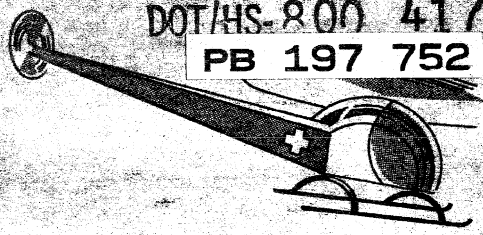
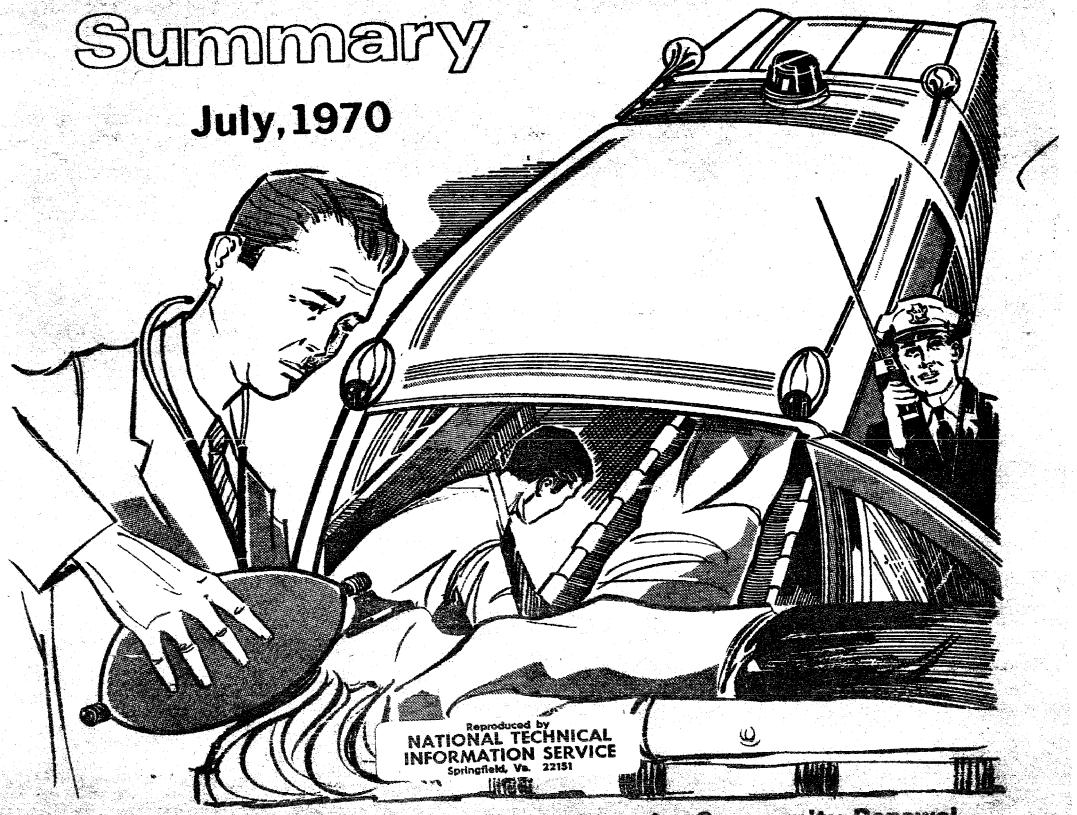
EMERGENCY MEDICAL SERVICES FOR AN URBAN AREA



Summary

July, 1970



City of Detroit : Mayor's Committee for Community Renewal
University of Michigan : Highway Safety Research Institute
Prepared for: U.S. Department of Transportation National Highway Safety Bureau Contract No. FH 11-6901

EMERGENCY MEDICAL SERVICES FOR AN URBAN AREA:
THE DETROIT DEMONSTRATION PROGRAM

SUMMARY

Prepared by

The Mayor's Committee for Community Renewal

and

The University of Michigan
Highway Safety Research Institute

for

U. S. Department of Transportation
National Highway Safety Bureau

Washington, D.C. 20591
Contract No. FH-11-6901

July 1970

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ALGER F. MALO
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September 28, 1970

Mr. Norman L. Miller
Executive Assistant
Room 1126, City-County Building
Detroit, Michigan 48226

Dear Mr. Miller:

Re: Detroit Emergency Medical Service Demonstration Project

We are pleased to submit this report describing the recent study of Detroit's public ambulance service. The report consists of two volumes: One is a summary while the other contains the complete details, methods and findings of the project.

The study was conducted under a grant from the United States Department of Transportation for the purpose of demonstrating and evaluating existing and alternative methods, including new techniques, of providing emergency medical services in an urban area. The project was carried out from July, 1968, to January, 1970, by a study group from the Community Renewal Program and the University of Michigan Highway Safety Research Institute.

The types of service demonstrated included the police and fire rescue squad emergency response system presently in use, a commercial service which provided data for both a private franchise service and a public ambulance corps as

alternatives to the present system, and a helicopter ambulance which supplemented the ground systems. Evaluation was based on the speed of service, the quality of treatment, and the costs of each of the methods.

At the start of the study, our committee was established to serve in an advisory capacity to the project staff. The committee is composed of representatives of a number of City departments and other agencies involved in transportation, health and public safety.

It is the intent of the study and this report that the project findings be shared nationally with other municipalities seeking to review and improve their emergency medical services. However, our committee has also reviewed these findings and conclusions for their application to planning improvements in Detroit's service and in bringing our public ambulance system into conformity with the ambulance operating standards of the Michigan Ambulance Act (P.A. 258 (1968)).

Our committee unanimously endorses a number of specific recommendations for Detroit which follows the list of project findings contained in the front of both the project Summary and the Report.

The major recommendation made is that the responsibility for the entire public emergency ambulance service be transferred to the Detroit Fire Department.

It is our belief that implementation of these recommendations will result in a more effective and efficient service for the citizens of Detroit.

Very truly yours,

A. F. Malo

A. F. Malo, Chairman
Advisory Committee
Emergency Medical Demonstration
Project

AFM:hm

ACKNOWLEDGMENTS

The Mayor's Committee for Community Renewal of the City of Detroit and the Highway Safety Research Institute of the University of Michigan wish to acknowledge with sincere appreciation the many organizations and individuals who contributed to this study.

The primary ambulance data was provided by the police officers and Fire Rescue Squads which operated in the four police precincts utilized for the demonstration. We wish to express our appreciation to these officers and firefighters, to precinct Inspectors, Eugene Ziolkowski, Odson Tetreault, Russell Gallaway, and Arnold Kleiner, and to Deputy Fire Chief Joseph Deneweth.

Background information, public ambulance system demand data and operational control of the police, helicopter and commercial ambulance field units was provided by the Communication Center of the Technical Service Division of the Detroit Police Department. Inspector Edward Walsh and Lieutenant Frank Staskon assisted in the operational planning and provided liaison and coordination with the Police Department.

Special mention must be given to Sergeant Art Dunchuck of the Police Communications Technical Division who designed and constructed the communications system for the helicopter, and to Patrolman Ray McClosky of the Motor Traffic Bureau who was the police observer on the helicopter.

Popular involvement in the emergency medical reporting process was made possible by participation of the Community Radio Watch, Michigan Consolidated Gas Co., General Electric, Checker Cab Co., Instant Communications and Detroit Edison. Similar contributions were made by the Detroit Street Railways and the Department of Streets and Traffic of the City of Detroit.

Special acknowledgment must be given to the project medical consultants, Dr. Charles Lucas of the School of Medicine, Wayne State University, and Dr. Stephan Fromm, formerly of the same institution. They developed and directed training programs, supervised the acquisition of medical data, and provided assistance and consultation on the medical phase of the program.

We are also grateful to the Wayne County Medical Society which donated space for the training program.

Invaluable assistance was also provided by Dr. Polibio Dilone, M.D., Saratoga General Hospital, Dr. Frank L. Donar, O.D., Martin Place West Hospital, Dr. Hildo Fiori, M.D., St. John Hospital, Dr. Edward G. Forgrave, M.D., Mt. Carmel Mercy Hospital, and Dr. Maurice A. Richards, M.D., St. Joseph Mercy Hospital.

Thanks must also be given to the many people of the emergency rooms of these and other hospitals who contributed their services.

