EVALUATION OF OUTCOMES FOR CARDIAC ARREST PATIENTS TREATED BY PROVINCIAL AMBULANCE SERVICE PERSONNEL IN THE LOWER MAINLAND OF BRITISH COLUMBIA

by

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We accept this thesis as conforming to the required standard

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Lynn E. Wilson, 1982
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ABSTRACT

Information was collected in an eight and a half month prospective study about 358 recent cardiac disease-related cardiac arrest cases which were attended by personnel from the Provincial Ambulance Service in the Lower Mainland of British Columbia.

When possible, advanced life support personnel (EMA Ills), regular ambulance attendants (EMA IIs) and Fire Department staff are dispatched to cardiac arrest calls. At the time of this study some areas in the region did not have advanced life support coverage, and some cardiac arrest calls occurred while the EMA IIs were already engaged with another case. Such calls, attended by EMA IIs, but not by EMA Ills, served as the comparison group for paramedic performance in this study. Patient outcomes were compared at admission to hospital and at discharge from hospital for the group of patients treated by EMA IIs and the group of patients treated by EMA Ills, or by a combination of EMA Ills and EMA IIs.

Strongly significant differences in initial outcome (hospital admission) were found between the two patient groups, with EMA Ill patients faring better (p.=0.002). Marginally significant differences in final outcome (discharge alive) between the two patient groups were found, with the EMA Ill group again doing better (p.=0.10). Whether or not the receiving hospital had a coronary care unit was not associated with a difference in initial (p.=0.45) or final outcome (p.=1.0) for the entire group of patients in the study. Short time in arrest without CPR was associated with better initial outcome (p.=0.00), and with better final outcome (p.=0.01) for all patients.
in the study, as was short time to definitive care (initial outcome p.=0.001; final outcome p.=0.03). EMA II patients had a better chance of survival when they arrested during attendance by EMA IIs than they did when they were found in arrest.

This study suggests that significantly more cardiac arrest victims reach hospital alive, and more survive to be discharged alive from hospital, when their prehospital treatment is provided by advanced life support personnel than when it is provided by regular ambulance personnel.
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CHAPTER I

INTRODUCTION

This study was designed to assess the impact of the advanced life support program of the Provincial Ambulance Service in British Columbia on outcomes for patients with cardiac arrests treated by the ambulance service.

Much has been written over many years about the magnitude of the problem of heart disease, not only in North America, but in many of the developed countries of the world. In spite of recent advances in treatment and an observed decreasing trend in mortality rates for ischemic heart disease and acute myocardial infarction, over 650,000 deaths annually are still attributable to coronary heart disease in the United States alone (Bergner, Eisenberg, Hallstrom & Becker, 1981; Rosenberg & Klebba, 1979). In Canada in 1978, the most recent year for which such statistics are available, over 55,000 people died from cardiac disease (Statistics Canada, 1980). This represents about one-third of deaths from all causes for that year, and indicates that the problem is still an important one. Many of those dying are individuals with many potentially productive years, whose contribution has been interrupted by premature death. The economic cost of these deaths is substantial. One estimate suggests losses are from 38 to 57 billion dollars a year (Bergner et al., 1981).

Because of the continued magnitude of the problem of heart disease, a great deal of effort and many research dollars have been
spent on studying its prevention and treatment. The result has been a number of advances in cardiac care within hospitals in recent years, from special coronary care units, which became widespread during the 1960's, to new drugs, to coronary bypass surgery for selected patients. However, because the majority of cardiac deaths occur soon after an attack (as many as two-thirds die within the first 4 hours of onset of a myocardial infarction, for example), intervention during the initial stages of an acute event is essential. It is generally accepted that without prompt, appropriate, intervention, patients experiencing a cardiac arrest will die. In order to save lives, then, advanced cardiac care must reach these victims in the community, before they are hospitalized. Usually this becomes the responsibility of the group providing emergency medical services for the community. In British Columbia this is the Provincial Ambulance Service of the Emergency Health Services Commission.

PREHOSPITAL CORONARY CARE IN BRITISH COLUMBIA

Ever since Pantridge and Geddes (1967) reported success with mobile coronary care units in Belfast, programs have proliferated throughout the United States, generally in large metropolitan areas. Currently there are at least three hundred paramedic programs (Eisenberg, Bergner, & Hallstrom, 1980a), one of the most well-publicized and apparently successful of which was established in Seattle (Bergner et al., 1981; Hoffer, 1979).
In 1974 the Emergency Health Services Act was passed in British Columbia (British Columbia, 1974). It provided for establishment of a provincial ambulance service to serve citizens throughout the province. Ambulance personnel, by the very nature of their activities, came into regular contact with emergency department staff at local hospitals who encouraged them and helped them to improve their emergency treatment skills. Eventually, emergency physicians working in the hospitals expressed a willingness to train ambulance personnel to undertake advanced life support for cardiac patients in order that these patients would arrive at the emergency department in better condition. This movement was given further momentum by the publication of very encouraging results from the Washington State programs, particularly since Vancouver and the Lower Mainland area generally, were perceived to be very similar to Seattle and its suburbs where the paramedic programs had been established.

By the end of 1974 most of the legal hurdles for establishing a paramedic program had been dealt with, and the first team of trained paramedics had been approved. Working out of Royal Columbian Hospital in New Westminster, British Columbia, paramedics began accepting emergency calls in April 1975 (verbal communication: Dr. L. Vertesi, currently Medical Director of the Advanced Life Support Program).

This pilot project was strongly supported by the medical community in the area, and in time additional paramedic vehicles were equipped and staffed to work out of other ambulance stations in
different parts of the Lower Mainland. Service personnel were convinced that the advanced life support vehicles and personnel were a valuable addition to the emergency services of any community, and there was pressure for further expansion of the program, which continues even today.

In the face of this pressure, an initial evaluation of the impact of the paramedic program was proposed.

RESEARCH QUESTIONS

This study was designed to evaluate outcomes for recent cardiac arrest victims in the Lower Mainland of British Columbia who were treated by one or more types of Provincial Ambulance Service personnel before they were taken to hospital. This rather limited group of patients was chosen for evaluation because outcomes for people with this condition were unambiguous (alive/dead), other similar programs were reporting their success with these cases, and because cardiac care was expected to be a major component of the activities of the paramedics: it was expected that as many as 70 per cent of the calls to which the paramedic vehicles would be sent would be from patients with cardiac problems (verbal communication: L. Vertesi).

The research questions were:

1. Are there statistically significant differences in the proportion of patients surviving to hospital admission between the group of patients treated by Emergency Medical Assistant IIs only (EMA IIs--regular ambulance personnel) and those treated by Emergency Medical Assistant IIs only (EMA IIs--paramedics/advanced life support personnel) or a combination of EMA IIs and EMA IIs?
2. Are there statistically significant differences in the proportions of patients discharged alive from hospital between the group treated by EMA Ills only and the group treated by EMA Ills only or a combination of Ills and Ills?

DEFINITIONS:

Cardiac arrest: for purposes of this study, a patient with a cardiac arrest was a patient with an apparently pulseless condition confirmed by ambulance personnel (see p. 63 for information about excluded cardiac arrest cases).

EMA II: an ambulance attendant who has been trained in and has passed examinations for providing advanced level first aid.

EMA III: an ambulance attendant trained in and successfully examined for providing advanced life support, as defined by the American Heart Association (for definition refer to Appendix A, Part I). This type of personnel is also known as paramedics and as advanced life support personnel.

Bystander CPR: cardiopulmonary resuscitation undertaken by any individual who is not a member of the ambulance service and is not employed by either the Police or the Fire Department.

Time Without CPR: generally this is an estimate in minutes made by the ambulance crew member completing the study form of the interval from when the patient seemed to stop breathing to the time when someone started CPR, based on discussions with people at the scene or on personal observation. Where the collapse was not witnessed, this information is not
available.

**Time To Definitive Care:** for EMA II cases, this was deemed to be the time from receipt of the call at central dispatch until the time when the patient arrived at the hospital. For EMA III cases, this was deemed to be the time from receipt of the call at central dispatch, until the time when the EMA III crew arrived at the scene of the incident.

**THE RESEARCH STUDY**

This first chapter has provided a very general introduction to the evaluation project. Chapter II presents a review of literature on evaluation, coronary care, mobile coronary care, and the evaluation of mobile coronary care. Chapter III describes how the advanced life support program was established in British Columbia. Chapter IV describes in detail the methodology for the study, discusses reliability and validity issues, and outlines the analytic techniques employed for the analysis of findings. Chapter V presents the findings from the study, which are discussed at length in Chapter VI. Chapter VI also deals with implications for planning and suggestions for further research in the area.
CHAPTER II

LITERATURE REVIEW

EVALUATION STUDIES

Why evaluate? What is the purpose of evaluation projects? Weiss (1972) suggests that the purpose of evaluation is "to measure the effects of a program against the goals it set out to accomplish as a means of contributing to subsequent decision making about the program and improving future programming" (p. 4).

In the field of health care, evaluations are important. Many authors have discussed the fact that expenditures for health care are very large in absolute terms, and the size of these expenditures, often from the public purse, has grown rapidly (Barstow, 1982; Evans, 1975; Shortell & Richardson, 1978; Thorner, 1979; Winkelstein, 1972). Particularly in difficult economic times such as those we now face, governments want to know that their scarce resources are being used well, and evaluation provides some information on this subject. If a program is falling far short of its goals, governments may want to consider whether or not support for the program should continue. Of course, information provided by a program evaluation project has to be considered in light of other important factors such as whether or not there are alternative ways to achieve the goals, and whether or not the program is cost-effective compared to possible alternatives (Hoffer, 1979; Shortell & Richardson, 1978; Sidel, Acton, & Lown, 1969; Suchman, 1967; Weiss, 1972). Although it is reasonable to
evaluate programs, results from evaluation studies are not absolute; that is, they do not often provide decision-makers with information which is so hard and fast that decisions can be made about whether or not the program should continue (Cain & Hollister, 1972). Results have to be looked at together with other factors which have an impact on the program (Rossi & Williams, 1972). Acknowledgment of this is important, because evaluators must depend on the cooperation of those running the program which is to be evaluated. If trust is not established between the parties participating in such studies, there are many ways in which the project can be sabotaged. It is acknowledged that evaluation takes place in a political setting:

The interest is in finding positive effects and not negative effects or no effects at all. Those who have proposed programs do so with the conviction that the programs are effective; those who administer the programs have an interest in showing that under their leadership the programs have accomplished something; and evaluators who are connected more or less intimately with the programs are not likely to want to offend by showing that programs do not work. (Rossi & Williams, 1972, p. 22)

There are a number of ways to look at evaluation. Schulberg Sheldon and Baker (1969) suggest two basic models - goal achievement and systems. They indicate that the former is a more limited way to approach evaluation, and the latter is more difficult. The systems model contends that organizations always have a variety of objectives, and success in achieving any one goal must be studied in light of the impact that this has on other organizational goals.

Evaluation can be designed primarily to provide feedback for
program improvement as the evaluation is carried out, or it can be primarily for assessment of degree of success in achieving specified outcomes. In the first case the evaluation report is directed primarily to service providers and administrators; in the second, to policy makers, either within or outside the organization. The report has to be tailored to the audience for which it is intended (Rossi & Wright, 1977).

Evaluations which serve as aids to planning are concerned with relating resource inputs to outcomes. Studies which describe programs in terms of their resources are often the simplest studies. Studies looking at the processes which take place within the program as service is provided are somewhat more difficult. The type of study which is generally most difficult and costly to do well is the outcome evaluation study. Outcome, however, is of critical importance. A major problem in conducting such studies is determination of valid and useful measures of output or outcome, particularly since outcomes themselves might be quite different, depending on the perspective used (Willemain, 1977). Successful outcomes for a program may be quite differently defined by patients, clinicians, patients' families, training institutions, consumer advocates, and funding agencies (Attkisson & Hargreaves, 1979).

An evaluation study, then, ideally starts with a statement indicating the perspective from which it is being undertaken. It proceeds to a statement about the goals, in clear, specific, achievable, measurable terms, which have been agreed to for the
program being evaluated. Once goals have been identified, then
criteria to be used to measure the success of the program in achiev-
ing these goals must be identified and agreed to by all parties
participating in the evaluation. Once there is consensus on these
issues, then measurements of program performance can be undertaken.
Hopefully these measures will permit assessment of the degree of
success the program is having in achieving its stated objectives,
and determination of whether or not successful outcomes can reason-
ably be attributed to program activities (Ibrahim, 1976; Rossi &
Williams, 1972; Schulberg et al., 1969).

ADVANCES IN CARDIAC CARE

A number of major developments in the treatment of myocardial
infarction patients have occurred since the early 1960's. Two
important advances were introduction of coronary care units in
hospitals and coronary bypass surgery for selected cardiac patients.
While these developments met with enthusiastic approval when they
were first introduced, the initial favorable evaluation has since
given way to concern about the benefits to be derived from their
widespread use (coronary care units: Colling, Dellipiiani, Donaldson,
& MacCormack, 1976; Hill, Holdstock, & Hampton, 1977; Lown & Selzer,
1968; Mather, Morgan, & Pearson, 1976; Peterson, 1976), (coronary
bypass surgery: Aronow & Stemmer, 1975; Braunwald, 1977; Hutter,
Russell, Resnekov, et a., 1977; Murphy, Hultgren, Detre, et al.,
1977).
Regardless of whether these developments in care help or hinder patients, patients must reach the hospital alive if they are to benefit from them. Numerous studies have indicated that from half to two-thirds of those experiencing heart attacks die before reaching hospital care, many within the first hours after the onset of symptoms (Acton, 1973; McIntyre, 1979; Pantridge & Geddes, 1967; Pyo & Watts, 1970, Sidel et al., 1969; Tweed & Wilson, 1977).

Canadian statistics for 1978, the most recent year for which data are available, indicate that a total of 55,362 Canadians died of heart disease. The figure for British Columbia is 6,001 (Statistics Canada, 1980). When we consider that the attack rate is several times the death rate (Nagel, Hirschman, Nussenfeld, & Rankin, 1970), we can see that in terms of numbers alone, this is a significant health problem.

In recent years the rates of coronary heart disease mortality have tended to decrease in North America and some other, though not all other, developed countries. A variety of hypotheses have been advanced to explain this observation: changes in lifestyle which have reduced risk, treatment changes such as the development of coronary care units and availability of new drugs (e.g., those to control rhythm disturbances), changes in surgical practice (e.g., coronary bypass surgery), and emergency system changes (e.g., better emergency communication systems, and more people trained in lay CPR techniques) (Cooper, Stamler, Dyer, & Garside, 1978; Editorial, The Lancet, 1980; Eisenberg, Bergner, & Hallstrom, 1980a; Rosenberg & Klebba, 1979; Stallones, 1980; Stern, 1981). Probably
the observed decline is attributable, at least in part, to each of these factors, although the magnitude of the contribution of certain of the factors is still a matter of debate, as suggested earlier.

