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

REPORT

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

CITY OF DETROIT

MAYOR

Roman S. Gribbs

COMMON COUNCIL

Mel Ravitz, President

Ernest Browne	William G. Rogell
David Eberhard	Robert Tindal
Nicholas Hood	Phillip J. Van Antwerp
Carl Levin	Anthony Wierzbicki

CITY CLERK

George C. Edwards

CITY TREASURER

Robert J. Temple

MAYOR'S COMMITTEE FOR COMMUNITY RENEWAL
CITY OF DETROIT

Norman L. Miller, Chairman
Community Development Coordinator
Mayor's Office

Charles Blessing, Director City Plan Commission	Robert P. Roselle, Controller Controller's Office
James L. Trainor, Coordinator Mayor's Committee for Industrial & Commercial Development	Harold Varner, Director-Secretary Detroit Housing Commission
Project Director	Homer Hall, Acting Director Mayor's Committee for Community Renewal
Project Staff	John L. Krause, Principal Investigator Kenneth W. Malkowski

HIGHWAY SAFETY RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN

Robert Hess, Ph.D., Director

Project Director	James O'Day, Head Systems Analysis Division
Project Staff	Robert E. Scott, Principal Investigator William K. Hall Erik Hanitzsch, Former Principal Investigator Rollin Davis

ADVISORY COMMITTEE ON THE DETROIT
EMERGENCY MEDICAL DEMONSTRATION PROJECT

Alger Malo, Chairman
Director, Department of Streets and Traffic
City of Detroit

Joseph Deneweth
Deputy Chief
Detroit Fire Department

Garnet Griffin
Managing Director
Traffic Safety Association of Detroit

Grovenor Grimes
Assistant Administrator
Detroit General Hospital

Homer Hall, Acting Director
Mayor's Committee for Community Renewal
City of Detroit

Robert Hess, Ph.D., Director
Highway Safety Research Institute
The University of Michigan

William Polkinghorn
Director of Traffic
Detroit Police Department

Frederick Rehm
General Manager
Automobile Club of Michigan

Reuben Ricard, Inspector
Motor Traffic Bureau
Detroit Police Department

Arthur Sonnenberg, Inspector
Accident Prevention Bureau
Detroit Police Department

Edward Walsh, Inspector
Communications
Detroit Police Department

COMMISSIONERS
Frederick N. Rehm
President
Charles F. Arnold
Bernard J. Youngblood

City of Detroit
ROMAN S. GRIBBS, Mayor
DEPARTMENT OF STREETS AND TRAFFIC
WATER BOARD BUILDING
Detroit, Michigan 48226

963-5303

Alger F. Malo
Director
Holden M. LeRoy
Assistant Director

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

REPORT

LIST OF TABLES:

LIST OF FIGURES:

LIST OF CHAPTER ATTACHMENTS:

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 suggest 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.

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.

clusions:

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.

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.

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.

CHAPTER ONE

A HISTORICAL NOTE ON THE CITY OF DETROIT'S EMERGENCY MEDICAL SERVICES

Preceding page blank

CHAPTER ONE

A HISTORICAL NOTE ON THE CITY OF DETROIT'S EMERGENCY MEDICAL SERVICES

It has been within the last century that America's cities have experienced rapid and extensive growth. Typically, the pattern of urban growth and sprawl has not only left a physical mark on the geography of the developing urban center but left a parallel, though less visible mark on the service pattern of the city. In most instances neither the growth nor the noncomitant service pattern was planned.

Detroit and its public emergency medical service exemplify this general description. As the city developed, the demand for emergency medical service grew, and city agencies were compelled to respond. As the police officer assisted more and more victims of home injuries, assaults or traffic accidents, his role in emergency services evolved. As the fire fighter developed new techniques in fire fighting, such as use of oxygen and extrication tools, his responsibility in emergency service became more apparent, specialized and put to wider use.

1-1. THE POLICE DEPARTMENT'S PADDY WAGON

Prior to 1960, the paddy wagon, a carry-all van, was stationed in each of the police precincts. This truck was utilized for emergency medical calls as well as for prisoner transport. The van carried up to three patients. Policemen today can remember holding patients to stabilize them as the vehicle careened around corners.

The staffing of the paddy wagon was an interesting feature of the Police Department's method of handling emergency service. It evolved through several approaches. Initially, two patrolmen were assigned to a van as the full-time crew. After a period of time the crew was reduced to one man full-time to save manpower. Later still, the staffing was changed so that a precinct clerk would be the on-call driver of the vehicle. The clerk would drive the van to the scene of a crime or accident, meet patrolmen there and trade vehicles

Preceding page blank

with them. The clerk would return with the patrolmen's vehicle to the precinct station. When the patrolmen were through with the van, they would return it to the station and pick up their squad car.

The decrease in full-time officers assigned to the van meant an increase in officers available for police work. This same trade-off of the police function with the ambulance function was still evident when the vehicle for conveying the sick and injured was changed from the van to the station wagon in 1960. Detroit was the first large city to use station wagons for patrol duty. The "ambulwagons" allowed, in theory, a fast response time with a minimal detraction from police duties. The station wagons are the mode of present police service.

1-2. THE FIRE DEPARTMENT'S FLYING SQUADRON

It is interesting to note that one of the first rescue squads in America was developed by the Detroit Fire Department in 1908; the squad was the department's first automobile unit. The crew of the unit was known as the "Flying Squadron." Crew members earned their name as well as their $80.00 a year bonus pay by responding to alarms at speeds of up to sixty miles per hour and executing often daring rescues. In a horse-drawn era their speed and daring became a local legend.

Within ten years there were four units operating as squads. Equipment carried in the vehicles included life nets, breathing apparatus, cutting equipment and other specialized tools. Present day squads carry updated versions of these items.

Since 1951 seven squads have provided service for the entire city. Crews are made up of five men who respond not only to fires but also to resuscitation and extrication emergencies. For the most part, the area of responsibility of Fire Department squads in emergency service has been quite distinct from that of the police, who are concerned generally with injury, assault or accident cases.

1-3. EARLIEST REFERENCE TO THE CITY'S SERVICE

The earliest reference in city records to the provision of ambulance service occurs in the Journal of the Common Council.[1] In 1910 a citizen, in a letter to the Council, severly critized the hospital and ambulance service being provided. The chief complaint was that attendants refused to transport unless they were assured of payment.

The citizen noted that other cities had established or contracted for a city ambulance service, and he offered to purchase and donate an automobile type ambulance presumably if the city would consider establishing a separate ambulance corps. The matter was referred to the Committee on Health and City Hospitals but from what records are available, no significant action seems to have been taken.

After sixty years, two similarities are evident:

1) the suggestion of a municipal ambulance corps is still worth considering, and

2) the problem of bill collection is still prevalent in the industry.

1-4. DETROIT'S EARLIEST PRIVATE AMBULANCE[2]

Detroit's first commercial ambulance dates from 1867 and was a hump-back, horse-drawn delivery wagon, which made calls for births, deaths, accidents and the transport of the insane. The wagon also reported to all large fires.

The remarks of the retiring owner of the city's first firm are recorded regarding the two major problems that he had confronted in forty years of the business. One of these was the problem of false calls. The owner said, however, that the threat of a $50.00 fine deterred many people from making such calls. The second problem was the difficulty of transporting mental patients. In many instances the attendant had to physically overpower the patient to force him into the horse-drawn wagon. Both of these problems, despite changing circumstances, are encountered today.

The brief look at the past is intended only to put the service into perspective for considerations of its present and future problems.

---

[1] Journal of the Common Council, Jan. 18, 1910, p. 44.
[2] Detroit Free Press, PII, p. 1, Jan. 13, 1907.

CHAPTER TWO

THE PRESENT EMERGENCY RESPONSE SYSTEM IN DETROIT

Preceding page blank

CHAPTER TWO

THE PRESENT EMERGENCY RESPONSE SYSTEM IN DETROIT

2-1. DETROIT'S EMERGENCY TEAM

In the City of Detroit public emergency medical response services are, at the present time, provided primarily by the city's Police and Fire Departments without charge. This chapter describes the operation of this system, which, for the purpose of this report, stops at the hospital emergency room.

2-2. THE POLICE DEPARTMENT

The Nature of the Calls

Generally the medical emergency calls received by the Police Department are the result of injuries or illnesses occurring in homes or public places. The calls are either direct requests for assistance--"My child has swallowed an unknown substance"; "A neighbor has fallen from a ladder"--or reports of incidents--"There's a man lying on the sidewalk"; "An accident just happened at the corner." Many of the injuries occur as the result of a crime. Some of the calls are for serious emergencies, but for many the seriousness is actually minor or even imagined.

Number of the Calls

In 1968 the police Communication Center received over three million calls of all types and dispatched assistance for over 650,000 of them. A total of 37,887 of these dispatches were in response to requests for assistance and transport of victims of illness or injury.

Of those transported, one out of seven were given first aid and two thirds were conveyed by a police station wagon. It is estimated that, even after screening, a considerable number of the transports made were not for true medical emergencies.

Preceding page blank

Detection and Notification

The Telephone: Emergencies are usually detected by an observer or bystander who phones for assistance. If contacted first, telephone operators route emergency calls to the proper agency. Calls requesting police assistance can also be made directly to the Police Department by dialing the number of the IMPACT Center (IMmediate Police ACTion). The Center has a bank of phones operated by field-experienced police officers.

IMPACT officers also receive calls for assistance through several other detection-notification systems. Among these are the Community Radio Watch (CRW), the Citizens Band Network (CB Net), the Freeway TV surveillance system, the police communications network itself, and several volunteer citizen band radio groups.

The CRW Program: The Community Radio Watch (CRW) is a police sponsored activity which enlists the voluntary assistance of businessmen and governmental agencies who operate radio equipped and dispatched vehicles, including commercial trucks, cars, and cabs. Drivers who witness a crime, accident or other irregularity (e.g., a broken stop light) radio the incident to their fleet dispatcher, who relays the information to the Police Department by phone. Over forty-one hundred radio equipped vehicles from forty-eight firms or agencies cooperate in the program. Although most of these vehicles are on the road only during regular daytime business hours, some do operate twenty-four hours a day. The coverage provided by these vehicles is random, however, because their travel patterns are dictated by their business functions.

The CB Net Program: The Citizens Band Network also serves an emergency reporting function. The program originated as a joint experiment by the General Motors Corporation and the City of Detroit Department of Streets and Traffic, which operates the system now. The cars of many private citizens, in addition to the staff vehicles of both agencies, are equipped with CB radios. Drivers notify a central network monitor stationed in the Department of Streets and Traffic offices, who relays the accident information to the Police or Fire Departments by direct police phone.

The TV Surveillance System: The TV Surveillance System operates on 3.2 miles of the John Lodge Freeway. In the event of a severe automobile crash, a request for emergency assistance would be phoned to the Police Department by persons monitoring traffic. TV coverage of the accident is instantaneous and usually accurate enough to allow the viewer to assess its severity and request the emergency equipment needed.

Police Network: Police Network requests for medical transport assistance are also received from radio-equipped police vehicles. In addition, many police officers are equipped with personal radios, which permit them to be in constant contact with the Communications Center when on foot patrol. The police communication network, then, is also a part of the detection-notification system.

Screening and Dispatch

Police screening of calls and dispatches of assistance take place in two physically separate units of the Communication Center: the IMPACT Center and the Dispatch Center.

IMPACT Center: The IMPACT Center, as mentioned above, consists of a series of phone stations operated by an average of ten experienced police officers. Each station is equipped with an electrowriter that is connected to copiers at each of four dispatch consoles in the Dispatch Center. Calls from the public for all types of assistance are routed to the IMPACT Center, where they are evaluated for police service. Sick and injury calls are screened at the center according to the guidelines included as Attachment 2-A. Only field-experienced officers are used for the IMPACT function since the proper handling of these and other calls requires trained judgment. As will be indicated later in this chapter, the screening of sick and injury calls is essential to the proper utilization of police resources. After a sick or injury call is received, the necessary information is transmitted to the appropriate dispatch console, often while the IMPACT officer is still debriefing the caller. If the call for assistance involves a heart attack, stroke or respiratory problem, the information is relayed by phone to the Fire Department for action.

Dispatch Center: The Dispatch Center is manned by an average of twelve men. To facilitate control the city's thirteen precincts are divided into four dispatch districts of three or four precincts each. (See Figure 2-1.) Communication with each district is done with one of the four consoles, each of which are operated by two officers, who select and dispatch vehicles according to information received from the IMPACT Center. Dispatch officers constantly monitor vehicle availability within the district precincts. If an ambulwagon is not available within one precinct for an emergency run, one from an adjacent precinct within the district may be dispatched. On occasion, requests are made for available vehicles from other districts.

Vehicles and Equipment

The emergency vehicle used by the Police Department is a rear loading station wagon, commonly referred to as an "ambulwagon." It is equipped with two collapsible cots, securing rails on the floor and, when available, a woolen blanket. No other medical equipment is carried.

During 1969 a pool of 110 station wagons was maintained for the dual purpose of police and emergency medical service. At any given time approximately twenty of these were out of service for routine maintenance and repairs. An average of eight station wagons were assigned to each of the precints.

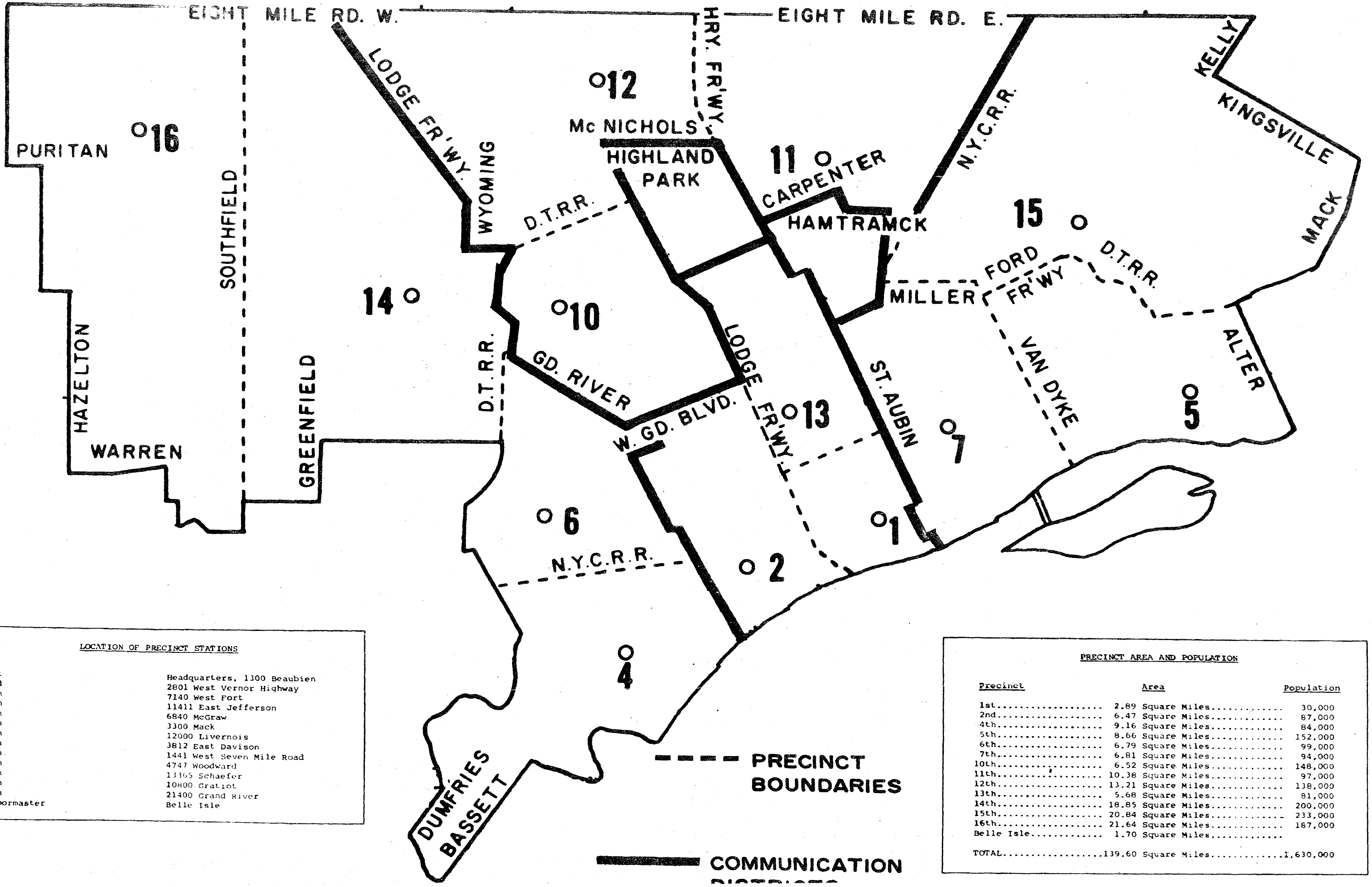
Several basic problems have been experienced during the nine year period that station wagons have been used as ambulances:

(1) Adequate treatment during transport is sometimes hindered because of the restricted space. For example, height of the roof prevents the proper application of cardio-pulmonary resuscitation even while transporting only one patient. When two patients are carried, treatment is essentially limited to what can be administered from the front seat.

(2) Because of the police functions performed by these vehicles, the maintenance of interior cleanliness suitable for patient transport is a continuing problem.

FIGURE 2-1

POLICE PRECINCT BOUNDARIES



LOCATION OF PRECINCT STATIONS

1st	Headquarters, 1300 Beaubien
2nd	2801 West Vernor Highway
4th	7140 West Fort
5th	11411 East Jefferson
6th	6840 McGraw
7th	3300 Mack
10th	12000 Livernois
11th	3812 East Davison
12th	1441 West Seven Mile Road
13th	4747 Woodward
14th	11365 Schaefer
15th	10800 Gratiot
16th	21400 Grand River
Harbormaster	Belle Isle

PRECINCT AREA AND POPULATION

Precinct	Area	Population
1st	2.89 Square Miles	30,000
2nd	6.47 Square Miles	87,000
4th	9.16 Square Miles	84,000
5th	8.66 Square Miles	152,000
6th	6.79 Square Miles	99,000
7th	6.81 Square Miles	94,000
10th	6.52 Square Miles	148,000
11th	10.38 Square Miles	97,000
12th	13.21 Square Miles	138,000
13th	5.68 Square Miles	81,000
14th	18.85 Square Miles	200,000
15th	20.84 Square Miles	233,000
16th	21.64 Square Miles	187,000
Belle Isle	1.70 Square Miles	
TOTAL	139.60 Square Miles	1,630,000

(3) The installation of any additional equipment presents an operational problem by limiting the space available for carrying out primary police functions.

(4) Only two patients can be transported at one time.

Staff

Each station wagon is operated by two patrolmen, who are assigned as a patrol unit with a primary mission of law enforcement and crime deterrence. Some of the patrolmen who staff these vehicles have mixed attitudes about the assignment of the medical transport service to the police in that they question whether it is a proper police function. Others consider the service to be a natural extension of the police function of protection of life and person.

All police personnel receive Advanced Red Cross First Aid instruction when receiving their initial training at the academy. Review sessions are conducted periodically to familiarize the entire force with new methods. The patrolmen staffing the ambulwagons do not receive any additional training as a result of their assignment. In general, the officers emphasize speed of transport to the hospital rather than treatment at the scene on the rationale that a hospital providing all necessary facilities is only minutes away from any incident. This emphasis on speed also allows a quicker return to police duty.

Operational Sequence, An Example

The following is a somewhat oversimplified description of activities that might follow an automobile accident; it is intended to describe the events which might take place between the time an accident occurs and the time the victim arrives at an emergency facility:

> A severe automobile accident occurs at a major intersection. A passer-by runs to a pay phone in a nearby gas station and dials the operator, telling her that he wants to report a bad accident. He is immediately connected with the IMPACT Center. The IMPACT officer receiving the call elicits certain essential information, which he simultaneously transmits to the

> Dispatch Center by electrowriter. The Dispatch officer scans a card rack before him and determines that an ambulwagon is on patrol nearby. The information is radioed to the available vehicle within ninety seconds after the caller reached the IMPACT Center. Three and one-half minutes later the ambulwagon arrives at the scene to find two conscious victims, one bleeding from lacerations of the head and the other complaining of hitting the steering wheel. The officers suspect internal injury of the second person. A two-man scout car, also sent by the dispatcher, arrives to handle the anticipated traffic snarl. The first officers on the scene load the victims, covering the more seriously injured with a blanket. One of the other officers radios the dispatcher to ask that he notify the hospital that they are bringing in what appears to be a "bad one." The officer also requests that a truck be sent to help move the cars. The dispatcher phones the hospital, which happens to have a police phone in the emergency room, and then locates and assigns a truck equipped with rubber, "pushing bumpers" to the scene. Shortly thereafter the ambulwagon arrives at the hospital, and the officers and victims are met at the emergency room door. Transport time to the hospital has been four minutes. The officers complete their reports in fifteen minutes, wait an additional three minutes to get their stretcher back, place it in the wagon, set up the seats and call back in service. Total elapsed time from dispatch of the run--32.5 minutes.

Documentation of Police Runs

Sick or injury runs are documented in two separate reports by the police. In the Police daily activity log a mileage total and the total number of runs are recorded as are the number of medical conveyances, the estimated miles traveled and the time spent on that function. The second form, a "conveyance slip," details the specific run. The date, time and location of the incident, the name and address of the victim and the place to which the conveyance was made are some of the items of information obtained. Copies of both forms are included as Attachments 2-B and 2-C.

2-3. THE FIRE DEPARTMENT

Nature of the Calls

The types of emergency medical calls received by the Fire Department can be generally categorized as heart attack, stroke and respiratory problems, and extrication problems. The Fire Department refers to these cases as "special runs." In general, the medical category with the highest number of requests for service is "difficulty in breathing." Other categories are asphyxia, chest pains, fainting spells, and so forth. That the Fire Department responds to respiratory problems is an unpublicized fact, yet their service is recognized by most Detroiters.

Number of Calls

During 1968 the rescue squads made 12,003 special runs and attended 12,122 patients.[1] Hospital transportation was provided to 6,364 of these. As with the Police Department, it is estimated that many of the requests made for emergency services are not for true emergencies. In addition to the "specials," the squads also responded to over eight thousand fire alarms in 1968.

Detection and Notification

The largest percentage of "specials" are occasioned by emergencies detected and reported by a relative, neighbor or other person in the home of the person suffering the respiratory or other ailment.

The Fire Department's Communication Center receives, on the average, over ten thousand calls a year from citizens which result in special runs. Other Fire Department units receive and pass on an additional thirteen hundred squad calls. A special problem arises when a fire-alarm box is pulled in an attempt to obtain a rescue squad, as the Communication Center cannot determine what assistance is needed.

[1] For a nine-year comparison of police and fire calls, see Table 2-1.

It should be recognized that many "special" calls are initially received by the police IMPACT Center, and these are referred to the Fire Department by way of the police "hot line." This same line enables the fire dispatcher to notify certain hospitals of the necessity for special treatment--e.g., a case requiring defibrillation.

The Communication and Dispatch Center

The Fire Department's Communication Center is staffed usually by a team of four and is operationally smaller than the police department center, whose staff of over twenty men handles a far larger volume of calls. Two members of the team man a switchboard to receive calls and dispatch vehicles to fires and specials. Other members are constantly monitoring the availability and location of vehicles. The men controlling the switchboard also screen calls by using a cross-index directory to check telephone numbers against addresses given.[2] Misinformants usually hang up when confronted with discrepancies. When all information for an emergency run has been obtained, one of the seven rescue squads located throughout the city is dispatched by phone or radio. The areas covered by each of the squads, which share the same quarters with regular Fire-Fighting units, are shown in the map on the next page, Figure 2-2.

The Vehicle and Equipment

Vehicles operated by the rescue squads are enclosed, van-type trucks. The rear van area is 8 feet wide and 4 feet 8 inches high with two bench-type seats on each side of the compartment. Patients are transported on these seats. Each vehicle can accommodate two patients on the seats and one on the floor if necessary. The truck is designed primarily as a piece of fire-fighting apparatus with a rescue capability; transport is a secondary consideration.

Equipment carried in the vehicle includes an 8 1/2-foot life net, two mechanical resuscitators, eight bottles of

[2] Screening and operational criteria for the dispatch of squad vehicles is to be found as Attachment 2-D.

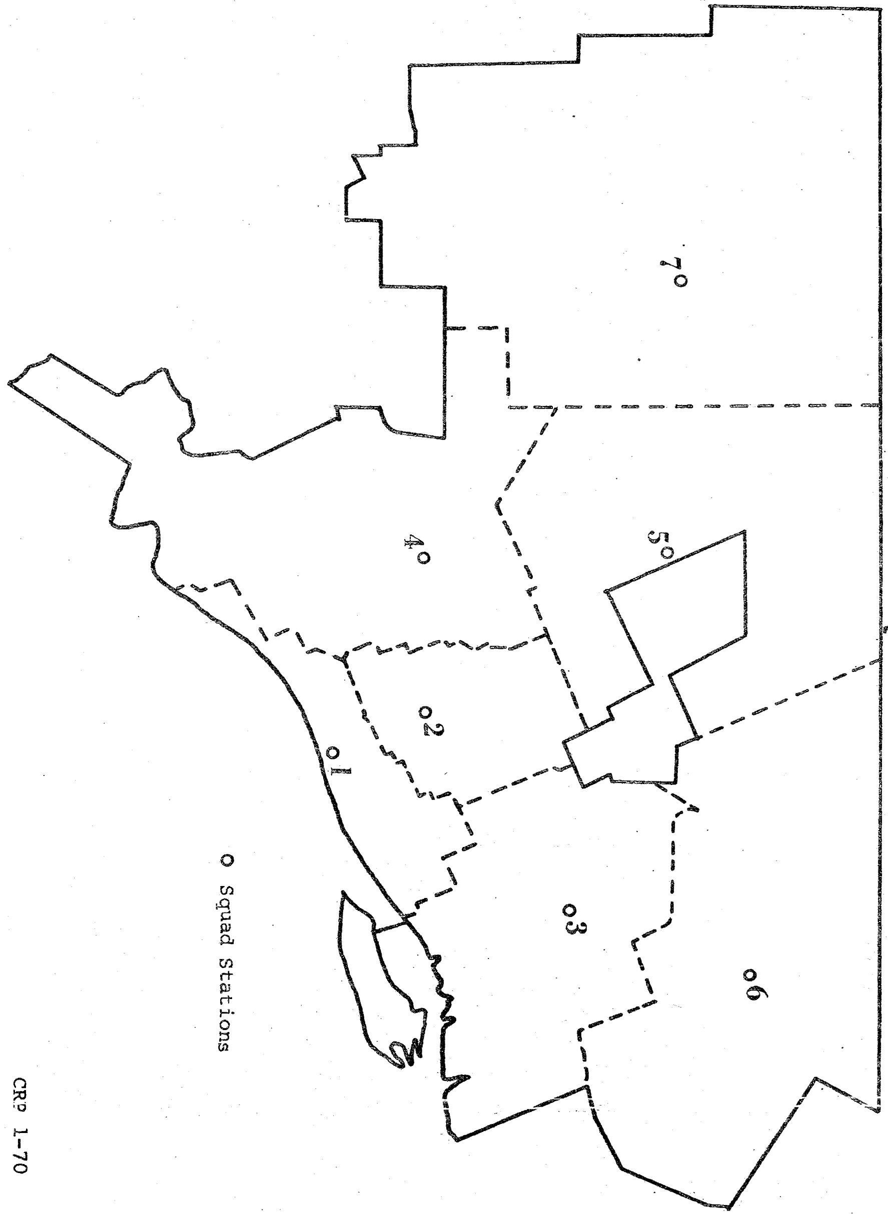


FIGURE 2-2

FIRE RESCUE SQUAD AREAS

oxygen, four pole-type stretchers, two soft stretchers, a full-ring Thompson leg splint, a disposable blanket, a wool blanket, and acetylene torch, various gas and electric saws assorted shovels, picks, hammers, chisels, wrenches and a pair of bolt cutters.

Staff

Five firemen comprise a rescue squad. Fire personnel may volunteer for squad duty only after five years of fire-fighting experience. Fire fighting remains the primary function of the crew, although they have also become specialists in rescue operations. This is despite the fact that only forty percent of their assignments in 1968 were to fires; the remainder were emergency medical runs. Red Cross Advanced First-Aid instruction of all fire personnel is initially provided in the training academy, and daily use by squad personnel keeps this knowledge fresh. In addition on-the-job emergency care training is provided, which is primarily concerned with resuscitation, the application of oxygen, and external cardiac massage but also places stress on speed of transport.

Operational Sequences, Examples

The following examples have been included to better illustrate the operational sequence of the rescue squad.

> The Fire Department received a phone call from the wife of a retiree who was said to be having a "stroke". The man was described as having difficulty breathing and suffering paralysis of the right side of his body. While the dispatcher screened the call, he alerted the appropriate squad with a buzzer. Once he determined the call to be an emergency, the dispatcher phoned the relevant information by direct line to the waiting squad. He then requested the Police Department to dispatch a vehicle to the scene.

A police vehicle is requested for several reasons:

(1) If the person needing assistance dies, the police officers on the scene can make a preliminary investigation, notify the

medical examiner and await his arrival. Police officers in either an ambulwagon or scout car can serve this function equally well.

(2) If the person needing assistance is alive and requires transport to a hospital but not oxygen or cardiopulmonary resuscitation (CPR) and if the police on the scene have a station wagon, they will carry out the transport. This allows the rescue squad to return to service immediately.

If the person needing assistance is suffering a stroke, requires oxygen and/or CPR, the rescue squad will complete the transport.

> The rescue crew arrived and determined that the retiree needed oxygen and should be transported to a hospital. Oxygen was administered immediately, and the man was transported to the nearest emergency room. The hospital was notified to have a cardiac care team ready.

A second example, provided below, illustrates how both police and fire emergency units may be dispatched for a single incident. Taken from The Detroit News of July 8, 1969, it also shows how citizens can circumvent screening procedures through misinformation to obtain a response.

> It was shortly after 2:00 a.m. on a Tuesday, and the Police IMPACT Center and the Fire Department Communication Center both received calls from the same man requesting transport service. The caller reported that a neighbor woman had come to his home seeking help and that she was experiencing labor pains occurring about a minute apart. As regulations do not permit obstetrical transports, communication personnel in both departments denied the request and suggested an alternative source of transport service. (See Attachment 2-A, Section 36.)
>
> Before the caller could choose another method of conveyance, he found that the birth was now taking place; and he assisted the woman in giving birth to a seven-pound, fourteen-ounce baby boy. While the delivery was taking place, the caller's wife instructed another neighbor to call both the Police and Fire Departments and report a heart attack case at her residence. "Within minutes," according to the newspaper article, "twelve firemen and six policemen showed up." When one of the officers asked who was having the heart attack, the woman who requested the call threatened that she would, if no assistance was given to the mother and the new-born baby in her home. A team of the officers wrapped the mother and child in clean sheets and transported them to a nearby hospital.

Documentation of Squad Special Runs

The squads document their cases fairly completely. Distances traveled, the times of commencement and termination of runs, and total duration of runs are precisely recorded. The location, the victim's name, address, sex and age, his condition at the scene, the treatment provided, the place transported to, the name of the person or agency requesting the service and the victim's condition when left at the hospital are all documented. A copy of the form used by the squad is included as Attachment 2-E. The information gathered is used mainly for internal management.

2-4. A BRIEF ANALYSIS OF THE EMERGENCY RESPONSE SYSTEM

In order to understand some of the factors which affect the load placed upon the emergency response system and to also establish some basis for projecting the number of emergency transports that can be expected in future years, it is revealing to study the fluctuation in the combined police and fire transportation statistics for the last nine years. As indicated in the figures in Table 2-1, the dual-purpose ambulwagons, which were initiated in 1960, carry the greatest number of emergency victims transported each year. Although the vast majority of responses made by the police result in transport to a hospital, the type of emergencies responded to by the fire squads require transport only in about half of the cases reported here. The figures presented in the Fire Rescue Trucks column actually reflect the total number

TABLE 2-1

EMERGENCY MEDICAL RUNS BY VEHICLE TYPE: 1960-1968

	POLICE VEHICLE				FIRE RESCUE TRUCKS	TOTAL TRANSPORTS
	Ambul-Wagon	2-Man Scout	Other	Total Police		
960	1,268	27,432	20,084	48,784	5,001	53,785
961	28,941	12,880	4,791	46,612	5,117	51,729
962	39,193	10,981	2,572	52,746	5,860	58,606
963	43,325	10,265	2,701	56,291	6,875	63,166
964	46,852	7,372	2,694	56,918	7,508	64,426
965	88,875	5,328	2,105	96,308	8,476	104,784
966	40,392	3,511	1,815	45,718	9,180	54,056
967	32,041	4,178	1,864	38,083	10,973	49,056
968	25,138	7,864	1,755	34,757	12,003	46,760

Sources: Annual Reports, Police and Fire Departments.

of responses made by the fire squads.

Total transports were on the rise in the early sixties and reached a peak in 1965. The reason for the rise was a decision, early in the decade, to cease all screening procedures at the police IMPACT Center. As indicated in Table 2-2 and Figure 2-3, the number of transports increased and, in 1965, was almost double the number of 1961. As a result, the present screening policy was adopted with the resultant decline in load levels.

It is interesting to note the gradually increasing number of calls serviced by the rescue squads since 1960, despite the existence of a screening policy similar to that of the police. It might be postulated that the public has been "educated" to the types of calls to which the Police and Fire

Departments will respond. Without exception a claim of "difficulty in breathing" effectively assures prompt service.

Need for Screening

The transport statistics presented in Tables 2-1 and 2-2 reflect the acknowledged demand for service and not the frequency of actual demand. The need for screening is evident. In anxiety-producing situations, requests for emergency assistance are apparently based more on emotional than rational criteria, and in many instances the assistance is requested more to reduce the anxiety than to provide an essential service to the victim. Recognizing this characteristic, reasonable criteria to screen requests for assistance is vital. (See Attachments 2-A and 2-D for the criteria presently used.)

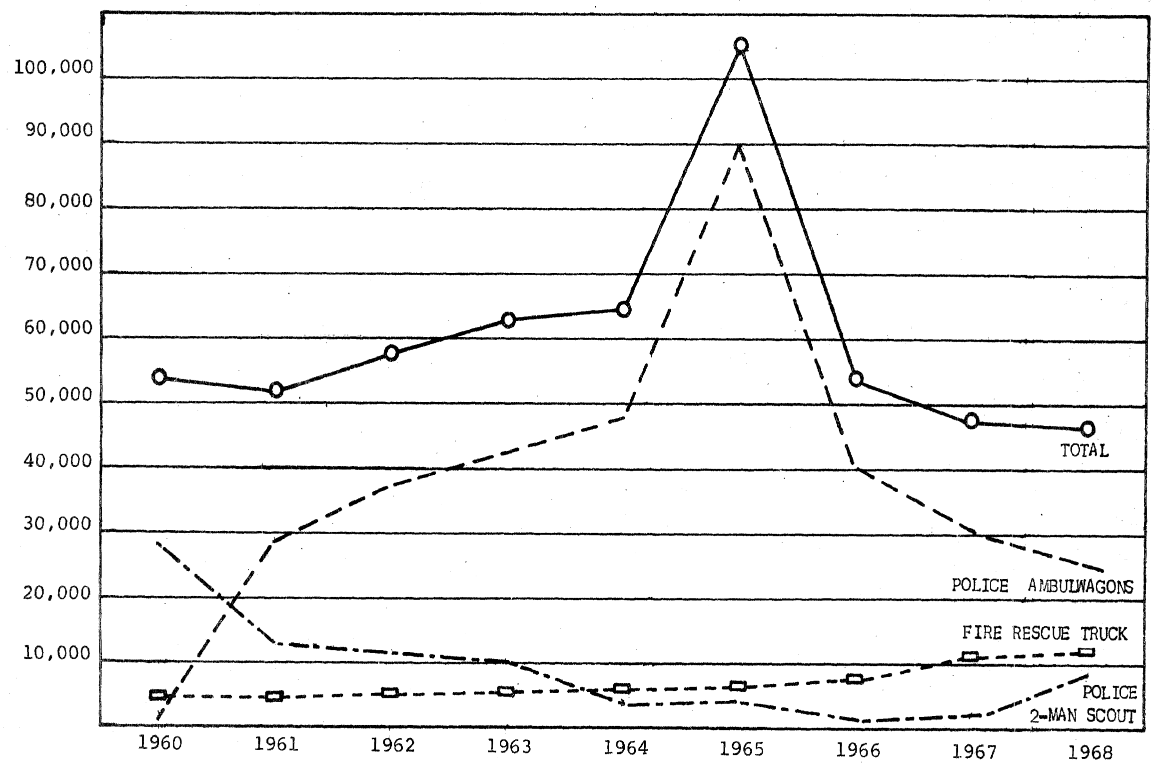
Operational Effect of Demand - Police

Police Department records indicate that practically every type of vehicle operated by that department transports victims of illness or injury. Of the total number of man-hours worked by all motor personnel each year, an average of 3.3% are spent on emergency medical transportation. Of the total miles traveled by all police vehicles each year, an average of 1.3% is traveled for emergency medical purposes.

Examination of the figures on Table 2-4 suggest that, despite the fluctuations in the individual percentages of the total medical runs made by the wagon and the two-man scout, the combined percentage for the vehicles appears to be nearly constant. Conversely, these figures suggest that a fairly constant proportion of the cases are carried by other police vehicles. If this is true, then it would seem that a certain portion of the conveyances will always be made by the police simply because of their presence and availability even if this service were formally assigned to some other department. In order to keep this residuum of conveyances down to the minimum, any alternative system must be designed to have response time characteristics similar to the police system.

Ambulwagons and Two-Man Scouts: These two types of vehicles transport the largest proportion of emergency medical cases

FIGURE 2-3 Emergency Transports by Vehicle Type
City of Detroit
1960-1968



From: Detroit Police and Fire Department
Annual Reports for the years listed.

CRP 1-70

TABLE 2-2
EMERGENCY TRANSPORTATION CHARACTERISTICS
Police Ambulwagons and Fire Rescue Trucks
CITY OF DETROIT
1960 - 1968

	POLICE AMBULWAGONS					FIRE RESCUE TRUCKS				
	# Runs	# Hours	# Miles	Min./ Run	Mi./ Run	# Runs	# Hours	# Miles	Min./ Run	Mi./ Run
1960[a]	1,268	903	5,803	43	4.6	5,001	1,268	29,430	15	5.9
1961	28,941	19,805	156,489	41	5.4	5,117	1,281	31,807	15	6.2
1962	39,193	29,190	221,656	44	5.7	5,860	1,497	37,530	16	6.4
1963	43,325	31,634	251,970	44	5.8	6,875	1,718	44,596	15	6.5
1964	46,852	36,747	273,602	47	5.8	7,508	1,862	49,122	15	6.6
1965[b]	88,875	40,990	302,880	28	3.4	8,476	2,060	54,197	14	6.4
1966	40,392	33,219	233,025	49	5.8	9,180	2,292	58,445	15	6.4
1967	32,041	28,177	180,946	53	5.6	10,973	2,826	70,394	16	6.4
1968	25,138	21,484	144,708	51	5.7	12,003	2,948	76,315	15	6.4

[a] Police started to use Ambulwagons during the latter part of 1960.
[b] Demand for Police transportation peaked during 1965. As a result, the Police IMPACT Center was directed to implement a revised screening procedure.

Sources: Annual Reports, Detroit Police and Fire Departments.

although, at one time or another, all types of police vehicles provide this service. The two vehicles combined make 95% of the runs, travel 91% of the miles and contribute 93% of the man-hours spent on this activity. (The two-man scouts are capable of transporting children and adults able to sit.)

