OUT OF HOSPITAL CARDIAC ARREST IN SASKATOON: 
AN ASSESSMENT OF THE EMERGENCY MEDICAL SYSTEM 

By 

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We accept this thesis as conforming 
to the required standard 

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Abstract

The question addressed in this thesis is should the City of Saskatoon, Saskatchewan develop an emergency medical system (EMS) specifically designed to deal with out-of-hospital cardiac arrest?

In order to answer this question, a series of subsidiary questions must be dealt with, as follows:

1. Can an EMS provide real health gains in terms of decreased morbidity and mortality from cardiac arrest?

2. What are the components of an EMS that are required to achieve this decrease in morbidity and mortality?

3. Is the community in question typical for cardiac arrest in terms of sociodemographic, morbidity, and mortality patterns, or sufficiently different from population data in the published literature that the EMS will be required to accommodate the differences?

4. How important a cause of morbidity and mortality is cardiac arrest, and will it become a greater or a lesser problem in the next decade?

5. Is the establishment of such a service an effective way of reducing morbidity and mortality from cardiac arrest, or are there ways of dealing with cardiac arrest that will have more impact?
The province of Saskatchewan and the City of Saskatoon are attempting to deal with these issues in order to develop long range plans for an effective and affordable ambulance service for both the province and the larger cities.

The causes and extent of sudden cardiac death in Canada and in Saskatoon are described from reports in the existing scientific literature and local death registry data. The epidemiology of coronary heart disease (CHD) and the impact on mortality from CHD by an array of primary, secondary and tertiary preventive interventions are presented in order to provide a context from which the most appropriate approach for Saskatoon may be chosen.

Highly developed EMS's in North America are described from published reports. Their impact on mortality is analysed, with particular attention paid to recent developments which appear most promising for Saskatoon and area. Features of the system which is currently operating in Saskatoon are drawn from data in the annual reports of the Saskatoon and Area Ambulance Board from 1980 to 1983.

Recommendations based on the compiled data are specific to Saskatoon and area and are related to the needs, existing services and structures, and available resources in that community.
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I am very pleased to be able to express my thanks to the members of my thesis committee for their encouragement and advice.

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My association with these advisors has radically changed my understanding of health and health care, and I owe them a great debt of gratitude.

Any errors, and the limitations of this study are solely my responsibility.

October 1984

Lorna Medd
Chapter I  Statement of the Problem and Background

The question dealt with in this thesis is should the City of Saskatoon, Saskatchewan develop an emergency medical service system (EMS) designed specifically to deal with out-of-hospital cardiac arrest?

The question cannot be answered until a series of subsidiary but necessary questions are first addressed.

1. Can an EMS be expected to provide real health gains in terms of decreased morbidity and mortality from cardiac arrest?

2. What are the components of an EMS that are required to achieve this decrease in morbidity and mortality?

3. Can a city with a population of 170,000 support a service that fulfills these requirements?

4. How important a cause of morbidity and mortality is cardiac arrest, and will it become a greater or a lesser problem in the next decade?

5. Is the establishment of such a service an effective way of reducing morbidity and mortality from cardiac arrest, or are there ways of dealing with cardiac arrest that will have more impact?
Efforts to resuscitate the dead are as old as history itself, and the resuscitation techniques of many cultures and eras have been documented. Sudden cardiac death has been depicted in Egyptian relief sculpture from the tomb of a noble of the Sixth Dynasty, approximately 4500 years ago. Mouth to mouth resuscitation is described in the Bible (II Kings 4 (34) King James Version) and there have been historical attempts to revive an individual electrically.

The institutionalization of resuscitation in contemporary terms began in the 1960's with the advent of coronary care units (CCU). In 1967 Pantridge and Geddes published a landmark paper describing mobile coronary care units ("flying squads") operating in the streets of Belfast. A rapid and widespread evolution of similar emergency medical response systems followed immediately. These systems were directed toward preventing deaths from coronary heart disease (CHD) which at that time had reached the peak of its epidemic curve. The modern origins of out-of-hospital emergency medical services (EMS) are thus inextricably linked to sudden death from cardiac disease.

EMS has come to be defined as programs that deliver definitive care for cardiopulmonary arrest (CPA) in the field. Although there are other applications for EMS, cardiac patients remain the single largest user group. Non-cardiac arrest uses of emergency medical services will not be addressed in the paper.
A fully developed EMS system is large, technologically complex and costly. Its components include a mechanism for rapid access to the system, usually a universal emergency number such as 911; citizens trained to deliver CPR; first response units staffed with personnel trained and effective in delivering basic life support (BLS); paramedic units with more highly trained staff able to deliver the wider range of services (many of them physician-delegated) that comprise advanced cardiac life support (ACLS). Examples of ACLS techniques include defibrillation, establishment of intravenous lines, EKG interpretation and drug administration.

Because time is so crucial a factor in a successful response and because of the technologically sophisticated support systems required, EMS works best in large metropolitan areas. Rural communities have rarely been considered appropriate sites for paramedic units, although the inequity of establishing an EMS for a city but not for nearby smaller communities is an important issue.

When specific questions about developing an EMS are posed, there are two major obstacles that prevent the development of complete answers. The first is the scarcity of reliable supporting data. Research into and evaluation of emergency medical services as one component of the health care system has intensified, but until recently the quality and quantity of the data have not been adequate to provide a basis for making informed judgments on the utility of the
The second obstacle is the sheer force of the emotional component involved in the provision of emergency ambulance services. Policy planners may be able to deal in the abstract with numbers and quality of lives saved by competing systems, but one television clip of an ambulance at the scene of a collapse, lights flashing, with paramedics resuscitating an individual on the pavement can overpower reasoned judgment in the minds of taxpayers. The most rational arguments in favor of preventing such a scenario instead of dealing with it after-the-fact go by the board.

This study arose from the efforts of the Saskatoon and Area Ambulance District Board (SAADB) to plan and direct the evaluation of ambulance services in the City of Saskatoon and surrounding rural districts. The Board is developing a plan in concert with efforts by the provincial planning unit, the Ambulance Services Unit, to establish a uniformly adequate EMS across the province of Saskatchewan. In the near future the Board will be dealing with issues of equity of access for rural and urban constituents, the costs and benefits of establishing a 911 system, the optimum level of training for ambulance personnel, sources of funding for salaries if personnel are required to take additional training, and optimal deployment of ambulance units within the District. This paper attempts to provide information that may assist the Board in its deliberations.
Chapter I Notes


Chapter II  Methodology

1. Sources of Data

The epidemiologic features of the group who most need emergency ambulance services are described in Chapter III, The Epidemiology of Cardiac Arrest. This chapter also situates ambulance services within the context of the classical model of levels of prevention (primary, secondary, tertiary) as applied to diseases causing cardiac arrest. It discusses evidence for the primary and secondary prevention of those diseases, including maximum numbers of people in cardiac arrest affected by emergency medical services under ideal situations. Data for this discussion are drawn from the published literature.

Chapter IV describes the development of emergency medical services in general terms from the mid-1960's to the present. The history of the service, the fully developed model as it exists in a few urban centres in the United States, and the impact in terms of length of survival are taken from analyses published in the current literature. The comparative analysis of three Canadian city systems is derived from consultants' studies carried out on behalf of those cities and from discussions with individuals who have observed those systems firsthand.
Chapter V, Emergency Medical Services in Saskatoon, has been developed from documentary data available from provincial and municipal sources. Sociodemographic data has been taken from Neighborhood Profiles, a document published by the City of Saskatoon Planning Department using 1981 Census data and 1983 provincial population figures. The epidemiology of cardiac arrest in Saskatoon is derived from local vital statistics information available from the Saskatoon Community Health Unit and the University of Saskatchewan Department of Social and Preventive Medicine.

The analysis of the operation of the SAADB ambulance system was developed from the Annual Reports 1980-83 of the ambulance district operation. The primary data that form the basis for the reports consist of the individual ambulance run reports, formatted for and analyzed by a computer program developed by Joan Feather of the University of Saskatchewan Department of Social and Preventive Medicine. The program is run by the Hospital Systems Study Group (HSSG) and data processing was carried out by HSSG personnel.

2. Plan of Analysis

The analysis of the data has been structured by Chambers' need/demand-supply model. In this model, need is defined as:
"...services that should be provided to the public on the basis of the perceptions of the experts... This includes interpretation of need for health services on the basis of health status information about target groups."

Need thus includes epidemiological analyses and assessment by "experts" in the field. Demand is defined as:

"...the types and amounts of health services requested or desired by the public once they know the costs and prices involved... Consumers' wants change with additional knowledge of what it will cost (or what alternatives would be foregone) to fulfill them... frequently demand is expressed in public action by informed consumers."

Supply is defined as:

"...a consideration of 'the numbers and distributions of facilities and health personnel relative to the populations they serve,' or a consideration 'of the quality of care provided by these services!"

The Epidemiology of Cardiac Arrest coupled with the Saskatoon data on cardiac arrest, is intended to provide an estimate of need. The description of the components of the system in both general and specific terms represents supply. Demand, or want informed by knowledge of cost, is not easy to typify. In large part this is because the relative costs and benefits of alternatives or options to be foregone are not well understood, and have yet to be elucidated by further research. To complicate the paucity of data, competing interest groups (i.e. cardiologists and community physicians) may present conflicting and opposite pictures of demand
using the fragments of information that are available. A third complicating issue is the fact that in a discussion of this most concrete "life-or-death" issue, rationality becomes clouded by emotion more than it would in more abstract "health" debates.