If further reductions in mortality rates from heart disease are to occur, the attack on this complex of problems will have to continue to be multi-faceted. Although the largest gains will likely be from activities such as screening and prevention, prehospital coronary care will remain important because "Better than half, perhaps better than 65% of those who die suddenly, prematurely, and unexpectedly do so in the kitchens, churches and shopping centres of their communities..." (McIntyre, 1979, p. 89). Thus, effective prehospital coronary care can contribute to a continued decline (Crampton, Aldrich, Stillerman, et al., 1975b; Killip, 1979; Myerburg, 1979; Nagel, 1979; Sidel et al., 1969).

Provision of advanced life support via mobile units within the community is a response to the following observations:

- Sudden death is frequently due to a disturbance in heart rhythm, generally ventricular fibrillation, which if untreated leads to asystole (Cobb, Baum, Alvarez, & Schaffer, 1975; Moss, Wynar, & Goldstein, 1969; Pantridge & Adgey, 1969; Sidel et al., 1969).
- Arrhythmia death is frequently preventable and reversible (Pantridge & Geddes, 1967; Sidel et al., 1969; Wallace & Yu, 1975) provided that the patient receives appropriate treatment soon after onset of the attack.
Because rhythm problems frequently develop or increase during transport, possibly as a result of moving the patient (Crampton, Aldrich, Gascho, Miles & Stillerman, 1975a; Pantridge & Adgey, 1969; Pantridge & Geddes, 1967), it is important to stabilize the patient's condition at the scene and to have personnel who are able to deal with problems which might develop en route accompany the patient to the hospital.

Advanced life support units worthy of that designation, in addition to basic life support capability, have special equipment and techniques available: effective emergency communications systems, appropriate drugs, cardiac monitors, defibrillators, equipment for endotracheal intubation and establishing and maintaining intravenous infusion lifelines (Standards for Cardiopulmonary Resuscitation, 1974).

The prototype mobile coronary care unit was developed in 1966 in Belfast (Pantridge & Geddes, 1967), and was staffed by physicians. This type of staffing proved impractical in North America, and the mobile prehospital coronary care units which were developed in areas such as Seattle, Miami, and Los Angeles County, were manned by paramedics specially trained to deal with cardiac emergencies (Cobb, Alvarez, & Copass, 1976; Lewis & Criley, 1977; Liberthson, Nagel, Hirschman, & Nussenfeld, 1974). These advanced life support programs using paramedics served as the models for the development of a paramedic ambulance service in Vancouver (verbal communication:
L. Vertesi, 1978).

In addition to prevention of deaths from heart attacks, a variety of other benefits accrue from the prehospital coronary care provided by community-based emergency services personnel: reduced incidence of cardiac arrests and shock and pump failure, relief of pain, reduction in the number of cardiac invalids, peace of mind for citizens who know the service is available if it is needed for themselves or for family and friends, greater awareness among the general public of the symptoms of heart attack and of the importance of calling for help quickly, more people in the community willing to make the effort to take CPR training, and more opportunities to prevent heart attacks because of increased awareness and receptivity to public information about the disease (Adgey & Geddes, 1977; Crampton et al., 1975b; Steel, Cooper, & Fox, 1969; Urban, Bergner, & Eisenberg, 1981). Even with unsuccessful outcomes there are potential benefits: family members are comforted by the knowledge that everything that could be done under the circumstances was done for the victim, and if the patient is an organ donor, medical personnel can be made aware quickly that donated organs are available (Outcome Measurement Panel, 1975).

CRITICISMS OF PREHOSPITAL CORONARY CARE PROGRAMS

Reports in the literature about prehospital coronary care programs have not been uniformly positive. McIntyre (1979), Pyo and Watts (1970), Schwartz (1974), Shu (1971), Steel, Cooper and Fox,
have all voiced some concern.

One reservation is the high cost of having an advanced life support program (Anderson, Knobel, & Fisch, 1971; Schwartz, 1974). This criticism has been addressed by several authors. It was pointed out that in North America the units are generally manned by paramedics, rather than by teams of doctors and nurses, and this use of auxiliary personnel tends to reduce costs (Graf, Polin, & Paegal, 1973; Luxton, Peter, Harper, & Hunt, 1975). It is possible to use regular ambulances which have been adapted and supplied with portable equipment, rather than expensive, specially-built and equipped vehicles (Binnion, Mandal, & Makous, 1973; Graf et al., 1975; Yu, 1971). Finally, as Yu has pointed out, the relatively high cost of implementing some of the systems has been the funding of the research projects which have been associated with them.

Some have suggested that advanced life support units do not benefit enough people to make them a worthwhile investment of scarce health care resources (Nagel, Liberthson, Hirschman, & Nussenfeld, 1975; O'Rourke & Michaelides, 1975; Yu, 1971). Graf et al. (1973) noted that an intensive publicity campaign about the program increased the volume of emergency calls without increasing the proportion of inappropriate calls, so efforts to increase public awareness will enable the program to benefit more people. Even when an advanced life support vehicle responds to an inappropriate call, "Some education of the public is accomplished every time the mobile unit picks up a patient....Education is a most necessary step in the
treatment of heart attacks..." (Binnion et al., 1973, p. 923).
Furthermore, surely some benefit is derived from the service when it is determined that no major problem exists, in terms of peace of mind for the patient (Sidel et al., 1969). In British Columbia the problem of small numbers of people benefiting from the service is minimized, since paramedic ambulances respond to a variety of types of emergency calls.

Rapid arrival of help in the initial stages of an incident is essential. Five minutes without attention may be too long for cardiac arrest victims (Aronow, 1981; Copley, Mantle, Rogers, Russell, & Rackley, 1977; Eisenberg, Bergner, & Hallstrom, 1979a). If, as has been shown in several studies, the major component in delay to medical treatment is patient or patient/physician delay in asking for assistance (Cretin & Willemain, 1979; Hackett & Cassem, 1969; Mogielnicki, Stevenson, & Willemain, 1977; Moss et al., 1969; Pyo & Watts, 1970; Simon, Fienlieb, & Thompson, 1972), then the opportunity for a paramedic program to have an impact on the course of an emergency may be limited. Public education programs are needed to address the issue of patient delay in order to take full advantage of the potential of the service. In the case of sudden collapse, however, provided that the incident is witnessed, delay time is often ambulance response time, and if there are people at the scene capable of initiating CPR and maintaining it until the ambulance arrives, the effectiveness of the paramedic program is enhanced (Cobb et al., 1976; Copley et al., 1977; Eisenberg,
The issue has been raised of whether or not those surviving cardiac arrest have suffered neurologic deficit to such an extent that they have become a burden to their families and to society (Webster, 1980). Some reports indicate that this has not been a major problem (Lemire & Johnson, 1975; Lewis, Ailshie, & Criley, 1975; Libeathson et al., 1974; Pantridge & Adgey, 1969; Tresch, Grove, Keelan et al., 1981), though just what constitutes a substantial problem has not been stated with any accuracy, while others take a less optimistic view (Copley et al., 1977; Earnest, Yarnell, Merrill, & Knapp, 1980; Lund & Skulberg, 1976; Tweed, Bristow, & Donen, 1980).

The cardiac problem with which mobile coronary care units have had spectacular success is primary ventricular fibrillation, that is, ventricular fibrillation not associated with myocardial infarction. It is therefore disturbing to read reports (Baum, Alvarez, & Cobb, 1974; Cobb et al., 1975, Nagel et al., 1975; Schaffer & Cobb, 1975) that survivors of ventricular fibrillation are prone to sudden death from similar causes within 24 months of their discharge from hospital following the initial event. Nagel et al. (1975, p. 218) specifically state that this is so in spite of whether or not the patients were prescribed antiarrhythmic medications on discharge.

In a number of areas then, particularly neurologic deficit and
long-term survival rates for initial survivors of cardiac arrest, a note of caution is sounded.

However, even reports of failures are useful:

Understanding of the EMA structure and planning of successful intervention would be far better served by a few analytic case histories of failures and an honest appraisal of the underlying reasons than by the present potpourri of unconvincing success stories. (Gibson, 1974a, p. 14)

EVALUATION STUDIES OF PREHOSPITAL CORONARY CARE

Evaluation of emergency services is challenging, since the system is such that it attracts personalities to whom forceful action is much more attractive than is careful evaluation (Willemain, 1977). The goal of an emergency service system is "to prevent death, disability, and suffering in persons with injury or acute illness" (ibid., p. 2). Do paramedic programs providing advanced life support outside hospitals actually achieve this? To answer the question we can choose to focus on input measures for the system, process measures, and/or output measures, but defining appropriate measures and developing consensus about their appropriateness is difficult.

Examples of input measures are the number of ambulances per 100,000 population, number of trained attendants staffing each ambulance, number of runs per ambulance, and patient need (clinical need for services which are provided by ambulances and ambulance crews). The comparative value of such measures is questionable because ideal standards are not well defined and may vary, depending on local circumstances.
Examples of ambulance service process measures are the time from receipt of a call to arrival at the scene of the incident, type of aid administered by ambulance personnel to patient requesting assistance, appropriateness of calls requesting the ambulance (Gibson, 1973, 1974b; Willemain, 1977). While it is useful to have these measurements, they require interpretation. For example, a dispatch system which involves questioning the caller in order to dispatch a suitable vehicle to the site may result in a longer response time on average than if the dispatcher simply took the call and dispatched a vehicle immediately. A low response time, therefore, may not reflect an efficient dispatching system (Willemain, 1977). Process measures reflect the actual use of services and the actual care received (Gibson, 1974a). They evaluate the dynamics of providing the service, rather than its outcome.

Examples of outcome measures are mortality rates, morbidity and residual disability measures. Willemain (1977) notes that Gibson raised some salient issues around these measures: mortality rates reflect more than just ambulance service performance, and we do not have effective ways of controlling for intervening variables; mortality rates have in the past not correlated well with subjective impressions of quality of service (ibid., p. 8); when mortality rates improve, residual disability measures may register increases. In light of such problems Willemain (1977) pointed out Gibson's observation that:

There is little in the literature to disprove the hypothesis that the emergency system is treating patients
whose survival is solely a function of their condition and that EMS expenditures only influence when and where the death takes place. (p. 8)

While we are able to measure how many people become ill or are injured and die, and from what causes, we do not have a clear picture of the range of intervention strategies which could save lives and avoid or reduce residual disability, and the costs associated with alternate intervention strategies (Gibson, 1974a). Nor do we measure the opportunity costs associated with dedication of scarce resources to relatively ineffective programs (Willemain, 1977). Surely these are important considerations for decision-makers.

Despite these caveats, there are numerous reports in the literature of the impact of prehospital cardiac arrest programs on mortality rates for these patients. Eisenberg et al. (1980b) reviewed 21 articles reporting on outcomes for programs in 15 locations within the United States. He noted that most studies were descriptive and few made use of comparison or control groups. Though success rates for admission to hospital varied from 22 per cent to 65 per cent, and for discharges alive from hospital from 3.5 per cent to 31 per cent, it was difficult to interpret these differences. He described "lack of standard terminology, methodological unevenness, definitional inconsistencies, and a variety of formats used in reporting outcomes" (p. 236), and went on to say,

The proliferation of different terms, case definitions, methodologies, and reporting formats preclude effective evaluation of paramedic programs. It is impossible to compare one program with another or against a commonly accepted standard. (p. 237)
To illustrate the distortions which can result from this situation, he used data from one of his own studies:

This study compared outcomes of cardiac arrests treated by paramedics and emergency medical technicians (EMTs). The combined discharge rate for patients treated by both groups was 15 per cent. If cardiac arrests treated only by paramedics are considered, 22 per cent of patients were discharged from the hospital. If only witnessed cardiac arrests are considered, 28 per cent of patients were discharged. If only those cases in ventricular fibrillation (VF) on arrival of the paramedic unit are considered, 30 per cent were discharged. Finally, if patients in VF are considered where cardiopulmonary resuscitation (CPR) was initiated within 4 minutes of collapse and definitive care provided within 8 minutes of collapse, then 60 per cent of patients were discharged. (p. 237)

In view of the potential for confusing results, Eisenberg went on to propose a uniform reporting system which would permit more accurate evaluation of the impact of paramedic programs on prehospital cardiac arrests, and ensure comparability of information coming from different geographic locations.

A number of factors discussed in the literature do seem to be associated with likelihood of successful outcomes from cardiac arrest:

- cause of arrest (Eisenberg & Bergner, 1979; Urban et al., 1981);

- whether or not the event was witnessed (since un-witnessed events mean there is generally little chance of early intervention) (Bergner et al., 1981; Eisenberg, 1979a, 1980b);

- short time to definitive care (generally this is closely associated with availability of paramedics) (Eisenberg et al., 1979a, 1980b; Webster, 1980); and
- short time from collapse to initiation of CPR, which often means availability of bystanders willing and able to perform cardiopulmonary resuscitation until emergency services personnel arrive on the scene (Copley et al., 1977; Eisenberg et al., 1979a; Guzy et al., 1979; Lund & Skulberg, 1976; Tweed et al., 1980c).

**STUDIES OF OUTCOMES FOR CARDIAC ARREST VICTIMS TREATED BY PARAMEDICS**

In spite of the limitations described by Eisenberg and his colleagues which certainly appear valid, five studies of outcomes for cardiac arrest cases handled by paramedics have been chosen for more complete presentation here:

1. Diamond, Schofferman, and Elliot (1977) reported on paramedic runs in Torrence, California, (Los Angeles County), during a ten and one half month period ending in May 1975. Six paramedic fire rescue squads operate out of a single base hospital, though half of the cases which they attend are taken to other, closer, local hospitals. These paramedics appear to meet the criteria set out by the American Heart Association for advanced life support personnel. Seventeen patients from a total of 2,152 runs were judged to have died before the paramedics reached the scene, and resuscitation was not attempted for them. Fifty-six per cent of all runs were "non-critical", and most of these involved children or young adults. An additional 27 per cent had serious but non-lifethreatening medical problems. One hundred twenty cardiac arrests from all causes occurred (5.6% of total runs), and these will be discussed here, though the study does report on other types of cases as well.
Most of the cardiac arrest calls were to people in the 50-70 age group, and most were men (98 of 120). One hundred twelve arrests were judged to be of primary cardiac etiology (93%), and response time for cardiac arrest calls was under 4 minutes, 70 percent of the time. Ventricular fibrillation (VF) was documented for 50 cases, and asystole for 40 more. One hundred eight cases were found in arrest (90%), and 12 arrested during attendance by paramedics. Of the 108 people found in arrest, 30 survived to the emergency department, 24 were admitted to hospital, and 15 (14% of the 108 cases) were discharged alive. Of the 12 cases arresting during attendance by paramedics, VF occurred in nine cases, five patients were admitted to hospital, and only one survived. Overall, 16 of 120 cardiac arrest patients (13%) handled by paramedics were discharged alive.

The report does not mention the types of hospitals receiving cardiac arrest patients and possible differences between them in terms of their ability to provide special cardiac care. No mention is made of whether or not incidents were witnessed, nor of the frequency with which bystanders provided lay CPR before emergency services personnel arrived. It is not clear what proportion of the cardiac arrests in the study community were attended by paramedic personnel. No comparison group was monitored to permit comparison of outcomes for patients attended by paramedics and patients who were dealt with in some other way. The study concludes, "The concept of intricate, prolonged stabilization in the field, while
suitable for the cardiac arrest victim...needs further study for other medical problems" (p. 46).