TABLE 2-3
POLICE DEPARTMENT
MOTOR PERSONNEL AND VEHICLE ACTIVITY

		All Activity	Emer. Med. Activity	% of Total
‑ HOURS:	1966	2,190,640	78,236	3.6
	1967	2,091,888	69,644	3.3
	1968	2,114,126	61,065	2.9
LEAGE:	1966	19,777,068	277,242	1.4
	1967	18,977,174	224,219	1.2
	1968	18,396,484	212,391	1.2

urces: Annual Reports, Detroit Police Department.

Operational Effect of Demand--Fire Rescue Squads

The figures presented in Table 2-2 show that over the last nine years, the number of emergency medical runs made by the Fire Department have increased; in fact, they have doubled. As mentioned above, only approximately half of the runs result in the transportation of the victim to the hospital. This is due to two factors: First, the nature of the emergencies serviced by the fire trucks is such that transportation is not always necessary. Second, because there are only seven squads to service the entire city, police vehicles, particularly ambulwagons, are simultaneously dispatched when available to provide transport. The police vehicles are

TABLE 2-4
POLICE DEPARTMENT
EMERGENCY MEDICAL TRANSPORTS

	2-Man Scout	Ambul-wagon	Total	PERCENT OF TOTAL Scout	Wagon	Combined
RUNS						
1966	3,511	40,392	45,714	7.7	88.4	96.1
1967	4,178	32,041	38,083	11.0	84.1	95.1
1968	7,864	25,138	34,757	22.6	72.3	94.9
MILEAGE						
1966	22,180	233,025	277,242	8.0	84.1	92.1
1967	23,081	180,946	224,219	10.3	80.7	91.0
1968	48,161	144,708	212,391	22.7	68.1	90.8
MAN-HOURS						
1966	6,686	66,438	78,236	8.5	84.9	93.4
1967	7,340	56,354	69,644	10.5	80.9	91.4
1968	13,958	42,968	61,065	22.9	70.4	93.3

Sources: Annual Reports, Detroit Police Department

used when the equipment carried by the truck is not needed during transport.

The assistance provided by the police reduces the time that the squads are unavailable for other assignments and probably contributes somewhat to the relatively low service times recorded for the squads.

2-5. EFFECT OF THE SYSTEM ON POLICE AND FIRE OPERATIONS

As already indicated, the primary functions of the Police and Fire Departments are to provide services other than emergency medical care and transportation. The assignment of functions other than those which are the primary purpose of the department's existence must necessarily interfere with the ability to perform the primary functions to some degree. Economists attach a cost to such interference, terming it an "opportunity cost."

When not on an assigned police run, the police maintain patrol status, which serves a crime deterrent function. Inasmuch as the benefit derived from this function is difficult to estimate, the opportunity cost of interrupting the patrol function by assignment of an emergency medical run is equally difficult to estimate. For the police it may be more or less than the contributed personnel cost, which is discussed in the chapter on Cost Analysis (Chapter 14.) By contrast, the fire personnel and vehicles do not perform a patrol function when not on an assigned run. Once an assignment is completed, they return to their station and prepare for the next assignment. Nevertheless, an opportunity cost will also arise for the Fire Department if the number of emergency medical runs reaches such a volume that they interfere with the ability of the squads to respond to fire alarms. (It should be noted for proper perspective, however, that the number of false alarms received in the last several years has exceeded the number of runs made for emergency medical calls.[3])

[3]False alarms in 1965 were 6,610; in 1966, 8,260; in 1967, 10,848; and in 1968, 14,178. False alarms are estimated to be even larger in 1969.

ATTACHMENTS

CHAPTER TWO

ATTACHMENT 2-A

SCREENING OF TELEPHONE REQUESTS FOR POLICE SERVICE

(From General Order No. 2145, August 19, 1968)

VII. SICK OR INJURY CALLS

A. Private Dwellings

If the caller describes the illness or condition as a cut finger, headache, toothache, doctor or hospital appointment, trip to drugstore, fever and chills and similar minor conditions, advise the caller that the Police Department provides transportation in emergency cases only and suggest the following course of action:

1. call a friend, relative or neighbor for transportation;
2. call a taxi or utilize other public transportation;
3. call a private ambulance service; or
4. call the City Physician's Office if the caller indicates no funds are available.

When from the conversation with the caller, it appears that the victim is suffering a stroke, severe difficulty in breathing or a heart attack, a Detroit Fire Department Rescue Squad or a police vehicle will be sent.

If the caller indicates other serious illness or miscellaneous injury, i.e., serious bleeding, hysteria, miscarriage, etc., or the caller is alone and cannot respond to adequate questioning, a vehicle shall be dispatched. Attempt to determine if a station wagon is required.

Preceding page blank

B. <u>Public Place</u>

Generally, when a person suffers illness or injury in a public place that requires medical attention, a vehicle shall be dispatched.

VIII. MATERNITY CASES

When a caller requests transportation for an expectant mother experiencing ordinary childbirth, advise the caller of the alternatives listed under Sick and Injury Calls.

IX. MENTAL ILLNESS

When a physician has prepared a written order that a person is mentally ill, Michigan State Law demands that the police convey the subject to a hospital or other place of confinement.

In cases where a caller describes a person as "crazy," "insane," or "psychotic" the caller shall be advised to contact the City Physician's Office. If the caller indicates that the party has homicidal or other dangerous tendencies, a car shall be dispatched and action may be taken as directed by Chapter 9, Section 71, of the Police Manual.

X. ANIMALS

A. <u>Animal bites</u>

It is not normally a police function to treat or convey persons bitten by an animal. A car will not be sent unless:

1. the victim was bitten by an unknown dog or other animal that is still at large; or

2. when the victim is bitten on the head or face; or

3. when the injuries from the bite are serious enough to require immediate medical attention.

If the above factors are not present, the caller shall be advised to take the victim (or go himself shall he be the victim) to a doctor. He shall report the animal bite to the Department of Health before or after treatment. Telephone No. 872-3334, between the hours of 8:00 A.M. and 11:00 P.M. daily, seven days per week.

Note: The Department of Health recommends medical attention to an animal bite within 72 hours. In the interest of public safety, recommend treatment within 24 hours.

XI. ACCIDENTS - VEHICULAR

When a call is received for police services at the scene of an automobile accident, determine the following:

1. Was anyone injured?

2. Was there damage to City property?

3. Was either driver under the influence of liquor or narcotics?

4. Was this a hit-run accident?

5. Can the car move under its own power?

If the answer is NO to questions 1 through 4, and YES to question 5, the caller shall be advised to report the accident at any precinct station.

Police shall be dispatched in non-injury type accidents described above only when extreme extenuating circumstances demand police service.

Chapter 5
Section 31

ICK AND INJURY PROCEDURES[1]

ection 29. Sick and Injured Runs. A police vehicle shall be ispatched immediately when requested to assist persons who are njured or become sick in a public place, in extreme emergency ases to private homes or business places, and whenever requested y a city physician.

hen conveying sick persons or persons injured in miscellaneous ccidents which occur on private property, the officer shall repare the report of persons conveyed, D.P.D. 117. The preliminary complaint record shall be prepared in addition to D.P.D. 17 only in sick or injury cases involving a crime or in cases here a crime is suspected. The miscellaneous accident report hall be prepared in addition to D.P.D. 117 only when a miscellaneous accident occurs on public property or when city-owned quipment is involved.

mmediately after a person injured in a traffic accident has been onveyed to the hospital the A.P.B. shall be notified. The omicide Bureau shall be notified of all other persons conveyed.

ick or injured persons shall be conveyed to Detroit General ospital (Central Branch) or a hospital certified to provide emergency service. If a person affected or a relative or companion equests that he be taken to another hospital or to his home, the equest shall be complied with unless the other hospital or his ome is appreciably more distant. On the recommendation of a hysician or if it appears necessary to the officers because of he seriousness of the injury or illness, the person shall be taken o the nearest hospital.

he police dispatcher shall keep an up-to-date list of hospitals ertified by the chief physician to provide emergency care.

[1]From Detroit Police Manual Chapter 5, Section 31, Page 51, 967.

Police prisoners shall be taken to Detroit General Hospital (Central Branch). Police ambulance service will not be used for transportation of contagious disease cases. When necessary, transportation of contagious cases to Detroit General Hospital (Herman Kiefer Branch) will be provided by Detroit General Hospital (Central Branch) ambulance.

In the event responding officers encounter difficulty concerning the admittance of persons to an emergency hospital, they shall submit a preliminary complaint record through channels to the commanding officer of the precinct who will forward it to the deputy superintendent. Responding officers shall likewise submit one copy of the preliminary complaint record through channels to the commanding officer of the precinct when a person is not transferred to the nearest hospital from the scene. This report should include the reason why the person was taken to another hospital.

Section 30. Persons Being Treated by Pulmotor. A person being treated with a pulmotor or other device shall not be moved until the experts administering the treatment have completed their work.

Section 31. Advance Notice to Hospital in Case of Serious Injuries. When a person is seriously injured, the officer in charge at the scene shall notify the dispatcher immediately of the hospital (except Detroit General) to which the injured is being taken. The dispatcher will inform the hospital of the number of seriously injured persons being conveyed there. If a large number of seriously injured persons are being conveyed to Detroit General then this hospital shall be notified also. The officer in charge at the scene of the accident will report to the officer in charge of the station the name and address of each person injured and the hospital to which he was taken. The officer in charge of the station will be responsible for notifying the next of kin.

Section 36. Obstetrical Cases. Any member receiving a request to transport a woman in child labor to a hospital shall direct the person making the request to telephone the City Physician's Office. Ordinarily an ambulance from the Detroit General Hospital (Central Branch) will be sent. If an ambulance is not available, the City Physician's Office will request the dispatcher to send a scout car, which will be directed to transport the patient to a specified hospital.

If an officer encounters a maternity case in which hospitalization has not been previously arranged, and to which he has not been dispatched, he shall obtain the following information which must be relayed at once to the City Physician's Office:

A. name, age, address and telephone number of the woman;

B. whether or not she has received any prenatal care at Detroit General Hospital (Herman Kiefer Branch);

C. whether or not this is her first baby;

D. whether or not the pending birth is premature; and

E. any other information volunteered by the patient or obvious to the officer about her condition.

The City Physician's Office will determine to which hospital the woman shall be taken.

If the baby is born before the officers arrive, it should not be transported but should be placed next to the mother and kept warm. The umbilical cord should not be cut. The city physician shall be notified to send a doctor. Neither branch of the Detroit General Hospital has facilities for handling obstetrical cases and will not accept them under any circumstances.

Section 37. Persons Killed in Public. When a person has been killed on a street or other public place, the responding officers shall call the Accident Prevention Bureau immediately if death was the result of a traffic accident or the Homicide Bureau if death resulted from any other cause. The officers shall follow the instructions of the A.P.B. or Homicide Bureau.

Pending disposition of the body, it shall be covered with a blanket and the scene of death shall be maintained intact. In his report the officer shall state which medical examiner responded and where the remains were sent.

In all sick and injury runs, members shall keep in mind that they are not competent to pronounce death unless it is obvious. In cases where a doubt is present, it is always correct to assume the victim is alive and transport him to the hospital.

When a member sends an unconscious or a dead unknown person to a

hospital or morgue, he shall give in his report the color and make of clothing worn and an accurate description of the person including approximate age, height and weight. The commanding officer, of the precinct shall forward the name, residence and necessary facts to the information desk and the Homicide Bureau.

Section 38. Suicides. Persons who have attempted to commit suicide shall be conveyed to a hospital unless relatives offer strenuous objections. A suicide shall be treated as a murder until confirmed by a member of the Homicide Bureau.

When submitting a report of a suicide or an attempted suicide, the following information is necessary:

A. sex;

B. age and color or race;

C. marital status (married, single, widow, widower, divorced, separated);

D. method employed such as gun, knife, razor, hanging, drowning, jumping from building, gas, auto exhaust, poison, etc.;

E. cause such as ill health, financial trouble (distinguish between business failures, other losses of money, or destitution), love affairs, domestic trouble, unemployment, despondency in general, unknown; and

F. any other pertinent information.

Section 39. Mental Disturbances. All cases of mental disturbance shall be conveyed to the Detroit General Hospital (Central Branch).

TTACHMENT 2-B

Detroit Police Department

ACTIVITY LOG

MILEAGE ______

GALS. GAS ______ QTS. OIL ______ QTS. ALCOHOL ______

PLT. OR TOUR	PRECINCT AND CAR	CODE R OIL CHANGE DUE AT	SPEEDOMETER	CODE X OIL CHANGE DUE AT	SPEEDOMETER
			ON		ON
			OFF		OFF

OFFICERS	BADGE NO.	ON DUTY	OFF DUTY	TICKETS MOVING	PARKING	PED.	MISC.

RECAPITULATION OF POLICE AND SICK AND INJURY ACTIVITIES

	B&E's DISCOVERED	SICK OR INJURY RUNS
	PRELIMINARY COMPLAINT REPORTS SUBMITTED	MISCELLANEOUS ACCIDENT REPORTS
RRESTS	MOTOR VEHICLE ACCIDENT REPORTS	SICK OR INJURED CONVEYED
ILD	VALUE OF PROPERTY RECOVERED	MILES—SICK OR INJURY RUNS
PLAINTS	PRISONERS TRANSFERRED	TIME SPENT ON SICK OR INJURY RUNS (MINUTES)
	TIME SPENT ON POLICE RUNS (MINUTES)	TOTAL RUNS
GATED	TIME SPENT ON PATROL (MINUTES)	TOTAL MILES
ATED	TIME SPENT ON SPECIAL DETAILS (MINUTES)	
D	OTHER TIME OUT OF SERVICE (MINUTES)	
ERED	SIGNATURE OF RANKING OFFICER CHECKING LOG	

VEHICLE INSPECTION

	YES	NO
CAR CLEAN	☐	☐
FIRE EXTINGUISHER	☐	☐
HAND SPOTLIGHT	☐	☐
SPARE INFLATED	☐	☐
DOG STICK	☐	☐
NUMBER OF STRETCHERS		
REPAIRS NEEDED		
VISIBLE DAMAGE		

TOTAL	TYPE RUN	ACTIVITY AND DISPOSITION

v. 9-67) D.P.D. 25C

Preceding page blank

TIME			TYPE RUN	ACTIVITY AND DISPOSITION
FROM	TO	TOTAL		

ATTACHMENT 2-C

Detroit Police Department

PERSON CONVEYED FOR MEDICAL ATTENTION

HOSPITAL OR ADDRESS TO WHICH CONVEYED			DATE	TIME	
PATIENT'S LAST NAME (PRINT)	FIRST	MIDDLE	AGE	SEX	RACE
RESIDENCE ADDRESS		CITY - STATE	PHONE		
NAME OF RELATIVE OR FRIEND		RELATIONSHIP	PHONE		
LOCATION CONVEYED FROM		TYPE OF LOCATION: ☐ BUSINESS ☐ MANUFACTURING	☐ RESIDENCE ☐		
EMPLOYER'S NAME AND ADDRESS (IF SICK OR INJURED ON JOB)					
DETAILS OF INJURY OR ILLNESS					
HOMICIDE BUREAU NOTIFIED? ☐ YES ☐ NO	WHOM	OTHER BUREAUS NOTIFIED			
SIGNATURE OF OFFICER IN CHARGE OF VEHICLE		BADGE NO.	ASSIGNMENT		

DISTRIBUTION: 1—Hospital 1—Precinct Station
1—Accounting Office (only if sick or injured on job)

Form C of D—619-RE (Rev. 8-66) (PRECINCT FILE COPY IS TO BE RETAINED TWO YEARS.) D.P.D. 117

ATTACHMENT 2-D

THE FIRE DEPARTMENT'S SCREENING PROCESS

The following information was obtained from the Fire Department's operation manual for the communication center.

Extra Alarms

No Squads shall be dispatched on Specials during Extra Alarms; refer calls for Squads to the Police Department.

Street Accidents

Dispatch a Squad on all known street accident case reports, in order that the special equipment carried on the Squads can be utilized to aid or assist victims of the accident if needed.

Artificial Kidney Patients

Effective immediately and until further notice ALL Squad companies shall be permitted to transport Artificial Kidney Patients, living in the City of Detroit, out of the city limits for emergency treatment at Wayne County General Hospital Artificial Kidney Center at Eloise, Michigan.

Notification To Police Department

When a Squad is dispatched on a Special, the Dispatcher at Central Office shall immediately notify the Police Department Dispatcher, who shall send a Scout Car to the location.

Out of the District

Squads shall not be dispatched out of their respective districts except in cases of alarms of fire. If no Squad is available in the district from which the party is calling, have them call the Police Department.

Picking Up Squads

On Squad runs where Central Office has already dispatched a Squad, and the Police Department advises that they have a car on the way, do not turn the Squad back unless you have specific information that the Police Department has already removed the patient to the Hospital.

Ambulance Service

Squads shall not be used for ambulance service. They shall transport patients to the nearest emergency Hospital.

ATTACHMENT 2-E

DETROIT FIRE DEPARTMENT

CASE NO. ____________

SQUAD COMPANY OPERATIONS REPORT

Squad Co. ____________ **Unit No.** ____________

Date ______________________________ Personnel Responding ____________ Men

Time ______________________________ Distance Traveled ____________ Miles

Time worked ________ hrs. ________ min. Location ______________________________

Nature of case ______________________________ Cause ______________________________

Name of subject ______________________________ Sex ______ Address ______________________________

Age ________ years Married ☐ Single ☐ Color ______________________________

Condition on arrival: Conscious ☐ Unconscious ☐ Breathing ☐ Not Breathing ☐

Condition of subject when left ______________________________

Type of service rendered ______________________________

Transported to ______________________________ By ______________________________

Employee of ______________________________ Address ______________________________

Was Doctor present? ________ Doctor's name ______________________________ Address ______________________________

In whose charge was subject left ______________________________

Department called by ______________________________

REMARKS: ______________________________

____

____

____

____

Co. Commander

DISTRIBUTION:
White—Chief of Department
Yellow—Company File

Form C of D—146-FO (Rev. 10-58)
105052

CHAPTER THREE

MICHIGAN'S AMBULANCE ACT:
REQUIREMENTS AND IMPLICATIONS

Preceding page blank

CHAPTER THREE

MICHIGAN'S AMBULANCE ACT:
REQUIREMENTS AND IMPLICATIONS

In 1968 the Michigan Legislature enacted Public Act 258 in response to Highway Safety Program Standard 4.4.11. This act, effective July 1, 1969, established certain standards of operation for all public, private or voluntary purveyors of ambulance service. Although the specific intent of Standard 4.4.11 is to reduce the number of fatalities and the severity of injuries associated with traffic accidents, these incidents produce only a portion of the total demand for emergency medical service. Therefore, the implementation of these statutory standards will have a beneficial effect on victims of all medical emergencies, traumatic and non-traumatic.

3-1. MAJOR REQUIREMENTS

The purpose of the statute is to regulate the operation and annual licensing of ambulances and the qualifications and annual licensing of ambulance drivers and attendants.[1] The requirements of the law relate to four primary categories: equipment, personnel, vehicles and sanitation.

Equipment Requirements

The first-aid and medical equipment specified by the law is based on the minimal list recommended by the Committee on Trauma of the American College of Surgeons. All ambulances and dual-purpose vehicles serving as ambulances must carry oxygen equipment, including reducing valves, masks, a simple aspirating device, various airways and a hand-operated, bag-mask resuscitation unit. Splinting-immobilization equipment required includes long and short back boards, a half-ring

---

[1] A copy of the Act, the Administrative Rules and Minimal Equipment List is included at the end of this chapter as Attachment 3-A.

Preceding page blank

leg splint, various other splints, padded boards and pillows. Bandages, tape and dressings of various sizes are also required.

Personnel Requirements

All persons employed as ambulance attendants or attendant-drivers must be licensed annually by the Michigan Department of Public Health. They must carry their license whenever they are performing ambulance attendant duties. Applicants must be in sound physical health, as evidenced by an annual physical examination, and they must be free from physical defects or diseases which might impair their ability to carry out their duties. In addition, they must supply information on any previous felony and misdemeanor convictions. Licenses are issued after investigation reveals that the applicant is not addicted to the use of intoxicating liquors or narcotics. Prior to amendment, the act required that both ambulance attendants and drivers be licensed. Presently, a valid driver's or chauffeur's license is sufficient for the driver provided he is accompanied by a licensed attendant or attendant-driver.

Persons employed as attendants or attendant-drivers must also meet minimum training requirements as a condition of licensing. The advanced course in first aid given by the American Red Cross, training courses by the U. S. Bureau of Mines, the Medical Self-Help Program, St. John's Ambulance Corps, the National Ambulance Training Institute, and various military corpsman training programs are recognized as sufficient.[2] The law specifies that the attendant and/or attendant-driver hold a current certificate of training. The issuance of temporary, non-renewable attendant licenses is authorized to those individuals who meet all of the requirements of the statute, with the exception of

[2] It should be noted that obvious inconsistencies exist between training course content and the use of some of the equipment required by the statute: specifically the use of oxygen equipment, resusci-bag, respiratory airways and the short and long backboards. In addition, instruction in external cardiac massage is not included in several of the recognized courses.

training. Issuance is contingent upon completion of ten hours of training and current enrollment in one of the recognized training programs. These temporary licenses are valid only for ninety days and require that the licensee be accompanied by a licensed attendant or attendant-driver while performing the duties of an ambulance attendant.

Vehicle Requirements

All ambulances and dual-purpose vehicles operated as ambulances must be operated only under the immediate supervision and direction of a licensed attendant or attendant-driver. The vehicle must be at least a rear-door-opening station wagon, equipped with lights, siren and first-aid materials, and must contain two stretchers or cots capable of being secured in a stationary position. All licensed ambulances must also pass the state police vehicle safety inspection at least annually.

Sanitation Requirements

The requirements of the act in the area of sanitation are extensive. Some of the main items include complete interior and exterior cleanliness of ambulances at all times and numerous equipment and storage requirements (see Attachment 3-A).

3-2. MAJOR IMPLICATIONS

As has been reported in Chapter 2, Detroit's public emergency ambulance service is provided through a combined police/fire system and transports approximately 50,000 victims annually. Since this service is closely integrated and coordinated with that of the police and fire-fighting services, it is immediately apparent that significant changes and modifications imposed upon ambulance operations will also require a re-evaluation of the operational inter-relationships of the entire ambulance-police-fire service complex.

It is anticipated that an additional number of man-hours will be required for training, supply replenishment and vehicle sanitation; that additional vehicle space would be taken by the medical equipment; and that additional administrative effort would be required to implement and maintain the equipment, licensing and training standards. The impact of these upon the police and fire functions need to be assessed. It is also apparent that the costs of compliance with the statute will vary with the number of vehicles operated, the number of personnel trained and licensed, and the manner of operation of the system. The costs and performance characteristics of the present system and a number of alternative systems are estimated and discussed in Chapter 14.

ATTACHMENTS

CHAPTER THREE

ATTACHMENT 3-A

Act No. 258
Michigan Public Acts of 1968
as Amended by Act No. 260 of 1969

AN ACT to regulate the licensing and operation of ambulances; to provide for renewal of licenses; to regulate the licensing and qualifications of drivers and attendants; to regulate the operation of ambulances; and to authorize counties, cities, villages, charter townships and townships to contract for ambulance and inhalator services.

The People of the State of Michigan enact:

Sec. 1. As used in this act:

(a) "Ambulance" means any privately or publicly owned motor vehicle for highway use that is specially designed or constructed and equipped, and is intended to be used for and is maintained or operated for the transportation of patients, including dual purpose police patrol cars and funeral coaches or hearses which otherwise comply with the provisions of this act.

(b) "Attendant" means a trained or qualified individual responsible for the operation of an ambulance and the care of the patients whether or not the attendant also serves as driver.

(c) "Attendant-driver" means an individual who is qualified as an attendant and as a driver.

(d) "Driver" means an individual who drives an ambulance and meets the qualifications of this act.

(e) "Dual purpose police patrol car" means a vehicle, operated by a police department, which is equipped as an ambulance, even though it is also used for patrol or other police purposes.

(f) "Health officer" or "director" means the director of the state department of public health.

Preceding page blank

(g) "Patient" means an individual who is sick, injured, wounded, or otherwise incapacitated or helpless.

Sec. 2. The director of the department of public health shall promulgate such rules as are necessary for the purposes of this act in accordance with the provisions of Act No. 88 of the Public Acts of 1943, as amended, being sections 24.71 to 24.80 of the Compiled Laws of 1948, and subject to Act No. 197 of the Public Acts of 1952, as amended, being sections 24.101 to 24.110 of the Compiled Laws of 1948.

Sec. 3. No person shall furnish, operate, conduct, maintain, advertise, or otherwise be engaged in or profess to be engaged in the business or service of the transportation of patients upon the highways, streets, alleys or any public way in this state except in an ambulance licensed under the provisions of this act. An ambulance operated by an agency of the United States shall not be required to be licensed under the provisions of this act.

Sec. 4. (1) No ambulance shall be operated, and no individual shall drive, attend or permit it to be operated on any highway, street, alley or public way while transporting a patient or patients unless it shall be under the immediate supervision and direction of a person who meets the qualifications required by this act for an attendant or attendant-driver.

(2) The provisions of this act shall not apply to an ambulance from another state nor to the driver, attendant or attendant-driver of an ambulance from another state which:

(a) Is rendering assistance to licensed ambulances in the case of a major catastrophe or emergency for which the licensed ambulances of this state are insufficient or unable to cope; or

(b) Is operated from a location or headquarters outside of this state in order to transport patients across state lines, but no such outside ambulance shall be used to pick up patients within this state for transportation to locations within this state without meeting the provisions of this act.

(3) This act shall not be construed to supersede, limit

or otherwise affect the provisions of the state civil defense act and the interstate civil defense and disaster compact dealing with licenses for professional, mechanical or other skills for persons performing civil defense, emergency or disaster functions.

Sec. 5. Applications for ambulance licenses hereunder shall be made upon such forms as may be prepared or prescribed by the director and shall contain:

(a) The name and address of the registered owner of the ambulance.

(b) The trade or other fictitious name, if any, under which the registered owner of the ambulance does business or proposes to do business.

(c) A description of each ambulance, including the make, model, year of manufacture, motor and chassis number; current state license number; the length of time the ambulance has been in use; and the color scheme, insignia, name, monogram or other distinguishing characteristics used to designate the ambulance.

(d) The location and descriptions of the place or places from which it is intended to operate.

(e) Such other information as the director deems reasonably necessary to a fair determination of compliance with this act.

(f) An accompanying fee of $25.00 per ambulance or $10.00 per ambulance for nonprofit volunteer ambulance services. All local units of government shall be exempt from paying the fees required by this subsection.

(g) Any change of ownership of a licensed ambulance shall terminate the license and shall require a new application and a new license and conformance with all the requirements of this act as upon original licensing.

(h) A certificate of insurance in the amount and coverage as required by rules promulgated by the director.

Sec. 6. Licenses shall be good for 1 year and shall be renewed annually upon such application as required by rules promulgated by the director and payment of the fees prescribed in section 5.

Sec. 7. No ambulance shall be licensed under the provisions of this act unless it shall meet the following minimum requirements:

(a) Be at least a rear door opening station wagon.

(b) Be equipped with a flashing, oscillating or rotating red or blue light placed in such position on the ambulance as to be visible throughout an arc of 360 degrees.

(c) Be equipped with a siren capable of emitting sound audible under normal conditions from a distance of not less than 500 feet.

(d) Be equipped with sufficient equipment for administering oxygen to patients in the ambulance.

(e) Be equipped with minimum first aid equipment meeting standards as set forth in rules promulgated by the director.

Sec. 8. (1) The driver of an ambulance, when responding to an emergency call or while transporting a patient, may exercise the privileges set forth in this section, but subject to the conditions herein stated, and only when such driver has reasonable grounds to believe that an emergency in fact exists requiring the exercise of such privileges. Subject to the provisions of this subsection the driver of an ambulance may:

(a) Park or stand, irrespective of the otherwise applicable provisions of law, ordinance or regulation.

(b) Proceed past a red or stop signal or stop sign, but only after slowing down as may be necessary for safe operation.

(c) Exceed the maximum speed limits permitted by law, ordinance or regulation so long as he does not endanger life or property.

(d) Disregard laws, ordinances or regulations governing direction or movement or turning in specified directions.

(2) The exemptions granted in this section shall apply only when such ambulance is making use of audible and visual signals meeting the requirements of law, ordinance or regulation.

(3) The provisions of this section shall not relieve the driver of an ambulance from the duty to drive with due regard for the safety of all persons, nor shall such provisions protect the driver from the consequences of his reckless disregard for the safety of others.

Sec. 9. Each attendant or attendant-driver shall be licensed under the provisions of this act. Application shall be made upon such forms as may be prepared or furnished by the director and shall contain:

(a) The applicant's full name, current address and length of time he has resided in this state.

(b) The applicant's age, marital status, height, color of eyes and hair.

(c) Whether the applicant has ever been convicted of a felony or misdemeanor, and if so, when and where and for what cause.

(d) The applicant's training and experience in the transportation and care of patients, and whether he has previously been licensed as a driver, chauffeur, attendant or attendant-driver, and if so, when and where, and whether his license has even been revoked or suspended in any jurisdiction and if so for what cause.

(e) Such other information as the director shall deem necessary to assure compliance with this act.

(f) An accompanying license fee of $5.00 or $1.00 for nonprofit volunteer ambulance attendant or attendant-drivers and public police officers or firemen engaged as ambulance attendants or attendant-drivers.

Sec. 10. Licenses shall be good for 1 year and shall be renewed annually upon such application as required by rules promulgated by the director and payment of the fees prescribed in section 9.

Sec. 11. (1) the director or his designated representative, within a reasonable time after receipt of an application, shall make such investigation as he deems necessary of the applicant for driver's, attendant's or attendant-driver's license.

(2) The director shall issue a license to an attendant or attendant-driver, valid for a period of 1 year, unless earlier suspended, revoked or terminated, when he finds that:

(a) The applicant is not addicted to the use of intoxicating liquors or narcotics.

(b) The applicant is able to speak, read and write the English Language.

(c) The applicant has been found by a duly licensed physician, upon examination attested to on a form provided by the health officer, to be of sound physique, possessing eyesight corrected to at least 20/40 in the better eye, and free of physical defects or diseases which might impair the ability to drive or attend an ambulance.

(d) For each applicant for attendant or attendant-driver's license, that the applicant has a currently valid certificate evidencing successful completion of a course of training equivalent to the advanced course in first aid given by the American Red Cross or the United States bureau of mines.

(3) The driver of an ambulance shall not be required to be licensed under the provisions of this act if he has a currently valid driver's or chauffeur's license and is accompanied in the ambulance by a licensed attendant or attendant-driver, or if in an emergency he drives an ambulance which is provided by an employer for the sole use and protection of employees of such employer in an emergency.

Sec. 12. (Repealed)

Sec. 13. Any city, township, charter township, village or county may contract with a private person to furnish ambulance and inhalator service for the use and benefit of its residents and may pay for the entire cost or any part thereof from general funds.

Sec. 14. Any city, township, village or county may establish ordinances regulating ambulances, attendants, drivers and attendant-drivers meeting not less than the minimum requirements of this act and the rules of the director promulgated hereunder.

Sec. 15. (1) The director or his designated representative may suspend or revoke a license for failure of a licensee to comply and to maintain compliance with, or for violation of, any applicable provisions, standards or requirements of this act, or the rules, or any other applicable laws or ordinances or regulations promulgated thereunder, but only after warning and such reasonable time for compliance as may be set by the director. Within 10 days after a suspension, the licensee shall be afforded a hearing after reasonable notice. The director of his designated representative, within 10 days after conclusions of such hearing, shall issue a written decision which shall include written findings as to the suspension of said license, subject to Act No. 197 of the Public Acts of 1952, as amended. The written decision shall be promptly transmitted to the licensee.

(2) The initial, semiannual, or other ambulance, equipment and premise inspection reports of the director shall be prima facie evidence of compliance or noncompliance with, or violation of the provisions, standards and requirements for the licensing of ambulances.

(3) Upon suspension, revocation or termination of an ambulance license, operations as such shall cease with such ambulance and no person shall permit continued operation with such ambulance. Upon suspension, revocation or termination of a driver's, attendant's or attendant-driver's license, such driver, attendant or attendant-driver shall cease to drive or attend an ambulance, and no person shall employ or permit such individual to drive or attend an ambulance.

Sec. 16. Any person who violates the provisions of this act is guilty of a misdemeanor. The misdemeanor provision does not pertain to rules or regulations promulgated by the director.

Sec. 17. This act shall become effective July 1, 1969.

Approved July 1, 1968

Amended effective August 11, 1969

MICHIGAN ADMINISTRATIVE CODE
DEPARTMENT OF PUBLIC HEALTH

OFFICE OF DIRECTOR

AMBULANCES

Filed with Secretary of State, August 29, 1969, 12:00 noon.

(By authority conferred on the director of public health by section 2 of Act No. 258 of the Public Acts of 1968, being section 257.1202 of the Compiled Laws of 1948.)

R 325.2201. Definitions.

Rule 1. (1) The terms used in these rules have the same meaning as prescribed in the act.

(2) "Act" means Act No. 258 of the Public Acts of 1968, being sections 257.1201 to 257.1217 of the Compiled Laws of 1948.

(3) "Non-profit volunteer ambulance" as used in the act means an ambulance owned or operated by a group of individuals joined together for the express purpose of providing ambulance service to a community on a non-profit basis.

R 325.2202. Ambulance licenses; applications and issuance.

Rule 2. (1) An application for an ambulance license shall be made on forms provided by the director. The check or other instrument for the fee prescribed in the act shall be made payable to the state of Michigan and shall accompany the application.

(2) A temporary license shall be issued to a new applicant for a period of 6 months when the application shows that the applicant complies with the minimum requirements of the act.

(3) A conditional license shall be issued for a limited period to allow the applicant to correct deficiencies and

comply with the minimum requirements of the act.

(4) An annual license shall be issued:

(a) Following a temporary license when inspection shows that the ambulance is in compliance with the act and these rules.

(b) Following a conditional license when inspection shows that deficiencies have been corrected.

(c) Upon renewal application when the ambulance is in compliance with the act and these rules.

(5) An ambulance license remains the property of the department of public health.

R 325.2203. Ambulance licenses; expiration, termination and display

Rule 3. (1) An ambulance license expires on June 30 of each year and an application for renewal shall be made at least 1 month before that date for continuation without a lapse.

(2) A change in ambulance ownership terminates the license and requires a new application and a new license.

(3) An ambulance license sticker shall be displayed on the right side window of the ambulance so it is visible from the outside of the ambulance. An unlicensed vehicle shall not display a license sticker.

(4) An ambulance license shall be available for inspection at the base station of the ambulance.

R 325.2204. Ambulance attendant and attendant-driver licenses.

Rule 4. (1) An application for an ambulance attendant-driver license shall be made on forms provided by the director. The fee prescribed in the act shall be payable to the state of Michigan and shall accompany the application.

(2) An ambulance attendant or attendant-driver license shall be issued to an individual who meets the requirements of the act for attending patients carried by an ambulance.

(3) An attendant and an attendant-driver shall have a currently-valid certificate evidencing successful completion of the advanced course in first aid given by the American Red Cross, the U.S. Bureau of Mines, or the equivalent, including Medical Self-Help or St. John's Ambulance Corps training, certification by the National Ambulance Training Institute, or recognized training as a medical corpsman in the armed forces.

(4) A non-renewable temporary attendant license shall be issued for a period of 90 days to an individual who:

(a) Meets all requirements of the act except as to training.

(b) Has completed a minimum of 10 hours of training in 1 one of the training programs described in sub rule (3).

(c) Is enrolled in 1 of the training programs described in sub rule (3).

(d) Is accompanied by a licensed attendant or attendant-driver while performing duties as an attendant.

(5) A license is valid for 1 year, unless otherwise stated.

(6) The license remains the property of the department of public health.

(7) The license shall be carried by the licensee while performing the duties for which he is licensed.

R 325.2205. Ambulance equipment.

Rule 5. (1) An ambulance shall carry a minimum of first aid equipment as recommended by the Committee on Trauma of the American College of Surgeons or its equivalent, and appearing in Appendix A.

(2) Oxygen equipment shall consist of at least 2 series D or E oxygen cylinders, or the equivalent, with reducing valves and appropriate mask.

(3) An ambulance shall carry a minimum of 2 stretchers

or cots, 1 or both of which may be a folding stretcher and shall have a means of securing a stretcher or cot in a stationary position.

R 325.2206. Sanitation and equipment condition.

Rule 6. (1) The interior of an ambulance and the equipment in the ambulance shall be clean and sanitary and maintained in good working order at all times.

(2) Equipment shall be of smooth and easily cleanable construction.

(3) Freshly laundered or disposable linen shall be provided on a cot used to transport a patient. The linen shall be changed after each patient is transported. Clean linen storage shall be provided. Pillows and mattresses shall be kept clean and in good repair. Protective covers shall be provided. Blankets shall be laundered or dry cleaned at reasonable intervals.

(4) A closed compartment, kept free from dust, insects and rodents, shall be provided in the ambulance for first aid supplies. This compartment may be a portable container.

(5) A covered container or compartment shall be provided for soiled supplies where deemed necessary.

(6) Storage spaces used for storage of linens, equipment, first aid and other supplies at base stations shall be kept clean and free from unnecessary articles.

(7) An implement to be inserted into a patient's nose or mouth should be single-service, wrapped, and properly stored and handled. The local health department shall be consulted for instructions in sanitization and handling of multiple-use items when used.

(8) The exterior surface of an ambulance shall be cleaned routinely.

(9) When an ambulance has been used to transport a patient known to the owner of the ambulance service or his agent to have a communicable disease other than a common cold,

the vehicle shall be cleansed and all contact surfaces shall be washed with soap and water before another patient is transported.

R 325.2207. Safety.

Rule 7. An ambulance shall pass the state police vehicle safety inspection at least annually.

R 325.2208. Insurance.

Rule 8. An ambulance owner or operator shall possess:

(a) Liability insurance in the amount of $100,000 for each individual claim and $300,000.00 for total claims for personal injury from any 1 occurrence.

(b) Liability insurance in the amount of $25,000.00 for property damage from any 1 occurrence.

APPENDIX A

MINIMAL EQUIPMENT LIST
for
Ambulances and Dual Purposes Vehicles serving as Ambulances
Approved by the Committee on Trauma,
American College of Surgeons, as Published in
Bulletin of the American College of Surgeons
Volume 52, March-April, 1967, Number 2.

1. Hinged half-ring lower extremity splint with webbing ankle hitch.

2. Two or more padded boards, 4½ feet long by 3 inches wide, and 2 or more similar padded boards, 3 feet long by 3 inches wide, of material comparable to 4-ply wood, for coaptation splinting of fracture of leg or thigh.

3. Two or more padded 15-inch by 3-inch wood or cardboard splints for fractures of the forearm.

4. Short and long spine boards with accessories.

ATTACHMENT 3-A

5. Oxygen tanks and masks of assorted sizes.
6. Hand-operated bag-mask resuscitation unit with adult-, child-, and infant-size masks, a unit which can be attached to oxygen supply being preferred.
7. Simple suction apparatus with catheter.
8. Mouth-to-mouth, 2 way resuscitation airways for adults and children.
9. Oropharyngeal airways.
10. Mouth gags made of 3 tongue blades taped together and padded.
11. Universal dressing, approximately 10 inches by 36 inches, packaged folded to 10 inches by 9 inches.
12. Sterile gauze pads.
13. One-,2-, and 3-inch adhesive tape on cylinder.
14. Six-inch by 5-yard soft roller-type bandages.
15. Triangular bandages.
16. Safety pins, large size.
17. Shears for bandages.
18. Several pillows.

CHAPTER FOUR

DETROIT'S EMERGENCY MEDICAL DEMONSTRATION PROJECT

CHAPTER FOUR

DETROIT'S EMERGENCY MEDICAL DEMONSTRATION PROJECT

This chapter will briefly summarize the Detroit Emergency Medical Demonstration Project and outline the steps taken to introduce new, measurable features into the present system. All of these features are described here except for the helicopter-ambulance, which is discussed in Chapters 13 and 14.

