U.S. Department of Transportation

National Highway Traffic Safety Administration

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Helicopters In Emergency Medical Service NHTSA Experience To Date

December 1972

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Contents

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The purpose of this paper is to document, in one source, the efforts by the National Highway Traffic Safety Administration to study the role of the helicopter in emergency medical service. A five-year period from mid-1967 to mid-1972 is documented by extracts from final contract reports with comments and overall conclusions by this writer.

The National Highway Safety Act of 1966 authorized and directed the Secretary (of Transportation) to assist and cooperate with other Federal departments and agencies, State and local governments, private industry and other interested parties, to improve highway safety. Limited funding provisions were included in the Act to assist in accomplishing its goals. Section 402 provided matching funds for State use and Section 403 provided for full Federal funding of Research and Demonstration Projects.

One subject, on which the Act directed the Secretary to provide a uniform standard for the States' highway safety program, was "Emergency Services." Highway Safety Standard 11 "Emergency Medical Services" was issued June 27, 1967. The stated purpose of this standard is to:

I. Provide quick identification and response to accidents.

II. Sustain and prolong life through proper first aid measures, both at the scene and in transit.

III. Provide the coordination, transportation, and communications necessary to bring the injured and definitive medical care together in the shortest practicable time, without simultaneously creating additional hazards.

Studies were made of existing operations, and methods were explored which would improve the response to highway-related emergencies. Along with other system improvements, the helicopter was proposed as one method of reducing the interval from the time of the accident to the arrival of emergency medical care, and to reduce the time of transportation from the scene to the hospital.

Two of these early studies which included specific information on utilization of the helicopter in the emergency medical service were *Economics of Highway Emergency Ambulance Service* and *Emergency Care Systems Demonstration Projects* funded under Section 403.

Economics of Highway Emergency Ambulance Service[1]

The *Economics of Highway Emergency Ambulance Service* provides information on the economic problems of emergency ambulance services and provides guidelines that planners can use in developing economical and efficient emergency ambulance service. This report provides guideline information that can be used to identify and evaluate alternate solutions to specific problems in providing emergency ambulance service.

One chapter of this report is devoted to the helicopter ambulance. Among the findings and conclusions was the determination that potential use of helicopters as emergency ambulance vehicles needs objective evaluation. Too many people have formed a positive opinion without benefit of data or cost-benefit evaluation studies. Careful planning and coordination among medical, police, manufacturer, purveyor and aviation agencies, and among municipal authorities are essential to make a helicopter system function effectively. Any viable system will cut across municipal, county (even State) bounds and coordinated action is required. Limited numbers of currently available and certified helicopters are suitable for individual emergency ambulance missions. Payload and size should accommodate two to four litters internally – smaller ones are unsatisfactory; larger ones are uneconomical.

Emergency Care Systems Demonstration Project[2]

The *Emergency Care Systems Demonstration Projects* was designed to provide a complete description of the emergency care system, in terms of its functional components, and to determine the subsystem design required to obtain an effective operational system. In addition, operational plans for emergency care demonstration projects were developed. One of the subsystems examined was airborne emergency care system vehicles. This included fixed wing Short Take-Off and Landing (STOL) aircraft as well as helicopters. Although the additional speed and payload of the fixed wing STOL aircraft gave certain advantages over the helicopter, the helicopter retained certain critical advantages especially at congested hospital delivery points.

[1] *Economics of Highway Emergency Ambulance Service*, Dunlap and Associates, Inc. (1968)–DOT/HS 003-295, NTIS/PB 178-837, Contract No. FH-11-6541.

[2] *Emergency Care Systems Demonstration Projects*, Franklyn Institute Research Laboratories (1968)–DOT/HS 800-006 thru 009 (4 volumes), NTIS/PB 179-847 thru 850 (4 volumes), Contract No. FH-11-6596.

In studying the U.S. Army success with the helicopter evacuation, it was found that one of its greatest assets was the efficient communication system which permits prompt notification and effective dispatch control. There is no civilian counterpart to this system and this lack of communications decreases the effectiveness of the civilian emergency helicopter ambulance. Cost figures for various operational plans utilizing a selection of available helicopter types were developed by this study.

In using either of these studies for planning, the planner must adjust the costs developed to present dollar values, and must account for new equipment and practices which have been developed since these reports.

During fiscal year 1968, two States utilized Section 402 matching funds to conduct pilot helicopter emergency ambulance service programs. Pennsylvania started a one-year operation in November 1967 with a Bell 47-J-2A; and the Nebraska 14-month study began in January 1968 utilizing two Sikorsky S-55 helicopters. Neither of these programs lived up to the high expectations of the planners, although much was learned from these early trials.

Pennsylvania Project No. EMS 68-1-001[3]

The Pennsylvania trial of the helicopter in emergency air ambulance use was of one year duration to determine how effective a helicopter ambulance could be in increasing the chances of survival of traffic accident victims. The test area, in the southeastern corner of Pennsylvania, consisted of nearly 900 square miles, one million persons and 34,000 miles of public highways. The Bell 47-J-2A was available from 7 a.m. to 9 p.m. for one year and was controlled by the State Police. For the first 3½ months the helicopter was based in the Philadelphia area and received 14 requests which resulted in three airlifts. During the remainder of the year, the helicopter was based in the more rural Exton area where 130 accident responses were made which resulted in 46 completed airlifts. Regular police traffic patrols were main-

[3] Commonwealth of Pennsylvania, *Helicopter Ambulance Study*. May 1969. Final Report. Project EMS 68-1-001. Robert R. Coleman, Project Director, Pennsylvania Department of Highways. DOT/HS 008-477, NTIS/PB 197-240.

tained during the trial period. The following table summarizes the major activities during the 12-month period:

Traffic Service	Flights
disabled vehicles	83
accident response	144
air lifts completed	49
Police Service	
criminal	55
civil search	24
miscellaneous	30
Other	
demonstrations, accident simulations, etc.	77
Patrols recording no incidences	244

Functioning as an ambulance, the helicopter completed 49 airlifts of victims to hospitals. The overall response from time of call to delivery of the patient to the hospital averaged 19.5 minutes. The average trip time from base to accident scene was 7.5 minutes and from accident scene to hospital, 5.8 minutes. (This indicates an average response distance of less than 10 miles and an average patient carry of less than 8 miles, and does not give a comparable ground ambulance response time.) The types of injuries sustained by persons airlifted included lacerations, fractures, chest and internal injuries. The time factor in transporting the victims to the hospital was not critical in the majority of incidents. Six of the 49 injured persons had suffered injuries that were later classed as "life threatening." Two of these six victims died after arrival at the hospital. Two lives were "probably" saved as a result of rapid transfer to the hospital.

While the Bell 47-J-2A was satisfactory for this study and performed well within its design limits, it had serious shortcomings and was not considered satisfactory for use in a regular emergency ambulance service. The internal litter and seating arrangements made it difficult to load a litter victim. For a two-week period, the helicopter operated as a unit of a ground ambulance service for test and evaluation. Ground ambulance attendants were part of the flight crew during

seven airlifts of injured persons. These attendants were impressed by the speed and accessibility of the helicopter, but regarded the space limitations, litter arrangements and limited medical equipment as quite inferior to their own ground ambulances.

The helicopter crew had direct radio contact with the State Police net and all messages to hospitals concerning arrival of injured persons had to be relayed by phone through the State Police stations. While the communication system could have been improved, the lack of requests for helicopter ambulance service throughout the study was a result of personal decisions rather than a communications hardware deficiency.

Nebraska Project No. EMS 68-1-001, 002[4] (Operation SKY-AID)

Operation SKY-AID was a 14-month study to field test, under civilian conditions, the role a helicopter might play in providing emergency service under the most diversified combination of circumstances possible and to provide operating data pertinent to helicopter operations, i.e., weather, night flying communications and maintenance. Two Sikorsky S-55 helicopters were utilized in the program which covered the 35 southeastern counties of Nebraska. During this program, flights were prescheduled for selected weekends and hours of unusually heavy traffic. Crews were on 15 minute calls from 8 a.m. to 5 p.m., Monday through Friday, and one hour call at other times.

Although any one of the ambulance flights potentially could have proved lifesaving to a severely injured accident victim, there were fewer casualties during the scheduled flying hours than had been anticipated. Most of the missions consisted of highway traffic surveillance. (This report does not state the total number of patients carried during the test, but indications are that it was more than one but less than five.)

The helicopters used during this project were reported ideal for space requirements, accessibility to patient in flight and stability; however, this type helicopter was reported too low powered for access to limited landing sites and the dispatch delay time was undesirable for emergency ambu-

[4]Nebraska Air Ambulance Project, *Operation Sky-Aid* July 1969, Final Report. Project EMS 68-1-001, 002. Paul R. Haith, M. Ed., Project Coordinator. DOT/HS 008-478, NTIS/PB 203-293.

lance service. Also, even though this project utilized to the fullest extent all available communication systems, communications were inadequate. This study also found that a standby helicopter ambulance program, with a helicopter parked at a medical center prepared to answer emergency calls, is neither feasible nor recommended. A more feasible plan would give consideration combining medical emergency services with services for other agencies.

Both of the foregoing tests experienced several common difficulties which can be expected in any attempted use of the helicopter for emergency ambulance service unless they are anticipated and planned around. Similar difficulties have also appeared in later Section 403 funded demonstration projects.

One difficulty which was not unexpected was the high cost of operation. What was not foreseen was the high cost per patient due to the low usage as an emergency ambulance. Although most advocates of emergency helicopter ambulance service can cite cases where this service could have saved lives or improved the final medical outcome due to the accident victim's injuries, they fail to realize how few such cases occur within the effective operating radius of the helicopter during any given time period. Even when there was a case for which the helicopter would have been the proper response vehicle, failure to alert the helicopter operator was, and still is, a primary problem.

Another difficulty indicated by these tests was the inadequate radio communications with the helicopter crew. Unlike the U.S. military radio communications which have a compatible world-wide system, civilian public service radio communications are generally fragmented or non-existent to the extent that much of the effectiveness of providing rapid helicopter emergency ambulance service is lost. The inability of the crew of the helicopter to communicate immediately with a control center, pick-up site personnel, or destination medical center can cause unnecessary delays. This problem was foreseen in earlier studies.

Also, both test programs indicated difficulties associated with the types of helicopters selected for use. The type of helicopter selected for emergency ambulance use will have a bearing on the outcome of any helicopter emergency ambulance project. There are many types of helicopters available today. Few of these helicopters are suitable for this type of work, and none can be considered ideal.

At the end of fiscal year 1968 and during fiscal year 1969, six projects were contracted under Section 403 (Research and

Demonstration Projects) which included investigation, to various degrees, of the use of helicopters as emergency ambulances. In the following paragraphs are abstracts of the emergency air ambulance portions of final reports from the contractors listed below:

University of California – Los Angeles

The Metropolitan Washington Council of Governments (DC)

City of Detroit, MI

Arizona State University

Metropolitan Inter-county Council (MN)

Mississippi State University

University of California – Los Angeles[5]

This project titled, "Emergency Medical Service Systems," was to develop and demonstrate means for evaluating the effectiveness of improvements to Emergency Medical Service systems. The project was to measure the benefit, in terms of patient outcome, of improvements to various EMS sub-systems aimed at reducing time to treatment and raising the level of care. Analytical models were developed to describe the operating characteristics and performance of proposed systems. Certain demonstration efforts were evaluated in communications, training of paramedical personnel, and helicopters.