TABLE OF CONTENTS

SUMMARY

Page

LETTER OF TRANSMITTAL..... v

ACKNOWLEDGMENTS..... vii

MAIN FINDINGS AND CONCLUSIONS..... xi

RECOMMENDATIONS FOR DETROIT.....xiii

INTRODUCTION..... 1

CHAPTER:

I. The Demonstration Project..... 3

II. Medical Emergency Occurrence Process and Demand..... 7

III. Medical Emergency Detection and Reporting..... 13

IV. Medical Emergency Service Process..... 17

V. Treatment and Training..... 21

VI. Allocation and Distribution of Recovery Vehicles..... 27

VII. Cost Analysis..... 33

VIII. The Helicopter Ambulance..... 43

FIGURES:

1. Empirical Distribution Function of the Time Between Ambulance Calls..... 9
2. Types of Medical Emergencies..... 9
3. Response and Transport Times..... 45
4. Service Times and Costs..... 45

TABLES:

1. Victim Disposition by Hospital..... 10
2. Mean Service Times and Distances..... 19
3. Factors Analyzed for Possible Effects on Service Time Variations..... 19
4. Diagnosis Evaluation..... 23
5. Percent of Cases--Treatment Attempted Consistent with Physicians Opinion..... 24
6. Ambulance Availability as a Function of Allocation Policy..... 28
7. Ambulance Availability as a Function of Distribution--Two Vehicles per Precinct..... 29
8. Dual Purpose Vehicle Availability as a Function of Allocation Policy..... 30
9. System Comparison: Operational Characteristics..... 35
10. System Cost Comparison Summary..... 37

MAIN FINDINGS AND CONCLUSIONS

Findings:

1. As few as 17 percent of the emergency responses made by public ambulances were for true medical emergencies, using a definition established by the study team.

2. For the ground ambulance systems studied, the mean time from dispatch of the ambulance to arrival at the scene was less than five minutes--and 90 percent were accomplished within eight minutes.

3. For the various ground ambulance systems studied the time from dispatch to hospital arrival for police, commercial and fire systems averaged 17.5, 14.3 and 13.1 minutes respectively.

4. The study of the effects of mobile radios on notification times were inconclusive. Simulation analysis suggests that one-fifth of all vehicles would need to be radio equipped in order to reduce the mean notification time by one minute.

5. Ambulance personnel who were responsible for only emergency medical care at the scene (fire and commercial systems) provided appropriate treatment more frequently than the police.

6. Although the frequency with which the police provided appropriate treatment was unchanged by additional training, it is suspected that this was due to the number of additional functions they are required to perform at the scene.

7. The distribution of ambulances within a service area can affect response times. However, there is little difference in the times achieved by a uniform distribution policy versus one which places the ambulances in high demand areas.

8. A helicopter ambulance can effectively execute medical evacuations in an urban area. The opportunities for landing were greatest on freeways and major thoroughfares and decreased sharply in residential areas.

9. The greater speed of the helicopter was offset by the shorter distances traveled by the ground ambulances, both to the scene and to the hospital.

Conclusions:

1. Because emergency responses in an urban area are relatively fast, it would be difficult to further reduce response times significantly. Further, the small differences in response times had no medical significance that could be demonstrated.

2. The data suggest that, given comparable training and equipment, the quality of treatment can be duplicated by dual function personnel provided that their activities at the scene are limited to emergency medical care. Policemen were not as effective as the firemen and commercial ambulance personnel because they had to perform other duties in addition to those of emergency medical care at the scene.

3. There was no significant improvement in the condition of the victim or in service time by using a municipal helicopter ambulance. The increased cost of an exclusive helicopter service was not justified.

RECOMMENDATIONS FOR IMPROVING EMERGENCY MEDICAL SERVICES IN THE CITY OF DETROIT

The Advisory Committee on the Detroit Emergency Medical Demonstration Project makes the following recommendations for emergency medical services in the City of Detroit:

MAJOR RECOMMENDATION

It is recommended that immediate action be taken to transfer the entire public emergency ambulance service to the Detroit Fire Department. This will establish an organizational alignment within which the standards of the Michigan Ambulance Act, the Project findings and other future improvements in emergency medical service can be readily implemented.

OPERATIONAL RECOMMENDATIONS

Reduction of Service Load

1. The change in the ambulance system should focus public attention on emergency medical service. At that time a continuing public information program should be instituted to emphasize the purpose of the service, the need for rapid but concise reporting and the desirability of limiting requests only to true emergency situations.

2. Although only 17 percent of Detroit's public ambulance dispatches may be for true medical emergencies, reduction in non-emergency runs should be sought through consistent application of the present screening policy and the acquisition of more complete information at the screening center rather than through the adoption of restrictive policies.

Communications

1. The advantages of a single emergency reporting number can be achieved by assigning the responsibility for receiving and screening all requests for emergency medical assistance to the Police IMPACT Center.

2. The responsibility for the selection, dispatch and coordination of the proposed ambulances should be placed in the Fire Department.

3. A communications link (e.g., electrowriter or phone) for the reliable transfer of information between the IMPACT center and the fire dispatch center should be established. This system should have the capability of recording the complete notification, screening, information transfer and dispatch process.

4. The proposed ambulances should be equipped with mobile radios having the additional capability of direct communication with existing police and hospital radio frequencies.

Service Policies

1. Compliance with requests for transport to specific hospitals should be limited to those that do not require travel significantly further than that to the nearest class "A" hospital.

2. Ambulance service times should be regularly monitored to insure maximum availability for further assignments.

Ambulance Type, Number and Placement

1. Full-sized, equipped ambulances should be utilized for this service rather than the presently operated station wagons or rescue trucks. (See Note, next page.)

2. A minimum of twenty-two ambulances should be continuously operated by the Fire Department in order to provide an adequate level of availability for response to medical emergencies. An additional four vehicles should be held in reserve to allow for routine maintenance and repair.

3. The ambulances should be distributed uniformly throughout the city at separate engine company stations. Relocation should be permitted to meet shifting fire and ambulance service demands.

4. Records of the times and dates of occurrence, the locations and types of incidents and the ambulance service time intervals should be maintained and the dynamics of the demand and service processes should be regularly analyzed and evaluated.

Personnel Training and Assignment

1. Fire personnel detailed to the ambulances should serve interchangeably as ambulance attendants and firefighters.

2. A regular in-service training program should be instituted for all personnel detailed to the ambulance function. The training program should meet the requirements of the Michigan Ambulance Act with additional training in the use of all equipment carried. (See Note, below.)

3. Since police officers will frequently arrive first at emergency scenes, the present police first-aid and review training programs should be continued.

Helicopter Operations

1. If Detroit should acquire a helicopter for general municipal service, consideration should be given to equipping the craft to perform ambulance functions.

NOTE: In order to assist communities in upgrading their emergency medical services, other studies prepared for the National Highway Safety Bureau have described optimal specifications for ambulance vehicles and equipment and have defined guidelines for ambulance attendant training.
AMBULANCE VEHICLES AND EQUIPMENT: Desirable specifications have been developed by the National Academy of Engineering. These appear in Ambulance Design Criteria, PB 185-106, National Academy of Engineering, Washington, D.C., June 30, 1969.
ATTENDANT TRAINING: A course entitled Basic Training Program For Emergency Medical Technician--Ambulance, has been developed by Dunlap & Associates, Inc. Materials for the course are contained in three documents, "Concepts and Recommendations," "Course Guide and Course Coordinator Orientation Program" and "Instructor's Lesson Plans," National Highway Safety Bureau, U.S. Department of Transportation, October 1969.

INTRODUCTION

Early in 1968, concurrent with state legislation adopting new ambulance operations standards, City of Detroit officials and the University of Michigan Highway Safety Research Institute submitted a joint proposal for an emergency-medical-services demonstration grant to the United States Department of Transportation. A grant of $360,222 was approved. The Demonstration Project afforded the City an opportunity 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. The experience gained is being shared nationally.

CHAPTER I

THE DEMONSTRATION PROJECT

The ambulance systems studied were (1) the Police Department, (2) the Fire Department, (3) a contracted commercial service and (4) a helicopter ambulance.

The Police Department's response system can be characterized as 80 to 120 station wagons operating as patrol vehicles and capable of a rapid response. These dual-purpose station wagons are assigned to police precincts. Medical equipment in them consists of two cots, and blankets when available. The training level of the patrolmen is that received at the police training academy. For the project, two additional first-aid training programs were instituted to provide additional levels for analysis.

The Fire Department's seven rescue squads provide emergency medical service across the city in addition to their fire fighting duties. The seven squads primarily respond in instances of heart attacks, strokes, respiratory difficulty and extrication. Squad trucks are staffed by five firemen and carry a full complement of extrication and oxygen equipment, cots, blankets and a very few other first aid items. The training level of rescue squad firemen is initially similar to that of the patrolmen, with emphasis on resuscitative measures. However, because of more intensive on-the-job experience and a regular retraining program, the rescue-squad level of training exceeds that of the patrolmen.

The third system consisted of two fully equipped commercial ambulances operated in response to public calls in order to compare a single-purpose service to the existing dual-purpose systems. It was intended that the training level and treatment potential of the professional attendants be compared to that of patrolmen and firemen.

The fourth system demonstrated was experimental--a helicopter ambulance. The ambulance-equipped helicopter was operated to test its feasibility in augmenting ground ambulances and to compare service times and costs. The helicopter attendant was a highly trained paramedic.