-1. A SUMMARY DESCRIPTION OF THE PROJECT

The emergency medical response study in Detroit involved the observation and analysis of several emergency response methods and their comparison, total or partial, with respect to costs and benefits. The city's existing emergency response procedures and units (police ambulwagon patrols and fire rescue squads) were augmented with several technical improvements that would be evaluated. Among these was the emergency reporting capability of citizens band radio groups, which added to the accident injury detection-notification process. Attendant police officers were given special medical training and furnished with emergency equipment, both of which would be assessed in terms of their effect on the quality of treatment provided against the training and equipment used in other response methods. Another feature introduced to the response systems was a contracted ambulance service. Two fully equipped ambulances with highly trained crews were assigned to transport, in selected areas, all police emergency patients. The use of this transportation service provided a means of comparing a single-purpose ambulance response system to the existing dual-purpose police and fire services.

To summarize, the emergency ground response systems to be demonstrated were:

1. the police ambulwagon service as normally operated.

2. the fire rescue squad service as normally operated.

Preceding page blank

3. the police ambulwagon service with personnel specially trained and equipped under the project.

4. the single-purpose commercial ambulance service with highly trained and equipped crews.

The four systems had differences of vehicle type, equipment carried and the size, duties and treatment capabilities of the crews.

The Demonstration Phases and Data Periods

Three demonstration phases, each of approximately three months, were established to implement the response systems within four of the city's police precincts. One month within each phase was designated as a data collection period.

In the first phase, from November, 1968, through January, 1969, the police carried emergency transports in the normal manner. For one month of that phase from mid-November to mid-December, police officers in the four precincts gathered control data for project purposes. They documented their conveyance cases with ambulance attendant forms, on which they indicated the treatment they had rendered. The patients transported were tagged with identification bands so that hospital staff could identify them and further evaluate the treatment rendered. The first demonstration phase and data collection period were concerned only with the existing police operation.

In the second demonstration phase, from February through April, 1969, the fire rescue squads, the commercial ambulances, and project-trained and equipped police were added to the demonstration response system. In April, the month chosen for data collection, the crewmen of the four response systems documented all cases requiring transport and treatment. Each system had an assigned demonstration precinct in which to operate. Staff of hospitals in or near the precincts evaluated the treatment rendered by personnel of the four response systems.

The third demonstration phase was from May through August, 1969, with August the data-collection month. Again, crews

of all four systems completed data forms on the treatment rendered, and hospital emergency room staff made evaluations. During this phase, however, the commercial service operated in a different precinct then during the second phase. Moreover, an additional group of policemen were trained and assigned to ambulwagons which were now specially equipped, in the precinct formerly serviced by the commercial attendants. The result was to allow all the response systems to be tested in one precinct. The principal benefit of this was that staff from one hospital could evaluate the treatment given by personnel of all the systems. This arrangement in turn resulted in the generation of more consistent and more comparable data, from which conclusions of greater empirical validity could be drawn.

4-2. THE ORGANIZATION OF THE PROJECT

The Mayor's Committee for Community Renewal was responsible for a variety of tasks connected with organization of the various elements of the project. Among the first tasks undertaken were the selection of specific geographic areas for the demonstration, and the determination of the agencies to be involved and the equipment to be used. After selection of four police precincts as demonstration areas, suitable hospitals in the vicinity were identified. In addition, liaisons with the appropriate city agencies were developed, the cooperation of hospital personnel enlisted, and the services of systems analysis consultants and commercial ambulance firms were contracted.

Other tasks included surveying citizen radio groups, briefing ambulance attendants and hospital personnel, arranging housing for the commercial ambulance attendants at city facilities, and tying the commercial ambulances into the police dispatch system. Information is provided in this section on these and other tasks involved in organizing the elements of the project.

Establishing A Committee

One of the first steps taken by the Community Renewal staff was establishment of an advisory committee on the Emergency Medical Demonstration Project. Representatives of private and public safety agencies concerned with emergency services or with the operations of the project were requested to serve on the committee. Starting in August of 1968, meetings were scheduled and held once a month. The procedure for committee decision making was agreed upon as "rule by simple majority." A full list of committee members and their affiliation is given in the acknowledgements.

The assistance of the committee was invaluable. The project staff relied greatly on their advice regarding contractors and the other resources available for the project and on their general guidance in solving often difficult technical problems. In addition, the members of the committee served to keep their parent agencies informed of the project's progress.

Choice of Precincts

Several factors were considered in selecting the area for the experiment. The recognition that the police received the greatest majority of public emergency cases requiring transportation was the critical factor causing the police precinct to be chosen as the demonstration area. Another factor was that police data on emergency medical services existed on a city-wide basis as well as for each individual precinct. Such information provided excellent background data which could be compared with the data gathered in the demonstration.

Selection of the specific demonstration precincts also involved consideration of a number of factors. These included the geographic size and socio-economic ratings of the areas, the ratio of police to population, the existence of expressways in the areas, and the location and number of open emergency rooms. Of the four precincts chosen, two are in the inner city--Precincts 6 and 7; and the other two precincts, 15 and 16, are located at the outer limits of the city. A precinct map can be found in Chapter 2.

The inspectors in command of the precincts were briefed on the project's purpose and the specifics to be demonstrated. With the precinct inspectors' approval, all patrolmen serving in each precinct were given an orientation to the project and instructed as to their role in it. Any one of

these men could be assigned a police station wagon for patrol. Altogether, the police ambulwagon demonstration would thus involve well over five hundred patrolmen at the four precincts.

Determination of Hospitals

The number of hospitals that could be involved was limited to those within or near the police precincts chosen. Selection of suitable hospitals within that group was governed principally by whether the emergency room was operating twenty-four hours a day. It is pertinent here to point out that even those hospitals which do provide around-the-clock emergency service routinely call the police IMPACT and fire dispatch centers, notifying them that the hospital is at capacity. In essence, the hospital is asking that public emergency patients be transported elsewhere if possible.

Previously a 1965 survey of police emergency transports had provided an indication of which hospitals accommodated the largest number of emergency patients. This was consulted to narrow down the number of hospitals to be considered, and the present police utilization of the remainder was ascertained from the inspectors at each precinct.

Based on the frequency of police use, fourteen hospitals were requested to participate in the demonstration. The most important was city-owned Detroit General Hospital, which receives about fifty percent of all the city's serious emergency cases and has been heavily relied upon by the population of two inner-city demonstration precincts. With some encouragement the administrators of all fourteen hospitals agreed to participate in the demonstration.

The fourteen participating hospitals were:

1. Henry Ford, 2799 W. Grand Boulevard
2. Zieger, 4244 Livernois
3. Northwest General, 8741 W. Chicago
4. Detroit General, 1420 St. Antoine
5. Deaconess, 3245 E. Jefferson
6. St. Joseph, 2200 E. Grand Boulevard
7. St. John's, 22101 Moross
8. Holy Cross, 4777 E. Outer Drive

9. Saratoga, 15000 Gratiot
10. Sinai, 6767 W. Outer Drive
11. Mt. Carmel, 6071 W. Outer Drive
12. Martin Place West, 19535 Schoolcraft
13. Redford Community, 25210 Grand River
14. Botsford General, 28050 Grand River, Farmington

Hospitals which developed a helistop during the project were: Detroit General, St. John's, Holy Cross, Saratoga, and Mt. Carmel. Botsford had a developed landing site before the project started. (The approximate locations of the participating hospitals are shown in Figure 4-1.)

Emergency room personnel at the participating hospitals were then shown how to complete forms on patients being transported to their facility as part of the program.

During the months of data collection the emergency room personnel completed the evaluation forms on all demonstration area patients transported by the police, rescue squads or the contracted ambulance firm. Patients were recognized through a hospital identification band which the transporting attendants secured to the patient. The bands were color-coded or otherwise marked to designate each police precinct, the fire rescue squad, or the private ambulance firm. Preceding each data period, emergency room physicians or their staff were briefed on the next period of data collection and advised of areas in which the medical evaluations could be improved.

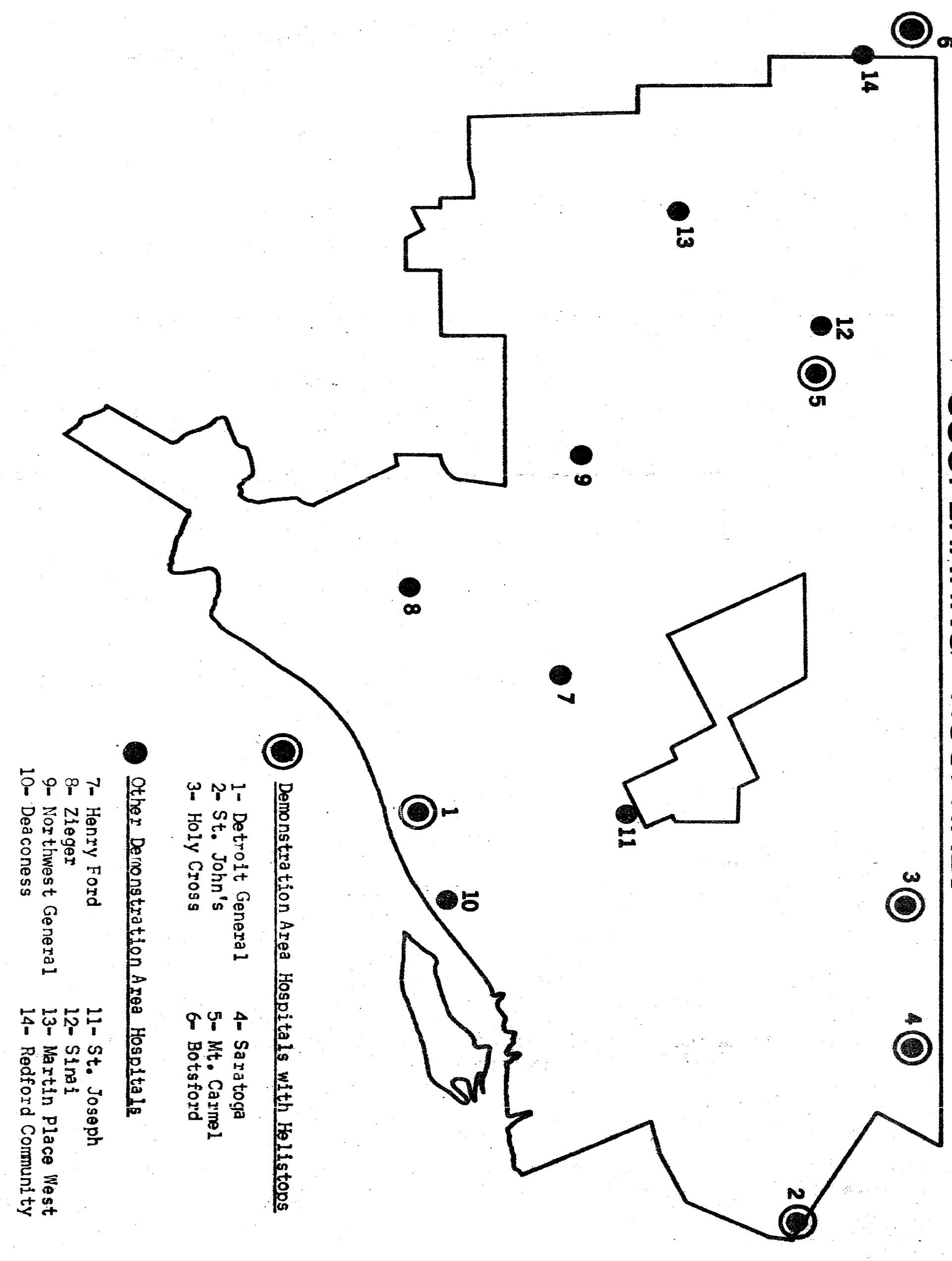
Survey of Emergency Reporting Groups

Project staff investigated several emergency detection and notification groups which voluntarily reported accidents or other emergency situations. These groups were outside the Police and Fire Departments' communication centers but supplemented the emergency reporting function. (The fire and police communication centers are described in Chapter 2.) When a group was large enough to have an impact on the reporting of incidents within the scope of the demonstration, they were requested to participate.

The communication groups investigated included the Community

FIGURE 4-1

COOPERATING HOSPITALS



Radio Watch, the Citizens Band Network, the expressway television-reporting system, and several other community-based radio patrol groups. Considering the fact that the 2.3-mile area of the expressway under surveillance, the Lodge Freeway, was outside the demonstration precincts and that, therefore, information accumulated would not directly relate to the project, the TV surveillance system was excluded from further study. Interviews with the citizens band patrol groups made it clear that they had a limited number of operational hours (mainly while driving to and from work and on week-ends) and that they operated chiefly on the highway system outside the city limits. Rarely, comparatively speaking, did they report injury accidents to the Detroit authorities. For these reasons volunteer citizens band groups were not included in the data base.

The Community Radio Watch: The Community Radio Watch is Detroit's largest radio-reporting volunteer group. The organization is sponsored by the Detroit Police Department. The group is comprised of forty-eight business and government agencies which dispatch their vehicles by radio--mostly commercial band. The intent is to have the driver on the road notify the company dispatcher of the incidents, crimes and accidents that he observes. There are well over forty-one hundred radio-equipped cabs, delivery trucks, and buses, etc., involved in the program.

Executives from firms having over fifty vehicles were interviewed for the purpose of obtaining the participation of firm vehicle drivers, in which they would make special note of emergencies requiring medical attention. The firms were left with promotional material, window stickers, and literature with instructions regarding proper reporting procedures for the drivers. Agreement to participate was obtained from fifteen, or nearly all, of the firms; and almost thirty-five hundred vehicles were thus added to the demonstration reporting system.

The Citizen Band Network: The Citizen Band Network is a driver-aid, emergency reporting network presently operated by the City of Detroit Department of Streets and Traffic. At the inception of the demonstration project, however, the network was at an experimental stage, jointly sponsored by the City department and the General Motors Research Laboratories. The purpose of the network is to receive reports

of unsafe conditions on city roadways and to dispatch road crews when necessary.

Calls requiring the assistance of some other city department are referred for its action. Serious injury accident reports are relayed to the Police IMPACT Center by direct police phone. Typical items reported include traffic hazards, vehicle accidents, stalled cars, and inoperative signal lights. Reports are recorded for computer analysis at a future date.

Functionally, the network is unique in that the operation of remote radio units is made possible by tying their short-range transmissions (Channel 9) into a telephone channel which boosts the distance of the messages.[1]

Approximately one hundred city and General Motors Company vehicles report through the network. The city vehicles are operated by persons who travel city streets in the course of their work day. A lesser number of General Motors cars function in a similar fashion. Additional staff were hired during the demonstration project for a period of time to run the control center seventeen hours a day and on week-ends so that the emergency medical reporting value of the system could be tested and observed beyond the scope of the existing operation.

Selection and Purchase of Equipment

Determination of the equipment to be used in the police ambulwagons was based on the listing suggested by the American College of Surgeons Committee on Trauma. The equipment was acquired and several methods of storing and placing it in the station wagon were attempted. Advice given by the Police Research and Development Bureau emphasized that the equipment should be secured so that it could not be stolen, and locked in place so that criminals being transported in the vehicle could not use it as a weapon against police officers. In accordance with their suggestions, two wooden, latch-lock boxes were built to

---

[1]Special Federal Communication Commission approval has been provisionally granted so that this system could be tested by G.M. and the city.

Each of the commercial attendants had taken the National Ambulance Institute Training Course. Several of the attendants were also veteran para-medics. In contrast to the police and firemen, the attendants had only one function to perform: to treat and transport injured patients.

A list of the equipment in the commercial vehicles is included as Attachment 4-C. A comparison can be made between the equipment package carried by the commercial service and the one installed in the ambulwagons.

Problems Encountered: Several significant problems were posed by the fact that a private firm would be transporting patients normally transported by the police. Anticipating the case of injured criminals, it was decided that commercial attendants would transport even those persons in police custody, but that a police officer would accompany them. Another problem was also related to police work. The guidelines for homicide and suicide cases were frequently reviewed with the private attendants so that court evidence would not be destroyed or moved. A third problem was one of "community relations." After a case in which the problem had arisen, the attendants were instructed to examine and treat injuries inside their vehicle if they expected any type of crowd antagonism. Despite the severity of injury and the requirements of professional technique, the attendants were advised against becoming the focus of crowd attention when they provided treatment.

Medical Training Programs For Police Attendants

One part of the project design was to develop an experimental emergency medical response method which employed specially trained and equipped police officers and which could be compared to the normal police method and the other methods of training and treatment used in the project. In keeping with this plan, two levels of first-aid training for officers were established: a twenty-hour advanced course and a five-hour review course. The officers were invited to volunteer for the paid course sessions.

The Advanced Course: The advanced level of training arranged by project staff was taught by professors of surgery from the Wayne State University School of Medicine. The surgeon-professors were contracted with to develop a twenty-hour training course. A total of twenty-five police officers from Precinct 15 were trained in the first class. These officers would drive the ambulwagons that would be medically equipped according to the specifications of the State ambulance law. Emphasis in the course was placed on mouth-to-mouth and cardio-pulmonary resuscitation. Each of the class sessions was limited to eight patrolmen so that practice sessions would be frequent and easy to supervise. A course syllabus listing the text and the teaching aids used (movies) is attached as Attachment 4-D. As mentioned in the summary description of the demonstration phases, a second advanced training session was held for some of the police officers participating in the third phase. Seventy-five police officers from Precinct 7 were trained. The professors decided that the course could be reduced from twenty to eighteen hours. The Wayne County Medical Society donated a classroom for training purposes and the Michigan Heart Association made several cardiac training manikins available for the practice sessions.

The Review Course: The review training course consisted of five hours of first-aid review training by instructors from the Detroit Fire Department Academy. These instructors were chosen to instruct the class because they were familiar with oxygen and could teach its use and application. The review course emphasized the "A,B,C's" of first-aid: airways, breathing and circulation. Officers were also familiarized with the equipment, particularly the back-and neck-boards and the oxygen cylinders, that would be placed in their station wagons. As in the advanced course, the class size was small; but practice sessions were kept to a minimum. A total of fifty police officers from Precinct 15 were given the review training. It was intended that these officers and the advanced-training officers in that precinct would supplement each other when they were on emergency medical runs and also provide a basis for comparing the two training levels.

4-4. BRIEFING SESSIONS

Before initiating any aspect of the project or any one of the three data-collection periods, briefing sessions were held by CRP and University of Michigan Institute staff with the personnel involved in the demonstration. For the first period only the officers from the four demonstration precincts and the emergency room personnel from the fourteen cooperating hospitals were briefed. Personnel from the five rescue squads, the commercial ambulances and the police and fire communication centers were included in the briefing sessions for the second and third data periods. Sessions were scheduled for each work shift at each of the cooperating units.

The briefings involved an explanation of the project's purpose, the attendant data form or the hospital evaluation sheet, the correct manner of completing forms and the patient tag identification system. Stress was placed on accuracy in filling out the data sheets. The briefings permitted the transmittal of feedback from previous data-collection periods which indicated areas that could be improved by the attendants and hospital evaluators. In addition, the meetings resulted in a general upgrading of the information gathered.

ATTACHMENTS

CHAPTER FOUR

ATTACHMENT 4-A

MEDICAL EQUIPMENT FOR POLICE AMBULWAGONS*

Airway Equipment

Adult and child resuscitation airways
Aspirating suction pump (foot-operated)
Six-foot rubber tubing for oxygen tanks
Folding, clear plastic resusci-bags with assorted masks and oropharyngeal airways
Oxygen cylinders "D" size (rented)
Oxygen bottle wrenches
Oxygen regulators with flow meter and content gauge
Tongue blades

Bandaging Equipment

Large, roller-type bandages
Gauze pads (assorted sizes)
Universal compresses
Tape (assorted sizes)
Bandage shears

Splinting and Immobilization Equipment

Folding aluminum backboards (for back and neck)
Inflatable leg splints
Inflatable arm splints
Wooden arm splints
Triangular bandages with safety pins

Other

Bags for carrying equipment
Pillows
Exceptions: blankets and cots already carried.
No linen was supplied.

*The equipment included is in accord with the specifications of the Michigan Ambulance Act, P.A. 258, which incorporated the recommendations of the American College of Surgeons. To conserve space, however, minor substitutions were made.

Preceding page blank

ATTACHMENT 4-B

City of Detroit
ROMAN S. GRIBBS, Mayor
MAYOR'S COMMITTEE FOR COMMUNITY RENEWAL
802 CITY-COUNTY BUILDING
DETROIT, MICHIGAN 48226
963-1012

HOMER HALL, Acting Director
MILTON ROHWER, Assistant Director

November 8, 1968

Gentlemen:

RE: Request for Proposal to provide an Ambulance Service in Detroit for the Emergency Medical Demonstration Project

The City of Detroit has been awarded a grant by the United States Department of Transportation for an 18 month emergency medical demonstration project. The demonstration project, centering on emergency ambulance services in Detroit, is being conducted jointly by the Detroit Community Renewal Program (CRP) and the University of Michigan's Highway Safety Research Institute. The project, designed to demonstrate a modern emergency medical system using up-to-date technologies, will basically consist of the operation of a number of communication systems, ambulance services, and medical activities, as well as the collection of data concerning these activities.

One of the objectives of the program is to increase the capability for coordinated dispatch of specially trained medical or paramedical assistance to accident victims. We intend to meet this objective in two ways. First, by augmenting the existing ground ambulance service in two police precincts in Detroit during the operational phase of the project. The CRP will introduce in precincts 7 and 16 a fully equipped modern commercial ground ambulance service from February 1, 1969 to July 31, 1969. Two fully equipped ambulances, housed three months in each precinct, will be required for this period.

Second, we intend to introduce a medically equipped helicopter ambulance service to operate on a city-wide basis. This service will operate from February 1, 1969 to July 31, 1969. The ambulance equipped helicopter will also be used for traffic surveillance during the assigned flight hours. This letter will

Preceding page blank

ATTACHMENT 4-B

:line our basic requirements for the ground and air ambulance :vice. If you are interested in supplying this service, we ɪuest that your firm submit a formal proposal to the Mayor's nmittee for Community Renewal specifying in sufficient detail ɪr capabilities to supply the service.

separate proposal may be submitted for the ambulance service 1/or for the ambulance equipped helicopter service. A com-ned proposal for both services may also be submitted. Proposals ould indicate the costs for the provision of the services and a :ailed description of the equipment is to be provided. The :ached list of information and requirements should govern your oposal.

will be happy to answer any questions you may have about ecific items. Because this project phase is scheduled to begin oruary 1st, we would appreciate learning of your intentions in jard to submitting a proposal by November 25, 1968. The actual oposal should be submitted by December 15, 1968.

Sincerely,

James D. Wiley
Director

:ach.

ATTACHMENT 4-B

I. THE AMBULANCE SERVICE

Considerations for the ground service are:

1. Dispatch — The vehicles and staff will be dispatched by the police communication prep radio system. The contractor will be responsible for radio equipment on loan. Instruction on use of the radio will be given.

2. Clientele — Clientele will be persons normally serviced by the Detroit Police Department. The ambulance will respond to these calls exclusively. Service shall be rendered without regard to race, color, creed, national origin or sex.

3. Ambulance — Two modern and mechanically sound ambulances will be required. The proposal should include a description of the vehicles to be used, type and make, the dimensions of the patient compartment, patient capacity, stretcher arrangement, loading facilities, air conditioning, etc.

The vehicles and their equipment shall be maintained and kept in clean condition by the contractor. Warning lights and siren must be in accordance with the laws of the State and City of Detroit. The vehicles shall also be equipped with instruments and meters to record mileage traveled. The ambulances to be used must be specified and are to be subject to inspection by members of the CRP staff.

4. Housing — The proposal should consider two separate alternates in planning for housing facilities.

a. Housing to be provided by the contractor

b. Housing to be provided by the city at no cost to the contractor.

5. Equipment

Equipment should approximate that which is recommended by the American College of Surgeons Committee on Trauma and conform to state law, HB #3946.

The equipment carried must include a heart lung resuscitator, a resuscitator with masks of assorted sizes, an aspirator, a hand Ambu, as well as large universal dressings, sterile gauze pads, assorted gauze, muslin and elastic bandages, adhesive tape, tourniquets, tongue blades, bandage shears, safety pins, triangular bandages or slings, assorted arm and leg splints, padded boards, oropharyngeal airways, mouth to mouth resuscitation airways, sandbags and spine boards.

A list of equipment (including safety equipment) must be included in the proposal.

6. Drivers and Attendants

Both the driver and attendant must have at minimum, National Ambulance Training Institute certification or its equivalent. Type and recency of training must be outlined in the proposal.

An attendant and driver for each vehicle must be available twenty-four (24) hours a day, seven (7) days a week for the contract period.

The driver must have a good driving record and be properly licensed.

Both the driver and attendant will be

required to fill out and complete check lists and forms on each patient run as part of the experiment.

Additional consideration will be given to those firms employing war veteran medics.

The contractor shall comply with the requirements of the Michigan Workman's Compensation Act and will maintain insurance to the limits required by law.

7. Insurance

The contractor must agree to furnish Property Damage Insurance in the sum of $50,000 and Public Liability (Bodily Injury) Insurance of $50,000 for one person and $200,000 for any more than one occurrence. The City of Detroit is to be additionally insured.

8. Fair Employment Practices

The contractor must agree that he will not discriminate against any employee or applicant for employment to be employed in the performance of this Contract with respect to his hire, tenure, terms, conditions or privileges of employment or any matter directly or indirectly related to employment because of his age, except when based on a bona fide occupational qualification or because of his race, color, religion, national origin or ancestry. (Act No. 251 P. A. 1955, as amended.)

The contractor further agrees that he will take affirmative action to insure that applicants are employed and that employees are treated during employment without regard to age, sex, race, creed, color or national origin. Affirmative action shall mean: 1) The issuance of a statement of policy regarding equal employment opportunity and its communication to all personnel involved in recruitment, hiring, training, assignment and promotion; 2) Notification of all employment sources of company policy and active efforts to review the qualifications of all applicants regardless of age, sex, race, creed, color or national origin; 3) Recruiting in the minority group community for employees; and 4) Establishing an internal system of reporting concerning equal employment, recruiting, hiring, upgrading and the like. (City of Detroit Ordinance No. 206-G.)

Breach of these covenants may be regarded as a material breach of the contract.

II. THE HELICOPTER-AMBULANCE SERVICE

1. Helicopter

The helicopter is to be ambulance equipped, modern, mechanically sound and have compartment provision for carrying a patient, an attendant and pilot, or two patients and a pilot.

A description of the helicopter, type, make dimensions of the patient compartment, stretcher/litter arrangement and loading facilities, etc., must be included in the proposal.

Maintenance of the craft and equipment, and storage will be a responsibility of the contractor.

Records of flight time will be kept and made available by the contractor.

2. Hours of Operation

Flight time and standby time will be required.

Flight time: Flight time is to be scheduled for two hours per week day, 4:00-6:00 p.m., Monday through Friday from February 1, through July 31.

During flight hours the craft, pilot and attendant will be available for emergency medical rescues, traffic surveillance, patient transfer, and blood plasma delivery, etc.

The cost of the assigned flight hours must be submitted with the proposal.

Stand-by time: Within budget limitations, a number of stand-by hours will be purchased. This will involve the craft pilot and attendant being available on a stand-by basis for emergency rescue operations.

The proposal submitted is to include a cost per hour for the provision of this service.

3. Staff

a. Pilots are to be appropriately licensed. Commercial Helicopter ratings of the pilots are to be available on request.

b. An attendant, employed by the contractor, with current National Ambulance Training Institute training, or its equivalent, will be required during flight hours for a six month period.

c. The contractor shall comply with the requirement of the Michigan Workman's Compensation Act and will maintain insurance to the limits required by law.

d. Additional consideration will be given to those firms employing war veteran medics.

e. The attendant will be required to fill out patient check lists and forms for emergency flights as part of the experiment.

f. The pilot must maintain and have available a flight log.

4. Equipment

Medical equipment will approximate, within reason, that which is suggested by the American College of Surgeons Committee on Trauma. (See equipment listed under the ambulance requirements.)

A list of those items with which the contractor can comply should be submitted in the proposal. The craft to be used must be specified and must be subject to inspection by members of the CRP staff.

5. Communication

The aircraft will be in communication with the Detroit Police Department Communications Center during flight hours.

Communication will be by police prep radio. An instruction period will be required.

The contractor will be responsible for radio equipment on loan.

6. Insurance

The contractor must agree to furnish Property Damage Insurance in the sum of $500,000, and Public Liability Insurance in the amount of $100,000. In addition vendor agrees to furnish $100,000 Passenger Liability Insurance per passenger. City of Detroit is to be named as an additional insured. A certificate of insurance is to be submitted with the proposal.

7. Service

Service shall be rendered without regard to race, color, creed, national origin, or sex.

8. Fair Employment Practices

The contractor must agree that he will not discriminate against any employee or applicant for employment, to be employed in the performance of this contract with respect to his hire, tenure, terms, conditions or privileges of employment or any matter directly or indirectly related to employment because of his age, except when based on a bona fide occupational qualification or because of his race, color, religion, national origin or ancestry. (Act No. 251 P.A. 1955, as amended.)

The contractor further agrees that he will take affirmative action to insure that applicants are employed and that employees are treated during employment without regard to age, sex, race, creed, color or national origin. Affirmative action shall mean: 1) The issuance of a statement of policy regarding equal employment opportunity and its communication to all personnel involved in recruitment, hiring, training, assignment and promotion; 2) Notification of all employment sources of company policy and active efforts to review the qualifications of all applicants regardless of age, sex, race, creed, color or national origin; 3) Recruiting in the minority group community for employees; and 4) Establishing an internal system of reporting concerning equal employment, recruiting, hiring, upgrading and the like. (City of Detroit Ordinance No. 206-G.)

Breach of these covenants may be regarded as a material breach of the contract.

Companies Mailed Request for Proposal:

Acme Ambulance Service
American Ambulance Company
Blue Star Ambulance Company
Detroit Ambulance Service
Dietrich Ambulance Service
Fleet Ambulance Service
General Ambulance Service
Michigan Ambulance Company
Quick Ambulance Service
Suburban Ambulance Service
Superior Ambulance Service
Universal Ambulance Service
Webb-Mercy Ambulance Service, Inc.

Subsidiary companies to above:

A. A. Ambulance Accommodation Company
Airport Ambulance Servic
Allen Park Ambulance Service
Ambulance Service Company, Inc.
Brooks Ambulance Service, Inc.
Central Ambulance Service
Chambers Detroit Ambulance
Dearborn Ambulance Service
East Side Ambulance Service
Lincoln Park Ambulance Service
Livonia Ambulance Service
McFarland Funeral Home
Mercy Ambulance Service, Inc.
North-End Ambulance Service
Pontiac Ambulance Service
Redford Ambulance Service
Taylor Ambulance Service
Webb Ambulance Service
West-Side Ambulance Service

ATTACHMENT 4-C

MEDICAL EQUIPMENT CARRIED BY THE COMMERCIAL AMBULANCES

Airway Equipment

Adult and child resuscitation airways
Rico suction equipment
Mechanical Resuscitator with assorted masks
Hand Ambu, with assorted masks
Oropharyngeal airways, child and adult
Oxygen cylinders, size "D"
Portable inhalation units
Fixed inhalation equipment in the vehicle
Tongue blades

Bandaging Equipment

Large and small trauma dressings
Gauze pads (assorted sizes)
Gauze (assorted sizes)
Muslin
Sterile burn bandages
Tape (assorted sizes)
Elastic bandages
Tourniquets
Bandage shears

Splinting and Immobilization Equipment

Backboards
Spine board
Inflatable leg splints
Inflatable arm splints
Cervical neck collars
Sandbags
Triangular bandages with safety pins
Timmons splint
Padded arm boards

Preceding page blank

ATTACHMENT 4-C

Other
Blankets Pillows Split stretchers Folding emergency stretchers Folding chair stretchers Metropolitan stretchers with head and leg elevations Flashlight Emergency childbirth delivery kit

requested:

Monopulse 807 B units (defibrillator, pacemaker, and electrocardiograph).

Heart Lung Resuscitation units where available.

ATTACHMENT 4-D

COURSE ON EMERGENCY CARE

FOR AMBULANCE ATTENDANTS

I RESPIRATORY RESUSCITATION

II CARDIAC RESUSCITATION

III CONTROL OF EXTERNAL BLEEDING AND SHOCK

IV FRACTURES

V TRANSPORTATION OF THE INJURED

VI REVIEW: Care of Simulated Emergencies

TIME: 4:30 - 7:30 P.M.

PLACE: Auditorium

DATES: 15 - 30 April, 1969

12 - 29 May, 1969

2 - 20 June, 1969

I RESPIRATORY RESUSCITATION

Films:

1. Emergency Airway: A plan of action. TF8-3224
2. First Aid - Part IV: Resuscitation, mouth-to-mouth, mouth-to nose. TF8-3021
3. First Aid for Asphyxia. MN-8181a2 (alternate)

Reading Material - Training Manual - Chapter 2 (pages 16-30)

Dates:	Groups A		B	Instructor	Instructor Assistants
April	15	&	16	- Dr. Fromm	1. (two) 6:30 P.M. to 7:30 P.M.
May	12	&	13	- Dr. Lucas	
June	2	&	3	- Dr. Fromm	

Equipment Needed

1. 16 mm. Sound movie projector
2. above films
3. Resusci-Anne X3
4. Ambu bag with mask X3
5. Plastic airways X3
6. S-shaped emergency plastic airways X3
7. Oxygen tank X1
8. Suction (vehicle type) X1

II CARDIAC RESUSCITATION

Films:

1. Resuscitation for Cardiac Arrest (Squibb)
2. V. A. Film) alternates
3. Smith, Kline & French)

Reading Material - Training Manual - Chapter 2 (pages 31-50)

Dates:	Groups A		B	Instructors	Instructor Assistants
April	17	&	18	- Dr. Lucas	1. (two) 6:30 P.M. to 7:30 P.M.
May	15	&	16	- Dr. Fromm	
June	5	&	6	- Dr. Lucas	

Equipment Needed

1. 16 mm. Sound movie projector
2. above films
3. Resusci-Anne X3
4. Ambu bag with mask X3
5. Plastic airways X3
6. S-shaped emergency plastic airways X3
7. Oxygen tank X1
8. Suction (vehicle type) X1

III CONTROL OF EXTERNAL BLEEDING AND SHOCK

Films:

1. First Aid for Bleeding. MN-8182
2. Quiz Film on Bleeding. MN-8976
3. Control of Hemorrhage. TF8-2539)
4. Emergency Medical Care--Shock. TF-3693) alternates
5. First Aid for Schock. MN-8183)

Reading Material - Training Manual - Chapters 3 & 5

Dates:	Groups A		B	Instructors	Instructor Assistants
April	21	&	22	- Dr. Fromm	None
May	19	&	20	- Dr. Lucas	
June	9	&	10	- Dr. Fromm	

Equipment Needed

1. Dressings
   a. slings X3 (triangular bandage)
   b. Universal X3
   c. tourniquets X3
   d. Aces 4" x 3
      6" x 3
2. 16 mm. movie projector with sound
3. Above films

ATTACHMENT 4-D

IV FRACTURES

ms:

First Aid for all Hands: Fractures. MN-8188a
Quiz Film on Fractures. MN-8977
Fractures. MF 8-9758 (alternate)

ding Material - Training Manual - Chapter 4

Groups es: A	B	Instructors	Instructor Assistants
il 23 &	24	- Dr. Lucas	None
22 &	23	- Dr. Fromm	
e 12 &	13	- Dr. Lucas	

ipment Needed

Splints (inflatable) a. leg size X3
b. arm size X3
Thomas splint X3
stockinette, 6" X3
back board X1
16 mm. movie projector with sound
above films

V TRANSPORTATION OF THE INJURED

ms:

First Aid for all Hands: Handling and Transporting. MN-8188f
First Aid Handling and Transporting of the Injured:
Introduction. MN-8187a
Transportation of the Sick & Wounded. TF-3485 (alternate)

ding Material: Training Manual - Chapters 1, 12, 15

Groups es: A	B	Instructors	Instructor Assistants
il 25 &	28	- Dr. Fromm	None
26 &	27	- Dr. Lucas	
e 16 &	17	- Dr. Fromm	

Equipment Needed:

1. Stretchers X3
2. 16 mm. movie projector with sound
3. above films
4. ambulance available in garage

VI REVIEW: Care of Simulated Emergencies

Films:

1. Pulse of Life
2. The unexpected moment. MI S-800
3. Penetrating Wounds of the Abdomen. MN-7470
4. Sucking Wounds of the Chest. MN-7477

Reading Material - Chapters 6, 16, 17, & 18

Groups Dates: A	B	Instructors	Instructor Assistants
April 29 &	30	- Dr. Lucas	1. (two), 6:30 P.M. to 7:30 P.M.
May 28 &	29	- Dr. Fromm	
June 19 &	20	- Dr. Lucas	

Equipment Needed

All equipment used in preceding 5 classes.

Exam. and Evaluation form to be mailed back.

SCHEDULE FOR LECTURES

	GROUP A & B
I	April 15 & 16 (Fromm)
II	April 17 & 18 (Lucas)
III	April 21 & 22 (Fromm)
IV	April 23 & 24 (Lucas)
V	April 25 & 28 (Fromm)
VI	April 29 & 30 (Lucas)

ATTACHMENT 4-D

GROUP C & D

I	May 12 & 13	(Lucas)
II	May 15 & 16	(Fromm)
III	May 19 & 20	(Lucas)
IV	May 22 & 23	(Fromm)
V	May 26 & 27	(Lucas)
VI	May 28 & 29	(Fromm)

GROUP D & E

I	June 2 & 3	(Fromm)
II	June 5 & 6	(Lucas)
III	June 9 & 10	(Fromm)
IV	June 12 & 13	(Lucas)
V	June 16 & 17	(Fromm)
VI	June 19 & 20	(Lucas)

CHAPTER FIVE

A SYSTEMATIC APPROACH

CHAPTER FIVE

A SYSTEMATIC APPROACH

5-1. FIELD TEST OBJECTIVES

The objectives of the Detroit Emergency Medical Demonstration Project are also discussed in the Summary. These objectives are to demonstrate methods of improving the emergency medical response system, or ambulance service, in the City of Detroit. The purposes of the project are to provide experience and empirical data that will be valuable to any large urban community that wishes to upgrade or re-examine its emergency medical recovery system. Several candidate subsystems that might effectively contribute to improve recovery system response and thus in turn to emergency medical care were either in operation in Detroit or were implemented on a demonstration basis in pursuance of the above objectives.

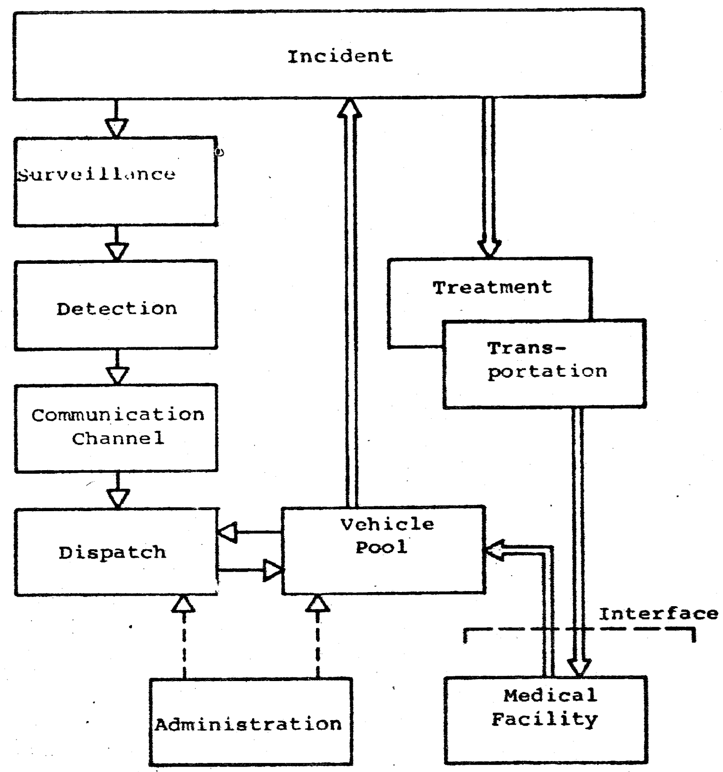
The recovery system can be depicted as shown in Figure 5-1. The double solid lines represent the action functions of vehicular movement and treatment. The single lines indicate command and communication, and the dashed lines indicate administrative control and operating policy.