The final recommendations of the study have evolved from a comparison of need/demand and supply, and seek to identify gaps or overlaps in service. They also address the alternative options for saving lives, which will be foregone if resources are allocated to an EMS.
Chapter II  Notes


Chapter III The Epidemiology of Cardiac Arrest

Coronary heart disease (CHD) is the leading cause of death in the industrialized world. In Canada in 1977 49% of all deaths were due to diseases of the circulatory system. These diseases were also the leading cause of hospitalization and potential years of life lost and were the most significant cause of disability. Diseases of the circulatory system have been identified as the top public health problem in Canada.¹

In the United States in 1978, 985,800 persons died of heart or blood vessel disease (51% of all deaths). Up to 1.5 million people were expected to have heart attacks in 1981 with a resulting 650,000 deaths. 4.3 million living Americans have a history of acute myocardial infarction (AMI), angina or both. For 1981 the projected cost of all cardiovascular disease in the United States was $46.2 billion, not counting losses in management skills, production experience, personnel development and labour.²

In spite of the pervasiveness of this epidemic of heart disease, there has been a remarkable decline in deaths from CHD in recent years. The decline began between 1964-69 but it was not fully appreciated or accepted as real until around 1978. Figure 1 shows trends in age-adjusted death rates due to cardiovascular disease in the United States between 1950-1976. The breaks in the curves represent the
3 major revisions in classification codes of ICDA. The decline has affected all age groups, both sexes, and three ethnic/racial groups.

Between 1968 and 1976 the age-adjusted overall mortality from ischemic heart disease in the United States declined by 20.7%, and by 24% for persons over 85 years of age. If the 1968 death rates had prevailed in 1978, about 114,000 more deaths would have occurred. For the entire decade there
were 568,000 deaths expected that did not occur.\textsuperscript{4}

In Canada between 1969 and 1977, mortality rates for CHD dropped 14\% for males and 21\% for females\textsuperscript{5} - overall 16.4\%.\textsuperscript{6} However, hospitalization rates for the same diseases increased. These findings may be consistent with some improvement in the case fatality rate of individuals hospitalized with myocardial infarction.\textsuperscript{7}

There are some striking differences in the pattern of declining rates across the industrialized nations. Table I shows the ranking of ten industrialized nations experiencing a decline between 1969 and 1977, and 17 industrialized nations showing an increase over the same time period. Among nations with declining rates, Canada ranks third, with a decline somewhat less than the remarkable changes demonstrated in the United States and Australia.
TABLE I

Countries With Decrease or Increase in Rate of Mortality Due to Coronary Heart Disease (men aged 35 to 74 years, 1969 to 1977)

<table>
<thead>
<tr>
<th>Country</th>
<th>1969 Rate</th>
<th>1977 Rate</th>
<th>Difference</th>
<th>% Difference</th>
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<tr>
<td><strong>A. Countries With a Decrease in Rate</strong></td>
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<tr>
<td>United States</td>
<td>864.7</td>
<td>669.5</td>
<td>-195.2</td>
<td>-22.6</td>
</tr>
<tr>
<td>Australia</td>
<td>643.7</td>
<td>683.1</td>
<td>-160.6</td>
<td>-19.0</td>
</tr>
<tr>
<td>Canada</td>
<td>703.3</td>
<td>624.1</td>
<td>-79.2</td>
<td>-11.3</td>
</tr>
<tr>
<td>Israel</td>
<td>653.3</td>
<td>551.0*</td>
<td>-102.3</td>
<td>-15.5</td>
</tr>
<tr>
<td>Norway</td>
<td>582.9</td>
<td>537.1</td>
<td>-45.8</td>
<td>-7.9</td>
</tr>
<tr>
<td>Japan</td>
<td>126.3</td>
<td>102.6</td>
<td>-23.7</td>
<td>-14.8</td>
</tr>
<tr>
<td>Belgium</td>
<td>446.1</td>
<td>426.8*</td>
<td>-19.3</td>
<td>-4.3</td>
</tr>
<tr>
<td>Finland</td>
<td>493.7</td>
<td>676.0*</td>
<td>+182.3</td>
<td>+36.8</td>
</tr>
<tr>
<td>Scotland</td>
<td>613.7</td>
<td>808.6</td>
<td>+195.1</td>
<td>+32.0</td>
</tr>
<tr>
<td>Italy</td>
<td>313.0</td>
<td>305.6*</td>
<td>-7.4</td>
<td>-2.2</td>
</tr>
</tbody>
</table>

| **B. Countries With an Increase in Rate** |           |           |            |              |
| Bulgaria     | 299.3     | 423.5     | +124.2     | +41.5        |
| Poland       | 186.5     | 307.7     | +121.2     | +65.0        |
| North Ireland| 782.4     | 857.1     | +74.7      | +10.8        |
| Rumania      | 170.5     | 237.3     | +66.8      | +38.8        |
| Hungary      | 441.6     | 499.2     | +57.6      | +13.0        |
| Yugoslavia   | 185.0     | 227.6     | +42.6      | +23.0        |
| Sweden       | 522.9     | 560.1     | +37.2      | +6.9         |
| Ireland      | 682.2     | 697.7*    | +5.5       | +0.8         |
| German Federal Republic | 427.3 | 458.1 | +30.8 | +7.2 |
| Austria      | 428.3     | 455.3     | +27.0      | +6.3         |
| New Zealand  | 773.3     | 747.1     | -26.2      | -3.4         |
| Switzerland  | 290.4     | 312.7     | +22.3      | +7.7         |
| Netherlands  | 478.7     | 500.5     | +21.8      | +4.6         |
| France       | 195.2     | 206.9*    | +11.7      | +6.0         |
| Denmark      | 566.1     | 576.3     | +10.2      | +1.8         |
| England and Wales | 662.1 | 671.7 | +9.6 | +1.4 |
| Czechoslovakia | 587.9 | 590.4* | +2.5 | +0.4 |

* 1976 data. † 1975 data.
ICD 410-414, 8th revision.
Rates per 100,000 population are averages of the rates for men aged 35 to 44, 45 to 54, 55 to 64, 65 to 74.

Figure 2 presents these changes in rates for a more select group of nations. In Japan throughout this time period, rates have been consistently low. Australia and the United States began the period with high rates but by the end of the decade the rates were comparable to those in England and Wales, where a small increase had taken place. Developing his argument from the data in the graph, Rose stated that the British are failing to prevent a preventable disease. The question is, what is happening in the United States, Australia and Canada that is not happening in the United Kingdom?

Figure 2. Age-adjusted death rates from CHD among men aged 35-74.

In the nations with significant decreases in mortality, the decline has been large enough and consistent enough that potential artefacts such as changes in completing and coding death certificates are considered inconsequential and the decline from peak rates has been judged as real. However, a fully satisfactory explanation for the decline has not yet been found. Is the reduction a consequence of reduced incidence (fewer people get heart disease, but the same proportion die from it) or increased survival (the same number get heart disease but fewer die, either because the disease is milder or because of improved intervention)? Figures 3a-3d show some of the possible contributions of the various primary and secondary interventions to the decline in coronary mortality. Not unexpectedly, there are strong proponents for nearly every possible contributing intervention.

Stern has reviewed the possible causes of the decline and the evidence for each. There is little information on what is happening to incidence, but Stern postulated that if incidence rates were in fact known to be dropping, the decline in mortality could be attributed to primary prevention. If the incidence rate is steady (or rising) the decline in mortality could be attributed to secondary prevention (improved medical care of patients with clinically manifest coronary disease). Stern did not examine the possibility that the disease is becoming less lethal. However, it is unlikely that the nature of the disease could change so much in a ten
Figure 3, a-d.
Reproduced From: The Epidemiology of Cardiovascular disease; Lecture notes (mimeo)
Herman Tyrolder
Minneapolis 1981

Can we identify factors causing the coronary mortality decline and measure their contribution?
year period.\textsuperscript{12} There are recent data from Minnesota that indicate a 9\% drop in incidence of AMI between 1965 and 1975, and a parallel 48\% decline in fatality rate.\textsuperscript{13}

Primary prevention of CHD involves preventing or eliminating known risk factors for the disease. The "big three" risk factors for CHD are hypertension, elevated serum cholesterol levels from a diet high in cholesterol and saturated fat, and cigarette smoking. Lesser risk factors include type A personality, physical inactivity, obesity and perhaps abnormalities of coagulation\textsuperscript{14}, including fibrinogen levels.\textsuperscript{15}

One argument in favor of risk factor reduction as a major contributor to declining mortality rates examines the chronological order of events. In 1960 the American Heart Association issued its first statement on cigarette smoking and cardiovascular disease. This was followed in 1961 by its first statement on diet and coronary heart disease. In 1964, the year of the first decline in CHD mortality, the Surgeon General published his landmark statement on the hazards of cigarette smoking. In 1973 the National High Blood Pressure Education Program was launched to tackle hypertension, which was identified as an American national public health priority.\textsuperscript{16}

Parallel changes in consumption of specific related products occurred from 1963 to 1980. The percent change in consumption of cigarette tobacco was -27.1\%, fluid milk and cream -24.1\%, butter -33.3\%, eggs -12.3\%, animal fats and
oils -38.8%, vegetable fats and oils +57.6% and fish +22.6%. Furthermore, the penetration of hypertension detection and control programs has been far greater than expected and is thought to have had a major role in the decline.

However, the link between the decline in risk factors and the decline in mortality is not a straight line relationship. Where all socioeconomic strata have experienced the decline in mortality it has been demonstrated that cessation of smoking and increased physical exercise have been differentially taken up by the higher socioeconomic groups. In Canada the prevalence of cigarette smoking declined by 16% between 1965-77, but women and younger age groups have changed their tobacco consumption minimally and yet are experiencing proportionately greater declines in their mortality from CHD than older males.

About 46% of the Canadian population now regularly participates in some form of physical exercise; however, the longterm impact has not yet been assessed because the phenomenon is so recent. Stern concluded the review of the role of risk factor reduction in the decline in mortality by attributing half the decline in white males and one-third the decline in white females to primary prevention.

Secondary preventive measures include coronary care units, out-of-hospital emergency medical services (EMS) and coronary bypass surgery. All have been credited with some impact on the decline in mortality rates.
There have been two study designs employed to prove that coronary care units (CCU) lower mortality: those using historical controls, and randomized controlled trials.