In order to study service time and treatment characteristics of

the ground ambulance systems, four police precincts representing different socio-economic areas of the city were selected. The cooperation of major hospitals in these areas was established so that victims transported during the demonstration could be evaluated by emergency-room physicians and a special medical team. Three one-month data gathering periods were designated for various seasons of the year. Over 2,600 victims were conveyed during the study.

The air ambulance was operated city-wide four hours a day for six months. The helicopter crew was dispatched by the police department. Twenty-three successful medical missions were completed.

REPORT STRUCTURE

The structure of the summary is:

The Emergency Occurrence Process. The study of the frequency of emergencies and the types of injuries--traffic and non-traffic.

The Detection and Reporting Process. Who reports emergencies, and how. Time-delay estimates for this process were developed and the potential time reducing effect of citizen-band radio is explored.

The Service Process. The definition, description, and data analysis of the parts of the service process.

One response mode demonstrated was the existing dual-purpose police service: regular police patrol and ambulance service. The primary characteristic of the police service process is the believed rapid response of a relatively large pool of patrolling vehicles covering a relatively small geographic area. Supplemental training and equipment were provided a selected group of patrolmen to provide two test variations for this response mode.

The operation conducted by firemen serving on rescue-squad trucks was also studied: The service process characteristics here were influenced by a small number of well equipped trucks each staffed by five firefighters who provide service to a medically select group of victims over larger-than-precinct areas.

The commercial ambulance response mode was contracted to provide emergency medical responses in two of the demonstration precincts, and the attendants were dispatched on public emergency calls through the city's communication system. The service process of

the commercial system was characterized by single-function attendants responsible for the single purpose of emergency care.

The helicopter ambulance was also contracted to test the operational feasibility and value of this city-wide response mode in an urban environment.[1]

Treatment and Training. The treatment and training levels demonstrated by the attendants of the various ambulance service modes were examined. Five levels of training are represented.

Recovery Vehicles. The number and placement of recovery vehicles required for a precinct was studied. Several alternative operating policies were investigated to determine the resultant vehicle availability and response. The total number of vehicles required for the entire city was extrapolated from these findings.

The various emergency systems were measured in terms of the time required for service and the treatment provided. Based on the cost effectiveness of each system presented in Chapter VII, and the requirements for emergency medical recovery in the city, final recommendations for improving ambulance service in Detroit are made.

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[1]The helicopter demonstration, considered a separate experiment, is analyzed in the last chapter of this volume.

CHAPTER II

MEDICAL EMERGENCY OCCURRENCE PROCESS AND DEMAND

THE INTENSITY OF THE OCCURRENCE PROCESS

The times and locations of emergency incidents in an urban area clearly cannot be predicted with certainty. An analysis of the process was undertaken using two one-month samples, one from Precinct 7 and the other from Precinct 15. Both samples included all events in those precincts which were perceived to be medical emergencies by the operators in the police IMPACT center, where most of the requests for emergency medical service are received and screened. The demand or load data collected, then, are measurements taken after screening and are not measurements of all calls received for emergency assistance.

The data was examined for the presence of cyclical variations in the rate of event occurrence. Several statistical tests failed to indicate any significant hourly, daily or weekly components.[2]

Other analyses were conducted to examine the distribution of the times between ambulance calls. Statistical analysis revealed that the variability of the process is slightly greater than that for a truly random sequence, indicating that the events tend to cluster more frequently.

For example, the mean times between ambulance calls within precincts 7 and 15 were 98 and 101 minutes respectively. Since the variances are similar and the mean times between calls differ by only 3 percent, the processes in both precincts can be approximated

[2]A third sample, composed of all emergency medical dispatches made in the entire city during one week, did indicate the presence of a marked daily cycle. This apparent inconsistency in cyclical characteristics cannot be explained except as a possible consequence of using a sample period of insufficient length.

by the single smoothed cumulative distribution function presented in Figure 1. By the use of this figure, the probability that the time between ambulance calls will be within certain limits can be determined.

While the mean times between ambulance calls is about 100 minutes, it is important to recognize that 50 percent of all calls in both precincts will occur within approximately 56 minutes of each other (dotted lines on figure). The distribution of the time between calls is important in determining the proper number or allocation of recovery vehicles to be operated in the ambulance system. This will be discussed later.

THE OCCURRENCE PROCESS BY TYPE OF EMERGENCY AND LOCATION

Information on types of medical emergencies and locations of the incidents also was collected during the project. During April and August data periods, ambulance attendant check sheets were collected on 1,437 victims. As indicated in Figure 2, almost a third were victims of traffic accidents, a third were injured in non-traffic incidents and slightly over a third were victims of acute illness and other non-traumatic processes.

Of medical emergencies not associated with traffic accidents, 65 percent occurred in the victim's home, 22 percent in a public place and 2.5 percent in an industrial place, with the remaining 10.5 percent occurring in miscellaneous locations.

MEDICAL DISPOSITION

Disposition of emergency cases made by hospital emergency rooms is meaningful to an understanding of the ambulance system. During the April and August data periods, emergency room information sheets were collected for 1,674 victims. Dispositions made by the hospitals are reported in Table 1, and show that over half the individuals conveyed are not seriously injured.

SERVICE DEMAND CHARACTERISTICS

Although data available from this project are limited in time and geography, it is possible to make cautious extrapolations to the entire city and to other urban areas.

FIGURE - 1

EMPIRICAL DISTRIBUTION FUNCTION
OF THE TIME BETWEEN AMBULANCE CALLS

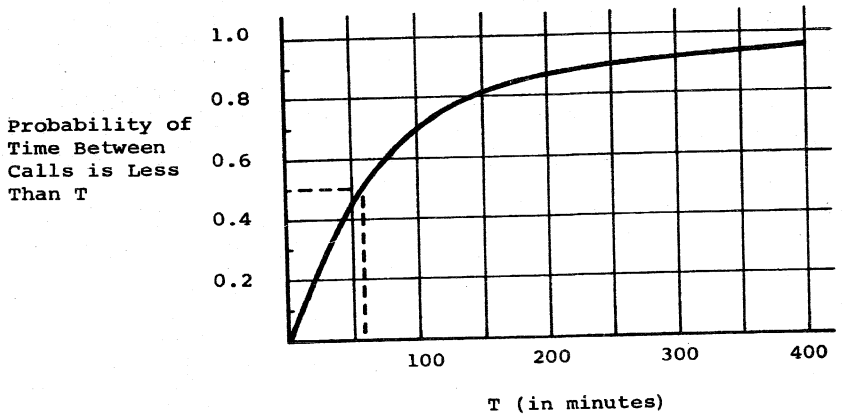

FIGURE - 2

TYPES OF MEDICAL EMERGENCIES

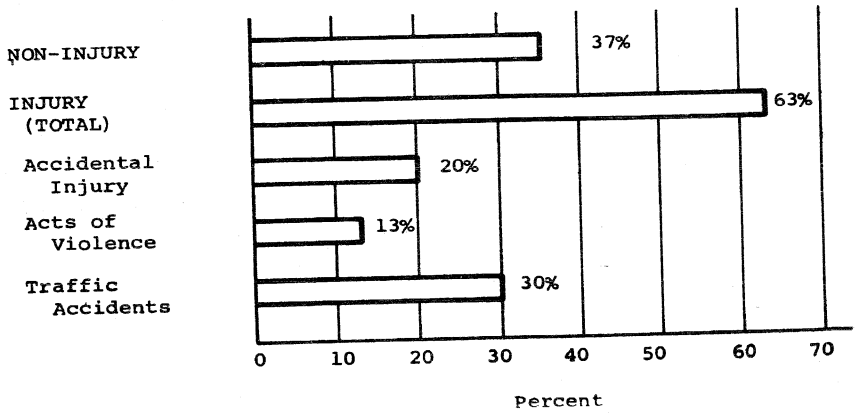

TABLE 1

VICTIM DISPOSITION BY HOSPITAL

In Percent

DISPOSITION	TRAFFIC VICTIMS	ALL VICTIMS
Dead on Arrival at Hospital	1.2	4.7
Expired in Hospital	0.6	1.5
Admitted	22.5	27.0
Treated and Released	67.8	59.4
No Treatment Provided	1.7	4.0
Other	6.2	3.4
	100.0	100.0

Investigation of the dispatches made in the four test precincts in April revealed that no assistance was required for 32.5 percent of the responses made. This closely approximates the percent of no-assistance calls experienced by the Fire Department in 1967 and in 1968.

In addition to the large number of runs made for which no assistance is required, it also appeared that many of the persons conveyed to a hospital were not true emergency cases and could have been moved to a hospital by ordinary means. Determination of the exact number of cases which were true emergencies was not possible. However, it is possible to make an estimate by defining them as those cases which received treatment at the hospital and for which the physician indicated a requirement for speed on the emergency room check sheet. According to this definition, it would be concluded that only 24.6 percent of the victims conveyed, or 17 percent of the dispatches made, actually require emergency response.

