CPR in the MICU. The differences in long-term survival were not significant. But the authors did not account for whether the patient had CPR before the arrival of the MICU and before the arrival at the ER. All survivors in the MICU study had CPR before the arrival of the MICU.

432112

218. **Nagel, E. L., J. C. Hirschman, and S. Nussenfeld, "Miami, Florida,"** ***Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)*** **(Dallas: American Heart Association, Inc., 1975).**

(ECC) **(Dallas: American Heart Association, Inc., 1975).**

This article reviews a 33-month study of the Miami emergency care system, which employs remote medical command of trained fire rescue personnel. Four rescue vehicles are equipped with telemetry and staffed by three paramedics.

Of 20,000 rescue vehicle runs, 2,200 had telemetered ECGs, 340 telemetered patients were in VF, and 200 were cardioverted. Eighty cardioverted VF patients survived to be admitted, and 50 percent of these were discharged alive.

Survival rates following discharge for the 40 VF survivors reveal that 50 percent were alive at the end of the 33-month study period, and the mean survival time was 8½ months.

421212

219. Nagel, E. L., J. C. Hirschman, S. R. Nussenfeld, et al., "Telemetry Medical Communication in Coronary and Other Mobile Emergency Care Systems," *Journal of the American Medical Association* 214: 332, October 1970.

Using a telemetry medical command system (a program based on cooperation between in-hospital physicians and mobile paramedic rescue crews), 146 consecutive victims were monitored remotely by telemetered ECG over a 24-month period. Of those successfully monitored, VF or standstill was found in 15 percent while bradyarrhythmias were found in 6 percent. Response time was 4 minutes or less in 80 percent of the cases. Reliability of communication was 80 percent.

This mobile emergency care system offers advantages over new and special physician-staffed systems in that it has a fast response time, uses highly trained paramedics, possesses immediate availability, entails lower costs, permits higher use by application to a greater variety of emergency conditions, and commands general community acceptance.

421221

220. Nagel, E. L., R. R. Liberthson, J. C. Hirschman, et al., "Emergency Care," *Circulation* 52:216-218, December 1975.

Prehospital VF can be treated successfully by paramedic personnel. One-half of prehospital sudden death victims experienced no prior warning and collapsed either instantaneously or within 1 minute of symptoms. The followup course was analyzed. Of 301 such prehospital VF cases, 199 were defibrillated successfully, but only 101 survived long enough to be hospitalized and only 42 were discharged alive. Predictors for successful outcome were initially rapid post-defibrillation heart rates and atrial fibrillation or sinus tachycardia rhythms. In the hospitalized group, 57 percent suffered repeat ventricular fibrillation and/or ventricular tachycardia, usually during the first 24 hours. Among those discharged from the hospital, mean survival was 13 months, with 28 percent dying suddenly regardless of the presence of antiarrhythmic therapy. Intensive antiarrhythmic therapy and monitoring of this survivor population seems indicated.

421212

221. Nahom, A., "Emergency Medical Care systems," *Journal of the American Medical Association* 217:1530-1532, September 1971.

This article discusses methods of assessing a medical care subsystem, that of emergency medical care, as a step toward improving present systems.

Functional analysis is likely to suggest practical operational changes and potential results. Implementation of cost-effective programs is most feasible when based upon an understanding of present functional status—an understanding rarely produced by the type of information generated by the usual surveys and studies of medical systems.

101222

222. Nolte, C. T., and W. J. Grace, "Life Support Units," *Heart and Lung* 3:779-784, September/October 1974.

This article gives an outline for life-support units that can either be mobile or fixed and can provide the skill of arrhythmia recognition and control in addition to CPR.

The authors discuss location, need, accessibility, capability, personnel, communication, equipment, drugs, cost, referral, recordkeeping, and plan of action.

101222

223. Norris, R. M., and V. S. Caunt, "Delay in Admission to a Coronary Care Unit," *New Zealand Medical Journal* 78:342-346, October 1973.

Norris uses a questionnaire study to analyze the delay prior to CCU admission of 153 MI patients. The four components studied are patient delay, physician delay, transport delay, and hospital delay. Patient delay is compared with time of day of severe symptom onset, place of onset, and previous ischemic cardiac pain. Physician delay was incurred in 127 patients before arrival at the hospital and was separated into examination delay and physician delay. Transport delay of more than 30 minutes was discovered in 10 percent of the cases. A hospital delay in admitting the patient to the CCU of more than 15 minutes occurred in 24 percent of the 127 cases referred by a physician and in 93 percent of the 26 self-referred cases.

Ambulance transport cases were not analyzed separately from cases of patients using other modes of transportation to the CCU.

492221

224. Nussenfeld, S., E. Nagel, J. Hirschman, et al., "Mobile Coronary Care Units," *Journal of the Florida Medical Association* 57:17-21, November 1970.

This article briefly describes "current" models of MCCUs internationally: Belfast, Ireland; Moscow, U.S.S.R.; St. Vincent's Hospital, New York City; and Miami, Florida. The MCCU, like the CCU, has a deserved place among the therapeutic processes used by the medical profession to reduce the excessively high mortality from CAD. Caveats offered include a need to prevent enthusiasm from overstaffing or overequipping the unit beyond what the community's resources warrant. Education and

support are deemed essential. The authors suggest that the "Miami, Florida, model may be the correct one for many communities in the U.S." (with a conventional unit manned by trained firemen and updated telemetry).

201222

225. Orchard, T. J., "Mobile Coronary Care," *The Lancet* 1:263-264, February 1974.

The author presents an analysis of already published results of studies of the MCC units in the following cities of the United Kingdom and Ireland: Belfast, Ballymena, Newcastle, Dublin, and Brighton. The author argues from the data that an MCCU staffed by regular ambulance personnel and operated by a local ambulance service "provides a cheaper, quicker service for a far greater population than the alternative medically staffed one, with no loss of benefit to the community." Further, the data reveal that use of the "999" telephone number instead of the general practitioner as an intermediary to call for the MCCU reduces the median delay in Brighton by 105 minutes.

432211

226. O'Rourke, M., "Australian Ambulances and Casualty Services," *Medical Journal of Australia* 1:772, May 1976.

The argument presented in this article is that whereas only to 1 to 2 percent of road crash deaths might be prevented by better emergency care on the spot, at least 20 percent of deaths from heart attack outside the hospital can be so prevented and with a resulting long-term survival. Therefore, improved out-of-hospital emergency care can save lives.

102222

227. O'Rourke, M. F., "Mobile Coronary Care Unit," *Singapore Medical Journal* 14:450, September 1973.

A municipal EMS system is examined in Sidney, Australia. The study population was 225 patients cared for by the MCCU. The first 116 patients (mixed) were examined (time frame not given). Findings indicated that of these first 116 patients, 105 were admitted to a hospital. Sixty-six percent proved to have MI, and 76 percent had acute cardiac disease. O'Rourke also reports the mean delay times for the coronary ambulance in 1969, 1970, 1971, and 1972. His findings reveal that total time taken on a coronary ambulance call consistently averaged about 45 minutes, although the time taken by the ambulance at the hospital in picking up the coronary team increased while the time taken at the patient site decreased from 1969 to 1972.

432211

228. O'Rourke, M. F., and J. Michaelides, "Pre-hospital Coronary Care: Review of a System in its Fifth Year," *Medical Journal of Australia* 1:615-617,

From the population of patients brought to the study hospital or attended by the hospital's coronary ambulance service during a 54-day period, the authors retrospectively identified 189 cases that were real or suspected cardiac emergencies.

Of the 189 cases, 36 were diagnosed as AIHD with AMI present in 20. The AMI mortality rate was 35 percent prehospital and 25 percent in-hospital. The study compares severity of illness with whether the ambulance request was initiated by a physician or a member of the public. The severity classifications include (1) "Dead on Arrival," (2) "Not Admitted to Hospital," and (3) "Admitted to Hospital." The "Admitted to Hospital" cases were further delineated into "Potentially Lethal," "Major," "Minor," and "Death in Hospital."

432212

229. O'Rourke, M., et al., "Modified Coronary Ambulances," *Medical Journal of Australia* 1:875-878, April 1972.

This is a descriptive research study in which a sample population of 116 ambulance patients was analyzed during 21 months of operation of a mobile CCU staffed by hospital personnel and serving a community of 400,000 people.

Less than 1 patient in 10 (1,120 patients with AMI were admitted to the hospital by conventional means during the same period) was taken to the hospital by the mobile CCU. The mean rescue response time was 15.60 minutes, and the mean transport time was 8.40 minutes. Of the 116 calls answered (mixed population) 105 (91 percent) reached the hospital alive and 94 (81 percent) left the hospital alive. Of those who reached the hospital alive, 69 (66 percent) had MIs and 11 (10.5 percent) had acute coronary insufficiency. The AMI in-hospital mortality rate is reported as 13.0 percent.

432211

230. Orr, R., "Mobile Coronary Care," *New England Journal of Medicine* 282:166-167, January 1970.

After spending time with MCCUs in Belfast, Ireland, and knowing that as of 1970 most ambulances in the United States are private, the author states that for a similar system to work here in the United States, the country needs hospital-based and hospital-staffed ambulance services and properly equipped ambulances. Staffing is not a problem because hospital CCU staff would work in the ambulance. The major problem would involve the financial backing of such a project.

101222

231. Oscherwitz, M., S. Edlavitch, and K. Greenough, "Patient and System Delay in Pre-hospital Coronary Care," *Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).

This was a 5½-month pilot study (1971—exact dates not given) in San Francisco, California, of 261 (187 men, 74 women) patients admitted to 14 hospital CCUs and discharged with a diagnosis of MI. Patient delay times (symptoms to patient seeking medical advice), System delay times (patient seeking medical advice in CCU admission), and total delay were determined and contributing factors examined for four age groups of patients in the sample. Men less than 60 years old, men at least 60 years old, women less than 70 years old, and women at least 70 years old. Overall, between one-third and one-half of the total delay between occurrence of the acute event and admission to the CCU was produced by patient

decision delay. Conversely, between two-thirds and one-half was caused by system delay. The factors that influenced the length of patient decision time did not always influence system response time in the same direction. Moreover, the length of patient decision and system response delays differed in the four age-sex groups investigated. The predominant findings were that older men and younger women had longer total delays than their younger counterparts, and that women came to CCU admission less quickly than men. An equally important conclusion is that emergency care programs that concern themselves solely with the portion of the system response time related to mobile CCUs (i. e., hardware, stewards, ambulances, telemetry, etc.) are insufficient to resolve the problem of total delay between onset of symptoms and receipt of definitive medical care. Other contributory parameters of system delay examined were value of a referral (doctor or clinic; physician or clinic referral for younger subjects of both sexes expedited hospital admission) and type of admission. General practitioner-admitted male patients regardless of age experienced the shortest system response time. Specialists had older women admitted fairly rapidly to the CCU.

401221

232. Ownby, F. D., "Factors Affecting Mortality in Acute Myocardial Infarction," *Diseases of the Chest* 56: 274-276, October 1969.

The author subscribes to the belief that the cardiac nurse is the most important link in the chain of treatment, yet often she does not have proper training. It is the physician's responsibility to train the nurses until a body of experienced cardiac nurses is sufficiently developed to train other nurses.

Future efforts to reduce mortality will be most effectively made by (1) the establishment of progressive care areas where patients can continue to be monitored after leaving the intensive care unit, (2) earlier hospitalization of patients with possible infarction, (3) educational programs for physicians and the public, (4) training of ambulance crews in CPR and in management of MI patients because MICUs will probably only operate in metropolitan centers.

102222

233. Pace, N., "An Approach to Emergency Coronary Care in Industry," *Journal of Occupational Medicine* 15:793-795, October 1973.

This article outlines the program of MCC currently practiced in the New York offices of General Motors, called the Emergency Cardiac Survival Program (ECSP) emphasizing the benefits derived from the rapid, definitive treatment of the cardiac emergency. The article includes a description of the "survival stretcher" used, the training of emergency personnel, and the procedures used by the emergency medical team.

101222

234. Pace, N., "Emergency Cardiac Care in a Metropolitan Office Building," *Heart and Lung* 3:755-758, September/October 1974.

This article describes the development and operation of an emergency cardiac program designed for a tall office building in a congested metropolitan center in which 6,000 people are employed (the General Motors offices in New York City).

101222

235. Pace, N., E. Kreps, and P. Kline, "A Mobile Life Support Stretcher System," *Journal of the American College of Emergency Physicians* 3:245-247, July/August 1974.

To provide mobile life support in cardiac emergencies, a survival stretcher system was designed for use in an MCCU. The system was instituted and evaluated at Lenox Hill Hospital Emergency Department. After several months' use, the stretcher was redesigned according to suggestions by Lenox Hill staff and put into service for further evaluation. The stretcher provides the means for a minimal staff to treat cardiac emergencies immediately and to monitor patients' conditions continually.

101222

236. Palm, T., and Elkjaer, P., "A Mobile Emergency Care Unit: Two Years of Experience," *Acta Anaesthesiologica Scandinavica* 18:195-200, 1974.

A system with mechanically staffed ambulances provided with the necessary equipment for observation and treatment is reported. This mobile emergency care system began in 1970. This article describes the experience gained within a 2-year period.

Of 165 emergency cases transported, 106 patients required treatment. Seventy-nine patients received CPR, and 27 received some other form of treatment. Of the 79 receiving CPR, further treatment was abandoned in 55 at the patient site. Primary resuscitation was successful in 24 patients, of whom 11 regained consciousness. Of these, eight patients were discharged from the hospital, two with cerebral damage. Of the 27 patients receiving treatment other than CPR, 9 died in the hospital and 18 were discharged alive.

422212

237. Pantridge, J. F., "Mobile Coronary Care," *Chest* 58:229-234, September 1970.

This article related the experience of the Belfast MCCU from 1966 through 1969. The MCCU managed 2,741 patients during this time. Forty-three percent had an MI. Ischemic pain with abnormal ECG occurred in 29 percent. The mortality rate of the 193 cardiac arrests encountered during this 5-year time span are recorded. There were 55 temporary survivors from cardiac arrest and 38 survivors discharged alive from the hospital.

