CONSIDERATIONS OF REGIONALIZATION AND CATEGORIZATION IN HOSPITAL EMERGENCY PLANNING

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ABSTRACT

This thesis explores some of the planning considerations associated with the fact that hospitals vary widely in their ability to render high-quality emergency care. This fact implies the need for a regional plan of cooperation between hospitals so that the patient can be brought to a hospital which is appropriately equipped and staffed to provide the necessary care within a reasonable amount of time.

Advances in medical technology and knowledge have made possible increasingly sophisticated emergency care. Such definitive care requires the rapid availability of a wide range of medical specialists together with an array of expensive diagnostic equipment and therapeutic facilities operated by skilled personnel at all times of the day or night. Since the costs in terms of personnel, equipment, and facilities to provide such definitive care are very high, considerations of both effectiveness and efficiency point toward the categorization and regionalization of hospitals' emergency facilities within a metropolitan area.

Categorization is the term which is generally used to describe the procedure of classifying hospitals into groups which have different care capabilities. The primary approach to categorization of hospital emergency care facilities in the United States has been one which classifies hospitals according to the degree of comprehensiveness of the entire spectrum of emergency services which they provide. This approach might be termed <u>vertical categorization</u>.

The major difficulty with the <u>vertical</u> approach is that the importance of time-to-treatment and the relative efficacy of life-support and stabilization treatment vary with the type of emergency. Knowledge of the pathophysiologic sequence of events (epidemiology) following particular types of medical emergencies has not been utilized in decisions regarding the location of emergency treatment facilities. There is also considerable variation in the degree to which different kinds of emergencies can be stabilized in small hospital emergency rooms by a small group of physicians, nurses, and paramedics without ready access

to sophisticated diagnostic equipment, therapeutic facilities or medical specialists. Such variations in the value of stabilization or life-support care also have important implications for the arrangement of treatment facilities.

This thesis attempts to develop a model for the spatial arrangement of emergency treatment facilities which takes into account the significance of epidemiological factors and the relative importance of stabilization and life-support care. This model is developed in Chapter Three of the thesis. The model is intended to be eventually used as a decision aid for emergency medical systems designers. It is hoped that the technique developed here will be refined and then used to improve the effectiveness and efficiency of regional systems of hospital care facilities.

Chapters One and Two introduce the problems associated with the categorization and regionalization of hospital emergency facilities. Basic conceptual issues are explored and research findings are cited when they are available. Three central issues are defined as follows:

1. Is the arrangement of hospital emergency facilities optimally designed in relation to the actual pattern of demands for emergency medical care?

2. Is the pattern of user response appropriately matched to the existing configuration of EMS facilities?

3. Will (can) the providers actually carry out a redesign of the arrangement of facilities on the criteria proposed here?

Chapter Three introduces the model for measuring the "risk" or "coverage" associated with a particular arrangement of emergency facilities. Chapter Four presents a series of interviews with public health officials and regional planners in an attempt to define problems in implementing regional emergency facility plans from a provider standpoint. Chapter Five presents policy recommendations and recommendations for further research.

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REGIONALIZATION AND CATEGORIZATION IN HOSPITAL EMERGENCY PLANNING

CHAPTER ONE

OVERVIEW

This thesis will explore some of the planning considerations associated with the fact that hospitals vary widely in their ability to render high-quality emergency care. This fact implies the need for a regional plan of cooperation between hospitals so that the patient can be brought to a hospital which is appropriately equipped and staffed to provide the necessary care within a reasonable amount of time.

Advances in medical technology and knowledge have made possible increasingly sophisticated emergency care. Such definitive care requires the rapid availability of a wide range of medical specialists together with an array of expensive diagnostic equipment and therapeutic facilities operated by skilled personnel at all times of the day or night. Since the costs in terms of personnel, equipment, and facilities to provide such definitive care are very high, considerations of both effectiveness and efficiency point toward the categorization and regionalization of hospitals' emergency facilities within a metropolitan area.

UNDERSTANDING THE PROBLEM

Categorization is the term which is generally used to describe the procedure of classifying hospitals into groups which have different care capabilities. The primary approach to categorization of hospital emergency care facilities in the United States has been one which classifies hospitals according to the degree of comprehensiveness of the entire spectrum of emergency services which they provide. This approach might be termed vertical categorization.

The major difficulty with the vertical approach is that the importance of time to treatment and the relative efficacy of life-support and stabilization treatment vary with the type of emergency. Knowledge of the pathophysiologic sequence of events (epidemiology) following particular types of medical emergencies has not been utilized in decisions regarding the location of emergency treatment facilities. There is also considerable variation in the degree to which different kinds of emergencies can be stabilized in small hospital emergency rooms by a small group of physicians, nurses, and paramedics without ready access to sophisticated diagnostic equipment, therapeutic facilities or medical specialists. Such variations in the value of stabilization or life-support care also have important implications for the arrangement of treatment facilities.

This thesis attempts to develop a model for the spatial arrangement of emergency treatment facilities which takes into account the significance of epidemiological factors and the relative importance of stabilization and life-support care. This model is developed in Chapter Three of the thesis. The model is intended to be eventually used as a decision aid for emergency medical systems designers. It is hoped that the technique developed here will be refined and then used to improve the effectiveness and efficiency of regional systems of hospital care facilities.

Chapters One and Two introduce the problems associated with the categorization and regionalization of hospital emergency facilities. Basic conceptual issues are explored and research findings are cited when they are available. Three central issues are defined as follows (Schon, 1974):

1. Is the arrangement of hospital emergency facilities optimally designed in relation to the actual pattern of demands for emergency medical care?
2. Is the pattern of user response appropriately matched to the existing configuration of EMS facilities?
3. Will (can) the providers actually carry out a redesign of the arrangement of facilities on the criteria proposed here?

Chapter Three introduces the model for measuring the "risk" or "coverage" associated with a particular arrangement of emergency facilities. Chapter Four presents a series of interviews with public health officials and regional planners in an attempt to define problems in implementing regional emergency facility plans from a provider standpoint. Chapter Five presents policy recommendations and recommendations for further research.

Under the heading of the implementation problem, we consider the effect of local political jurisdictions, hospital financial considerations, intertown rivalries, and the fragmented nature of local public services in inhibiting the cooperation of neighboring hospital emergency facilities within a planning region. These obstacles often interfere with efforts to implement a desired rearrangement of facilities.

The implementation problem refers to the difficulty in obtaining cooperation between facilities in order to improve the arrangement of care capabilities within a planning region.

Categorization

Categorization is the term which is generally used to describe the procedure of classifying hospitals into groups which have different care capabilities. Two approaches to categorization have been taken by health planners. One approach, which might be termed vertical categorization, classifies overall hospital emergency care capabilities according to the degree of comprehensiveness of the services which they provide. Another approach, which might be termed horizontal categorization, recognizes the fact that a hospital may be better equipped to treat some kinds of emergencies than others.

In the United States, the vertical approach to categorization has dominated the thinking of Emergency Medical Services (EMS) planners. For example, the American Medical Association, in the publication Categorization of Hospital Emergency Capabilities (1971), defines four specific categories of hospital emergency services. These categories and the care capabilities required for each are as follows:

> Comprehensive Emergency Service: The hospital shall be fully equipped, prepared, and staffed to provide prompt, complete and advanced medical care for all emergencies including those requiring the most complex and specialized services for adults, infants, and children, including newborns. It shall have a capacity adequate to accommodate the direct and referred patient loads of the region served and be capable of providing consultative support to professional personnel of other hospitals and health facilities in the same region.

Major Emergency Service: The hospital shall be equipped prepared, and staffed in all medical and surgical specialties to render resuscitation and life-support for adults, children and infants, including newborns. It shall also supply definitive care for all such patients except for the occasional patient who requires follow-through care in very specialized units. Transfer may be necessary and shall be under prior agreement with other hospitals.

General Emergency Service: The hospital shall be equipped prepared, and staffed in the medical and surgical specialties necessary to render resuscitation and life-support care of persons critically ill or injured of all ages. The availability of supplementary specialty services shall be prearranged with non-staff specialists. Transfer for patients for specialty care shall be by prior agreement with other hospitals.

Basic Emergency Service: The hospital shall be equipped, prepared and adequately staffed to render emergency resuscitation and life-support medical services for patients of all ages. Transfer when necessary shall be under prior agreement with other hospitals.

There are several alternative vertical categorization schemes (Youmans and Brose, 1970; Yu et al, 1971). In the proposed regulations for categorization of hospital emergency rooms in Massachusetts, the following categories are suggested:

Standby Emergency Services: Each hospital shall be capable of providing resuscitation and emergency life-support services to patients in need of such treatment. Such capability shall include the presence in the hospital at all times of personnel trained in resuscitation procedures, an internal communication mechanism for bringing such personnel to the patient immediately and such equipment and medications, accessible and ready for emergency use, as are necessary.

Routine Emergency Services: The hospital shall be equipped, prepared and staffed to render life-saving services, as well as to render resuscitation and life-support care of critically ill or injured persons whose requirements exceed available staff capabilities, pending transfer to hospitals providing comprehensive emergency treatment.

Comprehensive Emergency Services: The hospital shall be fully equipped, prepared, and staffed to render comprehensive and advanced life-saving services and shall have a capacity adequate to the population and emergency caseload of the population served.

It should be kept in mind when considering these categories that the presence of various resource inputs (physicians, technicians, equipment) does not guarantee high-quality patient care as an outcome. A quality control mechanism involving the monitoring of emergency hospital performance is necessary to insure high-quality patient care.

Planning activities within the area of hospital emergency services in recent years in the United States have emphasized the concept of vertical categorization. Nevertheless, the vertical categorization systems advocated by the A.M.A. and other groups do not take into account differences between types of emergencies in terms of epidemiology or in terms of frequency of occurence. Many health planning authorities (e.g., Boyd, Pizzano and Murchie, 1973) distinguish at least six different types of emergencies. These are - (1) trauma and acute surgical problems; (2) coronary emergencies; (3) psychiatric emergencies; (4) high-risk neonatal and pediatric cases; (5) poisonings; and (6) drug and alcohol overdoses. Each of these may require different systems of cooperative arrangements between hospitals with different points of entry into the system. For example, certain types of coronary emergencies may be relatively more time-dependent than other types of emergencies. Therefore, the coronary patient might well be routed to the nearest standby hospital emergency facility for diagnosis and, if necessary, immediate stabilization and life-support care. On the other hand, a psychiatric emergency patient might well be stabilized by an Emergency Medical Technician in the ambulance and then brought to a major psychiatric facility, completely bypassing the nearby hospital.

A horizontal approach to categorization takes account of the fact that requirements for life-support and definitive treatment facilities may differ by type of emergency. The spatial distribution of demands for emergency service and time factors associated with epidemiological considerations also vary widely by type of emergency. A horizontal approach to categorization classifies hospital emergency facility care capabilities by type of emergency. Advocates of the horizontal approach contend that it permits a closer matching of the spatial distribution of emergency treatment facilities to the spatial distribution of demands for emergency service.

A sample horizontal categorization scheme would classify hospital emergency facilities into four levels of care capabilities for each of the six diagnostic categories of emergencies listed above. The four levels of care capabilities are the following:

Level 1 - Treat even the most serious cases;

Level 2 - Treat all but the most serious cases;

Level 3 - Provide only basic stabilization and immediate transfer;

Level 4 - No capability in the diagnostic area.

Regionalization

Regionalization is the term generally used to refer to the cooperative arrangements between hospitals, physicians, ambulance purveyors, and local governments within a region to deal with different types of medical emergencies. Regionalization plans include definite dispatching and routing procedures involving ambulances and hospitals as well as transfer agreements between hospitals. Regionalization plans and procedures can help to insure that hospital emergency facilities which have been categorized as to their care capabilities are appropriately utilized.

In the interests of improved accessibility, effectiveness and efficiency, the regional planning process must include the taking of an inventory of existing emergency hospital facilities within a planning region. A methodology for detecting deficiencies and duplication of facilities must be developed. The terms "deficiency" and "duplication" have been used widely in the emergency medical planning literature, apparently without any consistent meaning. Criteria for detecting deficiencies in emergency hospital facilities must be defined in terms of the risk incurred due to the lack of immediate availability of appropriate medical coverage. Similarly, criteria for duplication of facilities must consider locations, utilization rates, and capacities in relation to the spatial and temporal distribution of demands for service. The use of the term "duplication" should imply that very little additional risk due to lack of immediate availability of medical coverage would occur if one of the two or more facilities were downgraded or eliminated. It is only by relating an inventory of existing facilities to real clinical need that intelligent resource allocation decisions can be made as to the arrangement of emergency hospital facilities within a planning region. It should be noted that existing and desired transfer patterns of emergency patients between hospitals may cross the boundaries of the planning region. Therefore, cooperative agreements between adjoining regions are a necessary part of the regional planning process.

The American Hospital Association, in its publication Emergency Services - The Hospital Emergency Department In An Emergency Care System, stresses that an individual hospital's future planning in the area of emergency care must take into account many interrelated factors:

> The most important of these are the actual and the planned services in nearby institutions. In addition, the immediate environment must be taken into account: existing or projected housing development, industrial plants, schools, nursing homes, and other institutions; predictable changes in the density or character of the population; adequacy of public transportation; and established or anticipated patterns of hospital utilization by residents and physicians. Observable trends in conditions presented by patients also should be noted. For example, recent studies of emergency department patients suggest a need for concentrated alertness to new patterns of drug use and to certain kinds of accidents, such as lawnmower injuries, that occur with increasing frequency.

Recent planning activities by the Federal government in the Emergency Medical Services area have centered around the concept of a "comprehensive systems approach". Dr. John Hanlon (1973), an Assistant Surgeon General and Coordinator for Public Health Programs, Health Services Administration, feels that:

> There are gross inadequacies in planning, training, equipment, and especially coordination. To approach the problem perhaps backwards, there has been a duplicative and often wasteful proliferation of emergency rooms (not necessarily emergency departments) regardless of need. Often they seem to have been established to meet hospital accreditation standards or to provide a base of inpatients.
>
> The following examples of lack of planning cooperation, and systematic approach in the emergency medical field are the rule rather than the exception: hospitals individually developing emergency departments independently of each other and unrelated to ambulance services; satisfactory communications equipment in ambulances but not in hospitals;

good equipment but no trained personnel; satisfactory hospitals and ambulances but no means of access to the system or no central dispatch; good on-site and in-transit care but no preparation at the hospital; bypassing a hospital with a coronary care unit to deliver a cardiac patient to an inappropriate or ill-equipped and staffed institution; no ambulance service beyond a city's limits or at night; and either no ambulance or several at once with attendants arguing as to who gets the patient. Examples are legion and common knowledge.

Issues for Planners

In addition to the problem of coordinating hospital emergency departments, ambulance services, and communications capabilities, there are several major planning issues involving hospital emergency facilities alone. The first of these might be labeled the facilities arrangement problem. This problem can be stated in the following way:

> "Given a limited quantity of resources available for emergency hospital facilities, what is the best way to arrange these facilities (in terms of care capabilities and location) within a planning region?"

The second planning issue might be termed the matching problem. The matching problem can be phrased as follows:

> "Given a fixed arrangement of facilities with varying levels of care capabilities, how can we insure that these facilities are appropriately utilized by various types of emergency patients?"

The third planning issue might be referred to as the implementation problem. The implementation problem, as previously mentioned, can be phrased as follows:

> "Will (can) the providers actually implement a redesign of the arrangement of facilities based on the application of a planning model?"

The facilities arrangement problem is actually a special kind of optimization problem and thus falls within the purview of operations research. A solution to this problem, which is attempted in Chapter Three of this report, is important to the improvement of resource allocation decisions within a planning region. The solution to the problem depends very heavily on epidemiological considerations associated with the type of emergency under consideration. Although most planners agree that there should be some system for categorizing facilities, a systematic procedure for determining the relative desirability of a particular arrangement of facilities has not yet been devised.

The facilities arrangement problem discussion has as its focus the improvement of the emergency medical system's potential for delivering emergency medical services if patients utilize the appropriate facilities for their emergency care needs. The matching problem refers to the fact that emergency medical systems in operation never live up to their potential because patients often do not utilize available facilities appropriately. As Gibson (1973b) notes:

> "Many patients are treated in hospital emergency departments woefully deficient in necessary resources; and many other patients presently treated in hospital emergency departments for non-urgent conditions could more appropriately be treated in alternative ambulatory care settings."

Gibson defines the two types of mismatches as System Under-Response and System Over-Response. System Under-Response is defined as an event in which "a patient is treated at an emergency department lacking resources clinically needed for his condition" and System Over-Response is defined as an event in which "a patient is treated at an emergency department with resources in excess of those needed for his condition."

In Gibson's (1973b) study of the emergency medical system in metropolitan Buffalo, New York, System Under-Response was present to the degree that:

> "Of the emergency visits (that is, life-threatening). . . no less than 41 percent were treated at facilities lacking necessary resources."

With regard to System Over-Response Gibson found that:

> "The most specialized facilities have a higher rate of inappropriate use than the least specialized. Thus, for the comprehensive facilities, about half of the patients did not need an emergency department at all, while practically all of the remainder needed a far less specialized one."

Critically ill or injured patients in outlying or suburban areas often do not receive treatment at the comprehensive facilities which are often located in the central city (see Gibson, 1973). There may be several reasons for this phenomenon, in addition to the problem of an inappropriate spatial arrangement of facilities. Patients are often reluctant to visit the comprehensive emergency facilities which are often located in slum areas of large cities. The patient's physician may be reluctant or unable to refer him to a comprehensive or teaching hospital since the physician may not have admission privileges at the hospital (Gibson, 1974). Ambulance attendants and policemen often take the patient to a nearby hospital within the same political jurisdiction rather than a hospital in another political jurisdiction that might have more appropriate care capabilities for the type of emergency under consideration. Finally, hospitals may be reluctant to encourage the rerouting of emergency patients to other hospitals since the hospital's occupancy rate might drop as a result.

The matching problem might be perceived as largely a public education problem. A study of Emergency Medical Services In The City Of Boston (Kleinman et al, 1972) indicates that 87 percent of the emergency room patients provided for their own non-ambulance transportation. Hence, the public must be kept informed as to which emergency facilities are appropriate for a given type of emergency. A central regional dispatch facility, such as that provided in some areas on telephone number "911", could help direct patients to the nearest appropriate facility or dispatch an ambulance if judged necessary by the dispatcher. The Boston finding that only 16 percent of those cases considered true medical emergencies arrived by ambulance emphasizes the need for both improved ambulance service and better public information.

The implementation problem is caused by many of the same political, financial and institutional factors that cause the matching problem. However, the two problems are conceptually distinct. The matching problem refers to the inappropriate utilization of an existing arrangement of facilities. The implementation problem refers to the difficulty in obtaining cooperation between facilities in order to improve the arrangement of care capabilities within a planning region.

Among the factors which contribute to the implementation problem are considerations related to hospital financing, inter-town rivalries, political and jurisdictional considerations, and the lack of formal mechanisms for inter-hospital cooperation.

The question of hospital financing, which is discussed in Chapter Two, hinges largely on the effect of hospital admissions from the emergency room on the hospital's census. If certain kinds of emergency patients are rerouted to another hospital, the first hospital may experience an adverse effect on its census. This problem is likely to be particularly acute for hospitals with an excess capacity of beds. A recent study by a Minneapolis health research firm - Interstudy - indicates that the U. S. currently (mid-1974) has 60,000 excess hospital beds with 7,000 more expected by the end of 1974 (quoted in the Washington Post, September 12, 1974).

It seems clear that gains and losses of patients with certain kinds of emergencies affects a hospital's financial status in a complicated way. Research now beginning at the University of Pennsylvania (Hamilton et al, 1974) and elsewhere is aimed at delineating these effects by developing "improved methods and data for assessing the economic impact of EMS financing and delivery mechanisms now in use or under consideration."

The Pennsylvania researchers feel that the lack of understanding of the economics of emergency medical systems inhibits the development of regional emergency medical planning. They anticipate that "documented case studies and guidelines for projecting the costs and revenue implications of proposed improvements will help to encourage local communities to consider organizing regional EMS systems." In addition to the impact on hospital emergency admissions, another important question involves the cost of upgrading or downgrading a hospital's emergency facilities to meet new categorization standards. It is important to identify actual (as distinguished from accounting) financing mechanisms and operating costs so that decision-makers can project the costs and potential revenues associated with proposed modifications to hospital emergency facilities.

In addition to the economic impact (costs and financing) of regionalization of hospital emergency facilities, the political impact on individual towns within a region must be considered. Neighboring towns often develop fierce rivalries and hospitals in such towns often compete with each other in providing emergency health services. A regional planning decision which proposes the upgrading of a facility in one town and the downgrading of a facility in another town might be politically unpopular and very difficult, if not impossible, to implement. Residents of the town whose hospital emergency facility has been downgraded might continue to use the facility as a matter of habit, civic loyalty, or convenience. It is the current practice of many law enforcement officials and ambulance services to bring patients to hospitals within the same political jurisdiction, even though the emergency facility in a neighboring jurisdiction might be far superior for the particular type of emergency under consideration.