The estimate suggests that the system demand could be modified substantially if some reliable means could be found to improve the identification of the true emergencies at the time of notification.

Despite the great potential benefits of accurate identification, the task is difficult. Defining a true emergency is complex. It has been defined as a human condition in which the preservation

of life or the avoidance of permanent disability depends on the rapidity with which appropriate treatment is rendered. Restriction of response to only that type of incident would be difficult--and such a policy might be overly restrictive. Such cases often cannot be recognized by persons who detect the incident and who are relied upon to request assistance. Recognition is difficult even for ambulance attendants, despite their training and experience. Furthermore, the reduction of temporary disability and pain, or even the relief of anxiety may justify an emergency response, despite the resultant increase in the system load. The more general problem would seem to be clarification of the responsibility or mandate of political jurisdictions for public-supported response to problems that can only be managed by medical care.

CHAPTER III

MEDICAL EMERGENCY DETECTION AND REPORTING

THE DETECTION AND REPORTING PROCESS

The time required for detecting an emergency and reporting it is no less important than the time required to travel to the scene or transport the victim to an emergency room--and may be much more vital. For example, preservation of life may be more dependent on the speed with which measures are taken by trained attendants at the scene to control severe hemorrhage or maintain an adequate airway, than speed in getting the victim to the emergency room.

The primary reporting channel is by telephone. In an examination of the Police Department's IMPACT Communications Center, pedestrians' phone calls reported 31 percent of the emergencies resulting from traffic accidents. Workers and residents in nearby buildings reported 38 percent. Thus, persons not involved in the incident accounted for 69 percent of the traffic accident notifications. Workers and residents also reported over 50 percent of the non-traffic emergencies. By contrast, motorists reported only 19 percent of the traffic accidents to which police responded.

Empirical measures of the total notification time (detection plus reporting delay) were obtained for traffic accidents by comparing recorded times of occurrence with the time of receipt of calls at the Police Department. The recorded times of occurrence proved to be somewhat unreliable. However, the data suggest that the mean notification time was approximately eight minutes.

Attempts to evaluate potential reduction in notification delay that might be possible with the availability of radio communication channels were inconclusive because of the lack of data collected. For example, although 113 notifications of possible medical emergencies by a citizens radio watch (CRW) were examined, only in six cases could the results be compared with other reporting sources.[3] The difficulty of collecting data on the

[3]Attempts at analyzing radio communication channels included three systems. The first was the Community Radio Watch which involved the operations of taxi cabs, public utility vehicles with

auxiliary radio reporting systems is inherent within the reporting and screening process; many calls from radio equipped vehicles do not include information on the existence of injuries (thereby assuring response) and the information is relayed through second parties so clarification or further interrogation by the police is impossible.

In the absence of a large amount of empirical data, an analytical model of the telephone system as augmented by a radio reporting system was developed.[4] Although not comprehensive, the model suggests that a large number of vehicles--possibly 20 percent of the vehicles on the road--would be required to reduce the mean notification time by one minute.

IMPLICATIONS FOR SYSTEM DESIGN

Attempts to reduce the detection and notification time should be directed to the general public, since people on the street and in nearby buildings reported most of the incidents.

Since these people must use the telephone, this channel should be the target for improvement. Two improvements are possible. The first is a single emergency number such as 911, and the second is a public education program on the importance of rapid response.

A single number would be difficult to establish in Detroit since many suburban communities share exchanges with the city. However, the present linked operation between the Police and Fire Departments approaches the single number concept; a call to police will elicit the appropriate response for any emergency, including fires.

A public education program designed to decrease notification time must be carefully planned if it is to be successful without stimulating an increased demand for unnecessary services. Recognition

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radios, and city buses--all having a dispatcher. The second was the City department of Streets and Traffic citizen band station involving their vehicles plus some citizens. The third was the Citizens Band Monitor Net which involved private groups patrolling areas of the city. All three systems report information in addition to medical emergencies.

[4]See Section 9-5 of the Report.

should be given to the fact that such a program also would provide the opportunity to reduce demand by reinforcing screening procedures in relation to a defined emergency response policy.

CHAPTER IV

MEDICAL EMERGENCY SERVICE PROCESS

The primary functions of the service process are transportation of the ill and injured, and initial treatment at the scene and in transit. The time elements of the service process are the subject of this chapter.

TYPES OF EMERGENCY SERVICE

During the demonstration, three modes of response were examined. Two were represented by the existing public response service (police and fire department operations) and the third (commercial ambulance) was introduced for the demonstration.

1. The police station wagons, which provide the major portion of the public ambulance service, respond from their patrol status. During the demonstration period, four to seven station wagons were normally operated in each precinct.

2. The Fire Department rescue squads also provide a portion of the public ambulance service, but they responded from fixed stations. Seven squads provided service within all 13 precincts.

3. During the demonstration, two commercial ambulances were dispatched to those emergencies normally handled by the police. Unlike the police station wagons, the commercial ambulances responded from fixed stations. Each ambulance was located at a separate base within the precinct serviced.

TIME ELEMENTS EXAMINED

The time elements investigated for each of the administrations were:

1. Dispatch delay (time from notification to actual dispatch),

2. Transit time to the scene,

3. Time at the scene,

4. Transit time to the hospital,

5. Time at the hospital.

The minimum time before the arrival of assistance is a function of the first two time elements of the service process. The first four elements determine the minimum time before arrival of the victim at a medical facility where he may receive necessary care. The sum of elements two through five is the total vehicle service time--the period of time that the vehicle is out of service or unavailable for response to other emergencies. As this duration affects vehicle availability, vehicle service time is an important consideration in determing the number of vehicles to be operated and their distribution. Vehicle allocation and distribution will be discussed further in Chapter VI.

Many factors which might influence the length of service times could not be experimentally controlled in the study, but the analyses do provide additional insights into factors which influence service times and are fundamental to sound systematic design.

The observed mean time elements and the mean transit distances of the service process are shown in Table 2.

The commercial ambulances were dispatched by the police in lieu of patrol station wagons. It is believed that the longer dispatch delay for commercial ambulance service is due to the occasional dispatch of a police unit to the scene first to verify the need for ambulance assistance rather than the lack of available ambulances.

One would expect transit times (to the scene and to the hospital) to be functionally related to the distance traveled. However, only 25 percent of the variations in times can be attributed to distance traveled. Remaining differences had to be attributed to other factors such as differences between administrations, treatment rendered at the scene, etc. A list of factors examined are shown in Table 3. Although a number of effects detected are discussed in detail in the Report, these effects were not great.

TABLE 2
MEAN SERVICE TIMES AND DISTANCES

	Administration		
	Police	Fire	Commercial
Mean Times in Minutes			
Dispatch Delay	2.7	--*	5.8
Time to Scene	4.7	4.2	4.2
Time on Scene	5.5	4.1	4.9
Time to Hospital	7.3	4.8	5.2
Time at Hospital	15.8	5.3	13.5
Total Vehicle Service Time	33.3	18.4	27.8
Mean Distances in Miles			
Distance to Scene	1.74	2.34	1.94
Distance to Hospital	3.08	2.56	2.69

*Dispatch delays for the Fire Department were not recorded.

TABLE 3
FACTORS ANALYZED FOR
POSSIBLE EFFECTS ON
SERVICE TIME VARIATIONS

Controllable Factors	Uncontrollable Factors
Type of Conveyance:	Traffic
Police	Weather
Fire	Other difficulties en route (mechanical, tires, etc.)
Commercial Ambulance	Type of emergency
Distance	a. Traffic vs. non-traffic
Use of Lights	b. Violent vs. non-violent
Use of Siren	Condition of Victim
Number of Treatments Rendered at Scene	
Choice of Hospital	

IMPLICATIONS FOR SYSTEM DESIGN

Several inferences can be drawn from the analysis of the service process:

1. An ambulance system with many multipurpose vehicles on patrol (police station wagons) does not seem to provide a substantially faster response in an urban area than a system with a few single-function, fixed-base recovery vehicles (fire department vehicles or commercial ambulances).

2. The transit time to the scene is not highly influenced by the use of sirens and lights or by random elements such as traffic and weather.

3. The time on the scene depends on the treatment provided but not on the apparent condition of the victim.

4. The time to the hospital is highly influenced by hospital choice.

5. The time out of service is highly variable, depending on system administration. Significant time reduction could probably be achieved by closer management of this interval.

Perhaps the most important finding in the analysis of the service process is the verification of the relatively short medical emergency service times in an urban area. The mean transit time from dispatch to the scene was less than five minutes for all three administrations--and 90 percent of the transit times were accomplished in eight minutes or less. In addition, the mean time from dispatch to arrival of the victim at the hospital varied from only 13 to 17 minutes.