The focus of this article is to emphasize the reduction in delay time from onset of symptoms to initiation of coronary care that has resulted from the MCCU operation. This median delay time has been reduced from more than 8 hours to 1 hour and 40 minutes.

432211

238. Pantridge, J. F., "Prehospital Coronary Care," *British Heart Journal* 36:233-237, March 1974.

Pantridge cites numerous studies regarding cardiac mortality (specifically deaths from VF and rate of

prehospital deaths) and concludes that the major problems lie outside the hospital, resulting in the development of prehospital care schemes. Studies of MCCU operations in England, Europe, the United States, Australia, and Japan are referenced and Pantridge suggests the MCCUs have enabled patients to receive intensive care rapidly.

Pantridge notes that few MCCUs are in operation in Great Britain and explains the problems: re (1) cost, (2) unavailability of medical personnel, (3) misconceptions regarding MCCUs, (4) education of the public, and (5) necessary cooperation of the general practitioner.

201222

239. Pantridge, J. F., and A. A. J. Adgey, "Early Coronary Care," *Giornale Italian Cardiology* 1:497-505, 1971.

This article reports the Belfast system from January 1, 1967, to December 31, 1969. The sample is from 2,741 MCCU cases. Two hundred eighty-four MI cases seen within 1 hour of the onset of symptoms were analyzed to determine incidence of LTAs occurring within the first, second, third, and fourth hour of MI symptom onset. The effect of lidocaine on ventricular ectopics within the first and second hour of infarction is studied. One hundred ninety-three arrests are studied to determine outcomes of efficient and inefficient resuscitations (within 4 minutes). None of the 99 asystole cases were successfully resuscitated.

432212

240. Pantridge, J. F., and A. A. J. Adgey, "Pre-hospital Coronary Care: The Mobile Coronary Care Unit," *The American Journal of Cardiology* 24:666-673, November 1969.

The Belfast MCCU experience from January 1966 to March 1969 is described. There were 794 patients with proven AMI and 126 patients with cardiac arrest outside the hospital. Among patients with posterior infarction seen within the first hour of MI, 32 percent had bradycardia at the initial examination.

The 126 patients with cardiac arrest were studied to determine time of resuscitation and subsequent outcomes. Sixty-one of the arrest cases were in VF, and of the 13 not resuscitated within 4 minutes, none survived. "Inefficient" resuscitation within 4 minutes yielded a success rate of 61 percent out of 18 patients in VF. "Efficient" resuscitation within 4 minutes was performed on 30 patients, and 93 percent were successfully resuscitated. Of the 39 patients successfully resuscitated, 36 had MI and 24 of these patients survived the hospital stay. Followup of these 24 patients reveals 1 with residual cerebral dysfunction and 4 deaths within 28 months of discharge.

432212

241. Pantridge, J. F., A. A. J. Adgey, and J. S. Geddes, "Acute Phase of Myocardial Infarction," *Lancet* 2:501-504, September 1971.

Arrhythmias occurring within 1 hour of the onset of symptoms of AMI are documented in 284 patients. A high incidence of bradyarrhythmia is noted. Ventricular arrhythmias were also frequent and showed disappointing response to lidocaine therapy. Early care prevents death from VF and diminishes incidence of shock and pump failure by preventing or immediately correcting arrhythmia and limiting the size of the MI. The patients resource for coronary care is directed toward the prehospital phase.

Among 447 patients with acute infarct seen in 1969, there was a lower incidence of shock and lower hospital mortality among those seen early than among those seen after 3 hours. One hundred eleven of 123 patients seen within the first hour survived to leave the hospital and 99 (89 percent) of these patients were alive at the one year follow up.

432212

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

The Belfast MCCU was summoned on 338 occasions in its first 15 months of operation (January 1966 to March 1967). Three hundred twelve patients were admitted to the hospital with a suspected diagnosis of coronary thrombosis. Of these, 155 proved to have an MI. The time after onset of symptoms at which the 155 MI patients came under intensive care is studied. Seventy-eight of the 155 (50 percent) received intensive care within 2½ hours. Ten patients were resuscitated outside the hospital. Four of these patients experienced VF in transit, three were discharged from the hospital alive, and one died in the hospital. Six patients were in VF prior to transit, three of these patients survived, two died after 1 week and one died after 3 weeks.

432211

243. Pantridge, J. F., S. W. Webb, and A. A. J. Adgey et al., "The First Hour After the Onset of Acute Myocardial Infarction," *Progress in Cardiology* Volume 3, Lea and Febigev, Philadelphia.

Six hundred fifty-two patients with definite MI who came under intensive care within 1 hour have been identified. The MCCU treated 565 of these, and the remaining 87 developed an MI in the hospital or reached the emergency department within 1 hour. The last 294 of these MI patients were seen between September 1970 and February 1973.

The last 294 patients were analyzed for location of infarct and incidence of arrhythmias. Primary VF occurred in 55 of the 294 patients, 28 patients had primary VF within the first hour following onset of symptoms, and 23 of these were in VF on arrival of the mobile unit. The location of MI was investigated with respect to time for treatment. Therapeutic intervention with atropine and lidocaine is reported. Of 35 patients given atropine, 28 had a rise in heart rate and blood pressure, 4 had a rise in heart rate only, and 3 had no effect. With respect to the administration of lidocaine, findings show that when the heart rate was between 60 and 90, the drug had a beneficial effect in 74 percent of the patients. The mortality among the 27 patients in the sample under 70 years of age is reported as 9.9 percent.

432212

244. Paul, O., "Prehospital Management of Acute Myocardial Infarction," *Medical Clinics of North*

America **57:119-124, January 1973.**
The prehospital management of AMI is of critical importance because the majority of deaths occur in the first few minutes after the onset of symptoms. It is essential that individuals considered to have possible, probable, or definite AMI proceed directly to the hospital without waiting to reach their physician.

Resuscitation is valueless unless these efforts are applied by trained personnel. Allied health personnel offer the most in the way of availability, competence, and economy for out-of-hospital management. At the same time, it is not necessary or wise to await arrival of an ambulance to transport every patient with AMI to the hospital. Some AMI patients may also be treated at home.

101222

245. Pearson, D., E. J. Bernacki, J. W. Meigs, et al., "An Emergency Medical Care Facility: Program Characteristics and Patient Attributes," ***Journal of the American College of Emergency Physicians*** **5: 174-179, March 1976.**
The objectives of this research were (1) to describe the programmatic structure and characteristics of an emergency medical care facility that is a satellite clinic of the North Shore Clinic of Middlesex, Connecticut Memorial Hospital, a community hospital; (2) to describe the types of illness treated; and (3) to characterize the patients who used the facility. One-half of the presenting patients were treated for traumatic conditions. A major factor of clinic use for patients was proximity. For patients with nontraumatic illnesses the clinic was used when private physicians were unavailable. Almost 20 percent of all presentations resulted from referrals, suggesting acceptance of the clinic by private practitioners in the area. Previous users had more tenuous relationships with private physicians than did initial users and no difference was found between initial and previous users in the amount of nontraumatic illness. Patient attributes of high mobility, lower socioeconomic status, and younger age were associated positively with frequent clinic use.

401222

246. Petersen, H., G. Hansen, P. Andersen, et al., "ECG Recording in Emergency Home Visits," ***Acta Medica Scandinavica*** **201:231-232, 1977.**
During the first half of 1974, 756 emergency home calls were made by six doctors in the City of Oslo. A portable ECG instrument was available for all visits. The visits were unselected as regards complaints. ECG was recorded in 7 percent (51) of all patients and in 19 percent of all patients over 60 years of age. The main indication for recording an ECG was chest pain (nearly two-thirds of all recordings). In only a small number of cases did the recording give a definite result as regards diagnosis or management of the case. However, a slight additional benefit was obtained with a majority of the ECG recordings, including what was defined as psychotherapeutic benefit. The results of this study indicate that the value of a portable ECG is very limited for emergency home calls in a city.

402122

247. Petrizilkova, H. Z., I. Stolz, and H. Geizerova, "Population Study of the Early Phase of Acute Myocardial Infarction and Sudden Coronary Death," ***Cor et Vasa*** **18:145-153, 1976.**
This article reports data collected in Prague's District 4. The authors found that 226 (15 percent) of 1,620 people registered with the WHO Registry of Ischemic Heart Disease had IHD during a two year period. Subjects who had died of SCD because of IHD were studied. Ninety-two percent had died within the first hour, and 93 percent had died outside the hospital. A history of previous MI was evident in 40 percent, and previous angina pectoris in another 14 percent.

For registered AMI patients who went to the hospital, the median overall time delay is reported to be 10 hours, with median patient delay equal to 3 hours.

The study emphasizes the suddenness of cardiac death and the disproportionate length of patient delay. The authors recommended education of the public, acceleration of transportation, and more rapid physician response.

402211

248. Pole, D. J., "Delays Between Onset of Acute Myocardial Infarction and Definitive Care," ***Heart and Lung*** **3:263-267, March/April 1974.**
This article points to the need for early treatment because of the early mortality following MI. The author states that delay in the response of patients can be correlated to both subjective and objective factors. Medical service delays are described, and possible means of reducing these delays are discussed, including the operation of an MCCU.

102222

249. Pole, D. J., "Myocardial Infarction in Perth," ***Medical Journal of Australia, Special Supplement*** **2:23-26, August 1973.**
In Perth, Australia, during 1971, 1,184 patients diagnosed as having definite or possible MI were questioned. Information about the events prior to hospitalization was obtained in most cases by direct interview with the surviving patient, if possible.

Patient delay was the biggest single delay factor, but it accounted for slightly less than half of the total delay until admission to a CCU.

The evidence presented established that it may be more advantageous to reduce the delay time in the hospital before the patients reach monitoring facilities, rather than for the hospital to augment the ambulance system. An analysis of the time that patients took, compared with various features of their illness and their attitude, suggests, guidelines whereby patient education could be contemplated.

402221

250. Polnitsky, C. A., S. H. Denman, and D. E. Gagnon, "Sudden Cardiac Death—Trends and the Rhode Island Community Response," ***Rhode Island Medical Journal*** **57:507-509, December 1974.**
Hospital coronary care, while appreciably effective, is able to care for only a small proportion of patients—those that survive to get there. Several steps toward

lowering mortality from coronary-related deaths can be taken: (1) early call for help, (2) educational programs, (3) EMTs on telemetered ambulances, and (4) CPR skills for the general public.

To date, 572 rescue men have been trained as EMTs in special programs by the Rhode Island Medical Society and Department of Health. Additional courses to train personnel have been started.

101222

251. Poulsen, H., and A. Lysgaard, "Emergency Aid Organization," *Acta Anaesthesiologica Scandinavica Supplement* 29:283-290, 1967.

The use of medical staff in ambulance transports of acutely injured and ill patients is studied from 1956-66. Eight hundred forty emergency patients were taken to the emergency department in ambulances staffed by anesthesiologists. A survey of the 840 patients classified by diagnosis reports the number of resuscitation attempts, the number of prehospital deaths (at the accident and in the ambulance), the number of hospital deaths (within 24 hours and after 24 hours), and the central nervous system status of the 314 patients discharged alive. There were 534 cardiac arrests, and 527 of these had attempted heart-lung resuscitation. Seventy cardiac arrest patients were successfully resuscitated and 27 were discharged alive from the hospital. Of those discharged, the central nervous system was slightly impaired in four patients and severely impaired in two patients.

432212

252. Pozen, M. W., M. Berezin, L. Modne, et al., "An Assessment of Emergency Medical Technician's Performance as Related to Seasonal Population Influx," *Journal of Community Health* 3:227-235, Spring 1978.

This study assessed the effects of a threefold increase in the summer resort population on Cape Cod, Massachusetts, on the accuracy of the diagnoses and treatment of EMTs. The technician diagnoses for ambulance patients were evaluated against those given by the ER physicians during the months of August 1975 (1,109 ambulance runs) and February 1976 (542 ambulance runs).

The overdiagnosis rate of 25 to 50 percent for common conditions, and the correct treatment rate for suspect MI of 65 percent did not vary significantly between summer and winter.

A large influx in population does not seem to adversely affect the diagnosis rates of EMTs. Wrong diagnoses were uncommon, but a high frequency of overdiagnoses were found, as well as a 41 percent rate of failure to follow through with a correct treatment for patients with suspected MI.

421122

253. Pozen, M. W., D. D. Fried, S. Smith, et al., "Studies of Ambulance Patients with Ischemic Heart Disease," *American Journal of Public Health* 67:527-531, June 1977.

Patient delay in seeking medical assistance for AIHD and the incidence of potentially LTAs en route to the hospital were examined during the first 22 months operation of two telemeterized ambulances in southeast Baltimore County (Maryland). Of 7,654 patients transported, 179 who had ECGs transmitted were found to have MIs or acute myocardial ischemia. Fifty percent of these patients summoned the ambulance within 30 minutes and 72 percent within 2 hours after onset of acute symptoms. Fifty-eight percent had potentially LTAs. Intervention with drugs and/or defibrillation was required in 22 patients with or without CPR. Intervention with CPR alone was required in six patients. Twelve of these 28 patients survived through hospital admission and six were alive after 3 months.

421211

254. Pozen, M., D. D. Fried, and G. G. Voight, "Studies of Ambulance Patients with Ischemic Heart Disease. II. Selection of Patients for Ambulance Telemetry," *American Journal of Public Health* 67:532-535, June 1977.

One hundred eighty-two of 1,928 patients transported by telemeterized ambulances in southeast Baltimore County during a 6-month period had ECGs transmitted. Review of the remaining 1,746 records by two cardiologists indicated that an additional 113 patients should have had their ECGs transmitted because of life-threatening conditions. Of the patients with AIHD, 47 had ECG monitoring and 24 did not. There were 22 percent more Killip III/VI patients with 19 percent higher mortality at 3 months among those whose ECGs were not transmitted, the controlling factor among relevant variables.

Critical presentations inappropriately affect the ambulance staff's selection of patients for monitoring. Reasons underlying inappropriately nontransmitted ECGs of patients with IHD were concern for getting patients to the hospital quickly, pressure by families and onlookers, and wrong diagnoses by rescue personnel. With respect to the erroneous diagnosis factor, Pozen reports a false negative rate of 34 percent and a false positive rate of 41 percent.