Pre-CCU era fatality rates of 30-40% may be contrasted with the current 10-20% achieved in CCU's. However, the use of historical controls ignores the possibility of changes over time in the characteristics of patients hospitalized with acute myocardial infarction. There is wide variation in the mix of mild and severe cases in pre- and post-CCU studies, and pre-CCU mortality rates as low as 15% have been reported, as have post-CCU rates as high as 48%. It is also possible that the case fatality rates are better in the post-CCU era because physicians are hospitalizing milder cases with better prognoses. Previously 20-40% of all myocardial infarctions were unrecognized or "silent", but with increasing publicity, patients' awareness and physicians' index of suspicion may be heightened, with the result that milder cases may now be being hospitalized.

The prospective randomized controlled trials carried out to date have both been in England.23,24 While neither showed an advantage for coronary care units, both studies have been criticized for not dealing with the critical two hours after onset of symptoms by not beginning randomization until relatively late in the prehospital phase. Presumably both studies thereby select for a group that survived the highest risk period, making it difficult to show an advantage of
CCU's over care at home.25

A retrospective randomized survey of urban and rural Manitoba hospital records in 1974-1976 revealed mortality rates from acute myocardial infarction (AMI) of 14-15%. There was no significant difference in mortality rates from AMI for urban hospitals with CCU's or rural hospitals equipped at best with a monitor and defibrillator. There was only a suggestion of a better outcome for urban hospitals. The authors postulated that the dissemination to the rural hospitals' of the principles of sophisticated coronary care if not the technologic capability, was the factor responsible for comparable CCU and non-CCU rates.26

Improvements in hospital coronary care beyond a 10-20% mortality rate will have minimal impact on overall CHD mortality. The major criticism of the impact of CCU's on CHD mortality is that two-thirds of the patients have been dying before ever reaching a CCU. If a greater percentage of victims of acute myocardial infarction have been reaching hospital because of improved EMS, the fall in case fatality rates would be expected to have had a correspondingly greater impact on overall mortality. This area requires further study.

The impact of emergency medical services (programs that deliver definitive care for cardiorespiratory arrest in the field) is easier to analyze than the impact of CCU's. Prototype systems such as those in Seattle and Miami report that from 10-25% of patients with documented out-of-hospital
ventricular fibrillation are eventually discharged from hospital and about 7-10% survive long term.\textsuperscript{27,28}

Eisenberg has stated that a well developed program can lower the annual mortality from ischemic heart disease on a community-wide basis by 8.4\%.\textsuperscript{29} However, as Stern pointed out, such programs are rare and could not possibly have affected overall national mortality. Only 68 of the 304 American Emergency Medical Services Regions are in the advanced life support phase of a federally sponsored program designed to achieve total national coverage by 1982.\textsuperscript{30}

Since Stern's review of the role of primary and secondary prevention, results have come in from a number of major multiple risk factor intervention trials conducted throughout the industrialized world. It had been anticipated that the effectiveness of primary prevention could be established by demonstrating that reducing risk factors would reduce the incidence of and mortality from CHD. There was surprise and dismay when the results turned out to be equivocal. Unlike earlier trials which modified risk factors post-infarct, these clinical trials selected subjects who were free of clinical heart disease at entry into the study. The best known of these trials include MRFIT (U.S.), the North Karelia study (Finland), the Oslo trial (Norway) and the WHO European Coronary Prevention Study.

Most of the trials were not blinded either because it was impossible, as with smoking cessation, or unethical, as
for example a no-treatment group for hypertension. It was also recognized that multiple interventions would be scientifically less precise than single factor intervention. The MRFIT was a randomized primary prevention trial involving 12,866 high-risk males aged 35-57 years who were randomly assigned either to a special intervention program consisting of stepped-care treatment for hypertension, counselling for smokers, dietary advice to reduce cholesterol levels, or to the usual sources of health care in the community. The average followup period was seven years. In both groups there was a greater than expected reduction in all three risk factors. However, the mortality rates in the special intervention group were not significantly different from those in the usual care group, although they were 7% lower. 31

Three explanations for these findings were considered:

1) The overall intervention program did not affect CHD mortality.

   This was rejected as inconsistent with most published scientific data.

   2) The intervention does affect CHD mortality but the benefit was not observed in this trial of 7 years' duration.

   If this is true then it is difficult to continue to attribute 30-50% of the decline in mortality between 1969 and 1978 to changes in risk factors in the population at large. It was concluded on the basis of recalculations that
the second explanation was unlikely.

3) Measures to decrease cigarette smoking and lower cholesterol may have decreased mortality within subgroups of the special intervention cohort, whereas there may have been an unfavorable change in mortality rates among hypertensive men with abnormal EKG's on treatment for hypertension.\(^{32}\)

The combination of favorable and unfavorable effects cancelling out what might have been a significant lowering of mortality rates is presently the interpretation accepted for the MRFIT results.

However, Oliver (Edinburgh) has reviewed the results of MRFIT, the North Karelia community intervention and the WHO European Coronary Prevention Study and has come to the conclusion that "the evidence against any substantial benefit to the community from multiple risk factor intervention is increasing."\(^{33}\) Although in North Karelia there was an aggregated fall of 17% in coronary risk factors, when compared to the control province Kuopio there was no change in the incidence of coronary heart disease. In the WHO study there was no change in incidence of CHD and in the Belgian section a small increase occurred. "The Finnish, American (MRFIT) and WHO findings—in strict primary prevention terms—all suggest that multiple risk factor intervention does not work in middle-aged men."\(^{34}\) Oliver recommended adoption of a more selective policy of intervention focusing on those at highest risk even though they are a relatively smaller group.
By contrast, Walker (United States) interpreted the MRFIT results to conclude the exact opposite, that risk factor reduction is indicated for all, not just those identified as high risk. He pointed out that the usual care subjects made significant changes to their risk factors, and that their observed mortality rates were 41% lower than expected. Further, the mortality rate from CHD was 21% lower in normotensive males in the dietary intervention group than among the controls. However, this effect was countered by a higher mortality in a treated subgroup of hypertensives. Walker also reviewed findings from the Oslo Study Group (1981) which had carried out a prospective randomized five year study of diet and smoking with intervention in normotensive males at high risk for CHD. In the intervention group the incidence of myocardial infarction and sudden death was reduced by 47%. Interpretation of these results has been relatively straightforward in contrast to the MRFIT results.

The impact of primary preventive measures on the incidence of and mortality from CHD is not yet clear. However, as Stern recommended, "... lack of definitive data on the causes of the decline should not be used as an excuse to slow the implementation of plausible public health measures."
The Syndrome of Sudden Cardiac Death

"Sudden cardiac death is the leading cause of fatality in the industrially developed world. In the United States, someone dies unexpectedly every 75 seconds, day or night. Sudden cardiac death has been shadowing man's life since the inception of recorded history. The unpredictability of its occurrence burdens our dreams and provides an awesome reminder of the fragility of our biology. While it is recognized that sudden cardiac death is due to an electrical derangement of heart rhythm known as ventricular fibrillation, no clear acute morphologic lesions in the heart have been identified which trigger this event."

"Sudden cardiac death presents a paradox: a massive, unheralded catastrophe, yet in the heart a paucity of changes. Extensive coronary artery disease is the rule, but the severity and distribution are not distinctive. The underlying process is known to be caused by atherosclerosis but the trigger for the terminal, nearly instantaneous event remains undefined."37

Lown's dramatic statement above conveys the gravity and mysteriousness that makes the issue of resuscitation for sudden cardiac death (SCD) such an emotionally charged issue.

Over two-thirds of SCD occur out-of-hospital, usually within two hours of the onset of symptoms. For 25% of victims, SCD is the first sign of heart disease. Kuller et al38 described the prodromal symptoms and other features of SCD and found that a large number of their group of patients had already had evidence of cardiovascular disease at the time of death. 38% had received medical care within the previous two weeks, so the collapse is not entirely unheralded.

Surveys from the Seattle Medic I system have characterized
the range of conditions which caused out-of-hospital cardiac arrest and prompted a call to the emergency medical service. Sudden cardiac deaths (as distinguished from cardiac arrest secondary to non-cardiac disease) comprise the great majority of these deaths. Traumatic causes of cardiac arrest were excluded from these series.

Sudden Cardiac Death in King County, Washington

<table>
<thead>
<tr>
<th>CAUSE OF DEATH</th>
<th>LOCATION, YEAR</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CITY 1978³⁹</td>
<td>SUBURBS 1979⁴⁰</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>primary heart disease</td>
<td>931</td>
<td>79.0</td>
<td>528</td>
</tr>
<tr>
<td>respiratory disease</td>
<td>39</td>
<td>3.3</td>
<td>17</td>
</tr>
<tr>
<td>cancer</td>
<td>38</td>
<td>3.2</td>
<td>26</td>
</tr>
<tr>
<td>neurologic disease</td>
<td>37</td>
<td>3.1</td>
<td>18</td>
</tr>
<tr>
<td>sudden infant death syndrome</td>
<td>23</td>
<td>2.0</td>
<td>10</td>
</tr>
<tr>
<td>drowning</td>
<td>20</td>
<td>1.6</td>
<td>14</td>
</tr>
<tr>
<td>valvar heart disease</td>
<td>14</td>
<td>1.2</td>
<td>--</td>
</tr>
<tr>
<td>alcoholism</td>
<td>13</td>
<td>1.1</td>
<td>10</td>
</tr>
<tr>
<td>overdose/suicide</td>
<td>12</td>
<td>1.0</td>
<td>7</td>
</tr>
<tr>
<td>overdose/non-suicide</td>
<td>12</td>
<td>1.0</td>
<td>6</td>
</tr>
<tr>
<td>all other</td>
<td>40</td>
<td>3.5</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>1179</td>
<td>100</td>
<td>649</td>
</tr>
</tbody>
</table>
In suburban King County the average age of all cardiac arrest patients was 61 years and of heart disease patients, 65 years. Men comprised 72% of the total group and 74% of the primary cardiac group.40

Another study from suburban King County described the epidemiology of cardiac arrest in children.41 Over a six year period (1976-1982) 119 cardiac arrests receiving emergency resuscitation were documented, for a rate of 12.7/100,000 individuals less than 18 years of age. Sudden infant death syndrome accounted for 38 cases (32%). The next two commonest causes were drowning, 22%, and respiratory causes, 9%. Nearly half the arrests occurred in children under one year of age. Asystole was the most common presenting rhythm (77%) with ventricular fibrillation being the presenting rhythm in only 9%. Overall, 8 (7%) of the children were successfully resuscitated and discharged alive from hospital. Over half of these were near drownings. There were no resuscitations from among the sudden infant death group.