These rapid time periods have significant implications with respect to victim condition and attendant training in an urban area which will be discussed in the next chapter. Additionally, these rapid service times may indicate that to accomplish any appreciable reductions in service time will be difficult.

CHAPTER V

TREATMENT AND TRAINING

The elements of emergency medical service discussed earlier were evaluated on the basis of time required for recovery of the victim. The remaining measure of system performance is the quality of treatment provided at the scene or en route to the hospital.

In the demonstration, the relationship of treatment, training and the importance of a single-function attendant (rather than a dual one) at the scene was developed by analyzing data on the various attendants' diagnostic capabilities and the treatment rendered and by assessing the value of higher attendant-treatment potentials.

LEVELS OF TRAINING

A total of five attendant-training levels were evaluated in the project. Three involved police officers and two represented Fire Department rescue squads and commercial attendants.

Police Training. The first level of police training was represented by the first-aid course given all cadets at the Police Academy. The second level was the Police Academy course supplemented by a five-hour review course for a group of patrolmen in one precinct. The review included updating of existing knowledge and familiarization with the equipment to be carried during the demonstration period. The third police level of training was represented by an 18-hour advanced course given to a number of patrolmen in two of the demonstration precincts. This course, taught by professors of surgery, emphasized the principles and practice of emergency care including mouth-to-mouth and cardiopulmonary resuscitation, and practice in the use of first-aid equipment which was added to the police ambulwagons.

Fire Rescue Squad Training. Rescue squad training was and is continuously updated by in-service review programs including advanced first-aid, practical knowledge and experience in the use of oxygen equipment, resuscitation measures and extrication equipment.

Commercial Ambulance Attendant Training. The commercial ambulance attendants employed were former military medical corpsmen whose

experience was supplemented by a 40-hour course. The course consisted of 35-hours on initial care and handling of the sick and injured and five hours of traffic-safety law.

Police officers in all three training levels shared one common feature--they were required to perform more than the treatment function at the scene such as crowd control and accident investigation. On the other hand, the Fire Department rescue squad team performed only the medical function at the scene as did the commercial attendants.

EVALUATION OF DIAGNOSES

To get additional insight into the types of service offered, diagnostic capability of the attendants was evaluated as well as the treatment provided.

The diagnoses were evaluated by comparison of the results on the ambulance check sheet prepared by ambulance attendants with those on corresponding emergency-room check sheets. Each diagnosis was graded on a scale of 1 through 8, according to the appropriateness of the attendant's diagnosis. Appropriate diagnoses include those that were the same as the physicians and those that were related to the physician's diagnosis and were indicative of the appropriate first-aid.

The result of the diagnosis evaluation is given in Table 4.

Only two of the units show statistically significant differences in performance--police who received the refresher course and the Fire Department rescue squads. Police who had attended the refresher course diagnosed significantly better than all other units, but no explanation based on course content can be given. The lower performance of the rescue squads may reflect differences in the nature of case load rather than valid differences in performance. Most of the medical emergencies referred to the Fire Department are non-injuries, and are more difficult to diagnose than the large number of obvious injuries encountered by the police.

TREATMENT EVALUATION

The second method of evaluating the effect of training on treatment was based on the information provided by the emergency-room physicians. For each victim, the physicians indicated whether or

TABLE 4
DIAGNOSIS EVALUATION

Ambulance Unit	Appropriate Diagnoses As a Percent
Police	
Academy	67%
Refresher	83
Advanced	67
Commercial Ambulance Service	72
Fire Rescue Squads	51*
Total	69%

*Fire rescue squads handled more non-injury cases which are harder to diagnose.

not treatment was needed, and was attempted, and if attempted, the success of the technique. This information was provided for the following first-aid measures: (1) use of a rigid backboard, (2) cardiopulmonary resuscitation, (3) control of severe hemorrhage, (4) splinting of long bones, and (5) guarantee of adequate respiration. A sixth treatment--control of light bleeding or simple bandaging--was considered during the evaluation since minor open wounds were encountered frequently.

A summary of the treatment measures by training level is provided in Table 5.

The commercial attendants controlled light bleeding much more frequently than other units (96 percent compared with less than 38 percent for other units). This is not a life saving measure but was encountered much more frequently than the more serious problems. For this reason the summary results also are given with this treatment excluded. Backboards and cardiopulmonary resuscitation were required and used less frequently than the other first-aid measures. Therefore the results given in Table 5

TABLE 5
PERCENT OF CASES
TREATMENT ATTEMPTED CONSISTENT
WITH PHYSICIANS OPINION

Unit	Control of Light Bleeding Included	Control of Light Bleeding Excluded
Police		
Academy	30%	42%
Refresher	28	50
Advanced	41	46
Commercial	84	73
Fire Rescue	79	85

are weighted with emphasis on control of hemorrhage, guarantee of respiration, and splinting.

Statistically significant differences do not exist between the three police units. Although the difference between the police with refresher training and the commercial attendants did not prove to be statistically significant, there was a significant difference between the police with academy and advanced training and the commercial attendants. Interpretation of the data representing the fire rescue squad training level cannot be made because of inadequate sample size. However, a strong treatment capability is indicated for the treatment measures of cardiopulmonary resuscitation and the administration of oxygen. It should be recognized that it is difficult to attach medical significance to these measures in relation to the training levels studied.

ASSESSMENT OF POTENTIAL

The third measure of treatment as related to training was provided by the emergency-room physicians in a subjective response to questions aimed at determining the adequacy of: (1) the present training levels (2) speed of service (3) the potential benefits of increasing the present training levels and (4) utilizing the paramedical techniques of endotracheal intubation and intravenous fluid therapy.

The data indicated that the American Red Cross First-Aid Training was an adequate training level for over half of the cases evaluated; a speedy arrival at the hospital (within 10 minutes of arrival at the scene) was important in less than a third of the cases. More highly trained paramedics would have eliminated the need for speed in transit in only 9 percent of the cases. The attendants' possible use of intravenous fluids and endotracheal intubation involved only a small fraction of the demonstration cases. Physicians indicated mixed opinions on the value of these measures in an urban environment with a rapid emergency response system.

The assessment of higher levels of training as it relates to treatment is the least conclusive indicator of the three reported.

IMPLICATIONS TO SYSTEM DESIGN

The examination of treatment of victims and training levels of attendants had the following conclusions of importance in designing an emergency medical system.

1. The single-function attendants provided appropriate treatment more reliably than the police officers, who had to perform more than the medical function at the scene, such as crowd control. In the context of the demonstration, both the Fire Department rescue squads and the commercial ambulance attendants were responsible for only the emergency medical care function at the scene.

2. With regard to diagnoses (which presumbably takes relatively little time) the police personnel did as well as their counterparts on the commercial ambulances and better (as a percent) than those men staffing the rescue squads. However, it should be recalled that the rescue squads deal with more non-injury cases which are much harder to diagnose.

CHAPTER VI

ALLOCATION AND DISTRIBUTION OF RECOVERY VEHICLES

A study of the effects of allocation (number of vehicles assigned to a service region) and distribution (placement of the vehicles within the service region) of recovery vehicles was not included in the preliminary project design. However, it became apparent that medical emergencies may and do occur when no police station wagons are available in the dual-purpose police ambulance system. It also was apparent that an experimental investigation of the number and placement of vehicles required would assist in planning a satisfactory service, if a new system was to be established in Detroit.

In response to these problems an allocation and distribution study was undertaken. The service region selected for the study was a police precinct. The results however can be applied to any community having service areas with comparable size and demand.

MEASURES OF ALLOCATION AND DISTRIBUTION

Two measures of effectiveness, vehicle availability and service time, were chosen to evaluate the effects of allocation and distribution policies. Vehicle availability is the probability that at least one vehicle is available to serve a call. Vehicle service time is the total length of time required to service a call. The only portion of the service time affected by allocation and distribution is the response time (the time from dispatch to arrival at the scene). Thus service time can be minimized by a distribution policy that maximizes the probability that the distance to the scene will be short. The most desirable qualities for an optimal system are a high level of vehicle availability and low response times.

Data from the project experiments were used to develop a mathematical model of single and dual-purpose victim-recovery systems. The model, based on queing theory, allows numerical evaluation of availability and service time, the selected measures of performance.

AVAILABILITY OF SINGLE-PURPOSE AMBULANCES

The availability of single-purpose vehicles as related to the number of vehicles in one precinct is summarized in Table 6.

TABLE 6
AMBULANCE AVAILABILITY AS A FUNCTION OF ALLOCATION POLICY
(Single-Purpose Operation)

Number of Vehicles In a Precinct	Probability of at Least One Vehicle Available
1	78.9%
2	97.7%
3	99.8%
4	100.0%

As the number of vehicles is increased from one to two, the availability increases by 18.8 percent. The addition of a third vehicle only increases the probability by 2.1 percent. If two ambulances are assigned to a precinct, at least one will be available approximately 98 percent of the time. Two such vehicles in a precinct represent a desirable operating condition; addition of a third vehicle results in only marginal improvement.