The surveillance and detection processes are performed in most communities by private citizens. The one communication channel available to all citizens is provided by the public telephone system. The dispatch facility, vehicle pool and administration are included in the diagram because these components establish the dispatch protocol and screening policy and dictate the distribution and allocation policy for the recovery vehicles. The medical facility to which the patient is conveyed in Detroit is nearly always a hospital emergency room. A complete description of the present recovery system in Detroit is given in Chapter 2.

The existing system has been augmented by alternative system configurations and supplementary subsystems which will be discussed in Chapter 6. The field test portion of the program is addressed to the quantitative evaluation of the performance and benefits of the subsystems.

FIGURE 5 - 1

EMERGENCY RECOVERY SYSTEM



The principal goal of the recovery system is to deliver the patient to a facility that can provide definitive care, and in a manner that maximizes the likelihood of a favorable prognosis with minimum morbidity. This simple, concise statement is sufficient to identify the system characteristics which determine the ultimate performance. The time from the onset of illness or injury to the initiation of treatment, and the treatment and care provided at the scene or in transit are the only factors through which the recovery system may affect the condition of the patient. These are the two characteristics which are the subjects of the field test.

5-2. REDUCTION OF TIME TO TREATMENT

One of the primary objectives of the program is to demonstrate and evaluate techniques for reducing the time from trauma or illness to treatment. The temporal sequence of an emergency medical recovery is shown in Figure 5-2. The times of cardinal events specified below the horizontal line are instants of occurrence or epochs. Intervals are indicated above the horizontal line. The term delay has been used in instances in which an ambiguity between interval and epoch might result from the use of the word time alone. The term delay does not connote protracted or inefficient operation.

A detection delay is the time required for detection and recognition of the incident by an agent who may report the incident to the response system. The detection delay also includes that time necessary to reach the decision that the emergency must be reported. The reporting delay is the time required to gain access to a communication channel and notify the dispatch center. The sum of these two delays will be called the "notification delay." The entire process of surveillance, detection and reporting is normally external to, and independent of, the ambulance service. Nevertheless, it may be a significant component of the time to treatment.

The dispatch delay and the transit-to-scene delay are self evident. Their sum will be called the "response delay" or the time from notification to arrival of the rescue vehicle at the scene of the incident. Both the dispatch delay and transit-to-scene delay are directly related to the administration and policy of the ambulance service. The dispatch delay is a function of both the structure of the system and

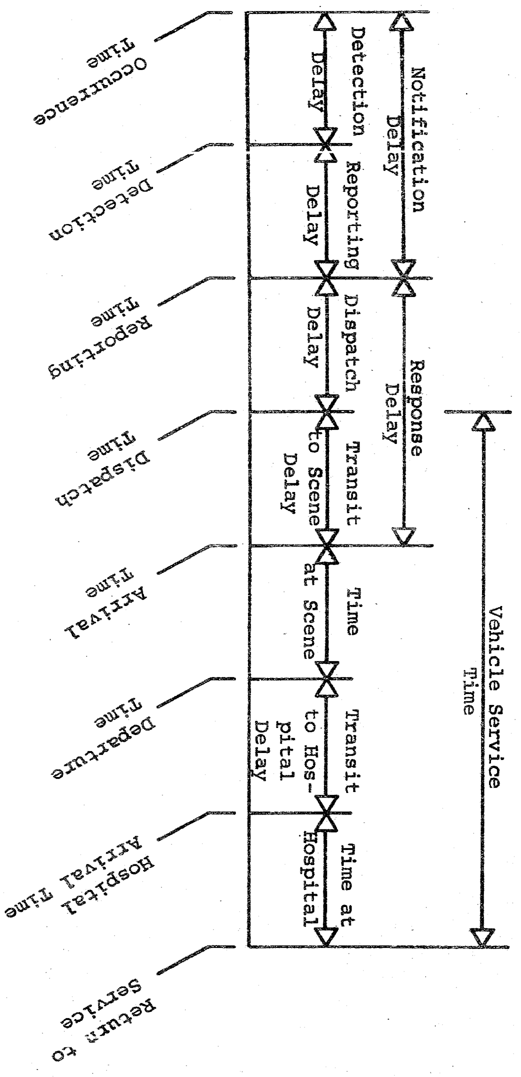


FIGURE 5 - 2

REALIZATION OF THE EMERGENCY MEDICAL RECOVERY PROCESS

operating protocol. The transit delay is related to the vehicle allocation and distribution policy.

The remaining elements of Figure 5-2 which constitute the time from arrival at the scene to arrival at the hospital do not appear to be directly dependent on system configuration, but are uniquely determined by the geographic distribution of emergencies and medical facilities. They are, however, indirectly related to the recovery system design. For example, the time at the scene may be related to the initial treatment or aid provided by the attendant. Both the time at the scene and the transit time to the hospital are functions of the operating policy of the system, and additional duties and responsibilities if the service is provided by a dual function system such as that of the Police Department.

The notification and response delays together determine the time from injury to the first treatment available from the response system which is that provided by the attendants at the scene. This time is of particular interest because it is the minimum elapsed time before life-saving or stabilizing measures can be provided by the response system. There is no question that reduction of this time will be accompanied by reduced morbidity/mortality. Any benefits to be realized from advanced medical technology and techniques in rescue services must ultimately be conditional on timely application. Important objectives of the program, then, were to determine how incidents are detected and reported, identify problem areas and demonstrate several communication networks that might reduce or bound the notification delay.

5-3. IMPROVED TREATMENT AT THE SCENE AND EN ROUTE

While reduction of the time from arrival at the scene to delivery at a hospital emergency room is a desirable goal, the ultimate sequel may be improved by treatment at the scene--even at the expense of time to definitive treatment.

Within the confines of the demonstration, i.e., the duration of the program and the available sources of medical information on patients, a definitive and comprehensive study of treatment versus eventual outcome was not possible. Instead, a surrogate was selected. Specifically, the level and quality of treatment was examined as a function of the training of the attendant and the system within which he operated.

The treatment provided by attendants' training programs and system administrations are in a sense intermediate measures of system performance.

CHAPTER SIX

FIELD TEST DESIGN AND PLANNING

CHAPTER SIX

FIELD TEST DESIGN AND PLANNING

6-1. DEVELOPMENT OF THE TEST

A demonstration project operating in a complex real environment is of little potential value unless the program is planned and executed with careful consideration of the project evaluation. Furthermore, projects which are involved in an area of critical community services must be implemented in a manner that minimizes disturbances of the service, both at the commencement and termination of the program. The development of the Detroit Project was addressed to both of these equally important requirements.

Detroit has enjoyed a long history of public ambulance service.[1] In order to successfully meet the two requirements stated above, the project was planned and conducted within the framework of the existing system. All subsystems which were the subject of examination but not previously in operation were superimposed upon the existing system.

The major portion of the public ambulance service in Detroit is provided by the Police Department. This service, which is described in detail in Chapter 2, is provided by approximately four to eight station wagons on constant patrol in each of the precincts which range from three to twenty-two square miles in area. This recovery system offers the potential advantage of rapid response with a vehicle relatively close to any point in the city. Disadvantages are the difficulty and cost of maintaining modern equipment standards in a total of 120 ambulwagons, and high proficiency in current first aid skills in over 1500 officers assigned to motor patrol in the thirteen precincts. The police ambulwagons represent one recovery system "mode," i.e., dual-purpose vehicles operating on constant patrol.

---

[1]A history of the Detroit service is given in Chapter 1.

Preceding page blank

The rescue squads of the Detroit Fire Department also respond to medical emergencies. Since they carry oxygen they frequently service calls for patients with cardiac or respiratory problems or strokes. The public is aware of this and often calls the Fire Department directly for these cases.[2] The rescue squads represent a second mode, one which is also dual-purpose but with vehicles operating from fixed "stations."

Both the police and fire response systems illustrate the basic characteristics of several possible "administrations" which relate to the speed of service through their respective allocation and distribution policies. Dual-function systems, as represented by the police and fire systems, provide emergency medical recovery in many localities because they offer an advantage of efficient utilization of manpower or they have evolved as an existing system and have assumed responsibility for the community ambulance function. Single-function systems are used in cities that have developed response systems specifically for the emergency medical problems of the community.

Either allocation policy may be coupled with two basic distribution modes. These are (1) roving vehicles on patrol and (2) operation from fixed stations. Thus the four combinations given in Table 6-1 are possible. Patrol operation of a single function ambulance system, has not been used in any locality and is not characterized by a set of parameters unique to that mode. Consequently, modes 1, 3 and 4 were selected for inclusion in the demonstration.

The first mode is represented by the Police Department operation and the third mode by the Fire Department rescue squads.[3]

[2]During the two months of the demonstration data periods, 69% of the requests for emergency medical service were from citizens and 28% were from the Police Department.

[3]The rescue squads were not included in the pilot data collection period which is discussed in Section 6-3. Their full significance to the project was not realized until after plans were completed for the first data collection. Exclusion of the cardiac and respiratory cases would have resulted in biases in the types of patients represented.

TABLE 6-1

RECOVERY MODES

Mode	Function	Distribution
1	Dual-Function	Patrol
2	Single-function	Patrol
3	Dual-function	Fixed station
4	Single-function	Fixed station

The fourth mode was provided by a private ambulance service under contract for the duration of the demonstration. In addition to the three modes utilizing surface transportation, a helicopter was included to evaluate the operational capability and cost of air evacuation in an urban environment. The use of the helicopter was not limited to medical missions. The helicopter program, including the objectives and non-medical utilization are discussed in Chapter 13.

The surveillance and detection functions, which are exterior to the ambulance service, are difficult and costly to augment. Auxiliary adjuncts performing these functions must provide extensive coverage if a useful quantity of data on emergency notification is to be obtained in a reasonable length of time. Furthermore, any detection or communication scheme which depends upon cooperation of the public requires a period of exposure after its introduction before equilibrium and representative utilization are achieved.

However, several communication systems are in operation in Detroit which are used for general information relevant to public services, including reporting of medical emergencies. They are particulary useful for reporting traffic accidents. These systems, which are described in Chapter 4, are a television surveillance network on the John Lodge expressway, the Community Radio Watch (CRW) and a Channel 9 citizens band network operated by the Department of Streets and Traffic. However, the final selection of test areas precluded consideration of the television network. Thus only the other two networks, involving large groups of radio equipped vehicles were incorporated in the program.

The system elements and parameters that have been described above are all related to the time required for recovery of the patient. The second major objective of the experiment was to measure the extent and quality of treatment provided by attendants of each of the modes. The first-aid training of the police and fire rescue squads is described in Chapter 2. Both units receive training meeting the requirements of the state law, although they do not necessarily hold current Red Cross certificates.[4] Neither unit carries the full complement of equipment established by the law. Thus the intent of the law is not satisfied by either unit.

The other end of the spectrum is represented by professional attendants who provide no other service, but are organized, trained, and employed solely to provide emergency medical care.

Evaluation of the performance of the recovery system modes must include measures of the effects of the attendant training or treatment possible in each mode. Thus two new training programs were implemented. A level to represent the capability implied by the intent of the state law was obtained by providing a five-hour first-aid refresher course for police officers. The course was given by personnel of the Fire Department Academy. An eighteen-hour advanced course given by physicians was also provided for police officers. Lists of the equipment of all units and synopses of each course are given in Chapter 4. The levels of training and equipment which were included in the program are given in Table 6-2.

The first level (C) is the existing police service and was selected as the experimental control. The second two levels (R,A) were implemented by adding equipment to the police ambulwagons and providing the two courses mentioned above. Level N was represented by the contract ambulance service. Although fire rescue squads (level F) are not shown in Table

[4]The requirements of the state law are discussed in Chapter 3.

TABLE 6-2

LEVELS OF TRAINING AND EQUIPMENT

Level	Training	Equipment
C	Academy training	Minimal
R	Refresher course	State law
A	Advanced course	State law
N	NATI[5]	Commercial ambulance

6-2, they are analogous to level R except for characteristics unique to their experience and recovery mode. Exceptions include the use of oxygen equipment and training in cardiopulmonary resuscitation. The combinations of training level and equipment and recovery modes which were included are:

Recovery Mode	Training Level
1	C
1	R
1	A
3	F
4	N

By placing the contract ambulance service and helicopter under operational control of the Police Department, all of the experimental "treatments" were dispatched from a single communication center with the single exception of the fire rescue squads. Communication with the helicopter was provided by the installation of standard portable police radio equipment. The Fire Department Communication Center uses a direct police phone for transfer and coordination of calls between departments. This permits a combined operation that closely approaches the efficiency of a single dispatch center.

[5]National Ambulance Training Institute

6-2. TEST AREA SELECTION

The recovery modes and training levels presented in the previous section must be evaluated in an experiment that provides results which are representative of an entire jurisdiction or city. The test areas were selected to provide some stratification of the city. The final selection was based on police precincts. Each precinct provides administrative supervision of all recovery units within the precinct and thus provided a control point for management of the experiment and data collection. Complete randomization of the experiment with 3 modes and 3 training levels would have required nearly all of the 13 precincts of the city. A demonstration of this magnitude was not within the scope of the project and not all precincts are tactically capable of supporting the added load of an experiment.

Seasonal effects in either the distribution and nature of medical emergencies or the response capability of the recovery units can only be included or examined by extending the experiment over several months. By collecting data in each of three periods which were seasonally distributed, four test areas were sufficient to factorize the experiment.

The four precincts were selected to represent both inner city or core areas and outer city areas approaching the character of the suburbs. Precincts 6, 7, 15 and 16 shown on Figure 2-1 were chosen after discussion between representatives of the project and the Police Department. The area and population of each is given in Table 6-3.

Precincts 6, 7 and 15 are all bisected by the Edsel Ford expressway. The Southfield Freeway forms the eastern boundary of precinct 16. Thus all four precincts include depressed expressways as well as arterial and residential surface streets. The approximate length of expressway in each precinct is given in Table 6-4.

Further discussion on the choice of precincts is given in Chapter 4.

TABLE 6-3

DEMONSTRATION PRECINCTS[6]

Precinct	Area (Sq. Mi)	Population	Density (1000/sq. mi.)
6	6.79	99,000	14.6
7	6.81	94,000	13.8
15	20.84	233,000	11.2
16	21.64	187,000	8.6
TOTAL	56.08	614,000	----
% of City	40.2	37.6	----

TABLE 6-4

EXPRESSWAY IN TEST AREAS

Precinct	Expressway	Length
6	Edsel Ford	2.8 mi.
7	Edsel Ford	2.9
15	Edsel Ford	5.5
16	Southfield	8.0
TOTAL	-----	19.2

Figure 2-2 shows the areas served by the 7 fire rescue squads of the city. Precinct 6 is served by squad 4, Precinct 7 by squads 1 and 3, Precinct 15 by squads 3 and 6, and Precinct 16 by squad 7. Thus 5 of the 7 squads serve the selected precincts.

[6] From the Detroit Police Department

EXPERIMENT STRUCTURE

Conducting the demonstration in four precincts during three periods of one month each resulted in a total of 12 test units. Factorization of the experiment within the 12 units is shown in Figure 6-1. The three data collection periods were:

I	Nov. 18 - Dec. 18, 1968
II	Apr. 1 - Apr. 30, 1969
III	Aug. 1 - Aug. 30, 1969

The first period was planned to provide experimental control and serve as a pilot data collection. For many reasons that are discussed in Chapter 7, much of the data collected in this period was of limited quality. Consequently the analysis was based primarily on data from the latter two periods, and the first served as a very valuable pilot project.

The final program shown in the figure evolved from modifications to the program following the pilot demonstration.

Professional attendants serving no other function (4-N, represented by the commercial ambulance service) were used in both inner and outer city precincts--7 and 16.

The advanced training given specific groups of officers covered the use of equipment required by the state law but not normally carried in the ambulwagons nor covered in the academy training. This included spineboards, inflatable splints and oxygen with masks. This equipment was added for the demonstration on a precinct basis. Officers who received the refresher course, intended to demonstrate the minimum training required for use of the equipment, were selected from the same precinct to reduce the equipment required and the logistics problems. Volunteer officers from Precinct 15 were requested for each course. The advanced course was attended by 25 officers who were in platoon 1 (2400-0800 hr.) during April. An equal number of officers from each of the remaining two platoons received the five-hour refresher course.

In April, May and June 25 officers from each platoon of the

FIGURE 6 - 1

DEMONSTRATION FACTORIZATION

COLLECTION PERIOD	INNER 6	PRECINCTS 7	OUTER 15	PRECINCTS 16
I	1-C	1-C	1-C	1-C
(Nov./Dec.)				
II	1-C	4-N	1 R.A.	1-C
(April)	3-F	3-F	3-F	3-F
III	1-C	1-A	1 R.A.	4-N
(August)	3-F	3-F	3-F	3-F

The notation is given in Tables 6-1 and 6-2.

Seventh Precinct were given the advanced training. This was done for two reasons, the first of which was to include this level in an inner city precinct. The second, but equally important purpose, was related to the hospital distribution.

Detroit General Hospital (Receiving Branch) is located just outside the southeast corner of Precinct 7. This city facility is the teaching hospital of Wayne State University Medical School and has a large emergency room which treats over 300 patients a day. The project medical consultants serve on the surgery department staff of both the hospital and medical school. Because of apparent problems with inconsistent data collection in November/December--problems which were corrected in subsequent periods[7]--the advanced training level was included in Precinct 7. Thus, the control group, advanced training group and commercial attendants were all used in a single area; and project medical consultants were able to personally supervise the collection of data on all major levels (C,A,F,N).

Selection of the hospitals in the project is described in Chapter 4, and their locations are given in Figure 4-1. The hospitals were requested to provide medical data on the condition of the patient at the time of admission to the emergency room, and information on first-aid administered before admission. Results of the first data collection indicated that 91% of the patients conveyed by the Police Department were taken to the selected hospitals.

6-4. DOCUMENTATION

Data Collection Methodology

Experimental evaluation and investigation of the system elements examined in the project required the collection of a large amount of data. Data from the ambulance attendants, police, fire, and commercial--and from the emergency rooms--involved many observers, so recording data by machine methods was not feasible and hand documentation on printed data forms was employed.

[7]The problems and corrective techniques are discussed in Chapter 7.

The data collected can be classified in three general categories: (1) measurements of the time of occurrence of the events depicted in Figure 5-2 and the parameters with which they may be correlated either probabilistically or deterministically, (2) measures related to the injury of the patient and treatment by the attendant and (3) etiological and demographic factors.

Information on the first category was obtained at the significant contact points in the reporting and response process. The detector is the first contact point. Detectors which are external to the existing system are the individual dispatch centers of CRW members and the CB Channel 9 network. The second contact point is the response system dispatch center, both the Police and Fire Department Communication Centers. Records which were satisfactory for the project were maintained at these points with the exception of the CRW members. Dispatchers of the latter were provided with log sheets for project data.

Information on the second category and on the etiology of injury were obtained on forms developed specifically for the ambulance attendants. The police officers and attendants of the commercial ambulance service were asked to complete a form on each patient conveyed from a test precinct. A plastic wrist tag[8] was placed on each patient for identification of the case in the emergency room. Each fire rescue squad carried maps of the precinct so they could complete project forms and tag only those patients conveyed from test areas. Members of the squads are familiar with the precinct boundaries because of experience with combined fire-police operations.

Emergency rooms personnel of participating hospitals were asked to provide data from category 2--the type and location of injury and information relating to patient condition and treatment by the attendant. They were also the source of demographic data.

The documentation material and associated operational procedures used for the collection of empirical data are

[8]The tag was coded to indicate the precinct and conveying agency.

discussed in detail in the following three sections.

Communication Data

Community Radio Watch: The dispatcher of each participating CRW member organization was provided log sheets upon which each medical emergency reported to the Police or Fire Communication Center could be recorded. The items of information requested on each incident or report were:

(1) Date
(2) Time
(3) Nature of incident
(4) Location
(5) Disposition (agency notified)

The CRW log sheets were collected from each member several times during each test period.

Citizens Band Radio Driver Aid Network: The base station of the CB network operated by the Department of Streets and Traffic maintains a complete record of all calls. Initial recording is manual, but each month the accumulated records are coded for machine processing. Since the normal documentation was satisfactory for the project requirements, listings of the monthly data file were obtained after each test period. The items listed for each report are given below. Those marked with an asterisk were pertinent to the project experiment.

(1) Radio report number
*(2) Date
(3) Weather, e.g. light rain
overcast
clear
(4) Roadway conditions
(5) Call sign
*(6) Time received
(7) Network receiver number
(8) Network transmitter number
*(9) Incident description, e.g. accident
multivehicle
movable, bodily injury

*(10) Time reported
*(11) Disposition
(12) Direction of travel
*(13) Location

Fire Department Communication Center: The Fire Communication Center personnel maintained a log of all "specials" in the test precincts specifically for the demonstration project.[9] The information recorded included:

(1) Date
(2) Time
(3) Source--Citizen, Police, Squad
(4) Squad Number
(5) Location
(6) Time back in service
(7) Precinct

The Fire Department does not normally operate on a precinct basis. During the project, they added a precinct overlay to their master city map so they might provide item 7 above.

Police Communication: The Police Communication Center completes a dispatch ticket for each police response to a call for assistance. Information recorded on the ticket by both the IMPACT and Dispatch Centers includes:[10]

(1) Date and time of receipt of call
(2) Complaint (incident descriptions)
(3) Address
(4) Unit dispatched (precinct and vehicle)
(5) Time out of service (time of dispatch)
(6) Time back in service[11]

[9]A special is a rescue squad run for an emergency other than a fire.

[10]For a description of the operation of these centers, see Section 2-2.

[11]Indicated by Return To Service on Figure 5-2.

The time of receipt of a call is recorded by hand, but each operator has a clock with digital presentation. The times "out of service" and "back in service" are recorded by machine. Thus, the times recorded on the tickets have reliable resolution and the dispatch delay may be computed with an accuracy of one minute.

Several other items of information were requested to complete identification and for the detection and reporting study. These were added manually in the appropriate center. If a call involved a medical emergency the letter "D" was added to identify the dispatch ticket as pertinent to the demonstration. Dispatches of ambulwagons were indicated by a "W" to differentiate wagons and sedans. The source of the call (identification of the incident detector) was indicated by a numerical code for each of the sources listed in Table 9-2. Identification of the source required a specific request of information from the caller which is not included in normal operating procedures.

Those tickets identified by a "D" were sorted, and reproduced for weekly collection by project representatives. This entailed considerable effort on the part of Police Communication Center personnel since an average of approximately 1,800 tickets are generated daily.

Ambulance Attendants and Emergency Rooms

Pilot Data Collection: The form used by ambulance attendants in the November-December data collection is shown in Figure 6-2. During this period only police officers with academy training (control group) were participating.

Several problems were encountered in the use of this form. The space provided for entries was small and presented some difficulty and inconvenience, especially at night under poor light. The instructions which were given the officers at briefings, and the design of the form did not emphasize the need for accuracy in time and odometer records. As a result, odometer readings did not include tenths of a mile, and time was frequently given to the nearest five minutes.

The form provided for emergency room physicians is shown in Figure 6-3. During the initial contact with the prospective

FIGURE 6-2

HOSPITAL

Fill sheet out for each victim!

EMERGENCY MEDICAL SERVICE
AMBULANCE ATTENDANT'S
CHECK SHEET

EMS PRECINCT NUMBER ________

NAME ______________________________ Date: ____________

RESIDENT OF PRECINCTS [] Yes [] No

EMERGENCY TYPE AND TYPE OF VICTIM

[] TRAFFIC — [] Driver [] Passenger [] Motorcyclist [] Bicyclist [] Pedestrian [] other [] unknown

[] NON-TRAFFIC

SITE \ TYPE	ACCIDENTAL INJURY	ACUTE ILLNESS	VIOLENT ACT: SHOOTING	VIOLENT ACT: STABBING	VIOLENT ACT: OTHER
HOME					
INDUSTRY					
PUBLIC PLACE					
OTHER					

LOCATION OF ACCIDENT:
STREET & NO. ____________
NEAREST INTERSECTION ____________

ODOMETER READINGS:
At Dispatch ________ At Scene ________
At Hospital ________

LOCATION OF VEHICLE AT TIME OF DISPATCH — [] Ambulance Station [] Precinct Station Street Location ____________

TIME INFORMATION

	AM	PM
Call Received	______ AM	______ PM
Arrived at Scene	______ AM	______ PM
Depart from Scene	______ AM	______ PM
Arrival at Hospital	______ AM	______ PM
Depart from Hospital	______ AM	______ PM

USE OF LIGHTS & SIREN

	To Scene		To Hospital	
Lights	[] Yes	[] No	[] Yes	[] No
Siren	[] Yes	[] No	[] Yes	[] No

DIFFICULTIES IN ROUTE

	To Scene	To Hospital
Severe Traffic	[]	[]
Adverse Weather	[]	[]
Mechanical	[]	[]
Tire Trouble	[]	[]
Other	[]	[]

CONDITION OF VICTIM AT SCENE WHEN POLICE OR AMBULANCE ARRIVED — [] Conscious [] Unconscious [] Incoherent [] Apparent Death Before Arrival [] Apparent Death After Arrival

TYPE OF ACTION TO AID INJURED AT SCENE OR DURING TRANSPORTATION

	LAYMEN	PHYSICIAN	POLICE	AMBULANCE
Removal From Vehicle				
Cleared Airway				
Control Light Bleeding				
Control Heavy Bleeding				
Administer Oxygen				
Bandaging				
Splinting Limbs				
Neck/Spine Immobil				
Art. Respiration				
Cardiac Massage				

SHOULDER HARNESS
SEAT BELT

Available
[] Yes [] No
[] Yes [] No

Used
[] Yes [] No
[] Yes [] No

TYPE OF INJURY AND BODY AREA INJURED. (INDICATE ONLY THE FIVE MOST SERIOUS INJURIES OBSERVED)

INJURY TYPE \ BODY AREA INJURED	HEAD	FACE	NECK	THORAX	SPINE	ABDOMEN	PELVIS	UPPER EXTREMITIES	LOWER EXTREMITIES	NON APPLICABLE	COMMENTS OR DETAILS
Fracture											
Sprain/Strain/Dislocation											
Traumatic Amputation											
Contusion/Crushing											
Laceration											
Concussion											
Internal											
Burn											
Asphyxiation											
Drowning											
Poisoning											
Electrocution											
Other											

FIGURE 6-3

EMERGENCY MEDICAL SERVICE PROJECT

EMERGENCY ADMISSION CHECK SHEET

ADMISSION TO E. ROOM - Date:____________________

DISPOSITION
- [] 0 D. O. A.
- [] 1 Expired in Hospital
- [] 2 Adm. Direct to Hospital
- [] 3 Treat. & Adm. to Hospital
- [] 4 Treat. & Transfer to Other Medical Facility
- [] 5 Treated & Released
- [] 6 Referred to Private Physician
- [] 7 Left Without Treatment or No Treatment Required
- [] 8 Other
- [] 9 Unknown

Time of Death:____________________ Date of Death:____________________

Number of Days Spent in Hospital:_______

ARRIVAL AT E.R. [] 0 Conscious [] 1 Unconscious [] Shock [] Coma [] Anoxic

TYPE OF INJURY AND BODY AREA INJURED. (INDICATE ONLY THE FIVE MOST SERIOUS INJURIES OBSERVED)

INJURY TYPE \ BODY AREA INJURED	HEAD	FACE	NECK	THORAX	SPINE	ABDOMEN	PELVIS	UPPER EXTREMITIES	LOWER EXTREMITIES	NON APPLICABLE	COMMENTS OR DETAILS
Fracture											
Sprain/Strain/ Dislocation											
Traumatic Amputation											
Contusion/Crushing											
Laceration											
Concussion											
Internal											
Burn											
Asphyxiation											
Drowning											
Poisoning											
Electrocution											
Other											

All information furnished by physicians is treated as privileged medical information and will be used for research purposes only. The perforated section below, containing the name of the patient, will be torn off and destroyed once medical information has been recorded on IBM punch cards.

NAME OF VICTIM: Address:

Age: Sex: [] Male [] Female

RACE:
- [] 1 White Spanish American
- [] 2 White All Other
- [] 3 Non-White Negro
- [] 4 Non-White Oriental
- [] 5 Non-White American Indian
- [] 6 Non-White All Other
- [] 7 Unknown

MARITAL STATUS
- [] 1 Never Married
- [] 2 Currently Married
- [] 3 Separated
- [] 4 Divorced
- [] 5 Widowed
- [] 9 Unknown

Tear Here

NOTE: THIS PORTION TO BE RETURNED TO PROJECT COORDINATOR, AS SOON AS ONE OF THE FOLLOWING OCCURS: PATIENT RELEASED, PATIENT DIES, MORE THAN 30 DAYS AFTER ADMISSION

COMMENTS:

FIRST AID, OR LIFE SAVING MEASURES PRIOR TO PATIENTS ARRIVAL IN HOSPITAL

	ATTEMTED BUT NOT SUCCESSFUL	GIVEN AND NOT REQUIRED	REQUIRED AND NOT GIVEN	REQUIRED AND INADEQUATELY CARRIED OUT	OTHER
STOP SEVERE HEMORRHAGE					
MAINTAIN AIRWAYS					
SPLINT LONG BONES					
USE OF BACK BOARD					

NOTE: RETAIN UNTIL END OF DATA COLLECTION PERIOD hospitals, the draft data forms were presented and discussed. Several hospital representatives expressed reluctance to provide the data requested. They were concerned with medico-legal problems that might arise as a result of the demographic information and the data on adequacy of first-aid or lifesaving measures provided by the attendant. The form was then designed with the demographic and first-aid sections as tear-off sheets. The hospitals were instructed to separate the sections so the identity of the patient could not be associated with medical information.

Nevertheless, either because of the concern described above or for other reasons, many of the emergency room forms were returned with no information on the first-aid measures. The problem may have been the incompleteness of this section of the form. No provision was made for several possible events. Most notably, the very frequent cases requiring no treatment.

<u>Demonstration Periods II and III</u>: Several revisions were incorporated in the program before the April and August data collections to correct the problems described in the previous section.

The briefings given to all units participating in the data collection were repeated before each of the latter two periods. The ambulance attendants (police, fire, commercial) were asked to record odometer readings to the nearest tenth of a mile, and time to the nearest minute. They were also instructed to line out the entry if a particular reading could not be taken. The importance of providing data on all conveyances, including the minor or trivial cases, was also stressed.

Both the ambulance attendant's and the emergency room check sheets were redesigned and enlarged for the second and third data collection. The revised ambulance attendant form is shown in Figure 6-4. The figures are approximately 3/4 the scale of the actual forms. Although the information and format are very similar to the original, the improved form proved much more convenient to use in the field. The names and badge number of both police officers were added as an indication of the training levels of the officers who conveyed in precincts seven and fifteen.

The revised emergency room forms used in Periods II and III are shown in Figure 6-5, also at approximately 3/4 scale. The bottom section on first-aid provided by the attendant was expanded. Five additional questions relating to attendant training and to two "paramedic" treatment capabilities were added. These questions are discussed in detail in Section 12-4.

A medical evaluation committee was formed before the April data collection, composed of one physician from each of five of the more frequently used emergency rooms. The committee, which is described in Section 12-2, was responsible for considerable improvement in the collection of medical data. All sections of the form were completed at these hospitals. The data collection improved at all hospitals, including those not represented on the medical evaluation committee.

Helicopter Demonstration

The helicopter demonstration consisted of both medical and non-medical utilization. Discussion of the non-medical experiments are included in Chapter 13. Only the documentation of the medical evacuation demonstration will be included in this section.

The helicopter attendant used the form shown in Figure 6-4. This form provided the medical information on each case. Operational information on each air evacuation was provided by the pilot on the form shown in Figure 6-6. It should be noted that either the "Detection" or "Dispatch" section of the left column would be used for a particular evacuation, but not both. Similarly, only one of the three sections of the right column would be used on each form. Thus use of the form was not efficient. As a result of this inefficiency, and his many other tasks, the pilot normally kept his own separate log or primary record. The project form, Figure 6-6, was completed after each flight.

Several police functions were performed with the helicopter while it was on patrol. These functions, such as detection of accidents and fires and traffic and stalled vehicle reports, are discussed in Chapter 13. Reports of these incidents were reported on the back of the check sheets. A single sheet thus served several incidents, each of which would not require the complete form.

FIGURE 6-4

AMBULANCE ATTENDANT FORM PERIODS II AND III

Fill sheet out for each victim!

HOSPITAL________________

EMERGENCY MEDICAL SERVICE

AMBULANCE ATTENDANT'S CHECK SHEET

Precinct Number__________

Date:__________

NAME______________________________

RESIDENT OF PRECINCTS ☐ Yes ☐ No

EMERGENCY TYPE AND TYPE OF VICTIM

☐ TRAFFIC ☐ Driver ☐ Passenger ☐ Motorcyclist ☐ Bicyclist ☐ Pedestrian ☐ other ☐ unknown

☐ NON-TRAFFIC

SITE \ TYPE	ACCIDENTAL INJURY	ACUTE ILLNESS	VIOLENT ACT: SHOOTING	VIOLENT ACT: STABBING	VIOLENT ACT: OTHER
HOME					
INDUSTRY					
PUBLIC PLACE					
OTHER					

LOCATION OF ACCIDENT:

Street__________

Nearest intersection__________

ODOMETER READINGS:

At Dispatch________ At Scene________

At Hospital________

LOCATION OF VEHICLE AT TIME OF DISPATCH

☐ Ambulance Station

☐ Precinct Station Nearest Intersection__________

TIME INFORMATION

Call Received	______AM	______PM
Arrived at Scene	______AM	______PM
Depart from Scene	______AM	______PM
Arrival at Hospital	______AM	______PM
Depart from Hospital	______AM	______PM

USE OF LIGHTS & SIREN

	To Scene		To Hospital	
Lights	☐ Yes	☐ No	☐ Yes	☐ No
Siren	☐ Yes	☐ No	☐ Yes	☐ No

DIFFICULTIES IN ROUTE

	To Scene	To Hospital
Severe Traffic	☐	☐
Adverse Weather	☐	☐
Mechanical	☐	☐
Tire Trouble	☐	☐
Other	☐	☐

Decision as to specific hospital based on:

Patient Preference ☐

Closest ☐

Specific Equipment ☐

CONDITION OF VICTIM AT SCENE WHEN POLICE OR AMBULANCE ARRIVED

☐ Conscious ☐ Unconscious ☐ Incoherent ☐ Apparent Death Before Arrival ☐ Apparent Death After Arrival

TYPE OF ACTION TO AID INJURED AT SCENE OR DURING TRANSPORTATION

	LAYMAN	PHYSICIAN	POLICE	AMBULANCE	FIRE DEPT.
Removal From Vehicle					
Cleared Airway					
Control Light Bleeding					
Control Heavy Bleeding					
Administer Oxygen					
Bandaging					
Splinting Limbs					
Neck/Spine Immobil					
Art. Respiration					
Cardiac Massage					

TRAFFIC INJURY ONLY

SHOULDER HARNESS

SEAT BELT

Available

☐ Yes ☐ No

☐ Yes ☐ No

Used

☐ Yes ☐ No

☐ Yes ☐ No

TYPE OF INJURY AND BODY AREA INJURED. (Indicate only the five most serious injuries observed)

INJURY TYPE \ BODY AREA INJURED	HEAD	FACE	NECK	THORAX	SPINE	ABDOMEN	PELVIS	UPPER EXTREMITIES	LOWER EXTREMITIES	NON APPLICABLE	Comments or Details
Fracture											
Sprain/Strain/ Dislocation											
Traumatic Amputation											
Contusion/Crushing											
Laceration											
Concussion											
Internal											
Burn											
Asphyxiation											
Drowning											
Poisoning											
Electrocution											
Other											

Report submitted by________________ Shift #________ Car #________

Purpose of this project

The performance of ambulance services is rendered by the Detroit Police Department, the Detroit Fire Department, a private ambulance company, and a specially trained platoon in precinct 15 of the Detroit Police Department will be evaluated through data collected from the Communication Center, the ambulance attendant, and the emergency room personnel. No evaluation or criticism will be made of any individual. All results will refer to the performance of a group, in a precinct, during a one-month period.

Ambulance Attendants Check Sheet.

Fill out the form by checking all boxes that are applicable to the case, if the information is available.

E.g.: If it was not possible to determine whether victim in automobile accident was using safety belt do not record anything in the appropriate boxes. It is a part of this project to determine how often it is difficult or impossible to obtain this information.

Odometer readings require only the last four digits. For example, if your counter shows 88 127.2, write only 127.2 including the nearest tenth of a mile.

To describe difficulties en route, if the form does not clearly identify your difficulty, please check box marked "other" and explain in a few words.

The "type of action to aid injured" and the "type of injury and body area injured" for each case will be compared with similar information obtained from the emergency room, and then combined to obtain the group results.

The precinct number, shift number, patient name, date, and hospital name are very important for the proper evaluation of this project. Please be sure to include this information.

The time information will be evaluated by the computer, and it is possible to determine if your information is correct. Please fill out such information as accurately as possible and do not round off to the nearest five minutes or few minutes interval.

e.g., If time is 10:01 a.m., write 10:01 a.m. and not 10:00 a.m.
If time is 9:33 p.m., write 9:33 p.m. and not 9:35 p.m.

Comments: ____

FIGURE 6-5

EMERGENCY ROOM FORM PERIODS II AND III

EMERGENCY MEDICAL SERVICE PROJECT

EMERGENCY ADMISSION CHECK SHEET

Admission to E. Room — Date: ________ **Number of Days Spent in Hospital** ________

Disposition
- ☐ 0 D.O.A.
- ☐ 1 Expired in Hospital
- ☐ 2 Adm. Direct to Hospital
- ☐ 3 Treat. & Adm. to Hospital
- ☐ 4 Treat. & Transfer to Other Medical Facility
- ☐ 5 Treated & Released
- ☐ 6 Referred to Private Physician
- ☐ 7 Left Without Treatment or No Treatment Required
- ☐ 8 Other
- ☐ 9 Unknown

Time of Death: ________ **Date of Death:** ________

Arrival at E.R. ☐ 0 Conscious ☐ 1 Unconscious ☐ Shock ☐ Coma ☐ Anoxic ☐ D.O.A.

NOTE: THIS PORTION TO BE RETURNED TO PROJECT COORDINATOR, AS SOON AS ONE OF THE FOLLOWING OCCURS: PATIENT RELEASED, PATIENT DIES, MORE THAN 30 DAYS AFTER ADMISSION

Type of Injury and Body Area Injured (Indicate only the five most serious injuries observed)

INJURY TYPE \ BODY AREA INJURED	HEAD	FACE	NECK	THORAX	SPINE	ABDOMEN	PELVIS	UPPER EXTREMITIES	LOWER EXTREMITIES	NON APPLICABLE	Comments or Details
Fracture											
Sprain/Strain/ Dislocation											
Traumatic Amputation											
Contusion/Crushing											
Laceration											
Concussion											
Internal											
Burn											
Asphyxiation											
Drowning											
Poisoning											
Electrocution											
Other											

All information furnished by physicians is treated as privileged medical information and will be used for research purposes only. The perforated section below, containing the name of the patient, will be torn off and destroyed once medical information has been recorded on IBM punch cards.