The helicopter emergency ambulance study was conducted in three phases with a converted Bell Jet Ranger:

1. **A response time study** in which a helicopter was dispatched to emergency medical incidents in tandem with ambulances that serviced a suburban area; the helicopter did not land, but estimated probable landing difficulties;

[5] *Emergency Medical Service System,* University of California-Los Angeles, DOT/HS (to be published): NTIS/PB (to be published), Contract No. FH-11-6849.

2. **A landing feasibility study** to assess the operational potentialities of helicopters, in a suburban/urban environment, in a variety of controlled landing site conditions;

3. **A patient retrieval demonstration** to assess the operation efficiency and medical effectiveness of helicopter ambulance in a rural environment.

The overall objective of these demonstrations was to examine the feasibility of integrating helicopters into the emergency rescue transportation system, both to supplement and to complement ground rescue ambulances.

The feasibility of using helicopters as emergency air ambulances has been well demonstrated both in the U.S. and abroad. However, this project showed in its response time study that despite its speed and ability to fly to a destination in a straight line, a helicopter, on the average, cannot reach the scene of a medical emergency in an urban or suburban area ahead of a ground ambulance dispatched simultaneously from a well deployed fleet of vehicles. Furthermore, in highly developed areas, the presence of poles, overhead wires, tall buildings, and heavy street traffic tend to delay or preclude a helicopter landing, unless a trained controller is at the scene to point out obstacles, control traffic, and guide the helicopter by means of hand signals and/or direct voice communications.

Taking these factors into account, it appeared that helicopter ambulances had their greatest potential in rural areas, where the response time of conventional ambulance service was relatively long, and where the presence of open areas would permit unassisted helicopter landings and take-offs. Rural areas are also characterized by a relatively small population base. Thus the frequency of occurrence of medical emergencies was projected to be relatively low within the area serviced by helicopters. This infrequent demand for emergency ambulance transport, coupled with the high initial investment cost and recurring operating costs of a helicopter, indicate that it might be uneconomical to operate a helicopter solely as an air ambulance in a rural environment. Therefore, helicopters whose presence in rural areas has been justified for other purposes should be sought. In this way, the medical and operational benefits of the secondary role need only be balanced against the incremental cost of operation.

The area selected for the patient retrieval demonstration (Antelope Valley-Newhall area) contained a County Fire Department base and covers about 2,200 square miles, with a population of approximately 120,000. The county fire department helicopter standby hours for the emergency ambulance test were from noon to 8 p.m. on Fridays, Saturdays and Sundays for a 13-month period. Crews attended an 80 hour emergency medical training course at a teaching hospital prior to initiating the service. The incidents to which the helicopter responded were those for which the estimated response time of a conventional ambulance was 15 minutes or more.

The helicopter was deployed or scheduled for deployment as an air ambulance on 180 days. As an air ambulance it retrieved 88 patients and was considered instrumental in saving the lives of five. It also was successful in transferring 12 patients, six of whom were considered to have life threatening injuries, from small hospitals to hospitals with greater capabilities. Although extensive preplanning and establishment of protocol of operations was accomplished with all concerned organizations, data indicated that if the helicopter operator had been promptly notified of all potential qualifying cases, 41 additional patients would have been transported.

Of the cases transported, the reviewing physician judged 27% to have had sustained life-threatening injuries. In general, the helicopter was used for a greater portion of life-threatening cases than were the surface ambulances based on a 2:1 patient admission rate at the receiving hospitals. The following table compares service times for surface and air ambulance during the patient retrieval demonstration phase. The great difference in waiting time to treatment in the hospital is generally credited to advance notification by radio of arrival time and nature of patient's injury.

Comparative Service Times of Ground Ambulance Calls Greater Than 15 Minutes and Air Ambulance

Time from Dispatch to:	Mean Times		Diff. in Minutes	Pct. Change
	Ambulance	Helicopter		
Arrival on Scene	20.9	14.6	6.3	30.1
Arrival at Hospital	41.4	32.3	9.1	22.0
Treatment at Hospital	52.6	35.8	16.8	31.9

This comparison should be interpreted as a potential area of improvement in emergency ambulance service in this community and not as a criticism of existing service, since 50% of all calls were responded to by ground ambulance within 10 minutes. The foregoing table is based on only those calls with a greater than 15 minute response. Given the cost and utilization of the air ambulance, careful planning is required before the use of helicopters as air ambulances is arbitrarily decided upon.

This project concluded that the helicopter ambulance could provide improved emergency service to emergency victims who are located 15 minutes or more from the nearest ground ambulance. This improved emergency service, under conditions similar to this trial, would include a 30.1% decrease in time to arrival on scene and a 22% decrease in arrival time at the most appropriate (rather than merely the closest) hospital. This service could be offered at a cost comparable to present ground ambulance costs if the helicopter were made available daily and its use continued beyond the demonstration period. Air ambulance service could be used in other outlying areas of the country having potentially long response times (15 minutes or more) in emergencies. It cannot be stressed too strongly that these findings depend on (1) the helicopter having another function against which the procurement and other fixed costs of operation can be offset, (2) demand for emergency service continuing at identical levels, and (3) no expansion of ground ambulance service or deployment patterns that would effectively reduce the time to arrival on the scene. If one or all of the foregoing conditions were not met, then the economies of operation would change significantly and the medical benefits would be diminished.

The Metropolitan Washington Council of Governments (DC)[6]

This project was to explore the feasibility of integrating a regional helicopter ambulance service with existing ground ambulance service to provide a more efficient, rapid emergency rescue and treatment capability in the Washington

[6] *Report on the Feasibility of Developing an Experimental Helicopter Ambulance Service in the Washington Metropolitan Area* – Metropolitan Washington Council of Governments, Washington, D.C. (1969)–DOT/HS 800-530, Contract No. FH-11-6853.

metropolitan area (District of Columbia and five surrounding counties in Virginia and Maryland). As the study progressed, it became apparent that key blocks of data needed to determine both the quality and deficiencies of the existing crash rescue system were not available. As a result, the feasibility of integrating a regional helicopter ambulance service had to be based on unsupported estimates and probabilities. It was concluded that the feasibility could only be determined by a demonstration project. (An alternate method of determining feasibility would have been to institute a reporting system which would have collected the needed data. A demonstration project without comparable existing data cannot measure the benefits added by the demonstration.)