2. Lauterbach, Spadafora, and Levy (1978) reported on success rates for Cincinnati paramedics with cardiac arrest victims from all causes. Here a cardiac arrest was defined as "oscilloscope diagnosed ventricular fibrillation or standstill" (p. 356). The study covered a one-year period, and success was defined as the percentage of patients for whom resuscitation was attempted who survived until discharge alive from hospital. No mention was made of the number or per cent of patients for whom resuscitation was not attempted.

Seven mobile intensive care units (MICU) attached to four different fire departments provided coverage within the greater Cincinnati area. MICUs were staffed by paramedics who met the American Heart Association's standard for advanced life support personnel.

Basic life support occurred infrequently for patients attended by MICU personnel before the arrival of the unit. Initial resuscitation rate (alive on arrival at the hospital emergency department) was 32.7 per cent (48 of 147 cases). Twenty-two patients were discharged alive from hospital (15%) and 26 (18% of the total) died in hospital.

The age group for which resuscitation was most successful was 50-59 (35%), and men in this group had a success rate of 40 per cent. Only 35 patients (25%) were women. Over all age groups, the success rate for women was 8.6 per cent, compared to 17.4 per cent for men.
in the study.

A number of important issues were not discussed in this report: average response time for paramedics; proportion of all cardiac arrest cases included in the study; number and types of hospitals receiving victims after resuscitation; and the proportion of cases where the collapse was witnessed. There was no control or comparison group in this study.

3. Liberdson, Nagel, Hirschman, and Nussenfeld (1974) reported on 301 documented ventricular fibrillation cases which occurred over a 42 month period in Miami, and which were attended by fire department rescue squad personnel. All causes of ventricular fibrillation were included in this study. Only one-third of the patients in this study were found to have had symptoms which would have permitted intervention before collapse, and the rest collapsed virtually instantaneously. Seventy-five per cent of the patients were men, and the average age of the study group was 63. Eighty per cent of emergency cases were reached within 4 minutes of the call for assistance. Squad personnel qualify as advanced life support personnel using the American Heart Association's definition.

For this study success was defined as admission alive to hospital. The hospital had an intensive care unit and squad personnel had voice contact while at the scene and en route with a doctor in the intensive care unit.

Of 301 study patients, 102 (34%) could not be resuscitated
and 199 (66%) responded initially to defibrillation. Of the 199, 101 (34% of the whole group) were hospitalized, and 98 died before admission. Of the 101 hospitalized, 59 patients died in hospital and 42 (14% of the whole group) were discharged alive.

Sixty per cent of the survivors discharged from hospital returned to their former way of life, and the rest had varying degrees of residual neurologic impairment. Antiarrhythmic drugs were prescribed for 29 of 42 patients who were discharged alive after their cardiac arrest. Twenty-two patients were still alive by the time the article was written—a mean survival time of 8.3 months. Of the 20 patients who died after discharge from hospital, 12 did so suddenly, and 10 of the 12 had been discharged on antiarrhythmic drugs.

No mention was made of the frequency with which lay CPR was performed before the arrival of the rescue squad, and the proportion of the arrests which were witnessed is unclear. The report does not contain information about the proportion of cardiac arrest cases attended of all cardiac arrests occurring in the area, and does not discuss unsalvageable cases. This study had no control or comparison group.

4. Closer to British Columbia, Cobb, Baum, Alvarez, and Schaffer (1975) reported on the Medic 1 program's success with ventricular fibrillation cases in Seattle. Characteristics of the Medic 1 system are: 2-5 minute (mean 3 minutes), tiered response, public
education about heart attack, cardiopulmonary resuscitation, and availability of emergency response personnel, direct coronary care unit admission for appropriate patients, resuscitation from circulatory arrest, and early intervention with other life-threatening occurrences. Paramedics meet the standards for advanced life support personnel suggested by the American Heart Association. Access to the emergency system is via a 911 telephone number. Over 80,000 citizens in Seattle received CPR training, and in this study nearly 20 per cent of the resuscitations attempted by Seattle paramedics had been preceded by lay CPR.

During the four year period covered by the study, a total of 1,106 cardiac arrest patients with ventricular fibrillation were attended by paramedics. The number of these which were witnessed was not stated. There were 511 patients in the first 2 years of the study, and 595 in the second 2 years. There was a statistically significant improvement in the per cent of patients initially resuscitated and in the per cent of patients discharged alive from hospital when the first period results were compared with second period results. The rate for initial resuscitation increased from 34 per cent to 43 per cent, and the rate for live discharges from hospital increased from 11 per cent to 23 per cent. The authors suggest several reasons for the improvement: average response time was shortened in the second period by sending a fire truck when other emergency vehicles could not reach the scene within 5 minutes; firemen were given more CPR training; increasing numbers of Seattle
citizens had completed CPR training as the study progressed.

Two hundred thirty-four patients survived a total of 245 separate occurrences of ventricular fibrillation (22.5% of the total) out of hospital, and were discharged home. Two hundred seven were found in arrest, and 38 arrested during attendance by the paramedics. One hundred eighty-three survivors were male, and 51 were female. Average age of survivors was 59.8 years. The one-year mortality rate for patients discharged alive from hospital was 30 per cent, and the two-year mortality was 41 per cent. The study found the long-term survival rates for patients with primary ventricular fibrillation to be poorer than for other patients who had experienced ventricular fibrillation.

This study did not have a comparison or control group.

5. The last study to be reported here is the most elegant in design. Eisenberg, Bergner, and Hallstrom (1980a) reported outcomes for patients with out-of-hospital cardiac arrests (defined as pulseless condition confirmed by an emergency medical technician (EMT) or paramedic) caused by heart disease, occurring in suburban areas just outside Seattle, Washington. This group represents 80 per cent of all cardiac arrests attended by emergency services personnel in the areas. The study covered a three-year period which was divided into two parts—the first 17 months, and the second 19 months in length. In period 1, the study community had EMT services only. In period 2, paramedic services were added, and so the study
community then had both EMT and paramedic coverage. Paramedics in this study seem to meet the criteria for advanced life support personnel.

Two adjacent communities served as comparison groups for the study. The first had EMT services only (data from this community covers 24 months, since significant changes occurred after that in their emergency response system). The second had both paramedic and EMT services for periods 1 and 2. Study and comparison communities were found to be similar on such variables as sex ratio and proportion of citizens over 65. Most of the population in these communities were Caucasian.

In the study community during period 1 with EMT service only, 42 of 223 patients (19%) were admitted alive to a coronary care or intensive care unit, compared to 117 of 349 in period 2 (34%) when both EMTs and paramedics treated victims. The corresponding discharged alive rates for the two periods were 7 per cent of the total patient group (15 patients) and 17 per cent (60 patients) respectively. Both of these improvements were found to be statistically significant. Time to definitive treatment decreased from a mean of 27.5 minutes in period 1 to a mean of 7.7 minutes in period 2.

In the first comparison community which had only EMT services for 24 months, the rate of admission alive in period 1 was 11 per cent, and in the second period for this community was 24 per cent. This difference did not prove to be statistically significant. The discharged alive rates for the same periods were 4 and 3 per cent of the total patient group.
In the second comparison community which had both EMT and paramedic service for both periods, the rates of admission alive were 37 per cent in period 1 and 36 per cent in period 2. The discharged alive rates were 24 per cent of the total patient group (181 patients) in period 1, and 19 per cent (of 182 patients) in period 2.

The study reported that time to initiation of resuscitation, number of witnessed arrests, type of cardiac rhythm, person giving resuscitation, medical practice, and available hospital facilities remained essentially the same over the length of the study. The major change identified was decreased time to definitive care in the study community after introduction of the paramedics. The authors believe that this likely accounted for the observed improvement in outcomes for cardiac arrest victims in the study community from period 1 to period 2. They found also that most of the patients who survived to discharge were patients for whom ventricular fibrillation caused the cardiac arrest.

The article cautions that these results may apply only for similar services provided in geographically similar communities. Generally speaking, the Lower Mainland area of British Columbia meets these criteria, and it is felt that results achieved by British Columbia's paramedics with cardiac arrest victims whose arrests were caused by heart disease can usefully be compared with the results documented in this study, although the case definitions are somewhat different for the two programs.
OTHER LITERATURE

Additional mention of existing literature is included in Chapter IV, Study Methodology.
CHAPTER III

DEVELOPMENT OF THE ADVANCED LIFE SUPPORT PROGRAM IN B.C.

In 1968 a group of physicians interested in practicing emergency medicine banded together to form the Columbian Emergency Physicians and offered to provide Royal Columbian Hospital with 24-hour-a-day emergency room coverage. Their offer was accepted, and in the course of providing this coverage, the physicians came into contact with ambulance attendants, firemen and others who were providing prehospital emergency care within the local community.

A basic tenet of emergency room medicine is that the emergent patient should receive appropriate treatment as early as possible during the course of an incident in order to increase the potential for successful management of the problem. The "stabilize and transport" approach had already been shown to be much more successful than the "grab and run" approach with emergent patients. Vancouver had the example of Seattle's successful prehospital care program, and the emergency physicians working at Royal Columbian Hospital felt that a similar program could and should be implemented here. The chief question was, which group currently providing prehospital care should be offered paramedic training and support by emergency physicians.

The emergency physicians felt that there were clear differences in the quality of care being provided to emergent patients at that time by the various groups providing emergency services. Ambulance
personnel, as part of their own efforts to upgrade themselves and professionalize their occupation, had created and/or taken advantage of educational opportunities which came their way—often on their own time and substantially at their own expense. They had asked to be taught certain specific skills, or joined classes held to train other groups, such as the intensive care unit courses offered at Vancouver General Hospital. This enthusiastic group, providing ambulance coverage as their primary responsibility, seemed the obvious choice for support by the physician group.

Metropolitan Ambulance Company, which employed a large number of attendants and ran a major ambulance service, fully supported the idea (verbal communication: H. Parkin, the emergency physician who initiated the advanced life support program). From a large number of applicants for training the physicians chose nine candidates, each of whom had many years of experience as an ambulance attendant. Their experience had given them tremendous skill in assessing medical emergencies, and in addition they already had a substantial base of theoretical knowledge about emergency care because of the various training courses which they had attended.

People connected with the Royal Columbian Hospital generally supported the plan to train paramedics at the hospital, and most felt that such a program was overdue in the Vancouver area. A multi-disciplinary committee was struck to discuss the plan for training paramedics and having them work out of the hospital. Members had no philosophical bias against training non-physicians to provide
advanced care in the community to emergent patients. Because of their familiarity with the ambulance service and personnel, it was not difficult to obtain the necessary medical staff approval for the paramedic program.

One of the members of the Columbian Emergency Physicians group was also a member of the British Columbia Medical Association's Traffic and Safety Committee, which was chaired by a Victoria pediatrician, P. Ransford. This committee dealt with issues in the area of emergency services within British Columbia. The proposal that a paramedic program be established and approved was put before the committee, and eventually received committee endorsement. After a presentation to the BCMA's Board of Directors, the program received Board support too. The proposal then went to the College of Physicians and Surgeons of British Columbia and, although this group made it clear that it did not want to be the licensing body for paramedics, it gave its approval for establishment of the paramedic program (verbal communication: H. Parkin, 1978).

The biggest problem was the legal one. Some paramedic activities such as endotracheal intubation and administration of drugs would not be legal under the Medical Act. Even the training of people to perform these activities would require special approval from the Council and the Minister of Education (British Columbia, 1979).

Although it might have been possible to change the Medical Act to overcome these problems, it was felt that this would be met with
considerable resistance and would be a cumbersome and very long-
term undertaking. However, since the College of Physicians and
Surgeons of British Columbia had approved the program and informally
agreed not to prosecute people associated with it for either of the
two issues of concern, the criminal law problems were felt to be
manageable.

Obtaining protection from civil law prosecution, however,
proved to be more difficult (verbal communication: L. Vertesi,
1978). Since paramedics had to be held responsible for the results
of their actions in cases of negligence, it was impossible to ob-
tain complete protection against the threat of lawsuits resulting
from their work. Royal Columbian Hospital was able to obtain in-
surance to protect the hospital and the paramedics while they were
working within the hospital, but more was needed. Insurance to give
additional protection to physicians and paramedics involved in the
program was necessary.

Once the BCMA and the College of Physicians and Surgeons of
British Columbia had approved the program, the physician group ap-
proached the Canadian Medical-Legal Protective Association, asking
whether or not the insurance for physicians would protect physicians
in the event of a lawsuit arising from involvement with the paramedic
program. Although there was no immediate answer from the Association,
planning for the paramedic program began.

On May 23, 1973, training of the first group of nine paramedics
started. Then, part way through the course, the physician group
received a letter indicating that its insurance would not cover activities associated with the paramedic program. This left both physicians and paramedics in jeopardy for activities of the paramedics outside the hospital. It was decided that, since it seemed likely that an Emergency Health Services Commission would be established within a reasonable period of time and that it would be able to help overcome some of the insurance problems, it would be wise to wait for this before attempting to implement the paramedic ambulance service. At the end of their training program the paramedics returned to their stations as regular ambulance attendants, unable to use much of what they had learned during paramedic training.

The Emergency Health Services Act, passed in May 1974, resulted from the Foulkes Report (1973), commissioned by the New Democratic Party government after it was elected in 1972. Foulkes had been an administrator at Royal Columbian Hospital, and was familiar with the Columbian Emergency Physicians group and the proposal for paramedics for British Columbia. The Act, and the regulations accompanying it, provided for establishment of a single provincial ambulance service (Metropolitan Ambulance Company was soon taken over by the new provincial service) and officially permitted emergency medical assistants to administer medical care in appropriate circumstances. With this, the Commission was able to obtain the necessary insurance for paramedic activities, and the advanced life support program was reactivated. Since the paramedics had completed training many months earlier and had not been able to practice their special
skills in the interim, they were given a refresher course and another set of examinations. In April 1975, British Columbia's first paramedic vehicle, working out of Royal Columbian Hospital, New Westminster, began accepting emergency calls.

The first paramedic training program focused primarily on teaching emergency cardiac care, since it was felt that as much as 70 per cent of calls attended by advanced life support personnel would be for patients with this type of complaint (verbal communication: L. Vertesi). As time passed, however, it was found that they dealt with a much broader spectrum of medical emergencies, so the training course was altered to reflect these other responsibilities.

Currently British Columbia's advanced life support personnel receive approximately 1,800 hours of instruction and supervision over an 18-month period. After successful completion of their examinations, they are able to administer drugs, start I.V.s, defibrillate patients, interpret arrhythmias and perform endotracheal intubation. Their vehicles have advanced communication systems for dispatch, and while en route they can speak with receiving hospitals through dispatch. Thus they are comparable to the paramedics in and around Seattle, and conform to the American Heart Association's definition of advanced life support personnel (Standards for Cardiopulmonary Resuscitation, 1974).

EMA IIs in British Columbia complete 350 hours of training which includes CPR to the basic cardiac life support standard of the American Heart Association.
At the time this evaluation study was undertaken, paramedics worked out of three ambulance stations in the Lower Mainland, and provision was being made for another class of trainees to begin its studies. Graduates from this class would provide replacements for staff who had left the paramedic service, and would, in addition, provide staff for a fourth vehicle to be located in Vancouver, since call volumes in Vancouver were high. Collection of study data was discontinued June 1, 1980 when this class began its clinical placement on the three well-established vehicles, since it was felt that the performance of class members, at least initially, might be different from that of service veterans, and might therefore distort the findings.