During a comparable time period in the same service area 20% of adults were successfully resuscitated and discharged alive. The major distinction between adult and pediatric age groups in cardiac arrest is the etiology. The high incidence of sudden infant death and drowning in children contrasts sharply with the etiology in adults, where coronary heart disease causes 80% of cardiac arrests.
Figure 4 is an effort to summarize the role of prevention in CHD.

**Figure 4  The Role of Preventive Strategies in CHD**

- **Health**
  - Biological
  - Familial
  - Socioeconomic

- **No Atherosclerosis**
  - No risk factors

**PRIMARY PREVENTION**
- periodic exam for high risk groups
- screening for hypertension
- behavior modification
- multiple risk factor intervention trials

- **No Clinical Heart Disease**
  - Angina
  - AMI
  - CHD
  - SCD

**SECONDARY PREVENTION**
- EMS
- CCU
- Drug Therapy, Surgery

- **Clinical Disease**
- Sudden Cardiac Death

**TERTIARY PREVENTION**
- Antiarrhythmics
- Rehabilitation
- Implantable Cardioverter

- **Recurrence SCD**
- Anoxic Damage
From the diagram it may be seen that the outcome of primary prevention in the strictest sense is absence of CHD, although in the literature reviewed it is generally taken to mean absence of clinical heart disease including sudden cardiac death. At this early stage, prevention includes familial and socioeconomic variables which are difficult to modify, and absence of the classical risk factors of smoking, hypertension, elevated cholesterol level, obesity, lack of physical exercise, and Type A personality behavior.

Primary prevention includes measures designed to intervene and treat before expression of disease. It was earlier noted that in 20-25% of cases the first manifestation of disease is sudden cardiac death. Preventive measures in this category include the full range of techniques available to modify smoking and dietary behavior, periodic examination of high risk groups, screening and treating hypertension, and the multiple risk factor intervention trials.

Secondary prevention includes measures designed to reduce the severity and sequelae of established disease; in this case myocardial infarction and sudden cardiac death. Out-of-hospital emergency medical services, coronary care units and other definitive treatment and rehabilitation programs are the major secondary level interventions. Kuller has stated that of the 400,000 people in the U.S. dying each year of SCD about 20,000-40,000 could be saved by CCU's and effective EMS, and that it was clear that primary
prevention was the only feasible longterm route. 42

Tertiary prevention minimizes the impact and sequelae of established disease and there are two issues in particular to be considered in this realm. Resuscitation introduces a whole new complex of possibilities, including the syndrome of "recurrent sudden death" and the tragedy of individuals who have been "successfully" revived but have sustained significant anoxic damage and major motor or intellectual deficits.
Chapter III Notes


9. Primary prevention is defined as prevention occurring before a disease state becomes established. Secondary prevention is defined as prevention of clinical expression of disease or of early preclinical intervention.


11. Stern. ibid.


22. Stern. ibid.


32. MRFIT Research Group. ibid.


34. Oliver, M.F. ibid. p. 37.

35. Walker, W.J. ibid.


Chapter IV The System of Emergency Medical Services

1. Components of the System

After the publication by Pantridge and Geddes of the early results of the Belfast mobile coronary care units, the concept of layered-response out-of-hospital resuscitation systems was rapidly developed and implemented in the United States. Some of the better-known systems have been established in Los Angeles, Miami and Seattle. A proliferation of systems across the United States was encouraged after the 1973 Emergency Medical Services Systems Act was passed. By 1979 Stern noted that "...68 of the nation's 304 emergency medical service regions are in the "advanced" life-support phase of a federally-sponsored program designed to achieve "wall-to-wall" regional services by 1982."\(^2\)

The components of an emergency medical system are:\(^3\)

1) rapid (2-5 minute) response
2) resuscitation from circulatory arrest
3) early therapy for the initiating event (i.e. myocardial infarction, trauma and other life-threatening situations)
4) direct admission to a coronary care unit
5) education of the public
6) improvement of other emergency medical services.

Rapid response includes making potential users aware of the warning signs of impending cardiac arrest in order to activate the system. This is especially relevant to CHD patients and will be discussed subsequently.

Early activation of the system may be enhanced by rapid
access, such as is provided by a universal emergency telephone number (911). The probability of rapid response is increased when a significant proportion of citizens are trained to perform cardiopulmonary resuscitation (CPR) or basic life support (BLS). It is also improved when first-response units are sufficient in number and are located strategically in the area to be served.

Resuscitation from circulatory arrest includes three components: CPR, BLS and ACLS (see below).

**BLS** is defined as emergency first aid that consists of the recognition of airway obstruction, respiratory arrest and cardiac arrest and the proper application of CPR.

**CPR** consists of the opening and maintenance of a patent airway, the provision of artificial ventilation by means of rescue breathing, and the provision of artificial circulation by means of external cardiac compression.

**BLS** alone is unlikely to restore heartbeat and circulation to normal. Enns et al. demonstrated deterioration of rhythm in 13 of 21 patients in cardiopulmonary arrest (CPA) resuscitated and transported by a BLS system. In their series 5 of 10 patients found in a tachydysrhythmia (VF and others) deteriorated to asystole during transportation to hospital, as did 8 of 9 patients found in bradycardia or heart block. Enns and others have relegated BLS to the status of a holding action to prevent brain death until definitive therapy could be initiated.
ALS or ACLS (advanced cardiac life support) is defined as BLS plus the use of adjunctive equipment to support respiration and circulation; establishment of an intravenous line, drug administration, defibrillation and cardiac monitoring. It also includes two-way communication with the receiving institution and physicians.\textsuperscript{5}

Resuscitation from circulatory arrest includes bystander CPR and rapid arrival of a first-responder unit with personnel trained in BLS. In large metropolitan areas, fire fighting units are usually more widely distributed across the community than are ambulance units. In the highly efficient prototype systems it is the fire units with attendants trained in BLS that respond initially. The paramedic or ACLS units are dispatched simultaneously, but because there are fewer of these units, the response times are slower. Definitive therapy is begun with arrival of the ACLS unit. Removal to a hospital with a coronary care unit and surgical capability completes the system.\textsuperscript{6}

The crucial element in EMS is time elapsed until definitive treatment can be initiated. Brain cell destruction usually begins within four minutes of cardiac arrest and all efforts are directed toward reaching the individual in cardiac arrest before those four minutes have passed. A study in elapsed time for 998 fatal cases of CHD from Belfast was published in 1968.\textsuperscript{7} All deaths attributed to coronary artery disease occurring in Belfast from July 1965 to July 1966
were reviewed. The ACLS system was in place for a brief portion of the study but was judged not to have had an impact because the time was too short. Of 998 cases, 98 (9.8%) were found dead by ambulance personnel, 389 (38.9%) died either before an ambulance was called for, or arrived, 109 (10.9%) were pronounced dead on arrival at hospital, while in the ambulance, 305 (30.5%) were admitted and died in hospital and 97 (9.7%) were in hospital for other reasons and died of CHD. Overall, 596, or fully 60% of the cases died out-of-hospital. Of these, 229 were known to have survived for more than 30 minutes after onset of symptoms, 182 for more than an hour, and 143 survived more than two hours.

The authors analyzed six critical time periods in their series in which delay in reaching definitive care might have been reduced. Data were not complete and calculations were carried out on smaller subgroups of the total 596 out-of-hospital deaths.

1) Onset of symptoms to calling for help (GP, relative): The median time was 1 hour 17 minutes for men and 1 hour 6 minutes for women. In 20% of cases the time elapsed was more than 6 hours.

2) Calling for help to calling ambulance: The median time was 59 minutes for men and 1 hour 26 minutes for women.

3) Ambulance dispatcher receives call to dispatch of vehicle: The median time was 3 minutes for men and 8.5 minutes for women. The sex difference here was significant (P<0.01) and unexpected. The authors suggested that the onset of symptoms was more insidious in women and the physician was therefore less likely to stress urgency to the ambulance dispatcher.
4) Vehicle dispatched to arrival at patient: the median time was 8 minutes for men and 8.3 minutes for women.

5) Pickup of patient to arrival at emergency room: this time period was not presented.

Summary of time elapsed:

6) Ambulance dispatcher receives call to admission to ward: the median time was 74 minutes for males and 88 minutes for females.

7) Onset of symptoms to admission to ward: the median time was 7 hours 52 minutes for males and 8 hours 40 minutes for females.

In this study the greatest sources of delay lay with patients and their advocates in activating the system.

In another review, Doehrman found that although half of the patients surveyed arrived at the hospital within three hours of onset of symptoms, many delayed eight or more hours. Public and professional education, and possibly a universal-access emergency number might have averted a significant proportion of these deaths. The response times of the Belfast EMS per se were not out of line for 1965-66, when the ambulance procedure was "scoop and run", and not unusual for some jurisdictions today, although there are distinct differences from the best times currently being achieved.