City of Detroit, MI[7]

The "Emergency Medical Services for an Urban Area" demonstration project by the city of Detroit and the University of Michigan Highway Safety Research Institute was to study alternative methods of public-supported ambulance use in medical emergencies on the basis of timeliness, quality and cost. Sought were methods of improving emergency medical assistance. Existing public and private (contracted) ground and air ambulance services were evaluated as to time elapsed between the call for help and the victim's delivery to a hospital, and the treatment available from ambulance crews. There also was analysis of communications, including the performance of two citizen-band radio reporting groups, with the object of improving the speed of accident detection and notification.

In the air ambulance portion of this project, the Bell 47-J flew patrol missions over the 140 square mile area of the city between 4 and 7 p.m., Monday through Friday (weekend and late evening flights were scheduled on occasion), for a six month period. The primary mission of the crew was to land at injury accident sites, provide paramedic care, and transport the victim to one of six local hospitals having a helipad or helistop.

A police ground unit was necessary and always requested at the accident scene for traffic control or crowd

[7] *Emergency Medical Services for an Urban Area,* City of Detroit (1970), Final Report. DOT/HS 800-418, NTIS/PB 197-752, Contract No. FH-11-6901.

security. Four hundred and eighty-seven hours were flown on 131 missions. It was demonstrated that an air ambulance can successfully land – on a busy freeway or a major thoroughfare during rush-hour traffic, or on a vacant lot or playground in a residential neighborhood – and transport an injured victim to a hospital.

In the course of the demonstration, the crew was dispatched to 37 incidents, with 27 successful landings resulting in the transfer of 23 persons. Eight landings were made on freeways, 11 on surface streets, and 8 on off-street areas. Because the injury occurrence process was random, the range of victim's condition varied from minor injuries to critical cases. For the most part, those transported by helicopter were not seriously injured. Three of the victims, however, did fall into a critical category: one apparently died before the craft arrived, another died in flight, and the third was successfully transported and treated.

The primary benefit of the helicopter ambulance is its speed of response and the resultant benefit that this speed affords the victim. To place the helicopter in a perspective of an urban emergency-medical-response system, its time-saving benefits must be compared to those of ground ambulances. The helicopter, operating city-wide, did achieve some time savings, but the benefit was small when compared to the speed of ground operations. The average time from dispatch to hospital was 9 minutes for the Fire Rescue squads and 8.2 minutes for the helicopter ambulance. The helicopter usually could not approach a victim as closely as a ground vehicle and the victim loading process was more complex. In addition, the helicopter traveled greater distances and had only six helipad hospitals on which to rely, while the ground vehicles covered shorter distances and relied on 14 hospitals.

This demonstration study concluded that the time savings of a helicopter ambulance in an urban area does not justify the cost of a helicopter ambulance operating exclusively on patrol. Use of a helicopter for medical emergencies in an urban area may be justified under limited conditions. If a municipality operates a multipurpose helicopter which has a secondary role of standby for emergency medical transport, a screening procedure should be set up to limit the demand and reserve air conveyances for only the seriously injured. The definition of serious would include the nature of injury, the time-treatment requirement, and the distance to be covered to get to proper treatment.

Arizona State University[8]

The Air Medical Evacuation System (AMES) demonstration project by Arizona State University was to test the AMES concept previously developed at that University. This concept was to provide air ambulance service to rural portions of Arizona utilizing helicopters with additional missions. This system incorporated the helicopter, controlled by the Arizona State Highway Patrol, with well trained paramedical personnel, and a well designed communication system.

Two specially equipped FH-1100 turbine-powered helicopters operated 24 hours a day within a 150 mile radius from a base in central Arizona. The aircraft carried two internal litters, the pilot and an Arizona Highway Patrolman. Both men were trained as paramedical specialists and had over 150 hours in an advanced in-hospital training program. Three physicians, all with military air evacuation and rescue experience, monitored the system continuously. The AMES responded to medical emergencies such as highway accidents, hunting, camping and boating mishaps, and inter-hospital transfers. The communication system could reach any point in the State utilizing the Arizona Highway Patrol frequencies and a separate medical channel. The net could also be patched into the telephone system, whenever desired.

After several months of intensive training, statewide service was initiated on May 30, 1969. By January 31, 1970, the aircraft had flown 1,185 hours and evacuated 225 persons in the course of 213 missions. In addition to medical experience which included evacuation of accident victims, hospital and premature infant transfers, venomous animal bites, tetanus, burns and general trauma, the AMES flew 613 "other" missions, including manhunts, aircraft searches, patrol, surveillance, etc. AMES developed criteria for types of patients suited for this service as well as those definitely not suited; necessary on-scene preparation, procedures, and medications; standards of evacuation care; strategies and devices for comfort and telemetry; and choice of receiving facility.

On-site pickup of the ill and injured was made during the entire test. Hospital transfers to more suitable facilities

[8] *Air Medical Evacuation System (Ames)*, Arizona State University (1970), Final Report. DOT/HS 800-267, NTIS/PB 193-724; Appendix DOT/HS 800-268; NTIS/PB 193-725. Contract No. FH-11-7090.

were started near the mid-point of the project. Following is a summary of patient origin:

Distribution of Patients

Type Mission	No. Missions	No. Persons	Pct. of Total*	Persons/ Mission
1. Evacuation:				
a. Highway	81	116	52	1.42
b. Non-remote, non-highway	24	25	11	1.04
c. Remote	11	12	5	1.09
2. Transfer	55	72	32	1.30
3. Dry runs	42	0 (not included in % of Total)		
Total	**213**	**225**	**100**	

*(171 w/patient)

Physicians' comments concerning the patients after delivery by AMES indicate that the time saved effected a reduction in morbidity in at least 9 cases and the paramedic's action in at least one other case. The time saved improved the patient's chance of survival in at least four cases and on two occasions, the paramedic was credited with saving the patient's life.