421111

255. "Pre-hospital Coronary Care," *Journal of the Irish Medical Association* 64:500, September 1971.

Basically, this is an editorial on the state of the art of prehospital coronary care (e.g., Dublin Cardiac Ambulance Services and Belfast Medical Service). In addition, the article follows with the recommendations of a working party of the World Health Organization: (1) a physician with cardiac training should be the leader of the MCCU; (2) the MCCU should be part of a hospital; (3) 8 to 10 beds are needed for a population of 250,000; (4) average length of stay in CCUs to be cut to three weeks; (5) organization should come from nongovernmental sources and the state should "pick up the tab" later; and (6) public education is needed.

202222

256. Prolo, D. J., "Pre-hospital Management," *Journal of the Kansas Medical Society* 1:22-23, November/December 1972.

The pathophysiologic mechanisms of trauma are discussed. Prevention of the mishandling of the patient prior to his arrival at the hospital is outlined.

101222

257. **Rapaport, E., "Editorial: Prehospital Ventricular Defibrillation," *New England Journal of Medicine* 291:358-359, August 1974.**
Many deaths caused by disease are sudden deaths. The overwhelming majority of sudden deaths occur seconds to minutes after the onset of acute symptoms from VF secondary to advanced CAD. The author tells about the beginning of EMS with Pantridge, the shift to paramedics on MCCUs, the integration of EMS into the community, and how one-third to one-half of VF patients can be resuscitated successfully. The VF recurrence outlook is poor. Cobb et al. have stated this is because of coronary artery obstruction which may cause VF again later on. Research to date has indicated that it is hard to identify *specific* risk factors. The author recommends (1) long-term use of antiarrhythmic drugs, (2) public and professional education to reduce lag time between MI symptom onset and the patient's arrival at the CCU, and (3) continued intervention in coronary risk factors.
201222

258. **Redding, J. S., "Advances in Cardiopulmonary Resuscitation," *Clinical Anesthesia* 3:485-499, 1969.**
This is a state-of-the-art article that gives the historical background of CPR. Studies cited have to do with manual and mechanical aids in this area. Training of paramedical personnel for ambulances is briefly mentioned.
201222

259. **Reinhold, R. B., "Skoraya Pomosch: Emergency Medical Service of Soviet Union," *Archives of Surgery* 111:528-31, May 1976.**
The EMS of the Soviet Union as witnessed in 1975 shows evidence of central communication organization and planning. The Skoraya Romosch has developed into an elite medical corps with general and multispecialty emergency teams that include well-trained physicians and physicians' assistants. The emphasis is on bringing medical care to the patient at the site of the emergency. At its optimum, it is an elite corps that is uniformly available and capable of response to minor emergencies, as well as to major community disasters. Chronic problems of inadequate equipment and inappropriate use of the system continue to plague the Skoraya. Certain features, such as the central communication network, are probably adaptable to the United States, but, in general, the United States must continue to improve and devise its own EMS system.
102222

260. **Renner, W., "Emergency Medical Service: The Concept and Coronary Care," *Journal of the American Medical Association* 230:251-254, October 1974.**
Government decisions at the national level to grant a high priority to EMS have been the catalyst for revolutionary changes in the concept of EMS.

Emergency care is now seen as the first phase in an integrated progression of stages of care. EMTs now assume responsibility for care in the field, and the use of telemetry provides more efficient care.

Some problems still remain. One is that of determining to what extent the EMT should function under his or her own guidelines. Another is that the cost of saving lives is high.
101222

261. **Revelle, C., D. Bigman, D. Schilling, et al., "Facility Location: A Review of Context-Free and EMS Models," *Health Services Research* 12:129-146, Summer 1977.**
EMS location models are those formulated to address problems of EMS systems. Context-free models are those developed without reference to particular applications. The literature on these two types of public facility location models is reviewed, and the development of the maximal covering model from several earlier context-free models is described, with emphasis on problem statements and articulation of service objectives. An application of the maximal covering model to fire truck location indicates the ability of this model to handle multiple ojectives. According to the authors, the ability of the model to compare alternative solutions gives it utility for planning and evaluating EMS systems of a wide range of complexity. Potential applications of the maximal covering model are discussed regarding EMS problems involving multiple time standards and service objectives, location of special equipment, and location of fixed facilities.
201222

262. **Richupan, S., "The Effect of an EMS System on the Probability of Survival of AMI Patients—A Multivariate Probit Analysis," *Final Report on the Jacksonville Experimental Health Delivery System*, 1975.**
A multivariate probit analysis to investigate the effect of the Jacksonville EMS system on the survival of AMI patients is described. The study population is 1,546 AMI patients identified from hospital records from July 1, 1973, to December 31, 1974. The sample used is the 991 cases that have no missing values for any of the variables in the probit model. Of these 991, there are 253 cases treated and transported by the rescue unit and 738 arriving at the hospital by some other means.

The probit analysis shows that transportation and prehospital treatment by rescue personnel is not a significant factor in the probability of survival of AMI. Age, shock, congestive heart failure, sex, and the patient's drinking habits were significant in explaining the variation of the probability of survival of AMI patients. Patients with infarct of atrium, papillary muscle, or septum were found to be the highest risk group. The lowest risk group was found to be cases of subendocardial infarction.
411112

263. **Richupan, S., and L. Anderson, "Acute Myocardial Infarction (AMI) Mortality Study," *Final Report on the Jacksonville Experimental Health Delivery System Emergency Medical Services Systems Outcome Measurement Research Project*, 1975.**
In this article, Richupan presents a chi-square analysis to determine the effect of EMS care (EMT transport and treatment) on the probability of survival of AMI patients. The population base is patients identified from hospital records covering

July 1, 1973, to December 31, 1974. Of the 1,058 patients admitted first to the ER, the authors identified 371 who were treated and transported by rescue units.

Using 2 by 2 contingency tables, the authors looked at the significance of rescue treatment on both patient outcome after ER treatment and patient outcome at hospital discharge. Eighty-five percent of the resuce unit patients were alive after ER treatment, and 90 percent of those arriving by some other means were alive after ER treatment. The chi-square value was significant at the .05 level, indicating that the alternate hypothesis is accepted; i.e., AMI patient outcome at the end of ER treatment is not independent of field treatment and method of transportation. When the control variable "shock" is included, the chi-square value is not significant and the alternate hypothesis does not hold.

The same conclusion is determined for patient outcome at hospital discharge. Of the rescue unit patients 73.7 percent are discharged alive, 80.8 percent of the patients who arrived by other means are discharged alive. The null hypothesis that AMI patient outcome is independent of type of treatment and transport is rejected, except when "shock" is controlled for.

411112

264. Roberts, S.,C. Bailey, J. R. Vandermode, et al., "Medicopter: An Airborne Intensive Care Unit," *Annals of Surgery* 172:325-333, September 1970.

This article describes the medical aspects of the first 50 patients evacuated by helicopter to university hospitals in Columbus, Ohio. The article reports the components of the system and how they are operated.

In terms of results, 74 percent survived to leave the hospital, but this survival rate is not an evaluation of the program. The medical benefit of this project is documented by patients who arrived alive but who would have been dead on arrival by another mode of transportation. Of these 13 patients, six (46 percent) were discharged from the hospital.

401212

265. Robinson, J. S., and A. C. J. McLean, "Mobile Coronary Care," *Medical Journal of Australia* 2: 439-445, September 1970.

From May 1969 to December 1969 an MCCU in Perth attended 175 calls. Fifteen patients were dead when the team arrived. Ninety seven patients with AMI were transported, of whom 40 required treatment for cardiac arrhythmia in the MCCU. No patients died in transit. Three patients were successfully resuscitated from VF, but subsequently died in the hospital. There was an overall 17 percent hospital mortality rate and a 20.3 percent probability rate for the 97 AMI patients. The major component of delay in hospitalization of patients with MI was the patient's own delay in seeking medical aid.

432211

266. Rosati, M., A. Granatelli, G. S. Lustig, et al., "Community Hospital Mobile Coronary Care Unit," *New York State Journal of Medicine* 70:2462-2465, October 1970.

This article describes the use of a step-van-type of vehicle with modifications to the interior so that it may be used as an MCCU. The total cost of $10,000 supported by community organizations and family contributions. This Staten Island Hospital MCCU is presented as a prototype of a practical and effective coronary ambulance.

101222

267. Rose, L. B., "The Oregon Coronary Ambulance Project: An Experiment," *Heart and Lung* 3:753-755, September/October 1974.

This article describes the training of EMTs in the delivery of ECC. The author suggests that the EMT-paramedic can provide effective coronary care in the prehospital phase of AMI.

The article also reports the outcome of 210 cardiac arrest patients, including those known to be agonal before the arrival of the EMTs. Of the 210 patients, 81 survived and were alive in the hospital ER following EMT intervention. Of these 81, 33 were long-term survivors.

431212

268. Rose, L. B. and E. Press, "Cardiac Defibrillation by Ambulance Attendants," *Journal of the American Medical Association* 219:63-68, Jannary 1972.

This article contains a description of the organization of the Oregon Coronary Ambulance Project, specifically with respect to personnel training in defibrillation and electrocardiographic monitoring. Clinical results of the project are reported for the time period from September 1, 1969, through December 31, 1970. During this initial 15-month period, 307 patients were transported. Of these, 277 were admitted, and 102 proved to have an AMI. Thirty-seven of the AMI patients died in the hospital. The study reports 14 cases of cardiopulmonary resuscitation and/or defibrillation. Seven of these patients (five in VF and two in arrest) were discharged alive from the hospital.

431212

269. Rose, L. B., and E. Press, "The Oregon Coronary Ambulance Project: An Experiment in Independent Performance by Emergency Medical Technicians," *"Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* (Dallas: American Heart Association, Inc., 1975).

The institution of two coronary ambulances staffed with EMTs is discussed. A review of the clinical results from September 1, 1969, through July 1, 1971, and again through May 1, 1973, is presented. In the first 22 months, 471 cases were transported and monitored. Of these, 425 were admitted and 157 were proved to have had an AMI. There were 50 cases of cardiac arrest/VF, of which 22 received prompt CPR. Ten of those receiving prompt CPR regained consciousness.

For the first 45 months, the coronary ambulances encountered 1,600 cases of suspected MI patients; 11.3 percent of these patients were treated for cardiac arrest. Of the 181 arrest cases, 69 reached the hospital alive and 33 were discharged alive.

431212

270. Safar, P., D. Benson, P. Berkebile, et al., "Teaching and Organizing Cardiopulmonary Resuscitation," *Clinical Anesthesia* 10:161-192, 1974.

This article offers advice to those responsible for organizing and administering CPR educational and service programs within and outside of the hospitals.

101222

271. Safar, P., G. Esposito, and D. Benson, "Ambulance Design and Equipment for Mobile Intensive Care," *Archives of Surgery* 102:163-171, March 1971.

From their experience with ambulance design and equipment over the past 14 years, the authors suggest, (1) the establishment of national recommendations at the local level, (2) existing assembly line vehicles could be transformed into MICUs at relatively low cost, and (3) the equipment recommended and described has proven valuable in actual practice. Features of vehicles should be evaluated in the following order of importance: (1) portable and stationary life support equipment, (2) working space, (3) riding quality, (4) vehicle performance, and (5) cost. No presently feasible modification of existing vehicle types is ideal for all these features.

101222

272. Sandler, G., and A. Pistevos, "Mobile Coronary Care—The Coronary Ambulance," *British Heart Journal* 34:1283-1291, December 1972.

The organization of the Barnsey Coronary Ambulance Service covering a population of 200,000 is described, and an analysis is made of the first 500 calls over a 14-month period. A diagnosis of defined (60 percent = 299), probable (7 percent = 34), and possible (7 percent = 34) AMI based on World Health Organization criteria was made in 370 patients (74 percent). The various delay factors from the time of onset of the patient's symptoms up to admission to the hospital CCU are described. Seventy-five percent of the patients were reached by ambulance in less than 12 minutes and 95 percent in less than 22 minutes. One hundred eighty-five of the 370 patients (50 percent) had a total of 241 individual episodes of cardiac arrhythmia at some time before hospital admission. Cardiac arrests occurred in 16 patients, of whom there were only 3 long-term survivors discharged from the hospital, all with initial VF. The overall mortality in the 370 patients with MI was 18 percent.

An attempt is made to assess objectively the value of the coronary ambulance, and the cost effectiveness is also discussed. It is suggested that the service is both of medical benefit to the patient and of long-term financial benefit to the Government.

432211

273. Saner, R. G., "Ambulance Services and Modern Medicine," *South African Medical Journal* 47: 577-580, April 1973.

The author cites numerous studies with reference to different phases of an MCCUs use: (1) advantages, (2) ambulance equipment, (3) false calls, (4) training of personnel, (5) cost yield relationship, (6) communication system, and (7) legal circumstances. Saner recommends that all large cities reorganize their ambulances in light of newer concepts of patient treatment. He also emphasizes the importance of prompt diagnosis with the initiation of early therapy in a cardiac or other emergency. Saner concludes that the provision of MCCUs is imperative.

202222

274. Schaffer, W., and L. A. Cobb, "Recurrent Ventricular Fibrillation and Modes of Death in Survivors of Out-of-Hospital Ventricular Fibrillation," *New England Journal of Medicine* 293:257-262, August 1975.

This study examined the causes of death in patients previously resuscitated from out-of-hospital VF. In 51 months, 234 patients were successfully resuscitated, hospitalized, and discharged to their homes. During followup observations, 89 episodes of recurrent VF or death (or both) occurred, 64 of which (72 percent) were unexpected out-of-hospital circulatory arrests. VF occurred in 77 percent of 44 episodes in which the ECG was available. Ten patients survived one or more episodes of recurrent VF. Median time to recurrent circulatory arrest was 20 weeks. Prodromal symptoms were infrequent, and activity levels were generally low at the time of cardiac arrest. Recurrent VF or sudden death (or both) occurred predominantly when the initial episode was not associated with AMI. The authors conclude that patients resuscitated from VF are susceptible to early recurrence, probably reflecting continuing myocardial electrical instability.