The other critical time period that could have been reduced to some effect was the time elapsed between arrival of the ambulance and onset of definitive therapy. Had treatment been started on the spot instead of at the hospital another hour would have been saved. Bystander CPR, and first-responder BLS coupled with defibrillation, or ACLS
onsite would all reduce this time to a matter of minutes.

Based on experience from large American cities it has been estimated that one primary-response BLS unit is required for every 50,000 people and one definitive-response ALS unit for every 125,000 - 150,000 people.

One ALS unit requires a complement of 5 people including dispatcher and driver. To provide 24 hour service, 5 such teams or 25 people are required. Unless an ACLS unit can respond in less than 10 minutes, it will not improve mortality from SCD. In King County in 1982 the cost of one ACLS unit serving 100,000 people was $415,000 per year.  

2. Recent Modifications

Bystander CPR

Several studies have reported on the lifesaving capabilities of out-of-hospital advanced life support units but most were based on uncontrolled series. Eisenberg and Tweed carried out prospective controlled studies and Wennerblom conducted a prospective randomized controlled trial of standard care vs. ACLS care for AMI in Sweden (1982). These latter studies all confirmed the earlier reports that paramedic-treated patients had better survival rates than patients managed with BLS delivered by lesser-trained emergency medical technicians (EMT).
Table II demonstrates this finding by summarizing the results of studies of survival to admission to or discharge from hospital, for paramedic and EMT-treated patients.

Table II. Rates of Survival (%) for Paramedic-Treated or EMT-Treated Cases of Cardiac Arrest

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Paramedic Admitted %</th>
<th>Paramedic Discharged %</th>
<th>EMT Admitted %</th>
<th>EMT Discharged %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eisenberg et al¹⁸</td>
<td>487</td>
<td>39</td>
<td>27</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>Cobb et al¹⁹</td>
<td>595</td>
<td>44</td>
<td>23</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Tweed et al²⁰</td>
<td>849</td>
<td>--</td>
<td>--</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Eisenberg et al²¹</td>
<td>574</td>
<td>--</td>
<td>22</td>
<td>--</td>
<td>6</td>
</tr>
<tr>
<td>Vertesi et al²²</td>
<td>318</td>
<td>26</td>
<td>--</td>
<td>7</td>
<td>--</td>
</tr>
</tbody>
</table>

A successful outcome of resuscitation has been variously found to be associated with a short access time, short response time, location of call, patients' age, and presence of ventricular fibrillation instead of asystole or heart block. Tweed has provided an important analysis of some of the predictors of outcome, with particular emphasis on bystander CPR and ACLS units.²³ Table III (modified from Tweed) shows rates of survival following bystander-initiated CPR.
Table III Rates of Survival (%) Following Bystander-Initiated CPR

<table>
<thead>
<tr>
<th>Study</th>
<th>Type of EMS</th>
<th>No. of Patients</th>
<th>Rate of Survival (%) to Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>With Bystander CPR</td>
</tr>
<tr>
<td>Vertesi et al</td>
<td>Paramedic</td>
<td>224</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>EMT</td>
<td>98</td>
<td>6</td>
</tr>
<tr>
<td>Thompson</td>
<td>Paramedic</td>
<td>316</td>
<td>43</td>
</tr>
<tr>
<td>Eisenberg</td>
<td>Paramedic</td>
<td>487</td>
<td>23</td>
</tr>
<tr>
<td>Lund</td>
<td>EMT</td>
<td>631</td>
<td>36</td>
</tr>
<tr>
<td>Tweed</td>
<td>EMT</td>
<td>226</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>EMT</td>
<td>227</td>
<td>30</td>
</tr>
<tr>
<td>Guzy</td>
<td>Paramedic</td>
<td>115</td>
<td>27</td>
</tr>
</tbody>
</table>

While bystander CPR has been shown to be associated with improved survival, there is no relationship to the quality of performance by the bystander. Several studies have shown that CPR skills deteriorate rapidly and have virtually disappeared one year after training. Furthermore, the beneficial effect of bystander CPR disappears if the EMS response time is more than five minutes.

"Though bystanders who attempt CPR contribute in some way, perhaps by rapidly summoning help, to a higher rate of survival, there is no evidence that either the quality of the CPR or even the attempt at CPR has any significant influence." Bystander CPR has also been found to be highly predictive of
the presence of ventricular fibrillation, which is a major determinant of a successful outcome. The association has yet to be explained. The conclusion Tweed has drawn is that while some aspect of bystander-associated CPR is associated with improved outcome, whether it is the actual procedure or the ability to recognize cardiac arrest and activate the system promptly is not known.

Vertesi showed a synergistic effect of bystander CPR combined with ACLS. Bystander CPR did not enhance survival when only an EMT unit responded. Vertesi recommended development of these two components of an EMS in concert rather than either in isolation.26

These startling data on bystander CPR suggest, at a minimum, that except for research units, no additional resources ought to be directed toward training the public in CPR until the beneficial component is identified and better understood. That is, the present level of training may be maintained but should not be expanded.

Alternatives to Paramedic Units

Sixty percent of out-of-hospital cardiac arrests are caused by ventricular fibrillation (VF). Successful resuscitation is more likely if VF or similar dysrhythmias are present. Resuscitation is considerably less likely if heart block or asystole are the presenting rhythms. It has
also been shown that VF untreated or treated with BLS alone will deteriorate to asystole in 50% or more of cases, decreasing the probability of survival. These features viewed in combination suggest a new possibility: that rapid recognition of VF and application of countershock may be the most important component of pre-hospital ACLS.

This possibility was tested by Eisenberg in suburban King County, Washington, where emergency services were being provided solely by EMT's. In other published reports survival rates for cardiac arrest in this area were around 6%. A training program was developed for EMT's which consisted of 10 hours of instruction in CPR, arrhythmia recognition with emphasis on VF and the use of a defibrillator. The cost of the training program was $40.00 per student. Apart from defibrillation, no other ACLS technique was authorized.

During the preceding two year period when only BLS services were available, 4 of 100 patients in cardiac arrest (4%) were discharged from hospital. During one year when the BLS service was augmented by defibrillation only, 10 of 54 patients in cardiac arrest (18%) were discharged from hospital (P<0.01). Despite some drawbacks to the study, such as non-random assignment, a retrospective control group, and possible interference in the results by other aspects of the training program, the concept remained an exciting possibility.

Stults and colleagues developed a prospectively controlled study designed to test the effect of the same two
levels of intervention in much smaller communities in rural areas (average population 10,000). In 18 communities EMT's were trained in defibrillation. Twelve similar communities with EMT service only provided control data. The 16 hour training program was delivered to EMT personnel in all communities, the only difference being training in defibrillation was included for the study communities. Over a twenty-month period, 19% of patients (12 of 64) in the study communities were discharged from hospital compared to 3% (1 of 31) in the control communities (P<0.05).

Stults identified several cautions in interpreting the data including the fact that because there are large numbers of volunteer EMT personnel in small communities, and a low incidence of cardiac arrest, many EMT's trained in defibrillation might not be required to use their skills for years. He recommended a rigorous recertification schedule to prevent inappropriate application of defibrillation.

Most recently Eisenberg and others\(^3\) expanded on their earlier study by combining EMT personnel trained in defibrillation with backup ACLS units. They compared the impact on mortality from this expanded team to that of a standard EMT-paramedic team. With short response times for both levels of treatment the hospital discharge rate was the same, 39% and 37%. However, if the interval between arrival of EMT's and arrival of paramedics was longer than four minutes, survival in the basic EMT-treated group was 18% and 38%.
in the EMT-defibrillation group (P<0.01). Even after controlling for other variables such as age, sex and initial response time, there was a significant positive effect for EMT-defibrillation. This study did not compare EMT-defibrillation services to paramedic services, but rather assessed the additive benefit. The definitive randomized trial comparing the two treatment modes has yet to be published.

In summary the following possibilities have been examined:

1) When bystander CPR is accompanied by EMT only and not pre-hospital ACLS, there has been no improvement in survival rates (Vertesi; Tweed).

2) There is no evidence that the quality of bystander CPR, or the attempt at bystander CPR has any significant influence on mortality, although some feature of it is predictive of a successful outcome (Tweed).

3) ACLS units are very costly to operate although they improve survival rates. Smaller communities do not have the necessary tax base to support a paramedic service (Stults).

4) Early defibrillation by minimally-trained EMT personnel is an effective and relatively inexpensive way of dealing with out-of-hospital cardiac arrest, particularly in locations distant from large urban centres (Eisenberg, Stults).

5) It may be that there are only two key determinants of survival; initiation of CPR in less than 4 minutes after cardiac arrest, and early defibrillation (Tweed).
Taken together, these statements suggest that for all but the largest cities in Canada, an adequate EMS designed to deal with cardiac arrest may be provided by EMT-defibrillation teams in sufficient numbers and appropriate locations in the community to be served. Bystander CPR and ACLS units may be components of the system that could be foregone until further studies have been carried out.

The most recent technological development to impinge on this category of patients is the implantable cardioverter. A small (95 gram) fully programmable device has been tested in patients with recurrent ventricular tachycardia (VT) who were not candidates for surgical treatment of VT. Cardioversion required a very small shock (less than 0.5 Joules) and was well tolerated by the subjects. There were significant difficulties in this trial with differentiation of arrhythmias by the cardioverter. However, it is possible that the next generation will be able to defibrillate. The 20-25% of SCD victims who are discharged from the hospital have a 50% mortality over 4 years. The main cause of death is recurrent SCD induced by ventricular fibrillation. In the near future, this device may significantly improve longterm survival for such patients.

3. Impact of the System

One of the major concerns about management of out-of-hospital cardiac arrest is that rather than productive lives
being saved, death is merely being delayed a few months by means of an extremely expensive technology. Twenty to thirty percent of cardiac arrest patients are currently being successfully resuscitated and discharged from hospital alive. However, the age of the survivors and the quantity and quality of life after discharge have been the subjects of much debate.