Twelve general hospitals in the Lower Mainland received cardiac arrest patients from the ambulance service during the course of this study, and the vast majority of patients treated by ambulance personnel went to emergency departments which were open 24 hours a day with physicians in the department or on call for emergencies.
CHAPTER IV

STUDY METHODOLOGY

The Emergency Health Services Commission in 1979 had a total of 19 ambulance stations located throughout the Lower Mainland of British Columbia, providing service to 1,268,000 people (Statistics Canada, 1981) living within an area of approximately 10,300 square miles (British Columbia, 1981). The area which is known as the Greater Vancouver Regional District composes 92 per cent of this area, and is urban or suburban in nature.

At the time of this study (September 15, 1979 to June 1, 1980) only three ambulance stations had paramedic vehicles and staff in addition to regular ambulances (Figure 1). The remaining 16 stations providing service had regular ambulances only. Each station was associated with at least one hospital in its area which was committed to providing emergency care to the surrounding community.

Generally paramedic vehicles had a sufficiently large volume of appropriate emergency calls that they could not respond to calls outside the boundaries of their territories. Cardiac arrest calls, therefore, which occurred in areas which did not have paramedic coverage, or in paramedic areas when the paramedic vehicle was occupied with another call, normally would be handled by EMA IIs alone or with the assistance of the Fire Department. These cardiac arrest calls handled by EMA IIs without the assistance of EMA IIs served as a comparison group for paramedic unit performance in this
**FIGURE I:** GEOGRAPHICAL AREAS WITH AND WITHOUT ADVANCED LIFE SUPPORT VEHICLE COVERAGE IN THE LOWER MAINLAND OF BRITISH COLUMBIA

- With Advanced Life Support Vehicle Coverage **
- Without Advanced Life Support Vehicle Coverage

**Note:** Boundaries for the advanced life support vehicle serving New Westminster are flexible—they may be sent to Coquitlam, North Delta, North Surrey, and even Port Coquitlam, depending on their distance from the scene, call volumes, and patient need.
study of outcomes. It should be noted, however, that there was no independent confirmation by electrocardiogram that the cases judged by EMA IIs to be cardiac arrests were so in fact. It could also be that certain patients in ventricular fibrillation were not recognized by EMA IIs as being in urgent need of definitive care as early as EMA IIs would have realized it.

Although it is generally accepted that the ideal model for evaluation research is the randomized, controlled trial, use of the model is rare when the research is being carried out in a health care setting. In the field of health care, when it is generally accepted that one treatment is substantially more effective than another for a given problem, whether or not this has been proved experimentally, it is considered politically and morally unethical to randomly assign patients to one or the other treatment program (Killip, 1979; Rossi & Wright, 1977).

Researchers attempt to ensure the closest approximation to the ideal, given the circumstances (ibid.).

The requirements of experimental designs do not necessarily mean that service be withheld from anyone. The main requirement is that the program or project to be evaluated be different from the services made available to the control groups....A control group might be given traditionally available services." (Rossi & Williams, 1972, pp. 31-32)

Although this design does not permit definitive statements about the causes of outcomes which are identified, it does permit statements about associations between study variables and the outcomes which have been observed.
The initial proposal was to measure outcomes at two points in time for cardiac arrest patients treated by the ambulance service: (a) survival to arrival at hospital, and (b) survival to discharge alive from hospital. It was deemed acceptable to study only cardiac arrest victims, since some authors have claimed that the only cases for which paramedics clearly have an impact on mortality rates are those with cardiac arrests (Eisenberg et al., 1980b; Urban et al., 1981).

During the course of the study a substantial problem of misclassification was discovered. There was doubt about whether crews from different stations were recording survival to arrival at hospital in the same way. Some would call a patient dead on arrival at hospital when the patient was so pronounced by the emergency department physician, while others would consider a patient who was accepted into the emergency department for examination, even though he appeared to be dead, to have died while in the emergency department, rather than having been dead on arrival. Emergency departments contributed to the problem since some were so busy that they could not take a pulseless patient and attempt to resuscitate him if there was virtually no chance that he would survive, while other emergency departments would work on the patient for up to half an hour before deciding that he really had been dead on arrival. Because of the possible misclassification by ambulance crews and the differing policies among emergency departments, it was decided to use admission to hospital ward or special unit as the first point at which outcome would be measured. Thus the "died before
admission" category includes those dead at the scene, those who died in transit, and those who died in the emergency department.

Outcome measures for this study, then, are mortality rates. Some of the problems of using mortality as an outcome have been discussed earlier: residual disability is not measured; the rates are contaminated by other variables which intervene during the course of treatment, such as quality of emergency department care, the coronary care unit and general hospital care in the receiving hospital, and severity of the medical problem experienced by study patients (Gibson, 1974a, 1974b; Willemain, 1977). Furthermore, Willemain has pointed out that mortality rates for one tracer disease which is being studied may not correlate well with outcome measures for other conditions with which the same personnel are expected to deal. Mortality measures generally ignore successful outcomes for patients whose conditions are not likely to result in mortality, and make no attempt to measure morbidity differences which may exist.

Lastly, it has been pointed out that if an ambulance service is relatively ineffective, patients will die before they arrive at the hospital, but if it is very good, more marginal patients will be transported alive, but will die in the ambulance or at the hospital (Outcome Measurement Panel, 1975). In these cases, the main thing which has been altered is where the patient died, not the likelihood of this outcome (Gibson, 1974b). (It should be noted, however, that Cobb (p. 159 in Myerburg, 1979) suggests that this may not
always be so. Some patients who have clearly died will be taken
directly to the coroner's facility, since paramedics will feel more
comfortable making a decision that a death has occurred, and these
patients will never reach the hospital.)

Since this study was meant to be only an initial evaluation
of the paramedic program, and since many other paramedic programs
throughout North America were reporting success based on survival
measures for patients experiencing cardiac arrests, it was decided
in spite of the limitations inherent in using mortality measures,
to assess first patient survival to hospital ward or special unit,
and second to discharge alive from hospital, as criteria for
evaluation of the performance of British Columbia's paramedic
ambulance service. That is to say, the independent variable for
this study is the availability of paramedic (EMA III) care for
cardiac arrest victims, and the dependent variable is survival.

DISPATCH SYSTEM

All emergency calls to the ambulance service are received
at a central dispatch office. The calls can come to any of four
telephone numbers: 1. the Emergency Health Service Commission
telephone number, though few calls would come on this line, 2.
the general emergency telephone number (911) which has been in
use in Greater Vancouver since 1977, 3. the emergency telephone
number listed for the ambulance service in the telephone directory,
or 4. the old Metropolitan Ambulance telephone number.
When the 911 telephone number is dialed, an operator based at Police Department headquarters answers and asks, "Fire, Police, or medical emergency?". She then rings the call through if it is for the Fire Department or the Provincial Ambulance Service. Ambulance dispatch has direct telephone lines to Fire Department dispatch offices serving the same areas where ambulance stations are located, and to emergency departments in most of the hospitals which regularly receive emergency patients from the ambulance service.

At the time of this study, dispatchers were required to have spent several years as ambulance attendants before moving into the dispatch office. One dispatcher per shift took all incoming calls, recorded the information, asked questions to clarify the situation so that he could determine the priority of the call and the type of vehicle which should respond if there was a choice, and then passed the information slip to another dispatcher who would actually dispatch the ambulance crew nearest the location of the incident.

Frequently it was extremely difficult to determine the urgency of an incoming emergency call, since much of the information was being provided by an upset family member or bystander. The skill of the dispatchers was in their ability to evaluate these emergency calls for an appropriate response.

All calls to the emergency lines of the ambulance service were recorded on tape. The slip which the dispatchers completed contained information about the incident as follows: sex and age of the
victim, symptoms, caller, time of receipt of call, time of dispatch of vehicle, type of vehicle sent, level of response (sirens used?), station responding, time the vehicle reached the scene, time the vehicle left the scene, time the vehicle reached the hospital, receiving hospital, time the vehicle was free to respond to another call. When these dispatch slips were matched with the Crew Reports (also known as Form IIs and basic call sheets), all the information which the ambulance service collected about regular ambulance calls was available.

HANDLING OF CARDIAC CALLS

During this study, any incident suspected of being cardiac-related would be assigned to a paramedic unit if one covered the area. A regular ambulance would be dispatched at the same time to assist, and the Fire Department dispatch office would be informed of the call. Most fire stations had fire and safety units. Personnel on these units had basic industrial first aid training, and carried first aid kits, oxygen therapy units and pulmonators with airways in their vehicles, in addition to the jaws of life and oxygen and masks for fire fighters. Fire Department staff would go to the scene and establish control while waiting for the ambulance crew(s) which they knew would be there as soon as possible.

Ideally, then, the response to an urgent cardiac call was as follows:

- If the incident happened in an area with paramedic coverage, the regular ambulance and the paramedic
vehicle would be dispatched to the scene, and the Fire Department would be notified of the incident. Since there were more Fire Department stations than ambulance stations, and more ordinary ambulances than advanced life support vehicles, generally the rescue and safety unit would arrive first, the EMA II ambulance second, and the advanced life support ambulance third. EMA IIs would take over treatment of the patient from Fire Department staff when they arrived, and would do whatever they could to help. EMA IIs in turn would take over when they arrived, and EMA IIs would remain to assist in any way they were asked.

- If the incident occurred in an area without paramedic coverage, or if the paramedic vehicle was not free to respond to the call, then an EMA II vehicle would be dispatched to the scene and the Fire Department notified. If appropriate, the advanced life support vehicle would be sent when it became free, unless the EMA IIs had already left with the patient to go to the hospital.

This tiered response system was designed to ensure that skilled help would reach the victim as quickly as possible.

**STUDENT CLERKSHIP**

In the fall of 1977 an initial evaluation of the cardiac care
component of the paramedic ambulance service was proposed. Although it would have been possible to carry out a before/after evaluation study when the advanced life support program was first established, this had not been done. The proposed study, therefore, would be the first formal evaluation of the paramedic service.

With an evaluation in mind, a clerkship was arranged with the Emergency Health Services Commission in Vancouver, for a student in the M.Sc., Health Services Planning program at the University of British Columbia. The purpose of the clerkship was to determine whether an evaluation study was feasible using existing ambulance service and other records, or whether a prospective study with special data collection forms would be necessary.

For a two-week period, all calls from four ambulance stations in the Lower Mainland were examined. Two of the four stations had both paramedic and regular ambulances. The other two stations had regular ambulances only. These latter two stations were selected by the Chief Dispatcher for their similarity to the two stations which had paramedic crews.

All the Crew Reports (see Appendix B) from the ambulance service were examined for the four stations in the study. The types of calls to which the crews from these stations responded were noted, and the call sheets from calls to suspected heart attack patients were kept separate for further analysis. The Medical Director of the Advanced Life Support Program established the criteria for identifying likely heart attack cases, and the Crew Reports from
from these runs were matched with the appropriate dispatch slips. In addition to this, all dispatch slips for the study period were examined for the four stations, to determine whether or not heart attack calls could be identified which had been missed by examining only the Crew Reports. For all identified cases, information about final outcomes was requested and received from Medical Records Departments at receiving hospital.

This initial examination of ambulance service records, however, showed that in too many cases some essential information which would be needed for the evaluation study was missing. This meant that the study would have to be designed and carried out prospectively, in order that the call record would be complete enough to make analysis practical.

For the prospective study Crew Reports, dispatch slips, and the special cardiac arrest forms which EMA IIIs were required to complete for such calls because of the special procedures which they use, were collected. In addition, a special cardiac arrest study sheet (Appendix C, Part 1) for EMA IIIs to complete was designed with Dr. Vertesi's help, so that it would be possible to capture for EMA II cardiac arrest calls some of the information routinely provided by paramedics.

Approval for research involving human subjects was requested from the University of British Columbia in the spring of 1978, and was received in a letter dated July 24, 1978 (Appendix D).
INITIATION OF THE PROJECT

Discussion was held early in the summer of 1979 with the Royal Columbian/Douglas College Joint Education Venture group, which agreed to provide some financial and clerical support to the project. They were interested in the work of the ambulance service since they provided some of the training for ambulance personnel, but their particular interest in the project was in the advantage that bystander CPR gives to likelihood of successful outcomes in cardiac arrest incidents since they provided instructors for and community education courses on cardiopulmonary resuscitation.

The ambulance attendants' union (C.U.P.E., local 873) was approached for its support for the study. This, was essential since EMA Ms were to be asked to complete special study data sheets for cardiac arrest cases which they attended. The requested support was quickly received, and the union representative offered to mail a letter to all union members in the Lower Mainland describing the purpose of the study and requesting cooperation with it. Further, as requested, the union representative arranged for the researcher to meet with delegates from each of the stations which would be involved in the study, so that the purpose could again be explained, the special data collection form discussed, and arrangements made for the representatives to call the researcher with any questions or problems which arose. These meetings took place in late August and early September 1979, forms were distributed to all stations, and data collection started on September 10, 1979. The first five
days were considered a trial period, and information from this period was not included in the final data set. There were very few questions about use of the forms, and at 12:01 A.M., September 15, 1979, collection of data to be used in the study began.

EMA IIIs were asked to complete a study data sheet in addition to their Crew Report for all cardiac arrest calls which they attended, regardless of whether or not EMA IIIs also attended the patient, provided only that there was reason to believe that the arrest was relatively recent. Patients who appeared to have been dead for some time were therefore excluded from the study since they were not candidates for salvage. Dispatch slips indicated whether or not there was a double response for each of the calls, and receipt of information from both EMA IIIs and IIIs served as a check that all cardiac arrest cases attended by ambulance service personnel were being identified in the data collection system. The EMA II form, however, was discarded when EMA IIIs attended the same case, unless it was required in order to complete information for the EMA III report. For study purposes cases with double response were attributed to EMA IIIs.

At the end of November all crew reports and dispatch slips for a two-week period in early November were examined to determine whether or not some cardiac arrest calls were being missed. As far as could be determined on the basis of this check, all cardiac arrest cases were being reported by either an EMA II special study form or the regular paramedic cardiac arrest report form.
PROBLEMS WITH DATA COLLECTION

In January it was observed that few cases had been reported from two of the ambulance stations staffed by EMA IIs only. This was drawn to the attention of the union representative who was asked to try to determine the cause. After investigation, he indicated that staff in these two stations were basically unwilling to participate and that appeals for their cooperation by union or E.H.S.C. representatives would be unlikely to be heeded.

The two stations in question were located in areas of downtown Vancouver with high call volumes. One was a Skid Road area in the centre of the city where ambulance personnel dealt with "tough characters", many deaths, and a large number of inappropriate calls for an ambulance. Outcomes for cardiac arrests experienced by residents of the Skid Road area would not likely be representative of outcomes for the general population because of a variety of complicating factors associated with their lifestyles, even if data had been collected for all the cases in this area. While all cases which were handled by EMA IIs were included in the study, some of those handled by EMA IIs only were not, and the exclusion of such cases may tend to overstate the effectiveness of EMA IIs as a group in this study with cardiac arrest cases.