421212

275. Schuman, L., H. Wolfe, and J. Sepulveda, "Estimating Demand for Emergency Transportation," *Medical Care* 15:738-749, September 1977.

Current and future demands for transportation services are estimated relative to actual and potential use by the population at risk. Correct and incorrect use are defined by matching levels of responses (MICU, BEA, transfer vehicle, nonemergency vehicle, transport/private vehicle) to the level of severity (life-threatening, urgent, routine, transfer, and dry run). From these definitions and data available from emergency facilities, demand and need are calculated. Multiple regression models are developed for estimating future demand. Data from a rural county (Beaver County, Pennsylvania) is then used with the models to develop predictive conditions. In both cases, five significant variables explain over 90 percent of the variation in number of calls for emergency transportation services. For both the demand and need equations, population, traveltime to the ER and the presence of a major highway through the district are significant variables.

301222

276. Schwartz, M., "Emergency Coronary Outside the Hospital," *Postgraduate Medicine* 56:119-120, December 1974.

This article gives an overview of MCC. The author discusses the reasons for using MCC and outlines the development, communications system, and training system of MCC programs. The article also discusses the criticisms of MCC.

101222

277. Semple, T., B. O. Williams, T. B. Begg, et al., "Early Transit of Hospitalized Myocardial Infarction

Patients," ***British Heart Journal*** **36:536-538, June 1974.**

Two hundred thirty-three patients with definite AMI were transferred directly from a CCU to another hospital via ambulance with a coronary care nurse and a battery powered defibrillator. There was no morbidity associated with transport, and the late mortality was not significantly different from that of patients retained in the parent hospital. Possible developments and advantages resulting from such a policy are discussed.

432212

278. Sherman, M. A., "Mobile Intensive Care Units: An Evaluation of Effectiveness," unpublished paper, Beekman Downtown Hospital, Emergency Care Institute, New York.

A quasi-experimental field study to determine the effectiveness of paramedic-staffed MICUs is discussed. Four similar suburban communities are studied independently over a 65-month period to compare differences in the mortality rates of MI patients (within the communities over time and between the communities) before and after the implementation of an MICU. Of 6,700 patients arriving at the ER, there were 1,566 MI patients admitted and 230 MI patients dead on arrival at the hospital.

Results showed a statistically significant reduction in mortality rates in two communities (41.1 to 23.9 percent, and 37.6 to 27.0 percent) after the MICU began service. A statistically significant increase in mortality was found in one community, while the fourth community showed a reduction that was not statistically significant at $p = .05$. An analysis of plausible rival hypotheses considered 18 variables, such as changes in population characteristics. Most of these were discarded as causes for the observed reduction in mortality.

421212

279. Shields, L. R., "Ambulance and Control Manning in the London Ambulance Service," Operational Research Unit, Greater London Council, November 1969.

This report uses ambulance demand estimates per hour and per diem to establish a guide to the appropriate manpower required both in the control and on the road, in anticipation of February 1971 when the emergency service and general stretcher ambulance service are combined under the same control.

302222

280. Shu, C. Y., "Mobile CCU's," ***Hospitals*** **45:14, Jannary 1971.**

Shu briefly reviews the effect of CCUs on hospital mortality rates. Then, in a discussion of MCCUs, he studies and concludes that expert opinion on the need for and use of MCCUs is not unanimous. He cites the problem of urgency of time when using ordinary ambulances and he commends upgrading ambulance personnel and equipment. But Shu notes that much of the delay in getting the coronary patient to the hospital (i.e., time lag between onset of symptoms and ensuing medical intervention) is due largely to the patient himself.

201222

281. Sidel, V., J. Acton, and B. Lown, "Models for the Evaluation of Prehospital Coronary Care," ***American Journal of Cardiology*** **24:674-688, November 1969.**

A model is presented for aiding in the application of decision techniques in the evaluation of alternative methods for prehospital care of heart attack (in this case, one system with prescreening and one without). Such a model forces critical examination of goals and of all feasible methods for achieving these goals, and requires comparison of costs with benefits or effectiveness, using the limited data available (from in-hospital and out-of-hospital experience with coronary care and from epidemiologic studies). This analysis suggests that if heart attack mortality in the population is to be substantially reduced, strategies of precoronary care are required that (1) would provide greater specificity as to who is at high risk of sudden death from heart attack and (2) would intercept the victim at the earliest feasible phase of the potentially fatal illness.

301222

282. Simon, A. B., "Sudden Death in Non-Hospitalized Cardiac Patients," ***Archives of Internal Medicine*** **132:163-170, August 1973.**

Sudden death due to coronary heart disease in nonhospitalized patients in southeastern Montgomery County, Maryland, was investigated over 1 year to determine the potential benefits from various intervention techniques. One hundred thirty-eight patients between the ages of 35 and 75 were studied. Fifty-seven percent had a history of heart disease. Premonitory symptoms were present in 65 percent, although only 22 percent had chest pain. Seventy-five percent died at home, 41 percent at work, 8 percent in the ambulance and 80 percent in a hospital ER. Thirty-six percent died unwitnessed, but 30 percent of these had informed someone of acute symptoms before being left unattended. Previous symptomatic heart disease was associated with a more rapid demise. Based on the time of cardiac arrest and the call for emergency aid, no more than 22 percent could have been aided by an MCCU.

401212

283. Simon, A. B., A. A. Alonzo, and M. Feinleib, "Patient Response to Acute Episodes of Coronary Heart Disease," ***Archives of Internal Medicine*** **133:824-828, May 1974.**

Of 382 patients with acute symptoms of CAD in southeastern Montgomery County, Maryland, 160 were hospitalized with acute coronary insufficiency, 16 were hospitalized with acute congestive heart failure, and 138 died before admission to the hospital. Self-treatment with prescribed medications or household remedies was noted in 74 percent of the entire group, changes in activity in 88 percent, and attention to social proprieties and continuing social obligation in one-third. Some forms of activity and self-treatment were potentially harmful. The spectrum of activities was similar in those hospitalized to that in those who died before hospital arrival.

411211

284. Simon, A. B., M. Feinleib, and H. K. thompson, Jr., "Components of Delay in the Prehospital Phase of Acute Myocardial Infarction," *American Journal of Cardiology* 30:476-482, October 1972.

One hundred sixty patients from a defined population with AMI were questioned about their activities before hospital arrival. HAT was divided into prodromal period, patient decision time, lay consultation period, medical decision time, and traveltime.

Forty-eight percent experienced prodromal chest pain before the acute onset of symptoms. The median HAT for all patients was 2 hours and 45 minutes. HAT was significantly prolonged in patients experiencing an increase in the severity of angina pectoris, and in those with a physician decision time of more than 1 hour.

Only 92 (57.5 percent) of the patients used the volunteer fire and rescue service. The patients who used the service tended to arrive earlier than those who used some other mode of transportation. However, there was no difference in the actual time spent traveling.

A nonsignificant trend in hospital mortality by HAT was determined.

401211

285. Simon, A. B., and J. O. Simon, "Utilization of Ambulance Services by Patients of Acute Cardiac Emergencies," *Maryland State Medical Journal* 23:32-34, August 1974.

Only 57 percent of a group of patients hospitalized with an AMI used a free rescue squad service to get to the hospital. No single demographic or past history variable was predictive in determining which patients would use this service. Of 138 cardiac deaths outside the hospital, 19 occurred while the patient was waiting for the ambulance to arrive or during transport. An additional eight ambulance-transported patients had a cardiac arrest in the ER. The relatively low acceptance rate of rescue squad services, and the high incidence of death outside the hospital are factors that limit the potential impact of MCCUs in reducing nonhospitalized cardiac death.

411221

286. Sloman, G., "Mobile Intensive Care Unit, Melbourne," *The Medical Journal of Australia* 2:519, September 1973.

This article reports on the operation of the MICU in Melbourne from September 1971 until June, 1973. A sample of 37 patients who had been resuscitated by the MICU staff and arrived at the hospital alive is considered. Of the 37 patients, 36 had a cardiac problem. Seventy percent of the 37 patients were discharged alive. Followup of the 26 patients discharged alive showed that 6 died after discharge (16 percent) with an average time of death of 5 months and a range of 7 weeks to 15 months.

432212

287. Smyllie, H. C., M. P. Taylor, and R. A. Cunninghame-Green, "Acute Myocardial Infarction in Doncaster. II. Delays in Admission and Survival," *British Medical Journal* 1:34-36, January 1972.

The time delay encountered for CCU admissions of patients with suspected AMI was observed over a period of 12 months, during which a "no-refusal" coronary care scheme was functioning with an emphasis on minimizing delay. During the same period, the duration of survival of cases diagnosed as coronary thrombosis by the coroner's pathologist was measured. Comparison of the two series shows that 75 percent to 80 percent of the coroner's cases had died before the median time of notification of the general practitioner by those patients referred to the hospital.

The conclusion reported is that the provision of MCC on request from general practitioners is unlikely to have an appreciable effect in preventing deaths from AMI outside the hospital.

402221

288. Snook, R., "Accident Flying Squad," *British Medical Journal* 3:569-574, September 1972.

This article describes the organization and equipment of the "accident flying squad." The author records his evaluation of the medical attendance at the scenes of the accidents. Also discussed is the integration of this within the ambulance after 3½ years, beginning in November 1967.

102222

289. Snook, R., and R. Pacifico, "Ambulance Ride: Fixed or Floating Stretcher," *British Medical Journal* 2:405-407, August 1976.

The alternatives of an ambulance constructed for a specific medical emergency and a specially designed stretcher suspension system were considered, and the features of the latter assessed by subjective and objective tests. The results showed a significant improvement in the quality of the ride offered to the patient.

302222

290. Sobel, B., "Reducing the Toll from Sudden Death," *California Medicine* 117:54-55, October 1972.

The potential value of MICUs must be considered in the context of the overall problem of sudden cardiovascular collapse and death. In general, patients fail to reach the hospital because death often occurs so quickly, because of patient and physician denial, and because transport is often slow. Thus, one must consider, along with the MICU, other approaches of potential value in reducing mortality. These are (1) identification of high-risk populations suitable for drug treatment, (2) precoronary care facilities available for self-referring patients, (3) use of electronic devices in selected patients of high risk, (4) aggressive surgical therapy in selected patients, and (5) prevention with diet and other metabolic and pharmacologic interventions.

101222

291. Soffer, A., "Only One Third Reach the Hospital," *Diseases of the Chest* 55:272-273, April 1969.

Two-thirds of the deaths from coronary heart disease occur before the patient reaches the hospital. Intensive cardiac units will have little effect on the majority of instances of SCDs unless we adopt community programs that go beyond hospital walls.

Pantridge's approach is indeed practical. The Sixth

Bethesda Conference convened to consider in depth what can be done about narrowing the gap between the onset of acute cardiac emergencies and medical care. The conference recommended a number of approaches: (1) patients with heart disease should carry a wallet-sized version of their previous cardiac history, (2) studies should be undertaken in several different types of communities in the United States, and (3) studies of MICUs and evaluations of MI detection center should be made.

101222

292. Special Report, The Robert Wood Johnson Foundation, "Emergency Medical Services," No. 2, 1977.

This article gives an explanation of EMS systems, including their purpose and function. In addition, three case studies are described and the viewpoint of David Boyd (head of the Federal Government's Medical Services Program) is presented.

101222

293. "Standards for Cardiopulmonary Resuscitation and Emergency Cardiac Care," *Journal of the American Medical Association* 227:833-868, February 1974.

This article is a report on the National Conference on Standards for CPR and Emergency Cardiac Care held in May 1973. At this meeting, standards for CPR and ECC were developed. They relate to (1) recommended principles and techniques for basic life support; (2) CPR training and certification according to American Heart Association standards; (3) training of medical and allied health personnel; (4) the role of the American National Red Cross and other agencies in training the lay public; (5) the role of life support units in stratified systems of ECC, and (6) medico-legal aspects of CPR and ECC.

101222

294. Stolfi, J. E., "Prehospital Emergency Care of the Heart Attack Patient," *Maryland State Medical Journal* 22:94-95, September 1973.

Stolfi cites statistics on people in the United States who die of SCD. He depicts the ideal method of treating the individual whose collapse results from a coronary heart attack. According to Stolfi, treatment should begin at the time of onset and continue through transportation (including CPR technique and ambulance telemetry) and arrival at the hospital.

201222

295. Stuckey, John G., "Arrhythmia in the Prehospital Phase of Acute Myocardial Infarction," *Medical Journal of Australia* 2:29-32, August 1973.

This article discusses some aspects of arrhythmias before hospitalization for MI.

Analysis of mortality figures in MI shows that most deaths occur within the first few hours of onset of symptoms. This may represent an important, potentially salvageable group of people in light of experience in the coronary care ambulance. Deaths in the prehospital phase of AMI are presumed to be caused by arrhythmias. The aim of prehospital management in AMI is to provide early relief of pain and treatment of arrhythmias. The number of patients who benefit from this form of therapy is uncertain.

102222

296. Swanson, L. W., W. C. Rosenfeld, and A. Jorde, "Resume of Mobile Coronary Care Unit Service in Mason City, Iowa," *Proceedings of the National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)* pp. 211-215, (Dallas: American Heart Association, Inc., 1975).

This article describes an MCCU in Mason City, Iowa, and compares its results with cardiac calls made by a regular ambulance. The results show that the mortality rates for the MCCU are lower than that for the regular ambulance. The authors believe the favorable comparison to be the result of the ambulance nurse's skill, her authority to initiate treatment, the radiophone, and the constant monitoring during transportation.

431212

297. "Telemetry Increases Scope of Houston's Emergency Service," *Texas Medicine* 70:111-114, February 1974.

A new telemetry system in Houston's emergency service is described. Since the new equipment was installed, a new phase of emergency service involving EMT-As has begun. This article reports the specific problems confronting the planners and their solutions and the subsequent development of the system.

101222

298. Thornton, J. A., J. S. Fleming, A. D. Goldberg, et al., "Cardiovascular Effects of Fifty Percent Nitrous Oxide and Fifty Percent Oxygen Mixture," *Anaesthesia* 28:484-489, September 1973.