The issues for planners introduced here and other conceptual issues associated with regionalization and categorization will be explored in Chapter Two of this report. A survey of hospital emergency care capabilities in the greater Boston area will be reported in Chapter Three. A quantitative model of regional emergency medical services "coverage" will be developed in Chapter

Three and the survey data from the Boston area will be used as an illustration of the applicability of the model. Chapter Four will focus on problems of implementing regional hospital emergency facility plans and will include reports of personal interviews of public health officials representing professional organizations, hospitals, and various levels of government.

As mentioned, Chapter Five will present policy recommendations regarding categorization and regionalization proposals. These recommendations will be presented in the light of the quantitative model, personal interviews, and conceptual issues discussed in the preceding chapters.

CHAPTER TWO

CONCEPTUAL ISSUES IN REGIONAL EMERGENCY HEALTH FACILITY PLANNING

INTRODUCTION

The major conceptual issues in the regional planning of emergency medical facilities involve the evaluation of the accessibility, quality, and efficiency of those facilities. Evaluative research in the Emergency Medical Services Systems area has been sporadic and uneven at best and normative categorization criteria for personnel and facilities have been developed from negotiation and expert opinion rather than research results. Furthermore, budget decisions regarding the quantity and location of additional EMS facilities and personnel have not been tied to data regarding the incidence, type and location of medical emergencies.

The resource allocation problem, then, exists on several levels. First, there has been little attempt to match the number and kind and location of facilities provided with the expected spatial distribution of the number and kind of medical emergencies within a region. Secondly, the standards for facilities which are designed to provide adequate care capabilities for particular kinds of emergencies have not been based on empirical findings regarding outcomes of particular kinds of treatment conditions. Thirdly, there has been little assessment of the quality of care or efficiency of medical services provided to non-emergency patients in an emergency room. The role of the emergency room in relation to other components in the health care system has not been well thought out and, as a result, "it is the twenty-four-hour rain barrel of ambulatory health care to collect everyone else's leaks" (Gibson, 1973a). Recent studies (e.g., Lavenbar et al, 1968 and Kleinman et al, 1972) indicate that no less than one-half to two-thirds of all urban hospital emergency room visits do not represent clinical emergencies.

In summary, the problem of evaluating changes in the system in order to determine what constitutes an improvement in emergency hospital services has not been adequately addressed in the literature. Public officials who have the responsibility of allocating scarce resources to improve the EMS must choose between a large array of options. A method must be chosen in order to specify the relative payoff for each available option. This involves establishing a context to evaluate research results and then performing the necessary research studies. It is clear that some victims of medical emergencies would die or be disabled no matter what kind of or how fast treatment is applied while others would survive and wounds would heal even in the absence of medical help. EMS research is aimed at discovering which medical interventions in which timeframes pay off in terms of avoiding death and disability. Given a limited budget, EMS decision-makers must try to obtain maximum coverage for that level of cost. Additional budgets are best justified when it can be shown that present monies are well allocated and the additional funds can provide expanded coverage that could not be obtained by reallocating present funds.

This chapter will focus on each of these conceptual issues in turn. We will discuss: (1) the regional planning process and the relationship of the arrangement and care capability categories of facilities to patterns of demand; (2) the overall measurement problem and the relationship of categorization standards to outcomes; (3) the treatment of non-emergency patients in the emergency room; and (4) the regional resource allocation decision problem. Relevant findings from the research literature will be cited where appropriate.

THE REGIONAL PLANNING PROCESS

The regional planning process was described in Chapter One as essentially a three-fold problem - arrangement, matching, and implementation:

1. the arrangement of treatment facilities as resource inputs in relation to patient needs;
2. the pattern of utilization which matches patients to treatment facilities as a part of the process of Emergency Medical Services system operation; and
3. the implementation of desired system modifications

(see Gibson, 1974).

The Arrangement Problem

The arrangement problem may be viewed as one of reconciliation between conflicting needs for accessibility, quality of care and efficiency. Ideally, from the standpoint of quality of care and accessibility, comprehensive treatment facilities would be located on every street corner. Unfortunately, such a system would be hugely costly and inefficient. Ideally, from the standpoint of system efficiency, all treatment facilities would be appropriately utilized at full capacity. Unfortunately, such a system would not provide equal access for all victims of medical emergencies, since demand is insufficient in some areas to permit facilities to operate at full capacity. In these areas, system planners must trade-off accessibility against efficiency.

One strategy for dealing with these conflicting requirements for accessibility, quality of care and efficiency is the categorization of hospital emergency facilities within a region. We have previously defined categorization as the segmentation of hospital emergency facilities into groups which have different functions. One approach to categorization, by overall levels of services, has been proposed by the A.M.A. and other groups. This approach, which we have termed the vertical approach, classifies hospitals according to the degree of comprehensiveness of the entire spectrum of emergency services which are provided. This approach can be used to promote the accessibility of basic or routine facilities which can provide life-support and resuscitation care for most kinds of emergencies while encouraging efficiency in the provision of the highly specialized and expensive definitive services which are available around the clock in a comprehensive facility.

A more sophisticated approach to categorization, which we have termed the horizontal approach, segments hospitals according to their care capabilities in each of several diagnostic categories. These diagnostic categories include trauma, coronary, high-risk neonatal and pediatric, psychiatric, poison, and alcohol and drug abuse. The horizontal scheme takes into account that the conflicting requirements for efficiency, accessibility and quality of care may vary according to the epidemiology of a particular type of emergency. For example, coronary emergencies are often very time-dependent. Accordingly, the decentralization of coronary care stabilization and life-support capabilities may be very desirable in terms of accessibility which is the critical dimension in this case. On the other hand, psychiatric emergencies may be stabilized by non-specialists so that centralized facilities staffed by highly trained specialists may be most desirable in terms of quality of care and efficiency which are more important in this case provided that the patient can be stabilized in a non-medical setting. Horizontal categorization also permits the location of specialized facilities close to demonstrated patient needs. For example, a trauma center might be located near a freeway, a high risk neonatal and pediatric center in a demographic area with a large number of young children, or an alcohol and drug abuse center in the inner-city. Horizontal categorization allows for more flexibility in system planning since accessibility, efficiency and quality of care trade-offs can be made for each diagnostic category according to the epidemiological requirements, needs of the population, and available financial resources.

The accessibility, efficiency, quality-of-care trade-off is inherent to emergency medical services system planning. The problem is particularly acute in low population density areas since the need for facilities is often not great enough to justify the cost of facilities. Similarly, the incidence of certain kinds of emergencies is greater at some times of day than at others. For this reason, many rural hospitals have a doctor present in the hospital during the day and early evening, but not at night. It is clear that accessibility and hence, the effectiveness of medical care suffers (to an unknown extent) by having the physician on call rather than at the hospital. As long as individual hospitals are required to be solvent, many of the accessibility/efficiency trade-offs are likely to be resolved in the direction of efficiency. In this regard, Mangold (1973) notes that "many rural hospitals have the dilemma of moral need to provide emergency care, yet inadequate utilization to meet its costs and provide a stimulating environment for physician practice."

Another illustration of the accessibility, efficiency, quality-of-care trade-off is the need for high quality care and productivity at the level of the individual hospital. One study of coronary care units (Bloom and Peterson, 1973) indicates that larger units have lower diagnosis-specific fatality rates, and greater productivity. One consequence, however, of larger units is greater centralization and less accessibility, given the number of beds in the system remains constant. Clearly, accessibility losses under conditions of optimal facility efficiency and quality of care will have less severe consequences for those types of emergencies in which the time to treatment is not as critical as it is in other emergencies or for emergencies which occur in populated areas dense enough to support a large facility which is easily accessible to everyone. In terms of the effectiveness of care, the need for decentralization of facilities depends on the type of emergency. Ceteris paribus, the greater the need for dispersal of facilities, the more difficult it will be to achieve efficient resource utilization. This variation by care capability requirements in the degree of decentralization needed is an argument for the selective categorization of facilities by type of emergency.

The Implementation Problem

A major barrier to accessibility and quality of care, as we have seen, is the level of overall funding in the system. Even if all facilities are operating at optimal efficiency, lack of funds may prohibit the opening of needed facilities. As the overall level of funding in the system increases, one might expect it to become more and more difficult to achieve the optimal efficiency frontier since marginal increments are likely to be for facilities that are designed for rarer types of emergencies and thus less frequently utilized.

Another major barrier to accessibility, efficiency, and quality of care is simply the lack of regional planning. A reasonable determination of the number, type and location of facilities required within a region is rarely made. Furthermore, financial requirements of individual facilities for solvency often create region-wide inefficiencies. Mangold (1973) points out that:

> A hospital may have an emergency department because it cannot tolerate the patient drain resulting from a neighboring hospital's having a functioning department of emergency medicine. This overt duplication of services can be called irresponsible, but frequently an administrator feels compelled by competition to make such a decision. Such situations point up the need for a program of categorization and regionalization.

Mangold, a senior partner in a group of emergency physicians which contracts and consults for a group of hospitals in

California, notes that "as inpatient occupancy rates decrease, many hospitals have turned toward an 'open-door' policy in their department of emergency medicine in an attempt to provide ambulatory health care delivery and thereby increase their admissions rate." He points out that in a southern California hospital with a "fairly typical 'open-door' emergency department":

> "24 percent of total admissions were via the emergency department and accounted for 29 percent of total inpatient days and for 34 percent of total inpatient revenue. It is logical to assume that patients entering via the emergency department are more seriously ill than the routine hospital admission, remain in the hospital longer, and utilize a greater percentage of diagnostic and therapeutic modalities than the non-emergency patients."

Since Mangold collected data from only two hospitals, more research is needed in order to confirm his findings with regard to emergency inpatient admissions. If Mangold's data are valid, they point to a possible difficulty in regional emergency facility planning. Since hospitals often establish emergency rooms as a base of inpatients, there may be a negative financial incentive to transfer patients to another hospital for follow-through care in specialized units after initial resuscitation and life-support care is rendered in the emergency room. Since reliable data apparently does not now exist as to how many transfers actually occur, it is difficult to test this hypothesis at this time.

The Matching Problem

The consequences of the transfer problem might lead us to divide Gibson's (1973b) concept of System Under-Response into two components - System Under-Response A and System Under-Response B. System Under-Response A is defined here as an event in which a patient does not receive adequate resuscitation and life-support care during the necessary timeframe while System Under-Response B is defined here as an event in which a patient does not receive definitive follow-through care after successful initial resuscitation.

The financial argument presented by Mangold may be a significant cause of System Under-Response B. Mangold points out that, in his example:

> 26 percent of all admitted patients from the emergency department went to a coronary care or intensive care unit. Consequently, while the emergency department may appear to be losing money according to traditional cost accounting methods, it can have a profoundly positive financial impact upon the hospital.

In addition to financial impediments to the transfer of patients there are also legal barriers. The hospital may be legally liable for the patient's welfare during transfer. In many states, an acute general care hospital has a legal obligation to treat all patients who present themselves. In other states, elaborate bureaucratic procedures must be followed in order to justify transfer of a patient (Rose, 1974).

All of these factors make it more difficult to eliminate System Under-Response B, given that the initial receiving hospital is not adequately equipped to provide definitive care for the emergency patient. The need to reduce System Under-Response B would seem to place particular importance on the correct initial routing of the patient. Unfortunately, this may lead to an increase in System Under-Response A. It is quite difficult to control initial routing, even if desired, since the majority of emergency cases do not arrive by ambulance. In the Boston study by Kleinman et al (1972), only 16 percent of those cases considered true medical emergencies arrived by ambulance.

In summary, it is difficult to prevent System Under-Response B because of financial, legal, and operational difficulties. This may have unfortunate consequences for quality of care, in cases where the patient requires very specialized follow-through care. This issue will be explored in greater detail later in this chapter.

The Measurement Problem

System effectiveness can be defined in three ways - in terms of availability of resource inputs, process measures of resource utilization, and quality of system outputs.

Input Measures

An input measure of system effectiveness is based on a comparison of clinical care capabilities within a region with the expected distribution of the number, kind and location of medical emergencies. If there is no facility or inadequate facilities for a given type of emergency, a system error may be said to have occurred. The definition of inadequate facilities is in terms of quality, quantity, and location. Hopefully, the quality standards will be based on empirical data regarding the effectiveness of various forms of treatment. This procedure would link an input measure of system effectiveness to care capability standards based on outcome measures. Unfortunately, most current care capability standards are developed from negotiation and expert opinion rather than research results.

The importance of system input error due to location would depend on the type of medical emergency. Epidemiological considerations associated with the type of emergency would determine the degree of decentralization for that specific care capability required within the region. One should also distinguish between the location of initial life-support and resuscitation capability and the location of definitive treatment facilities for specialized follow-through care. In the latter case, specific location within the region becomes less important provided transfer is feasible. Finally, a system effectiveness measure at the resource input level must verify that the supply of specialized treatment facilities is adequate to the average demand for them. Although a detailed measure of facility capacity in relation to a wide variety of demand contingencies is really a process measure of the system in operation, the input measure can check supply against long-run demand averages. An input measure meeting the above criteria is defined in Chapter Three.

Process Measures

Process measures of system effectiveness often focus on the appropriate utilization of facilities. Gibson's (1973b) concepts of System Under-Response and System Over-Response are excellent examples of process measures. Gibson (1973b) points out that, although appropriate resources for a given type of emergency are often available within a region, the patient often does not utilize them correctly:

> Highly specialized Trauma Centers at large teaching hospitals are often under-utilized as a result of trauma patients being treated at small community hospitals lacking needed emergency resources. Well-staffed and well-equipped large emergency departments often treat fewer critically ill patients than the smaller less adequate emergency rooms.

It should be pointed out again that EMS planners do not have great control over appropriate utilization since a majority of emergency cases do not arrive by ambulance. Gibson feels that the problem is best defined as "patient under-response" and feels that significant improvements can only come about if an effective way of educating the public can be found. As we have discussed earlier, there are considerable barriers to transferring a patient after his initial arrival at an emergency room - so public education becomes increasingly important. Law enforcement officials must also be encouraged to bring emergency patients to the most appropriate facility even if it involves crossing jurisdictional lines. The major conceptual problem in the area of process measures is the definition of an "acceptable" level of System Under-Response. In Gibson's (1973) study of metropolitan Buffalo:

> no less than 41 percent (of the life-threatening emergencies) were treated at facilities lacking necessary resources . . . An emergency system which under-responds to four in ten of the most critical patients is costing lives and avoidable disability.

One approach to reducing System Under-Response would be to rearrange the location of Comprehensive and Major emergency facilities within a region. Since patients might be expected to come to the nearest facility, relocating Comprehensive and Major facilities closer to the location of a larger number of emergencies should reduce System Under-Response. Another approach to reducing inappropriate utilization has been taken in the Soviet Union and will be discussed in a later section of this chapter.

The point is often made that changing the level at which categorization standards are set will change the pattern of patient utilization of hospital emergency facilities. Since we have seen that patients often under-respond in selecting a treatment facility, the effect of changing the categorization standards are not at all clear and cannot easily be estimated.

Output Measures and Research Results

Measures of system effectiveness based on the quality of system outputs are the most difficult to obtain (see Willemain, 1974). The whole issue of quality control is fraught with emotion within the medical profession (witness the debate over Professional Standards Review Organizations at the 1974 Medical Association convention; New York Times, August, 1974). The approach to quality control in the medical profession has traditionally been through the specialty board certification process rather than through the continuous monitoring of patient care. The recent establishment of Emergency Medicine as a board-certified specialty should help to improve the quality of initial life-support and resuscitation care. A requirement that all emergency room physicians be board-certified or board-certifiable could go a long way toward improving the quality of initial life-support and resuscitation care. However, since the quantity of board-certified emergency physicians is currently very limited, this proposal would be impractical at this time, since it would reduce the number of physicians eligible to practice in the emergency room.

The interface between the emergency room physician and inpatient hospital specialists is often a source of professional and administrative confusion in American hospitals. Thus, the quality of follow-through care requiring surgery or intensive care in very specialized units is highly variable and may be unrelated to the quality of initial life-support care.

An interesting study of vehicular fatalities caused by abdominal injuries by Gertner, Baker, Rutherford, and Spitz (1972) bears on the question of quality of inpatient care. These authors found an interesting relationship between the type of hospital and the number of deaths due to abdominal injuries in cases where the deaths occurred a considerable time after the accident. More deaths would be expected on the basis of the distribution of all motor vehicle-related injuries seen in the city occurred in the six hospitals which see the fewest highway injuries while fewer than the expected number of deaths occurred at the two university hospitals. The authors conclude that "the uneven distribution of deaths, suggesting that hospitals differ substantially in their ability to provide emergency care to the severely injured, supports the current campaign for a system of categorization of emergency care facilities of all hospitals." It should be noted that this study is one of only a few clinical studies of its kind and is based on a sample of only thirty-three cases.

The findings of Gertner et al (1972) bear on the second question presented at the beginning of the chapter - the relationship of categorization standards to patient outcomes. It is interesting that standards for emergency room physicians stress experience and knowledge in the handling of emergency cases while standards for inpatient hospital specialists do not. The Gertner findings suggest that hospitals which specialize in treating certain kinds of emergency admissions offer higher quality care than those inpatient facilities which have less experience in treating emergency admissions. Thus, experience on the part of inpatient hospital specialists in treating emergency admissions might be a more appropriate categorization standard than the mere presence of specialists and intensive care facilities at the hospital.

Duplication of inpatient emergency care facilities within a region may create a situation in which no one hospital staff gains sufficient experience with emergency patients to provide optimal quality of care. There is evidence from a study by Bloom and Peterson (1973) that larger coronary care units have greater productivity and lower fatality rates within diagnostic categories. Thus, the distribution of resources within a region may affect quality of care. In metropolitan areas, strong interdependencies exist so that if one hospital establishes a coronary care unit, for example, it would affect the utilization rate of a coronary care unit in a neighboring hospital. In such cases, according to Bloom and Peterson (1973), "it is clear from recent history that if decisions about provision of coronary care units are left to individual hospitals, excess capacity and inefficiency will result. These decisions must be made by bodies that are disinterested and have a broader view than that of a single institution."

In rural areas, survival rates are greatly affected by the quality and timeliness of initial emergency care at the scene of the accident. A study by Frey, Huelke and Gikas (1969) of motor vehicle accidents in a rural area indicates that 15 to 20 percent of the fatalities might have been salvaged "by a more perfect system of care of the injured than now exists". Frey et al note that some of the "salvageable" cases required sophisticated surgical procedures which could not have legally been performed by non-physician rescue workers. In one case, salvage "would have depended on the near-instantaneous activation of a perfect emergency retrieval system". Willemain (1974) notes that other studies indicate "further reason for caution in extrapolation from the results of Frey et al (1969)".

However, the study by Frey et al was one of the few which attempted to state the elements required to improve the care of the injured at the scene of the accidents, in transit to the hospital, or at the hospital. These authors studied autopsy reports of accident deaths in order to pinpoint "those skills and techniques most likely to augment survival of the injured patient". The skills and techniques could then be incorporated into a curriculum for training rescue workers and emergency physicians. Frey et al found that many of the ambulance attendants who responded to these emergencies were poorly equipped and inadequately trained. With reference to rural hospital facilities, these authors point out that "hospital facilities to which patients were delivered often were not staffed for night emergencies, and had to call a physician from his home to attend the patient. Some hospitals were unequipped in terms of specialty staff, operating room crew, or blood bank to deal with a person suffering from multiple injuries."

As previously noted, very few input and process standards (such as the availability of specialists and sophisticated equipment) have been validated in terms of their effect on patient outcomes. Thus, at present, we have no way of knowing "what innovations in either medical treatment or surgical treatment, or in the system itself, are really paying off" (Baker, 1971).

There are three major factors in determining the outcome following a medical emergency. These are: (1) the quality of initial life-support care; (2) the time interval between injury and the delivery of this care; and (3) the quality of definitive follow-through care. The second factor, which involves knowledge of the epidemiology of the illness or traumatic event, may be critical in determining the probability of success of the emergency treatment. For example, in the case of myocardial infarction, "approximately 50 to 65 percent of heart attack deaths occur within the first hour of the attack" (Sidel et al, 1969). An emergency medical system must respond very quickly if it is to have any chance at all of salvaging these cases.

