THE ROLE OF HELICOPTERS IN EMERGENCY MEDICAL CARE SYSTEMS

RESEARCH REPORT

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By

David P. Skogman

Approved by

Dr. W. L. Johnston
Chairman

Dr. D. R. Shreve

Dr. R. L. Street

Texas A&M University
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ABSTRACT

The major purpose of this paper is to contribute toward improved emergency medical care. The results of helicopter performance in civilian air rescue operations are presented. Suggestions as to the future role of helicopters within the emergency care system are discussed. The other major components of the emergency care system are examined and recommendations have been offered to aid in their improvement.

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The ideas, concepts, and results herein presented are those of the author and do not necessarily reflect approval or acceptance by the Department of the Army.

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CHAPTER I

INTRODUCTION

Accidental death and disability is a monumental problem in the United States today. Only a brief examination of the facts and statistics concerning accidents is necessary to verify that this statement is true. In 1969, 115,000 people died as a result of accidents. The total economic loss for all accidents in this same year was estimated to be 25 billion dollars. By comparison this figure approached the annual appropriation for conduct of the war in Vietnam. It might be added here that in the past 60 years, more Americans have been killed in accidents than in all of our wars.

Add to these statistics the fact that accidents are the leading cause of death between the ages of 1 and 37. The loss of countless productive years is immediately obvious. It is also known that one out of every 8 beds in general hospitals is occupied by an accident victim. In fact more hospital bed-days are taken by accident victims than by either heart disease victims or mothers delivering babies.

Given then that an immense problem exists, what is

the state of the emergency medical services available to handle these accidents after they occur. The fact is that emergency medical services in the majority of the United States today are woefully inadequate.

Every day critically injured persons bleed to death waiting for an ambulance. While no soldier in Vietnam is more than 35 minutes away from a facility capable of giving definitive, life saving care it is not unusual for a civilian injured in a rural area of this country to wait as long as 2 or 3 hours for an ambulance to arrive (Neel, 1968). This situation is allowed to exist despite the fact that it is known that 70% of all traffic deaths occur in rural areas.

It is ironic that in a country which scrupulously inspects and regulates the food we eat, almost no regulation is in effect over the quality of emergency care we receive. On June 27, 1967 the Department of Transportation issued national guidelines through what is known as the "National Highway Standard for Emergency Medical Services," (Pyle, 1969). This standard directs each state to provide an "up-to-date, comprehensive plan for emergency medical services." The standard also directs each state to provide:

1. Training and licensing requirements for rescue vehicle operators and attendants.

2. Requirements for types and numbers of emergency vehicles as well as supplies and equipment.

3. Requirements for operation and coordination of emergency care systems.

4. First aid training programs and refresher courses for emergency personnel.

5. Criteria for use of two-way communications as well as procedures for summoning and dispatching aid.

This standard while definitely a giant step toward better emergency care has been even more remarkable for the lack of compliance by the states. As of March 31, 1971 only sixteen states regulated or authorized the regulation of licensing ambulance services. Only sixteen states regulated the "medical ability" qualifications of ambulance personnel. Regarding equipment carried by the ambulance, sixteen states had adopted regulations.

This lack of compliance has resulted in what can be called the national disaster area of emergency medical care. Several estimates of the cost in needless deaths and cripplings because of inadequate emergency care are available. Dr. Verne L. Roberts, head of the Biosciences Division of the University of Michigan Highway Research Institute has said in speaking of highway deaths that "20% of total deaths or more than 10,000 last year (1968) need not have happened." The Ambulance Association of America has stated that 25,000 people are actually injured each year because of inadequate training of emergency personnel (Fry, 1969). The U. S. Jaycees, who have recently become involved in promoting better emergency

care, have estimated a total of 45,000 needless deaths and cripplings each year. They have also estimated that only one fourth of the ambulance attendants in this country have had any first-aid training (Bandy, 1970). This estimate would provide small comfort indeed to someone injured on our highways.

But all is not lost. Efforts by many groups and individuals are underway throughout this country to improve the quality of emergency medical care. This paper is intended to be a small part of that effort.

After an accident occurs, three critical life or death factors come into play. They are:

1. The time between accident occurrence and delivery of the victim to a facility capable of extensive life-saving treatment.
2. The first-aid treatment the victim receives at the scene of the accident as well as during transport.
3. The treatment the victim receives after arrival at the hospital.

Each of these critical factors will be examined in this paper. The primary purpose, however, will be to determine the proper role helicopters should play in the emergency medical care system. The primary advantage to be expected is a decrease in the long waiting time for an ambulance already noted.

There have been several projects where helicopters have been used as rescue vehicles. The next chapter will be a compilation of the results obtained from these pro-

jects. The goal will be a set of criteria under which the helicopter can be used advantageously.

The third chapter will provide a listing of the personnel and facilities necessary to support the ambulance (whether air or ground). This will include attendants, training, communication capability, and hospital facilities.