Given that the vehicles are single-purpose and operated from fixed based stations--in preference to a patrol operation--their availability is also a function of distribution. The availability effects of three possible distribution policies which bound the results for realistic choices is shown in Table 7.

The first policy places the vehicles in precinct sub areas--scout car territories--to achieve the greatest coverage in the areas of highest demand. The second policy places the vehicles in locations that provide uniform coverage, and the third places both

TABLE 7
AMBULANCE AVAILABILITY AS A FUNCTION OF DISTRIBUTION
--Two Vehicles Per Precinct--
(Single-Purpose Operation)

Distribution Policy	Probability of at Least One Vehicle Available
I - Areas of maximum demand	97.7%
II - Uniform coverage	97.6%
III - One location	97.5%

vehicles at the same location, one of high demand. Variations in the distribution of vehicles had little affect on the probability that at least one vehicle would be available. However, service time can be affected and these effects will be discussed under service times in this chapter.

AVAILABILITY OF DUAL-PURPOSE VEHICLES

In a dual-purpose system (the combined police-ambulance service) there will, from time-to-time, be a conflict between the ambulance function and the police function. This conflict affects the availability of ambulance service as the table below demonstrates.

If one police station wagon is serving a precinct, the availability would be 79 percent if the vehicle is not dispatched to any police emergencies. Availability drops to 62 percent if the probability of accepting a police run is 20 percent. Similarily if two ambulwagons are assigned exclusively for emergency medical response, the availability drops to 90 percent if the vehicles also respond to police calls. Four dual function vehicles are sufficient to assure a near 100 percent availability even if the proportion of police calls is much higher.

Assuming the operation of two dual-function vehicles in a precinct, availability could be improved if a protective dispatch policy is adopted. When one vehicle is busy (on a police or

TABLE 8
DUAL-PURPOSE VEHICLE AVAILABILITY
AS A FUNCTION OF ALLOCATION POLICY

Number of Vehicles	Availability with a 0% Chance of a Police Run	Availability with a 20%* Chance of a Police Run
1	79%	62%
2	98%	90%
4	100%	99+%

*The 20% probability has been assigned as a reasonable estimate of police runs for dual-purpose vehicles.

emergency medical call) the remaining vehicle could be protected by holding it reserved (except for critical situations). If the probability of accepting a police run is thereby reduced to 10 percent when one vehicle is busy, the reserved vehicle will be available 93 percent of the time thus increasing availability from 90 percent. A higher percentage of police calls would further increase the availability of the reserved vehicle.

POLICY EFFECTS ON SERVICE TIME

The major effect of modifying the distribution of recovery vehicles in a single-purpose fixed base ambulance system should be to decrease service times by reducing response times. Assuming two vehicles in a precinct, the placement of vehicles in areas of maximum demand (Policy I) results in the highest probability of short runs, 33 percent. Where two vehicles are uniformly distributed over a service region (Policy II) the probability of a short run is only 28 percent. Although the probability of a short run under Policy I is substantially greater than that under Policy II, the service times are nearly the same for runs both under and over a mile. Thus the mean service times that could be expected with a policy which places vehicles in areas of maximum demand would be 19.8 minutes, and 19.9 minutes using a policy of uniform distribution. The resulting difference in the total mean service times (0.1 minute) is neither statistically or operationally significant.

CONCLUSIONS AND APPLICATION TO A CITY-WIDE OPERATION

1. Based on the allocation modeling, it has been observed that a four-vehicle system in each precinct provides essentially 100 percent vehicle availability in both the single-purpose and dual-purpose operating modes. However, two single-purpose vehicles can perform nearly as well as a four-vehicle system especially when vehicles are placed at separate stations. If this two-vehicle recovery system is operated in a dual-purpose mode. vehicle availability can be improved by utilizing the protective dispatch policy discussed earlier.

2. By allocating two single-purpose recovery vehicles to each precinct, 26 vehicles would be required to provide city-wide service for the 13 precincts. It is quite likely that this number can be reduced by allowing ambulances to cross precinct boundaries and operating in service areas larger than a precinct, or by reducing the present demand. For instance, it seems possible that three vehicles servicing two precincts could provide adequate availability without severely increasing transit times to the scene. In this case, city-wide service could be provided with 19 or 20 vehicles. Clearly experimentation with such a system is desirable to validate this qualitative conjecture.

3. Placement of recovery vehicles within a precinct did not influence ambulance availability in any substantial way for the experimental systems studied. However, distribution could effect service times if larger service areas were used. If a policy of uniform vehicle distribution were adopted in a city-wide system, short response times--not substantially different from those achieved in the maximum demand distribution--would be expected.

CHAPTER VII

COST ANALYSIS

In the preceding chapters, project findings for a number of alternative emergency medical service system components and operational policies have been described. Changes in vehicle availability and response times were studied for several different systems, as operated by various types of personnel, and under a number of allocation and distribution policies. The incidences of correct diagnosis and treatment were studied as a function of the training received and the type of personnel utilized. These findings suggest that, on a performance basis, there are a number of acceptable and effective ways of structuring an emergency medical response system.

However, the operation of any service requires the expenditure of existing resources (whether they be dollars, manpower, facilities or material) which are limited and which present a very real constraint to service operation and system design. In order to identify those systems which will require the minimum resource expenditure for the particular level of performance desired, several alternative systems have been constructed for comparison.

In this analysis, a number of factors were examined such as personnel, personnel training and licensing, ambulance vehicles, emergency equipment and supplies, ambulance base stations and system administration. The costs developed were then used to derive the costs for four representative methods of providing emergency medical service: (1) contract with commercial ambulance companies and operation of (2) a municipal ambulance department, (3) a combined fire-ambulance service and (4) a combined police-ambulance service. Each system was constructed to service the total annual public emergency load.[5]

[5]In the Report, the costs of providing this service through the combined effort of both the police and fire departments was extensively discussed since this is the method of service historically provided in Detroit. The cost of this type of system, however, is basically reflective of the costs characteristic for each, as adjusted for the portion of the total service rendered.

Comparability was maintained by constructing each of these systems so that they met the operating standards of the Michigan Ambulance Act[6] and had equivalent response times and levels of vehicle availability. A summary of the basic operating characteristics of each of these systems is presented in Table 9.

ESTIMATION OF SYSTEM COSTS

Estimate of the personnel cost component of each of the systems, the major cost factor in all service operations, was made on a basic operating characteristic of ambulance service: that there are relatively long periods of system inactivity between the periods of actual system performance. This type of activity profile is indicative of a standby operation.

In the commercial and municipal ambulance systems, where the personnel are utilized only for ambulance service, the personnel cost component includes the cost of the standby time as well as of the service time. For the remaining two systems, where the ambulance service is combined with either the police or fire service and the personnel involved provide both services interchangeably, the major cost effect achieved is the removal of the personnel standby time from the costs chargeable to the ambulance service. Since time on standby is much greater than actual service times, a significant reduction in the total system cost results despite the fact that the police and fire personnel are more costly both on a per-man and per-hour basis.

However, other factors also must be considered in estimating the personnel cost component for the police-ambulance and fire-ambulance

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[6]Briefly, the statute requires that all vehicles be licensed annually, be at least rear door opening station wagons and be equipped according to the recommendations of the Committee on Trauma of the American College of Surgeons. Personnel also must be licensed annually and, at the time of application for licensure, have passed a physical examination and possess a currently valid certificate in the American Red Cross course in advanced first-aid or the equivalent. Proper sanitation of the vehicle compartment and equipment is required as well as fresh linen for each victim transported. The system costs include the additional expense for compliance with these standards.

TABLE 9

SYSTEM COMPARISON: OPERATIONAL CHARACTERISTICS

	Commercial	Municipal	Fire-Ambulance	Police-Ambulance
Service Administration	Exclusive Service Contract-Performance Monitored by City	Municipally Operated		
Personnel:				
Type of Personnel	Commercial Attendant	Municipal Attendant	Fire-Fighter	Patrolman
No. of Personnel Required	Contractor's Option	192	237*	851*
Type of Functions Performed	EMS Only		EMS & Fire	EMS & Police
Interference:				
EMS with Other Functions	No Other Functions		None	Moderate
Other Functions with EMS			Minimal	Moderate
Availability of Time for Training & Licensing	Time Readily Available (No Interference)			Limited Due to Interference
Portion of Personnel Cost Chargeable to System	Total Cost		No Cost	Ambulance Service Time PLUS Time of Related Activities
Vehicles:				
No. in Continuous Operation	20		22	69
Total Number Required	Contractor's Option	24	26	89
Type of Functions Performed	EMS Only			EMS & Police
Type of Response	From Fixed Bases			From Patrol
Base Stations: No. Required for Personnel & Vehicles	20		22	For Supplies Only
Communications:				
Screening of Calls	All Calls Screened at Police IMPACT Center			
Vehicle Dispatch	Police or Fire Department		Fire Department	Police Department

*Number of existing personnel to be trained and licensed

systems. Although a standby-time cost component does not exist, the estimation of the personnel cost of the ambulance service time in these two systems requires the examination of the operating characteristics of police and fire services, both of which include response to emergency calls.