The epidemiology of coronary failure is such as to encourage decentralization of life-support facilities for coronary care. As we have seen from the Bloom and Peterson (1973) study, it may be desirable from the standpoint of quality of care and system efficiency to limit definitive coronary care units to a few of the larger emergency facilities within a region. If sophisticated hospital personnel and facilities are necessary to significantly reduce medical risk, the contradictory requirements for accessibility, efficiency, and quality of care may be difficult to resolve. If relatively inexpensive stabilization and life-support care can significantly reduce medical risk, then a policy of transfer of many patients from a resuscitation and life-support facility to a definitive coronary care unit in another hospital after stabilization might be desirable. This policy would successfully resolve the trade-off between accessibility, efficiency and quality of care. Care must be taken, however, to minimize at-risk factors during transfer by utilizing ambulances staffed by emergency medical technicians and equipped with cardiac drugs, defibrillators, and facilities for telemetry transmission of the electrocardiogram from the vehicle to the receiving hospital. Considerations of the effectiveness of stabilization and definitive care on reducing medical risk for various types of medical emergencies and the implications of these considerations for the arrangement of hospital emergency facilities are considered in greater detail in Chapter Three.

Based on epidemiological studies of coronary heart disease (Yu et al, 1971), a committee of cardiologists have proposed a stratified system of coronary care. These physicians state that:

> "Because preventable deaths are occurring before patients reach medical attention, the delay between onset of symptoms and the establishment of effective monitoring and therapy must be shortened. . . Stratified coronary care means that medical facilities within a community are organized into a system consisting of three levels of capability:
>
> 1. Life-support Units to prevent and treat cardiac arrhythmias, to perform cardiopulmonary resuscitation and to stabilize patients before transfer to a Coronary Care Unit. Ambulances and all hospital emergency areas should have this capability.
>
> 2. Coronary Care Units for definitive and continuing hospital care including facilities for intermediate coronary care.
>
> 3. A Regional Reference Center for comprehensive cardio-vascular care".

In order to maximize the effectiveness of these life-support units, they must be strategically located within a planning region. A methodology for measuring the relative desirability of particular arrangements of facilities is given in Chapter Three.

TREATMENT OF NON-EMERGENCY CASES IN THE EMERGENCY ROOM

Several researchers have reported the proportions of emergent, urgent, and non-urgent visits to the emergency room in an attempt to identify those who might reasonably be treated in another setting. In the study of Boston area emergency rooms by Kleinman et al, 1972, 15 percent of all visits were classified as emergencies, 57 percent as urgent, and 28 percent as non-urgent. In a study of New Haven emergency rooms by Weinerman et al, 1966, 6 percent were rated as emergent, 36 percent as urgent, 56 percent as non-urgent and 2 percent could not be classified. It is unclear whether these differences in proportions reflect genuine variation between metropolitan areas, or simply differences in criteria and definitions. In the Boston study, the following definitions are presented:

1. Emergency - needs medical attention immediately to avoid possible loss of life or permanent harm.
2. Urgent - needs medical attention within a few hours to avoid possible loss of life or permanent harm, and/or needs medication for <u>pain</u> (other than aspirin).
3. All other conditions.

In the New Haven study, the definitions are as follows:

1. Emergent - Condition requires immediate medical attention; time delay is harmful to patient; disorder is acute and potentially threatening to life or function.
2. Urgent - Condition requires medical attention within the period of a few hours. There is possible danger to the patient if medically unattended; disorder is acute but not necessarily severe.

3. Non-urgent - Condition does not require the resources of an emergency service; referral for routine medical care may or may not be needed; disorder is non-acute or minor in severity.

It is interesting that the New Haven definition distinguishes emergent from urgent on the basis of severity as well as time contingencies whereas the Boston definitions stress only the time factor in distinguishing the urgent condition from an emergency. This difference may account for the higher proportion of emergencies in the Boston sample.

Whatever the exact proportions of emergent, urgent, and non-urgent visits, it seems clear the emergency room is playing an increasingly important role in the delivery of primary medical care. Gibson (1973a) points out that:

> "Patients are much more likely to receive their health care through an emergency department if they are black rather than white, young rather than old, poor rather than rich, poorly educated rather than well-educated, and urban rather than rural dwellers. If these characteristics are combined, as they undoubtedly are in many inner-city areas, it is likely that emergency dearrtments provide no less than 75 to 80 percent of all health care received by ghetto populations. . . In most inner-city areas, private physicians who relocate or die are not being replaced and contribute to a situation where large concentrations of low-income groups have neither physical nor financial access to a private ambulatory health care system."

It should not be assumed automatically that the utilization of the emergency room for primary medical care is inappropriate. As in any evaluation, this determination should be made on the basis of an assessment of the accessibility, quality of care, and efficiency of the service. Although there has only been one study that we could find on the quality of care received by non-emergency cases in the emergency room, this study does indicate that the treatment of these cases in an emergency room setting leaves much to be desired. In the study by Brook and Stevenson (1970), "the health system exerted a positive effective action in only 38 out of 141 patients (27 percent)". These authors conclude that:

> "By every criterion included in this study, the medical care was both inefficient and inadequate. The house staff performed incomplete physical examinations and too few routine laboratory tests for these patients. A rewarding physician-patient relationship was lacking, as indicated by the few patients who knew why they were scheduled for diagnostic x-ray studies or who learned the results of such procedures. When responsibility shifted from the emergency room appointment delays resulted in further inefficiency. . . The emergency room, staffed by interns and residents working long hours and psychologically prepared to handle catastrophies, must also handle an increasing case-load of non-emergency problems requiring integration of diagnostic and therapeutic services over a given period. The quality of care received by these patients is largely a matter of conjecture since no follow-up studies on non-emergency cases seen initially in the emergency room have been reported in the medical literature in English."

Gibson (1973b) cites data indicating that non-emergency care which is rendered in an emergency care facility becomes increasingly expensive as the facility becomes more comprehensive. He states that:

> "System over-response (a patient going to a facility with more resources than necessary) represents a prodigal waste of expensive resources and indeed, excess system costs for the same treatment. Standardized patient charges per visit, for example, were $40.05 at comprehensive facilities, $26.39 at major facilities, $19.48 at general facilities and $8.25 at basic facilities."

One of the goals of primary medical care is the consideration of the patient as an individual. Follow-up care, multiphasic screening and a personal relationship with a particular physician or medical group are all considered to be components of good primary care (Webb, 1969). In emergency medicine, on the other hand, the response must be to the crisis itself and the stress is on appropriate treatment within a reasonable timeframe. Emergency care is by nature episodic and continuing care cannot reasonably be expected to be provided in an emergency setting.

Emergency Medical Services In The Soviet Union

In order to help structure the discussion of alternative means of providing Emergency Medical Services delivery systems, a brief description of the Emergency Medical Service system in the Soviet Union is presented (from Scribner et al, 1974 and Storey and Roth, 1971).

The most striking difference between the Soviet and American systems can be found at the process level. In the Moscow EMS, it is possible to greatly reduce System Under-Response and System Over-Response because, once the patient has dialed "03" to enter the system, the system decides where the patient should go. In order to enter the system, the patient or passerby simply dials "03" from a public telephone (a free call). The call is received by a physician or feldsher (a highly trained paramedic at a central telephone dispatch). The dispatcher takes a brief history and decides whether the situation is emergent or not (a possible source of system error).

The basic philosophy of the Skoraya (as the EMS central organization is called) is to "Send the doctor to the patient". If the situation is considered by the dispatcher to be emergent, a specially equipped ambulance with the appropriate specialist is dispatched from one of the 22 regional aid stations. The dispatcher has at his disposal an up-to-date listing of the bed situation at each of the city's emergency hospitals. The dispatcher can thus direct the delivery of the patient to the appropriate facility.

The modus operandi of the Skoraya is to apply life-saving and life-supporting measures at the scene of the accident and during transportation rather than merely transporting patients to the hospital as rapidly as possible. There are six specialty medical brigades manning the specialty ambulances: cardiology, trauma and shock resuscitation, toxicology, neurology, acute abdomen, and pediatric emergencies.

In Moscow, there are five hospitals which are dispersed geographically throughout the city and which receive the vast majority of emergency hospitalization. Scribner et al, 1974, point out that each of these hospitals has:

> "specialty wards analogous to the specialty brigades previously described. On these wards, the EMS specialist gains expertise in the treatment of emergency diseases. He also gains follow-up experience and thus receives feedback on the quality of his treatment at the scene. Surgery, of course, is performed by surgeons, but the Skoraya specialist will participate in pre-operative and post-operative patient management."

The Moscow system is interesting because it greatly reduces the inappropriate utilization problem which plagues American EMS systems in metropolitan areas. System Over-Response A is greatly reduced by sending life-support and resuscitation teams to the scene of the emergency (a problem may occur here if the nearest specialty ambulance is on another call or if the emergency victim or a passerby fails to call the emergency number). System Under-Response B might be reduced since the specialized emergency hospitals receive almost all of the emergency admissions. In rural areas, patients are transferred to regional centers or major medical institutes as the severity of the illness warrants.

By removing the inappropriate utilization problems at the process level, the Russian system permits a much cleaner study of the relationship of resource inputs to medical outcomes than does the American system. The accessibility/efficiency trade-offs at the input level that exist in the American system are also present in the Russian. The Russian system, because of the way it is organized, permits research on quality of care to be incorporated more quickly into standards for resource inputs.

It would be interesting to contrast the Russian and American EMS systems in terms of actual beneficial outcomes in the management of emergency illness. Unfortunately, the data are not available to do this. One might hypothesize that because emergency patients are hospitalized in specialized emergency hospitals, the kinds of barriers to quality emergency inpatient care discussed by Gertner, et al, 1972, would be reduced in the U.S.S.R.

CONCLUSION

In conclusion, we note that there are many unresolved conceptual issues in the area of emergency health facility planning. In particular, the question of evaluating proposed changes in the arrangement of emergency health facilities in order to determine overall improvement has not been adequately answered in the literature. The often conflicting requirements for accessibility, efficiency, and quality of care have not been delineated with sufficient accuracy to permit planners to make intelligent trade-offs when necessary. Research into the epidemiology of emergency illnesses and traumatic injuries has not been sufficiently integrated into the emergency health facility planning process. As a result, accessibility requirements for emergency facilities have never been accurately defined.

In contrast to the arrangement problem, the facilities utilization or matching problem has been well defined by Gibson (1973b). However, the utilization problem has not been adequately recognized or solved at the implementation level by EMS planners in the United States. As we saw in the preceding section, considerable progress toward solving this problem has been made in the Soviet Union.

As a theoretical contribution, this report will attempt to clarify the facilities arrangement problem by means of a mathematical model. This effort will be described in Chapter Three. Chapter Four will focus on some of the practical problems in implementing desired changes in health facilities arrangement and utilization. Interviews with EMS planners in hospitals, regional organizations, and various levels of government will be reported. Finally, Chapter Five will present policy recommendations for the improvement of regional emergency health facilities planning.

CHAPTER THREE

A QUANTITATIVE MODEL OF COVERAGE WITHIN AN EMERGENCY MEDICAL PLANNING REGION AND AN APPLICATION TO GREATER BOSTON

INTRODUCTION

In Chapter Two, we saw that the question of evaluating proposed changes in the emergency medical system in order to measure overall improvement has not been adequately answered in the literature. One reason for this deficit is the problem of defining an appropriate measure (see Willemain, 1974).

It is difficult to use an outcome measure for a proposed system change unless the change has actually been implemented on an experimental basis. Furthermore, as Willemain (1974) points out:

> "Valid outcome measures are difficult to implement. Some of the problems are clinical, in that medicine does not yet fully understand the relationships between treatments and outcome. Some of the problems are conceptual, in that the concept of 'patient status' is elusive in all cases except death."

The choice, therefore, is often between using an input or a process measure of system improvement. Since process measures such as Gibson's system under-response are measures of facility <u>utilization</u>, it is again difficult to evaluate a proposed change without implementing the change on a pilot basis. Also, the use of process measures assumes that there is a system <u>potential</u> which is not realized because facilities are inappropriately utilized. What is that system potential? How do we measure it?

As we pointed out in Chapter Two, an input measure of system potential is based on a comparison of clinical care capabilities within a region with the expected distribution of the number and kind of medical emergencies. Facilities are evaluated in terms of care capability, quantity and location. Such input measures as number of emergency treatment rooms per capita and full-time emergency physicians per capita are incomplete because they do not consider overall care capabilities or the distribution of resources among facilities within a planning region (Willemain, 1974).

An input measure called emergency medical coverage is proposed here in an attempt to remedy these deficiencies in defining system potential. This measure takes account of the fact that a planning region has a particular spatial distribution of demands for service and a certain number of treatment facilities with varying care capabilities spatially distributed throughout a region. Although the coverage function has a precise mathematical definition which is given in a subsequent section, it is conceptually designed to be a measure of goodness of fit between the configuration of EMS facilities within a planning region and the spatial distribution of demands for emergency medical services. Our goal in defining this measure is to enable us to quantify the effects on emergency medical coverage of proposed system changes so that we may at least rank-order the options under consideration.

Risk is defined here as the inverse of coverage. In other words, if risk is minimized, coverage will be maximized. Both terms are used to describe the independent variable in the following discussion.

It should be stressed that the term risk, as used here, refers to the risk incurred by the patient due to the spatial separation from a medical facility of the appropriate level. In this context, we recall Weinerman's (1966) definition of the emergent patient as one whose "condition requires immediate medical attention, time delay is harmful to patient". Therefore, the term 'risk' as used here does not refer to the overall risk of loss of life or disability incurred as a result of the medical emergency. Rather, it refers to the additional risk incurred due to the lack of immediate availability of appropriate medical coverage.

DESIRABLE PROPERTIES OF A COVERAGE OR RISK FUNCTION

In order for the coverage or risk function to be useful as a measure in emergency medical services planning, it must incorporate many of the factors cited in the literature as being desirable in a good emergency medical service system. In other words, the characteristics of a good arrangement of facilities should be reflected in a high coverage or low risk score and the characteristics of a bad arrangement of facilities should be reflected in a low coverage or high risk score.

For example, proximity to a treatment facility is considered to be good because the patient may be brought to the treatment facility without considerable time delay. For some kinds of emergencies, it may be safe to transport a patient as quickly as possible to the nearest definitive care facility whereas in other cases it may not be safe to do so without first stabilizing the patient. Some types of emergency may be treated definitively at a community hospital whereas other diagnoses are too complex and must be referred to major regional centers. Some hospitals can provide comprehensive care for one type of emergency, but can only provide stabilization and immediate transfer for other diagnostic categories. All of these factors are incorporated into the coverage function which is defined and illustrated below.

Certain factors may be irrelevant to improving emergency medical system coverage and should therefore be left out of the coverage function; for example, if two hospitals very near to each other both provide a comprehensive care capability in a given diagnostic category, one of them may wish to downgrade its service and refer patients to the other hospital to avoid duplication and unnecessary expense. As long as the other hospital has sufficient capacity to treat expeditiously all the emergencies in that diagnostic category, we assume that there is no loss in emergency medical coverage. Under these circumstances the coverage function defined here does not give extra credit for an additional spatially adjacent facility with the same care capability. The model assumes that a single facility has sufficient capacity to take care of the patient load. This assumption permits the detection of "duplication" of facilities.

The reason a quantitative approach to coverage is taken here is that it allows one systematically to evaluate a pattern or configuration of emergency hospital facilities within a region. Most of the relevant factors which have been cited in the literature as being important to optimal medical coverage have been included in the equation for the coverage function. In addition, the technique provides a way of embodying within the model a physician's subjective impressions regarding the relative importance of time to treatment within a diagnostic category. The way in which this is done will be illustrated later in this chapter. The important point here is that the physician or planner can set this parameter himself and then evaluate the implications in terms of the recommended placement of various levels of treatment facilities.

ELEMENTS AND ASSUMPTIONS OF THE MODEL

In order to assign a value to a particular pattern of configuration of facilities, an equation for computing the coverage function must be developed. This equation can then be used to rank-order various configurations of EMS facilities. Each facility is assumed to have a care capability category and fixed location associated with it.

As a point of reference for the discussion of the assumptions which are made in the equation for the coverage function, the following diagram is presented as Figure 1.

Figure 1 is a diagram of a hypothetical planning region with three towns, one city, and three hospital emergency facilities. We wish to determine the hospital emergency coverage within this region for high-risk neonatal and pediatric patients. Town A has a population of 5,000 and no hospital. Town B has a population of 20,000 and a Level 2 hospital, H_2, with the care capability to treat all but the most serious cases in this diagnostic category. Town C has a population of 10,000 and a Level 3 hospital, H_3, which provides only stabilization and immediate transfer capabilities. Finally, City D has a

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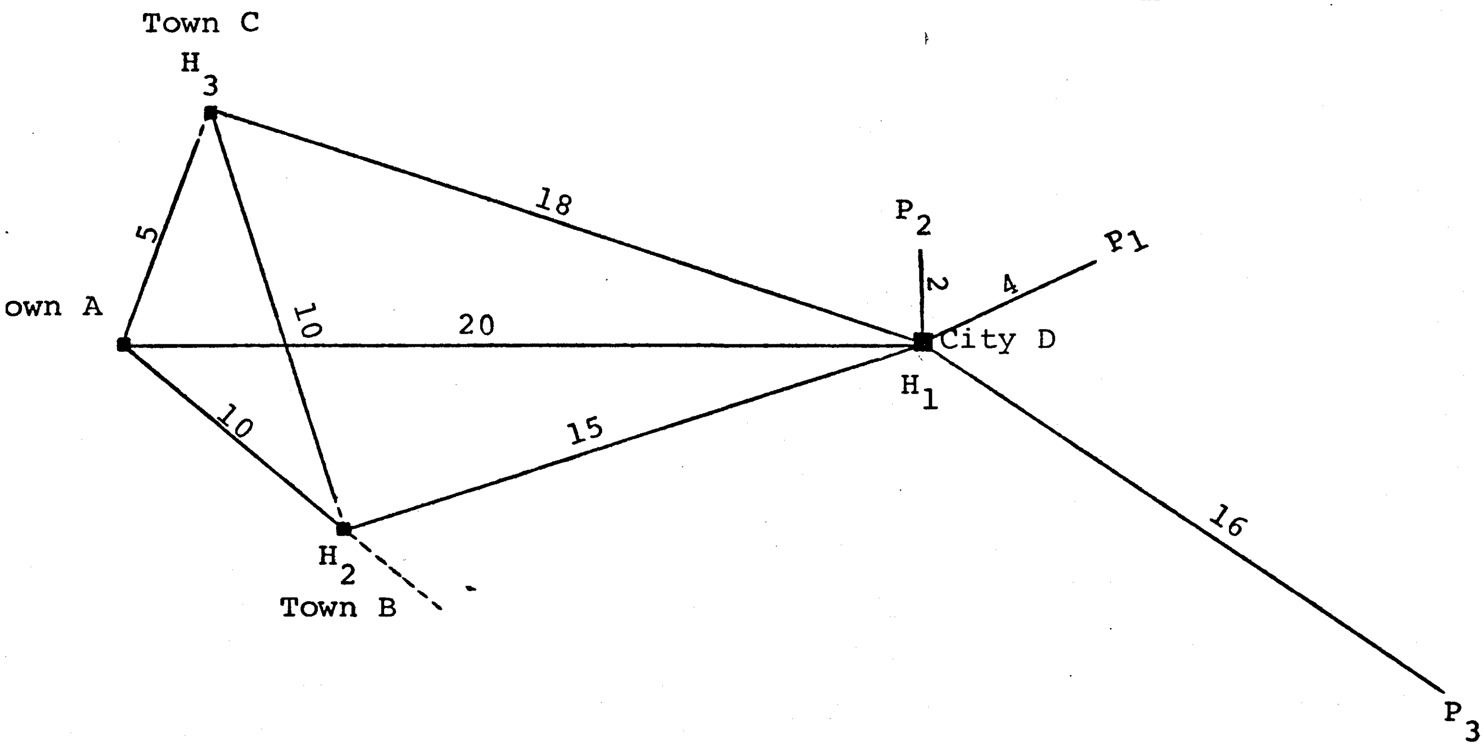


Figure 1

(P = Patient)

Place	Population
Town A	5,000
Town B	20,000
Town C	10,000
City D	50,000

Mileage

(H = Hospital)

	H_1	H_2	H_3
Town A	20	10	5
Town B	15	1	10
Town C	18	10	1
City D	1	15	18

population of 50,000 and a Level 1 hospital, H_1, with the care capability to treat even the most serious high-risk neonatal and pediatric cases. The distances between the towns, city, and hospital emergency facilities are shown in Figure 1.

The coverage function is designed to measure the desirability of an arrangement of emergency facilities, such as the arrangement of facilities shown in Figure 1. Since a medical emergency creates a situation in which a time delay in receiving medical treatment could be harmful to the patient, it is desirable for the spatial distribution of facilities to correspond closely to the distribution of demands for services. In other words, the hospitals should be accessible to the patients who need them. In a strict sense, temporal rather than spatial proximity is desired, but the two are closely correlated if the same or similar modes of transportation are utilized. It is sometimes a useful simplification to assume that travel speeds are constant throughout the region so that distance can be used as a surrogate measure for time.

In the coverage function which is defined here, it is assumed that coverage is an inverse function of distance; in other words, coverage is maximized if the average distance to an appropriate treatment facility is minimized. The average distance should be computed from the spatial distribution of demands for service so that appropriate weighting is given to geographical concentrations of demands for service within a region.