The fourth chapter will be a cost comparison between conventional ground ambulances and a system that includes helicopters. An attempt will be made to incorporate the cost of lives saved using the helicopter in this comparison.

The last chapter will contain a listing of recommendations and conclusions drawn from the preceeding chapters. The objective will be to contribute toward the goal of improving emergency medical care.

CHAPTER II

RESULTS OF HELICOPTER USE

To be effective as an air ambulance, a helicopter should possess certain operational capabilities. The four most desirable characteristics are as follows:

1. Quick takeoff: The helicopter selected should not require a significant engine warm up time. This time should preferably be less than 3 minutes.

2. Long range: To be effective the helicopter should have a round trip range of approximately 300 miles.

3. High speed: The helicopter selected should have a significantly higher cruising speed than ground ambulances.

4. Useful Load Capacity: The helicopter should be able to carry 2 crewmen (pilot and para-medic), 2 litter patients, and the required crash rescue and medical equipment.

Arizona State University has done an evaluation of 6 commercially available helicopters. The above criteria were used as well as the procurement and operating costs of each helicopter. The results of their analysis indicated that the Bell 206A and the Fairchild Hiller FH-1100 could most effectively perform the required mission (Schamadan et al., 1968). These two helicopters have

since become the ones most often chosen for air rescue operations. The relevant operating characteristics of the two helicopters are listed below.

TABLE 1. Important characteristics of the Bell 206A and FH-1100 Helicopters

	Bell 206A	FH-1100
Engine Type	Turbine	Turbine
Empty Weight	1400 lbs.	1450 lbs.
Gross Weight	2900 lbs.	2750 lbs.
Range at 5,000 ft.	425 mi.	396 mi.
Cruising Speed	140 mph.	128 mph.

These two helicopters both require a minimum amount of warm-up time when compared to older piston-type aircraft.

The original configuration of both these helicopters provided for the pilot and 4 passengers. The aircraft are now available with conversion kits for air ambulance work. The conversion kits make provisions for 2 litter patients, pilot, medical attendant, and sufficient medical supplies.

From the preceding discussion it is not to be concluded that the two helicopters described are the only ones that have been used. Another significant development has been the limited use of military surplus helicopters. For example, Nebraska and Ohio have used Sikorsky H-19's. The U. S. Army has long since declared these helicopters obsolete for combat use. In the one case, Nebraska purchased two H-19's from the Army for $50 each (Himmel, 1969). These helicopters while very cheap to obtain offer significant disadvantages. The operating costs are very

high and they do not have the operational capabilities already mentioned for an effective air ambulance.

With the winding down of the war in Vietnam a significant portion of the military's helicopter fleet will be returning to the United States. Secretary of Defense Melvin Laird has discussed the possibility of selling these surplus helicopters to civilian organizations (Kielty, 1970). However, the air ambulances used in Vietnam have a capacity of 6 to 10 litter patients. This large capacity is not needed in the majority of civilian emergencies. In addition operating costs for these aircraft are prohibitively high. A mix of 1 large military surplus helicopter for every 5 to 10 smaller aircraft might be feasible for civilian applications.

The problems in adapting military helicopters to civilian rescue are currently under investigation. In a joint project between the Departments of Defense and Transportation, helicopters are being provided for medical assistance to persons needing emergency care. The project, which was originally to cover the San Antonio, Texas area has been expanded to include the area surrounding Colorado Springs, Colorado and Seattle, Washington. The expressed purpose of the project is "to better determine the effectiveness of communications and coordination systems and training requirements for military and civilian participants under different climatic and geographical conditions."

As a general rule, the concept of having a helicopter available at all times for use only as an ambulance in a metropolitan area is not feasible at this time. These are several reasons why this statement is true.

1. Ground ambulances with trained personnel are generally available and the response time is as fast or faster than the helicopter.

2. Large medical facilities equipped to treat accident victims are available to the ground ambulance in a relatively short time.

3. Competition between hospitals and ambulance services in a metropolitan area is usually high and as a result a close working relationship with the police has been developed.

4. The landing of helicopters within the city is difficult or impossible because of the obstacles presented.

5. The helicopter's presence on an accident scene may be distracting to other drivers, thereby creating an additional hazard.

The reasons listed above are part of the conclusions reached from Project HASTE (Helicopter Ambulance Service to Emergencies). Project HASTE was administered by the Minnesota Department of Health and covered an eight county area, including the cities of Minneapolis and St. Paul.

The results obtained in this Minnesota study were not unexpected. For example, Jacksonville, Florida is a city with an area of 848 square miles and a population of

525,000 people. It has a progressive system for providing emergency medical care under the direction of Capt. John M. Waters. Capt. Waters has stated that with all 10 city ambulances deployed, 90 per cent of the citizens of Jacksonville are within a seven-minute response time of quality ambulance service (Waters, 1969). It is improbable that helicopters could reduce this response time.