Police-Ambulance Service Personnel Costs: As described in the section on vehicle allocation and distribution, when the ambulance function is combined with the police function, the demand for both services must be considered in establishing the number of vehicles required to achieve a particular level of vehicle availability for response. It is inherent in the police-ambulance service concept that the ambulance function will be performed between responses to police emergencies, during the time normally spent on patrol. Since patrol meets a primary objective of a police service, deterrence, the activity profile of a police service can be described as continuous. The performance of the ambulance function, including activities indirectly related to this function (such as are required by the Michigan Ambulance Act), will result in an interference with patrol and therefore a charge to the operation of the ambulance service[7]. This interference or opportunity cost has been estimated as the dollar cost of the personnel time expended.

Fire-Ambulance Service Personnel Costs: Although a fire service also responds to emergency calls, there is no function performed between emergency fire responses which is truly analogous to that of police patrol. The activity profile is identical to that of an ambulance service. Consequently the concepts used for determining the personnel-cost component of a fire-ambulance service are different than those used in the police-ambulance service.

The presence of such an activity profile and the fact that a 1-1 relationship does not exist between a particular fire emergency and a response vehicle results in an adaptability of response which is the basis for the operational compatibility between the fire and ambulance functions: the capability exists for utilizing fire and ambulance vehicles for response to fire emergencies alternate or substitute vehicles for response to fire emergencies

[7]Since the number of dual-purpose vehicles included in the design of the police-ambulance service is such that there should always be a vehicle available for response to a police emergency, there was no need to determine an opportunity cost for the contingency that response to a police emergency would be delayed because of a medical emergency run.

TABLE 10

SYSTEM COST COMPARISON SUMMARY

	SYSTEM			
	Commercial	Municipal	Fire	Police
Capital Costs				
Vehicles*	$ --ϕ	$ 85,200	$ 92,300	$ 35,600θ
Base Stations	3,500	3,500	3,850	780
Equipment	--ϕ	13,488	14,612	37,371
TOTAL	$ 3,500	$ 102,188	$110,762	$ 73,751
Annual Operating Costs				
Personnel	$1,330,080ϕ (Personnel, Vehicles*, Equipment combined)	$1,807,296	--#	$854,027
Vehicles*		32,825	$ 34,165	48,414
Equipment		19,808	20,042	28,303
Administration	7,000	20,000	2,000	7,000
TOTAL	$1,337,080	$1,879,929	$ 56,207	$937,744

*Although ambulances are recommended for operation, they are impractical for use in a combined police/ambulance service. To maintain the system cost comparison, the costs presented here assume the operation of station wagons.
ϕCost components included in contract price
θBased on the difference between the purchase price of a sedan and a station wagon
#See discussion in text

without a reduction in the effectiveness of fire control.

For those twenty-two engine companies at which ambulances are located, the probability that the ambulance function will interfere with the control of fires in those areas immediately adjacent to the engine station (that area in which the engine is the primary response resource) is rather small in Detroit[8]. Since the amount of interference of the ambulance function with the fire-fighting function is essentially non-existent, no personnel cost has been assumed for a combined fire-ambulance system.

FIRE-AMBULANCE SYSTEM OPERATIONS

The proposed fire-ambulance system would operate as follows: Between fire runs, the personnel detailed to the ambulance at each of the 22 engine/ambulance (E-A) stations would respond to medical emergencies as dispatched by the fire communications center. However, on the receipt of a fire run at one of these E-A stations, all engine personnel, including those on the ambulance detail, would respond to the fire alarm as at present. During this period, ambulance coverage for the area would be provided by adjacent E-A companies.

If a fire alarm occurred when the ambulance detail had already been committed to an ambulance run, there would be an insufficient number of firemen remaining at the E-A station to respond effectively to the fire emergency. On these occasions, an alternate engine company would be dispatched to the fire emergency in their place. In other words, the assignment of an ambulance run to an E-A station would result in that company being temporarily removed from ready-response status for fire alarms--an average of 20 minutes per ambulance run. The mean time spent daily on the ambulance function by each of the E-A companies is estimated to be 125 minutes, or 9 percent of the total available time.

It is estimated that, under the proposed system, the ambulance detail would be on an ambulance run at the same time that a fire

[8]The time spent by the average engine company in controlling fires in that engine's immediate area is less than 1 percent of the total available time. In addition, interference with the primary response engine will be reduced by the fact that almost 40 percent of the city lies within the primary response area of more than one engine company, due to substantial overlapping of engine areas.

emergency occurs in that engine company's primary response area approximately once every nine days. This is less interference than estimated for the present rescue squad ambulance operation. In addition to the greater frequency of interference of the ambulance function with the present squad operation, the interference is probably more substantial because of a limited ability to dispatch a substitute squad. (Only seven squads are operated versus a total of 51 engine companies).

It would appear, then, that the shift of the entire public-supported ambulance function to the engine companies, with the resultant reduction in demands presently placed on the squads, could actually enhance the quality of the fire service rather than interfere with it.

COMPARISON OF SYSTEM COSTS AND PERFORMANCE

Faced simultaneously with the important need for good emergency medical-care service and the reality of limited resources to support essential municipal activities, it is important to identify those service systems which achieve desirable levels of performance with minimal expense.

Of the four systems analyzed, the operational and performance characteristics of the commercial contract, the municipal-ambulance and the fire-ambulance systems are basically identical. The mean times spent in transit to the scene, at the scene, and in transit to the hospital for all three systems are equivalent. All three systems are characterized as having relatively large amounts of personnel standby time, as requiring only moderate numbers of men and vehicles for operation, and as using the ambulance vehicles only for emergency medical care. The presence of these characteristics has several desirable results: time is readily available for personnel training and licensing without interruption of other essential activities, the number of personnel to be trained and the number of vehicles to be equipped and operated will be moderate, and vehicle and equipment sanitation can be maintained at a level consistent with proper ambulance operation. Additionally, the presence of these characteristics would allow each of these systems to adopt technological improvements in emergency medical care (such as additional training and the utilization of more sophisticated equipment and specialized vehicles) at minimal cost.

In terms of quality of treatment, the demonstration data suggest

that the treatment provided by personnel whose function at emergency medical scenes is restricted to medical care would be equivalent to that provided by personnel whose sole function was emergency medical care. Given comparable training and equipment, dual-function personnel can be expected to provide equivalent levels of treatment provided that these functions are operationally distinct.

With all of the similarities between these three systems, there are only two areas in which the fire-ambulance system differs from the commercial and municipal systems. One of these differences is of substantial and the other of minimal impact.

The substantial area of difference is in the system cost. The high degree of operational compatibility of an ambulance and a fire service permits the ambulance function to be added with minimal operating expense.

The other area of difference involves the level of availability for response to medical emergencies. Almost all of the time, the level of ambulance availability in the fire-ambulance system would be equal to that of the commercial and municipal systems. However, it is expected that, on occasion, multiple fire alarms will occur simultaneously with the result that the number of ambulance crews available for response to medical emergencies will be limited. Nevertheless, in relation to the infrequency and short duration of these occasions, the percent of ambulance responses that are actually for true medical emergencies, and the cost reduction that results from a combined-service operation, these periods of limited availability for medical response could be considered acceptable.

In comparison to the commercial, municipal and fire-ambulance systems, there are a number of undesirable limitations included in the operational and performance characteristics of a police-ambulance system. During the demonstration, the quality of the treatment provided by all the police groups evaluated was not as high as that provided by the commercial and fire rescue squad personnel. This was a consistent finding despite the fact that the experimental design included providing some of the patrolmen with recent refresher training and others with an advanced course taught by professors of surgery. All three groups (control, review and advanced training) provided roughly the same quality of treatment which suggests that treatment quality was affected by

factors other than training. It is suspected that the fact that patrolmen have to perform more than the medical-care function at emergency scenes provides a distraction which dilutes the quality of treatment.

In addition, the number of men and vehicles required for a police-ambulance system is much greater with the result that more men must be trained and licensed and more vehicles equipped and operated. Since this large number of vehicles would be utilized for both police and medical functions, the effort needed to maintain proper vehicle cleanliness for the medical function would be increased--with the probable result that the level of vehicle sanitation would be variable and generally below that of the other systems.