The second area, known locally as the West End, contained a very mixed population. It had numerous high-rise apartments which attracted both young business people and successful retired couples. At the same time there were substantial numbers of elderly people
of limited means who had dwelt there for many years. It is also an area where many of the "street-wise" young and not-so-young plied their various trades. Generally speaking, it is an area where one would expect a number of cardiac arrest calls to occur because of the number of seniors in the area, but the study was unable to collect data on calls handled by EMA IIs only. An examination of crew reports for the area was carried out once the problem was identified, but it was impossible to tell from these documents in retrospect which cases might or might not have been appropriate study cases. They often contained billing information and the word "collapse" but little other information about the case. Since the only cases of interest were heart disease related cardiac arrests, it was not clear whether or not the cases of "collapse" should be included. They were therefore excluded.

It can be hypothesized that some of the cardiac arrests occurring in the West End would be the result of trauma or overdoses, and these would have been excluded from analysis in any event. However the high call volumes for the downtown and nearby West End areas likely mean that a number of appropriate EMA II study cases were lost to analysis.

A second significant problem appeared later in the data collection period. Contract renewal was being negotiated for ambulance service personnel, most of whom were unionized, in the spring of 1980 and negotiations were not going particularly well. Overall, the number of cardiac arrest cases being reported on
EMA II study forms dropped. The union representative, at the request of the researcher, contacted station representatives again to try to rekindle enthusiasm for the study where it might have been flagging, but doubtless the animosity involved in long labor negotiations played a role in our having a reduced number of study cases from EMA IIIs. It has been assumed that in this instance the lost cases did not occur in any systematic way which would bias the results. EMA IIIs continued to report in the usual way on their aggressive treatment of the cardiac arrest patients whom they attended.

Cases for the study were collected until 12:01 A.M., June 1, 1980. Later that day the newest paramedic trainees commenced work with veterans on the advanced life support vehicles. During the data collection period from September 15, 1979 to June 1, 1980, a total of eight and a half months, 443 cardiac arrest cases from all causes were identified for which the Provincial Ambulance Service had been called.

VARIABLES INCLUDED IN THE STUDY

The following information was collected for each cardiac arrest cases attended by EMA IIIs or EMA IIIs or a combination of both:

- date
- receiving hospital
- age of patient
- sex of patient
- type of ambulance(s) responding
- station responding
- time call was received
- time vehicle reached the scene
- time to definitive treatment for the patient
- CPR being done on arrival of the ambulance?
- if so, CPR done by whom?
- estimated time in arrest without CPR
- patient found in arrest/arrested during attendance by ambulance personnel
- presumed cause of arrest
- patient disposition on arrival at hospital
- patient disposition from emergency department
- course after admission to hospital (died/discharged alive)
- length of hospitalization
  (See Appendix C, Part 2)

These variables were chosen because they provided information which would later facilitate comparison of the study and comparison group, or because they were factors which were identified in the literature as being particularly relevant to outcomes from cardiac arrests. They were also variables which both groups of ambulance personnel could record regularly and reliably, or which Medical Records Departments were willing to provide on request.

We did attempt to collect information on whether or not the collapse was witnessed, but information on this was not provided with any regularity by EMA IIs completing the study data sheets, and this variable was excluded.

IN-HOSPITAL COURSE

Information regarding the in-hospital course of the patient was obtained by mailing a form identifying the date of the incident and the patient to Medical Records Departments of receiving hospitals. Some of the hospitals were accustomed to providing this information concerning cases handled by EMA IIs, and the rest had previously
agreed to provide it if asked. Hospital information was obtained for all the cases for which it was requested.

DATA PREPARATION

After collection, the information was coded and eventually key-punched in preparation for analysis using the computer. Where the information was not available on a variable, it was coded as "information missing". Obviously in some cases no information was expected, e.g., for course in hospital for a patient who died before admission, and this, too, was specially coded.

RELIABILITY AND VALIDITY ISSUES

Reliability

"Reliability refers to the consistency of measurement; that is, the extent to which the measure would remain constant for any particular subject if he were repeatedly tested under identical conditions" (Miller, 1975, p. 118). It is believed that most of the data recorded for the study was reliable. Although questions have been raised about the quality of data recorded by professionals and in medical records, little of the data which was collected for this study was open to interpretation: e.g., sex, responding station and times, and major outcomes such as admission to ward/special unit, died in hospital or discharged alive. In instances of double recording either by two EMA IIs both ensuring that the case was reported, or by an EMA II and an EMA III form for the same case, no evidence
was found of discrepancies in information (though one occasionally was more complete than the other).

Validity

There are two general types of threats to validity: threats to internal validity, and threats to external validity. The first is "the extent to which [measures] correspond to the 'true' position... on the characteristic being measured" (Sellitz, Wrightsman, & Cook, 1976, p. 161).

A variety of threats to internal validity are possible:

(a) History: If history is "any set of events other than the program, occurring between...two occasions of measurement" (Houston, 1972, p. 59), then history was not likely a threat to validity for this study. That is, there were no independent changes in management of or occurrence of cardiac arrests during the course of this study as far as could be determined.

(b) Maturation: It is believed that this threat was controlled for by the fact that data collection did not continue into the period when newly-trained paramedics started providing care to patients in their community. All study EMA IIs were experienced advanced life support personnel.

(c) Selection: It is at least conceivable that dispatchers might tend to send paramedics to cases where the chance for resuscitation appeared to be good, and EMA IIs to cases where the chance appeared poor. Dispatching in this fashion, however, was grounds for
dismissal, and during the time which the researcher spent in the dispatch office no evidence of this sort of bias was found.

It was felt that most recent out-of-hospital cardiac arrests were brought to the attention of one of the emergency services, and directly or through that service to the ambulance service, as Bergner et al. (1981) suggested. This type of selection bias was not thought to be a problem for this study, except as described in section (d) following.

(d) Experimental mortality: "The absence of data on some cases, may create observed differences between the experimental and the comparison groups" (Houston, 1972, p. 61). This may constitute a threat to validity for this study, since it is impossible to know with certainty what effect exclusion of some of the data from the Skid Road and West End areas of the city might have had on study findings. Similarly the effect of the loss of cases because of difficult labor negotiations cannot be determined.

(e) Demographic differences: Sherman (1979) has suggested that high-risk patients may choose to move into an area with paramedic services. There is no way to assess the likelihood of such an occurrence having compromised our study. Furthermore, although it is known that the first two paramedic units were based in areas where their acceptance by community hospitals and physicians was greatest (verbal communication: L. Vertesi), the third, in downtown Vancouver, was located there on the basis of greatest need, and this difference in population served was not controlled for during the course of this study.
(f) **Instrumentation:** The information which EMAs were asked to record for the study was generally very straightforward, and the recording of this type of information would not likely change over time. Although it would be possible to make an error in assessing an item such as presumed cause of arrest, it would frequently have been obvious if the cause were a severe, but not heart-related, medical problem, and there would likely have been someone at the scene to provide information about the medical situation for patients who had been ill for a while. Similarly, it should have been reasonably clear if the cardiac arrest were due to overdose, drowning, or trauma. If, however, there was a question about this or information about any other study variable, and no one was available who could provide reasonably reliable information so that the EMAs could complete the study sheet, the space for the information on the variable in question was left blank.

(g) **Community awareness:** Changes in community awareness of the paramedic ambulance service could constitute another threat to internal validity. No changes in community awareness of the ambulance service in general, or the paramedic service in particular, appeared to have occurred during the study period.

**External Validity, Or Generalizability**

There are also threats to validity which limit external validity, or generalizability. The most problematic for this study was contamination by intervening variables which have an effect on outcome.
Such variables as clinical severity, complicating factors, or certain patient characteristic differences between the study and comparison groups were not controlled for, all of which might have had an impact on outcomes. Such variables as socioeconomic status, smoking habits, and obesity would be difficult for ambulance personnel to record with any degree of consistency. Without detailed interviews with family members or examination of hospital records, prior medical history and severity of clinical condition could not be measured, and this study did not have the resources to assess these variables for patients in the study. Therefore it has been assumed that these variables were distributed comparably throughout study and comparison groups.

CRITERIA FOR SIGNIFICANT DIFFERENCE IN STUDY FINDINGS

There are two general types of significance that one can discuss in relation to study findings. The first is statistical significance, and the probability values associated with statistical tests used for analysis of study data give one information regarding the likely statistical significance of differences found.

The second type of significance is practical significance from the point of view of service administrators and providers, and is additional evidence of the value of the program, over and above statistical significance. After discussion with the Medical Director of the Advanced Life Support program, it was decided, before any data was collected, that a 10 per cent difference in
survival outcomes between the EMA II patient group and the EMA III patient group would constitute a significant difference in practical terms.
CHAPTER V

FINDINGS

This study was carried out to determine whether or not paramedics in British Columbia have a significant impact on survival following cardiac arrest, when compared to success rates for similar cases handled by regular ambulance personnel.

The traditional justification of advanced life support programs has been more patients admitted alive to hospital. However, from a health care system point of view, it is also important to know whether or not more paramedic-treated patients also survive to be discharged alive from hospital. If the good work done by advanced life support personnel in getting a higher proportion of those seriously ill patients to hospital alive does not result (for whatever reason) in significantly more such patients being discharged alive, then, as Gibson (1974b) has said, a great deal of money and effort has been spent altering where the death from the incident takes place, not the fact of the death itself.

As will be described, differences were observed in survival rates between EMA II and EMA III patients. A number of supplementary analyses were undertaken with a view to ruling out some of the rival explanations which might account for the findings.

RESULTS

A total of 443 recent cardiac arrest cases attended by staff of the Provincial Ambulance Service were identified for the period
from September 15, 1979 to June 1, 1980. For 7 cases (1.6%) the type of response could not be determined with certainty, and these cases were excluded from analysis. For another 17 cases (3.8%) the cause of arrest was not reported and these cases, too, were excluded. Of the remaining 419 cases, presumed cause of arrest was trauma for 14 (3.3%), overdose for 7 (1.7%), and other causes for 40 cases (9.6%), e.g., electrocution, drowning, SIDS, etc. The remaining 358 cases were believed to be cardiac arrests related to cardiac disease.

After discussion with the Medical Director of the Advanced Life Support Program it was decided to exclude cases with a "time in arrest without CPR" greater than 15 minutes, or a "time to definitive care" greater than 35 minutes, since such cases were judged to be unsalvageable. Using these criteria another 34 cases (9.5% of the 358 cases) were excluded from analysis. The remaining 324 cases form the basis of the following analysis.

Initial examination of the patient groups treated by EMA IIs and EMA IIIIs showed no statistically significant differences between the two groups on the basis of age, sex, time of day of incident (Appendix E, Tables I, II, and III).

Accordingly, the course of illness for the two patient groups as they existed was determined (Table I).

Initial outcome, course while in hospital for patients who were admitted alive, and final outcome were determined for the two patient groups. There were very clearly significant positive differences between proportions of EMA II and EMA III patients
admitted alive to hospital (p. = 0.002). The findings about
differences in proportions discharged alive from hospital, though
in the expected direction, are less clear (p. = 0.10). Extraneous
factors which might have influenced this finding are discussed in
Chapter VI.

The proportions of patients dying after admission to hospital
were not significantly different for the two groups.

TABLE I: NUMBER AND PERCENTAGE DISTRIBUTION OF OUTCOMES FOR
STUDY PATIENTS BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>OUTCOMES</th>
<th>EMA II PATIENTS</th>
<th>EMA III PATIENTS</th>
<th>STATISTICAL TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Initial Outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admitted Alive to Ward/</td>
<td>10 (11.1)</td>
<td>65 (28.3)</td>
<td>Corrected $X^2$ = 9.7</td>
</tr>
<tr>
<td>Special Unit</td>
<td></td>
<td></td>
<td>p. = 0.002</td>
</tr>
<tr>
<td>Died Before Admission</td>
<td>80 (88.9)</td>
<td>165 (71.7)</td>
<td></td>
</tr>
<tr>
<td>- Course in Hospital for Patients Admitted Alive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died in Hospital</td>
<td>5 (50.0)</td>
<td>36 (55.4)</td>
<td>Corrected $X^2$ = 0.00</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>5 (50.0)</td>
<td>29 (44.6)</td>
<td>p. = 1.0</td>
</tr>
<tr>
<td>- Final Outcome (Total Patient Group)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died At Any Time</td>
<td>85 (94.4)</td>
<td>199 (87.3)</td>
<td>Corrected $X^2$ = 2.8</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>5 (5.6)</td>
<td>29 (12.7)</td>
<td>p. = 0.10</td>
</tr>
</tbody>
</table>

Next, one of the other factors which might account for the
observed differences in outcomes was examined. It was found that
there were differences in proportions of patients found in arrest
vs. arresting during attendance in the two patient groups (Table II),
but the direction of the difference tends to favor EMA IIIs, since patients who arrest during attendance by the ambulance crew have potential for intervention earlier in the course of the incident, which should have a favorable impact on the chance for success.

TABLE II: NUMBER AND PERCENTAGE DISTRIBUTION OF PATIENTS FOUND IN ARREST AND ARRESTING DURING ATTENDANCE BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>PATIENT CATEGORY</th>
<th>EMA II</th>
<th>EMA III</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td></td>
</tr>
<tr>
<td>Found in Arrest</td>
<td>76 (83.5)</td>
<td>212 (91.0)</td>
<td>288</td>
</tr>
<tr>
<td>Arrested During</td>
<td>15 (16.5)</td>
<td>21 (9.0)</td>
<td>36</td>
</tr>
<tr>
<td>Attendance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>233</td>
<td>324</td>
</tr>
</tbody>
</table>

Corrected $X^2 = 2.98$

$p = 0.08$

The course of illness was examined separately for found in arrest and arresting during attendance patients by type of responding attendant (Appendix E, Tables IV and V). Since the found in arrest group is such a large proportion (88.9%) of the total patient group, they contribute substantially to the findings for the whole group, and it is not surprising, therefore, to find that for the found in arrest group, there are statistically significant differences favoring the EMA IIIs, in proportions of cases surviving to admission and to discharge alive ($p = 0.001$ and $p = 0.03$), respectively.)
Similar differences were not found for the group of patients who arrested during attendance by ambulance personnel.

As might be expected, the arrested during attendance group treated by EMA IIs fared better than the found in arrest group they treated. It appears that for the arrested during attendance patient group, rapid transport to definitive care at the hospital was useful.

Cardiopulmonary Resuscitation

A difference favoring EMA IIs (p. = 0.00) was found in the proportion of patients who were receiving CPR on arrival of the ambulance crew (Table III). This was to be expected, since the EMA IIs would generally be able to reach the scene ahead of the EMA IIs, and firemen or EMA IIs would have started CPR while waiting for the advanced life support crew to arrive.

<table>
<thead>
<tr>
<th>CPR ON ARRIVAL OF EMAs?</th>
<th>EMA II PATIENTS</th>
<th>EMA III PATIENTS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td></td>
</tr>
<tr>
<td>CPR Being Done</td>
<td>46 (60.5)</td>
<td>187 (88.6)</td>
<td>233</td>
</tr>
<tr>
<td>CPR Not Being Done</td>
<td>30 (39.5)</td>
<td>24 (11.4)</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>76</td>
<td>211</td>
<td>287</td>
</tr>
</tbody>
</table>

Corrected $X^2$ = 27.1
p. = 0.00

** Note: CPR/Bystander CPR only applies to cases where the patient was found in arrest, and not to cases where the patient arrested during attendance of ambulance personnel.
The number of patients in each of the two groups who received bystander CPR before arrival of the ambulance crew was also examined (Table IV).