Traveling by helicopter imposes a certain degree of roughness and vibration on the passengers. When comparing this to the roughness and vibrations encountered in riding in a ground ambulance, it is necessary to consider other factors such as smoothness and contours of the roadway. Any rough movement, vibrations or sudden jerks of a patient cannot help but to bring him further discomfort and could add to the severity of his condition. In only four cases did the paramedic comment about the adverse effect of the helicopter with respect to deterioration of the patient's condition. Relative to the ground ambulance, the helicopter was rated less detrimental on rural/remote missions and more detrimental on urban missions.

In addition, this project provided quantitative answers to the question of cost and operational effectiveness of civilian air medical (helicopter) systems. The expense of such a system is substantial. The conclusion was that the high cost

can be justified when the helicopter is operated as a rural, remote area system—not as a replacement for, but as a supplement to existing ground ambulance and law enforcement operations if the helicopter is used for other supporting missions, such as law enforcement, patrol, or surveillance, without sacrificing the medical evacuation capabilities or priorities of the system. On the basis of the experience that was gained, it was concluded that the helicopter can perform a very effective role in general law enforcement operations, while, at the same time, performing its primary mission of medical evacuation.

One additional significant conclusion of the project was that a properly designed emergency medical communications system is a key component of an air medical evacuation system operation.

Although not specifically pointed out in the report, the success of this project's operation was partly responsible to good planning by all agencies and organizations responsible for and interested in providing the existing emergency medical service for the demonstration area.

Metropolitan Inter-County Council (MN)[9]

This project entitled Helicopter Ambulance Service to Emergencies (HASTE) was a cooperative, coordinated multi-county emergency medical service response system. It was designed to determine the efficacy of utilizing highly trained and experienced rescue personnel, flown by helicopter to accident scenes, for providing primary or backup medical service to accident victims in the shortest time.

Designed and administered by the Metropolitan Inter-County Council, project HASTE was to take full advantage of the benefits and capabilities of a multi-county representative group organized to identify common needs and solve mutual problems through cooperative program efforts. The Minnesota State Health Department served as the prime subcontractor with responsibility for program implementation, data collection, and final evaluation.

The flight demonstration portion of this project was accomplished in two phases and utilized three types of helicopters. The first flight phase employed a Bell 47-J, without litter capability, which carried a well trained

[9] *Helicopter Ambulance Service to Emergencies (HASTE).* Metropolitan Inter-County Council, Minnesota (1971), Final Report. DOT/HS 800-495, NTIS/PB 200-308, Contract No. FH-11-7128.

Professional Rescue Instructor of Minnesota (PRIM) to stabilize the victim at the accident scene prior to his transportation to the hospital by ground ambulance. This phase was in operation for three months and resulted in three victims receiving care; nine missions to carry blood, serum, or drugs; and 20 missions being aborted for various reasons. The second flight phase employed a Bell Jet Ranger for the first 10 months (the subcontractor went out of business without prior notice) and a Sikorsky S-62-A which completed the last two months of the project. During this second phase, in addition to carrying the PRIM to the scene to care for the victim, helicopter transportation of the victim was provided to the hospital if the injuries warranted this type of transportation. Seventy patients were carried; on 45 missions patients were attended but not transported; blood, serum, or drugs were transported on 45 missions; and 336 missions were aborted for various reasons.

In the opinion of the medical advisory committee, only 35 of the 70 patients transported to hospitals by helicopter had conditions or suspected conditions serious enough to warrant helicopter transportation. And of these 35, the committee concluded that eight were benefited in a way in which they would not have been by ground ambulance transportation.

The high rate of aborted flights seems to be due to the dispatch criteria which was very liberal. The helicopter was dispatched on any information of a personal injury accident, including those monitored on police frequencies, without regard to severity or of ground ambulance capability in the area. Over 65% of the flights aborted were turned around due to prior arrival of ground units or because the victim had received either minor or no injury. The project personnel felt that the helicopter emergency ambulance was under-utilized and a careful reading of the report will give clues as to a variety of reasons. (The use of a trained central dispatcher could have improved the utilization of the helicopter and reduced the number of aborted flights.)

Conclusions derived from this demonstration project included the determination that helicopter emergency ambulance service in a large metropolitan area such as Minneapolis, St. Paul, and suburbs is not feasible, but that helicopter ambulance service would be reasonable in the outlying areas of the State. In order to be financially feasible and practical in these outlying areas, the helicopter emergency ambulance would have to have a multipurpose use.

In comparing the two types of helicopters utilized to transport patients, the Bell Jet Ranger was found to be adequate in nearly every aspect of operation. The possible exception would be the space limitation inside the helicopter. Lack of space restricts certain medical procedures that could have been done by paramedics such as cardiopulmonary resuscitation and splinting of lower extremities using fixation or traction type splints. Since only three or four instances of cardiopulmonary resuscitation were required during the project, this factor may not have been of too much consequence. The size problem could be remedied with a slight increase in cabin interior size. The Sikorsky S-62-A has adequate space in its interior cabin for all procedures. However, the ship's size proved a deterrent to officers on the ground. The 8,000 pound helicopter not only caused much more wind disturbance upon landing, but because of its large size it could not necessarily land on the untraveled portion of the highway or the shoulder as the Bell Jet Ranger could. Cost of operation of the Sikorsky S-62-A was found to be considerably more than that of the Jet Ranger.