This duality of vehicle function is presently achieved by using station wagons. Folding seats and rear storage space permit these vehicles to operate interchangeably as police scout cars and as ambulances, even though there is limited space for in-transit treatment. Although full-sized ambulances are preferred for victim transport, the special configuration of the true ambulance interior appears to preclude their use as dual-function vehicles.

Absence of standby time in police operations necessarily results in the interruption of other police activities for training and licensing. Inability to train without interfering with other activities, limited ability to incorporate more specialized vehicles and equipment into normal operations, and the large number of men and vehicles required would make the police-ambulance system both difficult and costly to modify in accordance with future technological improvements in emergency medical care.

Although the cost of the police-ambulance system would be less than that of the commercial and municipal systems, it would be substantially above that of the fire-ambulance system. As with the fire-ambulance system, there also would be occasions of limited response availability for medical emergencies, but it is estimated that these periods would be more frequent and of longer duration than those expected in the fire-ambulance system.

In conclusion, the results of this analysis suggest that the adoption of the fire-ambulance system alternative would result in a long-term solution to the problem of providing a quality service to the citizens of Detroit within existing and anticipated revenue constraints.

CHAPTER VIII

THE HELICOPTER AMBULANCE

This chapter will briefly describe the experimental helicopter-ambulance operation, summarize the major findings, provide a cost-benefit comparison of the craft and ground ambulances, list the non-medical missions and consider several of the general implications of an urban helicopter-ambulance. A more detailed discussion of this material can be found in the full report accompanying this summary volume.

OPERATIONAL DESCRIPTION

The helicopter-ambulance flew patrol missions over the 140-square-mile area of the city for nearly six months[9]. The primary mission of the crew was to land at injury accidents, provide paramedic treatment, and then transport the victim to one of the six local hospitals with a helipad or helistop.

The crew was dispatched to injury accidents by police radio, and in a few cases they initiated medical response action based on their own observation and detection. The air-ambulance response was completely dependent upon the city-wide, random occurrence of injuries and limited to the helicopter's hours of operation.

The police ground unit was necessary and always requested at the accident scene for traffic control or crowd security. The helicopter pilot coordinated their activities when landing. The entire police patrol force was prepared by a departmental memo to assist with the landings. Those officers who provided assistance did so readily and successfully. After a medical landing, the attendant treated and loaded the victim. The police crew member either assisted the attendant or directed traffic. Once the victim was secured aboard the helicopter and the receiving hospital notified, he was flown to the facility for additional treatment.

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[9]The hours of flight were from 4 to 7 p.m. Monday through Friday from April 22 through October 17, 1969. Weekend and late evening flights also were scheduled on occasion. In 131 missions the pilot and crew logged 487 flight hours. The craft used for the demonstration was a Bell 47-J.

FINDINGS

In Detroit, 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[10]. In the course of the demonstration, the crew was dispatched to 37 incidents, with 27 successful landings resulting in the transport of 23 persons[11]. Eight landings were made on freeways, 11 on surface streets and eight on off-street areas.

The helicopter did not transport in four of the landings. Operational problems at the scene usually prompted the decision that a ground vehicle was the most expedient method of handling these cases.

In the 23 successful responses, none refused transport. Because the injury occurrence process was random, the range of victim condition varied from minor injuries to critical cases. For the most part, those transported by the helicopter were not seriously injured. Three of the victims, however, did fall into a critical category: one (a coronary case) apparently died before the craft landed, another (a stabbing case) died in flight, and the third (a traffic-accident case) was successfully transported and treated.

BENEFITS OF THE HELICOPTER-AMBULANCE

The primary benefit of the helicopter-ambulance is its speed of response and the resultant treatment 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 as shown in Figure 3, but the benefit was small when compared to the speed of ground operations. The helicopter traveled greater distances and

[10] No reports of secondary accidents due to traffic stoppage during landings were called to the attention of the Police Motor Traffic Bureau.

[11] It should be noted that the helicopter usually could not approach a victim as closely as a ground vehicle and the victim loading process was more complex.

FIGURE - 3

RESPONSE AND TRANSPORT TIMES

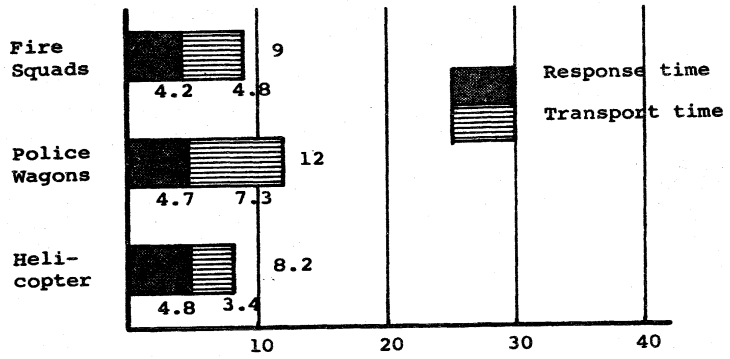
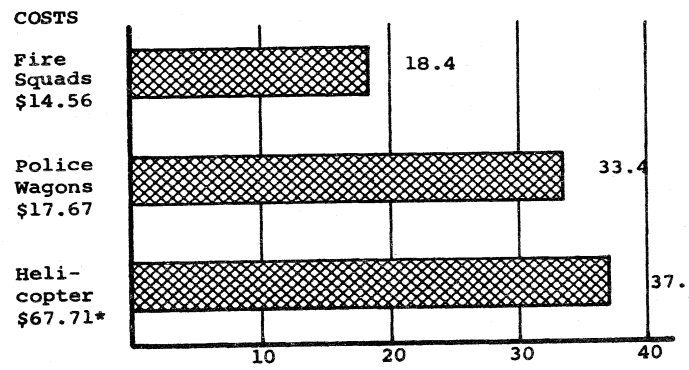


FIGURE - 4

SERVICE TIMES AND COSTS



*(lowest estimate)

had only six helipad hospitals on which to rely while the ground vehicles covered shorter distances and relied on 14 hospitals.

COSTS OF THE HELICOPTER-AMBULANCE

Costs for victims transported by the helicopter, based on the service time of 33.7 minutes, averaged $67.71 each.[12] While the benefits of helicopter transport are considered in the same range as those for a vehicle in the ground system, the cost is almost four times as great as shown in Figure 4. Extended cost consideration can be based on the helicopter demonstration experience. The patrolling helicopter could not carry a greater number or victim load per day than a ground vehicle. In that both vehicles potentially can meet a similar demand, the cost of operating the helicopter for a large number of victims would be considerably higher than a vehicle in the ground system, yet the benefits are similar.

OTHER HELICOPTER PROJECTS

While on patrol the helicopter and its crew were assigned several other projects--which did not materially affect their capability to perform emergency medical runs--such as traffic safety, police work, air pollution control and photography for city planning purposes.

Traffic-safety-related projects included daily traffic surveillance and reports for public information, alternate route studies, observation and filming of the effect of new ramp metering devices used on the freeway system, studies of freeway traffic re-routing during lane closures, surveys of high-accident street intersections with unusual geometric characteristics, a study of stadium-crowd movements and parking practices in conjunction with a major sporting event and a survey of potential corridors for the routing of a rapid transit line.

Police related projects included responding to bank robbery alarms,

[12]The cost was computed for the 23 patients transported by the helicopter based on the project cost of $110 a flight hour. Time spent at the hospital was included in the cost.

serving a warrant in an abortion case, pursuit of stolen vehicles, observation of crowds and public demonstrations for command purposes, and various air-to-ground communication and visibility experiments.

A small number of flight hours were allocated to the county for air-pollution-control studies. Air samples were gathered and photographs of industrial corridors where air pollution was high were taken. Similarily, photographs of renewal areas and the central business district were taken for several city planning projects.

CONDITIONS NECESSARY FOR A MUNICIPAL HELICOPTER AMBULANCE OPERATION

The Detroit demonstration study documents the fact that the time savings of a helicopter ambulance (versus ground transportation) do not justify the costs of a helicopter ambulance operating exclusively on patrol. Use of a helicopter for medical emergencies may be justified under limited conditions.

If transporting injured persons is a secondary function of a multi-purpose helicopter operation, the cost of initiating the ambulance function is minimal. The cost of beginning the service would be the purchase price of a helicopter cabin conversion kit, if necessary, and the appropriate equipment.

The demonstrated drawbacks of a patrol operation are (1) the uncertainty of landings and (2) the inability to differentiate a serious-injury accident case needing special care from a large number of injuries that can be adequately handled by ground ambulances. Assuming a municipality acquires a helicopter for several uses including victim transport, the standby mode of operation would be more appropriate. In a standby operation definite landing arrangements could be made in advance to eliminate the chance landings of the patrol operation.

If a municipality operates a multi-purpose helicopter which has a secondary role of standing by 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 proper treatment. For example, a case could merit helicopter transport based on the requirement for specialized care at a regional hospital.