<table>
<thead>
<tr>
<th>BYSTANDER CPR DONE?</th>
<th>EMA II PATIENTS</th>
<th>EMA III PATIENTS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td></td>
</tr>
<tr>
<td>Received Bystander CPR</td>
<td>16 (21.1)</td>
<td>26 (12.3)</td>
<td>42</td>
</tr>
<tr>
<td>Did Not Receive Bystander CPR</td>
<td>60 (78.9)</td>
<td>186 (87.7)</td>
<td>246</td>
</tr>
<tr>
<td>Total</td>
<td>76</td>
<td>212</td>
<td>288</td>
</tr>
</tbody>
</table>

Corrected $X^2 = 2.80$

$p = 0.09$

Relatively few instances (14.6%) of bystander CPR (defined in Chapter I) were observed during this study. Generally CPR, if it was done, was performed by emergency services personnel. The proportions of EMA II and EMA III cases receiving bystander CPR in this study were not significantly different ($p = 0.09$), though the direction of the findings tends to favor survival for EMA II patients.

**Time In Arrest Without CPR**

Reports in the literature have indicated that time in arrest without CPR is extremely important for cardiac arrest victims. The present study confirms this finding (Table V).
TABLE V: MEDIAN TIME IN ARREST WITHOUT CPR FOR STUDY PATIENTS

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>MEDIAN (Mins.)</th>
<th>STATISTICAL TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Outcome</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admitted Alive to Ward/Special Unit</td>
<td>3.1</td>
<td>Mood Median $X^2 = 15.2$ p. = 0.00</td>
</tr>
<tr>
<td>Died Before Admission</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td><strong>Course in Hospital for Patients Admitted Alive</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died in Hospital</td>
<td>3.7</td>
<td>Mood Median $X^2 = 2.1$ p. = 0.15</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td><strong>Final Outcome (Total Patient Group)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died At Any Time</td>
<td>5.1</td>
<td>Mood Median $X^2 = 6.2$ p. = 0.01</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>2.8</td>
<td></td>
</tr>
</tbody>
</table>

Patients who were admitted alive had significantly shorter times in arrest without CPR when compared to those who died before admission (p. = 0.00), and patients who were discharged alive from hospital had shorter times in arrest without CPR than did patients who died while in the study (p. = 0.01).

There was no difference in time in arrest without CPR for study patients (p. = 0.43) depending on which group of ambulance personnel ultimately provided their treatment (Table VI).

* Note: For analysis of observed differences in variables measured in units of time, where information on the variable was missing the case was excluded from analysis of the time-related variable (n ≤ 41). There appeared to be substantial skew in the mean times calculated, even when the data were log-transformed (Appendix E, Tables VI, VII). Therefore the conservative Mood median test, rather than a t-test was used to test for significant differences between all time variables analyzed.
TABLE VI: MEDIAN TIME IN ARREST WITHOUT CPR FOR STUDY PATIENTS BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>TYPE OF RESPONDING ATTENDANT</th>
<th>MEDIAN TIME IN MINUTES</th>
<th>STATISTICAL TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMA II Patients</td>
<td>4.8</td>
<td>Mood Median $X^2 = 0.61$</td>
</tr>
<tr>
<td>EMA III Patients</td>
<td>4.9</td>
<td>$p = 0.43$</td>
</tr>
</tbody>
</table>

Again, this is not surprising in view of the fact that often Fire Department personnel reached both groups of patients ahead of ambulance service personnel and began CPR, and when EMA IIIs were dispatched simultaneously with EMA IIIs, they would generally reach the scene and take over performance of CPR for the patient while waiting for EMA IIIs to arrive. Since no difference was found in proportions of EMA II and EMA III cases where bystanders initiated CPR before any ambulance arrived, then it is reasonable to find that there were no differences in time in arrest without CPR for the two patient groups.

Receiving Hospital

Three hundred nine patients were transported to hospital. Of the 12 hospitals receiving cardiac arrest victims from the ambulance service during the study, six had coronary care units and emergency departments which were open 24 hours a day with a physician in the department or on call within the hospital. This group of six hospitals receive 85 per cent of the patients going to hospital. Hospitals without coronary care units received the rest. Analysis of this information by type of responding attendant
(Table VII) shows that a significantly higher proportion of EMA III patients were taken to hospitals with coronary care units (CCUs), whatever that might mean in terms of commitment to coronary care or in terms of skills of hospital staff generally.

TABLE VII: NUMBER AND PERCENTAGE DISTRIBUTION OF PATIENTS RECEIVED BY HOSPITALS WITH AND WITHOUT CORONARY CARE UNITS BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>HOSPITAL HAS CCU?</th>
<th>EMA II PATIENTS</th>
<th>EMA III PATIENTS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Received by Hospital With CCU</td>
<td>45 (50.0)</td>
<td>217 (99.1)</td>
<td>262 (84.8)</td>
</tr>
<tr>
<td>Received by Hospital Without CCU</td>
<td>45 (50.0)</td>
<td>2 (0.9)</td>
<td>47 (15.2)</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>219</td>
<td>309</td>
</tr>
</tbody>
</table>

Corrected $X^2 = 115.4$

Outcomes for patients taken to the two types of hospitals were then analyzed (Appendix E, Table VIII). No significant differences were found in proportions of patients admitted, dying in hospital, or discharged alive. That is, whether or not the receiving hospital had a coronary care unit did not appear to have had an impact on the course of illness for cardiac arrest patients delivered to these hospitals by the ambulance service.

**Time To Definitive Care**

By definition (see Chapter 1) time to definitive care is generally substantially shorter for EMA III patients than for
EMA II patients. This was, indeed, found to be so for patients in this study (Appendix E, Table IX).

Outcomes were then related to median time to definitive care for study patients (Table VIII).

### TABLE VIII: MEDIAN TIME TO DEFINITIVE CARE FOR STUDY PATIENTS

**BY OUTCOME**

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>MEDIAN (Mins.)</th>
<th>STATISTICAL TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Initial Outcome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admitted Alive to Ward/Special Unit</td>
<td>7.3</td>
<td>Mood Median $X^2 = 10.3$</td>
</tr>
<tr>
<td>Died Before Admission</td>
<td>9.7</td>
<td>$p = 0.001$</td>
</tr>
<tr>
<td>- Course in Hospital for Patients Admitted Alive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died in Hospital</td>
<td>7.9</td>
<td>Mood Median $X^2 = 0.81$</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>6.7</td>
<td>$p = 0.37$</td>
</tr>
<tr>
<td>- Final Outcome (Total Patient Group)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died At Any Time</td>
<td>9.3</td>
<td>Mood Median $X^2 = 4.6$</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>6.7</td>
<td>$p = 0.03$</td>
</tr>
</tbody>
</table>

Time to definitive care proved to be significant for patients who were admitted alive compared to those who died before admission ($p = 0.001$) and for those who were eventually discharged alive compared to those who died at any time ($p = 0.03$).

**Length of Hospitalization**

One of the arguments against having paramedics is that this may lead to a large number of people who will certainly die while
in hospital being admitted alive and using vast quantities of scarce resources before their eventual demise. One measure of resource utilization is the number of days spent in hospital. Analysis was done for patients in this study who were discharged alive, or who died while in hospital, to see if there were significant differences in lengths of hospitalization for those who had been treated by paramedics compared to those who were treated by EMA IIIs (Appendix E, Tables X and XI).

A longer median length of hospitalization was observed for EMA III patients discharged alive than for EMA II patients discharged alive, but this did not proved to be statistically significant (p = 0.59). EMA III patients who died in hospital had a longer median length of hospitalization than did EMA II patients who died in hospital, but the difference was not significant (p = 0.11).

Because EMA III patients dying in hospital had a longer median length of hospitalization than did the similar EMA II group, length of hospitalization was examined for all those in the group of patients who died while in hospital. The median length of stay for this group proved to be 2.1 days. Therefore, even if the observed difference between EMA II and EMA III patients had proved to be statistically significant, the difference in total number of days in hospital would not have been significant in practical terms since the length of stay was so short.

Survivors

The patients who survived their cardiac arrest and were
eventually discharged alive from hospital were examined as a group. As was expected, a higher proportion of patients under 50 years of age survived, and a smaller proportion of those 70 or older survived. The mean age of survivors was 61.6. Seventy-nine per cent of survivors were found in arrest, a smaller percentage than the 88.9 per cent for the study group as a whole. The greater potential for successful outcomes for patients arresting during attendance of ambulance personnel has been noted earlier in the chapter. Seventy-four per cent of survivors were male, and 65 per cent had the ambulance called for them during the day, rather than at night. Neither of these findings is particularly different from the findings for the study group as a whole.
CHAPTER VI

DISCUSSION AND CONCLUSIONS

RESEARCH QUESTION 1

Are there significant differences in the proportions of patients surviving to hospital admission between the group of patients treated by EMA IIIs only, and that treated by EMA IIIIs only, or a combination of EMA IIIIs and EMA IIIs?

Data from this study indicate that there are, indeed, survival differences between patients treated by EMA IIIs and those treated by EMA IIIIs or a combination of types of personnel, on this initial outcome measure (p = 0.002). Furthermore, these differences are significant in practical terms when the standard is a ten per cent difference in survival rates between the two patient groups as established before data collection began.

The initial outcome survival rate for EMA II patients was 11.1 per cent, compared to 28.3 per cent for paramedic patients; i.e., the rate for EMA III patients was more than double that for EMA II patients.

In the review of studies dealing with outcomes for cardiac arrest patients, only the study by Eisenberg et. al. (1979c) seemed to deal with a similar patient group (Eisenberg et al., 1980b). There the initial outcome rate for patients treated by non-paramedic technicians was 17.0 per cent, and for those treated by paramedics, 39.0 per cent. Other studies in that review dealt with a subset of the population studied here (e.g.,
patients with ventricular fibrillation, or patients with myocardial infarctions). They report initial survival rates for paramedic patients of from 34 per cent (ventricular fibrillation patients) to 65 per cent (acute myocardial infarction patients).

It is important, however, when evaluating the relevance of such findings, to remember the warning about differences in outcome rates which may be related to unreported differences in key variables associated with the particular population being studied. Such things as whether or not the arrest was witnessed, more rapid response time than elsewhere, more rapid initiation of CPR, etc., all have important implications for initial resuscitation rates. Many studies do not address these variables in their reports, and thus it is difficult to know whether or not British Columbia's advanced life support personnel should be evaluated against standards based on such findings in the literature.

Since, however, the traditional justification for having paramedic programs is higher initial survival rates for seriously ill patients, this study indicates that when cardiac arrest victims are studied, B.C.'s paramedic program appears to be justified both in statistically and in practically significant terms.

In Seattle, Cobb, Bau, Alvarez, and Schaffer (1975) documented an improved survival rate for paramedic patients of from 34 per cent to 43 per cent, and a survival to discharge improvement from 11 per cent to 23 per cent during a second time period compared to an initial time period. It would be interesting to examine results for
Provincial Ambulance Service personnel in British Columbia now that they have still greater experience in dealing with cardiac arrest victims, and, as well, many more people in the community have received training in cardiopulmonary resuscitation.

The patient groups treated by EMA IIIs and EMA IIIs appeared to be similar with respect to age, sex, and time of day of call. There were differences with respect to percentage of patients found in arrest and arresting during attendance of ambulance personnel (p. = 0.08), and incidence of bystander CPR (p. = 0.09), though the direction of these last two differences tends to favor better outcomes for EMA II patients. This adds weight to study findings of significantly better initial outcomes for paramedic patients.

Two differences between the patient groups were as would be expected: more EMA III patients had CPR before arrival of the paramedics since other emergency services personnel were dispatched at virtually the same time and could generally reach the scene faster to begin CPR; and more EMA III patients were taken to hospital which had CCUs (these were the hospitals near the ambulance stations at which the paramedics were based, and often had been involved in providing training to or refresher courses for paramedics). When, because of such findings, time in arrest without CPR for EMA II patients was compared to time in arrest without CPR for EMA III patients, the differences were not statistically significant. When outcomes were examined for the
patient groups delivered to hospitals with and without CCUs, no statistically significant differences were found. Thus, these differences would not likely explain the observed differences for EMA II and EMA III patients on the initial survival measure.

Analysis was done separately for the found in arrest group of patients by type of responding attendant, and for the patient group arresting during attendance by type of responding attendant. When initial outcome was examined for the found in arrest group, a statistically significant difference was observed in initial outcome ($p = 0.001$), with paramedic patients doing better (26.3 per cent surviving to admission, vs. 7.9 per cent for the EMA II patient group). This also meets the criterion for significant difference in practical terms. This difference on the initial survival outcome did not appear for the group of patients who arrested during attendance by ambulance personnel, indicating that for this patient group at least, EMA IIs who can transport patients rapidly to definitive care at local hospitals may provide a useful service. Since, however, there can be no service control over the likelihood of the patients' arresting during attendance of ambulance staff, rather than arresting before they arrive, this finding has few service planning implications. Mention should perhaps be made of the fact that a widespread public education campaign which was aimed at informing people of the signs and symptoms of heart attacks, of whom to call for help when such an incident occurs, and of the need for lay people to be trained to provide CPR,
might result in ambulances being called earlier for heart attack victims which would tend to give patients greater chances of successful outcomes from such incidents. It may well, however, also result in more inappropriate calls tying up ambulances which would better be sent to other emergencies!

Significant differences were found between EMA II and EMA III patient groups on the basis of time to definitive care, but as was pointed out in Chapter V, this is so almost by definition.

**RESEARCH QUESTION 2**

Are there significant differences in the proportions of patients discharged alive from hospital between the group treated by EMA IIIs only and the group treated by EMA IIIIs only or a combination of IIIIs and IIIs?

Data from this study indicate that there are only marginally significant differences between EMA II patients and EMA III patients on this final outcome measure (p. = 0.10). Though the observed differences (5.6 per cent of total EMA II treated group discharged alive and 12.7 per cent of total EMA III treated group discharged alive) do not meet the criterion of a 10 per cent difference in outcome for practical significance, twice as many paramedic patients were discharged alive from hospital as EMA II patients. Paramedic performance in this study was similar to that observed in three of the five studies critiqued in some detail in Chapter II in terms of percentage of total paramedic patient group discharged alive from hospital: Diamond, Schofferman, and Elliot (1977)—13 per cent; Lauterbach, Spadafora, and Levy
(1978)--15 per cent; Libethson, Nagel, Hirschman, and Nussenfeld (1974)--14 per cent. It is also similar to results from the first two years of the study by Cobb, Baum, Alvarez, and Schaffer (1975)--11 per cent, though lower than their 23 per cent success rate for the second two-year period, and lower than the (17%/24%/19%) rates from the study by Eisenberg, Bergner, and Hallstrom (1980a).