As an illustration of the relationship between coverage and distance, consider Figure 1. A resident of City D is assumed to have better coverage for high-risk neonatal and pediatric cases than a resident of Town A. This is because H_1, a facility which can provide definitive care for even the most serious high-risk neonatal and pediatric emergencies, is located in City D. In terms of computing the coverage function for the entire region, the value of the coverage for City D weighted ten times as heavily as the value of the coverage function for Town A. This is because the value of the coverage function is proportional to the spatial distribution of demands for service. It is assumed that demands for service within each diagnostic category are proportional to population. City D has 50,000 people while Town A has 5,000.

In the model presented here, risk is defined as the inverse of coverage. In other words, if risk is minimized, coverage will be maximized. Both terms are used to describe the independent variable in this discussion. For example, we can say that risk increases with distance or that coverage decreases with distance. In Figure 1 a resident of Town A is considered to be at greater risk in case of a neonatal or pediatric emergency than a resident of City D.

From the standpoint of system efficiency, it is desirable to minimize duplication of facilities so that facilities' cost can be minimized for a given level of coverage. For the sake of simplification, the assumption is made here that a given facility has sufficient bed and staff capacity to provide coverage for a given geographic area. Therefore, it is assumed that there is no reason for the duplication of facilities in order to increase capacity.

A complicating factor is introduced when we consider the categorization of facilities into groups which have different functions. Different kinds of patients require different kinds of facilities. The distance to be minimized in order to maximize coverage is the distance from the emergency to the nearest appropriate treatment facility. Some hospitals, such as H_1 in Figure 1, treat even the most serious cases within a certain diagnostic category while other hospitals, such as H_2, may be prepared to treat all but the most serious cases. Still other hospitals, such as H_3, may provide only basic stabilization and immediate transfer while others may not provide any services at all for the particular type of emergency under consideration. These variations in hospital care capabilities must be considered in relation to patient needs when measuring emergency care coverage within a region.

Another complicating factor in designing a coverage function is that individual hospitals may vary in the level of care they provide for different types of emergencies. Thus, a hospital may treat even the most serious coronary cases but only provide basic stabilization and immediate transfer for high-risk neonatal and pediatric patients. The coverage function must, therefore, be computed separately for each diagnostic category.

The importance of the travel time from a medical emergency to a treatment facility also varies with the type of emergency. The epidemiology of the emergency may require that medical care be delivered in a very short time. In other diagnostic categories, time to treatment may be somewhat less critical.

Therefore, an epidemiology constant must be included in the coverage function for each type of emergency so that the gain in coverage from being ten miles rather than twenty miles from an appropriate facility can be accurately assessed. It should be pointed out here that the importance of time to treatment may vary considerably within a diagnostic category. It is assumed here that differences in epidemiology across diagnostic categories are significant when compared with intra-category variation. We, therefore, feel it is a useful simplification to estimate an epidemiology constant for each diagnostic category.

As an illustration of the use of an epidemiology constant in the model, again consider the hypothetical planning region depicted in Figure 1. The epidemiology constant E is used as an exponent to the distance D from a definitive treatment facility to obtain the value of the risk function for an emergency occurring at any point P. In the form of an equation, the value of the risk function R at any point P can be expressed as $R_p = D^E$. If we assume that the epidemiology constant E = 1, then risk to the patient is directly proportional to distance. As an example, consider the case of patient P_1, who is four miles from a treatment facility, H_1 and patient P_2, who is two miles from a treatment facility, H_1. The risk to patient P_1 is $R_p=D^E=4^1=4$. The risk to patient P_2 is $R_p=D^E=2^1=2$. Let us now assume that the epidemiology constant E = 2. Then the risk to patient P_1 is $R_p=D^E=4^2=16$. The risk to patient P_2 is $R_p=D^E=4$. In other words, the risk to patient P_1 is now four times as great as the risk to patient P_2. Finally, let us assume that the epidemiology constant E = 1/2. The risk to a patient P_3, who is sixteen miles from a treatment facility, H_1 (assuming that this is the only treatment facility in the region) is now $R_p=D^E=16^{1/2}=4$. The risk to patient P_1 who is four miles away from the treatment facility is $R_p=D^E=4^{1/2}=2$. In other words, the risk to patient P_3 is only twice as great as the risk to patient P_1, despite the fact that patient P_3 is four times as far away from the treatment facility. We can see, therefore, that the epidemiology constant is a way of embodying a doctor's subjective impression of the importance of an hour or a mile. The simple exponential form of the constant is not intended to be definitive, but illustrative of the way epidemiological considerations can affect the relative goodness or badness of an arrangement of treatment facilities. The epidemiology constant need not be clinically exact since it is not used in clinical decision-making but only to help determine the relative desirability of arrangements of treatment facilities.

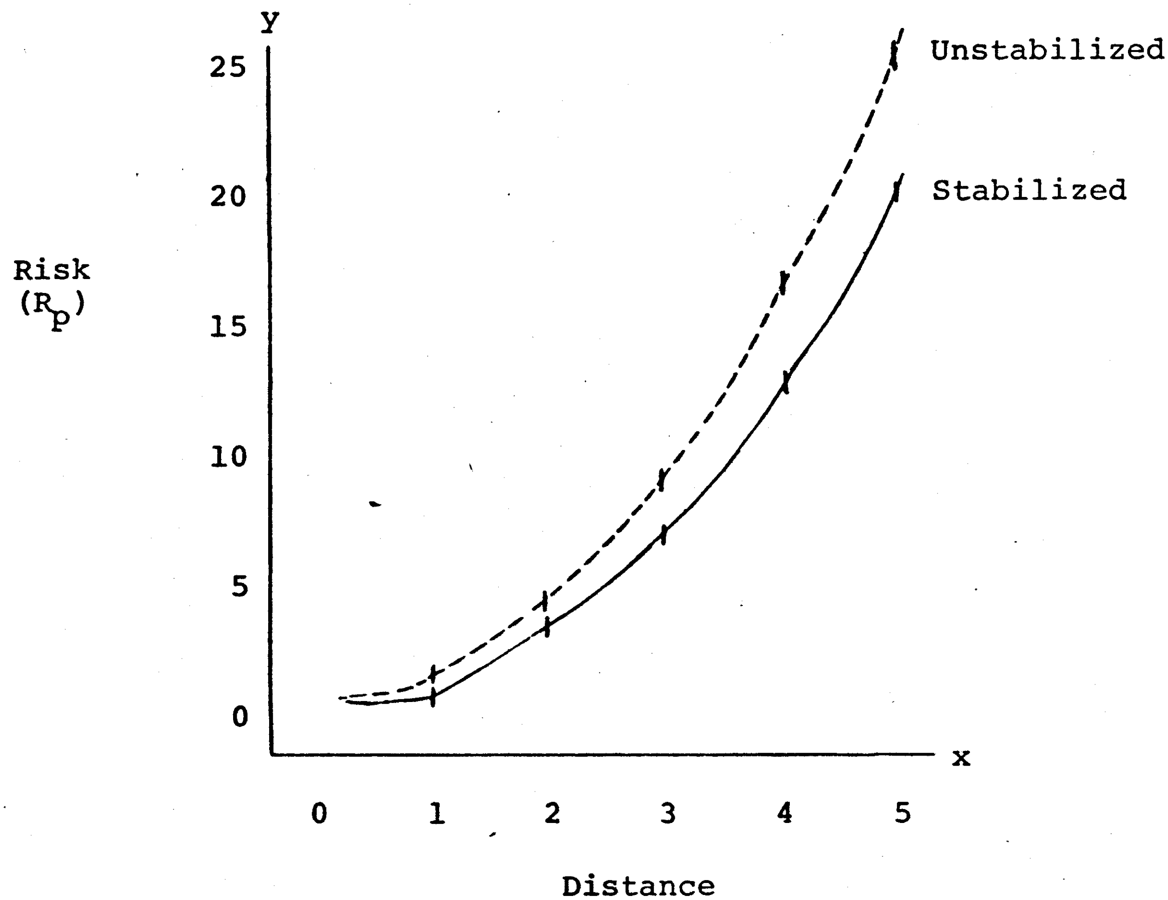
The importance of basic stabilization and life-support care also varies by diagnostic category. It may be assumed that the risk of travel to a definitive care facility is significantly reduced by initial stabilization and life-support care. In the model presented here, the risk to a stabilized patient 10 miles from a definitive treatment facility is considered to be some fraction (called the stabilization constant, S) of the risk for an unstabilized patient the same distance away from a treatment facility. The specific value of the fraction depends upon the relative importance of stabilization to an emergency patient within a diagnostic category.

Rcturning again to Figure 1, let us assume that patient P_3 has been stabilized at a Level 3 hospital before traveling the 16 miles to definitive treatment facility H_1. Assuming that the stabilization constant S = .5 and the epidemiology constant E = 1, the risk function $R_p = SD^E = .5 \times (16)^1 = 8$. The stabilization constant is assumed here to modify the coverage function in a linear fashion. That is, the form of the risk function for a stabilized patient is similar to the form of the risk function for an unstabilized patient. The value of the risk function for a stabilized patient is always a constant fraction of the value of the risk function for an unstabilized patient at any given distance from a definitive treatment facility. Figure 2 illustrates the shape of the risk functions for stabilized and unstabilized patients with E = 2 and S = .8.

The exponential form of the epidemiology constant is used because it allows for variations in the importance of time to treatment units as time elapses. Very few research studies have examined the relationship between survival rate and time to treatment. The studies which do exist (Andrews, et al, 1973; Cretin, 1974) indicate that a non-linear relationship does exist between survival rate and time to treatment for acute myocardial infarction (Cretin, 1974) and Hypertensive and Arterioselerotic Heart Disease (Andrews, et al, 1973). These findings do indicate that an exponential form is proper for the epidemiology constant with $E < 1$ in both cases. Interestingly, Andrews, et al (1973) found no significant relationship between survival rate and time to treatment for the other four categories of emergencies which were studied: (1) crushing, perforation and internal injuries;

The Relationship between Risk and Distance For Stabilized and Unstabilized Patients with E=2 and S=.8

Figure 2



		1	2	3	4	5
	(x) Distance	1	2	3	4	5
(y)	--- R_p (Unstabilized)	1	4	9	16	25
	—— R_p (Stabilized)	.8	3.6	7.2	12.8	20

R_p (Unstabilized) $= D^E = D^2$

R_p (Stabilized) $= SD^E = .8(D)^2$

$E = 2$
$S = .8$

(2) poisonings and overdoses; (3) central nervous system injuries; and (4) hypertensive and arteriosclerotic cerebro-vascular disease. Although the lack of statistically significant results may have been a function of small sample size, it may be true that survival rate may be independent of time to treatment for some types of events usually designated as emergencies ($E = 0$).

Very few studies have been performed on the effect of stabilization and life-support treatment on survival rates. In lieu of any research data, we assumed a linear form for the stabilization constant.

Finally, in the model presented here, we make the assumption that the patient is a utility maximizer. That is, he has all of the relevant information and he acts in his own best interest. This assumption, which is always made in micro-economic theory, is considered to be a useful simplification in the complex situation described here. That is, we will first determine how much potential coverage or risk there is in a region if everyone behaves optimally. Although it is not attempted here, a subsequent analysis could attempt to build in the "patient under-response" behavior described by Gibson (1973). Since emergency victims in the United States usually arrive at a hospital emergency room without the intervention of the emergency medical care system, it might be more useful from the standpoint of system design to assume that patients always travel to the closest facility. In the Soviet Union, where the system decides to which hospital the patient should go if the patient enters the system by dialing the emergency number, it may be safer to assume that the patient proceeds to the appropriate facility.

In the United States, it is quite unrealistic to expect the general public to learn a complex set of decision rules regarding entry points into the emergency care system.

A MODEL FOR MEASURING EMERGENCY MEDICAL COVERAGE WITHIN A REGION

Data Requirements

In order to compute the coverage function for one diagnostic category within a region, it is necessary to separate demands for emergency service into two groups. One group (Type A emergency) requires a facility with the care capability to treat even the most serious cases. The other group (Type B emergency) requires a facility with the care capability to treat all but the most serious cases. Each of the hospitals in the region must then be classified as to its care capability within the diagnostic category. The four care capabilities used in the model are the following:

Level 1. Treat even the most serious cases (treat Type A or B).

Level 2. Treat all but the most serious cases (treat Type B only).

Level 3. Provide only basic stabilization and immediate transfer.

Level 4. No capability in the diagnostic area.

Consistent care capability criteria must be established for each of the four levels of treatment facilities. Sufficient diagnostic data must be collected and analyzed to determine the proportions of patient Types A and B which require Level 1 and Level 2 facilities respectively. An epidemiology constant E and a stabilization constant S also must be estimated for each diagnostic category.

The six diagnostic categories to be considered in determining emergency medical coverage within a region are the same as those used in statewide emergency facilities planning in Illinois (Boyd and Murchie, 1973):

1. Acute coronary medical problems;
2. Trauma, accidents, and acute surgical problems (including burns);
3. Poisoning - information and treatment;
4. Drug and alcohol overdose;
5. Psychiatric and acute emotional disturbances; and
6. Pediatric crises and problems of newborns.

Other information which is required in order to compute the coverage function for a region consists of the relevant population of each town or city in the region together with the distances between all towns and all hospitals and all inter-hospital distances.

In summary, the following data is needed in order to compute the coverage function for a region:

1. Relevant population of all towns and cities;
2. Travel distances between all towns and all hospitals;
3. All inter-hospital travel distances;
4. For each of the six emergency diagnostic categories -
    a) The assignment of a Level Number of 1, 2, 3 or 4 for each hospital in the region based on the level of its care capability.
    b) The proportion of emergency patient Types A and B requiring Level 1 and Level 2 facilities, respectively, as definitive treatment facilities, for each town.

c) An epidemiology constant E (a positive number) and a stabilization constant S (a positive number between zero and one).

COMPUTING THE COVERAGE FUNCTION

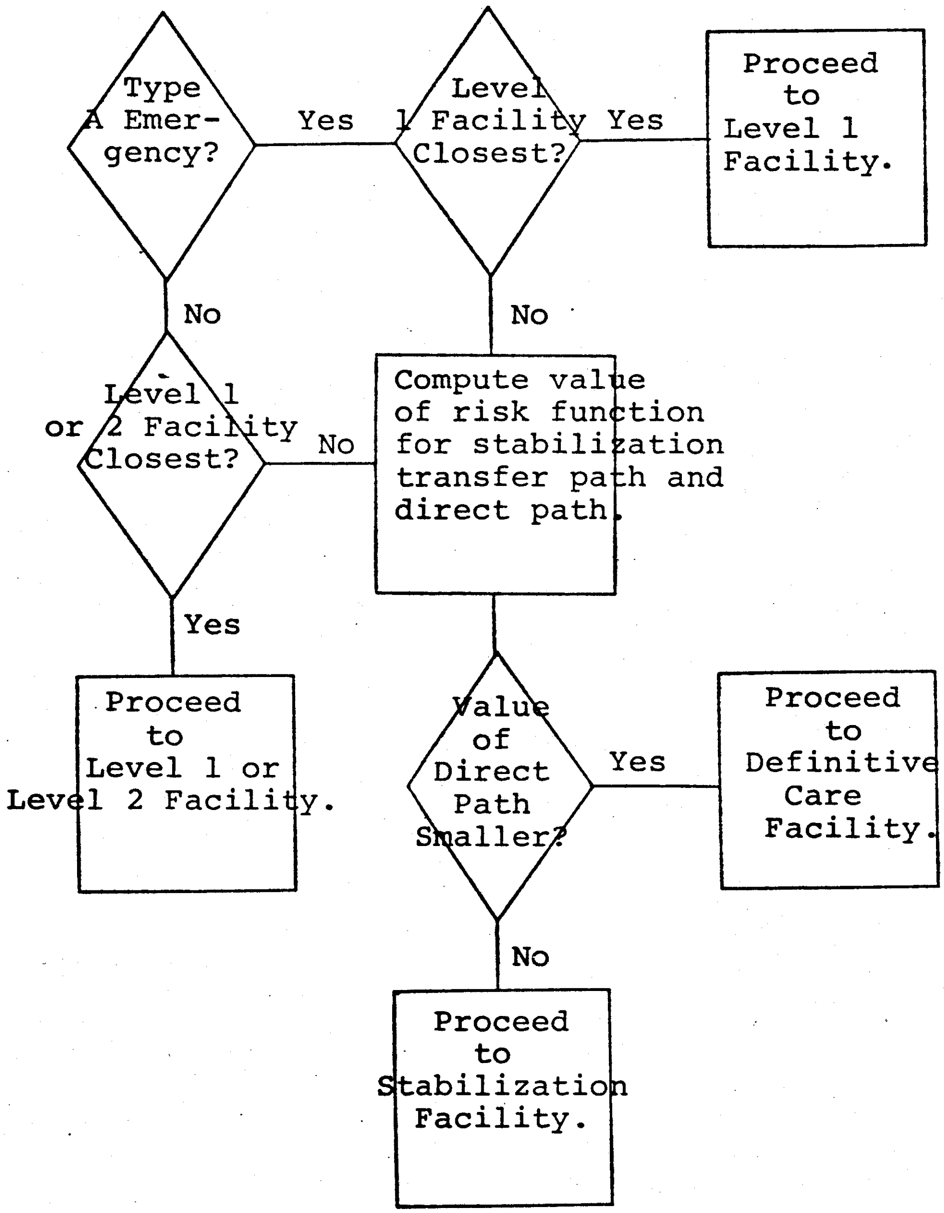
The coverage function is computed for each town in the region. The town values are then summed to produce a regional total. Each town value is weighted by the relevant population of the town so that the regional total reflects the spatial distribution of demands for service. It is assumed that the demands for service within each diagnostic category are proportional to the town's population. Although it is recognized that some towns are likely to have a disproportionate number of demands for some kinds of service (e.g., high-risk infants in suburban "bedroom" towns, drug abuse and alcohol in inner-city areas), it is felt that this assumption is reasonable in view of the simplifying assumption made elsewhere in the model.

The coverage function is computed according to the logic described on the following flow chart (Figure 3).

The value of the coverage function for each town is a weighted sum of the values for Type A and Type B emergencies; where the weights are the proportion of the emergencies belonging to each type. The logic described in the flow chart is designed to illustrate the geographical path which an emergency patient will follow if he receives appropriate treatment. If an appropriate facility is also the closest facility, it is assumed that the patient goes directly there. It is assumed that Type A patients require a Level 1 facility while Type B patients can receive definitive care at either a Level 1 or

Flow Chart for Hospital Emergency Facilities Entry Point Decision Assuming Optimal Behavior

Figure 3



Level 2 facility. The model does allow patient over-response for Type B patients since the patient could not reasonably be expected to go to a Level 2 facility if Level 1 is closer. It should be remembered here that each facility is assumed to have sufficient capacity to treat, without significant delay, all emergency patients who present themselves. It is also assumed that non-emergency patients are appropriately triaged so that they do not tie up emergency treatment facilities.

A complication arises when the closest facility is not a definitive treatment facility for the type of emergency under consideration. It must be decided whether to go to the closer facility for basic stabilization and immediate transfer or directly to the facility with the definitive care capability. According to the logic shown in the flow chart, one computes the value of the risk function for each of the two alternative paths and then chooses the path which minimizes the risk (i.e., maximizes the coverage). The value of the risk function for the direct path to the definitive facility is simply the distance to the facility D raised to the power of the epidemiology constant E. The value of the risk function for the direct path may be formally defined as $R_D = D_D^E$ where the subscript D denotes a direct path from emergency to definitive treatment facility. The value of the risk function for the stabilization-transfer path is $D_S^E + SD_T^E$ where S represents the stabilization constant (a fraction between 0 and 1). The value of the risk function for the stabilization-transfer path may be formally defined as $R_T = D_S^E + SD_T^E$ where the distance between the emergency and the <u>stabilization</u> facility is designated by D_S and the distance between the stabilization facility and the definitive care facility to which the patient is transferred is designated by D_T. A comparison is then made between the risk function $R_D = D_D^E$ computed along the direct path and the value of the risk function $R_T = D_S^E + SD_T^E$ computed along the stabilization-transfer path. The smaller value is accepted as the value of the risk function and the corresponding path is chosen.

It should be pointed out that the equation of the risk function could be computed in other ways than the simple exponential form shown here. Risk might be a more complicated function of distance and epidemiology. The risk equation might take a different functional form for stabilized patients as compared with unstabilized patients. Finally, time might well be used in the equation instead of distance, so that more rapid modes of transportation, such as the helicopter, could be considered in the risk function.

A sample calculation of the risk function can be made based on the hypothetical planning region depicted in Figure 1. Let us assume that a Type A emergency occurs at Town A. A Type A emergency requires a Level 1 facility for definitive care. It can be seen from the figure that the distance between Town A (the site of the emergency) and H_3 (the stabilization facility) is 5 miles, the direct distance from Town A to H_1 (a definitive care facility) is 20 miles, and the transfer distance from H_3 to H_1 is 18 miles. Let us assume an epidemiology constant E = 1, which means that it is twice as risky to be 20 miles from a treatment facility as ten miles. Let us also assume a stabilization constant S = .8, which means that it is 80 percent as risky to travel to a definitive care facility after stabilization as compared with the risk of traveling before stabilization.