Name of Victim: ________

Address: ________ **Age:** ________ **Sex:** ☐ Male ☐ Female

Race:
- ☐ 1 White Spanish American
- ☐ 2 White All Other
- ☐ 3 Non-White Negro
- ☐ 4 Non-White Oriental
- ☐ 5 Non-White American Indian
- ☐ 6 Non-White All Other
- ☐ 7 Unknown

Marital Status ☐ 1 Never Married ☐ 2 Currently Married ☐ 3 Separated ☐ 4 Divorced ☐ 5 Widowed ☐ 9 Unknown

Is American Red Cross First Aid-Standard Training sufficient and adequate for ambulance attendant to handle this case?
☐ **YES** ☐ **NO** ☐ **NOT APPLICABLE**

Would an I.V. fluid, started on scene by properly trained personnel have improved patient's condition?
☐ **YES** ☐ **NO** ☐ **NOT APPLICABLE**

Was speedy arrival at hospital of importance in this case?
☐ **YES** ☐ **NO** ☐ **NOT APPLICABLE**

Would an endotracheal intubation on the scene by properly trained personnel have improved patient's condition?
☐ **YES** ☐ **NO** ☐ **NOT APPLICABLE**

Would highly trained ambulance attendants (50 to 75 hours of training by physicians) be in a position to cope with this case so as to eliminate the need for fast transportation?
☐ **YES** ☐ **NO** ☐ **NOT APPLICABLE**

First aid, or life saving measures prior to patients arrival in hospital:

		STOP SEVERE HEMORRHAGE		GUARANTEE ADEQUATE RESPIRATION		SPLINT LONG BONES		USE OF BACKBOARD		* CPU	
		needed	not needed	needed	not needed	needed	not needed	needed	not needed	needed	not needed
ATTEMPTED	Successful										
	Unsuccessful										
Not Attempted											

* Cardiopulmonary Resuscitation

NOTE: RETAIN UNTIL END OF DATA COLLECTION PERIOD

Precinct no. ________ Shift no. ________

Purpose of this project

The performance of ambulance services is rendered by the Detroit Police Department, the Detroit Fire Department, a private ambulance company, and a specially trained platoon in precinct 15 of the Detroit Police Department will be evaluated through data collected from the Communication Center, the ambulance attendant, and the emergency room personnel. No evaluation or criticism will be made of any individual. All results will refer to the performance of a group, in a precinct, during a one-month period.

Emergency Check Sheet

In addition to the above stated objective, this study will also attempt to establish a pattern of injury to be used to determine requirements for the training of ambulance attendants.

The cost benefit analysis part of this project should allow us to make recommendations as to what level of training is desirable for ambulance attendants in the city of Detroit, and how often special occurrences will place demands on the ambulance personnel which are above or below their level of capability.

The forms should be filled out under the supervision (delegation of authority is acceptable) of a physician.

Some entries are purely clerical in nature, however the description of injury should preferably be completed by a qualified nurse.

The questions about required level of training are to be answered by a physician. The subjective appraisal of different physicians under varying circumstances of stress and environment will not be a cause for a major bias in the final evaluation because many hospitals are involved and only group results will be considered.

The bottom tear-off sheet is to be filled out by a physician; comments will be appreciated. Immediately after completion, they should be separated and place into an envelope or file so that, after a one-month data collection period is complete, an appraisal can be made of the performance of a group, in a batch mode, without causing any risk of liability to patient, ambulance attendant, or physician. On this tear off sheet, the following information is important to identify the group.

Precinct #
Shift #
Police, fire department, or private ambulance company.
#1 for period midnight to 8:00 a.m.
#2 for period 8 a.m. to 4 p.m.
#3 for period 4 p.m. to midnight

Both the top portion and the bottom tear-off will be delivered exclusively to a representative of the Highway Safety Research Institute at regular intervals during data collection and after completion of the one-month data collection period.

Comments: ____________________

FIGURE 6-6

HELICOPTER PILOT FORM

HELICOPTER CHECK SHEET

(To be filled out whenever helicopter responds to an emergency)

Date ________ Mission ________

Task being performed at time of incident detection or dispatch

☐ Patrol ☐ Project (specify) ________

Crew on board (in addition to pilot) and mission

1. ________

2. ________

DETECTION

(To be completed whenever helicopter detects incident)

Time of detection ________

Time of reporting ________

Location of incident (nearest intersec.) ________

Altitude at detection ________

Type of incident

Traffic accident ☐ Pedestrian ☐ Motor vehicle

☐ Other accident/injury

☐ Crime

☐ Fire

☐ other (specify)

WEATHER ANALYSIS

(Each Mission)

Weather conditions

Ceiling (estimated) ________

Visibility (estimated) ________

Wind ________

☐ Precipitation

☐ Rain

☐ Other precipitation (specify) ________

☐ Fog/Smog

☐ Other (specify) ________

DISPATCH

(To be completed whenever helicopter is dispatched to incident)

Requesting agency ________

Time of dispatch ________

Location when dispatched ________

Time of arrival at scene ________

Location of incident ________

Problems in transit

☐ Weather

☐ Difficulty in locating site

☐ Other (specify) ________

Distance traveled to scene ________

FEASIBILITY OF LANDING

(To be filled out for each emergency mission)

1. Landing successfully accomplished

Time of landing ________

Location of landing (Nearest intersection) ________

Location of incident (If not at landing location) ________

Distance between landing site and incident ________

Problems encountered

☐ No clear area adjacent to site

☐ Trees ☐ Buildings

☐ Wires ☐ Wind

☐ Other obstructions (specify) ________

☐ Other (specify) ________

Ground assistance rendered (specify) ________

2. Landing desirable but unsuccessful

Problems encountered which prohibited landing

☐ No clear area adjacent to site

☐ Trees ☐ Buildings

☐ Wires ☐ Wind

☐ Other obstructions (specify) ________

☐ Other (specify) ________

Ground assistance rendered (specify) ________

Would it have been possible to lower a man to the ground if this had been desirable and equipment was available? ☐ Yes ☐ No

Would a landing have been possible with the assistance of a

☐ Ground Attendant ☐ Trained Ground Attendant ☐ No landing possible with either of these

Distance to nearest feasible landing site ________

3. Landing not necessary and not attempted

Reason ________

Could a landing have been made at this site? ☐ Yes ☐ No

If yes, indicate any problems which might have occurred ________

If no, list reasons below ________

Tasks performed after landing

☐ 1. Victim extrication

☐ 2. Medical aid to victim

☐ 3. Transport victim to hospital

☐ 4. Crowd control

☐ 5. Other (specify)

NOTE: If (2) or (3) above is performed, the Ambulance Attendant Form must be completed.

Comments ________

____

6-5. ANALYSIS AND EVALUATION

The ambulance attendant and emergency room check sheets, and copies of the IMPACT Center dispatch tickets were collected weekly. They were then collated by hand. Each case (patient) was numbered and the forms from the three above sources were matched. The matching of forms for patients who were admitted to a hospital could not be completed until the forms were collected following dischage or after 30 days of hospitalization. Thus the matching was not completed until after a month following the end of a demonstration period.

After completion of matching, each case was coded and filed on magnetic tape for machine data processing.

The unmatched cases, those not documented by both ambulance and emergency room forms, were also coded.

The helicopter conveyed 23 patients. Since the number of cases was small, the helicopter data were analyzed by hand.

The details of the methods of analysis are included in the discussions of each segment of the evaluations which are presented in Chapters 8 through 13.

Both the fire rescue squads and contract commercial ambulances represent operations from fixed stations, e.g., modes 3 and 4 of Table 6-1. However, a detailed experimental investigation of the effects of allocation and distribution policy upon recovery vehicle availability was not possible within the scope of the demonstration. Therefore, an analytical study was undertaken. The development of a model of the recovery system and the results based on an empirical distribution and occurrence measurement of the medical and non-medical emergencies serviced by the Police Department are discussed in Chapter 11.

CHAPTER SEVEN

SUMMARY OF THE FIELD TEST OPERATIONS AND DATA COLLECTION

CHAPTER SEVEN

SUMMARY OF THE FIELD TEST OPERATIONS AND DATA COLLECTION

7-1. SUMMARY OF OPERATION

Operational and experimental descriptions of the project have been presented in Chapters 4 and 6 respectively. A summary of the project operation will be given here without repeating details. A summary of the data collection will be given in Section 7-2 and the more significant problems encountered will be discussed in Section 7-3.

During the first demonstration period data were collected on the existing ambulance service provided by the Police Department in four precincts. The police service was operated without modification. Data were collected at the Communication Center and from the ambulance attendants and emergency rooms. Although the fire rescue squads also conveyed patients during this period, they were not included in this initial data collection.

During the second period in April, two commercial ambulances under the control of the Police Department replaced the police service in Precinct 7, and officers with supplemental training and equipment provided service in Precinct 15. Data were also collected from the fire rescue squads.

In the third demonstration period in August, the commercial ambulances were moved to Precinct 16 and officers with supplemental training were used in both Precincts 7 and 15.

7-2. SUMMARY OF DATA COLLECTION

Data forms were collected on a total of 798 cases or patients in the November/December period. Ambulance forms for 658 of these were available, and emergency room forms for 458 were obtained. The number of cases for which the ambulance and emergency room forms matched was 318. Because of the problems mentioned in Section 6-4., these data were not used in the final evaluation. However, the dispatch tickets for all police runs in November, both for emergency medical and normal police functions, were obtained and used to derive the system load characteristics that are employed in the allocation and distribution study of Chapter 11.

The number of forms collected in both April and August is shown in Table 7-1. Of the 968 cases in April, forms matched on 760 or 78%. Matched forms were obtained in 979 or 95% of the 1,026 cases in August. The improvement resulted from increased coordination with the hospitals and members of the medical evaluation team. As a result, however, many emergency room forms were obtained for patients for whom there were no ambulance forms. Thus the percentage of the ambulance forms that matched dropped from 71% in April to 66% in August.

The small number of forms submitted by police officers in the precincts serviced by the commercial ambulances--15 in Precinct 7 in April, and 4 in Precinct 16 in August--would seem to indicate the commercial ambulances were dispatched to convey nearly all patients in these precincts. This is not the case however. Information taken from the Daily Vehicle Activity Logs and from Conveyance slips indicates that the police conveyed 134 patients from Precinct 7 in April, while the commercial ambulances conveyed 212.[1]

The commercial ambulances then carried 61% of the patients.[2] Similar data is not available for Precinct 16 in August. However, information taken from conveyance slips for June indicates the ambulances carried 60% of the patients from 16.[3] The police carried fewer patients during July, and while complete numbers are not available, the relative utilization of the commercial ambulances may have been greater in August.

---

[1] This information was obtained by Lt. Frank Staskon, Communication Center, Detroit Police Department.

[2] These figures do not include conveyances by the fire rescue squad. They are based on calls serviced by the Police Department.

[3] The commercial ambulances operated in Precinct 16 in May, June and July for familiarization.

TABLE 7-1

SUMMARY OF APRIL AND AUGUST DATA COLLECTIONS

		April					August					Total				
		6	7	15	16	Sub-Tot.	6	7	15	16	Sub-Tot.	6	7	15	16	Cum. Tot.
Ambulance	Police	133	15	192	62	402	45	170	187	4	406	178	185	379	66	808
Attendant	Comm.	-	185	-	-	185	-	-	-	98	98	-	185	-	98	283
Check	Fire	17	35	86	22	160	23	52	89	22	186	40	87	175	44	346
Sheets	Total	150	235	278	84	747	68	222	276	124	690	218	457	554	208	1437
Emergency Room Check Sheets		126	239	261	134	760	117	367	315	180	979	243	606	576	314	1739
Matched	Police	87	10	149	41	287	37	162	181	2	382	124	172	330	43	669
Check	Comm.	-	147	-	-	147	-	-	-	91	91	-	147	-	91	238
Sheets	Fire	8	26	55	16	105	20	46	82	22	170	28	72	137	38	275
	Total	95	183	204	57	539	57	208	263	115	643	152	391	467	172	1182
No. Cases (Patients)		181	291	335	161	968	128	381	328	189	1026	309	672	663	350	1994

Twenty-five officers of Precinct 15 completed the advanced course, and 50 the refresher course, before the second demonstration period. While this number was intended to include those officers who would be assigned to the ambulwagons, transfers and reassignment resulted in some attrition. Many patients were conveyed by officers without supplemental training. Seventy-five officers (twenty-five from each platoon) from Precinct 7 completed the course before the August period. The percent of patients carried by officers with supplemental training in each of these precincts is given in Table 7-2. Each ambulwagon has a crew of two. The officer with the higher level of training was used to determine the training level of each conveyance, both in Table 7-2 and in Chapter 12.

The distribution of the patients by hospital is given in Table 7-3. The data are from the emergency room forms collected in April and August, and include all recovery modes.

TABLE 7-2

UTILIZATION OF POLICE WITH SUPPLEMENTAL TRAINING

	Conveyances by Officers with Indicated Training: Number	Percent
Precinct 7 (August)		
Academy Training (C)	71	42
Refresher Course (R)	---	---
Advanced Course (A)	99	58
Precinct 15 (April & August)		
Academy Training (C)	189	50
Refresher Course (R)	111	29
Advanced Course (A)	79	21
Total (4 precincts April & August)		
Academy Training (C)	512	64
Refresher Course (R)	111	14
Advanced Course (A)	178	22

TABLE 7-3

DISTRIBUTION OF PATIENTS BY HOSPITALS
(In Percent)

	Precinct 6	7	15	16	Total
Deaconess	--	3.6	0.5	---	1.4
*Detroit General	58.9	74.5	0.2	1.3	37.1
Henry Ford	22.2	---	0.2	---	3.2
Holy Cross	----	---	11.6	---	3.8
*Martin Place West	----	---	---	66.3	12.0
*Mt. Carmel	----	---	---	16.2	2.9
Northwest General	8.2	---	---	0.3	1.2
Redford Community	----	---	---	12.7	2.3
*Saratoga	----	---	28.9	---	9.5
Sinai	----	---	---	3.2	0.6
*St. Joseph	----	21.6	9.7	---	10.8
*St. John's	----	---	40.9	---	13.6
Ziegar	10.7	---	---	---	1.5
Missing Data	----	0.3	---	---	0.1
TOTAL	100.0	100.0	100.0	100.0	100.0
Number	243	606	576	314	1739

*Represented by physicians on the medical evaluation team.

7-3. PROBLEMS ENCOUNTERED IN DATA COLLECTION AND ANALYSIS

During the course of the demonstration, several problems were encountered which are directly related to the collection of data. These problems are not unique to this particular program and certainly would be experienced in varying degree by other investigators engaged in similar studies. These problems are discussed in this section. Several are described in subsequent chapters where they relate to specific subjects, and will only be summarily discussed here.

The intent is not to overemphasize the problems or to imply lack of cooperation from any group or agency. A large number of observers and participants were involved in the demonstration and voluntarily provided services which required considerable expansion of their normal work load. Nevertheless, the experience obtained in this program could assist others in the execution of similar investigations. If for no other reason, the problems encountered are an appropriate subject of discussion.

The greatest and most serious problem associated with the detection and reporting study was lack of data. This is discussed in detail in Chapter 9. While a substantial number of accidents were reported by members of the Community Radio Watch and by the Citizens Band net, very few responses by the Police Department to these notifications were documented. In addition, the officers in the IMPACT Center had difficulty determining the source of public telephone calls for assistance. The measure employed to alleviate the latter problem and the results are discussed in Section 9-2.

Some problems were also experienced in obtaining full utilization of project services. The commercial ambulances which were to supplant the use of ambulwagons in the demonstration were not dispatched for all conveyances. The reasons for not dispatching the ambulances more frequently are not known. It was not because they could not handle the load. The dispatchers in the Communication Center are resource conscious and this has been suggested as a possible explanation. During the project they had at their disposal an added capability, but they might have been reluctant to commit the units for many calls that were not obviously true emergencies.

Similar reluctance to use (or dispatch) the helicopter was evident. During 450 flight hours, the helicopter was dispatched to 46 accidents, or an average of 1 dispatch every 9.8 hours. Interestingly, 12 of the 23 actual evacuations occurred on Fridays. Use of the helicopter may have also suffered from a resource conscious attitude. There may be other contributing factors however. For example, a dispatch ticket (a request for service) normally is transmitted from

an IMPACT operator to a district dispatcher. If the dispatcher wanted to use the helicopter, he had to notify the traffic central operator who monitored the helicopter radio traffic. Thus, coordinating efforts were necessary in the dispatch center which were alien to normal operations. The modification of procedures necessary to achieve smooth operation is sometimes difficult to implement for an experiment of limited duration.

Several problems associated with the documentation by ambulance attendants were mentioned in Section 6-4. The commercial attendants submitted forms on 87% of the patients they conveyed in April. In August the figure dropped to 71%. However, some of the patients serviced in August were conveyed from an adjacent precinct. While project representatives asked for and received forms on these patients, the attendants might have realized that these were not part of the demonstration and may have provided forms with less reliability. Thus, the reliability on patients from Precinct 16 may have been greater than 71%. Comparable data on the police attendants are not available. Estimates, however, can be derived. The disposition of all dispatch tickets from April is given in Section 8-1. Comparison of the dispatches for which forms were received with the disposition of other dispatches indicates that forms were received for 63% of the police conveyances from those precincts that were not serviced by the commercial ambulances.

The original concept of the demonstration emphasized reduction of sequelae of traffic accidents. Thus the injury matrix was addressed to traumatic injury. However, many of the emergencies that must be serviced by a public recovery system are, naturally, medical problems for which the matrix is not suitable. Such cases were usually described by brief notes on the attendants check sheet and emergency room form. The comments were not in a standardized format that could be coded for machine processing.

A minor documentation problem which arose frequently resulted from the lack of specific provisions for recording abrasions. While these wounds are usually minor, they may be the most obvious to the attendant; indeed, minor contusions and abrasions may be the extent of trauma.

The procedure for tagging patients for identification was instituted so that ambulance and emergency room data could be collected independently and preserve the objectivity of the information from each source. As a consequence, however, the emergency room personnel could not always determine what first-aid measures, if any, had been used by the ambulance attendant. The patient's initial condition and treatment needs were often obscured by treatment rendered at the scene or by the passage of time. This problem and the eventual method of analysis used as a result, are described in Section 12-2. The problem could be avoided if a serial documentation sequence were employed. Such a procedure was suggested by Bordner.[4] The emergency room personnel then have access to the attendant's data on a case-by-case basis and are informed of his findings at the scene and his subsequent action.

Exchange of information between ambulance attendants and emergency room personnel is valuable and in individual cases, even vital. However, during the planning phase of the program there was concern that if the hospitals were given a hard copy of the first-aid procedures, the emergency rooms would simply endorse the care provided by the attendant. The initial reaction of several hospitals to the project, particularly in the medico-legal area, reinforced this concern.

A completely satisfactory solution to the problem is not yet evident. Verbal communication between the attendants and nurses or physicians was not, and must not be discouraged. Nevertheless, exchange of hard copy on first-aid measures still appears potentially dangerous to objective research.

---

[4] Bordner, Kenneth, et. al., Emergency Care Systems Demonstration Projects, Vol. I, Report 1-214, Contract FH-11-6596, June, 1968.

CHAPTER EIGHT

ANALYSIS OF THE MEDICAL EMERGENCY OCCURRENCE PROCESS

CHAPTER EIGHT

ANALYSIS OF THE MEDICAL EMERGENCY OCCURRENCE PROCESS

The empirical findings relevant to the medical emergency occurrence process in an urban area are presented and discussed in this chapter. While these data were obtained from the city of Detroit during specific data collection periods, it is felt that the study design permits cautious extrapolations of the results to other urban areas and time frames. Hence these results should be of interest to other agencies and researchers studying urban medical emergencies.

In addition, these data are useful in the present study to determine the characteristics of the demand function for urban public ambulance service. This is important, since a major objective of this project is to make the ambulance service more responsive to this demand. (Thus the data of this chapter on the intensity of the medical emergency occurrence process are used extensively in the recovery vehicle allocation study of Chapter 11.) Furthermore, a study of the demand function may serve to indicate methods for modifying the demand for public ambulance service.

The distribution of medical emergencies in time and space (the intensity of the occurrence process) is discussed in Section 8-1. The etiological mechanisms leading to medical emergencies are discussed in Section 8-2, and the demographic characteristics of the victims of these emergencies are presented in Section 8-3. Finally the nature and severity of injuries resulting from the occurrence of medical emergencies are discussed in Section 8-4.

8-1. INTENSITY OF THE MEDICAL EMERGENCY OCCURRENCE PROCESS

The times and locations of ambulance calls in an urban area clearly cannot be predicted with certainty and therefore these must be described as random processes. Their characteristics will be examined in this section. Note that the objective here is not to develop specific techniques for forecasting the times and locations of emergencies.

However, the results of this section can be used to make intrinsic forecasts of ambulance demand (forecasts based upon past realizations of the processes). The use of supplemental, non-historical data to make extrinsic forecasts is not considered in this report.

In this section the characteristics of the times between events perceived to be ambulance calls in the police IMPACT Center are examined. The distribution of the geographic locations of these events are studied and the disposition of these events in the existing police ambulance system are examined.

Times between Ambulance Calls

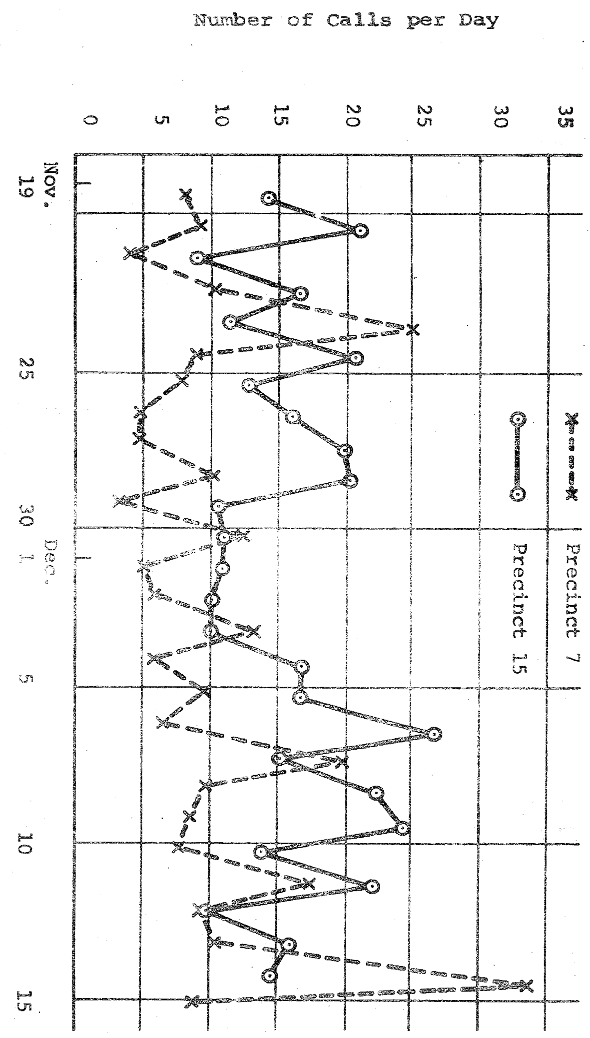
Two samples were used in this analysis. A one month sample of all events perceived to be medical emergencies in the IMPACT Center was taken from Precincts 7 and 15 during the November/December, 1968 data-collection period. This sample was used to examine potential trends and cycles during a one-month period and to identify the nature of the distribution of times between perceived ambulance calls. Second, a one-week sample of calls for public ambulances in all thirteen police precincts was taken during July 14-20, 1969. This was used to obtain further insight into the characteristics of the series of events.

A realization of the number of events per day in the November/December two-precinct study is given in Figure 8-1. Visual inspection of this figure shows no obvious trends or cycles. The intensity of calls seems to be somewhat greater in Precinct 15. A two week subset of the Precinct 15 sample was decomposed into series for each of the three police shifts. (Figure 8-2.) Here again, no major differences appear. Statistical tests were conducted with all November/December data from the two precincts to determine if there were hourly, daily or weekly cycles which were not detected in the graphical analysis. No significant cycles were detected, however.[1]

[1] These statistical tests utilized the sample spectrum and autocorrelation function of the series of events. They are described in Cox and Lewis, <u>The Statistical Analysis of Series of Events</u>, Metheun, London, 1966.

FIGURE 8 - 1

NUMBER OF AMBULANCE CALLS PER DAY
NOVEMBER 19, 1968 - DECEMBER 15, 1968



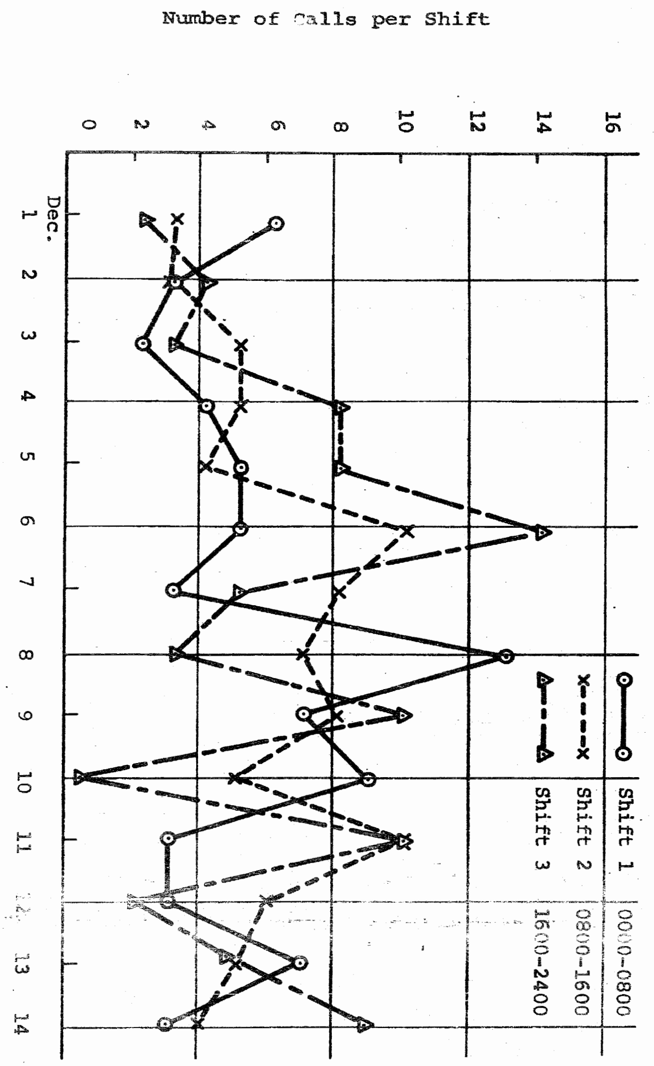


FIGURE 8 - 2

NUMBER OF AMBULANCE CALLS PER SHIFT
PRECINCT 15 DECEMBER 1 - DECEMBER 14, 1968

Further statistical analyses were conducted to examine the distribution of the times between ambulance calls. If these calls occur randomly over time, then, as is well known, the distribution of the times between calls obeys a negative exponential law (a Poisson process). Various "goodness of fit" tests[2] were utilized to test this hypothesis, and these tests all indicated that the process is not Poisson. Further analysis indicated that a "Gamma" distribution of times between calls is a good model for the occurrence process. The variability of the process is slightly greater than that for a truly random sequence, indicating that events tend to cluster more frequently. This factor is important in determining the proper allocation of recovery vehicles (Chapter 11). Certain summary statistics for the one-month sample are presented in Table 8-1.

TABLE 8-1

STATISTICS FOR MARGINAL DISTRIBUTION OF INTERARRIVAL TIMES BETWEEN AMBULANCE CALLS

Statistic	Observed Value Precinct 7	Observed Value Precinct 15
Mean	98.072 min	101.166 min
Variance	18378.207 min^2	15679.672 min^2
Coefficient of Variation	1.396	1.238
Coefficient of Skewness	3.603	2.449
Kurtosis	20.950	10.462
Range (min. - max.)	1-1120 min	1-866 min

[2]Including Kolmogorov-Smirnov and Anderson-Darling tests. Also in Cox and Lewis.

The sample cumulative distribution function for Precinct 15 is given in Figure 8-3. From this one can determine the probability that the time between ambulance calls will be within certain limits. For instance, approximately 40% of all calls occur within 50 minutes of each other (dotted lines on figure).

From these results it may be observed that the average time between ambulance calls in each of the two test precincts is about 100 minutes. However, the times between calls show substantial variation about this mean and tend to cluster with shorter intervals.

The one-week sample of all precincts taken from July 14-20, 1969, was tabulated by the number per hour of the day for both traffic and non-traffic emergencies. The raw data are presented in Table 8-2. Figure 8-4 presents the moving three-hour mean of all the data (the moving average was computed in order to smooth the data). A substantial daily cycle occurred in this one week data. The lower intensity of emergencies in the early morning and the higher intensity in the late afternoon and evening are intuitively reasonable. However, they disagree with the results for the November/December data, where no such cycle was detected. A tentative explanation for this lack of agreement comes from further inspection of Figure 8-2. During the week of December 1-7, the number of ambulance calls per shift in Precinct 15 was consistently lower during shift one--a result which is consistent with the smoothed curve figure. However, during the week December 8-14, no such cycle was present in the one month sample. Hence we can tentatively conclude that the daily cycle may or may not be present in the medical emergency occurrence process, depending on the week under consideration.

The implication of this result is that analysis of much longer samples of the series of medical emergency occurrences is necessary in order to detect cycles and trends of the type discussed here. Since the proper allocation of recovery vehicles within a service region is highly dependent upon the nature of the emergency occurrence process, such a study should be undertaken in those urban areas planning changes in the recovery system operation.

FIGURE 8 - 3

EMPIRICAL DISTRIBUTION FUNCTION - TIMES BETWEEN AMBULANCE CALLS - PCT. 15

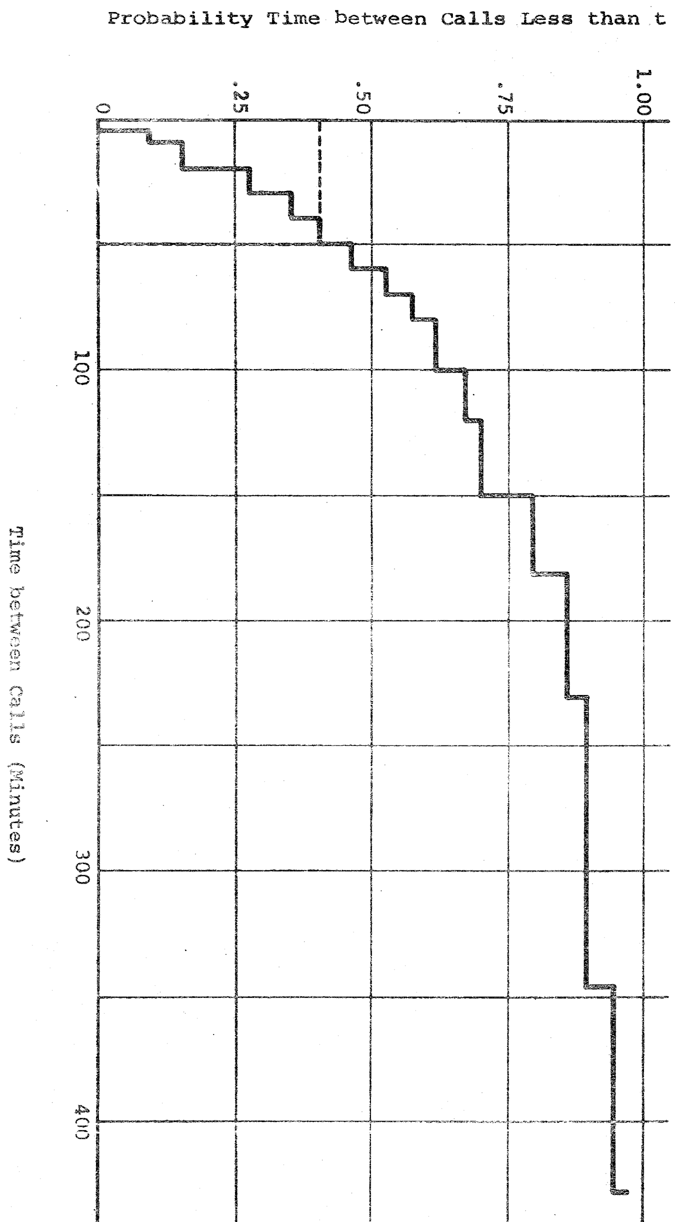


TABLE 8-2

DISTRIBUTION OF EMERGENCY MEDICAL CALLS FOR ENTIRE CITY
14-20 July 1969

Hour	Traffic No.	Traffic %	Non-traffic No.	Non-traffic %	Total No.	Total %
0-1	21	6.8	93	5.9	114	6.0
1-2	10	3.2	61	3.8	71	3.7
2-3	18	5.8	62	3.9	80	4.2
3-4	11	3.6	39	2.5	50	2.6
4-5	1	0.3	33	2.1	34	1.8
5-6	2	0.6	28	1.8	30	1.6
6-7	11	3.6	21	1.3	32	1.7
7-8	9	2.9	37	2.3	46	2.4
8-9	8	2.6	37	2.3	45	2.4
9-10	5	1.6	39	2.5	44	2.4
10-11	5	1.6	58	3.6	63	3.3
11-12	10	3.2	43	2.7	53	2.8
12-13	17	5.5	89	5.6	106	5.6
13-14	11	3.6	79	5.0	90	4.7
14-15	12	3.9	72	4.5	84	4.4
15-16	11	3.6	78	4.9	89	4.7
16-17	31	10.1	93	5.9	124	6.5
17-18	18	5.8	101	6.4	119	6.3
18-19	19	6.2	70	4.4	89	4.7
19-20	19	6.2	71	4.5	90	4.7
20-21	15	4.9	88	5.5	103	5.4
21-22	12	3.9	109	6.9	121	6.4
22-23	15	4.9	114	7.2	129	6.8
23-24	17	5.5	74	4.7	91	4.8
TOTAL	308		1589		1897	
%	16.2		83.8		100.0	

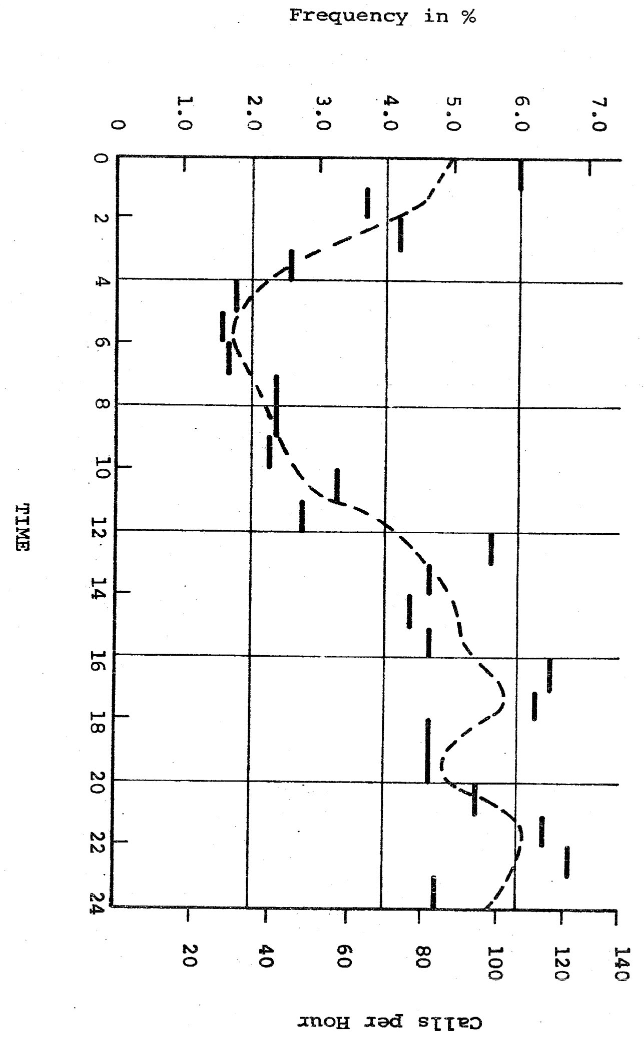


FIGURE 8 - 4

DISTRIBUTION OF EMERGENCY MEDICAL CALLS INTO IMPACT CENTER FOR DETROIT JULY 14-20, 1969

(Dashed line is 3 hour Running Average)

Locations of Ambulance Calls

The geographic distribution of medical emergencies was briefly studied to search for areas of unusually heavy demand to provide data for the recovery vehicle allocation study. The locations of medical emergency calls in Precincts 7 and 15 during the November/December data collection period was identified by the scout car territories of each precinct.[3] Figures 8-5 and 8-6 present these results.

Significant variations are present between scout car territories within each precinct. While the causes of these variations have not been studied in this research, the implications of such variability on recovery vehicle placement are discussed in Section 11-3.

Disposition of Medical Emergency Calls

Detailed information was collected only on calls for assistance that resulted in conveyances, and it was not complete even on these. Thus the data collected from ambulance attendants and emergency rooms do not constitute the total response to, or disposition of, calls to the Police Department for medical assistance. This information is necessary to describe the total load on the public system and to determine the importance of "false alarms" and the effectiveness of the present screening process used in the IMPACT Center.

Approximately 2,000 dispatch tickets were written in the police Communication Center (including the IMPACT Center) in April for apparent medical emergencies in the four test precincts. During the same period, a total of 779 ambulance attendant check sheets were collected, of which 587 were from the Police Department. Only 747 of the dispatch tickets matched with ambulance forms.

The disposition of the cases for which ambulance forms were not received was determined by examining the corre-

[3]The location selection was based on the address or street intersection given to the police dispatcher.

FIGURE 8 - 5

PROBABILITY DISTRIBUTION OF NOVEMBER/DECEMBER AMBULANCE CALLS PRECINCT 7
N = 276

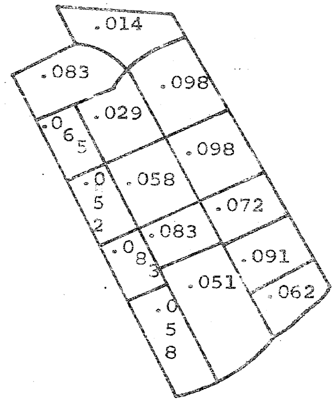
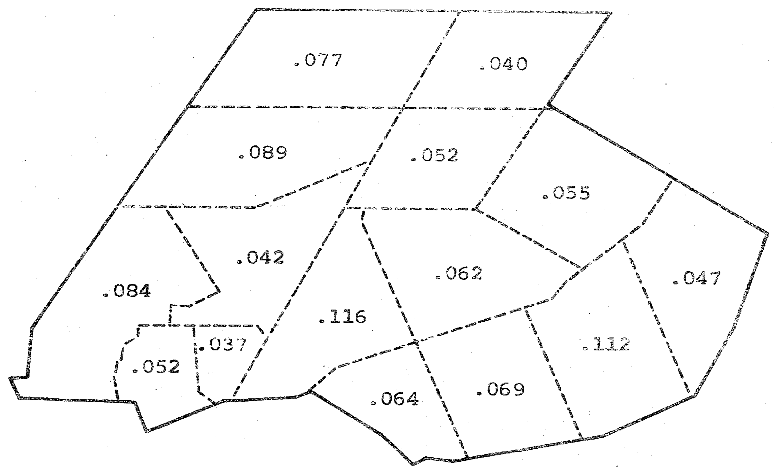


FIGURE 8 - 6

PROBABILITY DISTRIBUTION OF NOVEMBER/DECEMBER AMBULANCE CALLS PRECINCT 15
N = 403



sponding conveyance slips and Daily Activity Log entries at each of the four precinct stations. Table 8-3 gives the disposition of all the April dispatches. The figures include the conveyances for which ambulance forms were collected as well as those for which they were lacking.

Frequently, more vehicles than one are dispatched to the same incident. The vehicles participating in a multiple response but not conveying a patient account for the disposition listed as "Conveyed by Other Vehicle." Because of the multiple responses, the total of 1,971 dispatches does not represent distinct incidents. The estimated number of such incidents is 1,708.

Several statistics which can be derived from Table 8-3 are given in Table 8-4. Ambulance attendant check sheets were collected on 63% of the conveyances by police to hospitals. This is consistent with other estimates of the data collection. It should be noted that the number of cancelled calls was only 1.4%, which is lower than was anticipated, while the number of calls resulting in a conveyance by police units was 45%, which is greater than anticipated.