Mississippi State University[10]

This project known as Coordinated Accident Rescue Endeavor-State of Mississippi (CARE-SOM) was conducted under two separate contracts. The first by the College of Engineering, Mississippi State University, was to evaluate the problems and benefits of a comprehensive and integrated medical response system using a balanced program of helicopter and ground ambulance to serve three large predominately rural areas of the State. The second portion was conducted by the College of Business and Industry, Mississippi State University, which continued the original studies and developed cost and organizational information for the helicopter ambulance use in a multipurpose role.

Three operational zones of a 50 mile radius each were utilized with the operation of the system composed of helicopters and ground ambulances, based on using the method of transportation which could get to the injured and transport them to the nearest hospital in the minimum amount of elapsed time. Time-Response Contour Maps were

[10] *Coordinated Accident Rescue Endeavor, State of Mississippi (CARE-SOM)*, Mississippi State University (1970), Final Report. DOT/HS 800-460, NTIS/PB 199-756; Appendices DOT/HS 800-461, NTIS/PB 199-757, Contract No. FH-11-7146; and Extension of Project CARE-SOM, Final Report (1971), DOT/HS 800-584, NTIS/PB 204-999; Contract No. HS 019-1-020.

developed to determine the portions of the operating area which were better served by the ground ambulance. Each zone system was operated by local people who were a part of the existing emergency medical services, including physicians, hospital personnel, ambulance attendants and law enforcement officers.

One FH-1100 helicopter was assigned to each zone to provide the air ambulance service. Existing ground ambulances were utilized and were provided with two-way radio communications to hospitals and law enforcement officers. The helicopters operated between the hours of 7 a.m. and 9 p.m. daily, from November 1969 through June 1970, and again from November 1970 through February 1971.

During the six month period of November 1969 - April 1970, a total of 828 missions were flown for all purposes; of these, 457 were directly involved with medical emergencies and the transferring of 332 patients. During the four month period of November 1970 - February 1971, a total of 478 missions were flown, of which, 207 were directly involved with medical emergencies and 189 patients were carried on 161 missions. The missions from these periods were classified, as follows:

Type of Medical Mission	Inclusive Dates 11/69-4/70	11/70-2/71
Traffic accidents	182	97
Inter-hospital transfers	180	70
Other medical emergencies	82	38
Blood, drug, equipment transfers	13	2
Total	457	207

Poor response and cooperation by hospitals and ground ambulance services resulted in insufficient data for any attempt to estimate lives saved or reduction of patient condition deterioration because of helicopter rather than ground ambulance patient movement. (More and better planning is needed in this area.)

The number of requests for the helicopter, other than hospital transfers, appeared to be inversely proportional to the distance of the caller from the helicopter base. This reluctance to request the helicopter for long-range missions could be due to the lack of familiarity with the project. Of interest is the average distance by type of mission. Less than 5% of all missions involved flight distances falling in the 50 to

80 mile range. Inter-hospital transfers generally involved flight distances in excess of 80 miles. The average distance flown during inter-hospital transfers was 107.67 miles as compared to only 30.63 miles for traffic accidents and other medical emergencies.

The flight speed of the helicopters varied with the type of mission being flown. Since traffic accidents and other medical emergency flights were generally of short duration, the portion of the time spent in steady level flight was less, in relation to the total flight time, than that of the longer inter-hospital transfer missions. As a result, the average flight speed of the three helicopters was only 83.56 miles per hour for traffic accidents and other medical emergency missions as compared to an average speed of 94.73 miles per hour for inter-hospital transfers.

Summarized in the report are recommendations for improvements to the configuration of the FH-1100 as used in this project. Some of the problems which were encountered were with the communication system, litters, and cabin space. Additional findings of this project which are relative to any study of the helicopter as an emergency ambulance are listed below:

- The results of a study made among 61% of the CARE-SOM participating hospitals reveal that an estimated average of 26 minutes was saved in getting an emergency case under the care of a physician as a result of having radio communications with the ambulances (surface). Only 7% of the hospitals in Mississippi have a doctor on the premises on a 24-hour basis.

- The highest frequency of missions flown by the Project CARE-SOM helicopters to traffic accidents and other medical emergencies were within a distance of 25 miles from the location of the helicopter base of operations, but the effective range of the helicopter is best determined from the Time-Response Contour Map.

- The helicopter speed advantage over ground units was most effectively utilized for inter-hospital transfer missions of approximately 80 miles distance or greater.

- Helicopters were effective in responding to non-traffic related emergencies in areas removed from public roads or highways.

- The time saving of the helicopter (FH-1100) over a ground ambulance can be predicted from the equation:

$$th = 6.68 + 0.23d$$ where

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

th = time savings of the helicopter over a ground ambulance in minutes.

It was the conclusion of the CARE-SOM Extension project team that a statewide, State-funded helicopter ambulance system operating under a State agency will provide a more efficient operating system than would a system of autonomous locally-operated units within a State. The statewide system would be a dual-purpose system. The primary purpose would be that of emergency medical services; the secondary function would be police traffic services. The advantages of this type of system from the standpoint of costs and management are many. Cost savings would accrue from the elimination of duplicative management. Economies in the purchase of items ranging from aircraft, fuel and parts to office supply items could be affected. Centralized parts depots and maintenance shops could be established. The use of standardized equipment and procedures would improve operational efficiency and effect cost reductions.

Further conclusions from the CARE-SOM Extension reported were that emergency medical services are increasingly becoming a function of the public rather than the private sector, and all people of the State would receive a more effective service at a lower cost, by the use of strategically located, State-operated, helicopter ambulances. One of the most important advantages of a State-operated system is the ability to utilize the helicopter more fully. As an ambulance serving the civilian populace the helicopter is an extremely expensive method of transporting patients because of its low utilization rate and relatively high operating costs, fixed costs especially. The saving of human lives by the prevention of accidents is as important, and likely less costly in economic terms alone, as the saving of lives after injury has occurred. Helicopters have proven to be effective in police traffic services activities. In the event of a natural or man-made disaster, several helicopters could be more effectively utilized if they are part of a State-operated system under one manager.