Similar results have been obtained from a study conducted in the San Fernando Valley area of the Los Angeles Basin in California. This area contains 235 square miles and a population of over 1,000,000 people. The Valley serves as a suburb of the more industrialized portions of the Los Angeles Basin. The study concluded that, "no response time reduction could be obtained by dispatching helicopters on every ambulance call. In fact, due to the fixed takeoff time and the dispersed ambulance stations, average helicopter response time would be slightly longer than that of the rescue ambulance" (Mitchell et al., 1968).

The general rule then that helicopters should not be used exclusively as air ambulances in urban areas has been amply demonstrated. This is not to say, however, that helicopters cannot be used to advantage in large metropolitan areas. Emergency situations will arise which can be handled much more effectively with air rescue than by ground ambulance. The common denominator here of course is time. In situations where limited access freeways, rush hour traffic, or adverse weather have increased

ground ambulance response time to an unacceptable value, helicopters should be available. Dr. Eugene P. Durbin, director of the UCLA Emergency Medical Care Project, has proposed that this unacceptable response time be established as 15 minutes (Durbin, 1969).

The city of Chicago has used helicopters for traffic accident rescue operations since 1967. The Chicago Fire Department is responsible for providing emergency medical services to persons hurt in traffic accidents. The Department operates two helicopters; a small conventional piston-driven model and a Bell Jet Ranger (206A). As of October 1970, the helicopters were required to evacuate persons injured in expressway traffic between 15 and 20 times a month. In addition the helicopters are being used to transfer critical patients between hospitals. For example, persons suffering critical burns have been transferred to Cook County Hospital's 'burn center' where specialized treatment for this type of injury is available. This helicopter service is provided despite the fact that under favorable circumstances no accident site in Chicago is more than 10 minutes away from a hospital by ground ambulance (Kielty, 1970).

The California Highway Patrol has also integrated helicopters into its highway safety work. An experimental study funded 60 per cent by the National Highway Safety Bureau has made possible the purchase of 3 FH-1100 helicopters. The three aircraft have been assigned to patrol

portions of the state's massive network of freeways. One helicopter is assigned to the San Francisco Bay area, the second covers the Los Angeles Freeway System, and the third patrols stretches of Interstate 101 to the Arizona border. The primary mission of these aircraft is aiding in the clearing of impediments to traffic flow and assisting ground patrol units in enforcement. The secondary mission includes assistance in disasters or civil disturbances and emergency evacuation. The benefits to be derived from this secondary mission can be revealed by an example. An accident occurred during the morning rush hour which backed up traffic for 3 miles on a major freeway. A ground ambulance was unable to reach the scene because of traffic tie-ups. A helicopter, however, was able to land within 100 yards of the accident. The total time from first notification of the helicopter to delivery at the hospital was less than 15 minutes. The helicopter operation not only took a fraction of the time that would have been involved but minimized the risk of further accidents (Crane, 1970).

A definite need for helicopters to be used as air ambulances in metropolitan areas has thus been established. But it can be anticipated that the helicopter's main asset, high speed, can be used to even greater advantage in remote, rural areas. The death rate from traffic accidents in rural areas is four times greater than in urban zones (Schultz, 1969). This higher death rate is

probably due in large part to the longer delay in receiving medical attention and delivery to a hospital incurred in rural areas. In turn this longer delay may explain the fact that 70 per cent of the traffic deaths in this country occur in rural areas. A study of traffic fatalities in California in 1961 attempted to estimate the influence of response times by comparing rural and urban fatalities. The study concluded that "the people dying in rural accidents more frequently died at the scene of the accident, died sooner after injury, and died of less serious injuries than did those injured in urban accidents" (Waller et al., 1964).

The response times to emergencies in rural areas can be significantly reduced through the use of helicopters. In a study conducted in Pennsylvania, the total travel time was reduced 30 to 80 percent using helicopters as opposed to ground ambulances. The 30 percent reduction was obtained during periods of light traffic while the 80 per cent reduction occurred in periods of very high traffic volume. These results were obtained in an area where ground ambulance services are above average and also because of the location of helicopter bases the trip lengths of the helicopters were about double those of the conventional ambulances (Coleman, 1969).

A similar demonstration of the air medical evacuation concept using helicopters in rural areas has been completed in Arizona. This project concluded that on

the basis of time, the helicopter ambulance operated at twice the speed of ground ambulances. During 171 medical missions (116 evacuations and 55 inter-hospital transfers) the total time saved was 154.5 hours. Stated another way, this time savings amounts to 41 minutes per patient carried (Schamadan et al., 1970). The 55 inter-hospital transfers contributed significantly to this time savings because the helicopter's speed is more effectively utilized where the distances involved are greater.

A computer simulation model has been developed which treats the highway rescue system as a queuing system with accident occurrences as customer arrivals competing for services (Clark et al., 1970). The results of this model indicate the time savings of the helicopter over ground ambulance can be expressed by the following equation:

$$t = 6.68 + 0.23d$$

where t = time savings in minutes

d = round trip distance in miles $10 \leq d \leq 70$

The primary difference in the effective use of helicopters in rural as opposed to urban areas is a reversal of priorities. In rural applications the primary mission is as an air ambulance while secondary uses involve highway traffic safety. The helicopter has been shown to be an effective tool in general law enforcement operations while at the same time performing its primary mission of medical evacuation. This secondary mission can involve routine surveillance as an accident prevention tool,

direct law enforcement operations in the search for and apprehension of criminals, and search and rescue operations for missing vehicles, missing persons or downed aircraft.