8-2. ETIOLOGY OF OCCURRENCE PROCESS

The objective in this section is to characterize the causative mechanisms leading to medical emergencies in an urban area. The statistical data for this analysis come from all ambulance forms collected during April and August, 1969.

The distribution of traffic and non-traffic medical emergencies by precinct is presented in Table 8-5.

Medical emergencies resulting from traffic accidents constituted 30 percent of our sample.

The traffic-related medical emergencies were subsequently analyzed by victim type and these results (percentages) are presented in Table 8-6.

As a matter of ancillary interest, the availability and utilization of passenger restraint devices were recorded by the ambulance attendant. The raw data are presented in Table 8-7.

TABLE 8-3

DISPOSITION OF APRIL DISPATCHES
FOR EMERGENCY MEDICAL ASSISTANCE

Disposition	Precinct				
	6	7	15	16	Total
Patient Conveyed to Hospital	186	280	227	149	842
Call Cancelled	4	5	4	14	27
No Assistance Required or No Injury	71	70	75	72	288
Found Nothing at Scene	26	37	37	8	108
Conveyance by Other Vehicle	32	142	58	31	263
Conveyance by Fire Department	12	25	53	15	105
Assistance Given But No Conveyance	2	3	8	4	17
Refused Aid	19	23	13	9	64
Conveyed to Residence	10	14	10	8	42
Conveyed by Private Ambulance	3	0	0	5	8
Conveyed by Private Vehicle	9	4	6	4	23
Referred to City Physicians Office	3	14	2	3	22
Called Medical Examiner	17	2	14	6	39
Conveyed to Precinct Station	3	5	6	4	18
Report Taken at Hospital	11	32	13	6	62
Other Disposition	0	0	0	0	0
No Disposition Given	12	17	9	5	43
TOTAL	420	673	535	343	1971

Disregarding the missing data, it may be observed that seat belts were available in 62% of the cases and harnesses in 36.7%.[4] When a belt was available, it was utilized

[4]These are surprisingly high percentages which suggest recording errors. However, if missing data regarding shoulder harnesses are assumed to imply harness unavailability, a percentage of 23% is obtained. This is a more reasonable estimate of this parameter.

TABLE 8-4

SUMMARY OF DISPOSITION OF
POLICE EMERGENCY MEDICAL DISPATCHES

1. Conveyances in Percent of Number of Dispatches

Police*	44.8%
Fire Department	5.3%
Private or Commercial	1.5%
TOTAL	51.6%

2. Conveyances by Police to a Hospital*

42.7% of Total Dispatches
0.427 Conveyances per dispatch
0.493 Conveyances per incident

3. Dispatched, Cancelled Before Arrival

1.4% of Total Dispatches

4. No Medical Assistance or Action by Police Officer Necessary

52.1% of Dispatches

5. No "On Scene" Emergency Assistance by any Public Agent Required

32.5% of Dispatches

*The conveyances by police include those made by the contract commercial ambulances since they were under the operational control of the police and supplanted the ambulwagons.

9.5% of the time, and when a harness was available it was utilized 7.7% of the time.

The non-traffic medical emergencies were analyzed by

TABLE 8-5

DISTRIBUTION OF TRAFFIC/NON-TRAFFIC
MEDICAL EMERGENCIES

	Precinct 6	7	15	16	Total
Traffic	78	105	165	85	433
Non-traffic	140	346	388	123	997
TOTAL	218	451	553	208	1430

TABLE 8-6

DISTRIBUTION OF TRAFFIC EMERGENCIES BY VICTIM TYPE

(Percentages Based on Column Totals)

	Precinct 6	7	15	16	Total
Driver	20.2	28.2	31.0	34.8	29.1
Passenger	43.8	30.6	28.9	35.9	33.3
Motorcyclist	3.4	3.2	6.1	8.7	5.4
Bicyclist	2.2	2.4	3.0	1.1	2.4
Pedestrian	13.5	13.7	14.2	12.0	13.5
Other	14.6	19.4	15.7	7.6	14.9
Unknown	2.2	2.4	1.0	0.0	1.4

emergency type and emergency site. Table 8-8 presents these results for all precincts.

The row and column percentages of the totals in Table 8-8 are presented in Table 8-9.

The results given in Table 8-8 can be combined with the

TABLE 8-7

AVAILABILITY AND USE OF PASSENGER RESTRAINTS

		Seat Belt Utilized: Yes	No	Missing Data
Seat Belt Available	Yes	10	97	10
	No	0	51	21
	Missing Data	0	6	116

		Shoulder Harness Utilized: Yes	No	Missing Data
Shoulder Harness Available	Yes	5	60	8
	No	0	91	39
	Missing Data	0	8	100

TABLE 8-8

DISTRIBUTION OF NON-TRAFFIC EMERGENCIES BY SITE AND TYPE

	Accident Injury	Acute Illness	Shooting	Stabbing	Other Act of Violence	Total
Home	141	407	17	16	69	650
Industry	12	11	0	0	2	25
Public Place	88	72	8	9	40	217
Other	44	34	2	0	23	103
TOTAL	285	524	27	25	134	995

TABLE 8-9

INCIDENCE OF MECHANISM AND SITE OF NON-TRAFFIC MEDICAL EMERGENCIES

I. Mechanism*

Mechanism	Percent of Patients	
Accidental Injury	28.6	
Acute Illness	52.7	
Violent Act	18.7	
Shooting		2.7
Stabbing		2.5
Other Act of Violence		13.5
TOTAL	100.0	

II. Site

Site	Percent of Patients
Home	65.3
Industry	2.5
Public Place	21.8
Other	10.4
TOTAL	100.0

*The emergencies resulting from mechanisms producing traumatic injury amounted to 47.3% of the total.

traffic cases to obtain the incidence of traumata. Of the 1428 patients represented by Tables 8-5 and 8-8, 904 or 63.3% received traumatic injuries and 524 or 36.7% suffered non-traumatic problems. The discrepancy of two cases results from missing data on the indication of traffic/non-traffic.

The distribution of the diagnoses of non-trauma on the emergency admission check sheets collected in April and August is given in Attachment 8-A. All cases were included in which definite information indicating non-trauma was available.

The diagnoses are listed as they appeared on the forms with the following exceptions. The cardiac cases include all forms of heart failure, i.e., myocardial infractions, congestive heart failure, etc. The DOA's listed are those patients for whom a diagnosis was not given and may include a few who died from traumatic injuries. Ingestion of drugs which was apparently not accidental was included as overdose. All patients with only fever indicated are listed as hyperthermia regardless of the term used on the form.

3. DEMOGRAPHY OF THE OCCURRENCE PROCESS

In this section are presented the distributions of various demographic characteristics associated with medical emergency victims from the April and August samples. The results are presented separately, for each precinct, and in certain cases for traffic and non-traffic emergencies.

The following results are presented:
(1) Table 8-10 - Age of Victim
(2) Table 8-11 - Sex of Victim
(3) Table 8-12 - Race of Victim
(4) Table 8-13 - Marital Status of Victim

Missing data has been excluded from these results.

TABLE 8-10A

AGE OF VICTIM*

	Precinct					
Age Bracket	6	7	15	16	Total	%
01-10	19	65	65	30	179	10.7
11-20	46	92	96	64	298	17.8
21-30	56	119	99	57	331	19.7
31-40	30	66	42	36	174	10.4
41-50	32	72	59	33	196	11.7
51-60	19	73	54	32	178	10.6
61-70	15	48	73	19	155	9.3
71-80	9	33	62	22	126	7.5
81+	4	13	15	9	41	2.4
	230	581	565	302	1678	

*Traffic and non-traffic emergencies were not separated in these analyses. However, the mean ages are presented below for various levels of this variable (all precincts).

TABLE 8-10B

MEAN AGE OF VICTIM

	Number	Mean Age of Victim	Estimated Standard Deviation
Traffic	348	30.2	19.1
Acc. Injury	188	35.8	25.3
Illness	402	49.0	22.8
Stabbing	21	28.6	9.3
Shooting	25	33.9	18.6
Other	152	32.8	21.9

TABLE 8-11

SEX OF VICTIM

	Male		Female	
Traffic				
Pct. 6	31		21	
7	57		32	
15	74		73	
16	29		38	
TOTAL	191	(54%)	164	(46%)
Non-Traffic				
Pct. 6	64		34	
7	187		107	
15	175		139	
16	59		45	
TOTAL	485	(60%)	326	(40%)

TABLE 8-12

RACE OF VICTIM

	White Sp. Amer.	White All Other	Non-White Negro	Non-White Oriental	Non-White Indian	Non-White All Other	Other (Unknown)
Traffic							
Precinct 6	0	22	25	0	0	0	3
7	0	31	54	0	0	2	0
15	2	111	34	0	0	0	0
16	2	60	0	0	0	0	0
TOTAL	4	224	113	0	0	2	3
(%)	0.6	65.1	32.8	0.0	0.0	0.6	0.9
Non-traffic							
Precinct 6	2	26	60	0	0	0	6
7	2	62	219	0	0	0	3
15	1	267	39	0	1	0	2
16	0	89	3	0	0	0	0
TOTAL	5	444	322	0	1	0	11
(%)	0.6	56.7	41.1	0.0	0.1	0.0	1.4

TABLE 8-13

MARITAL STATUS OF VICTIM

	Never Married	Married	Separated	Divorced	Widowed	Unknown
Traffic						
Precinct 6	20	10	3	1	3	0
7	35	28	0	0	6	0
15	67	54	5	0	5	0
16	30	23	1	4	1	0
TOTAL	152	115	9	5	15	0
(%)	51.4	38.9	3.0	1.7	5.1	0.0
Non-traffic						
Precinct 6	27	20	6	2	6	0
7	87	68	18	5	26	0
15	86	138	3	10	43	0
16	19	56	1	4	8	0
TOTAL	220	282	28	21	83	0
(%)	34.7	44.5	4.4	3.3	13.1	0.0

8-4. NATURE OF INJURIES RESULTING FROM OCCURRENCE PROCESS

The extent and severity of injuries associated with the medical emergencies conveyed during the April and August data-collection periods are discussed in this section. The findings presented here should be useful in developing a baseline description of the extent and severity of injuries within an urban area.

The injury/body-area matrices on the hospital emergency room forms were analyzed to develop frequency counts for the various cells. The data by type of injury are presented in Tables 8-14 and 8-15 separately for traffic and non-traffic medical emergencies. The incidence of injury to the nine indicated body locations is given in Table 8-16 for traffic and non-traffic injuries. The figures given are the row percentages based on column totals from Tables 8-14 and 8-15. Therefore, the non-traffic cases represented are those with traumas which were indicated on the injury matrix.

Chi squared tests indicate highly significant differences in the anatomical distribution of injuries between the traffic and non-traffic origins. A greater proportion of the injuries of non-traffic origin are to the head and upper extremities than in the case of traffic injuries. On the other hand, a greater proportion of the latter are to the neck and lower extremities. It is important to note, however, that the non-traffic data in both Tables 8-15 and 8-16 comprise the total number of injuries of the indicated type, and include only those patients with traumas that were described by the matrix and were conveyed by the public recovery system.

TABLE 8-14

TRAFFIC INJURIES BY TYPE AND BODY AREA

355 Patients
318 Patients with Injury Indicated in Matrix

INJURY TYPE \ BODY AREA INJURED	HEAD	FACE	NECK	THORAX	SPINE	ABDOMEN	PELVIS	UPPER EXTREMITIES	LOWER EXTREMITIES
Fracture	4	10	3	11	1	0	5	14	26
Sprain/Strain/ Dislocation	1	1	14	2	6	0	2	10	11
Traumatic Amputation	0	0	0	0	0	0	0	0	0
Contusion/Crushing	54	18	8	18	8	10	4	35	46
Laceration	51	67	0	4	0	0	4	21	24
Concussion	29	2	1	0	0	0	0	3	4
Internal	1	0	0	0	0	4	0	0	0
Burn	0	0	0	0	0	0	0	0	0
Asphyxiation	0	0	0	0	0	0	0	0	0
Drowning	0	0	0	0	0	0	0	0	0
Poisoning	0	0	0	0	0	0	0	0	0
Electrocution	0	0	0	0	0	0	0	0	0
Other	4	5	1	1	1	3	1	11	14

Since the information indicating traffic or non-traffic is included on only the ambulance attendant form, only matched cases are represented in Tables 8-14 and 8-15. The incidence of injury from all emergency room forms is presented in Table 8-17.

The total number of fatalities in April and August was 131. Of these, 96 were dead on arrival and 35 expired in the hospital. The injuries of the 96 patients who were dead on arrival (DOA) at the hospital are listed in Table 8-18. The patients who expired in the hospital (EIH) are listed in Table 8-19. Only nine of the fatalities resulted from motor vehicle accidents. The distribution of the age of the fatality victims is given in Table 8-20.

Some measures of the severity of the injuries were available on both the ambulance attendant's and the emergency room forms. The condition of the victim at the scene when the ambulance arrived and at the time of arrival at the emergency room is tabulated in Table 8-21 for traffic and non-traffic emergencies.

The disposition of the patient by the hospital is tabulated in Table 8-22 for traffic and non-traffic emergencies.

It is interesting to note that 60% of the victims were treated and released, while about 27% were admitted or transferred to another hospital.

A frequency count of the number of days spent in the hospital by those victims who were admitted is presented in Table 8-23.

TABLE 8-15

NON-TRAFFIC INJURIES
BY TYPE AND BODY AREA

820 Patients
298 Patients with Injury
Indicated in Matrix

INJURY TYPE / BODY AREA INJURED	HEAD	FACE	NECK	THORAX	SPINE	ABDOMEN	PELVIS	UPPER EXTREMITIES	LOWER EXTREMITIES
Fracture	11	5	1	1	2	0	3	17	16
Sprain/Strain/ Dislocation	1	1	1	1	4	0	1	6	5
Traumatic Amputation	0	0	0	0	0	0	0	0	0
Contusion/Crushing	28	13	2	9	2	2	2	8	10
Laceration	61	36	4	5	1	2	2	43	19
Concussion	20	0	0	0	0	1	0	0	1
Internal	0	2	1	2	0	2	0	0	[illegible]
Burn	3	3	0	1	0	0	2	5	1
Asphyxiation	1	3	0	0	0	0	0	0	0
Drowning	0	0	0	0	0	0	0	0	0
Poisoning	2	0	0	0	0	0	0	0	0
Electrocution	7	0	0	8	1	4	0	3	0
Other	0	0	0	0	0	0	0	1	1

TABLE 8-16

INCIDENCE OF INJURY BY BODY LOCATION

(In Percent)

TRAFFIC	PERCENT	NON-TRAFFIC	PERCENT
Head	24.9	Head	33.4
Face	17.8	Face	15.7
Neck	4.7	Neck	2.2
Thorax	6.2	Thorax	6.7
Spine	2.8	Spine	2.5
Abdomen	2.9	Abdomen	2.7
Pelvis	2.8	Pelvis	2.5
Upper Extremity	16.3	Upper Extremity	20.6
Lower Extremity	21.6	Lower Extremity	13.7
TOTAL	100	TOTAL	100

Nearly all the people intimately involved with the public emergency medical response service in the city agree that many patients who are transported in emergency vehicles do not require true emergency conveyance. Many of the problems encountered are of a minor nature, and these patients could have used more conventional transportation. Reliable estimates of the cases that truly require emergency response are difficult to obtain. None of the items of information on the data forms can be used for valid assessment of the seriousness of the injuries. Certainly the state of consciousness alone is not a meaningful measure. The injury matricies provide only gross indications of type and location, but not of degree of trauma.

The "disposition of the patient" given on the emergency room form is likewise not a sufficient indicator of injury severity. Injuries that appear potentially critical to lay personnel, or even trained ambulance attendants, might be adequately treated in the emergency room and result in "treated and released." Conversely, certain medical conditions which are not time critical may be best managed by admitting the patient to the hospital.

TABLE 8-17

INJURIES BY TYPE AND BODY AREA
1739 PATIENTS

INJURY TYPE \ BODY AREA INJURED	HEAD	FACE	NECK	THORAX	SPINE	ABDOMEN	PELVIS	UPPER EXTREMITIES	LOWER EXTREMITIES
Fracture	22	22	5	19	5	1	13	46	56
Sprain/Strain/ Dislocation	3	2	29	8	23	0	3	21	21
Traumatic Amputation	0	0	0	0	0	0	0	0	0
Contusion/Crushing	108	60	18	47	18	17	11	74	100
Laceration	184	163	8	17	1	10	7	103	72
Concussion	80	3	1	2	0	1	0	4	6
Internal	3	1	0	1	0	8	0	0	0
Burn	3	5	1	2	0	0	2	7	3
Asphyxiation	1	3	0	0	0	0	0	0	1
Drowning	1	0	0	0	0	0	0	0	0
Poisoning	2	0	0	0	0	0	0	0	0
Electrocution	0	0	0	0	0	0	0	0	0
Other	18	8	5	14	5	11	2	20	20

TABLE 8-18

EMERGENCY ROOM DIAGNOSIS OF
PATIENTS DOA AT HOSPITAL

I. Traffic Accidents — 4 patients DOA

Auto Driver - Fractures of head, face, thorax, upper extremity, crushing of face, thorax.

Passenger - Probable internal injuries of thorax and head, seat belt and shoulder harness available, not used.

Motorcyclist - Fractures of head, neck.

Pedestrian - Fractures, lacerations, contusions of face, pelvis, lower extremity.

II. Non-traffic		Number of Patients
No Diagnosis, No Trauma		66
No Diagnosis, Trauma Involved		4
Possible Cardiac, Diagnosis not Definite		6
Carbon Monoxide Poisoning		1
Asphyxiation, Infant		1
Electrocution		1
Gun Shot Wounds:	Location Not Given	1
	Thorax	2
	Thorax, Abdomen, Lower Extremity	1
	Head	2
	Face	1
	Abdomen	1
Infant Fall, No Diagnosis		1
Fall, Fracture of Head		1
Burns and Smoke Inhalation (In a single residential fire)		3

AGE OF FATALITIES

AGE	Traffic DOA	Traffic EIH	Traffic Total	Non-traffic Traumatic DOA	Non-traffic Traumatic EIH	Non-traffic Traumatic Total	Non-traffic Non-traumatic DOA	Non-traffic Non-traumatic EIH	Non-traffic Non-traumatic Total	Non-traffic Total	Total
0-1				5		5				5	5
2-3							2		2	2	2
4-5										0	0
6-10				2		2				2	2
11-15				1	1	2				2	2
16-20										0	0
21-25	1	1	2	2		2		2	2	4	6
26-30										0	0
31-35	1		1	1		1		2	2	3	4
36-40				1	1	2	3	1	4	6	6
41-45	1	1	2	1		1	2		2	3	5
46-50							4	1	5	5	5
51-55							1	5	6	6	6
56-60							6	3	9	9	9
61-65							6	2	8	8	8
66-70		1	1	2		2	10	2	12	14	15
71-75		2	2				14	4	18	18	20
76-80				2		2	7	3	10	12	12
81-85							3	2	5	8	8
86-90					1	1				1	1
MD	1		1	4		4	16	0	16	20	21
MEAN AGE (No MD)	33.7	65.2	47.8	28.1	46.3	30.9	63.5	59.0	62.0	55.8	55.2

TABLE 8-19

EMERGENCY ROOM DIAGNOSIS OF PATIENTS WHO EXPIRED IN HOSPITAL

Fatalities Resulting from Trauma

	Head	Face	Neck	Thorax	Spine	Abdomen	Pelvis	Upper Extremity	Lower Extremity
Traffic									
Motorcycle Passenger	Cont.*			Cont.		Cont.			
Auto Driver	Cont.			Fx.				Fx.	
Pedestrian	Fx.	Fx.					Fx.		Fx.
Pedestrian	Cont.			Fx.			Fx.		Fx.
Pedestrian		no diagnosis							
Non-traffic									
Fall in home	Lac. Fx.								
Fall from tree	Fx.								
Gun Shot Wound						Lac.			

Fatalities Resulting from Non-Traumatic Problems

	No. of patients
No Diagnosis	4
Cardiac	8
Cardiovascular Accident	4
Drug Ingestion	3
Pulmonary Edema	2
Pneumonia	1
Diabetic Acidosis	1
Diabetes, Alcohol, Cardiac, GI Bleeding	1
Portal Hypertension, UGI Bleeding	1
Cirrhosis, Bleeding Esophagus	1
Cirrhosis, Bronchial Pneumonia	1

*Abbreviations in table are for contusion, fracture and ration.

TABLE 8-22

VICTIM DISPOSITION BY THE HOSPITAL
MATCHED FORMS ONLY

	Traffic	Acc. Injury	Illness	Shooting	Stabbing	Other Non-traffic	Total (Incl. M.D.)	%
DOA	4	7	39	3	0	8	78	4.6
Expired in Hospital	2	2	13	1	0	1	25	1.5
Admitted directly	4	3	4	1	0	0	20	1.2
Treated & admitted	51	42	109	9	1	15	318	19.0
Treated & transfer to another hospital	22	13	40	0	0	10	115	6.9
Treat & released	232	103	176	7	23	97	994	59.3
Referred to private physician	17	5	5	0	0	4	37	2.2
Left without treatment/no treatment required	6	9	13	0	0	11	67	4.0
Other	4	1	5	0	0	3	19	1.1
Unknown	0	0	0	0	0	1	1	0.0
							1674	

TABLE 8-21

VICTIM CONDITION AT ARRIVAL OF AMBULANCE

	Conscious	Unconscious	Incoherent	Apparent DBA	Apparent DAA
Traffic	379	19	27	3	1
Acc. Injury	196	14	16	5	1
Illness	307	97	57	50	4
Shooting	18	2	3	3	1
Stabbing	22	1	1	0	0
Other Non-traffic	140	12	24	7	0
TOTAL	1071	145	128	68	7

VICTIM CONDITION UPON ARRIVAL AT EMERGENCY ROOM

	Conscious	Unconscious	Shock	Coma	Anoxic	DOA
Traffic	325	4	2	2	0	4
Acc. Injury	168	5	0	0	0	8
Illness	314	34	1	5	5	42
Shooting	17	1	0	0	0	3
Stabbing	25	0	0	0	0	0
Other Non-traffic	136	7	0	2	0	7
TOTAL (Incl. M.D.)	1482	78	8	11	8	79

TABLE 8-23

DAYS IN HOSPITAL

No. Days	Expired in Hospital (All E.R. Forms) Traffic	Expired in Hospital (All E.R. Forms) Non-traffic	Admitted Directly or Treated and Admitted (Matched Forms Only) Traffic	Admitted Directly or Treated and Admitted (Matched Forms Only) Non-traffic
0-1	4	16	1	4
1-3	1	5	5	8
3-5		4	5	21
5-7		1	6	11
7-9		0	2	14
9-11		2	2	9
11-13		0	4	5
13-21		1	1	23
> 21		0	3	4
TOTAL	5	29	29	99
Missing Data	0	1	23	85

The emergency room form included the question "was speedy arrival at hospital important in this case."[5] A measure of the portion of the patients conveyed who required emergency transportation may be obtained by the combination of the response to this question and the patient disposition. One might conjecture that such patients would be represented by a yes response to the question on speed, and a disposition that indicated treatment at the facility to which they were conveyed. Those DOA at the hospital should not be included, however, since nearly all were evidently dead upon the arrival of the ambulance. The above criteria would include patients who expired in the hospital, or were admitted directly to hospital, treated and admitted, treated and transferred or treated and released.

The estimate of the patients requiring emergency transportation based on the above criteria is 24.6%.

This estimate is subjective and the rationale used has not been validated by independent measures. It is interesting that this figure is higher than the "guesses" of many people with whom the subject was discussed.

[5] A discussion of this and the five related questions on the form is included in Section 12-4.

ATTACHMENTS

CHAPTER EIGHT

Preceding page blank

ATTACHMENT 8-A

NON-TRAUMATIC MEDICAL EMERGENCIES

Cardiac	78
Dead on Arrival	54
Overdose	42
Psycho Mental Illness	42
Alcohol	35
Epilepsy	34
Diabetes	32
Cerebral Vascular Accident	29
Poisoning	21
Convulsive Disorder	20
Loss of Consciousness	19
Asthma	18
Hypertension	18
No Diagnosis	16
Alleged Rape	15
Anxiety	12
Delirium Tremens	12
Chest Pain	12
Seizure	10
Hyperthermia	9
Pneumonia	9
Epilepsy, Alcohol	7
Cancer	6
Epistaxis	6
Gastritis	6
Upper Gastro-intestinal Bleeding	6
Ingestion of Foreign Body	5
Vaginal Bleeding	5
Cirrhosis	4
Emphysema	4
Pregnancy	4
Pulmonary Edema	4
Shortness of Breath	4
Abdominal Pain	3
Alcohol Asthma	3
Arthritis	3
Bronchitis	3
Dyspnea	3
Incomplete Abortion	3
Lower Gastro-intestinal Bleeding	3
Sick	3

Preceding page blank

Vague Complaint	3
Alcohol, Diabetes	2
Allergy	2
Anemia	2
Asphyxiation	2
Brain Syndrome	2
Endometritis	2
Epilepsy, Diabetes	2
Hernia	2
Hyperventilation	2
Hysteria	2
Miscarriage	2
Pancreatitis	2
Pansinusitis	2
Senility	2
Tonsilitis	2
Tuberculosis	2
Urinary Infection	2
Virus	2
Abdominal Abcess	1
Anoxic	1
Appendicitis	1
Arterial Sclerosis	1
Aspiration of Water	1
Blood Clot	1
Cold	1
Drug Withdrawal	1
Duodenum Ulcer	1
Enteritis	1
Gall Stones	1
Gas Pain	1
Gastro-intestinal Pathology	1
Gynecomastia	1
Hanging	1
Hepatitis	1
Hypothermia	1
Infected Fallopian Tubes	1
Inhalation	1
Laryngitis	1
Loss of Speech	1
Malaise	1
Meningitis	1
Migraine	1
Palpitation	1
Pneumothorax	1
Pyelonephritis	1

Renal Calculi	1
Sickel Cell Disease	1
Sore Throat	1
Ulcerated Foot	1
Uremia	1
Vertigo	1
Vulvovaginitis	1

TOTALS

Involvement of:	Alcohol	47
	Epilepsy	43
	Diabetes	36

Number of Patients Represented	467
Number of Individual Diagnoses	649

CHAPTER NINE

MEDICAL EMERGENCY DETECTION AND REPORTING

CHAPTER NINE

MEDICAL EMERGENCY DETECTION AND REPORTING

9-1. DETECTION AND REPORTING PROCESS

The response of the emergency care systems begins with notification of the existence of an emergency requiring assistance. The process was diagramed in Figure 5-2. The occurrence of the incident is the onset of acute illness or the injury-producing accident or act. Detection of the emergency is the recognition of both the incident and the need for emergency medical care by a person who reports the incident to the response system. The agent reports via a communication channel and response is then initiated. The total delay from the time of occurrence of the incident to the time of reporting to the emergency system will be called the "notification delay." The time elements of detection and reporting are the subjects of this section. The response or service by the emergency medical care system will be discussed in Chapter 10.

Nearly all requests for emergency assistance in Detroit are ultimately transmitted to the responding agencies, either the Police or Fire Departments, by public telephone. The only exceptions are those cases that are detected by units of the respective departments with access to radio facilities. Private citizens are encouraged to use the fire and police emergency phone numbers. These numbers take all calls into either the central Fire Department Communication Center or the Police IMPACT (IMmediate Police ACTion) Center.

Operation of the Police IMPACT Center and the screening of requests for assistance are described in Section 2-2.

The public telephone system is augmented in Detroit by several radio communication networks which offer the possibility of decreasing the reporting time. While one would not expect the detection time to be affected, the reporting time for incidents that occur on public thoroughfares might be reduced by the increased accessibility of a radio communication channel. This could be achieved through networks such as that of the Community Radio Watch (CRW) which is composed of organizations which operate radio equipped motor vehicle fleets. A similar operation is the Citizens Band Network under which the Department of Streets and Traffic operates a central receiving and transmitting station on citizens band channel 9 which permits communication with departmental vehicles and other private units anywhere in the city. In addition, the National Proving Ground for Freeway Surveillance Control and Electronic Traffic Aids operates a TV surveillance system over 3.2 miles of the John Lodge Expressway. The TV system is monitored during most daylight hours and can be used to alert the Police Department of serious accidents which are likely to require emergency medical care.

In addition to the units listed above, which are described in Section 2-2, the Detroit Street Railways (DSR) has installed two-way radios in the city buses, which enable drivers detecting emergencies to immediately call their dispatcher, who will in turn call the Police Communication Center. The DSR dispatcher may use a direct police line which terminates at the police dispatch supervisor's position, or he may call the IMPACT Center on a public phone circuit.[1]

Several informal volunteer citizens band radio groups have formed in Detroit. These groups operate their own patrols and report accidents, traffic congestion, crimes and suspicious activity to volunteer monitors who may call IMPACT on public telephone circuits.

The original objective of the detection and reporting study was to evaluate the performance of the above communication systems, in particular their effectiveness in detecting injury accidents and reducing the reporting time. If probabilistic descriptions of parameters of the process could be modeled mathematically, the model could then be used to examine the sensitivity of the emergency medical recovery system to improvements in the

[1]While the DSR is a member of the CRW, it is mentioned separately here because it is the only member with a police phone.

communication system, and cost-effectiveness analyses could be used to provide the criteria for augmenting or expanding existing communication channels. Unfortunately, the statistical parameters necessary to describe the processes sufficiently well for modeling were not available from the demonstration. The two primary problems are lack of reliable measures of the time of the accident, and the small sample sizes.

The data collection is described in detail in Section 6-4. The time of a call into the IMPACT Center was recorded on the dispatch ticket for each response by the police or commercial ambulance during the April demonstration period. The officers in the IMPACT Center were asked to also include the source of the call for assistance. Member organizations of the CRW who participated in the demonstration program were given forms upon which they could record all notifications of emergencies originating from one of their units. The base station of the Streets and Traffic Citizens Band Network routinely maintains a punched card record system. Monthly listings of all calls into the base station and of the disposition of the calls were available to the project.

Data were not collected from the volunteer CB radio groups because of the informal operation of most of the groups and the non-uniform coverage they provide. The precincts selected for the demonstration as discussed in Section 6-2 do not include the John Lodge Expressway. Therefore, the TV surveillance system could not be explicitly included in the program.

9-2. ORIGIN OF CALLS

During the month of April dispatch tickets were collected for all responses by the Police Department to medical emergencies. These included dispatches of the commercial ambulances. Very little information on the source or origin of the call was obtained during this period. This information is not normally obtained or recorded by the officers in the IMPACT Center. Several factors complicated the collection of these data. The officers answer incoming calls from throughout the city and are not organized on a precinct basis but the information desired for the project pertained to only four of the thirteen precincts in the city. Thus the officers had to identify the precinct in which an incident occurred while they were still talking to the caller, which was earlier than when the precinct is normally determinated. Secondly, the caller was frequently distraught and hurried and not sympathetic to apparently unnecessary questions.

The collection of source data was repeated for one week in July.[2] During this one week the sources of all calls for emergency medical assistance from the entire city were asked. Thus the problem of precinct determination during the call was avoided and uniform procedures established. The source of the call was classified in thirteen types and coded on the dispatch ticket by number. The number of tickets obtained in the one week are given in Table 9-1.

TABLE 9-1

SOURCE OF CALL
DATA COLLECTION

	Number of Dispatch Tickets	Percent	Percent of Tickets with Source Data
Traffic Accidents	317	16.3	38.2
Non-traffic Accidents	1626	83.7	39.4
TOTAL	1943	100.0	39.2

These dispatch tickets do not represent 1,943 incidents or patients since several calls may be received regarding the same incident. If multiple calls are taken by several officers and each is not aware of other calls, then multiple dispatch tickets are generated.

[2]July 14 through 20 inclusive.

Information on the source was obtained on approximately 40% of the calls. The 60% without data could represent a serious bias if the data were not a random sample. While the existence of serious bias cannot be discounted, examination of the tickets without source data did not uncover any obvious indications of bias, either in type or location of the incident.

Likewise, no mechanisms in the collection of data that would produce bias have been identified.

The distribution of the sources of the 761 calls for which information is available is given in Table 9-2.

TABLE 9-2

DISTRIBUTION OF SOURCE OR ORIGIN OF CALLS

Source	Percent of Available Data: Traffic	Non-traffic	Total
Driver or Passenger	9.9	3.4	4.5
Passing Motorist	5.8	1.4	2.1
Pedestrian in Vicinity	30.6	7.5	11.2
Resident or Worker in Bldg.	38.1	42.6	41.9
Community Radio Watch	0	0.6	0.5
Mobile Phone	0.8	0.3	0.4
Citizens Band Monitor Net	2.5	0.3	0.7
T.V. Surveillance	0	0.2	0.1
Streets and Traffic CB Station	0	0	0
Police Vehicle	0.8	3.6	3.2
City Bus System	4.1	1.7	2.1
Fire Department	0.8	24.3	20.6
Other	6.6	13.9	12.7

The number of calls represented in several of the categories is very small and are hardly significant. Only 4 calls came from the CRW, 3 from mobile phone operators, 5 from the volunteer CB groups (listed in Table 9-2 as

CB monitor net), 1 from the John Lodge TV system, and none from the Streets and Traffic CB station. While 24 calls were from police vehicles, they do not all represent detection by police units. Frequently a scout car is dispatched to an incident not identified as a medical emergency. After arrival at the scene, the police may call the Dispatch Center for an ambulwagon if they find an injury or illness. The 157 (20.6%) calls from the Fire Department are notifications to the police by the Fire Department Communication Center. They represent both cases referred to the Police Department for disposition, and requests for scout cars to accompany the fire rescue squads. The sources of calls into the Fire Department were not obtained. While the fire rescue squads will respond to street accidents, only 1 traffic accident was reported by the Fire Department in this period of one week.

Residents or workers in nearby buildings reported 38% of the traffic accidents and 43% of the non-traffic cases. If we assume the distribution of calls into the Fire Department is similar to the distribution of reports of non-traffic cases to the Police Department, we might estimate that 56% of the calls relating to non-traffic incidents are from residents or workers. While 31% of the traffic accidents are reported by pedestrians in the vicinity, only 7.5% of the non-traffic cases are thus reported.

Several of the differences in the results given in Table 9-2 for traffic and non-traffic cases are statistically significant at the 5% confidence level. The results for driver or passenger, passing motorist and pedestrian are all significantly higher for traffic cases. The results for resident or worker and for the Fire Department are significantly higher for non-traffic cases. The size of the samples in other categories is not large enough to indicate significant differences.

The results given in Table 9-2 are grouped in Table 9-3. Note that the columns do not add up to 100% since the groups are not mutually exclusive. While 50% of the traffic accidents are reported by people on the street, 31% are pedestrians and only 19% are motorists. The number reported by private radio was too small to provide a reliable estimate.

An attempt was made to detect any changes with time of day in the distribution of sources of calls for traffic accidents. One might expect, for example, that the proportion of accidents reported by pedestrians would decrease during early morning hours. While the amount of data is insufficient to permit reliable conclusions, the distribution was substantially constant and pedestrians reported accidents uniformly throughout the day.

TABLE 9-3

DISTRIBUTION OF CALLS BY CLASS

Source	Percent of Available Data: Traffic	Non-traffic	Total
Any Motorist Except City Vehicle	19.0	5.4	7.7
Pedestrian	30.6	7.5	11.2
Citizens on Street	49.6	12.9	18.9
Persons in Nearby Buildings	38.1	42.6	41.9
Private Radio	3.3	1.2	1.6
City Vehicle	4.9	5.3	5.3
Fire Department	0.8	24.3	20.6
Other	6.6	14.1	12.8

9-3. CITIZENS BAND AND COMMUNITY RADIO WATCH

During April and August, logs were maintained by six members of the CRW, including the DSR. The logs contained 113 notifications of possible medical emergencies in the four test precincts that were referred to the Police Department. While most of the incidents were traffic accidents, a minor number of miscellaneous cases were reported, such as "a person down." The number reported by each of the agencies is listed in Table 9-4.

Only 26 of the 113 reports were documented with dispatch tickets from the Police Department. Tickets were not found for the remaining 87 cases. Either the tickets were lost or the cases did not meet the police screening policy requirements for emergency response. The latter seems more likely.

TABLE 9-4

CRW EMERGENCY REPORTS

	Precinct 6	7	15	16	Total
DSR	22	23	22	12	79
Detroit Edison	2	1	0	0	3
Checker Cab	7	10	5	1	23
Mich. Consolidated Gas	1	2	1	0	4
General Electric	1	0	1	0	2
Instant Communications	0	0	0	2	2
TOTALS	33	36	29	15	113

A measure of the effectiveness of the CRW in reducing the total notification delay can be obtained by comparing the times (epochs) at which several reports on a single incident are received by IMPACT. A comparison can be made only if multiple dispatch tickets are available and when the ticket corresponding to the notification by a CRW agent can be identified by source code, time or the description of the incident provided by the caller. These conditions were satisfied in only 6 incidents out of the 26 documented by both CRW logs and dispatch tickets.

The time saved by the CRW is the time of the first report by a source other than the CRW minus the time of report by CRW. The times saved in the 6 cases for which data are available were: -5, -5, -4, -2, +1, and 0 minutes. These results are presented with considerable reservation since the meager data hardly justify any interpretation.

The base station of the Citizens Band Network, which is operated by the Department of Streets and Traffic, was in operation during all three periods in which detection and reporting data were collected. In April the station was in operation from about 0715 to 2400 hours on weekdays and from 0600 to 2400 hours on weekends. A total of 500 hours of operation were logged in April. During August the operating hours were from 0630 to 2200 on weekdays (to 2400 on Fridays), from 1400 to 2100 on Saturdays and from 1300 to 2000 on Sundays for a total of 399 hours. During the one week communication data collection in July the station operated from 0700 to 2400 on weekdays, 0900-2400 on Saturday and 1300-2400 hours on Sunday. Data from the station logs were collected for the entire 1,006 hours. The periods of operation include the hours of peak traffic density.

Traffic accidents are the only type of incidents involving medical emergencies which are reported via the Channel 9 network, and these constitute approximately 15% of the base station traffic. Normally the CB base station operator notifies the Traffic Central operator in the Police Dispatch Center of all accident reports on a direct police phone line. Occasionally the appropriate precinct is notified over public phone circuits. The precinct station must then call the Communication Center, which dispatches all police vehicles. The precinct stations may use a direct line, in which case the call is received in the Dispatch Center, or they may use the public emergency number of the IMPACT Center. All dispatches in response to calls into the IMPACT Center result in full dispatch tickets. Service of calls into the Dispatch Center, either from the CB base station via Traffic Central, or from police units using radio or police lines, are documented by abbreviated dispatch tickets called "half" tickets.

The number of accidents reported to the Police Department by the CB base station in the three detection and reporting data-collection periods are shown in Table 9-5. The April/August data represent calls from the four demonstration precincts over an aggregate period of two months. The July data are for seven days over the entire city (thirteen precincts). While a total of 79 accidents were reported by the base station, only 9 of these were reported as bodily injury accidents.

TABLE 9-5

ACCIDENTS REPORTED BY THE CHANNEL 9 CITIZENS BAND NETWORK

	Period: April/August	Period: July (1 week)
Property Damage and Injury Accidents Reported to:		
Traffic Central	50	13
Precinct Station	11	5
TOTAL	61	18
Bodily Injury Accidents Reported to:		
Traffic Central	4	1
Precinct Station	2	2
TOTAL	6	3

Communication Center documentation could be found for only two of the reports. Two IMPACT Center dispatch tickets correspond to one of the bodily injury accidents reported in August. Both tickets list a time of call received one minute before the base station log entry. Since the base station called a precinct directly to report this particular accident, it is uncertain if either dispatch ticket was the result of a call from the precinct station or from independent observers. The other accident with police documentation was a bodily injury accident in the July period. The accident was reported to Traffic Central. The single dispatch ticket is a full ticket, however, indicating a call into the IMPACT Center. Thus the ticket was not in response to the CB net.