There are some recent data on longterm survivors of out-of-hospital cardiac arrest. Eisenberg and others followed a series of patients over four years after resuscitation. The initial series consisted of 1567 cases of cardiac arrest of whom 557 (36%) were admitted and 302 (19%) were discharged. Of those discharged, 276 were available for longterm followup. Two hundred and fifty of the 276 went home; 26 had major sequelae and went to nursing homes or extended-care facilities. Forty-seven percent of a group interviewed at six months post-discharge had worked either full or part-time prior to their arrest. Thirty-four percent of this group were able to resume full or part-time work after the event.

The probability of survival at 6 months, one year, two years, three years and four years was 81, 76, 66, 55 and 49% respectively. The 49% 4-year survival rate was contrasted to an 80% survival rate for an age-sex-matched normal group, and a 66% rate for a group with uncomplicated myocardial infarction. The cause of death after discharge was overwhelmingly (89%) due to atherosclerotic heart disease.33
Rockswold and others collected a series of 514 consecutive patients suffering out-of-hospital cardiac arrest in Minneapolis between 1974 and 1976. Of the 514, 83 (16%) were discharged alive from hospital. Thirty-four had significant impairment, primarily neurologic, and 49 were ambulatory, with good mental function. Of those 49, 47 were followed for a period of up to two years. Overall, the survival rates in this group were 85% at the end of one year and 50% at the end of two years. The majority of deaths during the followup period were attributed to SCD. 34

Cobb and others followed 234 discharged survivors of cardiac arrest for an average period of 14 months. The mean age of the group was 60 years. The survival rate was 70% at the end of one year and 59% at the end of two years. Thirty of Cobb's patients (13%), experienced recurrent SCD after discharge. Fifteen were resuscitated from their second episode, with 10 surviving longterm, and subsequently 3 of these were resuscitated from a third episode, with one longterm survivor. 35

All three studies provided clear evidence that patients in ventricular fibrillation (VF) in the absence of myocardial infarction experienced considerably higher mortality than patients resuscitated from VF associated with myocardial infarction. In particular, patients in VF without infarction proved to be at high risk for recurrence of VF in the early post-discharge phase (17 weeks).
As this high risk group became apparent, a search began for predictors of risk in an effort to further improve survival rates. Lesch and Kehoe found a three-fold increase in the risk for SCD after myocardial infarction if frequent or complex ventricular ectopic activity was present. The increased risk rose to six-fold if congestive heart failure was added to the ventricular ectopic activity. At present there is no single technique with sufficient sensitivity and specificity to distinguish low- and high-risk groups, and a combination of techniques is required. Further, the utility of suppressing ventricular ectopic activity, and of coronary bypass surgery remain to be demonstrated. For the present a systematic approach to management is recommended, including a regimen of anti-arrhythmics after a complete hemodynamic and electrophysiologic review (via Holter monitoring and radionuclide imaging).

The newest technological advance (vide supra), the implantable cardioverter, may in the future provide a method for reducing post-discharge mortality in this group of patients. However, it is still in the very early stages of development.

To summarize, about 10-20% of victims of cardiac arrest are being discharged alive from hospital. The proportion sustaining significant neurologic damage is variable but may be as high as 40%. For those discharged without impairment, usually males in their late fifties to late sixties, a
50-60% two year survival may be expected. Over a third of those alive at 6 months will be back at work. The primary cause of death among these longterm survivors is SCD and efforts are currently being directed toward identifying high-risk subgroups and devising effective interventions to prevent recurrent SCD.

Crampton has reviewed data from several EMS and has expressed the results in terms of lives saved. The average was found to be 6.8 life-saves per 100,000. He calculated the value of a lost livelihood as worth $41,000 per 100,000 people in 1980 dollars. If a definitive care EMS can save 6.8 lives per 100,000 the gross value per year of survival will be about $280,000. The cost of one ACLS unit in King County, Washington in 1979 was estimated at $275,000.

If these data may be compared, they suggest a cost:benefit ratio of 1:1 in the first year of survival. The benefits will increase with each additional year that survivors work, but not all survivors are generating a livelihood. On balance, a cost:benefit ratio of 1:1 does little to recommend a paramedic ACLS unit. Since the impact of SCD is undeniably large, however, it will be worthwhile to pursue the less costly but equally effective options described in the preceding section.
Chapter IV  Notes


18. Eisenberg, M. and others. opcit.


20. Tweed, W.A. and others. opcit.


22. Vertesi, L and others. opcit.

23. Tweed. opcit.

24. Tweed. opcit.

25. Tweed. opcit. p. 430

27. Tweed, W.A. and others. opcit.


Chapter V  Emergency Medical Services in Saskatoon

1. The Provincial Context

Because health is a provincial responsibility, ambulance services generally emanate from provincial Departments of Health and each province has different priorities, different legislation and different patterns of operation. Larger municipalities within provinces have developed their local EMS beyond provincial standards to meet the unique demands of cities, and this has resulted in a multiplicity of structures, levels of funding and services.

Provincial licensing regulations for ambulances were introduced in Saskatchewan in 1946. Initially the regulations covered equipment and vehicle specifications only. In 1958 they were upgraded to address the issue of training for ambulance attendants (at that time the training required was a St. John's First Aid Certificate).

During the 1970's ambulance operators were struggling with rising costs, marginal profits and the need to increase user fees. They therefore made presentations to the provincial government to develop a system for indirect provincial funding of ambulance services. The Municipal Road Ambulance Program (MRAP) provided funding for ambulance services through a per capita grant to municipalities. The funds were derived through the Revenue-Sharing agreement between the province and
the municipalities. In several geographic areas, neighboring communities joined together to form ambulance districts. Currently there are about 100 districts in the province, with 95 licensed operators. Municipalities transfer the per capita grant to ambulance boards, which in turn disburse the funds to the ambulance service providers.¹

In Saskatoon in 1977, the Provisional Board of Health was a new entity constituted to,

"formulate the objective, bylaws, organizational structure and related matters necessary to the establishment and functioning of a permanent health board capable of coordinating and integrating the delivery of health care to the citizens of Saskatoon and/or surrounding area."²

This group was asked to review the preliminary MRAP grant proposal and make recommendations to City Council. Over the following year, efforts were made by a committee of the Provisional Board of Health to bring other surrounding municipalities into an ambulance district. In addition to this major recommendation to amalgamate urban and rural municipalities into a district, with a representative board, the committee also recommended:

1) that there be an exclusive contract with one operator;

2) that standards of operation be established for the contractor, to be monitored by a Technical Advisory Committee of the Ambulance District Board.

In 1979 fourteen municipalities including Saskatoon passed
bylaws authorizing participation in a single ambulance district. The rural communities were grouped into three geographic areas, and a board composed of four Saskatoon and three rural representatives was formed.

During the same timespan a community board was being established to guide the operations of the Saskatoon Community Health Unit, previously the Department of Health for the City of Saskatoon. The Board of the Health Unit regarded coordination of health services as part of its mandate, and sought and was granted the role of host agency for the Saskatoon and Area Ambulance District Board (SAADB). The Health Unit has since provided administrative support for the SAADB and in addition two individuals hold cross-appointments on both Boards to facilitate an exchange of information. Although there has not been much latitude for local discretion in apportioning the funds provided, the SAADB since its inception has taken an active role in shaping local services, and has paid considerable attention to the development of the service and to measurements of quality control.

In 1978 a province-wide training program based in Regina was developed to upgrade the qualifications of the ambulance attendants. By 1980, through efforts by the Saskatchewan Medical Association and the Saskatchewan Road Ambulance Association, the provincial department of Continuing Education established the Emergency Medical Technicians (EMT-1) program, with a refresher program added later. EMT-1
certification is conferred by a 131-hour program of instruction. When augmented by 25 hours of actual emergency experience, an Emergency Medical Assistant (EMA-1) certificate is issued.

About 300 ambulance personnel throughout the province are currently certified at the EMT or EMA-1 level. Regulations currently require city operators to have at least one EMT-1 on for each shift. The course has not been made accessible except for those near Regina, and rural personnel in particular either do not have the basic certificate or are unable to take the refresher in order to maintain the standard.

In addition to serious difficulties with training (especially when compared with the extensive program offered through the Southern Alberta Institute of Technology in Calgary, for example) there were other major problems with the province's emergency medical services. In 1982 the newly elected Conservative government established the Ambulance Review Committee chaired by MLA Larry Birkbeck to review the structures, standards and financing for ambulance services in the province.

The problems noted in the Birkbeck Report were as follows:

1) legislation pertaining to ambulance services is contained within five separate acts administered by five different departments of government.

2) there is a lack of autonomy, expertise, and direction among the District Boards.

3) there is no uniform system of communications and no policy
pertaining to a communications network.

4) funds used to support ambulance services come from a confusing mix of public and private sources including variable charges to the users of ambulance services.

The majority of funds (57% in 1982-83) are provided by the provincial government.

The recommendations of the Ambulance Review Committee were cautious but addressed all the foregoing issues. Specifically they included recommendations that covered the following areas:

1) with respect to provincial organization, that all aspects of ambulance services be brought into Saskatchewan Health and that a dedicated administrative unit guided by a provincial advisory body be established with the Department. This change has been initiated. The Ambulance Services Unit has been actively operating since 1983.

2) With respect to legislation, that Ambulance Services be covered by a single separate piece of legislation.

3) With respect to ambulance operations throughout the province, that:

3.1 the local organization remain a mix of public and private agencies, with consideration to be given to regionalization of more specialized services over the longterm;

3.2 that training be standardized at the basic EMT-1 level and offered on a decentralized modular basis throughout the province;
3.3 that communication be standardized with respect to equipment and frequencies and that improved access via a toll-free number or universal access number (911) be considered;

3.4 that funding be rationalized to reflect differences across districts in distances travelled and call volumes.

At present the per capita grant system is not responsive to different patterns of use.