One of the main disadvantages of helicopters is their restricted use under certain weather conditions. When visibility is poor or instrument flight rules are in effect the helicopter is unable to respond. A comparison of this difficulty under opposing climatic conditions would be helpful here. In the state of Mississippi it has been reported that between 3 and 4 per cent of helicopter emergency missions were aborted because of adverse weather conditions (Clark et al., 1970). In Minnesota, on the other hand, in a study covering the full extremes of Minnesota weather, only 10 of 471 emergency calls were refused because of unacceptable flying conditions (Richards et al., 1971). In general then, weather conditions have no significant effect on helicopter operations.

Another factor which could affect the helicopter's availability is it's mechanical reliability. Combining the results of the two studies in Mississippi and Minnesota, only 8 out of 1299 total helicopter missions were refused because of mechanical difficulties. With careful and complete maintenance, mechanical malfunctions will have little or no effect on the helicopter's effectiveness.

A significant factor in any new program that is a public service is the public's reaction to such a program.

A public opinion survey where helicopters had been used indicated an overwhelming endorsement of the concept (Schamadan et al., 1970). This endorsement is probably due in large part to the exposure the public has received to helicopter medical evacuation in the Vietnam war. The general public could be expected to support helicopter rescue operations in spite of increased cost.

An analysis of the results of air ambulance operations would be incomplete without consideration of the value of human life. People are alive today who most certainly would have died without helicopters. Because of faster response times, emergency treatment is available sooner than it has been before. Any evaluation of helicopter ambulance systems must consider this inescapable fact.

The helicopter is but one element in the emergency medical care system. The next chapter will consider the other important elements that are involved.

CHAPTER III

ELEMENTS OF THE EMERGENCY CARE SYSTEM

The helicopter's role in emergency medical services is best described as a supplement to and not a substitute for the existing system. The total system will have 5 major components as follows:

1. Helicopters
2. Ground Ambulances
3. Hospitals
4. Communication System
5. Para-medic Attendants (air or ground)

Each of these components will be examined to identify specific problems that exist in each area. The purpose of this examination will be to describe the characteristics of each element that will make the total emergency medical care system most effective.

Helicopters

The operating capabilities of a suitable helicopter air ambulance have already been discussed. The helicopter should be designed and equipped to provide the same degree of life saving and life supporting care as that of the conventional ground ambulance. The particular equipment

needed will be discussed in the next section on ground ambulances. Whether the complete recommended list of extrication equipment is carried or not will depend on the useful load capacity of the particular helicopter being used. As a minimum an extrication kit (crowbar, hacksaw, and jack) should be carried.

Ground Ambulances

The second provision of the National Highway Standard for Emergency Medical Services requires that each state shall provide "requirements for the types and numbers of emergency vehicles, including supplies and equipment to be carried." The vast majority of the states have not complied with this provision. Only ten states specify the first aid equipment that should be carried while just four require periodic inspections of the vehicle. Of the fifty state capitals only eleven have comprehensive ordinances covering emergency medical services. In one state recently a state ordinance was proposed. One of the principal objections to this statute was the $5 fee for licensure of an ambulance service it required. This happened in a state where the licensing fee for beauty school operators is $500 (Owen, 1971).

In 1956 an effort to establish closer cooperation between the medical profession and those responsible for traffic safety resulted in the formation of a Joint Action Program. This program was sponsored by three organizations; the American College of Surgeons, the American

Association for the Surgery of Trauma, and the National Safety Council. Late in 1959 the policy committee of this Joint Action Program asked the Traffic Conference of the National Safety Council to develop a model ordinance or statute relating to transportation of the injured. On October 23, 1963 a model ordinance was submitted and approved by the Traffic Conference. In 1970 the ordinance was amended to require ambulance equipment for handling several kinds of emergencies and additional training for ambulance attendants. It was also concluded at this meeting that the model ordinance would be more effective if adopted as a state law. The model statute provides standards for licensing, training, reports, personnel, etc., as well as penalties for noncompliance. The purpose of the model is to guide those responsible for this necessary public service and to provide uniformity in the quality of service.

The influence this model ordinance has exerted has been significant. An analysis of newly adopted ambulance ordinances has shown that they compare favorably with the model statute (Owen, 1971). The model has served well as a national guideline. However, it is recommended that all states adopt this ordinance so the maximum benefit can be obtained.

The National Academy of Engineering, operating through the National Research Council, has completed a project to develop design and performance criteria for ambulances.