When final outcome was determined for found in arrest and arresting during attendance patients by type of responding attendant (Appendix E, Tables IV and V), significant differences in final outcome favoring the EMA III group were found for those found in arrest (p. = 0.03), but not for those arresting during attendance (p. = 1.0).

The number of patients in this study who were discharged alive is small, and results may have been colored by such things as EMA II error in not recognizing serious rhythm disturbances in patients who subsequently arrest, and other important differences which were not addressed in this study; for example, morbidity differences resulting from aggressive intervention by emergency response personnel: damage done while administering CPR, administration of oxygen to patients in such a fashion that further problems develop, etc. (Agdal & Jorgensen, 1973; Atcheson & Fred, 1975; Caroline, 1975; Jeong & Caccamo, 1975; McIntyre, Parisi, Benfari, et al., 1977; Patterson, Burns, & Jannotta, 1973; Stewart, 1977). No measurement was made of whether or not a more seriously ill group of patients was delivered alive to the hospital by EMA IIs.
No assessment of hospital differences beyond availability of a coronary care unit and an emergency department which was open 24 hours a day was undertaken, and, clearly, other hospital differences could well have an impact on final outcomes for cardiac arrest patients. It is obvious that a number of intervening variables which might have a role to play in how likely it is that a given patient will be discharged alive from hospital after a cardiac arrest have little or nothing to do with how well the ambulance personnel complete their treatment of cardiac arrest victims, but do have an impact on final outcome measures.

If the question is, "Do EMA IIs save a higher proportion of the cardiac arrest victims whom they treat than do EMA IIs?", then the answer appears to be "yes", particularly for those patients (the vast majority) who are found in arrest.

OTHER VARIABLES EXAMINED

Time in Arrest Without CPR

Although no significant differences were found in median time in arrest without CPR for EMA II and EMA III patients, this time in arrest without CPR did prove to be very significantly different between those who lived and those who died, both initially at admission to hospital (p = 0.00) and at discharge alive (p = 0.01). Given this finding, there are a number of ways to attack the problem of reducing time in arrest without CPR. One is to reduce the time it takes emergency response personnel from whichever service, Fire Department, Police Department, or Provincial Ambulance Service, to
reach the scene and to begin CPR. A far less costly alternative might be to teach more lay people how to perform CPR and how important it is that this be started quickly when a cardiac arrest occurs. Cobb et al. (1976) reported that the cost of such education courses at that time was a total of $1.25 (U.S.) for each student, though courses in CPR offered in Vancouver to the general public in recent years have charged from $15 to $20 per student. If this is, indeed, an accurate estimate of the real costs of teaching citizen CPR, then perhaps such courses would be better targeted at relatives of those at high risk for heart attacks. Cost, however, in this case need not be a matter of prime concern for planners except insofar as cost reduces the numbers of people willing to take training, since fees are paid by those enrolling in the course, rather than from the public purse.

Another issue arises when the importance of availability of bystander CPR is discussed. Pantridge and Adgey as early as 1969 noted that without regular practice, ability to perform effective CPR deteriorates rapidly after the completion of training. Some, however, believe that the critical thing is early initiation of CPR by bystanders before arrival of emergency response personnel, regardless of how well or how poorly it is performed (verbal communication: L. Vertesi, 1982).

**Time To Definitive Care**

Time to definitive care was, by definition, different for paramedic and non-paramedic patient groups. However it is only
when impact of time to definitive care on outcomes is examined that the substantial difference quite small amounts of time make becomes apparent. From Table VIII in Chapter V it can be seen that the difference in median times between those who were admitted alive and those who died before admission was 2.4 minutes. A difference of 2.6 minutes was observed for those dying at any time compared to those discharged alive from hospital.

A shortcoming of this particular study is that the time variable is taken from when the call is received by the dispatch office, rather than from when the incident occurs, and what is important for the patient is the time lapse between when the incident occurs and the time he receives definitive care for the problem. For other evaluations of the Provincial Ambulance Service it will be important to devise a method for more accurate determination of time from onset of symptoms to time at which the intervention of interest takes place. If a more accurate measure of time from onset to various key interventions can be achieved, then more useful findings can be generated and analyzed:

The lack of discriminating time measurement could partially explain the wide variation in reported discharge rates: 6% to 24%....Presenting a summary discharge rate obscures the importance of times. By stratifying time and measuring outcome, the critical relationship between time and outcome emerges. (Eisenberg et al., 1979a, p. 1907)

Although it appears that a short time to initiation of CPR does buy time for the patient, it has to be coupled with a relatively short time to definitive care if the patient is to survive. Neither factor alone is sufficient.
A few options exist for reducing time to definitive care for patients. Increasing the number of ambulances available to rush cardiac arrest victims to the hospital would tend to reduce the time to definitive care for EMA II patients, but at a high cost to the taxpayer. The option of increasing the number of paramedic vehicles so that paramedics can provide definitive care to a higher proportion of the cardiac arrest victims who need it is a still more costly one. Furthermore, this latter action would tend to reduce the number of such calls handled by each paramedic, and it has been suggested that this would result in deterioration of the skills necessary to intervene successfully in cardiac arrest events (Bergner et al., 1981).

Where local conditions do not permit establishment of a paramedic service, improved outcomes for cardiac arrest patients might be achieved by having regular ambulance personnel trained to recognize the circumstances under which defibrillation is appropriate and in such circumstances, administer it (Eisenberg, Copass, Hallstrom, Blake, et al., 1980c). For this to be a viable alternative, however, a relatively short time from patient collapse to arrival of the defibrillator-trained ambulance personnel is essential.

Witnessed Arrests

In order to shorten critical time periods, it is important to

*** Refer to Appendix A, Part 2 for an estimate of the cost of running a single EMA II and a single EMA III vehicle in the Lower Mainland of British Columbia for one year.
have the collapse either witnessed or heard. In this study, although an attempt was made to collect information about whether or not a collapse had been witnessed, the information was not recorded with any regularity. Any further research on this subject should involve stressing to participants that this is a particularly useful variable for interpreting results, and should be recorded regularly and accurately.

Course While in Hospital for Those Admitted Alive

It is interesting to find that the course while in hospital never proved to be significantly different, whatever the two groups compared. For each pairing of groups, roughly the same proportion of patients died in hospital and were discharged alive.

Since this study did not attempt to assess variables such as severity of illness of patients, or prior medical history, it is impossible to know whether or not the paramedic patients admitted to hospital were generally more seriously ill than EMA II patients admitted alive. However it seems reasonable to assume either that the two groups were equally ill, or that the paramedics were able to deliver a more seriously ill group of patients alive to the hospital. If the two patient groups were equally ill, then the finding of similar courses of illness while in hospital is as expected. If, however, the EMA III patients were more seriously ill, then it appears that in spite of this, once they were admitted to a ward or special unit they had about the same chance of being discharged alive as did patients from a less ill group.
Length of Hospitalization

Although the median length of hospitalization for EMA III patients discharged alive from hospital was approximately five days longer than for EMA II patients discharged alive, this difference did not prove to be significant (p. = 0.59). Paramedic patients who eventually died in hospital did live longer than similar EMA II patients, but the differences were small, as discussed earlier. In this study paramedics did not transport patients to hospital who lived long enough to use substantially more resources before they died than did EMA II patients who died in hospital.

For the study group as a whole, patients who were discharged alive spent significantly longer in hospital (p. = 0.00) than did those who died in hospital (Appendix E, Table XII), but this is as expected. The median length of hospitalization for patients eventually discharged alive from hospital after an out-of-hospital cardiac arrest was 16.0 days.

CONCLUSIONS AND EVALUATION OF THE STUDY

This study found significant differences, statistically and practically, in outcomes on admission to and discharge from hospital for EMA III patients who suffered an out-of-hospital cardiac arrest, compared to outcomes for a similar group of patients treated by EMA II s, with a larger proportion of paramedic patients surviving.

This documentation of success with a limited section of the patient population served by the advanced life support program in
British Columbia is only the first of a series of steps which should be taken if the program as a whole is to be evaluated. For this reason, the study provides only a limited amount of the information which is needed by program planners and administrators.

Some of the shortcomings of this study have been mentioned during discussion of specific findings, but others which have not been identified are relevant:

- It has been impossible to assess what impact the EMA II cases which were lost because of lack of participation by two stations and because of difficult labor negotiations would have had on study findings.

- Important variables such as differences in socioeconomic status and age distribution of the populations in the study and comparison areas were not measured.

- Time from onset of patient symptoms until arrival of ambulance service personnel, or until definitive care was received, was not available.

- No assessment of level of function for patients who were discharged alive from hospital was undertaken.

- While the group of paramedics participating in the study were experienced and no new paramedics joined crews during the course of the study, no measure was taken of the experience levels of the EMA IIIs working in the Lower Mainland during the study.

- While it is believed that virtually all cases involving potentially salvageable cardiac arrest victims which occurred in
the Lower Mainland would be handled by personnel from the Provincial Ambulance Service, no independent assessment of the validity of this assumption was undertaken.

- The many intangible benefits discussed in the literature review section have not been measured and/or attributed to the paramedic program.

- Only a gross estimate of the cost of operating a paramedic vehicle compared to operating an EMA II vehicle has been included (see Appendix A, Part 2). No measurement of indirect cost has been undertaken, and no attempt has been made to apportion a certain amount of the identified costs to provision of services to cardiac arrest victims. Both direct and indirect costs (including opportunity costs associated with having an advanced life support program), and direct and indirect benefits should be measured, so that comparison of results and costs can be made.

- The focus of the advanced life support program has changed over time in recognition of the fact that paramedics must deal with a much broader range of life-threatening conditions than was first envisioned, but this study deals with only a small subset of the cardiac care which it was earlier felt would comprise much of their caseload.

This is an evaluation of a single small component of paramedic work today, and results must be considered in light of this fact.

**DIRECTIONS FOR FUTURE RESEARCH**

In order to more appropriately evaluate the paramedic program
in British Columbia so that the necessary information for planners and administrators is generated, a much broader, and therefore much more difficult, research project would have to be conducted.

In such an evaluation project the main areas of activity for advanced life support personnel today would be identified, and an assessment made of performance in each of them.

Two areas which would likely be identified for study are treatment of all cardiac patients, and treatment of trauma victims. Within each of these areas, patients treated could be grouped, for example, into "mild", "moderate", and "seriously ill" categories, before comparison with similar groups of patients treated only by regular ambulance attendants was undertaken. Expected outcomes for each of the patient groups would be identified, and criteria for significant differences in outcome measures, both in statistical and in practical terms, would be established. Skill levels, or at least training and years of experience, would be measured for EMA IIs and EMA IIs participating in the study. Patients treated by EMA IIs and EMA IIs would be compared on such variables as age, sex, socio-economic status, and prior medical condition. Hospital differences should be identified so that these differences can be considered in relation to any outcome differences found for patients. Time variables which are measured should be related to the time of onset of patient symptoms, rather than to the time at which the call was received at dispatch. Measurement of level of functioning for patients leaving the hospital should be undertaken. Costs, both direct and indirect, of running both the advanced life support and
regular ambulance programs should be identified, so that outcomes can be assessed in relation to costs of providing a specific type of service.

Clearly such a research project goes far beyond what was accomplished in this study. However, it is very encouraging that program administrators and service providers were willing to have an outsider examine the highly visible Provincial Ambulance Service for purposes of evaluation. For it is only with information from such real-life research that planners and administrators can make informed decisions about existing programs and new directions in the provision of health care services.
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Smith, Carson. Verbal communication, 1982 with the Executive Director of the Emergency Health Services Commission in British Columbia.


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APPENDIX A

Part 1

Advanced Life Support is basic life support plus use of adjunctive equipment, intravenous fluid lifeline (infusion), drug administration, defibrillation, stabilization of the victim by cardiac monitoring, control of arrhythmias, and postresuscitation care. Also it includes establishing necessary communication to ensure continuing care, and maintaining monitoring and life support until the victim has been transported and admitted to a continuing care facility. Advanced life support requires the general supervision and direction of a physician who assumes responsibility for the unit. It must have adequate communications on a 24-hour-per-day basis. This may necessitate appropriate legislation or standing orders for implementation (Standards for Cardiopulmonary Resuscitation, 1974, pp. 838-839).

Part 2

The Emergency Health Services Commission has determined that ten people are required to staff a single EHS vehicle providing service 168 hours a week, considering sick time, holidays and education days. An EMA III vehicle required support by an EMA II vehicle, and therefore takes a portion of the EMA II vehicle out of service from the point of view of the ambulance service as a whole. It is therefore deemed appropriate to add to the cost of operating the EMA III vehicle a portion of the cost of operating the EMA II vehicle which supports it. See page 2 for these calculations.
ESTIMATED COST IN 1981-1982 DOLLARS OF OPERATING A SINGLE EHS VEHICLE FOR 1 YEAR **

<table>
<thead>
<tr>
<th>COSTS</th>
<th>EMA III VEHICLE</th>
<th>EMA II VEHICLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel:</td>
<td>$410,000</td>
<td>$330,000</td>
</tr>
<tr>
<td>- 10 people per vehicle, plus employee benefits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Operation &amp; Support:</td>
<td>75,000</td>
<td>60,000</td>
</tr>
<tr>
<td>- administrative and dispatch services; maintenance; gas; drugs; depreciation, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuing Education:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 10 staff, overtime payment</td>
<td>6,000</td>
<td>3,200</td>
</tr>
<tr>
<td>- direct continuing education costs</td>
<td>6,250</td>
<td>1,000</td>
</tr>
<tr>
<td>Monitoring Physician and Emergency Medical Council:</td>
<td>10,880</td>
<td>--</td>
</tr>
<tr>
<td>Miscellaneous Costs:</td>
<td>12,500</td>
<td>12,500</td>
</tr>
<tr>
<td>Total:</td>
<td>$520,630</td>
<td>$406,700</td>
</tr>
</tbody>
</table>

To the cost of operating the EMA III vehicle, however, is added eighty-five per cent of the cost of operating the EMA II vehicle which provides support to it.