The report recommended that full-time medical attendants be utilized in an ongoing State-operated system. Inasmuch as a dual-purpose system is recommended, it was recommended that the medical attendants be members of the Highway Patrol. These individuals would be selected from among volunteers from the Patrol and would be permanently assigned to the air rescue service. They would receive additional medical training, and would receive pay commensurate with their added training and specialized duties.

Rapid and reliable communications capabilities are an absolute requisite if the potentialities and advantages of helicopter ambulances are to be realized. The greater the number of functions required of the helicopter, the more versatile the radio communications equipment must be.

In summary, the report stated that a State-operated helicopter system offers many advantages over autonomous helicopter ambulance districts. The helicopters can be utilized more efficiently, can provide highway safety services without disruption of medical service capabilities, and can be meshed into a State disaster plan more readily.

A complete plan for a Mississippi Statewide helicopter ambulance and police service is presented in the CARE-SOM Extension final report. This plan includes organization, job descriptions, equipment, operating procedures, budget, and report system.

The foregoing demonstration projects have shown that helicopters can be used as an emergency ambulance in a civilian emergency medical system. Certain truths have been established that should be recognized by any planner in considering the helicopter as an emergency ambulance vehicle:

- That the helicopter can rapidly deliver, to the scene of an injury or illness, an emergency medical technician who can evaluate the degree of danger to the victim and provide emergency medical care at the scene.

- That the helicopter emergency ambulance can transport a patient rapidly from point to point with an emergency medical technician to provide enroute emergency medical care as required.

- That the helicopter can provide rapid transportation of personnel, blood, drugs, or other material requirements to the place of emergency need from the place of supply.

- That the helicopter can provide the above services to some geographic areas not accessible to the ground vehicles.

- That there are some times and places where the helicopter has no advantage over the ground ambulance for response to the scene of an accident or illness.
- That there are other times and places where the helicopter has no advantage over the ground ambulance for response to inter-hospital patient transfer.
- That the above times and places should initially be identified during the planning stage of a proposed helicopter emergency ambulance service.
- That there are certain categories of injury or illness where the patient's condition will receive no additional benefit from helicopter use.
- That the use of the helicopter as an emergency ambulance can provide medical advantage in only a small percentage of the total number of sick or injured in any given operating area.
- That the helicopter emergency ambulance must be known to and accepted by all other elements of the emergency medical service as having a proper role and place in the system before it can function effectively.
- That communications can greatly affect the time from dispatch to treatment in both ground and helicopter emergency ambulance response, and that inadequate communications can negate the potential time advantage of the helicopter.
- That the more economical ground ambulance, if available, should be used when no apparent benefit to the patient will be realized by use of the helicopter.
- That needless expense can be incurred by the helicopter ambulance service when some form of control or other deterrent to misuse is not available.
- That funds on the order of $200,000 to $250,000 per year, per helicopter should be available to start a proper, continuously available emergency helicopter ambulance service utilizing the 3,000 lb. class jet helicopter (FH-1100 or Bell Jet Ranger). Savings from this amount can be realized by fleet type operations, shared personnel and facilities, and other favorable factors which may be available in certain operating areas.

- That each potential operating area for a helicopter emergency ambulance service is unique unto itself and plans for each area must recognize the various conditions existing in each area.
- That the benefits to a patient which may be derived by utilization of the helicopter emergency ambulance are difficult to measure (a problem common to most elements of emergency medical service) and that there is no common standard against which to measure these benefits.
- That there are certain equipment criteria and personnel proficiency standards which will increase apparent benefits to a patient and increase the effectiveness of the helicopter as an emergency ambulance.
- That the helicopter can be a useful supplement to an emergency medical service system, but is not a cure for all problems and will not replace proper planning, equipping, training and staffing of other elements of the system.

There appears to be three needs remaining to be resolved, other than funding, before the true benefits of the helicopter as an emergency ambulance can be realized. Each of these needs is interdependent upon the others and an attempt should be made to resolve each in the order listed below:

- A need to evaluate the possible additional benefits which can be accrued to a patient by use of a helicopter emergency ambulance over the ground ambulance.
- A need to establish a minimum criteria for the helicopter emergency ambulance vehicle and a minimum performance proficiency level for the assigned crew in order to achieve the most feasible and desirable of the benefits established above. It may also be desirable to establish a maximum equipment criteria and personnel proficiency level above which no significant additional benefits would be derived.
- A need to regulate the helicopter emergency ambulance service to assure a standard which will make these possible benefits available in any service offered.

It will not be necessary to fund additional complete demonstration projects in order to evaluate the results of studies of the foregoing needs. Existing helicopter emergency ambulance services can be utilized to make the evaluation.

At the present time it does not seem wise to invest in a helicopter emergency ambulance element to an emergency medical service system until all other elements of the system are complete and operating effectively. An inefficient and fragmented emergency medical service system will result in an inefficient helicopter ambulance service which will be extremely expensive for the limited benefits derived. Expenditure of a large portion of available emergency medical service funds for a helicopter operation will restrict the proper development of other elements of the service. However, a helicopter operation which is presently justified and operating outside of an existing emergency medical service system may be compatible with and augment the existing emergency medical service system with relatively small additional cost. Continued improvement of other elements of the system would still be financially possible and such improvements would increase the benefits derived from these multiple-use helicopters.

One test program to augment the civilian emergency medical service with helicopters and crews presently justified and operating for other purposes is the MAST test program which began in July 1970.