As part of this project a survey was taken of ambulances already in use. The survey resulted in the identification of five areas where design improvements are needed. These improvements are as follows:

1. Increased space for administration of cardiopulmonary resuscitation in transit.
2. Ceiling height sufficient for gravity flow of intravenous liquids.
3. Installed oxygen and suction devices.
4. Two-way radio, walkie talkie, intercom and public address.
5. Storage room for equipment for optimal treatment and for rescue.

The project also resulted in the publication of extensive ambulance design criteria. These criteria are intended to guide commercial ambulance manufacturers (Baerwald et al., 1969).

There are available luxury ambulances in the $15,000 to $25,000 price range. Unfortunately these models are not any more functional than much cheaper ones. The city of Jacksonville, Florida purchases its ambulances complete with equipment for $12,500. These ambulances are in full conformance with the "Medical Requirements for Ambulance Design and Equipments" of the National Academy of Science. Besides being cheaper to purchase, these ambulances are constructed such that the cabin separates from the chassis. It is expected that the cabin will last through three chassis (Waters, 1969).

The third important aspect of an ambulance, in addition to regulations and design criteria, is the equipment it carries. In 1961 the Committee on Trauma of the American College of Surgeons published a list of essential equipment for ambulances. This list was modified in May 1970 to include a poison kit, obstetrical kit and inflatable splints. The 1970 listing also includes the necessary extrication equipment an ambulance should carry.

Hospitals

Hospitals are the third element of the emergency medical care system. A definite need in this area is more hospital helipads. In 1969, of the 7,850 general hospitals in the United States only 147 had officially certified helipads with 38 more under construction (Himmel, 1969). This number had grown from 34 helipads reported in 1965 (Schultz, 1969). Although the number of helipads is increasing the process needs to be greatly accelerated.

Compared to other hospital facilities, the cost of obtaining a hospital helipad is quite minimal. Costs of $1,000 to $3,000 are most typical. The state of Montana has a unique program to promote hospital heliport construction. This program permits the Montana Aeronautical Commission to construct a helipad at any hospital that provides a suitable ground or rooftop area (Schultz, 1969). This is a provision most hospitals can meet because most hospitals have an adequate parking lot, an

unobstructed lawn or a level open roof area which could serve as the cite for a helipad. Perhaps if the necessary money was made available by other states, similar programs could be instituted to stimulate construction of hospital helipads.

The experiences of hospitals where helipads are available can provide evidence of the importance of this added facility. Walter R. Hoefflin, Jr., administrator of the Methodist Hospital of Southern California, has stated, "Our recommendation is that every hospital with any available land or large roof area provide such a facility." The first patient to use the helipad at this California hospital was a pilot who had crashed in the mountains 25 miles away. His injuries were so serious that Mr. Hoefflin feels he would have died if the facilities for helicopter transportation had not been available (Howard, 1965).

Another problem of hospitals is the availability of physicians for the hospital emergency room. The great majority of hospitals do not have physicians at the hospital on a 24 hour basis. In Mississippi for example only 7 per cent of the hospitals have a doctor on the premises around the clock (Clark et al., 1970). It makes little sense to speed the injured from the accident site to the hospital only to experience a long delay waiting for a doctor at the hospital emergency room.

Since the availability of physicians is not likely to increase in the near future another solution will have

to be found. Decreasing the time spent waiting for a doctor can be achieved by efficient communication between the ambulance and the hospital. The Mississippi study found that an average of 26 minutes was saved in getting an emergency case under a physician's care as a result of radio communications between the hospital and the ambulance.

Communication System

The preceding discussion leads to the fourth element in the emergency medical care system; the communications network. The need to improve communications has already been recognized. A 1968 study concluded that the "majority of local and regional communications systems are inadequate to provide effective control of the emergency care system" (Bordner et al., 1968). In an integrated helicopter-ground ambulance system the communications network must receive high priority in order to take full advantage of the system's increased capability. Proper coordination between the helicopter and ground ambulances will avoid unnecessary duplication of effort.

The most important feature of the communications network must be a central dispatching agency. Within this center the dispatcher must have a method to determine which type of ambulance to send to a given accident or medical emergency. This decision involves such variables as location, number of injured, and nature of the injuries. The primary advantage to be gained from this decision is

the reduction of the total response time. A helicopter should be dispatched if the total travel time from stand-by to the scene and from the scene to the nearest hospital is less than that of the nearest ground ambulance. The dispatcher can be aided in this decision by the preparation of a Time-Response Contour Map (Clark et al., 1970). This map will show by shaded areas whether a particular accident location can best be serviced by air or ground ambulance.

A second critical feature of the communications system is the inclusion of the hospital emergency room in the network. The reduction in time spent waiting for a doctor through the use of such a system has already been noted. The Hospital Emergency Services section of the Accreditation Manual For Hospitals recommends "a communications system that provides information from persons at the site of an accident or disaster or in a moving ambulance." If direct communication between the hospital and the ambulance is established, the physician can offer advice to the attendant on the care of the patient during transit. When this direct communication is not possible the dispatcher must notify the hospital of an ambulance's impending arrival. All information such as arrival time, number of injured, nature of injuries, etc., that the dispatcher has available should be given to the hospital.