3.5 that a variety of funding sources, including federal, provincial and municipal public sectors, and the private insurance sector be encouraged to continue but that a ceiling be put on the user fee to protect citizens requiring ambulance services.

4) That public education be utilized to improve the ability of citizens to respond to emergency situations.

The newly established Ambulance Services Unit has been active in establishing a uniform data base derived from standardized run-report forms to be completed for every call to every ambulance. The Unit is also actively developing proposals for training and licensing requirements and standards. However, it has not been in existence long enough to have fully implemented any of its mandated initiatives. In addition, while the run-report data are being collected, analysis has not yet begun.
While the Ambulance Review Committee's recommendations and the work of the Ambulance Services Unit have been welcomed by the SAADB, the Board indicated that Saskatoon and area constituted a special area because it included one of the two largest cities in the province. The Board accepted the Committee's recommendations as a baseline upon which they intend to build additional components related to the needs of a large metropolitan area surrounded by several rural communities.

The EMS service in Saskatoon is in a relatively good position with respect to data analysis because of the early initiative of the SAADB to monitor quality via a computerized analysis of locally designed run-reports. The data have been analyzed by Feather and published in the Annual Reports of the Saskatoon and Area Ambulance District Board for the years 1980-81, 1981-82 and 1982-83. This data base is the prime source of the information available on the operation of the system in the Saskatoon and Area District.

2. The System in Saskatoon

The three most commonly observed organizational models for urban EMS include:

1) multiple private operators;
2) one operator holding an exclusive contract with the municipality or other contracting agency;
3) The municipality or other agency operating an ambulance as a public service.

In Saskatoon there is a delicate balance between the first two models, with a single operator contracted by a community board, but with no municipal or provincial legislation to prevent other operators from entering into competition with the contracted operator.

The contracted operator, M.D. Ambulance, has worked well with the Board and has brought several features of the EMS into compliance with the recommendations of the Board over the past six years. At present the operator has three bases within the city, and 11 BLS vehicles. There is no sharing of space or communications with the Fire Department. The ratio often used in the literature for vehicle to population calculations is 1:50,000. One ACLS unit is generally planned for each 100,000 - 125,000 population. Using this maximum model, Saskatoon would require 4 BLS units and 1-2 ACLS units.

The staff of the ambulance service includes 20 fulltime and 10 parttime ambulance attendants, 4 dispatchers and 5 administrative staff. The attendants are unionized. A strike over wage demands was narrowly averted in 1981, and there is a contingency plan in place to cover such emergencies, which was developed by the operator in response to this earlier crisis.

Personnel certification has been upgraded in 1984 to the
point where almost all staff have EMT or EMA-1 qualifications. This is the first year that on-site training has been available. The wages of the fulltime ambulance personnel in the province are usually slightly above minimum wage (around $6.00 per hour). Because of the relatively poor remuneration, staff turnover is high and it is rare to have a fully trained complement of staff who also have long field experience. In rural areas the situation differs in that most first-response teams are comprised of volunteers who are committed to remaining in their community. The problem of turnover is replaced in this situation by the problem of providing adequate training to a large cadre of volunteers.

The annual budget for the BLS system described above is about $600,000. Increasing the wages of the attendants to $12.00 an hour would bring costs to somewhat over $1 million. If the vehicle-to-population ratios used in the larger systems were applied here, capital outlay the first year would triple, and operating costs would rise in proportion because of the additional costs of wages and benefits. A 911 communications system was estimated to cost $200,000 per year in 1982 dollars and a public education/awareness campaign would also contribute an additional $60,000.9

With respect to operators of the ambulance service the Annual Reports of the SAADB provide data on the number, geographic distribution and type of call (urgent, prompt, non-emergency or transfer, and dead). There are also data
on response times which have been used by the Board as a benchmark for quality of service. Over the course of 24 hours the three shifts are covered as follows: from midnight to 0730, 2 units; from 0730 to 1930, 4 units; and from 1930 to 2400, 3 units.

Over a year there are about 10,000 calls, 80% from within the city limits. The average number of calls per day has increased from 20 in 1980-81 to 28 in 1982-83. There are more emergency calls on Fridays and Saturdays (16% compared to 12-14% on other days of the week). The distribution of emergency calls throughout the day is fairly even at 5% per hour, except from 0100 to 0600 when the proportion drops to around 2%. Most elective transfers tend to occur during normal working hours.

With respect to source of call, patients and relatives initiate 25-30% of calls, police and fire 10-12% and the majority of the remainder are from hospitals (transfers) and nursing homes. About a quarter of the institutional calls are urgent or prompt. For the calls initiated by patients or relations, no information is available on the time interval between onset of symptoms and placement of call. A survey of elapsed time in this situation might indicate if delay is significant, and whether public education may be required.

The distribution of emergency calls through the city is 30% from the core area and 70% from the periphery (Appendix A). Response times are best for the core area, and decrease as the
city limits are approached. Over the past three years 40% of emergency calls have been answered in four minutes or less, 50% by 5 minutes, 65% by 6 minutes and 75% by 7 minutes (Appendix B). With BLS capability only, the system's response capability in under 4 minutes is unlikely to be effective in dealing with cases of SCD. A prospective survey of numbers and outcomes for SCD will be required, but a comparable system in Winnipeg has been shown to produce a 5% rate of discharge from hospital.\textsuperscript{11}

The standard for the City Fire Department is a response time of 5 or fewer minutes. To achieve this time, the city has established 6 fire halls. The Planning Department of the City of Saskatoon has suggested that if a 4 minute response time is required for ambulance services, it is probable that 5-6 ambulance stations will be required. This department has recommended deployment in each of six suburban commercial complexes. These shopping and recreational areas have been established in specific locations in order to provide services to units of 50,000 population. This service unit dovetails nicely with the standard of one BLS vehicle to 50,000 people.

3. The Epidemiology of Cardiac Arrest in Saskatoon

The population of Saskatoon is currently 170,000 (1984 Saskatchewan Hospital Services Plan) with about 10-11% being
people over the age of 65.\textsuperscript{12} While the city is already experiencing the "seniors boom" anticipated elsewhere in Canada over the next two decades, age standardized mortality rates (ASMR) are comparatively low for the leading causes of death.

In Table IV data extracted from volume 3 in the series, Mortality Atlas of Canada: Urban Mortality, are used to rank Saskatoon with other selected Canadian cities for deaths due to coronary heart disease.\textsuperscript{13} The data are aggregated over 1973-1979 and have been drawn from mortality figures for ICDA codes 410-413 (8th revision) and ICDA codes 410-414 (9th revision).

\textbf{TABLE IV}

Age Standardized Mortality Rates for CHD 1973-1979

<table>
<thead>
<tr>
<th>Selected Canadian Cities, by Sex</th>
<th>ICD codes 410-413 1973-76 (8th revision)</th>
<th>ICD codes 410-414 1976-79 (9th revision)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALE</td>
<td>FEMALE</td>
<td></td>
</tr>
<tr>
<td>SASKATOON</td>
<td>285.4</td>
<td>52.4</td>
</tr>
<tr>
<td>REGINA</td>
<td>300.6</td>
<td>69.9</td>
</tr>
<tr>
<td>ST. JOHN, N.B.</td>
<td>446.0</td>
<td>133.5</td>
</tr>
<tr>
<td>MONTREAL</td>
<td>420.6</td>
<td>127.2</td>
</tr>
<tr>
<td>KINGSTON</td>
<td>430.2</td>
<td>132.4</td>
</tr>
<tr>
<td>HAMILTON</td>
<td>353.9</td>
<td>101.9</td>
</tr>
<tr>
<td>WINNIPEG</td>
<td>362.4</td>
<td>96.1</td>
</tr>
<tr>
<td>CALGARY</td>
<td>289.7</td>
<td>76.1</td>
</tr>
<tr>
<td>EDMONTON</td>
<td>297.1</td>
<td>77.4</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>322.0</td>
<td>82.3</td>
</tr>
<tr>
<td>WHITEHORSE</td>
<td>424.0</td>
<td>57.7</td>
</tr>
</tbody>
</table>
It may be seen that Saskatoon had a significantly low mortality experience for CHD during those years.

Hosking has calculated numbers of deaths of Saskatoon residents coded ICDA 410 for the years 1980 to 1983. Table V shows for each year the total number of deaths in Saskatoon attributed to code 410 and those occurring out-of-hospital as opposed to those occurring within hospital or in a similar institution, and the average age of the patients.

Table V

DEATHS FROM ACUTE MYOCARDIAL INFARCTION
(ICDA CODE 410) SASKATOON 1980-83
From Hosking, D.J.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Total Deaths</th>
<th>Average Age</th>
<th>Out of Hospital No.</th>
<th>In Hospital Or Institution No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>157</td>
<td>78</td>
<td>36</td>
<td>121</td>
</tr>
<tr>
<td>1981</td>
<td>163</td>
<td>71</td>
<td>45</td>
<td>118</td>
</tr>
<tr>
<td>1982</td>
<td>233</td>
<td>75</td>
<td>54</td>
<td>179</td>
</tr>
<tr>
<td>1983</td>
<td>155</td>
<td>N/A</td>
<td>44</td>
<td>111</td>
</tr>
</tbody>
</table>

These figures are probably conservative since they are restricted to code 410, instead of codes 410-414, the usual range surveyed. In addition, when Gillum and others carried out a similar study in Minneapolis they conducted
an extensive ascertainment procedure to ensure complete counting of all out-of-hospital deaths that ought to have been attributed to these codes. They found about 8% of out-of-hospital deaths were incorrectly coded.¹⁵

Given these two possible sources for underestimating SCD in Saskatoon, a figure of about 60 such deaths per year is proposed as a working average. Estimates derived from literature cited previously have suggested a figure of 6 out-of-hospital cardiac arrests a year per 10,000 people (Eisenberg 1978). In a city of 170,000, about 100 SCD would have been expected. If 20-30% survived to be discharged from hospital, as happens in cities with the most extensively developed EMS, Saskatoon might experience 20-30 lives saved per year. With 50% mortality in the first two to three years, about 10-15 people, mainly men in the seventh and eighth decades would still be alive more than two years after the event, and of those, about 3 to 5 would be working full or part-time. However, given the actual data from Saskatoon for 1980 to 1983 and bearing in mind the significantly low mortality rates from CHD from 1973 to 1979, these "expected" calculations require reduction by about one-third to one-half.