A search of all full and half tickets as well as the Traffic Central log books for the periods indicated in Table 9-5 revealed no other documentation of dispatches or response resulting from the CB net operated by the Department of Streets and Traffic.

9-4. NOTIFICATION DELAY FROM ACCIDENT REPORTS

The data discussed in Sections 9-2 and 9-3 provide no information on the total notification delay, i.e., the detection delay plus the reporting delay. The time of occurrence is recorded on accident reports maintained in the Accident Prevention Bureau (APB) of the Police Department. The notification time can be determined by comparison of the time of the accident on the accident report with the reporting time on the dispatch ticket. An attempt was made to determine the notification time for the traffic accidents that were represented in the one week source data collection of July.

A total of 317 dispatch tickets for traffic accidents were obtained in this period.[3] Accident reports for 153 accidents, corresponding to 253 of the 317 dispatch tickets are on file. Source data were included on 100 (39.5%) of the 253 tickets for which APB reports are available.

The distribution of the notification delay is given in Figure 9-1. Since the recorded time of the accident is obtained from interviews with victims or witnesses at the scene after arrival of the investigating officer, one might easily suspect the accuracy of the data. Indeed, examination of Figure 9-1 indicates that the data are unreliable. In some cases there are negative notification delays, in which the reporting time to IMPACT was recorded as earlier than the recorded time of the accident, which is an impossible sequence. The accident was not reported for over 30 minutes by 15 of the 253 observers. This would seem to be an inordinately long time for notification.

The average of the distribution shown in Figure 9-1 is 8.4 minutes. The average notification time for each indicated source is given in Table 9-6. Examination of

[3] See Table 9-1.

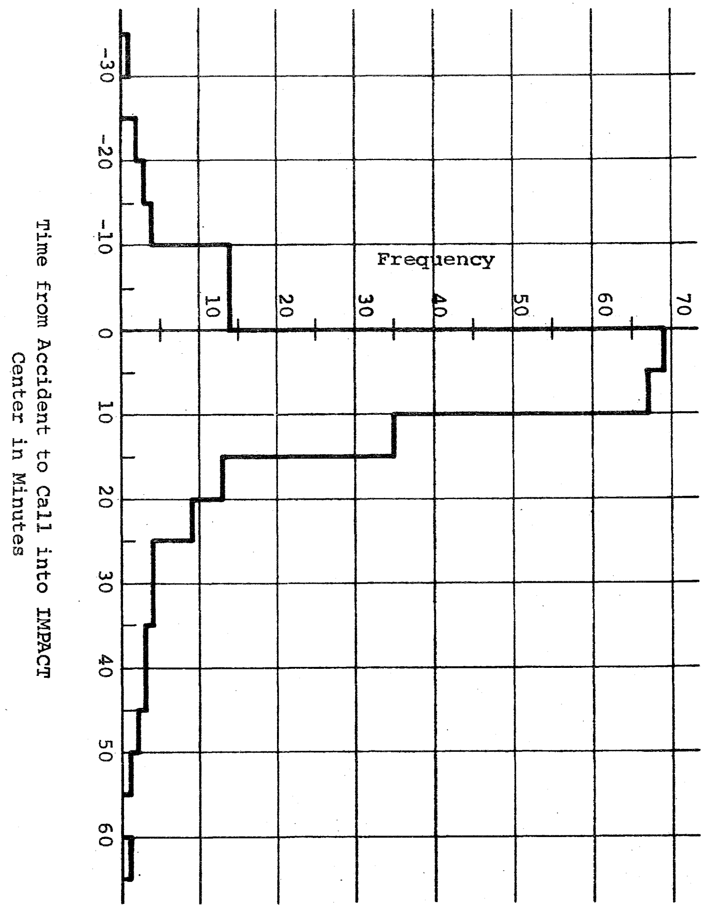


FIGURE 9 - 1

DISTRIBUTION OF NOTIFICATION DELAY

TABLE 9-6

NOTIFICATION TIME BY SOURCE

	Number	Maximum	Minimum	Average
Driver or Passenger	10	26	-2	12.5
Passing Motorist	6	10	6	9.8
Pedestrian	28	69	-15	7.5
Resident or Worker	39	37	-23	5.1
CRW	0	--	---	----
Mobile Phone	1	3	3	3.0
C.B. Volunteer Nets	1	5	5	5.0
T. V. Surveillance	0	--	---	----
S. & T. CB Net	0	--	---	----
Police Vehicle	3	13	8	1.0
Fire Department	1	5	5	5.0
DSR	5	34	2	12.6
Other	6	13	-7	3.2
TOTAL	100	69	-23	8.4

the cases with long notification times reveals that many accidents were not reported for over 15 minutes, and then two to three callers notified IMPACT within 1 to 2 minutes of each other. One might conjecture that the realistic results are contained in the 5-10 minute samples, and that many of the longer times are over-estimates by anxious victims or bystanders.

An indirect inference can be obtained by examining the time from the first to second call received by IMPACT. If the notification delay of the first call is assumed to have an exponential distribution or

$$P\ (t_N) = \alpha e^{-\alpha t_n}$$

the average time to the first call is:

$$\bar{t}_N = \frac{1}{\alpha}$$

and the probability that the incident is reported before time T is:

$$P\ \{t_N<t\} = (1-e^{-\alpha t})$$

This distribution of the time to first notification results from a sequence of individual calls which have a Poisson distribution. The time from the first call to the second call (Δt) would have an identical distribution or (2,p22)

$$p(\Delta t) = \alpha e^{-\alpha \Delta t}$$

The average time between calls is thus:

$$\overline{\Delta t} = \overline{t}_n$$

The average time from the first to second call for 103 traffic accidents for which multiple dispatch tickets are available is 3.86 minutes.[4] The corresponding time from accident to first report in the model given above would then be

$$\overline{t}_N = 3.86$$

The mode of the exponential distribution of the notification time is at zero. A minimum notification time might seem more appropriate. The same exponential distribution can be used to provide a minimum time, t', by letting

$$p\ (t_N) = \alpha e^{-\alpha(t-t')}$$

$$\text{and } \overline{t}_N = \frac{1}{\alpha} + t'$$

---

[4]From 231 traffic accidents in April and 253 in July.

The translation of the origin does not change the distribution of the time from the first to second call. Thus a minimum delay of:

$$t' = 8.4 - 3.86 = 4.54 \text{ minutes}$$

would be required to make the assumed distribution consistent with both the empirical notification delay and the measured time from first to second call. This minimum would seem to be unrealistically high.

The distribution of the measured time from first to second call is shown in Figure 9-2. The dashed line is the exponential distribution with the same mean value.

The data described above are not adequate to validate or test the hypothesis of a Poisson distribution. Therefore, the model should not be used to estimate notification times. It is presented here to reinforce the conjecture that the results based on accident reports are questionable, and that the actual notification delays for traffic accidents in Detroit are likely to be shorter than indicated by the experimental data collected in the demonstration.

9-5. ANALYTICAL EXAMINATION OF ACCIDENT REPORTING BY RADIO EQUIPPED FLEETS

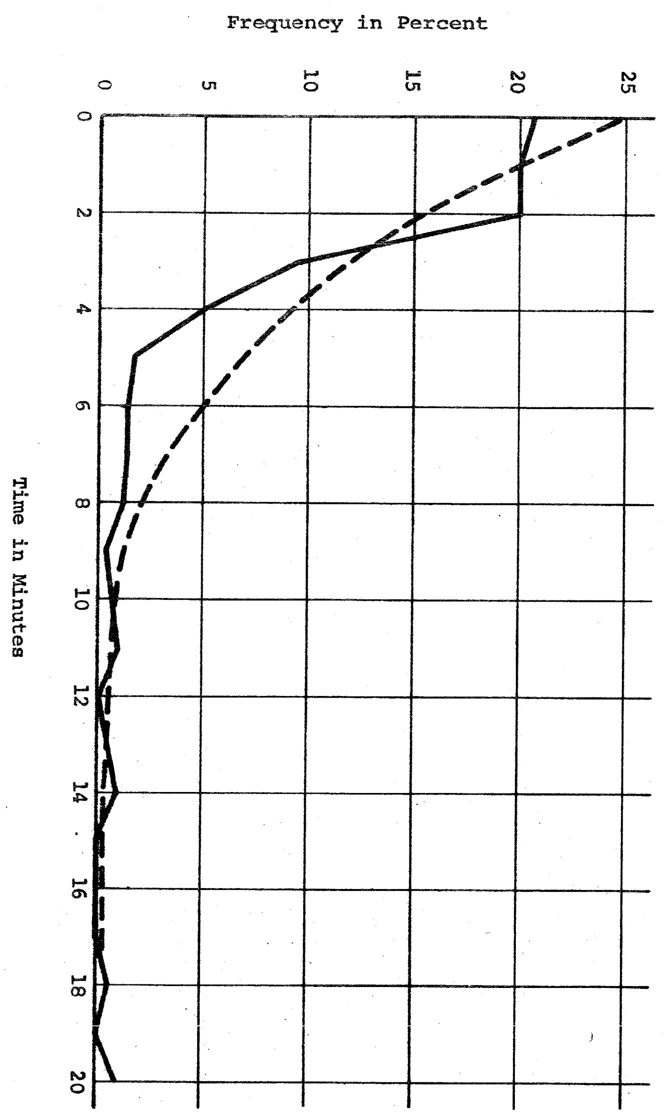
The most attractive benefit of the radio systems is reduction of the notification delay for incidents visible from the street, particularly traffic accidents. While the detection time may be greater because of fewer observers, a communication channel is readily available for rapid reporting.

The data available from the demonstration are not adequate for conclusive evaluation of the detection and reporting performance of either the citizens band or CRW programs. Essentially no information was obtained on the reporting times of either radio system relative to those of other sources.

The relative benefits of reduced reporting delay at the expense of detection-delay are not intuitively obvious. Some insight may be obtained from the simple analytical

FIGURE 9 - 2

DISTRIBUTION OF TIME FROM FIRST TO SECOND CALL INTO IMPACT



model developed in Appendix A. We shall consider two configurations. The first is a "base" system consisting of passing motorists reporting by public phones. The second is the base system augmented by a fleet of radio equipped vehicles. The fleet might represent the CRW members.

Both the detection and reporting delays of each system will be described by negative exponent probability distributions. Again this assumption implies a Poisson distribution for detection and for reporting by each system. The development in Appendix A also assumes that the detection and reporting processes are independent. While these conditions are not examined empirically, they are appropriate a priori hypotheses.

The probability that an accident is detected and reported in time T is then completely described by the parameters of each distribution. These are:

(1) $\overline{T}_{D1}$ = mean detection delay of system 1, the base system.

(2) $\overline{T}_{R1}$ = mean reporting delay of system 1.

(3) $\overline{T}_{D2}$ = mean detection delay of system 2, the radio fleet.

(4) $\overline{T}_{R2}$ = mean reporting delay of system 2.

Since the number of radio vehicles is much smaller than the number of observers in the base system, $\overline{T}_{D2} > \overline{T}_{D1}$.

A useful measure of performance is provided by the mean time to the first report, or $\overline{T}$. Figures 9-3 and 9-4 indicate the reductions in $\overline{T}_N$, N which is also the mean notification delay, resulting from utilization of the radio fleet. Figure 9-3 gives the difference as a function of the detection delay of the base system. Results are given for radio fleet detection delays of $10Td_1$ and

FIGURE 9 - 3

REDUCTION OF NOTIFICATION DELAY vs. DETECTION DELAY

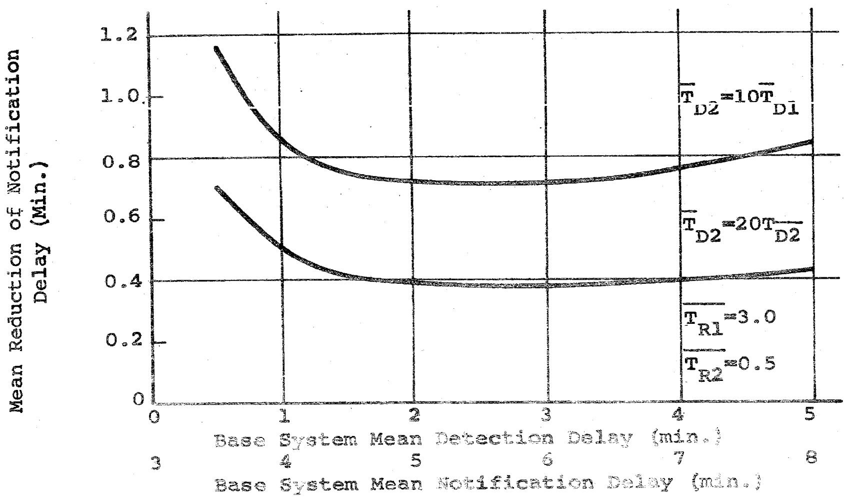
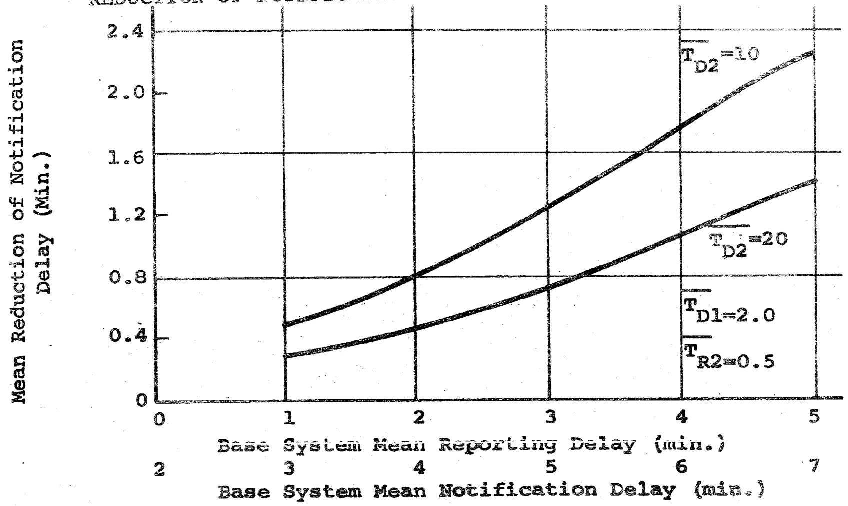


FIGURE 9 - 4

REDUCTION OF NOTIFICATION DELAY vs. REPORTING DELAY



$20Td_1$. Reporting delays of 3 minutes and ½ minute were used for both curves.

The improvement is given as a function of the base system reporting delay in Figure 9-4. The base system detection delay was fixed at 2 minutes and results are given for radio system detection delays of 10 and 20 minutes.

Figure 9-3 indicates that the reduction in the mean notifying delay provided by the radio fleet is sensitive to the ratio of the two individual detection delays but insensitive to the magnitude of the delay over an interval of reasonable values.

Furthermore, the figure suggest that if $\overline{T}_{R1} = 3$ and $\overline{T}_{R2} = 0.5$, a reduction of 1.0 min. in the mean notification delay can not be expected unless the ratio of detection delays is less than 10. We may note from Figure A-2 of Appendix A that the percentage reduction in $\overline{T}_N$ is approximately equal to the percentage reduction in the 90-percentile point of the distributions, at least for the ratios of $\overline{T}_{D2}/\overline{T}_{D1}$ which are shown.

One would expect the reduction of $\overline{T}_N$ to be sensitive to the base system reporting delay with fixed radio-fleet reporting delays, and thus to the ratio of reporting delays, because any change is the result of improved communication. This is shown in Figure 9-4.

The ratios of detection delays depicted in both figures are large, i.e., 10 and 20. If the ratio is assumed to be approximately equal to the ratio of the number of vehicles in each system, an approximate value can be computed to represent the CRW. The participating organizations in Detroit operate nearly 4200 vehicles. Approximately 76,000 vehicles are on the road in Detroit during midday hours.[5] If 3/4 of the CRW vehicles were also on the road,

$$\frac{\overline{T}_{D2}}{\overline{T}_{D1}} = \frac{\text{No. Total vehicles}}{\text{No. CRW vehicles}} = 24$$

the lower curves in both Figures 9-3 and 9-4 are appropriate.

---

[5] Personnel communication with the Department of Streets and Traffic.

The actual processes considered here are very complex in reality. It has been assumed that detection and reporting are independent, and has been suggested that the two detection delays are inversely proportional to the number of vehicles. Detection and reporting of accidents by several observers may be independent events for a period immediately following the occurrence. Once the scene no longer appears "fresh," this independence is probably lost. This might occur when several bystanders have gathered. The appearance of the scene and the circumstances will certainly influence the decision of whether to report the accident independently. Thus the surveillance function is only part of the detection process. If the processes depended only on recognition of an accident, most accidents in a large city would be detected nearly instantaneously. The decision process which has been included in the detection sequence may be very significant in these cases, when the observer density is high and each individual may assume someone else is taking responsible action.

Rapid, convenient communication channel access at the scene may well shorten the decision process. For example, a passerby at the scene of a serious accident may be torn between leaving the scene to search for a phone and remaining to provide assistance. The conflict could be resolved immediately if a radio were available. Then detection and reporting would not be independent, and the relative detection delay of a radio fleet might be less than an estimate based on the ratio of vehicles.

9-6. CONCLUSIONS

The available data are not sufficient to allow reliable estimates of the reduction in notification delay that might be provided by augmented detection and radio communication channels. In addition, there is no indication that the citizens band program or the CRW contribute significantly to the surveillance and detection of accidents in Detroit. The one possible exception is the DSR. The lack of evidence results from insufficient sample size.

The difficulty of collecting data is partially a consequence of the police screening procedure. Many calls from radio equipped vehicles do not include information

on injury and thus assure response. Furthermore, the information is relayed through second parties so that interrogation or clarification by the police is impossible. It does not follow, however, that augmented detection can not improve the recovery system response.[6]

Reliable empirical evaluation of the detection and reporting process will require much more data than are now available. However, inferences can be made that suggest that the potential reduction in time from accident to treatment that may be realized by augmented detection are marginal.

The analytical model discussed in the previous section indicates that a large number of radio-equipped vehicles--possible 20% of all vehicles on the road--would be required to reduce the mean notification time by 1.0 minute. This result is based on detection by motorists who evidently report only about 19% of the accidents to which the police respond. Thus the above estimate may be optimistic.

Pedestrians reported about 31% of the accidents, and residents or workers in nearby buildings reported 38%. These observers, who reported by public phone accounted for a total of 69% of the traffic accident notifications. They also reported over 50% of the non-traffic emergencies. Attempts to reduce notification time should be directed to this segment of the community. A paradox is possible, however, because it has been suggested in the summary that methods of reducing the demand function are an important area for further consideration. Immediate reporting of all accidents is not consistent with this recommendation.

---

[6]It should be emphasized that these conclusions relate only to detecting requirements for medical assistance. Both the CRW and citizens band net report many other kinds of incidents. These range from reports on inoperative traffic signals to criminal activity.

CHAPTER TEN

ANALYSIS OF THE MEDICAL EMERGENCY SERVICE PROCESS

Preceding page blank

CHAPTER TEN

ANALYSIS OF THE MEDICAL EMERGENCY SERVICE PROCESS

The time elements involved in the service of medical emergencies are analyzed in this chapter. These analyses were conducted to determine the magnitude and variability of the emergency service time elements and to identify the factors contributing to their variability.

Our approach in this analysis is to utilize analysis of variance techniques to study the effects of these factors on the mean time elements. It should be clear that many factors conceivably influence the emergency service times, and many of these were not (or could not be) experimentally controlled in the study. Consequently, it is possible that interactions between various factors are the truly significant effects, and it has not been possible to estimate and test all of these interactions within the context of the project. Moreover, the lack of total experimental control makes it impossible to determine whether certain factors actually "cause" the differences in times being measured. Nevertheless, these analyses do provide additional insights into the factors which influence emergency times and they do lead to several interesting inferences.

A sample realization of a typical sequence of medical emergency service times was presented in Figure 5-2. This chapter is addressed to those elements from the reporting time to return to service.

These five time intervals of Figure 5-2 are analyzed sequentially in Sections 10-1 to 10-5. The implications of these results in the design of an urban emergency recovery system are discussed in Section 10-6.

10-1. TIME BETWEEN REPORTING AND DISPATCH

The time between the reporting of a medical emergency and the dispatch of a recovery vehicle to service the emergency is composed of two elements: internal lags in the dispatch process and delays due to the fact that no recovery vehicles are available. It was not possible to separate the effects of these two components in the experimental data collection.

Preceding page blank

Instead, delays due to vehicle unavailability are examined using analytical techniques in Chapter 11, and we present aggregate empirical delay time information in this section.

The police dispatch tickets for all medical emergencies serviced by the commercial ambulance attendants in Precinct 7 during April were analyzed to compute two delay times:

(1) Time from first call to dispatch of the commercial ambulance.

(2) Time from first call to dispatch of a police vehicle (if a police vehicle is dispatched along with the ambulance).

These delay times were then compared with the times from the first call to dispatch of a police ambulance for all medical emergencies occurring in Precinct 15 during the same period. The results of these analyses are presented in Table 10-1.

From Table 10-1 several inferences can be made:

(1) The police ambulances were dispatched faster than the commercial ambulances. The average difference in dispatch times was 3.3 minutes (uncensored data), which is significant at the .05 level.[1]

(2) The police cars dispatched to emergencies with the commercial ambulances in Precinct 7 were dispatched on the average 2.4 minutes faster than the ambulances. This difference is also significant at the .05 level.

(3) No significant difference exists between the dispatch delays for police cars in Precinct 7 and police ambulances in Precinct 15.

[1]The standard "t-test" for the difference of two means was used to test these hypotheses.

TABLE 10-1

DISPATCH DELAY TIME STATISTICS-APRIL

	Precinct 7 Commercial Ambulance	Precinct 7 Police Car (with comm. amb.)	Precinct 15* Police Ambulance
Proportion of Times:			
Over 1 Minute	.64	.58	.47
Over 5 Minutes	.28	.16	.10
Over 10 Minutes	.11	.06	.04
Over 20 Minutes	.06	.02	.02
All Data (minutes)			
Sample Size (N)	114	55	137
Sample Mean	5.8	3.38	2.48
Sample Std. Dev.	8.76	5.48	4.04
Censored data (minutes) (times over 12 min. removed)			
Sample Size (N)	105	54	135
Sample Mean	3.26	2.74	1.96
Sample Std. Dev.	3.3	2.76	3.23

*Five negative delay times were encountered in Precinct 15. These errors were assumed to represent a zero delay, and they were analyzed accordingly.

There are two possible explanations for the significantly longer dispatch times for the commercial ambulances. First, the commercial ambulances may have been unavailable at the instant of the emergency in some proportion of the cases. (The allocation study of Chapter 11 indicates that two single function ambulances in a precinct should be simultaneously busy about 2% of the time.) Second, the dispatcher may have waited for the police car which was dispatched to the emergency to request the commercial ambulance before sending the recovery vehicle. It is impossible to separate the effects of these two factors without more detailed information. However, the fact that 6% of the commercial ambulance dispatches were delayed more than 20 minutes suggests that recovery vehicle unavailability alone is not the sole reason, since only 2% unavailability was predicted from the allocation study. Consequently, it is quite likely that both factors contributed to the delays (along with internal lags in the dispatch process).

The need to send both police vehicles and ambulances to medical emergencies is an interesting question which was not examined in this study. One might argue that dispatching both vehicles to urban medical emergencies is an inefficient and expensive utilization of scarce resources. On the other hand, the police vehicle can perform useful functions: determining if an ambulance is really needed, controlling crowds that might gather and/or protecting the ambulance crew, and performing usual police tasks in specific types of emergencies (criminal investigations, accident investigations, debris removal, etc.). If an independent ambulance system is instituted in an urban area, it will be necessary to carefully develop procedures for dispatching the police along with the ambulance. These problems are discussed elsewhere in this report.

2. TRANSIT TIME TO THE SCENE

In this section are examined the effects of various factors influencing transit time to the scene of a medical emergency. Some of these factors are totally or partially controllable through the recovery system designer or administration; others are uncontrollable. A list of the factors included in the analysis is presented below:

Controllable Factors:

1. System administration (police, fire or commercial ambulance)
2. Distance to scene (vehicle allocation/distribution)
3. Use of lights and siren

Uncontrollable Factors:

1. Traffic
2. Weather
3. Other difficulties en route (mechanical, etc.)
4. Type of emergency
   a) Traffic/non-traffic
   b) Violent/non-violent

Notice that the effects of these factors may not be independent. For instance, the allocation and distribution of recovery vehicles are partially dependent on the system administration.

To conduct the analyses, data from the ambulance attendants' check sheet in all four test precincts for April and August were merged into a single file. Various statistical analyses were then conducted on the data within this file to estimate and compare the effects of interest.

Analysis of System Administration and Distance to Scene

The empirical distribution function of the time to the scene is plotted for the police, fire and commercial ambulances in Figure 10-1. Various statistics from this distribution are presented in Table 10-2.

A one-way analysis of variance was conducted to test the hypothesis that the mean times to the scene were equal for all three administrations, and this hypothesis was rejected at a .05 level. From Table 10-2 it can be observed that the time to the scene was significantly longer for the police ambulances. This result is suprising, since one would expect the distance (and time) to the scene to be less for a recovery system with many patrolling vehicles.[2]

To examine this result in more detail, the distance traveled to the scene was examined for the systems. The empirical

---

[2]Four to six police station wagons are generally on patrol in a police precinct.

FIGURE 10 - 2

EMPIRICAL DISTRIBUTION FUNCTIONS - DISTANCE TO SCENE

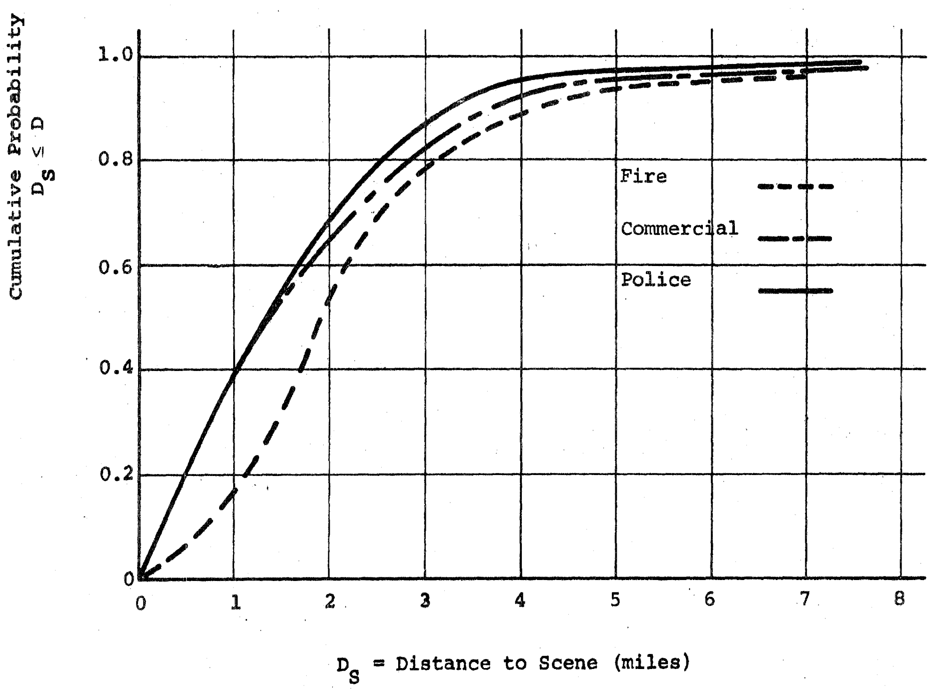
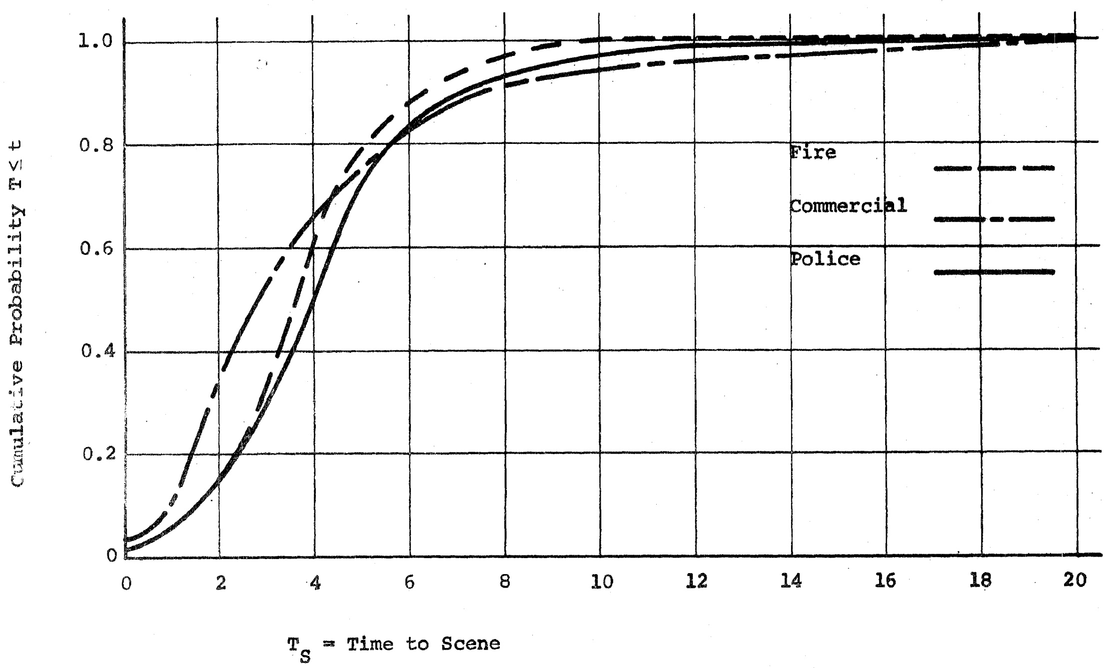


FIGURE 10 - 1

EMPIRICAL DISTRIBUTION FUNCTIONS - TIME TO SCENE



distribution function is presented in Figure 10-2 and various summary statistics are shown in Table 10-3.

TABLE 10-2

SUMMARY STATISTICS--TIME TO SCENE
(minutes)

	Police	Fire	Commercial
Sample Size[3] (N)	767	343	275
Mean Time	4.73	4.24	4.15
Std. Dev.	2.69	1.84	3.21
Range (min.-max.)	(0-20)	(0-14)	(0-20)

TABLE 10-3

SUMMARY STATISTICS--DISTANCE TO SCENE
(miles)

	Police	Fire	Commercial
Sample Size (N)	748	339	233
Mean Distance	1.74	2.34	1.94
Std. Dev.	1.35	1.30	1.66
Range (min.-max.)	(0-11.5)	(0-7.0)	(0-10.7)

From Figure 10-2 it can be observed that the distances to

[3]All sample sizes are corrected for missing data.

the scene were distributed similarly for the police and commercial ambulances, while the fire rescue squads traveled a longer distance a larger proportion of the time and hence had a longer mean distance.[4]

Differences in transit time to the scene prevail when an analysis of covariance is utilized to remove the effects of varying transit distances.[5] Hence, further analyses were conducted to determine if the effects of other factors were conducted to determine if the effects of other factors contributed to these differences.

Analysis of Remaining Factors

The effects of the use of lights to scene and siren to scene and of traffic, weather, other difficulties en route, and the type of emergency were examined for each system administration or mode through use of analysis-of-variance techniques. The results are presented in Table 10-4; significant differences (at the .05 level) are noted.

Only two significant differences were found in these analyses of the transit times to the scene:

(1) Police ambulance times to the scene were significantly shorter when difficulties en route were observed. This result is ambiguous and can be attributed to observational or random error.

(2) Commercial ambulance times to the scene were significantly different depending upon the

[4]This difference in transit distance was significant at a .05 level.

[5]The estimated correlation coefficient between transit time to the scene and transit distance to the scene was .48, indicating that only 25% of the variation in times could be attributed to distance. This result indicates that the distribution of recovery vehicles will not substantially affect transit times to the scene.

TABLE 10-4 (CONTINUED)

	Police		Fire		Commercial	
	Percentage of Cases	Mean Time (min.)	Percentage of Cases	Mean Time (min.)	Percentage of Cases	Mean Time (min.)
Type of Emergency						
Traffic	40.6	4.50	2.3	3.00	33.9	3.66[c]
Accidental Injury	18.2	4.86	8.5	4.24	21.8	3.32
Illness	20.4	4.86	84.8	4.32	25.8	3.61
Shooting	2.2	4.71	0.1	4.00	3.0	4.25
Stabbing	2.6	5.85	0.0	----	1.8	5.60
Other non-traffic	16.0	4.84	4.3	3.53	13.7	3.95
N	764		341		271	

[a]Sample Size--no missing data

[b]This variable is actually "lights and siren to scene", since the siren was never used without lights.

[c]Statistically significant at the 5% level.

TABLE 10-4

EFFECTS OF VARIOUS FACTORS ON TIME TO SCENE

	Police		Fire		Commercial	
	Percentage of Cases	Mean Time (min.)	Percentage of Cases	Mean Time (min.)	Percentage of Cases	Mean Time (min.)
Lights to Scene						
Yes	47.4	4.65	100.0	4.24	97.1	4.16
No	52.6	4.77	-----	----	2.9	3.87
N[a]	760		343		274	
Siren to Scene[b]						
Yes	35.1	4.66	100.0	4.24	92.3	4.26
No	64.9	4.82	-----	----	7.7	3.10
N	286		343		271	
Severe Traffic						
Yes	79.4	5.00	72.2	4.35	53.3	4.50
No	20.6	4.42	27.8	3.80	46.7	4.93
N	286		36		30	
Other Difficulties						
Yes	8.7	3.68[c]	5.6	4.00	13.3	6.25
No	91.3	5.00	94.4	4.21	86.7	4.46
N	286		36		30	

TABLE 10-5

USE OF LIGHTS AND SIREN
(April data)

Code to Scene*	Code to Hospital*	Percent of Runs: Police	Commercial	Fire
1	1	33.9	3.9	0
2	1	2.2	5.6	0
3	1	11.1	44.9	0
1	2	3.1	0	0
2	2	2.6	0.6	0
3	2	2.9	7.9	0
1	3	6.5	0	0
2	3	2.9	0.6	0
3	3	34.6	36.5	100.0

*Code 1 is without lights or siren, 2 is with lights only, 3 is with lights and siren. Only one form indicated the use of the siren without lights.

TABLE 10-6

FREQUENCY OF CODE TO SCENE AND TO HOSPITAL
(April Data)

Code to Scene	Code to Hospital	Percent of Runs: Police	Commercial	Fire
1	1,2,3	43.5	3.0	0
2	1,2,3	7.7	6.8	0
3	1,2,3	48.6	89.4	100
1,2,3	1	47.2	54.4	0
1,2,3	2	8.6	8.5	0
1,2,3	3	44.0	37.1	100

type of emergency. The short times to the scene of traffic accidents and non-traffic illnesses probably account for the low overall average times.

The results of these analyses do not resolve the surprising difference in mean times observed in Table 10-2. However, one can make several conjectures as to the reasons for these differences in time to the scene for the three types of recovery system administration. First, almost all of the fire runs were made to service home illnesses and the Fire Department responds with lights and siren to all emergencies. These two factors probably contribute to the short average time to the scene for the fire rescue vehicle by compensating for the longer average distance to the scene. The commercial and police ambulances responded to approximately the same distribution of types of emergency, but the commercial ambulance was significantly faster in servicing home illnesses and traffic accidents. The police responded at about the same rate to all types of emergencies. One reason for the longer police response time may be behavioral. The police have learned that they can respond anywhere in the precinct in about five minutes (on the average). Hence, they may adjust their rate of response to meet this level of performance. This adjustment negates the distributional advantage the police have from continuous patrolling within the precinct, and, in fact it makes their average response time longer than for the commercial ambulances and fire rescue units. We conjecture, however, that this time difference, although significantly greater than zero, is probably not large enough to drastically influence the medical condition of most victims. (See Chapter 12 for a fuller discussion of the relationship between response time, treatment and medical outcome).

The statements above allude to possible behavioral differences in the responses of the systems. Differences in conveyance policy are also suggested by use of lights and sirens which are shown in Table 10-5. Combined results for the distribution of each code to the scene and to the hospital are given in Table 10-6.

The fire rescue squads use code 3 on both segments of all runs. The commercial ambulances used code 3 to the scene on 89% of their runs, but to the hospital on only 37%. The police used code 1 and 3 with comparable frequency both to the scene and to the hospital. The commercial attendants changed the code at the scene on 59.0% of their runs; while the police change on only 28.7%.

These results suggest that the policy of the commercial operator is to proceed to the scene under code 3, and then to make a decision on the code to the hospital. The police are less inclined to make a decision at the scene; the choice is determined at the time of dispatch. This policy inference is consistent with the hypothesis that the police adjust to a standard level of performance since the traffic conditions and approximate distances are known at the time of dispatch.

10-3. TIME AT THE SCENE

The time at the scene of a medical emergency should be a function of the system administration, the type of emergency, and victim's condition and the treatment rendered by the ambulance attendant. The empirical distribution functions of this time interval are presented in Figure 10-3, and various summary statistics are tabulated in Table 10-7.

The mean times at the scene were found to be significantly different at a .05 level for the three systems. Multiple comparison tests revealed that the single significant difference is between the mean fire and the mean police times on the scene, with the police times being about 1.4 minutes longer (on the average).

TABLE 10-7

SUMMARY STATISTICS--TIME ON SCENE
(minutes)

	Police	Fire	Commercial
Sample Size	782	344	274
Mean Time	5.54	4.09	4.91
Std. Dev.	5.44	2.75	4.69
Range (min.-max.)	(0-40)	(0-20)	(0-37)

FIGURE 10 - 3

EMPIRICAL DISTRIBUTION FUNCTION - TIME ON SCENE

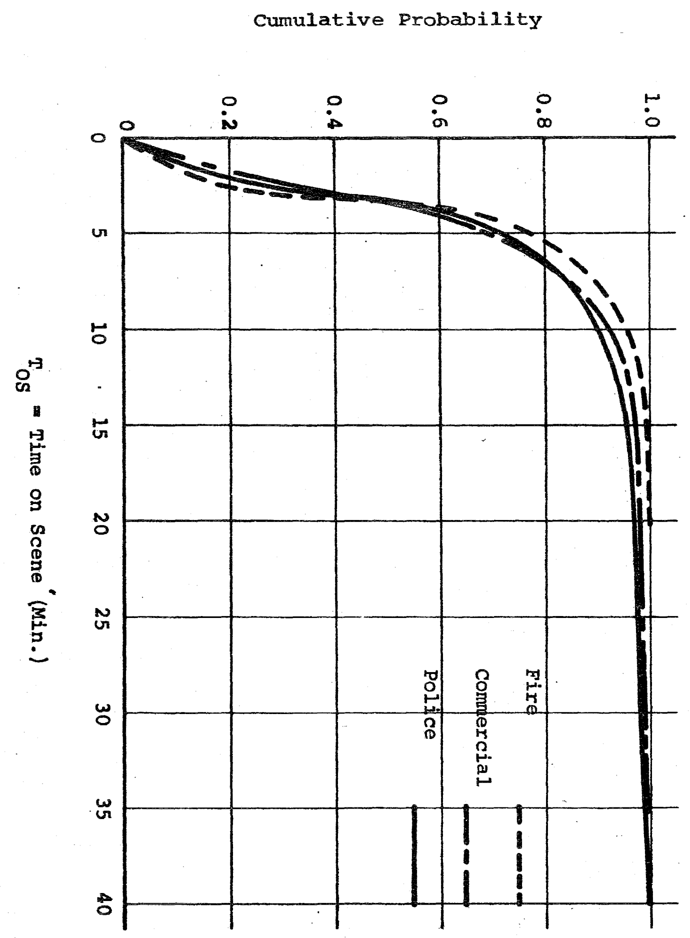


TABLE 10-8

EFFECTS OF VARIOUS FACTORS ON TIME ON SCENE

	Police		Fire		Commercial	
	Percentage of Cases	Mean Time (min.)	Percentage of Cases	Mean Time (min.)	Percentage of Cases	Mean Time (min.)
Type of Emergency						
Traffic	41.2	5.37	2.3	6.12	34.1	5.83
Acc. Injury	18.1	4.66	8.8	3.47	21.9	4.90
Illness	20.0	5.85	84.5	4.09	25.9	3.77
Shooting	2.2	4.59	0.1	4.00	3.0	6.38
Stabbing	2.6	4.50	0.0	----	2.5	4.00
Other Non-Traffic	15.9	6.66	4.4	4.53	13.7	4.60
N	779		342		270	
Condition of Victim						
Conscious	80.4	5.61	59.2	3.99	81.6	4.78
Unconscious	7.8	5.22	19.1	3.74	6.4	6.47
Incoherent	9.4	5.42	9.4	5.00	6.7	5.78
D.B.A.	2.2	5.82	11.7	4.62	4.1	3.64
D.A.A.	.3	3.00	0.6	3.00	1.1	5.67
N	774		341		267	
Number of Treatments Rendered by Attendant						
0	63.9	6.05*	22.7	4.42	40.5	4.47*
1	30.1	4.83	64.4	4.01	35.4	4.76
2	5.0	5.72	9.3	3.91	15.0	5.17
3	0.9	2.88	3.4	4.16	6.2	5.24
4	0.0	----	0.1	2.00	2.2	7.83
5	0.1	1.00	0.0	----	0.7	19.50
N	781		343		274	

*Statistically significant at the 5% level.