Para-medic Attendants

The last and most important element of the emergency

medical care system is the ambulance attendant. The best equipment that money can buy is of little value if the attendant is unable to use it properly. Without dedicated and competent personnel any attempt to improve emergency medical care will be doomed to failure.

The ambulance attendant needs to become a well-trained, competent professional. The American College of Surgeons and the American Academy of Orthopedic Surgeons, recognizing this fact, have recommended that the qualified emergency medical attendant be accepted as a full member of the medical team. This means that a properly trained and proficient attendant would have equal status with x-ray, laboratory, and physical therapy technicians for whom courses of instruction are accredited by the American Medical Association Council on Medical Education.

A further attempt to establish the ambulance attendant as a profession has been the formation of a national accreditation system for personnel involved in emergency medical services. The organization is called Registry Emergency Medical Technician Ambulance. The Registry will issue certificates of registration to attendants who have demonstrated a high level of proficiency in emergency medical care. Applicants for registration will be required to take and pass an exam prescribed by the Board of Directors of the Registry. The exam will be a frank evaluation of an applicant's knowledge and his ability to put it into practice.

Thèse developments do not guarantee that the ambulance attendant will be a highly qualified professional. In order to attract quality personnel sufficient incentives must be offered. Good pay, good working conditions and other associated benefits must be provided. This will minimize costly turnovers in personnel and also justify the additional expenses that may be incurred in training programs.

At the present time, only 8 states prescribe the level of instruction that ambulance attendants will receive. There is a great need for adoption of nationwide standards for the training of ambulance personnel. In response to this need the Committee on Emergency Medical Services of the American Medical Association has issued a recommended course of instruction. The level of proficiency this course will attain is intended to be used as a standard by which states can certify ambulance personnel. In addition to traditional first aid procedures an attendant must know, the course also contains sections on safety precautions at the scene of an accident, records, the use of communication systems and priorities of care. The publication of this report is a first step toward the goal of nationwide standards for the training of ambulance personnel.

Perhaps the most important feature of any suggested improvement is the associated cost. The question as to whether the money is well spent must be answered. The

next chapter is a cost comparison of the ground ambulance and helicopter ambulance systems.

CHAPTER IV

COST COMPARISONS

The availability of funds will ultimately dictate whether a proposed improvement is made or not. Although it might be desirable to provide every family in the United States with an annual income of $10,000, the money is just not available to do so. The problem then is one of the best possible distribution and allocation of the available funds. The criteria for the allocation of these funds is likely to be the expected return on investment. If it can be shown that the monetary benefits of a proposed project justify the initial investment, that project is likely to receive more favorable consideration. The hard fact is that if an improvement cannot be justified in terms of cost, it is not likely to be made.

This fact has often been ignored by safety personnel who are deeply concerned with the preservation of human life. People in this category have made statements to the effect that if one unnecessary death can be avoided what difference does it make how much it costs. Because of our society's attitude toward death, these statements have a certain amount of emotional appeal. But this

attitude, while understandable, is unrealistic. People in authority who must decide how the available money will be spent, are forced to make these decisions on a monetary investment return basis and not on what appeals to their emotions. So any proposal concerned with safety will have a much greater probability of acceptance if it can be shown to be justified on a monetary basis.

These conclusions must also apply to the helicopter ambulance system that has been discussed. Although it is certain that lives can be saved through the significant reduction in response times, this statement does not insure sufficient justification. This reduction is achieved only through considerable additional expense. The ground ambulance can perform the same rescue mission at less cost than the helicopter can. But on the other hand the helicopter can perform other functions which the ground ambulance cannot. From these observations it is obvious that a cost analysis should provide answers to certain questions. Some of the more important questions are as follows:

1. How much do helicopters and ground ambulances cost to operate?
2. How much more area can a helicopter service or equivalently, how many ground ambulances can it replace?
3. How much are the other functions a helicopter can perform worth?
4. Can a reasonable cost estimate of the lives saved using the helicopter be made?

The cost analysis presented here will seek answers to these questions. Whenever possible documented cost figures available from actual operations will be used. If these figures are not available reasonable estimates will be made and justified. Since costs will inevitably vary from one area to another, the figures presented will by only applicable to the example they describe. The purpose of this cost analysis will be a familiarization with the magnitude of probable expected cost.

Throughout this paper a distinction has been made between urban and rural environments. This distinction will continue to apply in the following cost presentation. A cost comparison between the integrated helicopter and ground ambulance system and the ground ambulance alone will be given for both urban and rural environments.

Rural Environment

The Air Medical Evacuation System (AMES) demonstration project was conducted in Arizona and administered by Arizona State University. The project has been completed and reports were published in June, 1970. These reports included comprehensive cost data and it is believed these costs are representative of what can be expected for ambulance operations in a remote, rural area.