Military Assistance to Safety and Traffic (MAST) [11]

Military Assistance to Safety and Traffic is a program of utilizing military helicopters and medical corpsmen as an adjunct to the existing local emergency medical service system for the purpose of providing assistance to civilian victims of traffic accidents and other medical emergencies. Existing equipment and personnel from active duty Army and Air Force units are involved. These military personnel work in cooperation with local health care providers and law enforcement officials according to a locally developed plan between the civilian and military communities. No personnel or equipment are transferred solely for the purpose of MAST support. The program is sponsored by six government agencies forming the MAST Interagency Executive Group, with administration assigned to the MAST Interagency Coordinating Committee. This committee is comprised of representatives from the Departments of Defense, Transportation, and Health, Education and Welfare.

MAST projects were initiated during the test program and are continuing operations at San Antonio, Texas; Colorado Springs, Colorado; Seattle - Tacoma, Washington;

[11] *MAST, report of test program,* Interagency Study Group, July-December 1970, GPO Stock NR. 1727-0030.

Phoenix, Arizona; and Mountain Home, Idaho. This program attempts to provide better care in medical emergencies by transportation of medical specialists and equipment to the emergency scene; transporting patients from the scene of the emergency to the appropriate medical facility; and inter-hospital transfer of critical patients where ground ambulance transportation is not available, or air transportation is in the best interest of the patient. In the first six months of the program test, 182 missions were flown, 249 patients were carried, and 290 hours were flown. Of these patients, 115 were emergency site pick-ups and 134 were inter-hospital transfers.

As of June 30, 1972, MAST has completed 1,165 missions, carried 1,433 patients, and logged 2,494 hours flight time at the five sites. Costs are being covered by funds already available for operations and training. No special funds have been allocated, nor have existing funds been reapportioned. No charge has been made for any assistance provided.

Originally, Reserve and National Guard units, as well as active duty military units, were studied to determine the possibility of their use. Many problems, as yet not resolved, were encountered in planning their use. It was decided early in the study to restrict the test program to only regular active duty military units. During the test period it was learned that certain types of military units could engage in the MAST program with no degrading impact on either unit training or operations, and by their very nature provide realistic training experience and motivation. These units were identified as U.S. Army Medical Units (Air Ambulance) and U.S. Air Force Recovery and Rescue Units (Local Base Rescue). Army tactical units were found to be able to support a MAST project, but could do so at the expense of their other training and operational programs.

Although the Army's UH-1 and the Air Force's H-43 helicopters were well-equipped for their military mission, the one predominant problem in their use in civilian emergency medical service was the lack of radio communication. Where civilian radio capability did exist, military equipment was not compatible.

During the test program, it was attempted to establish radio communications by use of portable radios in the helicopters on public service frequencies. Several difficulties were encountered:

- Various public safety organizations in each operating area utilized different frequencies on any one of three

available bands. A different radio would be required for each of the bands utilized and each radio is normally limited to one or two preset frequencies in that band. An emergency medical communication system is needed in each operating area which would require the helicopter to have only one additional radio with one or two frequencies on the same band similar to the system described in project CARE-SOM.

- The portable radios utilized were not integrated into the helicopter's normal communication system which utilizes headphones and microphone integral with the crewman's helmet. Use of the portable radio required the pilot or crewman to remove his helmet and be isolated from the interphone system of the helicopter. The safety and efficiency of the helicopter and crew is compromised by the arrangement.

- The portable radios used an antenna attached to the radio. With the antenna being inside of the helicopter, the performance of the radio was reduced. A remote, outside mounted antenna would improve the performance of the radio.

Following the evaluation of the MAST test program, a decision was made to continue the five test sites in operation and to plan for expansion to other sites where Army Aero-medical units and Air Force Local Base Rescue units were located, and where the surrounding civilian communities expressed a desire to receive MAST support. MAST is not intended to compete with any existing or planned emergency air ambulance service, but may be utilized to augment such a service. As with other helicopter emergency ambulance projects, the benefits to be received will be relative to the effectiveness of the civilian emergency medical service which the MAST project supports. The emergency medical service which MAST will support is expected to provide the military unit with radio communication equipment compatible with its own emergency medical service communication system, and to provide heliports or helistops at its hospitals designated to receive MAST patients.

Activation of additional MAST projects where planning is complete is awaiting congressional sanction of the MAST concept. After additional experience is gained at those sites where additional funding is not required, thought can be given to utilizing other military resources to assist the civilian emergency medical services.

In brief summary, the helicopter is not any more ready to completely replace the ground ambulance in emergency medical service than the helicopter air taxi is ready to completely replace the ground taxi. It does not take any great effort or management skill to buy or lease a helicopter, hire a pilot and start flying over the countryside. Add a litter and it could be called a helicopter ambulance. Hire another pilot or two and it can be ready to fly at any time, day or night. You still do not have an effective helicopter emergency ambulance, and will not have one until you utilize a **proper helicopter** with the **proper equipment** and man it with a **pilot and attendant** who maintain a **desired level of proficiency** in flying and medical care. Your helicopter emergency ambulance may now be effective if its use is planned and coordinated with other effective elements of an emergency medical service system designed specifically for the area in which it is designated to operate.

Present policy of the National Highway Traffic Safety Administration is:

1. Beginning with FY 1973, the NHTSA will not approve Federal funding participation in new purchases of helicopters under Section 402. Similarly, the NHTSA will not approve applications for Federal funding of rented, leased, or contractor-provided helicopters or helicopter services.

2. NHTSA will contribute to the cost of maintenance and operation of helicopters previously leased or purchased under Section 402, but participation will be limited to those costs related to traffic safety operations.

3. New helicopter demonstration projects proposed for funding under Section 403 will not be approved unless the project involves field testing of new concepts or new types of equipment to prove their effectiveness in traffic safety programs. Each proposal will be justified and determined on a case-by-case basis.

Publications identified by NTIS/PB-(number) are available from:

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