Let us now evaluate the risk function for both the direct and indirect paths so that we can choose the path with the smaller value. By the direct path, the risk function $R = D^E = 20^1 = 20$. By the indirect path, the risk function $R = D_S{}^E + SD_T{}^E = 5^1 + (.8 \times 18^1) = 5 + 14.4 = 19.4$. Accordingly, the indirect path is chosen and the patient proceeds to hospital H_3 for stabilization and immediate transfer to hospital H_1.

Let us now assume that a Type B emergency occurs at Town A. A Type B emergency requires a Level 2 facility for definitive care. It can be seen from the Figure that the distance between Town A (the site of the emergency) and stabilization facility H_3 is 5 miles, the direct distance from Town A to definitive care facility H_2 is 10 miles, and the transfer distance from H_3 to H_2 is also ten miles. Again assuming an epidemiology constant E = 1 and a stabilization constant S = .8, the risk function by the direct path is $R = D^E = 10^1 = 10$. By the indirect path, the risk function $R = D_S{}^E + SD_T{}^E = 5^1 + (.8 \times 10^1) = 5 + 8 = 13$. Accordingly, the direct path is chosen and the patient proceeds directly to hospital H_2.

SAMPLE COMPUTATIONS FOR REGIONAL RISK FUNCTIONS

The procedure for computing the risk function within a region for a particular diagnostic category of emergency is shown in Figure 4. This procedure is as follows:

1. Using the best available medical advice and research findings, obtain values for the epidemiology constant E and the stabilization constant S. The epidemiology

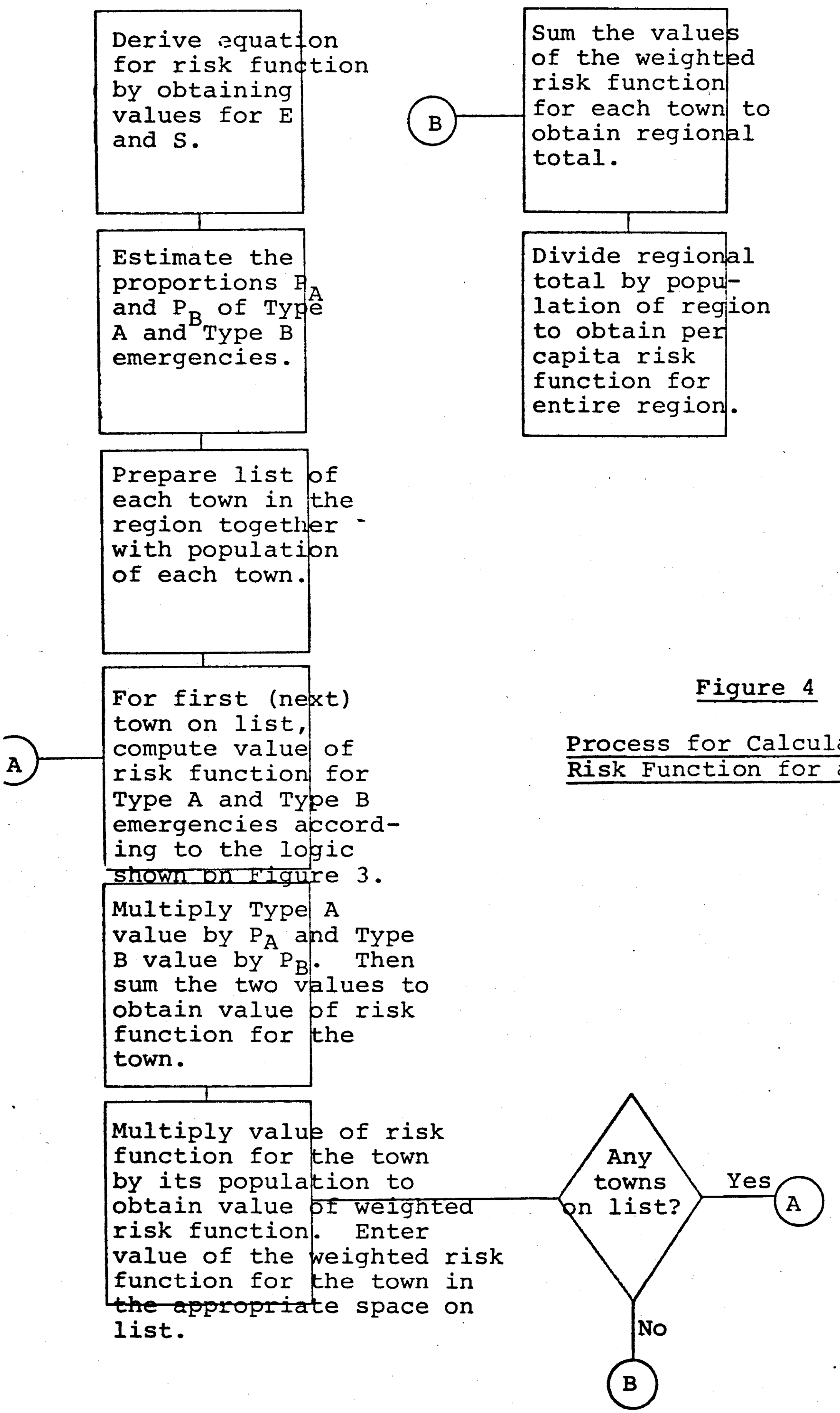


Figure 4

Process for Calculating Risk Function for a Region

constant must be a positive number (or else time to treatment would not be a critical factor and the event would not be classified as an emergency). The stabilization constants must be a positive number between 0 and 1. The assumption is that it is less risky to transport a stabilized patient than an unstabilized one. If S were 0 there would be no relationship between risk and time to treatment so we could assume that the stabilization treatment could be equated with definitive care. If S were 1, the stabilization treatment would have had no discernible effect in reducing risk to the patient. While this might be true in individual cases, we would expect that, on the average, stabilization would have some effect in reducing risk.

2. By using patient utilization data in relation to hospital care capability criteria, an estimate of the proportion of Type A and Type B emergencies can be made. Current design efforts on care capability criteria (e.g., Ramp, 1974) are aimed at making Number 2 facilities capable of providing definitive care for 90 percent of all cases without referral. In the examples used in this study, the proportion P_A of Type A emergencies is assumed to be 10 percent. In any case, P_A and P_B must add up to 1.

3. For each town in the region, compute the value of the risk function for a Type A emergency and a Type B emergency. Use the procedure described in the flow chart in Figure 3 to compute the value of the risk function. Multiply the

value of the risk function for Type A emergencies by P_A and the value of the risk function for Type B emergencies by P_B. This calculation provides the proper weighting for Type A and Type B emergencies in proportion to the frequency of occurrence. Then sum the weighted values for Type A and Type B emergencies to yield the value of the risk function for the town.

4. Multiply the value of the risk function for each town by the population of each town. This calculation is also designed to provide proper weighting to the frequency of demands for service. Then, sum the town values to obtain a regional total. Divide the regional total by the population of the region to obtain a per capita risk function for the entire region. This per capita value can be contrasted with similarly computed values from other planning regions or for different assignments of care capabilities to hospitals. A sample calculation of the risk function for a particular diagnostic category of emergency in the hypothetical region shown in Figure 1 is given in Figure 5.

AN EXAMPLE FROM GREATER BOSTON

In order to test the methodology described above on a real-life situation, a survey was made of hospitals in the greater Boston area. The survey form was designed by the author in conjunction with Mr. David Rioux, Project Director, Emergency Medical Services Project, Health Planning Council for Greater Boston, Inc. A copy of the model form is shown in Figure 6.

Sample Calculation of the Risk Function for a Hypothetical Planning Region

Figure 5

Place	Population	Unweighted Value of Risk Function	Weighted Value of Risk Function
Town A	5,000	10.94	54,700
Town B	20,000	2.20	44,000
Town C	10,000	9.64	96,400
City D	50,000	1.00	50,000
Total	85,000		245,100

Per capita risk function = 245,100/85,000 = 2.88

$E = 1$, $S = .8$, $P_A = .1$, $P_B = .9$

Place	Emergency Type	Value of Risk Function for Emergency	Proportion	Value of Risk Function for Town
Town A	A	19.4	.1	1.94
	B	10.0	.9	9.00
				10.94
Town B	A	13	.1	1.30
	B	1	.9	0.90
				2.20
Town C	A	15.4	.1	1.54
	B	9.0	.9	8.10
				9.64
City D	A	1	.1	.10
	B	1	.9	.90
				1.00

further columns for this purpose.)

Figure 6

HOSPITAL CARE AND TRANSFER ARRANGEMENTS FOR EMERGENCY PATIENTS

HOSPITAL	TRAUMA (including burns)			CORONARY			HIGH RISK NEONATAL & PEDIATRIC			PSYCHIATRIC			POISON			ALCOHOL-DRUG ABUSE			OTHER (specify & add columns as necessary)		
Name of individual hospital	Care Capability*		Transfer To**	Care Capability*		Transfer To**	Care Capability*		Transfer To**	Care Capability*		Transfer To**	Care Capability*		Transfer To**	Care Capability*		Transfer To**	Care Capability*		Transfer To**
	Present	Desired		Present	Desired		Present	Desired		Present	Desired		Present	Desired		Present	Desired		Present	Desired	

*Care Capability: (write in appropriate number above)
1 = Treat even the most serious cases
2 = Treat all but the most serious cases
3 = Provide only basic stabilization and immediate transfer
4 = None of the above

**Transfer To: (write in name of hospital)

In the survey each hospital was asked to rate its emergency department's ability to treat and manage the following (from The Greater Boston Plan, 1974).

1. Acute coronary medical problems;
2. Trauma, accidents, and acute surgical problems (including burns);
3. Poisoning - information and treatment;
4. Drug and alcohol overdose;
5. Psychiatric and acute emotional disturbances;
6. Pediatric crises and problems of newborns;
7. Other serious medical problems which frequently occur in the area.

Each hospital is asked to rate its present care capability in each of these areas as either a Level 1, 2, 3 or 4. This is the same procedure described earlier in this chapter. The care capabilities and corresponding numbers are shown in Figure 6. The model form also has spaces for desired care capability and transfer arrangements if the hospital's care capability is not Level 1 for a given diagnostic category.

A major problem in the survey which was performed was that no consistent care capability criteria have been developed for the four levels of service within each diagnostic category. As a result the model survey form may have been interpreted differently by different hospitals. Consequently, the results of the survey are only used here for illustrative purposes, and no concrete recommendations for upgrading or downgrading of facilities in the greater Boston area are made in this report.

A total of 36 hospitals in the greater Boston area responded to the model form survey. Included in this group were nine hospitals from Sub-state Planning Region III (West Suburban Boston), seven hospitals from Region V (South Suburban Boston), and 20 from Region VI (Boston Proper plus a few nearby communities). Average care capabilities were computed based on the hospitals' self-ratings for each of the six diagnostic categories. These averages were computed for Planning Regions III, V, and VI and for the total of all three regions. The averages are presented in Figure 7.

Some interesting results emerge from the survey, despite the difficulties in interpretation noted above. For example, every hospital in Regions III and V felt that it could treat even the most serious acute coronary medical problems.

In order to choose a diagnostic category for a sample calculation, desirable characteristics were considered to be a significant amount of variation in hospital care capabilities and an average care capability somewhere in the middle range between Levels 2 and 3. The high-risk neonatal and pediatric category met both of these criteria and so was chosen for a sample calculation.

Region III (West Suburban Boston) was chosen for the sample calculation for two reasons. One reason was a clustering of facilities and population in one corner of the region, leaving other areas in the region relatively exposed. Another reason involves current plans for a new facility near the center of the region (the proposed Lahey Clinic in Burlington, Mass.). This enables us to compute the effect that the proposed

Figure 7

Average Care Capabilities
by Planning Region

Diagnostic Category	Total	Region III	Region V	Region VI
Trauma	1.5	1.2	1.7	1.7
Coronary	1.4	1.0	1.0	1.8
High-Risk Infant	2.5	2.4	2.1	2.6
Psychiatric	2.4	2.0	2.5	2.6
Poison	1.8	1.3	1.6	2.1
Alcohol/Drug Abuse	2.0	2.0	1.4	2.3

additional facility has upon the risk function within the region. Since care capability decisions for the new facility have not been finalized, various levels can be tested for their potential effect on risk. Thus, an illustration is provided of how the model can be used as a decision aid to the resource allocation process. It should be reiterated at this point that the calculations performed in this example are for illustrative purposes only. An actual resource allocation decision might well utilize the technique described here, but more consistent care capability criteria must be developed before the self-estimates of care capability numbers can be considered consistent and credible.

Relevant populations for each town and city in Region III were obtained from the 1970 census. For the purpose of consideration of high-risk neonatal and pediatric emergencies, the relevant population is defined to be the population under 18 years old. Population under 18 for each town and city in Region III, along with total population and percent under 18 are shown in Figure 8. A map of the region showing the location of all towns and hospitals in the region is also included. It is interesting to note that the town or city possessing the smallest percentage of population under 18 in the region (Cambridge) contains the only three hospitals in the region with Level 1 care capabilities for high-risk neonatal and pediatric emergencies. Burlington, the site of the proposed new Lahey Clinic facility, contains a percentage of population under 18 that is more than twice as high as the Cambridge percentage (46.8 percent to 20.1 percent).

Distances between towns in the Region and the 10 hospitals (including the proposed facility) were computed with the aid of a road map of metropolitan Boston. If a hospital is located within the boundaries of a given town, an average distance of one mile was assumed. The distances between all hospitals having differing care capabilities were also computed so that calculations of stabilization-transfer pathways could be made.

The calculation of the risk function for high-risk neonatal and pediatric patients is shown in Figure 8. In the absence of reliable epidemiological information, we assume an epidemiology constant E = 1 and a stabilization correction factor S = .8. We also assume that 10 percent of the cases are Type A emergencies (requiring a Level 1 definitive care facility) and the other 90 percent are Type B emergencies (requiring a Level 2 definitive care facility).

In Figure 9, we illustrate the smaller value of the risk function that occurs as a result of locating a Level 1 facility at the proposed site of the Lahey Clinic in Burlington.

Figure 10 illustrates that locating a Level 2 facility at the proposed Lahey Clinic site also results in a significant reduction in the risk function. The values of the risk function for the three cases are summarized in Figure 11.

The fact that almost three-quarters of the reduction in the risk score is obtained by locating a Level 2 facility in Burlington as compared to a Level 1 facility can be explained by the assumption that 90 percent of the emergencies are Type B (requiring a Level 2 facility). The additional reduction in risk score

Risk Function for Region III Without Lahey Clinic

FIGURE 8 - Per Capita Risk Function = 5.53

PLACE	POPULATION UNDER 18 (Hundreds)	UNWEIGHTED VALUE OF RISK FUNCTION	WEIGHTED VALUE OF RISK FUNCTION
Total:	2,565		14,197
Chelmsford	133	10.0	1,330
Westford	44	10.0	440
Littleton	26	10.0	260
Groton	19	17.0	323
Ayer	23	14.0	322
Boxboro	8	10.0	80
Stow	16	8.0	128
Bolton	8	12.0	96
Hudson	66	11.0	726
Acton	64	6.0	384
Maynard	34	7.0	238
Concord	62	2.0	124
Carlisle	12	6.0	72
Lincoln	32	3.7	118
Weston	39	7.2	281
Billerica	141	8.6	1,213
Andover	89	16.2	1,442
Tewksbury	99	13.2	1,307
Wilmington	74	8.2	607
Burlington	103	6.2	639
Bedford	53	4.7	246
Lexington	123	5.2	640
Woburn	141	5.2	733
Winchester	78	3.2	250
Arlington	157	1.2	188
Belmont	77	2.1	162
Watertown	112	3.0	336
Cambridge	202	1.0	202
Somerville	267	2.0	534
Medford	193	2.1	405
Stoneham	70	5.3	371

Figure 8 (Cont'd.)

$E = 1$, $S = .8$, $P_A = .1$, $P_B = .9$

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Chelmsford	A	19	.1	1.9
	B	9	.9	8.1
				10.0
Westford	A	19	.1	1.9
	B	9	.9	8.1
				10.0
Littleton	A	19	.1	1.9
	B	9	.9	8.1
				10.0
Groton	A	26	.1	2.6
	B	16	.9	14.4
				17.0
Ayer	A	23	.1	2.3
	B	13	.9	11.7
				14.0
Boxboro	A	19	.1	1.9
	B	9	.9	8.1
				10.0
Stow	A	17	.1	1.7
	B	7	.9	6.3
				8.0
Bolton	A	21	.1	2.1
	B	11	.9	9.9
				12.0
Hudson	A	20	.1	2.0
	B	10	.9	9.0
				11.0
Acton	A	15	.1	1.5
	B	5	.9	4.5
				6.0
Maynard	A	16	.1	1.6
	B	6	.9	5.4
				7.0

Figure 8 (continued)

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Concord	A	11	.1	1.1
	B	1	.9	0.9
				2.0
Carlisle	A	15	.1	1.5
	B	5	.9	4.5
				6.0
Lincoln	A	10	.1	1.0
	B	3	.9	2.7
				3.7
Weston	A	9	.1	0.9
	B	7	.9	6.3
				7.2
Billerica	A	14	.1	1.4
	B	8	.9	7.2
				8.6
Andover	A	18	.1	1.8
	B	16	.9	14.4
				16.2
Tewksbury	A	15	.1	1.5
	B	13	.9	11.7
				13.2
Wilmington	A	10	.1	1.0
	B	8	.9	7.2
				8.2
Burlington	A	8	.1	0.8
	B	6	.9	5.4
				6.2
Bedford	A	11	.1	1.1
	B	4	.9	3.6
				4.7
Lexington	A	7	.1	0.7
	B	5	.9	4.5
				5.2
Woburn	A	7	.1	0.7
	B	5	.9	4.5
				5.2

Figure 8 (continued)

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Winchester	A	5	.1	0.5
	B	3	.9	2.7
				3.2
Arlington	A	3	.1	0.3
	B	1	.9	0.9
				1.2
Belmont	A	3	.1	0.3
	B	2	.9	1.8
				2.1
Watertown	A	3	.1	0.3
	B	3	.9	2.7
				3.0
Cambridge	A	1	.1	0.1
	B	1	.9	0.9
				1.0
Somerville	A	2	.1	0.2
	B	2	.9	1.8
				2.0
Medford	A	3	.1	0.3
	B	2	.9	1.8
				2.1
Stoneham	A	8	.1	0.8
	B	5	.9	4.5
				5.3

Risk Function for Region III with Lahey Clinic as Level 1 Facility

FIGURE 9. - Per Capita Risk Function = 4.32

PLACE	POPULATION UNDER 18 (Hundreds)	UNWEIGHTED VALUE OF RISK FUNCTION	WEIGHTED VALUE OF RISK FUNCTION
Total:	2,565		11,077
Chelmsford	133	9.2	1,224
Westford	44	9.6	422
Littleton	26	9.7	252
Groton	19	16.7	317
Ayer	23	13.7	315
Boxboro	8	9.7	78
Stow	16	7.7	123
Bolton	8	11.7	94
Hudson	66	10.7	706
Acton	64	5.7	365
Maynard	34	6.7	228
Concord	62	1.7	105
Carlisle	12	5.4	65
Lincoln	32	3.6	115
Weston	39	7.2	271
Billerica	141	6.0	846
Andover	89	12.0	1,068
Tewksbury	99	8.0	792
Wilmington	74	4.0	296
Burlington	103	1.0	103
Bedford	53	4.0	212
Lexington	123	3.0	369
Woburn	141	2.0	282
Winchester	78	3.1	242
Arlington	157	1.2	188
Belmont	77	2.1	162
Watertown	112	3.0	336
Cambridge	202	1.0	202
Somerville	267	2.0	534
Medford	193	2.1	405
Stoneham	70	5.0	350

Figure 9 (Cont'd.)