This project covered a circular area 150 miles in diameter centered around Phoenix. The main helicopter operations base was located near Phoenix with satellite

bases located 50 to 75 miles from the main base. Two FH-1100 helicopters were used in this study and were manned such that evacuation could be performed 24 hours a day, 7 days a week. The helicopter crews (pilot and para-medic) were given 3 weeks of intensive first-aid training before the flight operations began. The helicopters were dispatched through the regional and district Arizona Highway Patrol communication centers. The helicopters responded on the basis of a confirmed accident location and a reasonable need for an ambulance. Throughout the conduct of this project it was emphasized that the helicopters were intended to act in cooperation with and not compete against the existing ground ambulance services. During this study the helicopters performed a secondary mission involving general law enforcement operations.

Because the helicopters performed dual functions of evacuation and law enforcement, it was necessary to calculate the cost of equivalent law enforcement capabilities as well as the cost of equivalent ground ambulance capabilities. As a result costs for the helicopters, Highway Patrol groups and ground ambulances were presented to enable meaningful comparisons. For cost purposes the number of patrolmen required to man a specific location 24 hours a day was taken as 4.5. The costs calculated are presented in Table 2.

TABLE 2. Rural Costs

System Components	Cost Per Year
2 helicopters	$379,071
2 Highway Patrol groups	$137,078
2 ground ambulances	$106,996

On the basis of time it was found that on the average the helicopter operated at twice the speed of the ground ambulance or the patrol car. Therefore it was assumed that 2 helicopters should at least be equivalent to 2 Highway Patrol groups and 2 ground ambulances. Under this assumption it can be seen that the helicopters cost $134,997 more per year than equivalent ground facilities.

As far as area serviced was concerned, it was estimated that the 2 helicopters were equivalent to 3 Highway Patrol groups and 6 ground ambulances. On this basis the helicopters annual cost is $379,071 as compared to $526,605 for equivalent ground facilities.

The AMES final report did not attempt to place a monetary value on the lives that the use of helicopters probably saved. However, an evaluation such as this would seem to be legitimate and justified. In computing accident costs the U. S. Army Materiel Command uses $60,000 as the cost of each death due to an accident. During the AMES demonstration, the physician who received the accident victim was asked to rate the benefit the victim received as a result of helicopter transport. During the 9 month period when medical missions were

flown, 225 persons were carried. Of these 225 persons the physicians estimated that 3 lives were probably saved as a result of rapid helicopter transport. Using the Army's rates for accidental deaths and assuming these 3 people would have died if rescued by ground ambulance, an additional cost of $180,000 can be attributed to the ground system. If this is done, the ground facilities are more expensive to operate on either a time or area serviced basis.

Urban Environment

In urban environments the helicopter's speed advantage over ground ambulances does not prove of significant value in the vast majority of emergency evacuation missions. As a result in urban applications the primary mission of the helicopter is likely to be other traffic safety related work. This mission may involve traffi- surveillance and reporting, photographic studies, riot control or general law enforcement activities. The secondary mission would be as an air ambulance. The criteria for using the helicopter as an ambulance might be seriousness of the injury or an anticipated long response time for a ground ambulance.

The basic difficulties of a cost analysis for an urban environment are the same as for a rural environment. The functions that the helicopter can perform are not easily equated with the functions performed by the

police and ground ambulance. The specific situation will determine which of the three components should be used to achieve maximum effectiveness.

A helicopter demonstration project has been completed in the Minneapolis-St. Paul area. In this study a contractor furnished the helicopter and pilot. At a usage rate of 60 hours of flight per month the contractor reported a cost of $185 per flight hour (Richards et al., 1971). The helicopter used was a Bell 206A Jet Ranger which is satisfactory for use as an air ambulance. In order to have an attendant available at all times along with the helicopter it will be estimated here that an additional $50,000 per year will be required. This allowance is reasonable in order to attract the high quality attendants that are desired. At a usage rate of 720 hours per year (60 hours/month x 12 months/year), the cost of the helicopter and pilot is $133,200 per year ($185/hour x 720 hours/year). With the additional $50,000 for an attendant, the total operating cost of the helicopter is $183,200 per year.

Several estimates are available as to the yearly cost of operating a ground ambulance. In Jacksonville, Florida the cost has been reported as $63,447 (Waters, 1969). The AMES project in Arizona calculated a cost of $53,498 (Schamadan et al., 1970). Dunlap and Associates, Inc. concluded that a reasonable stimate was $51,470 (1968). This last estimate is understandably lower

because personnel costs have risen sharply since it was made.

In an urban environment it is obvious that a greater number of policemen are required. Although the same number of policemen cover a smaller area in an urban situation, it will be assumed that the cost is the same as that reported for the Arizona Highway Patrol Group. Therefore, the cost of patrolling a specific area will be taken as $68,559. The costs that are assumed applicable are listed in Table 3.