A study of the inhalation of a 50:50 mixture of nitrous oxide and oxygen (Entonox) was undertaken on 24 patients undergoing cardiac catheterization for underlying cardiac diseases. Cardiac output, blood pressure, and heart rate were measured in 12 patients breathing Entonox and in 12 patients breathing a simple nitrogen and oxygen mixture.

A depression of cardiac output of the order of 12 percent followed the administration of Entonox. This appears to be related, in part, at least, to the administration of an increased concentration of oxygen in the inspired mixture.

401222

299. Tjoe, S. Z., and M. H. Luria, "Delay in Reaching the Cardiac Care Unit: An Analysis," *Chest* 62:617-621, June 1972.

Seventy-five patients were studied with regard to the occurrence of delays in entering a CCU. The greatest delay was the decision time—the interval between the onset of acute symptoms and the patient's decision to seek medical help. The second most important cause of delay was physician delay. A lengthy waiting period in the ER was also found. Transportation time appeared of less consequence when other delays were considered. Thus, the need for MCCUs was questioned. The results indicate that community-oriented educational programs are required to inform more fully the population at risk of symptoms of AMI. Earlier hospitalization of patients with chest discomfort by physicians is also needed. Furthermore, individual hospital evaluations similar to the present study, by underscoring where significant delay occurs, may help expedite the care of these patients.

401221

300. Toregas, C., R. Swain, C. Revelle, et al., "The Location of Emergency Service Facilities," *Operations Research* 19:1363-1373, October 1971.
This paper is concerned with a facility location problem concerning the special aspect that the maximum line or distance that separates a user from his closest service is a crucial parameter. As such, the problem is seen as most applicable to the location of emergency services such as fire stations, although one may equally apply it to the location of ordinary services, such as schools and libraries.

101222

301. Estell, Douglas A., Smock, Sidney N: "Blind Defibrillation Outside the Hospital" *JACEP* 5:512-514, July 1976.
Blind defibrillation, defibrillation of an unconscious, pulseless adult without electrocardiographic verification of arrhythmia, allows early definitive treatment of cardiac arrest victims. Basic EMT-As have the ability to perform blind defibrillation in a prehospital setting, and place an esophageal obturator airway. When basic EMT-As are performing blind defibrillation, there should be a standard operating procedure involving diagnosis defibrillation, CPR and re-evaluation.

101222

302. Uhley, H., "Electrocardiographic Telemetry from Ambulances. A Practical Approach to Mobile Coronary Care Units," *American Heart Journal* 80:838-842, December 1970.
Uhley reports one approach to a segment of precoronary care that attempts by means of ECG telemetry to use the merits of the MCC system without the associated overwhelming cost.

101222

303. Uhley, H. N., "Experience with a Private Ambulance Service," *Heart and Lung* 3:765-769, September/October 1974.
A private ambulance emergency care system that has been in operation for over 4 years in San Francisco is described. The system places a physician or nurse in contact with trained paramedics. Of 200 successive calls, the diagnoses were as follows: MI, 18 percent; no MI, 36.5 percent; arrhythmia, 9 percent; syncope, 9.5 percent; respiratory distress, 11 percent; miscellaneous, 8.5 percent; and no signal, 7.5 percent. Of the combined MI and no-MI groups, 41.3 percent had a discharge diagnosis of MI and 32 percent of the total number of cases were diagnosed as having had an infarction. The overall mortality rate for the 200 patients was 11.5 percent. Nine patients (4.5 percent) were dead on arrival and four (2 percent) were found to be in cardiac arrest. Thus, in 13 cases where the opportunity to resuscitate occurred the treatment was successfully employed four times.

421112

304. Vaisrub, S., "A Magic Carpet Is Not Enough," *Journal of the American Medical Association*, 221:404, July 1972.
The author cites studies indicating high percentages of sudden death from MI occurring before the patients reach the hospital. The one "if only" that is posited is that "if only" patients did not wait so long before calling. Yet, there are at least two other problems: (1) high percentages of patients died minutes from symptom onset and (2) three out of six resuscitations failed. Thus, faster resuscitative care delivery will not solve the problem of SCD. The answers lie in preventive measures made available to patients at home. One example for the short run is self-administered drugs. At present there is little to offer, for the long run. Therefore, Vaisrub points to a great need for research to pinpoint those factors that initiate life-menacing arrhythmias so SCD are no longer sudden and unavoidable.

101222

305. VanDugterern, N. R., "Comment 2," *Medical Journal of Australia* 1:711-712, May 1976.
With regard to Australian EMS, the author mentions 19 guidelines accepted by the New South Wales Branch of the Australian Medical Association. Also, he indicates that the branch has explored establishing EMS in competition with the already existing one, linked up with hospitals and the Health Services Commission, and considered funding a pilot scheme for the Australian Medical Association-sponsored deputizing service. This is to ensure 24-hour coverage.

102222

306. Wallace, S., "Pre-hospital Coronary Care," *Nursing Mirror* 139:73-75, November 1974.
Wallace gives an overview of CAD and describes the first prehospital coronary care scheme developed at the Royal Victoria Hospital, Belfast, by Pantridge in 1966. She concludes by stating that the emphasis should be on early coronary care.

102222

307. Wallace, W. A., and P. Yu, "Sudden Death and the Pre-hospital Phase of Acute Myocardial Infarction," *Annual Review of Medicine* 76:1-7, 1975.
This article discusses the prehospital phase of AMI: what has been and can be done.

The authors state that if we are going to reduce mortality from AMI or coronary attack, it is imperative to deliver medical care to patients very soon after the acute coronary event. The major cause of delay has been identified as patient delay, so public and physician education is of paramount importance.

For large cities the MICU is one approach to the problem of rapid access to medical facilities that are capable of helping the patient. Fixed life support stations (which may be more feasible and practical for the majority of rural and urban areas) can also result in early cardiac care and can therefore reduce mortality.

101222

308. Waller, J. A., "Urban-Oriented Methods: Failure to Solve Rural Emergency Care Problems," *Journal of the American Medical Association* 226:1441-1446, December 1973.
Rural communities require different approaches to emergency care than are relevant to urban areas. The emphasis should be placed first on improving the capability to respond to emergencies that are life

threatening rather than on responding to the much larger number of less serious events. Most people who die unnecessarily could be saved with relatively simple techniques. Improvement of basic services and skills is much more important at this time than is the development of highly sophisticated training programs and response systems. ER nurses need better training, standard protocols for emergency response, and both nurse and ambulance personnel need frequent critique sessions to make up for the sparsity of real emergencies they encounter. Program evaluation must be an integral part of any improved effort.

101222

309. Walsh, M., G. Shivalingappa, K. Scaria, et al., "Mobile Coronary Care," *British Heart Journal* 34:701-704, July 1972.

Of 501 patients seen the first year of the MCCU operation in Belfast, the authors analyzed the first 300 and compared them with 112 patients admitted by conventional means. The authors use a coronary prognostic index in the comparison, hence controlling for severity. Findings show that patients seen by the MCCU have a significantly lower mortality, both in hospital ($p < .01$) and at 3 months ($p < .001$), and this was true in each prognostic group. The lower mortality rate for the MCCU patients was also evident in both the patients 70 years of age and younger and the patients over 70 years of age. The hospital mortality for those seen by the MCCU was 9 percent and for the conventionally admitted patients the hospital mortality was 22 percent.

432111

310. Ware, M., "Immediate Coronary Care," *British Medical Journal* 3:134-135, July 1968.

Ware states, "Mortality from acute MI reaches a peak within the first 24 hours, then rapidly declines." Other studies of CCUs emphasized high mortality among patients admitted within the first few hours of the illness wave. The McNeilly, Pemberton study is cited in noting that as resuscitation techniques become generally more available, attention is focused on treatment of patients who would die before reaching the hospital. The author cites Pantridge on the special MCCU for people who would die between the time when help is summoned and when they are admitted to the hospital. The problems connected with MCCUs concern organization, finance, and medical staff. Application on a national basis must make use of integrating existing ambulance services.

Ware indicates the need for further studies with MCCUs to estimate feasibility and cost to determine which patient must be admitted to the hospital and which can be kept at home and treated there.

One outcome may be the introduction of antiarrhythmic drugs by the medical attendant first on scene. One practical scheme would be to identify places of large or high risk. Resuscitation facilities on the spot and a trained first-aid staff could, with the aid of local hospital staff, be part of a life-saving service.

202222

311. Warren, J. V., "A Revolution in Coronary Artery Disease," *Journal of Chronic Diseases* 26:547-551, September 1971.

In research there is a reassembling of the basic concepts of the process of CAD and its relationship to clinical manifestations such as angina pectoris, MIs, and sudden death. Although substantial claims have been made and many lives have been saved from heart attack, by MCCUs and hospital CCUs the ultimate goal of prevention appears to be one for the future. There is a need to sort out the thinking with regard to primary prevention (risk factors are arrhythmia and congestive heart failure) versus secondary prevention (risk factors include elevated cholesterol, elevated other serum, lipids, lowered blood pressure, and heavy cigarette smoking) and to decide in what areas, if any, controlled clinical trials are warranted. The problem of evaluating bypass surgery at this time is a particularly difficult example.

101222

312. Warren, J., C. Mattingly, and S. Rand, "The Design and Operation of a Mobile Coronary Care Unit," *Abstracts of the 42d Scientific Session, Supplement III to Circulation* 39:111-212, October 1969.

An MCCU has been designed and put into use in Columbus, Ohio, to study sudden death and the early phases of MI. The vehicle has the conventional facilities of a hospital-based unit, plus data records and ECG telemetry capabilities. It operates in conjunction with the Columbus Fire Department Emergency Squad. In 2 months of operation, 120 responses were made. Over 50 percent of these were diagnosed as cardiovascular problems. Nine patients died before the vehicle arrived and 18 additional patients were eventually diagnosed as having AMI. No patient died in transit, but six died within 2 hours of hospitalization. In only one instance was defibrillation at the scene followed by an uneventful recovery.

431212

313. Waters, J. M., "The Jacksonville Emergency Medical System," *Nebraska Medical Journal* 59:44-49, February 1974.

This article reports on the community mortality rate for automobile trauma cases between 1968 and 1971 and reports on the rescue squad responses for suspected heart attacks during April 1972. Of 382 dispatches made in April 1972 for suspected cardiac cases, 232 (61 percent) were transported to hospitals; of these, 138 were transported with symptoms suggestive of respiratory/heart problems. Of these 138, 26 had arrests or arrhythmias treated (CPR required in all cases and IV drugs and defibrillation in some cases) prior to hospital arrival. Of these 26 patients, 15.4 percent were discharged alive.

421212

314. Watkins, R., "Emergency Coronary Resuscitation Ambulance," *Nursing Mirror* 127:33-35, December 1968.

This article describes an emergency coronary resuscitation unit at Royal Victoria Infirmary and the Newcastle General Hospital.

102222

315. **Webb, S., A. Adgey, and J. Pantridge, "Autonomic Disturbance at Onset of Myocardial Infarction," *British Medical Journal* 3:89-92, July 1972.**

The sample consists of 74 patients seen within 30 minutes of the onset of AMI. Ninety-two percent had signs of autonomic imbalance, 55 percent (41) had excessive vagal activity, and 36 percent (27) had sympathetic overactivity. Atropine was administered to certain patients with bradyarrhythmia and hypotension. IV protocol given to patients with sinus tachycardia or sinus tachycardia with hypertension. In most cases, drugs helped correct autonomic disturbance. These observations, according to the author, are relevant to sudden death in AMI. Sympathetic and parasympathetic overactivity may be related to the development of VF. The data presented showed that trying to correct autonomic disturbance after AMI is rewarding. "Seventy-two of 74 patients were aged under 70 and 65 of them serviced the three week period in hospital—an overall mortality of 9.7 percent."

432212

316. **Weil, M. H., H. Shubin, E. L. Boycks, et al. "A Crisis in the Delivery of Care to the Critically Ill and Injured," *Chest* 62:616-620, November 1972.**

Advances in biological science since World War II have provided methods for sustaining life and function in the critically ill. However, survival is unlikely unless the patient's life-threatening defects can be promptly inventoried and artificial methods immediately applied to support the functions of the vital organ systems. Medical science has the knowledge but has neither the resources of skilled manpower nor of equipment to deliver it to more than a minority of citizens.

Extrapolation of Vietnam experiences in the immediate care of wounded servicemen to civilian practice leaves little doubt of the life-saving impact of rapid transfer of a seriously traumatized patient to a center that is uniquely prepared for his medical care. There is also evidence that mortality may be further decreased through the use of MICUs that make possible effective treatment within 1 hour after the onset of chest pain.

The authors recommend that specific funds for dedicated research and development of systems by which services in critical care centers can be facilitated be established.

101222

317. **Weiman, C. G., "An Aid in the Treatment of Myocardial Infarction," *Journal of Occupational Medicine* 18:70, February 1976.**

This article describes alarm system of the First National City Bank that guarantees the arrival of medical personnel anywhere in two buildings within 2 minutes after notification of the emergency to the Medical Department.

101222

318. **White, N. M., D. A. Chamberlain, R. Binning, et al., "Mobile Coronary Care Provided by Ambulance Personnel," *British Heart Journal* 35:550, May 1973.**

The experience of the two coronary ambulances in Brighton during an unspecified time period is reviewed. The ambulances responded to 1,497 calls, of which 882 were suspected of having cardiac pain. VF is used as the tracer condition. Fifty-seven patients were in VF before the ambulance arrived, coordinated rhythm was restored in 16 cases, but only 1 patient did not suffer irretrievable brain damage. Eight patients developed VF in transit, and seven of these were defibrillated and reached the hospital alive. Five VF patients were discharged alive. Correct diagnoses by ambulance men (paramedics) were measured, and findings showed that over a 9-month period, 86 percent of all arrhythmias that occurred during a transit were diagnosed correctly.

422112

319. **White, N. M., N. S. Parker, R. A. Binning, et al., "Mobile Coronary Care Provided by Ambulance Personnel," *British Medical Journal* 3:618-622, September 1973.**

MCC has been provided by two MCCUs centrally dispatched in Brighton by ambulance personnel without immediate help from physicians or nurses. No additional vehicles or staff was required. The capital cost of the experiment was therefore small, and additional running costs were negligible.