$E = 1$, $S = .8$, $P_A = .1$, $P_B = .9$

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Chelmsford	A	11	.1	1.1
	B	9	.1	8.1
				9.2
Westford	A	15	.1	1.5
	B	9	.1	8.1
				9.6
Littleton	A	16	.1	1.6
	B	9	.9	8.1
				9.7
Groton	A	23	.1	2.3
	B	16	.9	14.4
				16.7
Ayer	A	20	.1	2.0
	B	13	.9	11.7
				13.7
Boxboro	A	16	.1	1.6
	B	9	.9	8.1
				9.7
Stow	A	14	.1	1.4
	B	7	.9	6.3
				7.7
Bolton	A	18	.1	1.8
	B	11	.9	9.9
				11.7
Hudson	A	17	.1	1.7
	B	10	.9	9.0
				10.7
Acton	A	12	.1	1.2
	B	5	.9	4.5
				5.7
Maynard	A	13	.1	1.3
	B	6	.9	5.4
				6.7

Figure 9 (continued)

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Concord	A	8	.1	0.8
	B	1	.1	0.9
				1.7
Carlisle	A	9	.1	0.9
	B	5	.9	4.5
				5.4
Lincoln	A	9	.1	0.9
	B	3	.9	2.7
				3.6
Weston	A	9	.1	0.9
	B	7	.9	6.3
				7.2
Billerica	A	6	.1	0.6
	B	6	.9	5.4
				6.0
Andover	A	12	.1	1.2
	B	12	.9	10.8
				12.0
Tewksbury	A	8	.1	0.8
	B	8	.9	7.2
				8.0
Wilmington	A	4	.1	0.4
	B	4	.9	3.6
				4.0
Burlington	A	1	.1	0.1
	B	1	.9	0.9
				1.0
Bedford	A	4	.1	0.4
	B	4	.9	3.6
				4.0
Lexington	A	3	.1	0.3
	B	3	.9	2.7
				3.0
Woburn	A	2	.1	0.2
	B	2	.9	1.8
				2.0

Figure 9 (continued)

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Winchester	A	4	.1	0.4
	B	3	.9	1.8
				3.1
Arlington	A	3	.1	0.3
	B	1	.9	0.9
				1.2
Belmont	A	3	.1	0.3
	B	2	.9	1.8
				2.1
Watertown	A	3	.1	0.3
	B	3	.9	2.7
				3.0
Cambridge	A	1	.1	0.1
	B	1	.9	0.9
				1.0
Somerville	A	2	.1	0.2
	B	2	.9	1.8
				2.0
Medford	A	3	.1	0.3
	B	2	.9	1.8
				2.1
Stoneham	A	5	.1	0.5
	B	5	.9	4.5
				5.0

Calculation of the Risk Function for Region III with Lahey Clinic as Level 2 Facility

FIGURE 10 - Per Capita Risk Function = 4.63

PLACE	POPULATION UNDER 18 (Hundreds)	UNWEIGHTED VALUE OF RISK FUNCTION	WEIGHTED VALUE OF RISK FUNCTION
Total:	2,565		11,882
Chelmsford	133	10.0	1,330
Westford	44	10.0	440
Littleton	26	10.0	260
Groton	19	17.0	323
Ayer	23	14.0	322
Boxboro	8	10.0	80
Stow	16	8.0	128
Bolton	8	12.0	96
Hudson	66	11.0	726
Acton	64	6.0	384
Maynard	34	7.0	238
Concord	62	2.0	124
Carlisle	12	6.0	72
Lincoln	32	3.7	118
Weston	39	7.2	281
Billerica	141	6.8	605
Andover	89	12.6	1,247
Tewksbury	99	8.7	644
Wilmington	74	4.6	474
Burlington	103	1.7	90
Bedford	53	4.7	578
Lexington	123	3.4	479
Woburn	141	2.5	195
Winchester	78	3.2	250
Arlington	157	1.2	188
Belmont	77	2.1	162
Watertown	112	3.0	336
Cambridge	202	1.0	202
Somerville	267	2.0	534
Medford	193	2.1	405
Stoneham	70	5.3	371

Figure 10 (Cont'd.)

$E = 1,\ S = .8,\ P_A = .1,\ P_B = .9$

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Chelmsford	A	19	.1	1.9
	B	9	.9	8.1
				10.0
Westford	A	19	.1	1.9
	B	9	.9	8.1
				10.0
Littleton	A	19	.1	1.9
	B	9	.9	8.1
				10.0
Groton	A	26	.1	2.6
	B	16	.9	14.4
				17.0
Ayer	A	23	.1	2.3
	B	13	.9	11.7
				14.0
Boxboro	A	19	.1	1.9
	B	9	.9	8.1
				10.0
Stow	A	17	.1	1.7
	B	7	.9	6.3
				8.0
Bolton	A	21	.1	2.1
	B	11	.9	9.9
				12.0
Hudson	A	20	.1	2.0
	B	10	.9	9.0
				11.0
Acton	A	15	.1	1.5
	B	5	.9	4.5
				6.0
Maynard	A	16	.1	1.6
	B	6	.9	5.4
				7.0

Figure 10 (continued)

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Concord	A	11	.1	1.1
	B	1	.9	0.9
				2.0
Carlisle	A	15	.1	1.5
	B	5	.9	4.5
				6.0
Lincoln	A	10	.1	1.0
	B	3	.9	2.7
				3.7
Weston	A	9	.1	0.9
	B	7	.9	6.3
				7.2
Billerica	A	14	.1	1.4
	B	6	.9	5.4
				6.8
Andover	A	18	.1	1.8
	B	12	.9	10.8
				12.6
Tewksbury	A	15	.1	1.5
	B	8	.9	7.2
				8.7
Wilmington	A	10	.1	1.0
	B	4	.9	3.6
				4.6
Burlington	A	8	.1	0.8
	B	1	.9	0.9
				1.7
Bedford	A	11	.1	1.1
	B	4	.9	3.6
				4.7
Lexington	A	7	.1	0.7
	B	3	.9	2.7
				3.4
Woburn	A	7	.1	0.7
	B	2	.9	1.8
				2.5

Figure 10 (continued)

Place	Emergency Type	Value of Risk Function For Emergency	Proportion	Value of Risk Function For Town
Winchester	A	5	.1	0.5
	B	3	.9	2.7
				3.2
Arlington	A	3	.1	0.3
	B	1	.9	0.9
				1.2
Belmont	A	3	.1	0.3
	B	2	.9	1.8
				2.1
Watertown	A	3	.1	0.3
	B	3	.9	2.7
				3.0
Cambridge	A	1	.1	0.1
	B	1	.9	0.9
				1.0
Somerville	A	2	.1	0.2
	B	2	.9	1.8
				2.0
Medford	A	3	.1	0.3
	B	2	.9	1.8
				2.1
Stoneham	A	8	.1	0.8
	B	5	.9	4.5
				5.3

Risk Function for Region III with Lahey Clinic as Level 4, Level 1 and Level 2 Facility

Figure 11

Figure Number	Lahey Clinic Level	Risk Score	Percent Reduction in Risk Score
8	4	5.53	0%
9	1	4.32	22%
10	2	4.63	16%

Figure 12

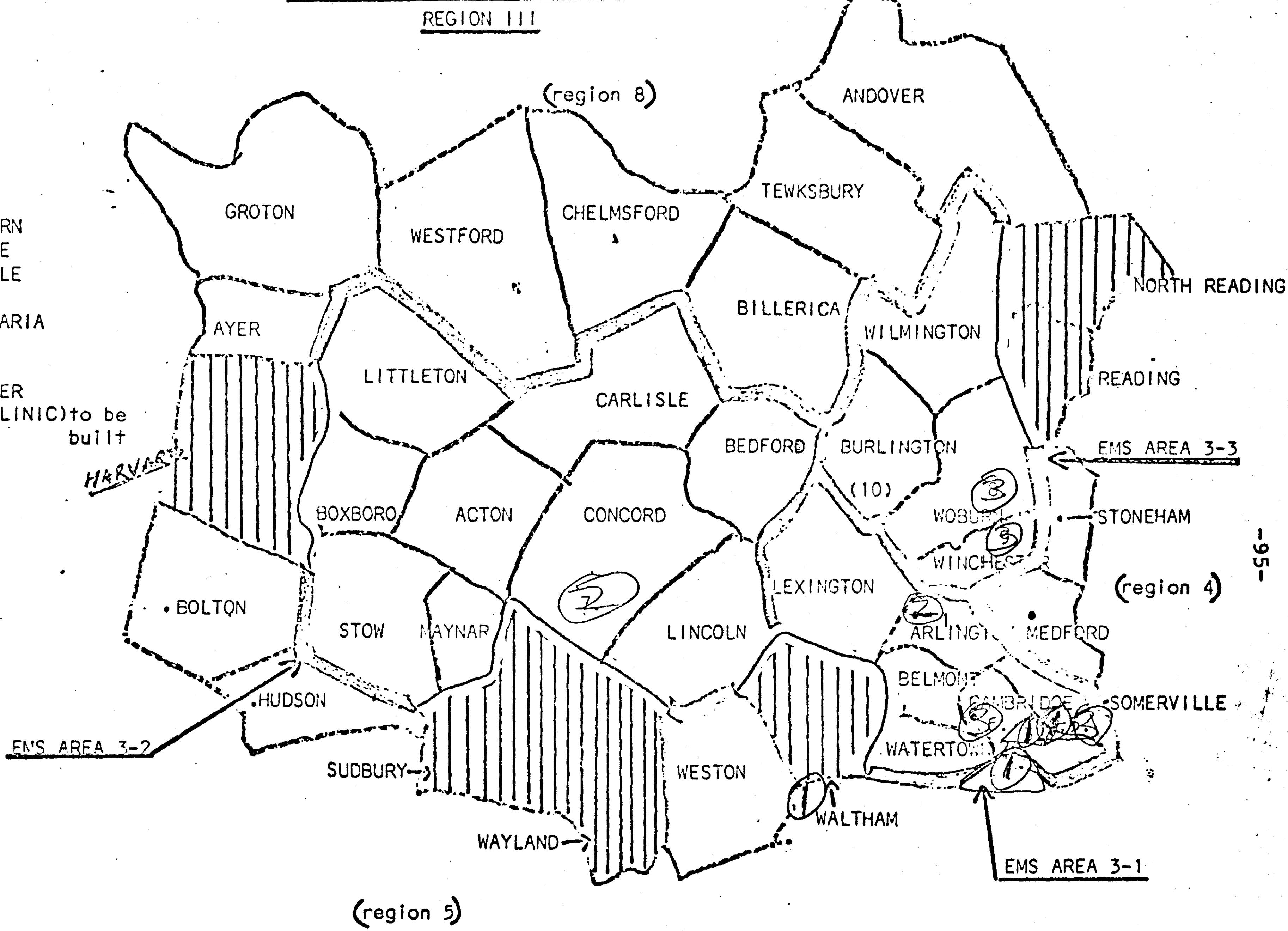
Population Under 18 for Towns in Region III

PLACE	POPULATION UNDER 18 (Hundreds)	TOTAL POPULATION (Hundreds)	PERCENT UNDER 18
Total:			
Chelmsford	133	314	42.5
Westford	44	103	42.5
Littleton	26	64	40.6
Groton	19	51	38.2
Ayer	23	74	31.5
Boxboro	8	15	42.9
Stow	16	40	41.0
Bolton	8	19	40.5
Hudson	66	161	41.1
Acton	64	147	43.2
Maynard	34	97	35.0
Concord	62	161	38.4
Carlisle	12	28	42.8
Lincoln	32	76	42.1
Weston	39	109	35.4
Billerica	141	316	44.6
Andover	89	237	37.6
Tewksbury	99	228	43.4
Wilmington	74	171	43.0
Burlington	103	220	46.8
Bedford	53	135	39.2
Lexington	123	319	38.4
Woburn	141	374	37.6
Winchester	78	221	35.5
Arlington	157	536	29.2
Belmont	77	283	27.2
Watertown	112	392	28.5
Cambridge	202	1004	20.1
Somerville	267	887	30.1
Medford	193	644	29.9
Stoneham	70	207	33.7

Map of Hospital Emergency Facilities in Region III

HOSPITALS

3-1 1. SYMMES
2. MT. AUBURN
3. CAMBRIDGE
4. SOMERVILLE
5. CENTRAL
6. SANCTA MARIA
3-2 7. EMERSON
3-3 8. CHOATE
9. WINCHESTER
10. (LAHEY CLINIC) to be built



(Bold lines enclose EMS Area)

|||| COMMUNITIES WHICH RELATE TO BOARDERING AREAS FOR EMS

that is obtained by locating a Level 1 facility in Burlington as compared with a Level 2 facility ($1 - \frac{16}{22} = 27\%$) is greater than would be expected on the basis of percentage of emergencies (10 percent).

The overall reduction in risk score which is possible with the same level of resources in the system is not known since the problem of specifying an optimal arrangement of facilities has not been solved in this report. The complexities of the decision rules for stabilization and transfer paths make the optimization problem non-trivial and not soluable by means of currently available linear programming techniques.

AN IMPORTANT QUALIFICATION

It is important to point out that the epidemiology within any diagnostic category varies widely according to the individual case. As a consequence, patient routing decisions in individual cases should not be based on category-wide epidemiology constants, but rather on a finer-grained analysis based on the specific diagnosis. The decision logic diagrammed in Figure 3 might be applied to an individual case, provided that the epidemiology and stabilization constants can be accurately estimated for that case.

For example, in the diagnostic category of trauma, accidents, and acute surgical problems (including burns), some patients might not survive without almost immediate stabilization and life-support care. Such conditions as severe shock, crushed chest, crushed pelvis, and airway obstruction are examples of conditions requiring immediate medical attention. Other conditions are such that it is safe to transport the patient as quickly as possible to a definitive care facility without stabilization.

Many factors not in the model, such as local weather conditions, time of day, traffic conditions, road conditions, and the like may influence individual decisions as to where to send a patient. The value of using a simple model which abstracts the essential elements of the decision process is that it permits the making of more rational resource allocation decisions based on long-term averages within diagnostic categories. Estimates of accessibility requirements based on epidemiology constants can be used to determine the type and location of stabilization facilities which are needed. Manpower and facility requirements can be developed in line with these estimates so that overall risk can be reduced as much as possible within the constraints of available resources. Although everyone agrees that there should be a system of stratified facilities, no one has yet devised a systematic way of determining the answer to the question, "How many of what kind of facilities are needed in which places?"

It should be pointed out that this analysis is only designed to consider those emergency cases where time delay could be harmful to the patient rather than those "urgent" cases in which the condition requires medical attention within the period of a few hours. Accordingly, the epidemiology and stabilization constants to be used in conjunction with this model should reflect the typical "emergency" case rather than the typical "urgent" case within a diagnostic category. The distinction between Type A and Type B emergencies is based strictly on the degree of complexity of each diagnosis or types of diagnoses that can be treated without referral. It should also be noted that the per capita risk function for a given diagnostic category does not provide any information as to the incidence of that kind of emergency in the general population, since some kinds of emergencies are much more prevalent than others. Public attention may focus on reducing the risk associated with the more common type of emergencies while treatment facilities for the rarer types of emergencies may be given a lower priority. It is never possible to eliminate risk in any diagnostic category. The degree to which risk can be reduced is partially dependent on the degree of optimization present in the arrangement of treatment facilities and partially dependent on the degree of appropriate utilization of existing facilities. It is also dependent on the amount of money which the public is willing to spend on emergency medical services.

CHAPTER FOUR

PROBLEMS OF IMPLEMENTATION IN REGIONAL EMERGENCY HEALTH FACILITY PLANNING

Thus far, the focus of this report has been on systems design and comparatively little attention has been paid to the practical problems of implementing proposed system changes. This chapter is an attempt to correct that imbalance by reporting on practical attempts to implement regional emergency health facility plans. The implementation of Area-wide Hospital Emergency Services planning in Illinois will be described, followed by a detailed discussion of the regional planning process in Massachusetts, including interviews with key participants. Finally, some recent developments at the Federal level will be reported.

REGIONAL HOSPITAL EMERGENCY PLANNING IN ILLINOIS

One of the main problems in implementing regional hospital emergency plans is simply inducing individual hospitals to talk to neighboring hospitals about their emergency rooms. Traditionally, hospitals do not relate to each other and, therefore, there is little reason to expect that cooperative hospital emergency planning will commence without an outside impetus. In Illinois, such an impetus was provided by state law which now requires that "all hospitals with emergency rooms must participate cooperatively in an area-wide plan to provide medical emergency services on a community and area-wide basis." (Boyd, Pizzano, and Murchie, 1973).

Inter-hospital cooperation began in Illinois in 1971 with the inauguration of the Illinois Trauma Program. According to Boyd, Pizzano and Murchie (1973), "this program aimed at the identification and functional categorization of 45 hospital Trauma Centers dedicated to the care of the critically injured patient. The functional hospital categories of trauma care (Regional, Area-wide and Local) were necessarily selective to provide well-identified access points to the emergency surgical care essential to the life-threatened accident victim."

In the Illinois Trauma Program, trauma patients are distributed among the three levels of Trauma Centers, local, area-wide and regional, according to the seriousness of their injuries. Patients are immediately transported to the next higher level facility if their clinical needs exceed the care capabilities available at the receiving facility.

The success of the initial Trauma Program in facilitating inter-hospital cooperation and area-wide planning led to the development of comprehensive emergency facilities categorization plans and "a basic regionalized medical emergency system utilizing current resources and building on the existing Trauma Program's initial structure and functional components, with further systems designs for the acute coronary, the high-risk infant, the poisoning, drug overdose and alcohol detoxification, and psychiatric problems." (Boyd, Pizzano, and Murchie, 1973).

In light of the discussion of the arrangement of hospital emergency facilities within a planning region in the previous chapter, it is interesting to note that the Illinois planning process permits the self-categorization of hospitals with only one legal restriction. Each area-wide plan must specify at least one "comprehensive" or "basic" (middle-category) emergency room. No formal procedure was used by the Illinois Bureau of Emergency Medical Services and Highway Safety to promote the optimal spatial arrangement of facility levels within a region. However, Boyd, Pizzano and Murchie (1973) do state that "the self-categorizations of each of the participating facilities may be readjusted as necessary to meet area-wide needs."

The successful implementation of the state-wide categorization program in Illinois was partly due to a successful educative process which was undertaken by the Illinois Bureau of Emergency Medical Services and Highway Safety. The potential benefits of the program were presented "to emergency medical patients, physicians, nurses, allied health workers, and hospitals. Initial awareness of the issues and problems of categorization had previously been encountered with the functional categorization of some 45 Trauma Centers across the state during the preceding year. The Trauma Program was a successful learning model and was effective in emphasizing the beneficial aspects of hospital categorization and area-wide planning to an entire state-wide health community" (Boyd, Pizzano and Murchie, 1973).

The Illinois Bureau of Emergency Medical Services and Highway Safety initiated the planning process at the local level and serves in a consulting capacity to the local planning committees which it helped to set up. According to Boyd, Pizzano and Murchie (1973):

"To initiate this planning process, the Bureau of Emergency Medical Services and Highway Safety held a series of 14 regional workshops across the state to provide technical and professional assistance to local planning groups. All appropriate health providers in each geographic service area were invited to attend and participate. At the workshops, the Illinois Hospital Association, the local ("B") and state ("A") Comprehensive Health Planning Agencies, Illinois Nurses Association, and the Illinois State Medical Society representatives participated with local area physicians, nurses, hospital administrators, ambulance operators, etc. to initiate and develop their area-wide EMS plans. . .

The local Emergency Medical Service Committee is responsible for the development, implementation, and on-going evaluation of each area-wide emergency service plan. The required minimum membership of this committee is a physician, a nurse, and an administration representative from each participating hospital."

All local plans are subject to approval, first by the local ("B") and then by the state ("A") Comprehensive Health Planning Agencies. All the hospitals within an area-wide planning region may have their licenses revoked unless the area-wide plan is approved by the Director of the Illinois Department of Public Health after final review by the Emergency Service Advisory Committee of the Hospital Licensing Board.

On the basis of the foregoing discussion, two generalizations regarding the reasons for the successful implementation of area-wide hospital emergency services planning in Illinois can be made. Firstly, and most importantly, participation in the planning process is tied to the hospital licensing procedure under Illinois state law. Secondly, strong direction was provided by the enthusiastic staff of the state-wide Bureau of Emergency Medical Services and Highway Safety.

Unfortunately, it was not possible to view the Illinois planning process first-hand so that some of the difficulties encountered in the planning process could be observed. It was possible to observe the planning process first-hand in Massachusetts and to discuss the problems of implementation with some of the key participants. These discussions and observations are reported in the following section.

REGIONAL HOSPITAL EMERGENCY PLANNING IN MASSACHUSETTS

The development of regional hospital emergency planning in Massachusetts has lagged behind the pace set in Illinois. The Illinois Trauma Program was the first state-wide program of its type in the nation and the development of a comprehensive emergency facilities categorization plan followed closely. In Massachusetts, regional emergency facilities planning did not commence formally until July of 1972. At that time, the Tri-State Regional Medical Program provided funds to support Emergency Medical Services projects located within Massachusetts' six regional ("B") Comprehensive Health Planning Agencies. In January, 1973, a state-wide Office of Emergency Medical Services was established in the Massachusetts Department of Public Health. In 1974, the Department of Public Health secured Federal funds through the Department of Health, Education and Welfare under the Emergency Medical Services Systems Act of 1973 (see the final section of this chapter) to coordinate EMS planning efforts on the state-wide level and to fund the on-going regional EMS projects.