TABLE 3. Urban Costs

System Components	Cost Per Year
1 Helicopter	$183,200
1 Ground Ambulance	$ 63,447
1 Police Group	$ 68,559

In an urban environment the average operating speed of a patrol car can be expected to be lower because of increased traffic. The helicopter's average operating speed should be the same as in a rural environment because it operates without this restriction. Since the helicopter's primary mission is traffic safety work and it will be operated in this mode the majority of the time, it will be assumed that the helicopter is equivalent to 2 police groups.

Operating as an ambulance the helicopter will perform two types of missions: emergency rescue and hospital transfers. The criteria for emergency rescue have already been described. Hospital transfers will involve

moving patients to hospitals with the required treatment capabilites. Operating in this mode the helicopter should be equivalent to at least 1 ground ambulance.

Under these assumptions a cost comparison can be made. The annual cost of 1 helicopter, $183,200, is less than the annual cost of 2 police groups and 1 ground ambulance, $200,565 (2 x $68,559 + 63,447).

So far this cost analysis does not consider the possibility that lives may be saved. The basic criteria defined for using the helicopter as an air ambulance in an urban environment should insure that the helicopter's main advantage, high speed, will be utilized. If the helicopter is used in this manner the resulting benefit in lives saved can be expected to be the same as in a rural environment where the same criteria is used.

For example, the city of Chicago uses a helicopter for medical missions. The usage rate averages 20 calls per month or 240 per year(Kielty, 1970). If lives are saved at the same rate as experienced in the AMES study, 3 deaths are prevented each year. Using an accident cost of $60,000 per death as before an additional savings of $180,000 can be attributed to the helicopter. The derivation of this $180,000 is based on several assumptions and may not prove correct but the possibility exists and should be considered.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This last chapter will be divided into two sections. The first section will contain a listing of recommendations and conclusions that apply to the complete emergency medical care system. The second section will be conclusions which are concerned specifically with the proper role of helicopters within that overall system.

The Emergency Medical Care System

Emergency medical service throughout this country falls far short of that which is desired. The following recommendations for improvement are believed to be among the most important:

1. The proficiency and capability of ambulance attendants must be improved. Increasing the quality of this one component of the emergency care system shows promise of being the single most significant improvement that can be made.

2. Comprehensive state legislation governing emergency medical services must be enacted. The reluctance of the majority of the states to shoulder this responsibility is no longer tolerable. In those states where weak and ineffective laws have been passed, this legislation needs to be strengthened.

3. Communication between the elements of the emergency medical system must be improved. It is recommended that all ambulances within an area be dispatched by a single controlling agency. This agency will know

the accident location and can dispatch the nearest available ambulance. This procedure will avoid needless duplication of effort and subsequent increased expense.

It is also recommended that communications be established between the ambulance and the receiving hospital. The primary purpose will be to inform the hospital that a physician will be required in the emergency room. If a physician is available he may offer advice to the ambulance attendant as to treatment of the patient during transit.

4. Perhaps it goes without saying but a well coordinated, efficient emergency medical care system is no accident. The prerequisites are a good deal of advance planning and organization. Too often all the elements of the emergency system are available but the necessary steps to integrate these elements into an effective working unit have not been taken. These necessary steps will include anticipating and planning for emergency needs, defining operating procedures, delegating responsibility, and supervision of the operating system.

   It is recommended that the responsibility for seeing that these steps are taken be placed within state and local governments. The importance of this organization and control demands a guarantee that it will be accomplished.

The Helicopter Ambulance

In recent years the helicopter has received widespread publicity largely as a result of the Vietnam war. Questions naturally arose concerning the feasibility of using helicopters in civilian rescue operations. Since that time, studies and projects designed to answer some of these questions have been conducted. A compilation and analysis of the results of these studies has prompted the following list of conclusions and recommendations:

1. The role of the helicopter is best described as a supplement to and not a replacement for the existing ground ambulance system. Helicopters should be integrated into the present system such that

their primary attribute, high speed, is utilized.

2. The helicopter is not justified for use solely as an air ambulance. The annual operating cost of the helicopter is approximately 3 times that of the conventional ground ambulance.

3. In a rural environment where long distances are involved and an unobstructed landing site is usually available, the helicopter's primary mission should be emergency rescue and evacuation. Its secondary mission should be to aid in law enforcement and traffic safety activities.

   The mission priorities governing helicopter usage in an urban environment should be just reversed. In this situation ground ambulance response times are short and a suitable helicopter landing site may not be available. Within most urban areas the traffic problems are such that the helicopter can be used to advantage in traffic safety work.

4. If the helicopter is used to perform dual missions as just described, it is cost effective in both urban and rural environments.

5. The use of helicopters has and will continue to save lives. This statement, which is understandably difficult to verify, probably best describes the helicopter's real usefulness.

6. The vast majority of accident victims have readily accepted the helicopter as an ambulance. This indicates that the general public is receptive to the use of helicopters in rescue work.

7. In this paper several assumptions were made in order to complete the cost analysis for an urban environment. It is recommended that further research be conducted in this area. An estimate of the helicopter's usefulness as a traffic safety tool needs to be demonstrated.

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