The results have been monitored by retrospective analysis of ECGs recorded in the ambulance and stored on magnetic tape. In the first 9 months of operation to July 1972, 1,082 patients with suspected cardiac emergencies were carried in two vehicles and monitored as possible cardiac emergencies. Subsequent analysis showed that 76 percent of these patients had acute symptoms from IHD or had circulatory arrest. Eighty-six percent of arrhythmias were diagnosed correctly by ambulance attendants. Though only eight cases of primary VF occurred during or shortly before transit, all were successfully reversed, and five of these patients subsequently left the hospital alive. Other benefits of the scheme have included appreciable reduction in the median delay time between onset of presenting symptoms in patients with AMI and admission to the hospital.

422111

320. **White, R. D., "Pre-hospital Life Support as a Component of Emergency Medical Services," *Minnesota Medicine* 59:93-94, February 1976.**

White proposes that although CAD necessitates intervention at the preventive level, until that becomes a reality, intervention is necessary at the prehospital stage.

101222

321. **White, R. D., T. Paul, and B. O'Donovan, "Pre-hospital Life Support Systems in Traumatic and Cardiac Emergencies," *Anesthesia and Analgesia* 53:734-743, September/October 1974.**

This article describes the experience of a private ambulance service in Rochester, Minnesota, serving a population of 85,000 in an area of 660 square miles. The sample consists of 83 patients with ECGs transmitted from the ambulances. Of this sample, 17 patients had cardiopulmonary arrest and received resuscitation attempts by the ambulance EMTs. Three patients (17.6 percent) were successfully

resuscitated at the scene and two of these were discharged alive. Of the remaining 66 patients whose ECGs were transmitted, 39 had chest pain (60 percent) with or without arrhythmia. No data on survival rates were reported for this group.

411212

322. **Wilder, R. J., "Cardiopulmonary Resuscitation by Trained Ambulance Personnel," *Journal of the American Medical Association* 190:531-534, November, 1964.**

Of the 153 cardiopulmonary resuscitations begun outside the hospital by the Baltimore City Ambulance Service from November 22, 1961, to March 19, 1964, 90 percent of the patients died following ambulance-personnel-administered CPR (138). Ten percent survived with complete return to normal activity. Thirty-three of the 153 patients were undiagnosable. Of the remaining 120 patients with available diagnoses, 60 percent had heart disease.

441212

323. **Willemain, T. R., "Notes on the Design of EMS Systems," unpublished second draft, April 1977.**

A system is a set of elements and relationships assembled to achieve certain goals. The author proposes a system design for EMS in which he describes three levels of a hierarchy of system design activities: evaluation of components, analysis of relationships among components, and problem framing and goal setting. The design process should demand high standards of evaluation of system components. Available tools of system analysis should be commonplace in the design process. There should not be any adapting components without reference to their interconnection with other components. Also, the EMS communities should accept intervention of political process in the system design cycle.

101222

324. **Willis, P. H., "The Nurse in the Mobile ICU," *Nurse Times* 64:1617, November 1968.**

This article describes the MCCU in Belfast from a staff nurse's point of view. The MCCU is at the Royal Victoria Hospital.

102222

325. **Willson, J. R., "Health Maintenance Organizations: Implications for Medical Education and Practice," *Journal of Reproductive Medicine* 10:24-27, January 1973.**

The concept of health maintenance is essential to the development of an adequate health care delivery system, but health maintenance organizations, as presently functioning and as planned, will not solve the problems. They are as crisis oriented as most medical practices and are likely to perpetuate the present system. Unless the development of home maintenance organizations is paralleled by the introduction of methods designed to educate patients to participate in their own health care and to educate medical students and practicing physicians in the value of preventive medicine and unless behavioral scientists and other professionals are incorporated into the health team, the program is bound to fail. Health maintenance organizations will be nothing more than a giant band-aid that will hold the system together temporarily, simply because so much acute care is needed. They will not correct the other inadequacies of health care delivery.

101222

326. **Winchell, S. W., and P. Safar, "Teaching and Testing Lay and Paramedical Personnel in Cardiopulmonary Resuscitation," *Anesthesia and Analgesia* 45:441-449, 1966.**

High school students and lay groups learned CPR as well as ambulance and dental students. First-year medical students and nurses performed better. Lay instructor results were similar to physician instructor results.

Backward tilt of the head and mouth-to-mouth ventilation should be taught more widely to the public, but external cardiac compression should not be taught casually because it is potentially dangerous.

Selected lay and paramedical personnel can be expected to perform external cardiac compression effectively and safely when taught under carefully controlled conditions.

101222

327. **Winton, R. R., "Early Coronary Care," *Medical Journal of Australia* 1:837-839, April 1972.**

From careful assessment of results achieved by MCCUs in the United States and the United Kingdom, Winton found they brought about a small but significant reduction in mortality. When planning national strategies for various means of improving the mechanisms of early coronary care (e.g., staffing with ambulance personnel and patient self-administration of drugs), there is a need to recognize that hospital CCUs and MCCUs are primary means for preventing accidental electrical death. The treatment offered has not the slightest effect on the underlying CAD. Primary prevention is therefore the only way of achieving long-term prognosis. The MCCU to date has a value for prophylaxis and for treatment of electrical disturbances of the heart. With limitations of MI set by CAD, there are limits to benefits that can be expected. Winton recommends cutting cost to the community through greater use of paramedical personnel resources.

201222

328. **Wolford, D. A., "Hospital-Based EMS Program Serves Rural County," *Hospitals* 49:51-52, 54, 56, November 1975.**

This article describes the planning and implementation of a hospital-based EMS system in Noble County, Indiana, 31,400 population. During the first full year of operation 1,210 runs were made (about 3 percent used the ambulance service) during April 1, 1974, to March 31, 1975. No further breakdown of these statistics was offered in the article.

411222

329. **Woodwark, G. M., and I. A. Gillespie, "Monitoring of Ambulance Patients by Radio Telemetry," *Canadian Medical Association Journal* 102:1277-1279, June 1970.**

Mainly a description of monitoring ambulance patients by radiotelemetry by the emergency ambulance of the Saanich Municipal Council. The

authors concentrate on discussing the details of the telemetry system.

102222

330. Yoon, P. H., and R. W. Watts, "A Mobile Coronary Care Unit: An Evaluation For Its Needs," *Annals of Internal Medicine* 73:61-66, July 1970.

To determine the usefulness of an MCCU, an evaluation of present patterns for care of AMI patients and patients dead on arrival at a west side Cleveland hospital was made. For the majority of patients with AMI, the main cause of delay in admission derives from failure of the patient to seek prompt medical help. The study of patients dead on arrival showed that the time needed for rescue squads to reach the patients was too long in almost all cases for effective resuscitation to be accomplished. Present transportation facilities for AMI in Cleveland are adequate. Added equipment and training of personnel for the existing units could obviate the need for a centrally based and more costly MCCU. Most important is the education of the public so that people will seek prompt medical help.

491221

331. Yu, P. N., "Future Trends in Coronary Care," *Journal of Practical Nursing* 19:31-33, October 1969.

The author mentions three areas of future trends in coronary care: the first is the study and prevention of sudden death of patients suffering from AMI. If patients can reach the hospital promptly, there will undoubtedly be a decline in the incidence of sudden death. The author discusses reasons for delays in patient response, physician response, and transportation. The second two areas of future trends in coronary care are the detection and management of pump failure and the application of computer automation.

101222

332. Yu, P. N., "Life Support Stations," *Archives of Internal Medicine*, 134:234, August 1970.

This article both reviews and suggests plans of action for life support units, both mobile and fixed. The author describes the functions and potential advantages of a life support station as follows: (1) initiation of early care with monitoring of the vital signs and ECG; (2) prevention and management of serious cardiac arrhythmias; (3) institution of CPR, including defibrillation; (4) stabilization of the patient's condition before transfer; and (5) reduction of the incidence of cardiogenic shock and overall mortality.

201222

333. Yu, P. N., "Pre-hospital Care of Acute Myocardial Infarction," *Circulation* 45:189-204, January 1972.

The author states that to reduce high mortality from AMI emphasis must be placed on prehospital care. He proposes several major approaches:

(1) To shorten the delay in securing medical care, public and professional education, a "911" system, and rapid transportation are required.

(2) Emergency life support stations, both fixed and mobile, should be established.

(3) The prevention of sudden death involves research, early diagnosis, and management of AMI prior to inception of symptoms; identification of high-risk patients (and treatment including periodic ECGs, antiarrhythmic therapy, and possibly automatic defibrillation); and early administration of antiarrhythmic drugs in patients with suspected or proven AMI.

101222

334. Yu, P. N., "A Stratified System of Coronary Care," *Circulation 44:979-981, December 1971.*

In parallel with intensive public and professional education, mechanisms should be provided for rapid entry of patients into the first level of coronary care—life support systems, both fixed and mobile.

Yu advocates the establishment of (1) a precoronary area attached to the emergency department, (2) intermediate care units attached to hospital CCU, (3) life support stations in areas of mass population, and (4) MCCUs.

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Zilberman looks at outcomes of resuscitation efforts as a function of (1) massive or intramural and subendocardial infarct, (2) severe circulatory insufficiency preceding MI or sudden stop of circulation, and (3) age of MI patient.

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Cross-Reference System

Column 1. Study Design

Concepts/Strategies

2, 5, 6, 7, 11, 15, 19, 22, 25, 29, 32, 33, 34, 35, 36, 37, 44, 46, 53, 54, 56, 59, 63, 64, 65, 66, 67, 69, 78, 82, 83, 84, 87, 88, 90, 93, 96, 97, 98, 99, 100, 103, 105, 106, 108, 111, 113, 114, 116, 118, 121, 123, 124, 125, 132, 135, 137, 141, 142, 145, 146, 150, 152, 153, 154, 156, 160, 163, 167, 168, 169, 176, 178, 187, 189, 196, 197, 200, 201, 202, 204, 206, 208, 209, 211, 214, 221, 222, 226, 230, 232, 233, 234, 235, 244, 248, 250, 256, 259, 260, 266, 270, 271, 276, 288, 290, 291, 292, 293, 295, 297, 300, 301, 302, 304, 305, 306, 307, 308, 311, 314, 316, 317, 320, 323, 324, 325, 326, 329, 331, 333, 334

Review/State of the Art

27, 40, 48, 49, 68, 72, 101, 110, 151, 175, 181, 188, 190, 205, 207, 224, 238, 255, 257, 258, 261, 273, 280, 294, 310, 327, 332

Theoretical

76, 81, 109, 112, 119, 136, 174, 275, 279, 281, 289

Descriptive

1, 3, 4, 8, 9, 10, 12, 13, 14, 16, 17, 18, 20, 21, 23, 24, 26, 28, 30, 31, 38, 39, 41, 42, 43, 47, 50, 51, 52, 55, 57, 58, 60, 61, 62, 70, 71, 73, 74, 75, 77, 79, 85, 86, 89, 94, 95, 102, 104, 107, 115, 117, 120, 122, 126, 127, 128, 129, 130, 131, 133, 134, 139, 143, 144, 147, 148, 149, 155, 157, 158, 159, 161, 162, 165, 166, 170, 171, 172, 173, 177, 179, 180, 182, 183, 184, 185, 186, 191, 192, 193, 194, 195, 198, 199, 203, 210, 212, 213, 215, 216, 217, 218, 219, 220, 223, 225, 227, 228, 229, 231, 236, 237, 239, 240, 241, 242, 243, 245, 246, 247, 249, 251, 252, 253, 254, 262, 263, 264, 265, 267, 268, 269, 272, 274, 277, 278, 282, 283, 284, 285, 286, 287, 296, 298, 299, 303, 309, 312, 313, 315, 318, 319, 321, 322, 328, 330, 335

Experimental

45, 80, 91, 92, 138, 140, 164

Column 2. Type of EMS System Studied

EMTs on Ambulances

30, 45, 80, 133, 203, 262, 263, 283, 285, 321, 328

Paramedics on Ambulances

10, 13, 16, 20, 41, 47, 86, 91, 92, 94, 171, 172, 173, 179, 180, 192, 193, 194, 195, 198, 218, 219, 220, 236, 252, 253, 254, 274, 278, 303, 313, 318, 319

Cardiac-Dedicated Ambulances

1, 3, 4, 12, 17, 18, 24, 26, 38, 39, 42, 43, 51, 52, 55, 57, 58, 60, 61, 62, 70, 71, 73, 74, 75, 79, 85, 102, 107, 120, 126, 127, 128, 129, 130, 131, 138, 139, 144, 148, 149, 157, 162, 164, 165, 170, 182, 183, 184, 191, 216, 217, 225, 227, 228, 229, 237, 239, 240, 241, 242, 243, 251, 265, 267, 268, 269, 272, 277, 286, 296, 309, 312, 315, 335

Unlicensed Technicians on Ambulances

21, 186, 322

Not recorded

14, 23, 31, 50, 77, 89, 95, 117, 122, 140, 143, 155, 158, 185, 223, 330

Column 3. Location of EMS System Studied

Domestic

6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, 25, 26, 27, 28, 29, 30, 31, 32, 34, 35, 36, 37, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 56, 57, 58, 59, 60, 61, 62, 63, 65, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 86, 87, 88, 89, 90, 91, 92, 93, 94, 96, 98, 100, 101, 102, 103, 109, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 136, 137, 142, 145, 146, 148, 149, 150, 152, 153, 154, 156, 157, 159, 160, 162, 163, 164, 166, 167, 168, 169, 171, 172, 173, 174, 177, 179, 180, 181, 182, 183, 184, 185, 186, 188, 189, 190, 196, 198, 200, 201, 202, 203, 204, 205, 206, 207, 209, 210, 211, 212, 213, 218, 219, 220, 221, 222, 224, 230, 231, 233, 234, 235, 238, 244, 245, 250, 252, 253, 254, 256, 257, 258, 260, 261, 262, 263, 264, 266, 267, 268, 269, 270, 271, 274, 275, 276, 278, 280, 281, 282, 283, 284, 285, 290, 291, 292, 293, 294, 296, 297, 298, 299, 300, 301, 302, 303, 304, 307, 308, 311, 312, 313, 316, 317, 320, 321, 322, 323, 325, 326, 327, 328, 330, 331, 333, 334

Foreign

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Columns 4-6. EMS Impact Measures Used

Process

10, 11, 18, 30, 31, 38, 39, 43, 45, 50, 80, 91, 112, 128, 129, 130, 131, 133, 138, 139, 140, 144, 155, 170, 171, 173, 182, 183, 192, 216, 217, 245, 252, 254, 262, 263, 303, 309, 318, 319

Outcome

1, 3, 4, 8, 10, 12, 13, 16, 18, 20, 24, 26, 30, 38, 39, 41, 42, 47, 51, 52, 55, 57, 58, 60, 61, 62, 70, 71, 73, 74, 75, 79, 85, 86, 89, 91, 92, 94, 102, 107, 117, 120, 122, 126, 127, 128, 129, 130, 131, 138, 139, 140, 147, 148, 157, 158, 161, 162, 164, 171, 177, 179, 180, 182, 183, 184, 186, 192, 193, 194, 195, 198, 199, 215, 216, 217, 218, 220, 225, 227, 228, 229, 236, 237, 239, 240, 241, 242, 243, 247, 251, 253, 254, 262, 263, 265, 267, 268, 269, 272, 274, 277, 278, 282, 283, 284, 286, 296, 303, 309, 312, 313, 315, 318, 319, 321, 322, 335

Delay

3, 4, 8, 9, 16, 38, 41, 55, 85, 91, 95, 102, 107, 112, 115, 117, 126, 129, 134, 138, 140, 155, 161, 164, 165, 173, 185, 192, 199, 203, 210, 212, 213, 219, 223, 225, 227, 229, 231, 237, 242, 247, 249, 254, 265, 272, 283, 284, 285, 287, 299, 309, 319, 330

APPENDIX B

Glossary of Terms for the Lay Reader

bradycardia: any slow heart rhythm, defined as less than 60 beats per minute.