In order to learn more about emergency facilities planning in Massachusetts, we spoke with several of the key participants. Our first interview was with a member of the senior planning staff in the state-wide Office of Emergency Medical Services. This individual came to Massachusetts from Illinois where she was a senior planner at the Bureau of Emergency Medical Services and Highway Safety. The senior planner's background prior to work in the Emergency Medical Services area was in the education field. The progress of the Illinois program was due in considerable measure to her success in educating local health providers (physicians, nurses, hospital administrators, ambulance operators, etc.) in the benefits and concepts of regionalized emergency medical services.

The senior planner explained that her primary goal in Massachusetts is to assist in helping hospitals to relate to each other when planning emergency medical services. As in Illinois, the emphasis is on hospital self-categorization and resource availability identification. The senior planner did not see her role as one of attempting to improve the spatial arrangement of facilities within a planning region. Rather, the focus is on identifying points of entry and transfer patterns with the goal of insuring that there is a plan for each type of emergency within a planning region.

The senior planner explained that there are eight emergency medical planning regions in Massachusetts, corresponding to the eight regional Comprehensive Health Planning ("B") Agencies. In 1974, seven of these planning regions had active EMS Regional Councils. These EMS Councils report directly to the Board of Directors of the regional Comprehensive Health Planning ("B") Agency. The membership of each of the regional councils is composed of 49 percent health care providers and 51 percent consumers. Among the health providers are hospital administrators, physicians, nurses, ambulance operations, civil defense officials, Red Cross representative, and others. The consumer representatives may not include health care professionals.

Each planning region is further subdivided into several planning areas. Each planning area has an EMS Steering Committee. There are also area EMS Subcommittees on Hospitals, Transportation, Public Education, and other problem areas. The area EMS steering committee is composed primarily of hospital administrators, physicians, and nurses.

The senior planner explained that it is very important to consider the pressures on individual hospital administrators when considering regional emergency hospital plans. She pointed out that hospital administrators must meet the four-fold requirements of: 1) the Board of Directors; 2) Federal price controls; 3) the medical staff of the hospitals; and 4) the Massachusetts state rules and regulations.

In Massachusetts, proposed new rules and regulations call for mandatory self-categorization for hospital licensing purposes. Hospitals must conform to the categorization standards of the category they choose - Comprehensive, Routine and Standby. However, there is no requirement in the proposed Massachusetts law that regional emergency facility plans be submitted to the state Department of Public Health for hospital licensing purposes. Therefore, the way the Massachusetts law is written places more emphasis on self-categorization by individual hospitals than on cooperative regional facility plans.

The senior planner distinguished carefully between categorization and regionalization for planning purposes. She noted that categorization was primarily for hospital licensing purposes whereas regionalization referred to cooperative agreements between hospitals to plan for the six categories of emergencies. She felt that regionalization was the heart of the planning process because its goal was to insure adequate coverage for all types of emergencies within a planning region. The senior planner expressed the view that the regional planning process would be more successful if it were undertaken on a local basis with democratic representation on planning committees than if it occurred in response to mandatory state rules and regulations. She felt that categorization was a more appropriate matter for state regulation because the public has a right to expect certain minimum standards (such as 24-hour physician coverage) from a Routine Emergency Service with signs designating the availability of such emergency services.

The senior planner also pointed out that hospitals' administrators are often encouraged by the hospital's Boards of Directors to improve the hospital's profit and loss statement.

She therefore expects hospital administrators to be very cautious about upgrading or downgrading their emergency facilities until the cost and revenue implications of such actions are better understood. The planner noted that hospital administrators must also be responsive to the wishes of the medical staff in any decision to upgrade or downgrade emergency facilities. The gains and losses of certain kinds of emergency inpatient admissions might affect the hospital's ability to keep and attract medical staff.

In her experience with hospital administrators, the planner has often detected a shift over time in the attitude toward regionalization and categorization plans by hospital administrators. She has found that an initial institutional fear of categorization goes away as her work continues, reassurances are given, and key questions are answered. She pointed out that the current President of the Massachusetts Hospital Association, who formerly held a high post with the Illinois Hospital Association, is very favorably disposed toward regionalization and categorization proposals and has acted as a positive influence on the hospital administrators.

In a final comment, the planner told us that she favors local control of the emergency planning process. She feels that regionalization of emergency medical services is more likely to work if local groups make their own plans with technical assistance from regional and state health planners rather than have the plans imposed by a central authority.

REGIONAL HOSPITAL EMERGENCY PLANNING IN GREATER BOSTON

In order to discover more about emergency facilities planning at the regional level, we spoke with the Project Director of the Emergency Medical Services Project of the Health Planning Council for Greater Boston, Inc. The Health Planning Council for Greater Boston, Inc. is the Comprehensive Health Planning ("B") Agency for substate Regions III, V and VI. Region III is composed of the northern and western suburbs of Boston. Region V is the suburban area to the south and southwest of Boston. Region VI is Boston Proper, together with Brookline and four cities and towns directly to the northeast of Boston.

The Project Director explained that the goal of his project was to work with the state-wide Office of Emergency Medical Services in improving emergency medical services systems within his substate region. He noted that there had been a shift of emphasis by the state offices of Emergency Medical Services over the two-year life span of his project. Initially, the concentration was on the pre-hospital care systems with a focus on improving ambulance systems. A new Ambulance Law became effective in Massachusetts on January 22, 1974. This law enables the Department of Public Health to set minimum standards for all ambulance services, public and private, in such areas as training of ambulance attendants, equipment, vehicle design, and regular inspection of vehicles.

After the passage of the Ambulance Law, the focus of direction provided by the state Office of Emergency Medical Services to the regional EMS projects shifted to the categorization of hospital emergency care capabilities. The activities of the state-wide office with regard to hospital categorization and regional facilities planning was described in the previous section. The Project Director described the activities of his office in support of the recent emphasis on hospital categorization and regionalization. His main focus was on assisting Area Hospital Subcommittees in commencing and carrying out their planning activities.

The Project Director pointed out that the planning areas within a planning region can be divided into three basic types. Type I is defined as a situation in which a single hospital must serve the town in which it is located and all of the surrounding towns. Type II is defined as a situation in which a pair of hospitals must serve a particular geographic area. Type III is defined as a situation in which more than two hospitals are within a "reasonable" distance and travel time.

The Project Director stated that the major difficulty in Type I cases involved the coordination of ambulance services in the different towns in order to insure rapid transport to the hospital. In Type II cases, inter-town rivalries are often involved and the major problems involve deciding which hospital should receive which kinds of cases. The Project Director cited one case in which two hospitals in neighboring towns had each kept exact pace with the other in purchasing new emergency equipment and acquiring new staff. As a consequence, each hospital has virtually the same care capabilities although the Project Director was under the distinct impression that one hospital provides a higher quality of care for most types of emergencies than does the other. The Project Director noted that the state Office of Emergency Medical Services hadn't addressed the quality of care issue at all. He stated that the usual decision rule in such cases was to bring the patient to the nearest hospital. He felt that this in itself would be a significant accomplishment since it is difficult to persuade ambulance operators to cross jurisdictional lines when inter-town rivalries are strong.

Planning in Type III cases is often more difficult, according to the Project Director. In such cases, one hospital may have a specialized emergency care capability, such as neurosurgery, that the others lack. Once such specialized resources are identified, arrangements must be made to route patients to the specialized facility. This can be accomplished both through the instruction of ambulance attendants and through transfer agreements with the other hospitals. The Project Director did not attempt to specify a decision procedure for determining under what circumstances it is better to bring the patient to the nearest hospital for stabilization before transfer to the specialized facility and under what circumstances it is best to instruct the ambulance attendant to bring the patient directly to the specialized hospital.

The Project Director stated that the major focus of his current work was to develop concepts and plans which would be applicable for three substate planning regions comprising Greater Boston. This effort resulted in a guidebook called "The Greater Boston Plan - A Basic Blueprint for Achieving an Improved Emergency Medical Services System". The guidebook has been officially endorsed by the Health Planning Council for Greater Boston, Inc. The guidebook includes a "Facilities Plan" which stresses the role of the hospital in upgrading the other components of emergency medical systems: transportation, training, communications and public education. Also stressed are "physician coverage (including specialists) and the burden of non-urgent cases". Relatively little emphasis is placed on identifying differing levels of hospital care capabilities for particular kinds of emergencies.

Our next interview was with the Chairman of the Region VI (Boston Proper) Regional EMS Council. A physician, the Council Chairman is a Professor of Community Medicine at one of Boston's medical schools. The council chairman described the hospital emergency room situation in Boston as a "competitive market" in which each emergency room is vying for its "market share". He stated that some Boston hospitals are trying to expand their emergency services, while some hospitals are satisfied with the present level and volume of emergency services rendered. The council chairman could think of no hospital in Boston that wanted to cut back its emergency services.

The council chairman contrasted the existing "competitive market" system with a theoretical "centrally-designed" system. He stated that a "centrally-designed" system might close down a number of hospital emergency rooms and enhance the care capabilities of others. He noted that such a system might improve efficiency and quality of care but might suffer losses in terms of accessibility. He was uncertain how to measure these possible effects.

The council chairman noted that most Boston hospitals are very suspicious of new state rules and regulations. They see the long-term goal of the state as one of trying to impose a "centrally-designed" system. He felt that many of the hospitals were engaged in "empire building" activities and feared state "efficiency experts" who might try to limit such activities.

The council chairman also expressed the view that the Boston City Hospital should be only a part of a larger system of hospital emergency facilities receiving municipal funding assistance. He noted that the city pours money into emergency care at Boston City while hospitals in other geographic locations within the city are not assisted. He felt that such practices are discriminatory to those city residents for which Boston City Hospital is not readily accessible.

The council chairman predicted that, in the short-run, the regional planning process within Boston would involve hard bargaining and negotiations between hospitals. He felt that trade-offs would be negotiated so that each hospital could offer certain kinds of specialized emergency service. In the long-run, the council chairman predicted, some of the smaller facilities might be squeezed out as acute general care hospitals and might become extended care facilities instead. He felt that, in the long-run, the government would insist on quality of care standards and would use reimbursement incentives under national health insurance in order to obtain compliance.

The council chairman noted that he and the Region VI Regional EMS Council were currently beginning to implement the short-run planning process described above. He noted that hospitals in Boston had begun the process of sitting down together to identify their respective care capabilities. He also pointed out that there had recently been a great deal of emphasis in the Regional EMS Council on Disaster Planning. Both a major fire and major airplane crash had occurred recently within Region VI. As a consequence, a great deal of discussion and planning activity ensued within the EMS Regional Council regarding plans for disasters. Accordingly, planning for the standard kinds of medical emergencies had been de-emphasized somewhat over the past few months.

EMERGENCY REGIONAL FACILITIES PLANNING
THE HOSPITAL'S VIEWPOINT

In order to obtain the perspective of the hospital on regional emergency facilities planning, we spoke with the President of the Massachusetts Hospital Association. Like the senior planner in the state Office of Emergency Services, he had recently moved from Illinois, where he was Senior Vice President of the Illinois Hospital Association. The hospital association official noted that the experience of hospitals in Illinois that had been designated as Trauma Centers had been economically very favorable. The impact of categorization of a facility as a Trauma Center invariably was to increase the hospital census through inpatient admissions from the emergency room.

The hospital association official expressed the opinion that the major reason for the successful implementation of the state-wide categorization system in Illinois was that the program was implemented so quickly that medical staff groups associated with hospitals not designated as Trauma Centers didn't have time to oppose it. The Illinois program was the first of its kind in the nation and hospitals and medical staffs not designated as Trauma Centers were unaware of the possible adverse economic effects of a reduced flow of inpatient admissions from the emergency room. The hospital association official predicted that there would be much greater resistance to categorization proposals in Massachusetts if an attempt were made to drastically alter the patterns of patient flow.

The hospital association official felt that the most costly item in the new Massachusetts Proposed Regulations for Categorization of Hospital Emergency Rooms was the 24-hour staffing requirement for Routine Emergency Services "by a physician who shall be in at least the second post-doctoral year". He noted that most of the hospitals in the state would want to qualify as Routine Emergency Services facilities and that the cost of physician staffing would be $45,000 per man-year. Approximately five man-years would be required for 24-hour coverage.

The hospital association official noted that the new Lahey Clinic facility in Burlington, Massachusetts has considered becoming a Comprehensive Emergency Facility but had not made a final decision because of the lack of hard analyses regarding costs and benefits, and the potential impact in terms of improved emergency medical coverage in the area. The analytical model proposed in Chapter Three and the sample calculation involving the Lahey Clinic is an attempt to address the latter need.

The hospital association president noted that the major economic problem in hospital emergency services is the delivery of primary care in the emergency room. He noted that such care was very costly when administered in the emergency room and could be administered much more efficiently in 24-hour neighborhood health centers. The hospital association official expressed the hope that one of the outcomes of the categorization process would be to reduce the flow of non-urgent patients to hospital emergency facilities. He noted that visits to the typical hospital emergency room average only 10 percent emergency cases. The non-emergency cases are typically not admitted to the hospital, and there is often difficulty in collecting the bill for these patients. The hospital association president felt the continuing decline of private health delivery created the need for better planning by hospital groups and governmental agencies.

In order to obtain the perspective of the individual hospital, we spoke with the administrator of a medium-sized community hospital. He stated that the major problem he faced was finding qualified emergency room physicians. The hospital administrator explained that:

> "Emergency services in my experience are lacking because of the difficulty in finding qualified individuals. Talk about physicians, I think they should be capable of doing minor surgery. They should be able to do minor orthopedic procedures. I think he should be capable of handling cardiac conditions. He should know what emergency services are. If he doesn't, then he's not an emergency room physician. These are the problems that we have encountered. A doctor will come in and apply to work in the emergency room, now he may be a good internal medicine man but when it comes to an accident case, he's lost and you'll have to depend on the back-up of other specialists involved to cover the emergency services involved which defeats the operation of emergency services."

We asked the hospital administrator if he used patient utilization data to determine what kinds of equipment or specialists are needed. The hospital administrator used cardiac emergencies as an example:

> "I go on the basis of MI's: serious or non-serious MI's. You've got a cardiologist on your staff, he states that 'Well, I want a capability of a pace-maker within emergency room service.' Well, how do we justify it? How many cases have we really seen? How many MI's have we had? Have we had an influx over one period greater than another period? Or has this been a continuing thing over a course of six, seven, eight months? Or has it remained stagnant where you receive once a month, one case. Based on the statistical analysis of the types of cases, gives you substantiation and documentation of the amount of funds to expend for specialized equipment or even specialized people."

The interviewer then asked the following question - "Do hospitals ever sit down with this type of data and figure out how many patients are coming in for each type of case within the whole region? Might there be a case where hospitals individually could not afford a service because utilization isn't high enough but one hospital within the region could afford a service if it received all relevant cases? Do you feel that it is a good idea to pool this kind of data?"

The hospital administrator answered:

> "Well, I think it will give you a certain amount of information but I don't think this would be the solution to the ultimate problem that we face in regionalization. Number one, if you have regionalization, who is the ultimate authority to say what type of patients go to which facility? Now in the military we used to have a system where you had to call a certain number, let's say you had a psychiatric case and you'd like a hospital bed for it. This controlling agency would give you a hospital to transfer the patient to. I think in order to be able to set up an appropriate regionalization program, you must have some kind of controlling agency."

The hospital administrator also stated that:

"I think the best approach to regionalization is at the state level. . . I think your Bureau of Hospital facilities would be the ultimate agency. I would think your Bureau of Hospital facilities should have some type of program on allocation of resources within a given geographical area. For instance, we have psychiatric cases, what do we do with them? Danvers doesn't take them, Lindeman Clinic doesn't take them, so what do we do with these cases, where do we send them? Who informs us and tells us where we go?"

The interviewer then remarked:

"I gather than you think this sort of system would materially improve the quality of care?"

The hospital administrator replied:

"Most certainly. It would improve the quality of care and at the same time make known the resources that were available. We don't know what resources are available. Hospitals have been predominately a very secretive type of operation. One administrator normally doesn't say to another what he's doing or how he's doing it; likes to keep it quiet. This has been true right along. When I want to add 150 beds I don't want to go down the street to John and say 'Well, I'm adding 150 beds!' Because I might be stealing economically from you, or I might then become such a sophisticated facility that no one else would want to use your facility because I am now the sophisticated (XYZ) medical center. I have the specialists, I have everything here. The only way it could be fair is at the state level, not in a dictatorial sense, but I think in a cooperative sense, establish with each community hospital, each general hospital, an agreement as to its responsibilities in the emergency care area."

Time limitations prevented us from discovering whether or not the views of this hospital administrator toward regionalization and categorization were typical of hospital administrators as a group. From his own remarks, however, one might infer that regionalization and categorization proposals could encounter considerable resistance from hospital administrators, especially if presented in a way that denies the individual hospitals their autonomy.

TWO DIFFERENT APPROACHES TO THE IMPLEMENTATION OF REGIONAL SYSTEMS OF HOSPITAL EMERGENCY FACILITIES

Based on the study of the Illinois Trauma program and the interviews with public health officials and hospital representatives in Massachusetts, two basic approaches to the implementation of regional systems of hospital emergency facilities have emerged. These may be termed the "top-down" approach and the "bottom-up" approach. The "top-down" approach involves a centrally planned system, probably at the state level, with the state having legal authority to enforce compliance. The "bottom-up" approach involves voluntary cooperation among neighboring hospitals in designing regional emergency facility plans.

A possible advantage of the "top-down" approach is that it would facilitate the implementation of a redesign of the arrangement of hospital emergency facilities based on a quantitative model of user requirements. This design could simply be imposed by the state public health authorities with legal authority tied to the hospital licensing procedure. A difficulty with a centrally imposed solution, especially one based solely on user requirements, is that it fails to take into account existing provider strengths and weaknesses in the present system. For example, one hospital may have developed a particularly strong capability for treatment of head injuries to trauma victims. Even if this facility is not optimally located geographically, quality of care considerations might make a good case for leaving the facility where it is.

The "bottom-up" approach has the advantage of exploiting existing provider strengths in the current system. Voluntary agreements between neighboring hospitals are likely to produce agreements in which one hospital specializes in one category of emergency care and a neighboring hospital specializes in another type of emergency care. Such a system has the advantage of creating "more chiefs and fewer Indians" by giving every provider a role in the emergency care system. Hospitals are unlikely to agree voluntarily to a system design which deemphasizes their role in the entire spectrum of emergency care activities, even if they are financially compensated for the loss of hospital admissions from the emergency room.

A possible disadvantage of the "bottom-up" approach is that user requirements are likely to be insufficiently considered in the resulting systems design. A systems design approach which promotes specialization in the provision of emergency care facilities may exacerbate the problem of inappropriate system usage. The presence of citizen representatives on the local Emergency Medical Services planning committee does not guarantee that epidemiological considerations or existing patterns of facilities usage will be adequately considered in the design process.

All of these considerations seem to argue for a mixed approach in which provider and user needs are both considered in the systems design process. A modeling approach which emphasizes epidemiological considerations as well as existing patterns of system entry might serve as a point of departure for the planning process. Meetings between provider groups and state representatives could insure that provider needs and strengths are adequately considered in the planning process. Provider groups could make the case for emphasizing quality of care considerations over epidemiological considerations in situations where quality of care gains are likely to be great and accessibility losses small. Although final approval of the emergency facility system design might be the responsibility of the state department of public health (as is the case in Illinois), every effort (including an appeal mechanism) would be made to secure the voluntary compliance of provider groups and user representatives.

The often severe economic effects on individual hospitals of regionalization decisions must be clearly delineated so that effective remedies can be designed. Research currently underway at the University of Pennsylvania places particular emphasis "on defining economies associated with EMS regionalization, evaluating alternative financing mechanisms, and developing guidelines for projecting the economic impact of planned EMS improvements. The outputs will provide a vastly improved basis for future decisions by EMS planners and those influencing EMS resources and funding" (Hamilton, et al, 1974). These authors also point out that:

"1. Most communities are unable to assess adequately the cost and revenue implications of modifying existing EMS delivery systems and -

2. The lack of convincing economic information may be an important obstacle to the development of effective regional emergency services. . . Improved information on the economic effects of EMS system development and operation is therefore an essential input to more responsible future decisions relating to national financing programs and community commitments to improved emergency services."

REGIONAL HOSPITAL EMERGENCY PLANNING - THE FEDERAL ROLE

In recognition of the need to assist Emergency Medical Services systems research and development, the Congress enacted, and the President approved, Public Law 93-154, the Emergency Medical Services Systems Act of 1973. This Act appropriates $185 million over three years to support the establishment and improvement of Emergency Medical Services systems, and research in the areas of emergency medical techniques, methods, devices, and delivery. Since federal funding of area-wide EMS planning projects under the Regional Medical Programs administration has been phased out entirely during 1974, funds from the Emergency Medical Services Systems Act are presently the major source of federal funding for regional EMS planning. Another source of EMS funding to states and counties continues to be the Department of Transportation, under the National Highway Safety Act. However, the Department of Transportation defines its responsibilities and funding interest as ending once the patient enters the hospital.