TOTAL COST OF OPERATING AN EMA III VEHICLE FOR 1 YEAR: (ESTIMATE)

EMA III Vehicle Cost $520,630 + .85 EMA II Vehicle Cost 345,695 TOTAL: $866,325

TOTAL COST OF OPERATING AN EMA II VEHICLE FOR 1 YEAR: (ESTIMATE)

TOTAL: $406,700

** Based on personal communication: Mr. Carson Smith, Executive Director, Emergency Health Services Commission, 1982.
<table>
<thead>
<tr>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Service</td>
<td>Day, Month, Year</td>
</tr>
<tr>
<td>Patient's Surname</td>
<td>Street Address</td>
</tr>
<tr>
<td>City or Town</td>
<td>Province</td>
</tr>
<tr>
<td>Billing Status</td>
<td>Car No.</td>
</tr>
<tr>
<td>Transport Time</td>
<td>Km Readings</td>
</tr>
<tr>
<td>Attending Physician</td>
<td>Escort Name</td>
</tr>
<tr>
<td>Other Treatments</td>
<td>Patient Deposition</td>
</tr>
</tbody>
</table>

**Medical Condition**
- Arrhythmia
- Bradycardia
- Hypertension
- Stroke
- Shock
- Heart Failure
- Other

**Symptoms**
- Sepsis
- Septic Shock
- Shock
- Other

**Signs**
- Pulse
- Respiration
- Blood Pressure
- Temperature
- Other

**Vital Signs**
- Time
- Level of Consciousness
- Temp.
- Pulse
- Respiration
- Blood Pressure
- Other

**Position Found In**
- Casualty Scene
- Home
- Other

**Position Found On**
- Casualty Scene
- Home
- Other

**Transport Location or Body Part**
- Brain
- Torso
- Limb
- Other

**Treatments**
- CPR
- Intubation
- IV
- Other

**Scene**
- Location
- Time
- Other

**Office Use Only**
- Basic Amount
- Distance Charge
- Time Charge
- Sub-Total
- Adjustments
- Final Amount

**Commission - Data Entry**
<table>
<thead>
<tr>
<th>Date:</th>
<th>Station:</th>
<th>Dispatch No.:</th>
<th>Cardiac Arrest Case:</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surname:</th>
<th>Given Name:</th>
<th>Sex</th>
<th>D.O.B.</th>
<th>Sex</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Chief Complaint** (check only one):
- Chest Pain
- S.O.B.
- Palpitations
- Collapse
- Other: [specify]  

**Other Symptoms**

**History Relevant to This Illness**

**Past Medical History**

**Medications**

**Initial Vital Signs**:
- BP
- Heart Rate
- Respiration Rate

**Level of Consciousness**
- Fully alert
- Semi-alert
- Unconscious, but responsive to pain
- Unconscious - no response to pain

**Skin Color**
- Normal
- Flushed
- Pale
- Cyanosed

**Pulse**
- Strong pulse
- Easily palpable, but weak
- Barely palpable
- None palpable

**Provisional Diagnosis**
- Suspected acute MI
- Suspected pulmonary edema
- Suspected cardiac arrhythmia
- Cardiac arrest
- Other (specify)

**Procedures Performed**
- O. by mask
- Ambubag ventilation
- CPR
- Other (specify)

**Name of Arrival Hospital**

Prior Notification Made:
- Yes
- No

**Condition on Arrival at Hospital**:
- BP
- Heart Rate
- Respiration Rate

**Level of Consciousness**
- Fully alert
- Semi-alert
- Unconscious, but responsive to pain
- Unconscious - no response to pain

**Skin Color**
- Normal
- Flushed
- Pale
- Cyanosed

**Pulse**
- Strong pulse
- Easily palpable, but weak
- Barely palpable
- None palpable

**Disposition**
- Admitted to Emergency
- Direct Hospital Admission
- D.O.A.

**CPR being done on admission?**
- Yes
- No

**For Cardiac Arrest Cases Only**
- CPR done before EMA II arrival: [check one or more of these]
  - by lay person
  - by Fire Dept.
  - by health professional

**Effective CPR**
- Yes
- No

- No CPR being done before EMA II arrival
- Estimated time in arrest before EMA II arrival
- Estimated time in arrest prior to any CPR
- Aspirated?

This patient was:
- found in arrest
- Was the arrest observed by anyone?
- Yes
- No
- arrested during attendance

**Presumed Cause of Arrest**:
- Cardiac
- Traumatic
- Overdose
- Other (specify)

**EMA II Attendant** (signed)

[Print name]
### APPENDIX C - PART 2
### CARDIAC ARREST DATA SHEET

#### INFORMATION

<table>
<thead>
<tr>
<th>CARD COLUMN</th>
<th>INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Case No.: __________</td>
</tr>
<tr>
<td></td>
<td>Date: _______________</td>
</tr>
<tr>
<td></td>
<td>Hospital: _______________</td>
</tr>
<tr>
<td></td>
<td>Name: _______________</td>
</tr>
<tr>
<td></td>
<td>Age: _______________</td>
</tr>
<tr>
<td></td>
<td>Sex: ____ (M=1, F=2)</td>
</tr>
<tr>
<td></td>
<td>EMA II: ____ EMA III: ____ Double: ____ Secondary: ____</td>
</tr>
<tr>
<td></td>
<td>(2) (3) (4) (5) Unk: ____ (9)</td>
</tr>
<tr>
<td></td>
<td>Station No.: __________</td>
</tr>
<tr>
<td></td>
<td>Dispatch No.: __________</td>
</tr>
<tr>
<td></td>
<td>Time Received: __________</td>
</tr>
<tr>
<td></td>
<td>1007 (0) __________</td>
</tr>
<tr>
<td></td>
<td>Time from call to definitive treatment: _____ Mins. ____ No</td>
</tr>
<tr>
<td></td>
<td>CPR being done on arrival? ____ (Y=1, N=2, Unk=9 info. Not Applicable = 8)</td>
</tr>
<tr>
<td></td>
<td>By whom? ____ (lay person=1, Fire Dept. =2, health profn1.=3 other=4, Unk.=9, Not Applicable=8)</td>
</tr>
<tr>
<td></td>
<td>Effective CPR? ____ (Y=1, N=2, No info.=9, Not appl.=8)</td>
</tr>
<tr>
<td></td>
<td>Estimated time in arrest before EMA arrival: _____ Mins. (No info.=999, Not applicable=888)</td>
</tr>
<tr>
<td></td>
<td>Estimated time in arrest before any CPR: _____ Mins. (No info.=999, Not applicable=888)</td>
</tr>
<tr>
<td></td>
<td>Aspirated?: ____ (Y=1, N=2, No. info.=9)</td>
</tr>
<tr>
<td></td>
<td>Patient was: ____ (found in arrest=1, arrested durg attend=2)</td>
</tr>
<tr>
<td></td>
<td>Arrest witnessed? ____ (Y=1, N=2, No info.=9, Unk.=9)</td>
</tr>
<tr>
<td></td>
<td>Presumed cause of arrest: ____ (Cardiac=1, Traumatic=2, Overdose=3, Other=4, Unk.=9)</td>
</tr>
<tr>
<td></td>
<td>Patient disposition: ____ (DOA=1, Admitted Emerg.=2, Direct Hospital Admission=3, Unk.=9)</td>
</tr>
</tbody>
</table>

#### HOSPITAL INFORMATION

|             | ER Diagnosis: ____ (Cardiac=1, Other=2, Unk.=9) |
|             | ER Disposition: ____ (Died in ER=1, Admitted ICU/CCU=2, Other=3, Unk.=9) |
|             | In-Hospital Course: ____ |
|             | Died in Hospital=1 Date: __________ |
|             | Discharged Alive=2 Date: __________ |
|             | Length of Hospitalization in days: __________ |
### APPENDIX E

#### TABLE I: NUMBER AND PERCENTAGE DISTRIBUTION OF AGES OF STUDY PATIENTS BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>AGE</th>
<th>EMA II</th>
<th>EMA III</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>50</td>
<td>6 (6.7)</td>
<td>21 (9.3)</td>
<td>27 (8.5)</td>
</tr>
<tr>
<td>50-69</td>
<td>44 (48.9)</td>
<td>105 (46.5)</td>
<td>149 (47.2)</td>
</tr>
<tr>
<td>70</td>
<td>40 (44.4)</td>
<td>100 (44.2)</td>
<td>140 (44.3)</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>226</td>
<td>316</td>
</tr>
</tbody>
</table>

\[ X^2 = 0.60 \]
\[ p = 0.74 \]

#### TABLE II: NUMBER AND PERCENTAGE DISTRIBUTION BY SEX OF STUDY PATIENTS BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>SEX</th>
<th>EMA II</th>
<th>EMA III</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Male</td>
<td>66 (73.3)</td>
<td>162 (69.5)</td>
<td>228 (70.6)</td>
</tr>
<tr>
<td>Female</td>
<td>24 (26.7)</td>
<td>71 (30.5)</td>
<td>95 (29.4)</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>233</td>
<td>323</td>
</tr>
</tbody>
</table>

Corrected \[ X^2 = 0.29 \]
\[ p = 0.59 \]

#### TABLE III: NUMBER AND PERCENTAGE DISTRIBUTION BY TIME OF DAY OF INCIDENT FOR STUDY PATIENTS BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>TIME OF DAY</th>
<th>EMA II</th>
<th>EMA III</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Day (0800 - 1800)</td>
<td>48 (52.7)</td>
<td>144 (61.8)</td>
<td>192 (59.3)</td>
</tr>
<tr>
<td>Night (1801 - 0759)</td>
<td>43 (47.3)</td>
<td>89 (38.2)</td>
<td>132 (40.7)</td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>233</td>
<td>324</td>
</tr>
</tbody>
</table>

Corrected \[ X^2 = 1.86 \]
\[ p = 0.17 \]
## APPENDIX E

### TABLE IV: NUMBER AND PERCENTAGE DISTRIBUTION OF OUTCOMES FOR STUDY PATIENTS FOUND IN ARREST BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>OUTCOMES</th>
<th>EMA II PATIENTS</th>
<th>EMA III PATIENTS</th>
<th>STATISTICAL TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>- Initial Outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admitted Alive to Ward/Special Unit</td>
<td>6 (7.9)</td>
<td>55 (26.3)</td>
<td>Corrected $X^2 = 10.2$</td>
</tr>
<tr>
<td>Died Before Admission</td>
<td>70 (92.1)</td>
<td>154 (73.7)</td>
<td></td>
</tr>
<tr>
<td><strong>- Course in Hospital for Patients Admitted Alive</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died in Hospital</td>
<td>4 (66.7)</td>
<td>31 (55.4)</td>
<td>Fisher's Exact</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>2 (33.3)</td>
<td>25 (44.6)</td>
<td></td>
</tr>
<tr>
<td><strong>- Final Outcome (Total Patient Group)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died At Any Time</td>
<td>74 (97.4)</td>
<td>183 (88.0)</td>
<td>Corrected $X^2 = 4.7$</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>2 (2.6)</td>
<td>25 (12.0)</td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX E

#### TABLE V: NUMBER AND PERCENTAGE DISTRIBUTION OF OUTCOMES FOR STUDY PATIENTS ARRESTING DURING ATTENDANCE BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>OUTCOMES</th>
<th>EMA II PATIENTS</th>
<th>EMA III PATIENTS</th>
<th>STATISTICAL TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td></td>
</tr>
<tr>
<td>- Initial Outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admitted Alive to Ward/ Special Unit</td>
<td>4 (28.6)</td>
<td>10 (47.6)</td>
<td>Corrected $X^2 = 0.6$</td>
</tr>
<tr>
<td>Died Before Admission</td>
<td>10 (71.4)</td>
<td>11 (52.4)</td>
<td>$p = 0.44$</td>
</tr>
<tr>
<td>- Course in Hospital for Patients Admitted Alive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died in Hospital</td>
<td>1 (25.0)</td>
<td>5 (55.6)</td>
<td>Fisher's Exact $p = 0.39$ (two-tailed)</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>3 (75.0)</td>
<td>4 (44.4)</td>
<td></td>
</tr>
<tr>
<td>- Final Outcome (Total Patient Group)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died At Any Time</td>
<td>11 (78.6)</td>
<td>16 (80.0)</td>
<td>Fisher's Exact $p = 1.0$ (two-tailed)</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>3 (21.4)</td>
<td>4 (20.0)</td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX E

**Table VI:** Time in arrest without CPR by type of responding attendant: mean time/mean time for log-transformed data and t-test on log-transformed data means

<table>
<thead>
<tr>
<th>MEAN</th>
<th>LOG-TRANSFORMED DATA MEAN</th>
<th>STATISTICAL TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMA II</td>
<td>5.7</td>
<td>1.8</td>
</tr>
<tr>
<td>EMA III</td>
<td>5.5</td>
<td>1.7</td>
</tr>
</tbody>
</table>

**Table VII:** Mean times and skew for time in arrest without CPR by type of responding attendant for original and log-transformed data

- **EMA II**
  - Mean: 5.7  Skew: 0.7
  - Mean on log-transformed data: 1.8  Skew: -0.6

- **EMA III**
  - Mean: 5.5  Skew: 0.7
  - Mean on log-transformed data: 1.7  Skew: -0.7
APPENDIX E

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>HOSPITAL WITH CCU</th>
<th>HOSPITAL WITHOUT CCU</th>
<th>STATISTICAL TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admitted Alive to Ward/ Special Unit</td>
<td>66 (25.6)</td>
<td>9 (19.1)</td>
<td>Corrected $X^2 = 0.57$</td>
</tr>
<tr>
<td>Died Before Admission</td>
<td>192 (74.4)</td>
<td>38 (80.9)</td>
<td>$p = 0.45$</td>
</tr>
<tr>
<td>Course in Hospital for Patients Admitted Alive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died in Hospital</td>
<td>37 (56.1)</td>
<td>4 (44.4)</td>
<td>Fisher's Exact</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>29 (43.9)</td>
<td>5 (55.6)</td>
<td>$p = 0.72$ (two-tailed)</td>
</tr>
<tr>
<td>Final Outcome (Total Patient Group)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died At Any Time</td>
<td>227 (88.7)</td>
<td>42 (89.4)</td>
<td>Corrected $X^2 = 0.0$</td>
</tr>
<tr>
<td>Discharged Alive</td>
<td>29 (11.3)</td>
<td>5 (10.6)</td>
<td>$p = 1.0$</td>
</tr>
</tbody>
</table>
### APPENDIX E

#### TABLE IX: MEDIAN TIME TO DEFINITIVE CARE FOR STUDY PATIENTS BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>Type of Responding Attendant</th>
<th>Median Time (in minutes)</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMA II Patients</td>
<td>20.0</td>
<td>Mood Median $X^2 = 129.9$</td>
</tr>
<tr>
<td>EMA III Patients</td>
<td>7.3</td>
<td>p = 0.00</td>
</tr>
</tbody>
</table>

#### TABLE X: MEDIAN LENGTH OF HOSPITALIZATION FOR STUDY PATIENTS DISCHARGED ALIVE BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>Type of Responding Attendant</th>
<th>Median Length (in days)</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMA II Patients</td>
<td>20.5</td>
<td>Mood Median $X^2 = 0.29$</td>
</tr>
<tr>
<td>EMA III Patients</td>
<td>15.3</td>
<td>p = 0.59</td>
</tr>
</tbody>
</table>
### APPENDIX E

#### TABLE XI: MEDIAN LENGTH OF HOSPITALIZATION FOR STUDY PATIENTS WHO DIED IN HOSPITAL BY TYPE OF RESPONDING ATTENDANT

<table>
<thead>
<tr>
<th>Type of Responding Attendant</th>
<th>Median in Days</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMA II Patients</td>
<td>1.1</td>
<td>Mood Median $X^2 = 2.63$</td>
</tr>
<tr>
<td>EMA III Patients</td>
<td>2.5</td>
<td>$p. = 0.11$</td>
</tr>
</tbody>
</table>

#### TABLE XII: MEDIAN LENGTH OF HOSPITALIZATION FOR STUDY PATIENTS WHO DIED IN HOSPITAL COMPARED TO STUDY PATIENTS WHO WERE DISCHARGED ALIVE

<table>
<thead>
<tr>
<th>Condition</th>
<th>Median in Days</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients Who Died in Hospital</td>
<td>2.1</td>
<td>Mood Median $X^2 = 26.2$</td>
</tr>
<tr>
<td>Patients Discharged Alive</td>
<td>16.0</td>
<td>$p. = 0.00$</td>
</tr>
</tbody>
</table>