The benefits of lives saved have been discussed in Chapter 4. If a life saved provided a benefit of about $41,000 per individual per year and if in Saskatoon under ideal circumstances 6-10 lives might be saved per year, the overall benefit would range from $240,000 to $410,000
The cost of developing the system to the point where 20-30% of SCD are discharged from hospital has been analyzed in the foregoing section. Initial capital outlay would have to triple and operating costs of just one ACLS unit would exceed the calculated benefits. It is well recognized that smaller communities do not have the tax base to support systems such as those operated in Seattle or Miami. The fact that the high mortality rates experienced in large American cities may not be experienced in communities in other regions also has a significant bearing on the argument. An adequate and affordable EMS for Saskatoon will be quite different from the prototype systems.

4. A Proposal with Alternatives

For any situation there are three basic alternative options. First, present programs may be continued, and in some cases, the do-nothing approach may be justified. Second, present programs may be modified within the constraints of available resources to address assessed needs in a more responsive way. Third, resources may be shifted away from present programs and put into new programs that more directly address the assessed need.

To continue with the present program means continuing with inadequate training and remuneration of staff, ineffectively located ambulance sites, a response time in 40% of emergencies
of greater than 6 minutes, and in 60%, of greater than 4 minutes, no organized approach to first-response teams in rural areas, no standardization of communication, no public awareness programs on early warnings of impending emergency except for ongoing bystander CPR training sponsored by community agencies, and finally, no specifically collected data on the numbers of SCD in the District or their salvage rate.

This option is unsupportable for the following reasons:

1) it is probably unethical to maintain current standards in the light of minimal costs required to upgrade training and improve deployment of ambulance units;

2) the treatment of the rural parts of the District is inequitable;

3) there are inefficiencies built into the system which may be fairly simply remedied;

4) bystander CPR in the absence of mobile definitive care may be doing harm and is possibly not doing any good.

Another alternative is to reallocate resources away from the existing program in order to begin new initiatives. In this instance the new initiatives would probably include smoking cessation, dietary counselling and fitness campaigns. Strictly speaking this may turn out to be the most effective solution in the longterm. However, the calculated beneficial effects of primary prevention initiatives on CHD mortality were set at one-half for white males and one-third for white
females. The failure of any clear, positive answers to emerge from the multiple risk factor intervention trials further detracts from the strength of this option. Finally it would almost certainly be politically unacceptable to reduce existing services, particularly when the present government has signalled its intent to move in the opposite direction.

The final option is to modify present programs in the light of assessed needs. The system requires better response times to initiation of CPR in both urban and rural areas before any other changes are introduced. Improved time to onset of definitive therapy and improved public response may also be required but further information must be gathered first.

The City of Saskatoon has an unusual urban planning capability in that the neighborhood districts that comprise the community are based on a grid compatible with census tract boundaries. The age-sex population pyramid for any of the 54 neighborhood districts is known, as are standard census sociodemographic data. In the immediate future, a postal code translation program will be added to the present system which will enable the City to attribute hospital morbidity and mortality data back to neighborhood of residence. This feature will permit analysis of the distribution and concentration of target conditions across city districts with known population bases. It will be possible within the next year to plot the distribution of
SCD and other emergencies by location and time.

The proposal for managing out-of-hospital cardiac arrest in Saskatoon and area has six components:

1. Assessment of the geographic distribution of SCD in both the urban and rural areas of the District. In the city this may be achieved by using the program outlined above. In rural areas, a prospective survey will be necessary.

2. A prospective survey of SCD incidence and salvage rates to be undertaken within the District. This will provide a baseline from which to refine calculations of costs and benefits.

3. A planning exercise to be undertaken regarding the number and deployment of vehicles in the city and the location of first-response teams in the rural area of the District. The exercise will be specifically directed toward reducing response time to four minutes or less.

4. A public awareness campaign to be initiated if prospective surveys indicate that there are significant delays between onset of symptoms and activation of the system.

5. All ambulance attendants to be upgraded to EMT-1 with regular recertification.

6. A pilot study of EMT-defibrillation to be initiated in one ambulance unit for the city service and in one geographic area of the rural part of the District.
Some of these components may be undertaken simultaneously which will reduce the time required for the study. Except for the public awareness campaign and the pilot study of EMT-defibrillation, resources required can come from existing allocations. Presumably both components with significant costs attached will be of interest to the provincial government because of the possibility of wider application. The likelihood of funding for these two components seems reasonable.


4. Saskatchewan Health. ibid.


6. The run reports were designed, implemented, and monitored by Mrs. Joan Feather, the secretary to the SAADB from its inception to 1981.


10. Annual Reports of the SAADB. ibid.


12. Annual Report 1983 Saskatoon Community Health Unit Saskatoon October 1984 156 p.)


14. Hosking, D.J. ibid. I am greatly indebted to Dr. Hosking for permitting me to use this mortality information.
Chapter VI  Summary and Recommendations

There are several key points contained in the material reviewed in this study.

First CHD is the leading cause of death in North America and in the city of Saskatoon. However, in Saskatoon the rates are comparatively low. Sudden cardiac death is numerically an important category of mortality from CHD in much of North America, but does not appear to be as prevalent as expected in Saskatoon. An estimate of 60 cases per year has been made for the city, but fully accurate data are not available. A prospective survey may be the best way to determine incidence of SCD for Saskatoon.

The incidence of and mortality from CHD are declining significantly in North America. An estimated one-third to one-half of the decline has been attributed to primary prevention but the data are not clear enough for this estimate to be unassailable. Secondary preventive measures applied optimally can salvage only about 10% of victims of CHD, and therefore do not provide a longterm solution. Until further studies are done, both primary and secondary preventive measures should be maintained.

With respect to EMS systems in operation today, it is known that one of the major sources of delay lies with patients not activating the system. The importance of public awareness of the symptoms of impending collapse
cannot be overstressed.

Although the lifesaving capabilities associated with ACLS and bystander CPR have been well documented, it is not clear that either component per se directly affects survival. It appears now that short time to initiation of CPR, and short time to definitive therapy (defibrillation) may be the key and may permit innovative variants on ACLS and bystander CPR. Bystander CPR in the absence of ACLS, or without the provision of definitive care in less than 10 minutes, does not improve survival, and may actually do harm. ACLS units have rarely been viewed as having universal application. They cannot work in rural or remote areas, and appear to be too expensive to be supported by smaller cities and towns.

Given present cost-estimates and the current mortality rates from SCD in Saskatoon the cost benefit ratio for a tiered-response system including ACLS and bystander CPR in this area is unlikely to exceed 1:1. Fortunately, there is new evidence that scaled-down alternatives such as EMT-defibrillation may produce similar benefits. The added advantage is that EMT-defibrillation has been shown to work in at least one study in a rural area.

The relatively few lives now being saved by EMS should not be discounted. Not only are people staying healthier later in life, but there are also new technologies being developed that may enhance the longterm survival of these patients.
Finally, Saskatchewan is undergoing a process of review and upgrading of EMS services on a province-wide basis, and the local ambulance board is strongly committed to developing the best service possible for the resources available. The political will to improve existing systems is on record, as is community support for the best affordable service.

Some of the difficulties with the Saskatoon Ambulance service may be rectified at minimal cost. Other changes ought to be preceded by a period of local study. The questions set forth initially in this paper may now be answered in part.

1. A properly designed EMS can provide small gains in terms of reducing mortality from cardiac arrest.

2. The components required to achieve this reduction in mortality may not be as costly or complex as once anticipated. They include a public education campaign, enough ambulance units in strategic locations that will permit BLS response in four minutes, adequately trained and remunerated ambulance attendants (EMA-1), deferral of consideration of ACLS, and possibly a trial of EMT-defibrillation.

3. Saskatoon and area may be able to afford the scaled-down version of the most effective EMS.

4. The epidemiology of cardiac arrest in Saskatoon appears to be different enough from published data that the fully developed ACLS system is not warranted.
5. CHD and cardiac arrest, notwithstanding the relatively low rates in Saskatoon, remain leading causes of death in the community.

6. There are other ways of impacting on CHD mortality that may be more effective in the long run. However, modest improvements in our EMS should be pursued in tandem with further development of primary prevention programs.

The recommendations arising from this study are as follows:

1. Both primary and secondary preventive programs directed toward reducing mortality from out-of-hospital cardiac arrest ought to be maintained and where possible improved.

2. Public awareness of the signs of an impending cardiac event, and appropriate response, is one component of an EMS that requires immediate attention.

3. Notwithstanding #2 above, community-based programs to teach bystander CPR should not be expanded from their present level of activity until the beneficial feature of bystander CPR is known.

4. Consideration by the SAADB of the components of the proposal in Chapter V for modifying the EMS in Saskatoon and area will hopefully provide material for debate and discussion.


Figure 3: Pick-up Locations for Emergency calls (Codes 3 and 4)

Legend:

- No calls, or less than 3 percent of total calls
- 3.0 - 5.9 percent
- 6.0 - 8.9 percent
- 9.0 - 11.7 percent

Scale: metric 1:50,000
Grid: 1 square mile

APPENDIX A
Figure 5: Proportion of Emergency Calls (Codes 3 & 4) for which Response Time Exceeded Six Minutes

Legend:

- 0 - 39 percent
- 40 - 59 percent
- 60 - 79 percent
- 80 - 100 percent

Scale: metric 1:50,000
Grid: 1 square mile