The Emergency Medical Services Systems Act includes funds for the support of research in emergency medical techniques, methods, and delivery systems. The research program is administered by the Bureau of Health Services Research of the Health Resources Administration, Department of Health, Education, and Welfare. According to guidelines for prospective grantees prepared by the Bureau of Health Services Research, the purpose of the Emergency Medical Services Systems Act "is to assist the development of integrated EMS systems which can utilize available technical information and medical capabilities in a coordinated manner; many experts have pointed out that adequate knowledge and expertise now exists to achieve a significant reduction in the toll of death and disability resulting from medical emergencies."

The focus of the guidelines is to encourage applied research on systems design and implementation problems. The guidelines stress the need for systems design research since "at the present state of knowledge, it would not be possible to devise regulations which could insure that effective systems would be developed nationally. Optimal relationships between the needs for accessibility, quality, and economy are not well-defined even for theoretical models, and the differences between communities in terms of needs, resources, and relationships complicate the problem significantly."

The guidelines also stress the need for research on implementation problems since "the development of a system to care for medical emergencies must consider sociologic and organizational problems, as well as economic effects. An EMS System represents a highly visible interface between community needs and health system responses, and is subjected to pressures from a variety of organizations and interests. . . The economic impacts of an expanding EMS System on hospitals, clinics, physicians, and many other interested groups have generated long and bitter controversies."

In addition to stressing the arrangement and implementation problems in emergency facilities planning, the research guidelines also call for studies on the following hospital-related topics:

"1. Organizational and economic impacts of EMS categorization.

2. Efficient designs for emergency facilities, including patient flow patterns and relationships to other systems.

3. Effects of changes in administrative policies, such as clinic operating hours, appointment systems, outreach programs, etc., on utilization of EMS Systems.

4. Analysis of differences between Emergency Departments managed by hospital staff versus those managed under contract, in terms of policies, referral and admission patterns, etc."

In order to learn more about the government research program and the federal role in regional emergency facilities planning, we spoke with an official of the Division of Health Services Evaluation, Bureau of Health Services Research, Health Resources Administration. A physician, the official emphasized his role as a coordinator of research programs. He stated that an important role of the federal government in emergency medical services research is to help see that duplication of effort is avoided and to put researchers in touch with others working in closely related areas. The official provided several references for the discussion of conceptual issues in Chapter Two of this report.

The official noted that the legal aspects of the regionalization of emergency medical facilities have not been thoroughly tested in the courts. He pointed out that, in many states, hospital trustees have a very significant legal responsibility for emergency patients. If a patient is transferred to another hospital, the first hospital may be legally responsible for the patient during transfer. If a hospital takes responsibility for excellence of care during transfer, it has increased its liability in damage suits.

The official also felt that there is a significant "image" impact on a hospital within a community if it transfers many patients to another hospital. The official noted that as long as hospitals are required to be solvent, regionalization programs will be severely impaired. He felt that a hospital will only upgrade or downgrade its emergency facilities if this action does not have a negative impact on the hospital's profit and loss statement.

In conclusion, the federal official stressed the need for information systems to support emergency medical systems design and implementation efforts. He pointed out that no one has accurately defined the data that is needed to support systems design and implementation activities. The problem of data definition and information systems design is one of the primary considerations in the final chapter of this report.

REGIONALIZATION AND CATEGORIZATION IN HOSPITAL EMERGENCY PLANNING - CONCLUSIONS

CHAPTER FIVE

Several sets of conclusions can be drawn from the information and discussions presented in this study. The first set of conclusions involves the arrangement of emergency medical facilities within a planning region. In Chapter Three, a model is developed for measuring the relative desirability of various spatial arrangements of emergency treatment facilities. This model takes into account variations in epidemiological factors and the efficacy of stabilization and life-support care in reducing risk for various types of emergencies.

As noted previously, medical research data regarding the pathophysiologic sequence of events (epidemiology) following particular types of medical emergencies has not been utilized in decisions regarding the location of emergency treatment facilities. In addition, variations in the value of stabilization and life-support care for different types of emergencies have also not been adequately considered in the spatial design of regional emergency facility systems.

Current approaches to categorization of hospital emergency care facilities have emphasized the classification of hospitals according to the degree of comprehensiveness of the entire spectrum of emergency services which they provide. As we have seen, such approaches do not take adequate account of variations in emergency facility requirements produced by epidemiological factors associated with particular types of medical emergencies and the efficacy of stabilization and life-support care in reducing risk for those emergencies.

Variations in emergency facility requirements produced by variations in factors relating to epidemiology and stabilization can be diagrammed in the form of a matrix. Such a matrix is presented in Figure 14. In the figure, high stabilization refers to the fact that stabilization is highly effective in reducing risk (in the model presented in Chapter Three, this property would be reflected in a low stabilization constant S). In the figure, epidemiology refers to the degree to which survival rates are dependent on time to treatment. If the probability of death rises sharply with increasing time to treatment, epidemiology requirements are considered to be high.

The matrix portrays the varying requirements for emergency facilities produced by the four epidemiology-stabilization requirement classes. It seems clear that the vertical system of categorizing emergency facilities according to the entire spectrum of emergency services which they provide is inadequate as long as requirements involving epidemiology and stabilization vary widely. Expert opinion (e.g., Ramp, 1974, McKenna, 1975), as well as research studies (Andrews, et al, 1973) indicate that epidemiological requirements and the efficacy of stabilization treatment do vary widely by type of emergency.

Such emergencies as respiratory failure or severe gastrointestinal bleeding have high requirements regarding epidemiology (time-to-treatment) but also require the facilities of a major

Figure 14

EMERGENCY FACILITY REQUIREMENTS

Stabilization \ Epidemiology	High	Low
High	Some definitive Many stabilization A	Few definitive Some stabilization B
Low	Many definitive Few stabilization C	Some definitive Very few stabilization D

emergency facility for successful treatment. Such emergencies are represented by Category C in the matrix and require many definitive facilities in order to reduce risk. Such emergencies are the most expensive to provide for in terms of emergency medical facilities. Tradeoffs between accessibility and efficiency are extremely difficult but necessary for this class of emergencies.

Such emergencies as acute myocardial infarction, ventricular fibrillation, airway obstruction, flail chest, and unrelieved tension pneumothorax (Cretin, 1974; Frey, Huelke and Gikas, 1969) also have high requirements in terms of epidemiology or time-to-treatment but stabilization and life-support care, if properly administered, is very effective in reducing medical risk. Such emergencies are represented by Category A of the matrix and require many stabilization facilities with a smaller number of definitive care facilities.

Other emergencies such as certain types of abdominal injuries from automobile accidents (Gertner, et al, 1972) have far less requirements in terms of time-to-treatment but greater requirements for specialized care. Such emergencies (matrix categories B and D) may require stabilization treatments but the key factor is the presence of a very high-quality definitive care facility somewhere in the region (it doesn't really matter where).

The differing requirements for emergency care facilities for these four different classes of emergencies would seem to indicate the need for separate systems designs for each of the four emergency classes. This approach has been discussed earlier in this report under the rubric of horizontal categorization. This hypothesis can be tested by means of an expansion of the model of emergency medical coverage developed in Chapter Three.

This comparison could be made by aggregating the risk for the four classes of emergencies shown in the matrix for each of two arrangements of treatment facilities. One arrangement would represent the optimal arrangement possible under a system of vertical categorization (for the moment, we assume that the optimization problem has been solved and it is possible to define such an arrangement.) Under vertical categorization, each facility would have to provide a Level 1, Level 2, Level 3, or Level 4 capability for the entire spectrum of medical emergencies. Another arrangement would keep the same level of resources in the system but would allow each facility to vary the level of care provided according to the type of emergency under consideration. We have called this arrangement horizontal categorization.

Risk functions could then be computed for each of the four classes of emergencies shown in the matrix for each of the two facilities arrangements. We would expect that the horizontal arrangement would prove to be as good or superior in each of the four classes of emergencies.

The risk functions for each of the four categories could also be aggregated to yield an overall risk score for the horizontal and vertical arrangements. In order to do this, it would be necessary to add a distance multiplier to tne risk function to take into account variations in the steepness in the relationship between distance (time-to-treatment) and risk as well as variations in the shape of the curve relating distance (time-to-treatment) to risk. The form of the equation which would be used is $R_D = KD_D^E$ for the direct path and $R_T = K(D_S^E + SD_T^E)$ for the stabilization-transfer path where K is the distance multiplier which indicates the steepness of the relationship between risk and E is the epidemiology constant which describes the shape of the curve relating distance to risk.

Although the arrangement based on horizontal categorization may be superior to the arrangement based on vertical categorization according to the criterion defined here (maximization of the system potential for emergency medical coverage), it may exacerbate problems of inappropriate system usage (Gibson, 1973b). Therefore, it is suggested that the alternative systems designs be compared on the basis of risk functions computed using the assumption that the patient always proceeds to the closest facility. In any case, the predicted pattern of system use should guide systems design efforts.

In terms of the emergency facility requirements matrix described earlier, the critical systems design problem is likely to arise in relation to emergency class C (high requirements for rapid emergency treatment - low effectiveness of stabilization and life-support care). For a class C emergency, a decision by the patient to proceed to the wrong hospital could mean the difference between life and death. From the standpoint of clarity and ease of public and ambulance driver education, it would seem appropriate to designate particular hospitals as "comprehensive" facilities in relation to class C emergencies. It would be poor systems design to have one hospital specialize in one type of class C emergency and a neighboring hospital in another type of class C emergency since the potential for user error is so high.

However, because a particular facility is designated a "comprehensive" facility for all class C emergencies doesn't mean it should be designated as a "comprehensive" facility for the entire spectrum of medical emergencies. Such a requirement is unnecessary from the standpoint of system effectiveness and extremely wasteful in terms of scarce emergency care resources. Furthermore, such a requirement might discourage a facility from providing comprehensive care for emergency classes where rapid definitive care really matters.

Systems design requirements for Type A emergencies indicate a decentralized system with all facilities providing appropriate stabilization and life-support care. System design requirements for Type B and Type D emergencies are not so critical because of the weaker relationship between time-to-treatment and risk. For these emergencies, division of specialization responsibilities between neighboring hospitals seems particularly appropriate.

To summarize the policy recommendations regarding emergency hospital facilities systems design, certain hospitals should be designed as "comprehensive" emergency system entry points. These facilities should provide definitive care for all class C emergencies (except those which are statistically rare) and stabilization care for all class A and B emergencies. Other emergencies facilities should provide life-support and stabilization care for class A and B emergencies and definitive care for emergency classes A, B, and D. Responsibilities for providing definitive care for emergency classes A, B, and D can be divided among these hospitals since time to definitive care treatment is not such a critical factor in these emergency classes. The system described here is called a selective categorization system because facilities are classified selectively on the basis of four classes of emergency facility requirements.

The model developed in Chapter Three can be further refined so that it can be used as an aid to the decisions as to where to locate these emergency facilities.

Travel times could be used instead of distances to take into account differences in travel times associated with the degree of urbanization, congestion, and mode of travel. Travel times could be measured at both peak and off-peak hours. The effect of ambulance attendance in providing stabilization and life-support care could be included in the model.

Finally, advances in medical research could provide the correct functional form for the relationships between risk and time to treatment for both stabilized and unstabilized patients for different categories of emergencies. Medical research involving these relationships is currently very sparse. As the state of medical knowledge improves, it should be possible to sort emergencies into the four classes defined above. This classification could then be used to define facility requirements for the "comprehensive" and "stabilization" facilities described above.

If the model developed in Chapter Three is to be used as an aid to the system design process, assumptions about patient behavior must be made which reflect the actual patterns of patient use. Ambulance drivers can make more sophisticated decisions about choice of a receiving hospital based on the type and severity of the emergency. A sophisticated decision procedure such as that outlined in Chapter Three may be applicable to the ambulance driver operating under a central dispatch. In the Soviet Union, it may be possible to design a whole system of emergency facilities using the Chapter Three decision procedure. However, in the United States, the vast majority of emergency facilities patients provide their own transportation so that an optimally effective systems design must be based on prevailing patterns of facility choice by the system user.

Probably the most useful assumption which can be made is that patients will always proceed to the closest facility. If this assumption were used in the model, facilities arrangements with "comprehensive" facilities closest to the largest number of emergencies would receive the lowest risk scores. Since the need for closeness is dependent on the type of emergency, emergency classes A and C will receive the heaviest weight in determining the location of stabilization and "comprehensive" facilities respectively. (It is assumed that the distance multiplier K described earlier in this chapter will be used when risk is aggregated across emergency categories. It is hoped that further analytical work on the model will result in a procedure for calculating the "optimal arrangement" of facilities under available resource constraints.)

In Chapter Four, we discussed two approaches to the problem of implementing regional hospital emergency facility plans. These were the "top-down" approach and the "bottom-up" approach.

An example of the "top-down" approach was the implementation of the Illinois Trauma Program and the subsequent Illinois Comprehensive Emergency Care System. The successful implementation of this program did result in a state-wide categorization of hospital emergency facilities with legal authority for compliance vested in the Illinois Department of Public Health. This program did produce clear entry points into the emergency care system for the trauma victim and later for other types of emergency patients. However, the system was implemented without adequate attention to the needs of the providers. Hospitals which were designed as Trauma Centers received a strong economic boost while hospitals which were not designated as Trauma Centers often suffered economically. The impact of categorization of a facility as a Trauma Center invariably was to increase the hospital census through inpatient admissions from the emergency room. If a facility was not categorized as a Trauma Center, inpatient admissions usually suffered.

An example of the "bottom-up" approach to the implementation of hospital emergency facility plans is the current categorization and regionalization effort in Massachusetts. Here, groups of providers identify their own care capabilities and work out mutually acceptable agreements to fill in gaps in coverage and eliminate apparent duplication of effort. Such a procedure is likely to result in a favorable series of arrangements and trade-offs from the standpoint of the individual providers. User needs for accessibility based on epidemiological considerations and clearly defined system entry points are likely to be inadequately considered in such a process.

A successful systems design must take into consideration the needs of both the users and providers. It is believed that the selective categorization system proposed earlier in this chapter meets both of these needs. Epidemiological considerations and patterns of system usage are both considered in the arrangement of facilities and the choice of certain facilities as "comprehensive" system entry points. Provider needs are considered in that the facilities not designated as "comprehensive" system entry points are selected to provide definitive care for emergency classes A, B, and D. A "top-down" procedure could be used to select the "comprehensive" system entry points while a "bottom-up" procedure could be used to divide definitive care responsibilities for classes A, B, and D among the hospitals not designated as "comprehensive" system entry points.

An optimal arrangement of emergency medical treatment facilities together with appropriate utilization of those facilities still does not guarantee high-quality emergency care as an outcome. Input and process standards must be validated in terms of their effect on patient outcomes. Recent efforts to improve emergency care have resulted in a "proliferation of normative standards and criteria particularly directed at structure (input) elements; these standards are derived from experience, negotiation, and expert opinion but few have yet been tested in terms of validity or significance." (Emergency Medical Services Systems Act Research Guidelines, 1974). Studies of effectiveness are particularly needed for new technological innovations. New sophisticated technologies are often included in categorization standards before their usefulness in terms of effectiveness and efficiency has been validated. Once input and process standards are validated, the delivery of consistently high-quality emergency care is dependent on the development and acceptance of reasonable quality control standards and procedures by the medical profession.

Procedures must be found to insure that appropriately trained physicians and paramedical personnel are placed in small community hospitals where high-quality stabilization and life-support care is especially critical for class A and B emergencies. Perhaps an incentive system which provides a free medical education in return for service in remote or out-of-the-way locations would help to ameliorate this problem.

Finally, the organizational, political, and financial barriers to the implementation of regional emergency facilities plans cannot be overlooked. There is a particular need for detailed studies of hospitals as organizations, with special reference to bureaucratic politics and standard operating procedures. The framework presented by Allison (1971) as a means of analyzing the effects of bureaucratic procedures, bureaucratic politics, and power struggles on governmental decision-making should prove to be especially helpful here. The natural imperialistic tendencies of bureaucratic organizations (such as hospitals) must be adequately dealt with if regionalization plans are to become effective. Much of the interview data presented in Chapter Four touches on this theme.

BIBLIOGRAPHY

Allison, Graham T., Essence of Decision. Boston: Little, Brown and Co., 1971.

American Hospital Association, "Emergency Services: The Hospital Emergency Department in an Emergency Care System." Chicago, 1972.

American Medical Association, "Recommendations of the Conference on the Guidelines for the Categorization of Hospital Emergency Capabilities," Chicago, 1971.

Andrews, R. B., L. E. Davis, J. R. Bettman, R. K. Granit, and K. F. Siler, "Methodologies For the Evaluation and Improvement of Emergency Medical Systems." Division of Research, Graduate School of Management, University of California, Los Angeles, 1974.

Baker, S. P., "Evaluation of Medical Care of the Injured," Journal of Trauma, Vol. II, No. 10, October, 1971, pp. 892-894.

Bloom, B. S. and O. L. Peterson, "End Results, Costs and Productivity of Coronary Care Units," New England Journal of Medicine, Vol. 288, No. 2, January 11, 1973, pp. 72-77.

Boyd, D. R., W. A. Pizzano and P. A. Murchie, "Categorization of Hospital Emergency Capabilities in Illinois: A Statewide Experience," Illinois Medical Journal, 1973

Brook, R. H. and R. L. Stevenson, "Effectiveness of Patient Care in an Emergency Room," New England Journal of Medicine, Vol. 283, No. 17, October 22, 1970, pp. 904-907.

Cretin, Shan, A Model of the Risk of Death From Myocardial Infarction, Technical Report No. 09-74. Cambridge, Massachusetts: M.I.T. Operations Research Center, July, 1974.

Frey, C. F., D. F. Huelke and P. W. Gikas, "Resuscitation and Survival in Motor Vehicle Accidents," Journal of Trauma, Vol. 9, No. 4, 1969, pp. 292-310.

Gertner, H. A., S. P. Baker, R. B. Rutherford and W. U. Spitz, "Evaluation of the Management of Vehicular Fatalities Secondary to Abdominal Injury," Journal of Trauma, Vol. 12, No. 5, May, 1972, pp. 425-431.

Gibson, G., "E. M. S.: A Facet of Ambulatory Care." Hospitals 47: 59-66, May 16, 1973 (a).

Gibson, G. "Emergency Medical Services in the Buffalo Area". Unpublished paper, 1973 (b)

Gibson, G., "Guidelines for Research and Evaluation of Emergency Medical Services," Health Services Reports, Vol. 89, No. 2, March-April 1974, pp. 99-111.

Hamilton, W. F. and J. W. Thomas, "The Economics of Regional Emergency Medical Systems." Philadelphia: Leonard Davis Institute of Health Economics, University of Pennsylvania, 1974.

Hanlon, J. J., "Emergency Medical Care as a Comprehensive System", Health Services Reports, Vol. 88, No. 7, Aug. - Sept. 1973, pp. 579-587.

Health Planning Council of Greater Boston, Inc., The Greater Boston Plan - A Basic Blueprint for Achieving an Improved Emergency Medical Services System. Boston, 1974.

Kleinman, J. C. et al: Emergency Medical Services in the City of Boston. Harvard Center for Community Health and Medical Care, December, 1972.

Mangold, Karl G., "The Financial Realities of EMS." Hospitals: Journal of the American Hospital Association, May, 1973.

McKenna, M. J. Personal communication, 1975.

Ramp, J. Personal communiation, 1974.

Rose, L. Personal communication, 1974

Schon, D. Personal communication, 1974.

Scribner, R., L. Raithaus and P. Ivanov, "Emergency Medical Service in the Soviet Union." Journal of Trauma, Vol. 14, No. 6, June 1974, pp. 447-452.

Sidel, V. W., J. P. Acton and B. Lown, "Models for the Evaluation of Pre-Hospital Coronary Care," American Journal of Cardiology, Vol. 24, November, 1969, pp. 674-688.

Storey, P. B., and R. B. Roth, "Emergency Medical Care in the Soviet Union. A study of the Skoraya." Journal of the American Medical Association, 217: 588-592, 1971.

Webb, M. L., The Emergency Medical System in a Metropolitan Area. Baltimore: Department of Medical Care and Hospitals, The Johns Hopkins University, 1969.

Weinerman, E. R., M. A. Rotner and A. Roffins, "Yale Studies in Ambulatory Medical Care V. Determinants of Use of Hospital Emergency Services." J. Public Health 56: 1037-1056, 1966.

Willemain, T. P., The Status of Performance Measures for Emergency Medical Services, Technical Report No. 06-74 (Cambridge, Massachusetts: M.I.T. Operations Research Center, July 1974.

Youmans, R. L. and R. A. Brose, "A Basis for Classifving Hospital Emergency Services," Journal of the American Medical Association, Vol. 213, No. 10, Sept. 7, 1970, pp. 1647-1651.

Yu, Paul N. et al., "Resources for the Optional Care of Patients with Accute Myocardial Infarction." Circulation, Volume XLIII, May 1971, pp. A-172 - A-183.