Cardiopulmonary Resuscitation (CPR): a technique used to ventilate and circulate blood in patients whose breathing has ceased and/or whose hearts have stopped beating. The prescribed technique is mouth-to-mouth resuscitation for ventilation and closed chest compression for circulation (i.e., perfusion).

Coronary Care Unit (CCU): special in-patient hospital clinical unit in which care is given to patients with acute cardiac disease. The unit is equipped with rhythm monitoring devices, pressure monitoring devices, and defibrillators. The units are usually directed by a cardiologist; there is a high level of nurse staffing; and there is ongoing physician/nurse monitoring of the patients.

defibrillation: use of a stationary or portable machine to electrically shock a patient (usually at 400 watt-seconds) to convert a life-threatening rhythm disturbance into a more normal rhythm. This technique is also called "cardioversion."

Hypotension: low blood pressure, frequently seen in patients having a heart attack, defined as a systolic blood pressure of less than 100 millimeters.

International Classification of Diagnosis, adapted (ICDA): the standardized coding system for all conditions listed on hospital discharge papers. In this report we will be dealing with the following conditions:

- **ICDA 410:** acute myocardial infarction; commonly referred to as a heart attack. Obstruction in one or more of the coronary arteries has resulted in permanent damage to the heart muscle.
- **ICDA 411:** angina pectoris; commonly referred to as angina or myocardial ischemia. There is at least a 50- and usually a 70-percent obstruction of one or more of the coronary arteries that results in an inadequate blood flow to one or more of the specific areas of the heart, usually causing the patient to experience chest pain.
- **ICDA 412:** chronic arteriosclerotic cardiovascular disease. Accurate use of this classification indicates a patient with a past history of a myocardial infarction, or objective evidence for chronic angina pectoris.

ICDA 415: cardiac arrest. This is a clinical situation in which the heart has usually stopped beating, either due to an acute myocardial infarction or due to a life-threatening arrhythmia that is inadequate to trigger the heart to pump blood in an effective manner.

ICDA 436: cardiovascular accident; commonly known as a stroke. A condition in which an obstruction of one of the blood vessels to the brain results in transient or permanent brain dysfunction.

In this report we use the following terminology relating to these ICDA classifications:

cardiovascular disease (ACD): ICDA 410, 411, and 419 only.

cardiovascular disease (CVD): ICDA 410, 411, 412, 415, and 436.

life-threatening arrhythmia (LTA): a rhythm disturbance potentially so disruptive to the cardiac pumping mechanism that the patient's life is in imminent danger.

point of entry plan: a systematic triage mechanism by which ambulances are dispatched to patients and by which the ambulances transport the patient to the nearest, most *appropriate* hospital for the given condition.

pump failure: condition in which so much damage has occurred to the heart muscle that an inadequate amount of blood is pumped from the heart to the vital organs of the body.

supraventricular tachycardia (SVT): A fast heart rhythm emanating from the upper portion of the heart (the atria) that can be potentially life-threatening.

sudden cardiac death (SCD): an unexpected, immediate death of a patient following an acute myocardial infarction or a life-threatening arrhythmia. In some studies it is defined as within 1 hour of the initial event, and in other studies defined as within 24 hours of the event.

vasopressor: drugs that increase the blood pressure for patients with hypotension.

ventricular arrhythmia: rhythm disturbances originating from the lower part of the heart (the ventricles); extremely life-threatening. The two most lethal forms of these rhythm disturbances are ventricular tachycardia (VT) and ventricular fibrillation (VF). VT is a regular and very fast ventricular rhythm that makes it difficult for the heart to pump effectively for any sustained period of time. VF is a chaotic ventricular rhythm totally inconsistent with efficient pumping. Both VT and VF can be successfully reverted to a normal rhythm by defibrillation.

APPENDIX C

Suggested Standard Definitions of Acute Cardiovascular Disease

Standardized definitions of acute cardiovascular disease ACD should be adopted. These definitions should be valid and universal. The degree of precision of the definition should be related to its use for categorizing homogeneous populations for mobile coronary care (MCC) epidemiological research (as opposed to defining in a more precise manner a population of patients for clinical research). The data base for these definitions should be generally available, inexpensive to collect, appropriate to the clinical condition, and at minimum risk to the patient. The list should include the following:

(1) **Sudden death** defined by a specific time indexed from the cessation of baseline life style activities to the time of death. Minutes would be too short a measurement for the prehospital coronary care system. We consider twenty-four hours, as used by others, to be too long. We suggest *1 hour.*
(2) **Myocardial infarction** defined by presenting history, typical electrocardiogram (ECG) changes of transmural or subendocardial infarct, and enzyme levels of creatine phosphokinase (CPK) and serum glutamic-oxaloacetic transaminase (SGOT). MB, myocardial component of creatininine phosphokinase though diagnostically more specific for myocardial infarction, are not uniformly available, so we suggest they not be used.
(3) **Angina pectoris** defined by history and typical ST segment or T wave changes with pain that revert to baseline following pain and/or positive exercise stress test with 1-millimeter ST depression used as the diagnostic criteria. Coronary arteriography, though more specific, is not warranted for emergency medical system (EMS) studies because of the expense and its invasive nature. It should be performed only for appropriate clinical indications. Thallium perfusion scans, though more diagnostically specific, are generally not available.

Standardized definitions should incorporate a measure of severity so that case mix can be ascertained in a consistent manner:

Sudden death—with/without previous history of a myocardial infarction (less/more than 6 months prior to the event).

Killip I—no heart failures.
Killip II—minimum heart failure (rates less than half way up the chest and/or pulmonary congestion by chest X-ray).
Killip III—pulmonary edema (by physical examination and/or chest X-ray).

Killip IV—cardiogenic shock (congestive heart failure in the presence of systolic blood pressure less than 100 millimeters mercury).

Angina pectoris

NYHA I—asymptomatic (angiographically proven)
NYHA II—symptomatic on unusual exertion
NYHA III—symptomatic on usual exertion
NYHA IV—symptomatic at rest

New onset or crescendo—unstable pattern

Development of proximate outcome parameters such as arterial blood gases to monitor the effectiveness of prehospital interventions.

Standardization of outcomes

(1) Distinguish outcomes for "sudden death" patients and all other patients with acute cardiovascular disease.

(2) Distinguish outcomes for patients found in cardiac arrest between those in ventricular fibrillator and those in asystole.

(3) Establish time frames for mortality rates:
(a) Mortality at the scene (prior to ambulance transport)
(b) Mortality in ambulance en route
(c) Mortality in emergency room
(d) Mortality in hospital during first 48 hours
(e) Mortality after hospital discharge
(f) Mortality 3 to 12 months after hospital discharge
(g) Mortality more than 1 year after hospital discharge

(4) Identify morbid events. We suggest neurological deaths following 2 days of stable cardiovascular status.

Continue to update literature search, via contract or the National Library of Medicine.

Computerize the present studies by the four-way classification we employed. Add this classification to the Medlar data on MCC studies.

More research needs to be based in the community as opposed to highly selected medical-school-affilated ambulance services. Research partnerships between communities and medical schools should be encouraged to optimize the strengths of each—the general service capacity of the community and the research/grantsmanship capabilities of the medical schools.

Only research using standardized definitions and process/outcome (mortality and morbidity) parameters should be encouraged.

Researchers should be encouraged and funded at high enough levels to examine MCC impact on the community at large as opposed to restricting the data base to patients accessing the ambulance service.

A minimum data set needs to be defined (see "Estimates of MCC Impact" in Chapter 2) for each patient. Multivariate analyses controlling for these variables is essential.

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Appendix D

Research Sources

Robert Andrews, Ph. D.
Graduate School of Management
University of California at
Los Angeles

Lawrence Bergner, M. D.
Seattle-King County Department
of Public Health

Leonard Cobb, M. D.
Harborview Medical Center
Seattle

Geoffrey Gibson, Ph. D.
Health Services Research
Johns Hopkins Medical School

Robert Gladstone, Ph. D.
Rand Corp.
Santa Monica

David Gustafson, Ph. D.
Center for Health Systems
Research and Analysis
University of Wisconsin

Martin Keller, M. D.
Department of Preventive Medicine
Ohio State University

Justin Myrick, Ph. D.
Health Systems Research Center
Georgia Institute of Technology

Eugene Nagel, M. D.
Department of Anaesthesiology
John Hopkins Hospital

Lee Sechrest, Ph. D.
Department of Psychology
Florida State University

Mark A. Sherman, Ph. D.
Emergency Care Institute
Beekman Downtown Hospital
New York City

Harvey Wolfe, Ph. D.
Department of Industrial
Engineering
University of Pittsburgh

Appendix E

Literature Search Data and Analysis Forms

Study Name: _____

Article Numbers: _____

1. Community: _____

2. Time Period: _____

3. Program Description: _____

4. Sample:

   a. Population Base: _____

   b. Size: _____

   c. Selection Criteria (include omitted cases if not obvious): _____

5. Reliability/Validity of Data Sources: _____

6. Research Design:

   a. Controls: _____

   b. Pre/Post Measures: _____

   c. Description: _____

   d. Threats to Internal Validity: _____

e. Threats to External Validity: _____

7. Statistical Analysis: _____

8. Effects Over Time in Serial Studies: _____

a. Study Time Period: _____

b. Changes in Outcome: _____

c. Changes in Condition Recognition/Treatments: _____

d. Changes in Response Times: _____

e. Changes in EMS System or Community Incidence Rates: _____

f. Changes in EMS System Use: _____

g. Changes in Patient Delay: _____

h. EMS Program Changes:

(1) Type and Intensity of Labor Inputs: _____

(2) Type and Intensity of Nonlabor Inputs: _____

(3) Triage, 911, Dispatch Decision Rules: _____

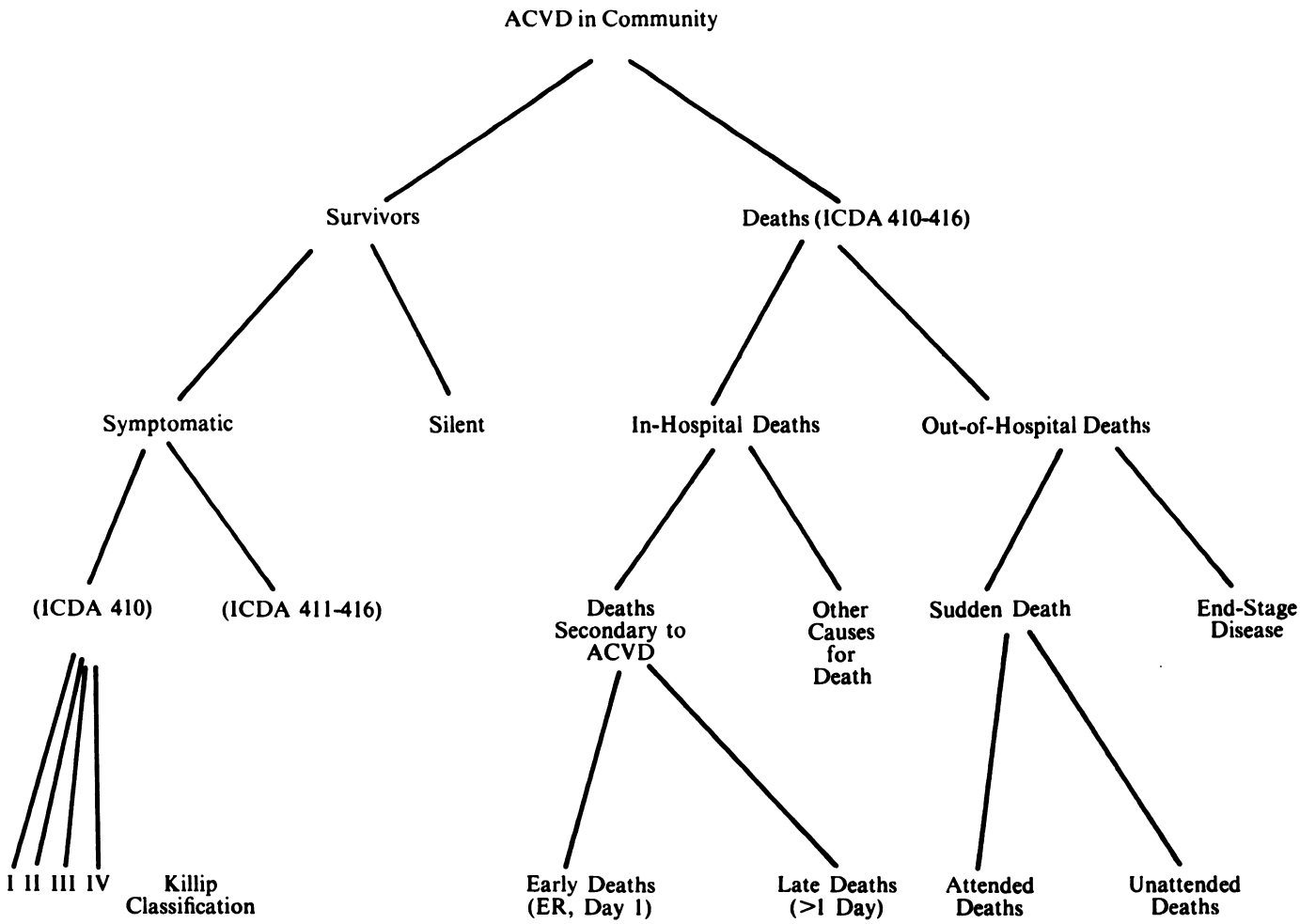
(4) Other: _____

i. New Technology: _____

Study Name: _____

Study Numbers: _____

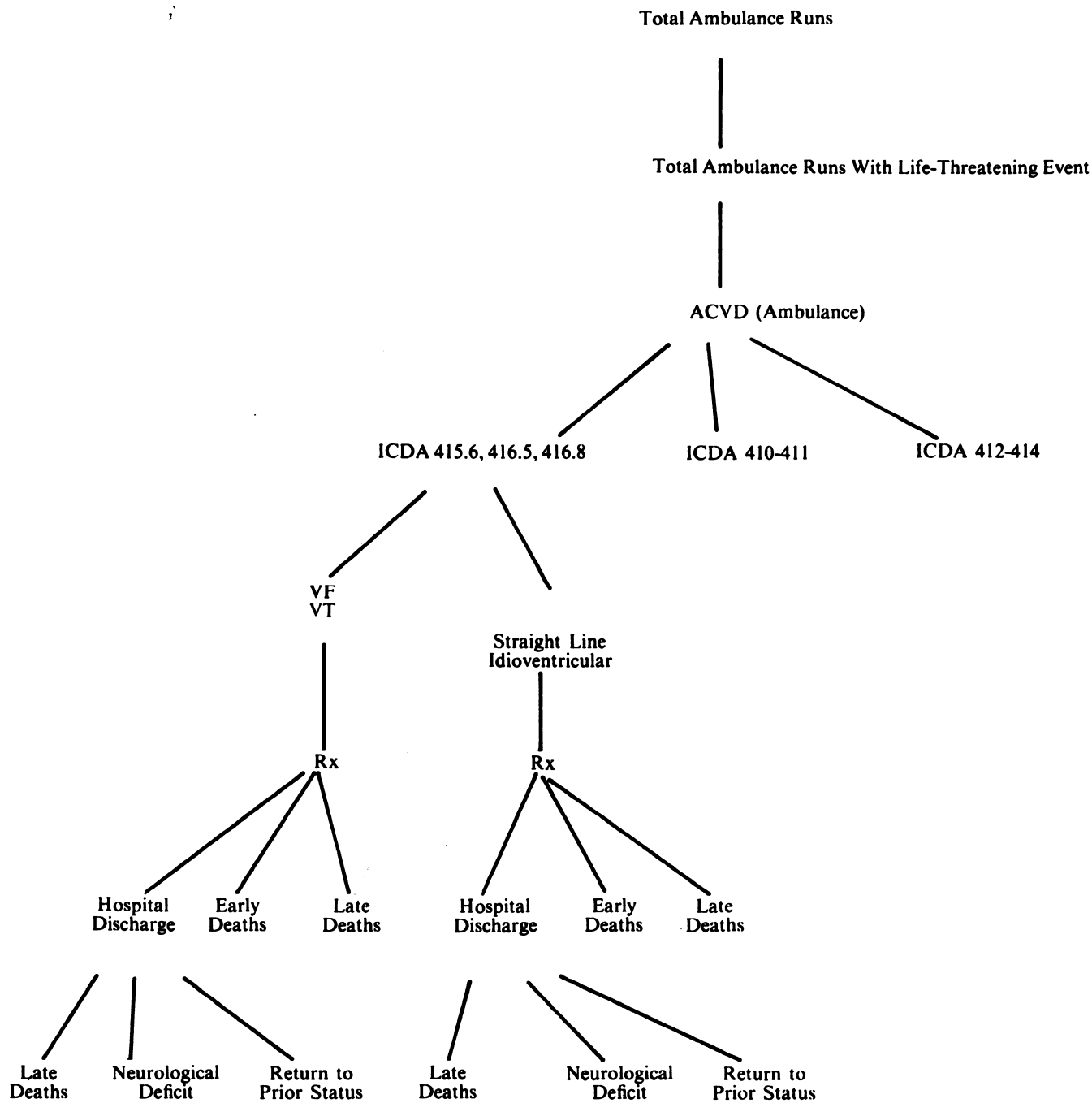
Time Frame: _____



Study Name: _____

Study Numbers: _____

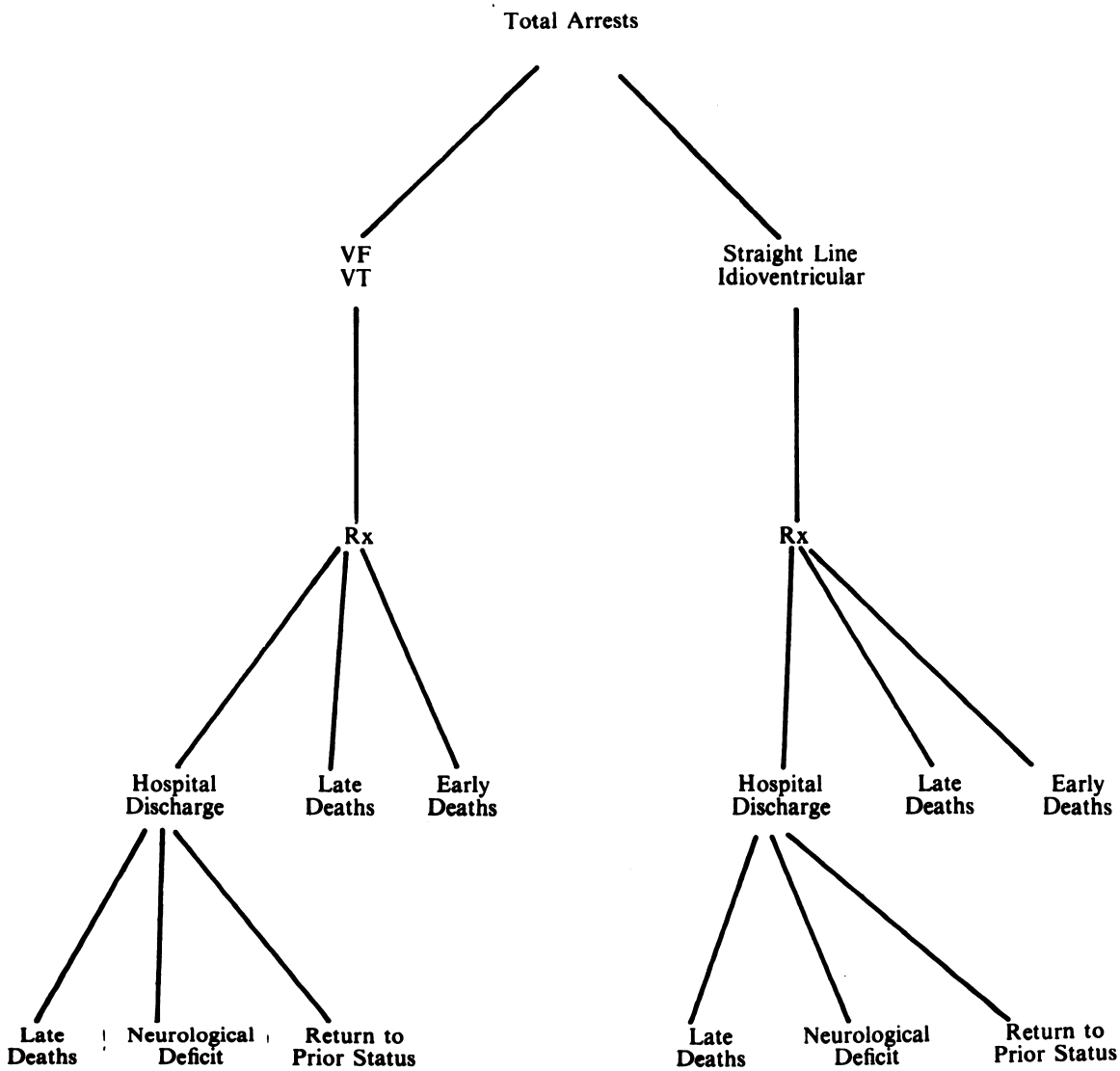
Time Frame: _____



Study Name: _____

Study Numbers: _____

Time Frame: _____

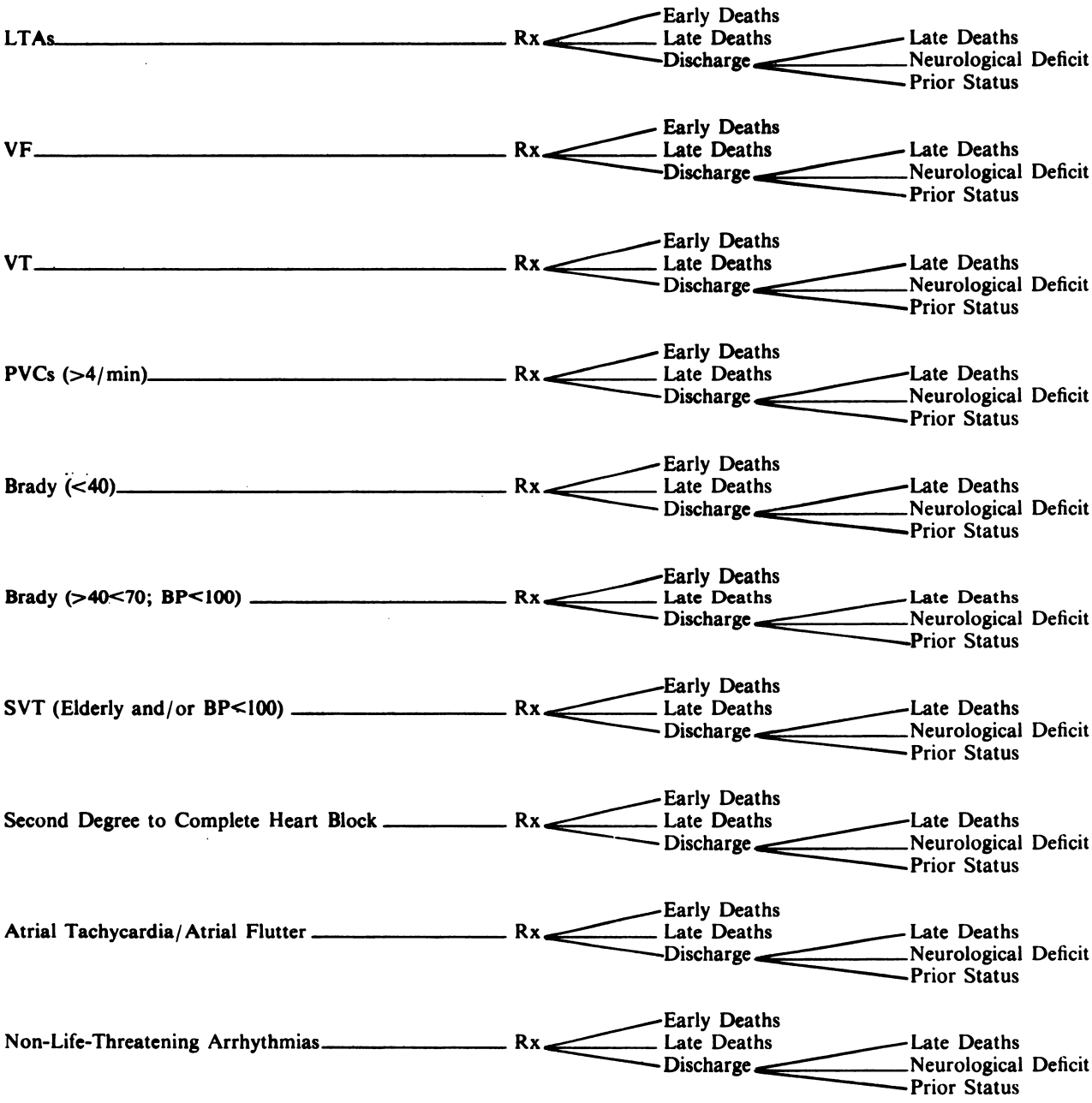


Study Name: _____

Study Numbers: _____

Time Frame: _____

ICDA 410-411



Study Name: _____

Study Numbers: _____

Time Frame: _____

Resuscitation Attempted, Either Basic or Advanced Life Support

Type: _____

Arrest Status	No Response to Resuscitation Effort	Only Transient Return to Coordinated Rhythm	Reached Hospital Alive	Discharged Alive	Total Sample Size
Ventricular Fibrillation					
Asystole					
Electrical Mechanic Dissociation					
Other					

Study Name: _____

Study Numbers: _____

Time Frame: _____

Participation of Lay People in Resuscitation of Patients With Cardiac Arrest

Outcome	Number of Cases	Resuscitation Started by—	
		Lay People	Ambulance Crew
Survived			
Died			
Total			

Study Name: _____

Study Numbers: _____

Time Frame: _____

Calls From Public and Physicians

Final Diagnosis	Number of Cases	Number of Calls			
		Public		Physicians	
		911	Other	911	Other

Study Name: _____

Study Numbers: _____

Time Frame: _____

Drug: _____ Dosage _____

Life-Threatening Arrhythmia	Results

Drug: _____ Dosage _____

Life-Threatening Arrhythmia	Results

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April 1981