Further analyses were conducted to determine whether emergency type, victim condition or the number of treatments rendered explained the remaining variation in time on the scene. Results are presented in Table 10-8.

The number of treatments rendered by the attendant significantly affects the time at the scene for both police and commercial attendants. The time at the scene is directly proportional to the number of treatments by the commercial attendant. However, no such simple relationship exists for the policeman, and it is difficult to determine how treatment does affect the policeman's time on the scene.

One may conjecture that the significantly longer time at the scene for the policeman may be due to the necessity of the patrolman to perform various police tasks not related to the recovery process. Unfortunately, the data from this study do not allow "proof" of this assertion. However, if it is true then the data of Table 10-7 indicate that (on the average) over one minute of recovery time can be saved at the scene of an urban medical emergency if the ambulance and non-ambulance functions are separated.

4. TIME TO THE HOSPITAL

The transit time to the hospital is potentially affected by the same factors governing transit time to the scene of the emergency. In addition, the ambulance attendant's assessment of the victims condition and the choice of a hospital may influence this time element. These factors shall be examined sequentially in this section.

The empirical distribution functions of the time to the hospital are plotted for each system administration in Figure 10-4. Various summary statistics are presented in Table 10-9.

A one-way analysis of variance test indicates that the mean times are significantly different (at a .05 level) for the three systems. Further analysis, conducted by using multiple comparison tests, indicates that the mean police transit time to the hospital is significantly longer than the commercial and fire times. No significant difference exists between the times of the fire and commercial ambulances.

FIGURE 10 - 4

EMPIRICAL DISTRIBUTION FUNCTIONS - TIME TO HOSPITAL

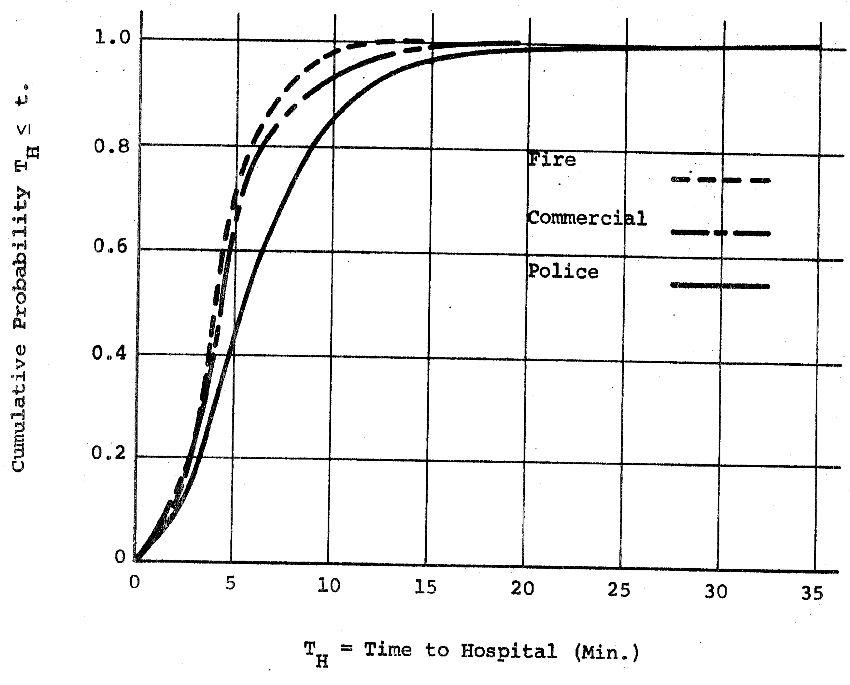


TABLE 10-9

SUMMARY STATISTICS--TIME TO HOSPITAL

	Police	Fire	Comm. Amb.
Sample Size	780	343	273
Mean Time	7.34	4.85	5.20
Std. Dev.	4.30	2.15	3.10
Range (min.-max.)	(0-35)	(1-15)	(0-19)

The effect of system administration or mode on distance to the hospital is presented in Table 10-10.

TABLE 10-10

SUMMARY STATISTICS--DISTANCE TO HOSPITAL
(miles)

	Police	Fire	Comm. Amb.
Sample Size	765	340	232
Mean	3.08	2.56	2.69
Std. Dev.	2.13	1.47	1.66
Range (min.-max.)	(0-16.4)	(0-8.7)	(0-11.0)

The fact that the rank order of the times to the hospital for the three systems is the same as the rank order of the distances leads to the conjecture that the distance-time relationship[6] is creating an artificial "system administration effect." Hence, an analysis of covariance was run

[6]As with the distances and times to the scene, the correlation between time to the hospital and distance to the hospital was 0.488.

TABLE 10-11 (CONTINUED)

	Police % Cases	Police Mean Time (min.)	Fire % Cases	Fire Mean Time (min.)	Comm. Amb. % Cases	Comm. Amb. Mean Time (min.)
Other Difficulties						
Yes	5.5	4.54	0.0	----	25.0	5.75
No	94.5	5.23	100.0	5.23	75.0	4.50
N	127		14		16	
Type of Emergency						
Traffic	41.2	6.54*	2.3	3.62	33.7	4.96*
Acc. Injury	17.9	7.16	8.8	5.00	21.9	6.44
Illness	20.1	7.45	84.5	4.89	25.9	4.96
Shooting	2.2	8.88	0.1	5.00	3.0	5.75
Stabbing	2.6	6.85	0.0	----	1.5	3.25
Other Non-traffic	16.1	9.18	4.4	4.73	14.1	4.50
N	777		341		270	
Condition of Victim						
Conscious	80.3	7.36	59.1	4.94*	81.6	5.29
Unconscious	7.8	6.97	19.1	5.32	6.4	6.29
Incoherent	9.5	7.18	9.4	3.75	6.8	4.22
D.B.A.	2.2	7.59	11.8	4.50	4.1	4.36
D.A.A.	0.3	6.50	0.6	4.50	1.1	2.67
N	772		340		266	
Hospital Choice						
Patient Preference	35.7	7.93*	25.0	5.54*	26.1	6.77*
Closest	49.6	6.02	73.1	4.51	65.4	4.42
Specific Equip.	14.7	9.62	1.9	6.50	8.5	6.65
N	740		308		234	

*Statistically significant at the 5% level.

TABLE 10-11

EFFECTS OF VARIOUS FACTORS ON TIME TO HOSPITAL

	Police % Cases	Police Mean Time (min.)	Fire % Cases	Fire Mean Time (min.)	Comm. Amb. % Cases	Comm. Amb. Mean Time (min.)
Lights to Hospital						
Yes	49.0	6.35*	100.0	4.85	47.0	4.86
No	51.0	8.30	0.0	----	53.0	5.56
N	773		343		270	
Siren to Hospital						
Yes	39.6	6.33*	100.0	4.85	38.4	4.73*
No	60.4	8.02	0.0	----	61.6	5.54
N	692		343		263	
Severe Traffic						
Yes	80.3	7.50	78.6	5.00	56.3	4.22
No	19.7	7.52	21.4	5.67	43.8	5.57
N	127		14		16	
Adverse Weather						
Yes	26.0	8.36	35.7	5.60	31.3	4.40
No	74.0	7.20	64.3	4.89	68.8	5.00
N	127		14		16	

to remove the effects of distance before testing the hypothesis of differing administration effects. The hypothesis of no difference in time to the hospital was again rejected at the .05 level, indicating that the three systems have different mean times to the hospital, even after the effects of distance differences are removed.

Various other factors were examined to assess their contribution to variability in the time to the hospital. The results of these are tabulated in Table 10-11.

Several significant differences were observed, regarding which the following points can be made:

1. The mean time to the hospital was significantly lower when the police and commercial ambulances used lights and sirens.[7] Unfortunately, it is impossible to determine whether the use of lights and sirens "caused" this shorter time, or whether the use of lights and sirens was ancillary to the ambulance drivers decision to proceed to the hospital in a more rapid fashion. Ultimately, determination of the effect of the use of lights and siren on transit times must be based upon controlled experimentation--possibly by randomly "assigning" the use of lights and sirens to various ambulance runs.

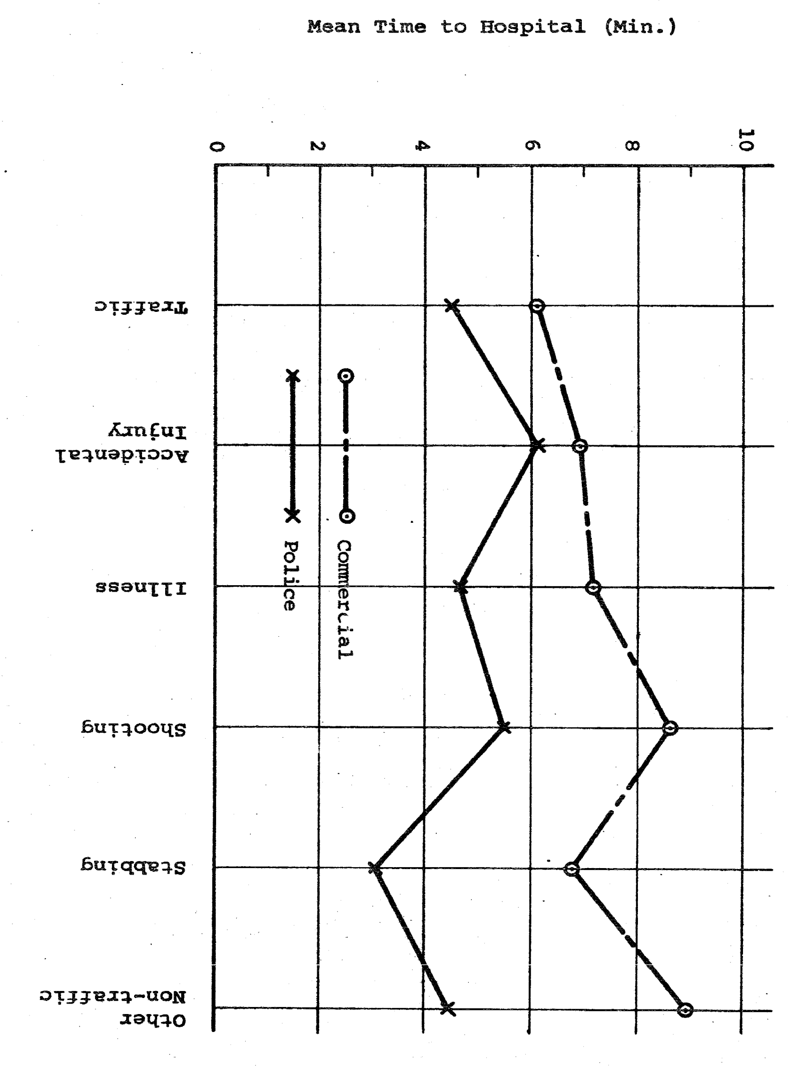
2. The time to the hospital varied significantly by emergency type for the police and commercial ambulances. The resulting mean times are plotted in Figure 10-5 to facilitate further analysis. One can observe that the time to the hospital for stabbings is the shortest for both systems. For the police the longest times were encountered for "other non-traffic", while for the commercial ambulances, the accidental injuries required the longest times. Unfortunately, the reasons for these differences cannot be resolved without further data.

3. For the fire rescue squads, the time to the hospital was significantly longer for unconscious victims. This

[7]No difference was observed for the fire rescue squads since lights and sirens were utilized in all of their runs to the hospital.

FIGURE 10 - 5

EFFECT OF EMERGENCY ON TIME TO HOSPITAL



may be because specialized choice of a hospital for these victims required a longer transit distance.

4. For all three systems, the method of hospital choice significantly influences transit time to the hospital. A plot of the resulting mean times is presented in Figure 10-6. Note that for the fire and police vehicles the times increase almost linearly, while the mean times for the commercial ambulances are approximately the same when patient preference or specific equipment was indicated. The mean distances to the hospital (all three administrations) are tabulated below as a function of hospital choice.

Closest	- 2.42 miles
Patient Preference	- 3.25 miles
Specific Equipment	- 4.25 miles

Unfortunately, the attendant's specific reasons for marking "specific equipment" as the basis for hospital choice are unknown. It is known that in some cases these reasons were non-medical. For instance, police prisoners are routinely transported to Detroit General Hospital, since a police guard is always on duty. If many of the police cases were transported to Detroit General for this reason and if police were inclined to transport these cases rather than assigning them to the commercial ambulances, a bias in the measures of time-to-hospital could result. This possibility can be examined, although not conclusively.

The distribution of hospitals to which patients were conveyed when the choice was based on specific equipment is shown in Table 10-12.

Thus 85% of all conveyances (by all systems) dependent on specific equipment were to Detroit General.

The distribution of the type of victim for which the choice of hospital was based on specific equipment is given in Table 10-13.

The patients with injuries resulting from violent acts would be most likely to include the police prisoners. The number of these victims conveyed for specific equipment are over represented by a factor of 2.5.

FIGURE 10 - 6

EFFECT OF HOSPITAL CHOICE ON TIME TO HOSPITAL

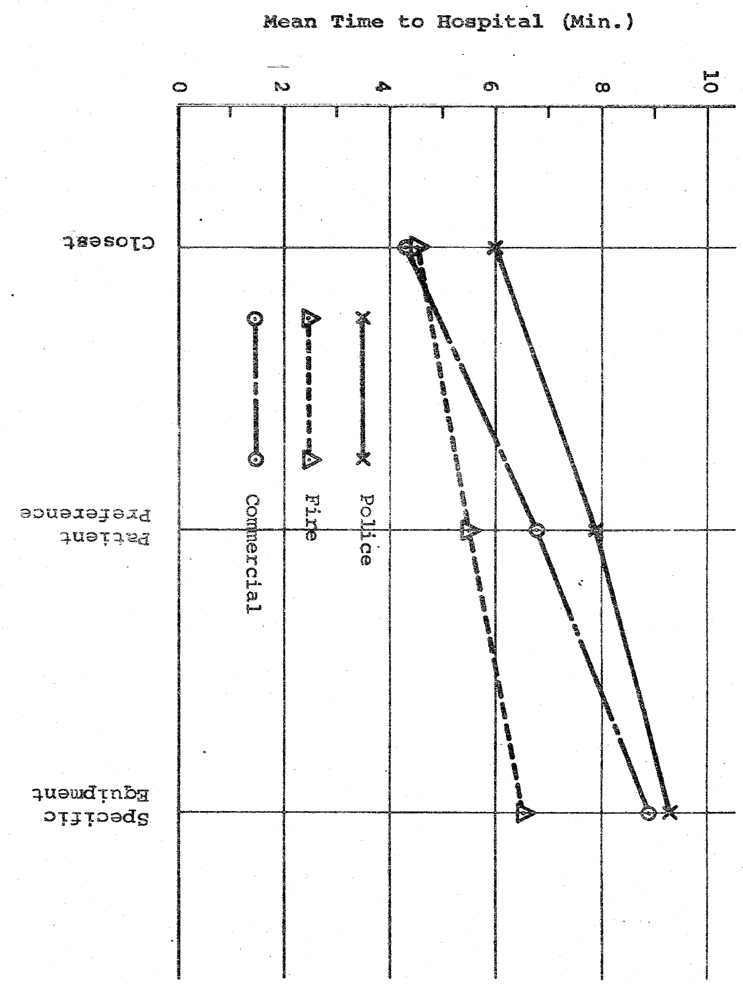


TABLE 10-12

DISTRIBUTION OF HOSPITALS
SELECTED FOR SPECIFIC EQUIPMENT

Hospital	Precinct 6	7	15	16	Total
Detroit General	45	58	15	1	119
Henry Ford	5				5
Mt. Carmel				4	4
Sinai				1	1
St. Joseph		11			11
TOTAL	50	69	15	6	140

TABLE 10-13

DISTRIBUTION OF TYPE OF
VICTIM FOR "SPECIFIC EQUIPMENT"

	Traffic	Non-Traffic Violent	Non-Traffic Non-Violent
Number of Victims	433	184	755
Number Conveyed for Specific Equipment	40	44	48
Expected Number *	41.7	17.7	72.6

*Expected number of patients who would have been conveyed for specific equipment assuming independence.

The over-representation of Detroit General among the hospitals and the number of victims with violent injuries, suggest that many of the "specific equipment cases" were police prisoners. If this represents a bias, the effects

can be partially removed by deleting these cases from the sample of police conveyances. The most distant conveyances to Detroit General have the most effect on the composite performance, and are those from Precincts 6 and 15. Removing this group of 65 cases from the police sample, lowers the mean time to the hospital from 7.34 (Table 10-9) to 7.00 minutes, a reduction of 0.34 minutes. This reduction is not sufficient to suggest a serious bias.

The observations discussed above are further complicated by the fact that Precinct 6 has no large hospital within its boundaries. Therefore, Detroit General may be used for reasons other than patient security. Nevertheless, the experimental data indicate that the decision to go to a hospital with specific equipment results in a 1.8 mile increase in average transit distance and a corresponding increase of 2 to 3.5 minutes in transit time (over the closest hospital). Since some doctors are advocating the utilization of large, centrally located urban trauma centers instead of smaller hospitals distributed throughout a city, the effect of this additional time delay must be studied further to forecast its effect on victim condition.

10-5. TIME AT THE HOSPITAL

The time at the hospital is the time taken to transfer the patient to the emergency room and to return to availability. The empirical distribution function of this time interval is plotted for the three systems in Figure 10-7 and various statistics are recorded in Table 10-14.

TABLE 10-14

SUMMARY STATISTICS--TIME AT HOSPITAL
(minutes)

	Police	Fire	Commercial
Sample Size	752	340	271
Mean	15.76	5.32	13.46
Std. Dev.	10.06	4.12	8.46
Range (min.-max.)	(0-81)	(1-51)	(0-35)

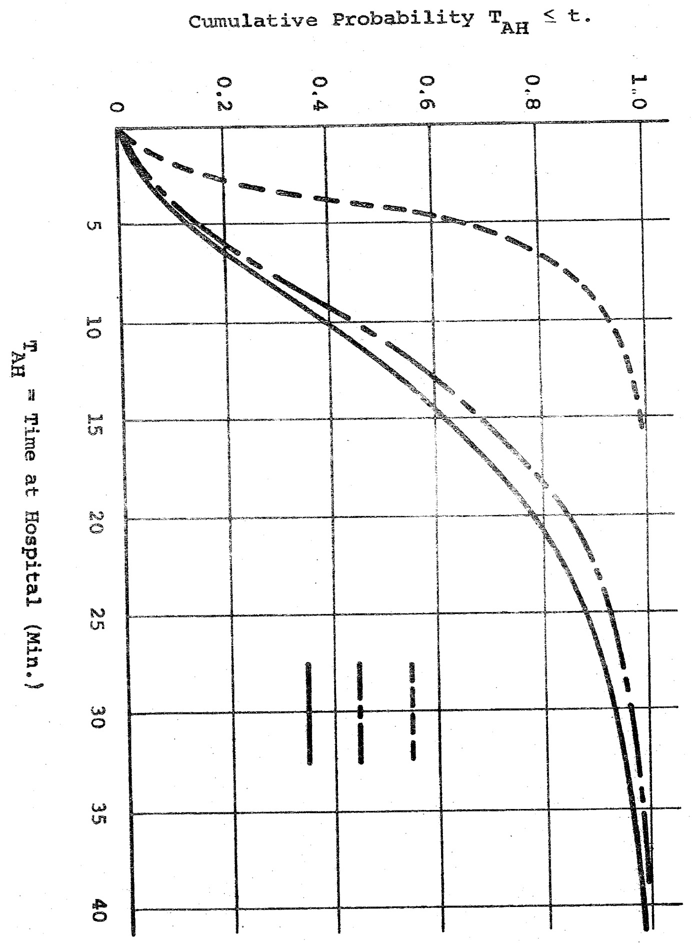


FIGURE 10 - 7

EMPIRICAL DISTRIBUTION FUNCTION - TIME AT HOSPITAL

A one-way analysis of variance indicated that the fire rescue squads spend a significantly shorter time at the hospital before returning to service. Here again, the reasons for the longer times at the hospital for the police and commercial ambulances are unknown. These must be determined before methods for reducing these delays can be developed and implemented.

10-6. IMPLICATIONS OF SERVICE TIME ANALYSIS ON RECOVERY SYSTEM DESIGN

The analyses of the five medical emergency service time intervals all indicate that there are significant differences between the mean times associated with the three systems examined. The components and the overall mean vehicle service times[8] appear in Table 10-15.

TABLE 10-15

MEAN SERVICE TIME SUMMARY STATISTICS

	Dispatch Delay	Time to Scene	Time on Scene	Time to Hospital	Time at Hospital	Total Vehicle Service Time
Police	2.7	4.7	5.5	7.3	15.8	33.3
Fire	?	4.2	4.1	4.8	5.3	18.4
Commercial	5.8	4.2	4.9	5.2	13.5	27.8

It is important to observe that one cannot use these data to conclude that a police ambulance system offers the worst emergency service times while a fire system offers the best. In reality, it is likely that changes can be made within an existing system administration to reduce

[8]The time from vehicle dispatch until return to service.

various components of the emergency service time.

However, several important inferences can be drawn from the analyses of this section:

(1) An ambulance system with many multi-purpose, patrolling recovery vehicles does not seem to provide a significantly faster response in an urban area than a system with a few single-function, fixed base recovery vehicles.

(2) The transit time to the scene is not highly influenced by the use of lights and siren or by the effects of random elements (weather, traffic, etc.)

(3) The time on the scene depends upon the treatment rendered but not on the type of emergency or apparent victim condition.

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

(5) The time out of service at the hospital is highly variable, depending upon the system administration. It appears that significant reductions in vehicle "out-of service" time can be obtained by closer management of this interval.

Perhaps the most important finding of this chapter is the verification of the relatively short medical emergency service times in an urban area. The mean transit time to the scene was less than five minutes for all three systems, and 90% of the transit times were less than or equal to eight minutes. In addition, the mean time from dispatch until delivery of the victim at a hospital was varied from 13 to 17 minutes, depending again upon the system administration.

These short response and recovery times have significant implication with respect to victim condition and attendant training in an urban area, and these implications are discussed in Chapter 12. In addition, the short times may indicate that fairly substantial measures will be necessary to facilitate reductions of appreciable magnitude. For instance, a 10% reduction in a 2 hour recovery time (typical

of certain rural areas in the U.S.) results in a saving of 12 minutes. The same percentage reduction on a 17 minute recovery time results in a decrease of only 2 minutes. The comparative benefits of the two savings, 12 minutes and 2 minutes, are not clear at this time. While the greater reduction in rural areas may seem a more valuable target, the improvement in the medical or emotional condition of the patient will depend on many factors which are not yet understood.

CHAPTER ELEVEN

ALLOCATION AND DISTRIBUTION OF RECOVERY VEHICLES

CHAPTER ELEVEN

ALLOCATION AND DISTRIBUTION OF RECOVERY VEHICLES

A study of the effects of the re-allocation and re-distribution of recovery vehicles was not included in the original project design. However, early in the project it became apparent that medical emergencies do occur when no ambulances are available in the existing dual-function police ambulance system. Furthermore, it was recognized that there was no information available on the number of recovery vehicles and their placement to provide adequate ambulance service in a single function ambulance system if such a system were implemented in Detroit. The research summarized in this chapter was undertaken to examine these two problems.

Using the terminology of McLaren,[1] the allocation of recovery vehicles is defined as the number of recovery vehicles assigned to a service region. In this study it will be assumed that the appropriate service region is an existing police precinct; qualitative extrapolations of these results to city-wide service are discussed in Section 11-4. The distribution of recovery vehicles is defined as the placement of the recovery vehicles throughout the service area. In a dual-function system, the recovery vehicles will be assigned to patrol car territories within a precinct. From these territories they respond to police and medical emergencies on a first come-first served basis. The effects will be examined of distributing the dual-function vehicles (1) to the regions of maximum ambulance demand and (2) "uniformly" throughout the service region. These two distribution policies as well as a policy of placing all recovery vehicles at a single station within the precinct will also be studied with reference to a single-function system.

---

[1]R. C. McLaren, "Allocation and Distribution of Police Patrol Manpower," Law Enforcement Science and Technology, Proc. of the First National Symposium on Law Enforcement Science and Technology, Academic Press, 1967, pp. 599-607.

The measures of effectiveness chosen for the allocation study are related to the recovery system response time--the time required for an ambulance to become available plus the transit time to the scene of the emergency. Specifically the probability that no recovery vehicles are available at the instant of a medical emergency will be considered for alternative allocation and distribution policies. In addition, the probability that the recovery vehicle is required to travel less than one mile to the scene of an emergency will be examined as a function of these policies.

It was not possible to utilize an experiment to evaluate these alternative distribution and allocation policies in the present study. Consequently, it was decided to utilize data from the four precinct experiments to develop a mathematical model of the recovery system. This model, which is based upon queueing theory, was then manipulated to derive performance quantities of interest for the various policies.

In Section 11-1 the statistical analyses which were utilized in the model construction are summarized. Then in Section 11-2 the model development is briefly described. Results from the analysis of this system model are described in Section 11-3, and these results are extrapolated to a city-wide recovery system operation in Section 11-4. A complete discussion of the procedure employed in such a statistical analysis and of the subsequent model development and analysis can be found in Hall.[2]

11-1. STATISTICAL ANALYSIS OF EMERGENCY OCCURRENCE AND SERVICE PROCESS

It is clear that the times of occurrence and the service times for emergencies cannot be predicted with certainty, and, therefore, these must be described probabilistically. In this section data from the operating system will be analyzed to develop these probabilistic descriptions. Since the operation of both single-function and dual-function recovery systems is of interest, it is necessary

[2] W. K. Hall, A Queueing Theoretic Approach to the Allocation and Distribution of Ambulances in an Urban Area, Ph.D. Dissertation, The University of Michigan, 1970.

to analyze the occurrence and service processes for both police and medical emergencies. Data from the November-December collection period were used in the statistical analysis of these problems.

As was indicated in Section 8-1, no trends or cyclical tendencies were detected in the one month sample of times of medical emergencies in Precincts 7 and 15. By utilizing various statistical tests,[3] it was found that the probability distribution of the times between these emergencies followed a "Gamma" distribution with a mean time of 98-101 minutes and with a coefficient of variation[4] of 1.15.

A similar statistical analysis was conducted on the times of police emergencies in Precinct 15 during November-December. No monthly or weekly trends or cycles were detected in the statistical analysis, but a significant daily cycle was observed. A decomposition of the daily number of calls into the number of calls per police shift shows this cycle (Figure 11-1). From this figure it can be seen that a smaller number of calls occur in the early morning shift, while the intensity of police calls in the remaining two shifts is significantly higher.

Further statistical analyses were carried out to estimate the probability distribution of the times between police calls. The sequence of police calls was decomposed into two sub-series (the calls between 0000 and 0800 and the calls between 0800 and 2400) to remove the effects of the daily cycle. It was found that the times between police calls in both of these sub-series followed a negative exponential distribution.[5] The mean time between calls in

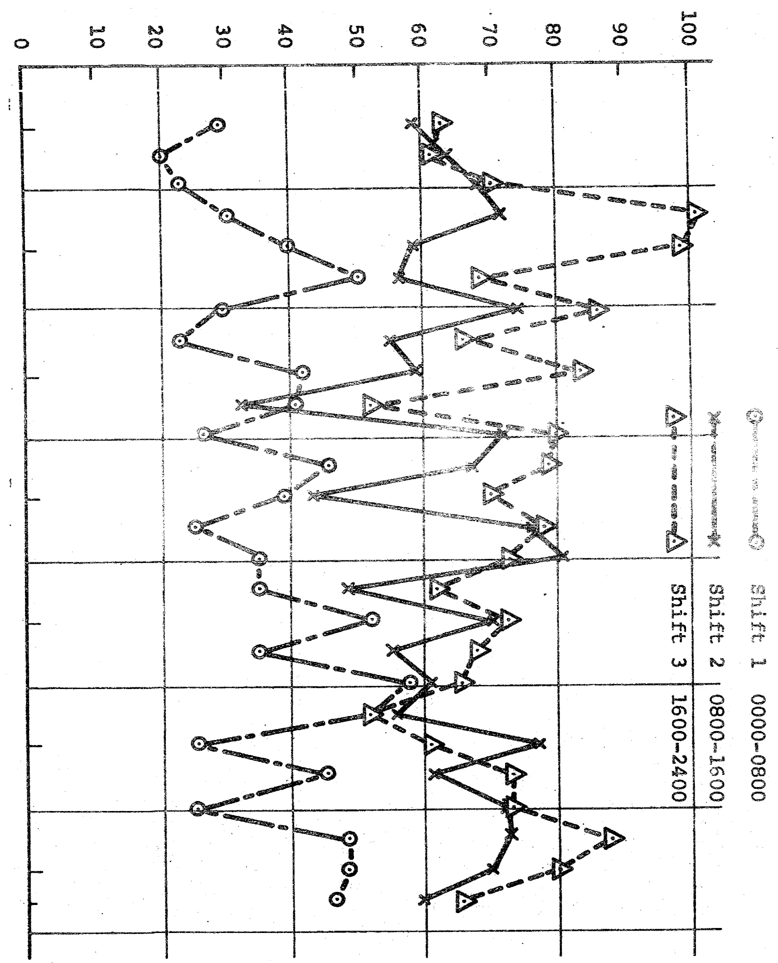
[3] The statistical tests utilized throughout this section to identify the distribution of the times between events include the Kolomgorov-Smirnoff Test, the Anderson-Darling Test, and the Moran Test. These are extensively discussed by Cox and Lewis in The Statistical Analysis of Series of Events, Methuen, London, 1966.

[4] Recall that the coefficient of variation of a random variable is the ratio of the standard deviation to the mean.

[5] This implies that the number of calls in any time period follows a Poisson process.

FIGURE 11 - 1

NUMBER OF POLICE CALLS PER SHIFT
PRECINCT 15 NOVEMBER 19 - DECEMBER 14, 1968



the early morning shift was estimated to be 42.7 minutes, and the mean time between calls in the remaining shifts was estimated to be 17.2 minutes.

In order to develop a model incorporating the differential dispatch and service characteristics of police and medical emergencies, it was necessary to consider a random process consisting of the <u>joint</u> occurrence of police and medical emergencies. In Section 11-2 it will be observed that modeling this joint process as a semi-Markov random process enables one to compute a wide range of useful system performance measures. A semi-Markov process is a stochastic process which makes probabilistic transitions between states, with a random time being spent in each state. The state-transition probabilities are Markov--that is they depend only on the current state of the process and not on previous states which were occupied. When the present state and the future state are determined, the state-occupancy times are independent random variables; that is, they do not depend on the previous times spent in each state.

In the present context, there are two states assumed by the arrival process: the emergency is either a police call or ambulance call. It was found that transitions between these two states occur completely at random.

Thus, the state transitions follow a very simple special case of a Markov process called a "Bernoulli" process. The probability that the emergency is a police call was estimated to be about .80.[6] The state-occupancy times generally were found to be negative--exponentially distributed with the following mean values:

---

[6]Note that this estimate is based upon <u>all</u> police calls. During the day when police calls are more intense this value is probably somewhat higher. In addition, ambulance calls which do not result in a conveyance might be considered as police calls, this assumption would also increase this value.

TABLE 11-1

SUMMARY OF STATISTICAL ANALYSES

	Occurrence Process		Service Process	
	Medical Emergency	Police Emergency	Medical Emergency	Police Emergency
Observed Trends in Time Between Events	None	Daily trend removed by analyzing time periods 0000-0800 and 0800-2400 separately	Not Applicable	Not Applicable
Observed Auto-correlations in Time Between Events	None	None when daily trend removed	Not Applicable	Not Applicable
Special Distributional Properties of Time Between Events	None	None	Conditioned on transit distances to the scene of less than one mile and greater than one mile*	None
Marginal Distribution of Time Between Events	Gamma with parameters k, μ	Negative exponential with parameter λ_1 (0800-2400 shift) and with parameter λ_2 (0000-0800) shift	Negative exponential with parameter a for distance less than one mile and parameter otherwise	Negative exponential with parameter
Parameter Estimates (Maximum Likelihood)	$\hat{K}$ = .77 $\hat{\mu}$ = 101 min	$\hat{\lambda}_1$ = 1/42.7 $\hat{\lambda}_2$ = 1/17/2	$\hat{\alpha}$= 1/18.4 $\hat{\beta}$= 1/20.5	$\hat{\gamma}$= 1/38.3

*The appropriate distance partitions were determined from the data analysis.

of steps discussed in Chapter 10 and shown in Figure 5-2, and it is eventually "discharged" by the recovery system. Mathematical models for queueing systems are well-developed, and these are discussed, for instance, by Cox and Smith.[8] Unfortunately, in the present case, these models do not exactly apply for the following reasons:

1. The arrival process consists of a mixture of two types of events (police and ambulance calls), and it does not obey a simple probabilistic process. (For instance, many traditional queuing models assume the occurrence process is Poisson.)

2. The assignment of emergencies to recovery vehicles is not random. Specifically, the dispatcher attempts to assign an emergency to the closest available vehicle. Furthermore, in the case of a medical emergency, when no police recovery vehicle is available, the dispatcher may assign it to a non-ambulance or an ambulance from another precinct. In the case of a police emergency, there is some probability that the call will be assigned to a non-ambulance, even when a dual-function vehicle is available.

3. The service process for medical emergencies depends upon the type of emergency serviced. Furthermore, since medical emergencies less than one mile from the vehicle can be serviced in a shorter average time, the service process also depends upon the location of the emergency.

Consequently, it was necessary to extend the theory of queues in order to develop a model responding to these three problems. The necessary theoretical extentions are discussed in Hall and shall only be summarized here.

Specifically, let us consider the following system of queues in parallel.

The sequence of emergencies constituting as inputs to the

[8] D. R. Cox and W. L. Smith, Queues, Methuen, London, 1966.

Event	Mean Time
Ambulance call followed by Ambulance call	14.33 min.
Ambulance call followed by Police call	16.20 min.
Police call followed by Ambulance call	23.08 min.
Police call followed by Police call	14.55 min.

Procedures from probability theory can be applied to this semi-Markov model of the joint emergency occurrence process to generate the sequences of ambulance calls or police calls discussed earlier in this section. These procedures are presented in Hall, and they indicate that the statistical results discussed earlier result in valid representatives of the separate processes.

A model of the medical emergency service process was constructed to correlate the effects of various transit distances to the scene on the total service time. As was indicated in Section 10-2, the correlations between transit distances and transit times are low--on the order of 0.5. From these empirical results one can conclude that altering the transit distance to the scene within a precinct will not drastically alter the system response time. Two explanations are given for this phenomenon: First, many factors other than distance to the scene can conceivably influence the transit time. Second, the recovery vehicle operator may recognize that he can get almost anywhere in a precinct in five minutes. Hence, when he has a "short" run, he adjusts his response rate to reach the scene in five minutes. Similarly, for a long run he goes faster, thereby achieving a five-minute average response time.

From the data analyses it was determined that transit times are (on the average) two minutes less for runs of less than one mile than for longer runs. The average total service times (excluding time at the hospital)[7] for these two types

[7]The time spent at the hospital was eliminated from the vehicle service times in these analyses under the assumption that the vehicle could respond to an emergency if

of runs were found to be 18.4 and 20.5 minutes respectively. The distribution of both time intervals was again found to be negative exponential.

The total service times for a sample of police emergencies in Precinct 15 during November/December were analyzed to determine their probabilistic characteristics. The mean for these service times was found to be 38.3 minutes; and, again, the distribution of these times was found to be negative exponential. The relationship between transit distances and transit times was not examined for police emergencies. This is unnecessary since only the effects of recovery vehicle re-allocation and re-distribution are being examined here. In this context, police calls serve as a probabilistic "burden" on the dual-function ambulance system, since they reduce vehicle availability. A detailed study of the police call service process is not needed, since the recovery system degradation can be modeled by utilizing only the overall characteristics.

The results of these statistical analyses on the emergency occurrence and service process are summarized in Table 11-1. These results will be utilized in the construction of a mathematical model of the recovery system in the next section.

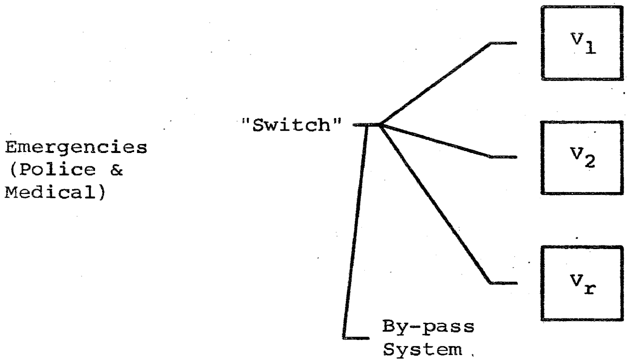
11-2. DEVELOPMENT OF THE RECOVERY SYSTEM MODEL

The recovery system model developed in this section is based upon concepts from queueing theory--the mathematical study of waiting lines. In the present case the following situation exists. Emergencies occur probabilistically in the manner described in Section 11-1. In accordance with specific assignment rules, they are then assigned to a recovery vehicle for service if one is available, or they are assigned to a non-ambulance vehicle or a recovery vehicle from outside the precinct. Once service is initiated, the emergency is served according to the sequence

it were needed during this interval. Further analysis has shown that the resulting system performance is not highly sensitive to this assumption.

FIGURE 11 - 2

THE EMERGENCY RECOVERY SYSTEM AS
A SYSTEM OF QUEUES IN PARALLEL



recovery system can be described by the bi-variate random sequence (X_n, Z_n), where X_n is the time between the n^{th} and $(n-1)^{st}$ emergency and Z_n is the type of the n^{th} emergency ($Z_n = 1$ if the emergency is a police call and $Z_n = 0$ if the emergency is an ambulance call). This bi-variate process is the semi-Markov process described in Section 11-1.

Assume that there are r recovery vehicles in the system. Each of these vehicles will be in one of four "states" at the instant of the n^{th} emergency occurrence. Let S_n^j be a random variable denoting the state of vehicle j at this instant of time. Further, let the states of this vehicle be described as follows:

S_n^j =
- 0 Vehicle j is idle (available)
- 1 Vehicle j is serving a police call
- 2 Vehicle j is serving an ambulance call which requires less than a one-mile transit distance to the scene
- 3 Vehicle j is serving an ambulance call which requires more than a one-mile transit distance to the scene

The states of all vehicles at the instant of the n^{th} emergency occurrence can then be denoted by the vector-value random process $(S_n^1, S_n^2, \ldots, S_n^r)$.

The "switch" which assigns emergencies to vehicles for service can also be described by a two-state process: the number of vehicles selected and the type of service required by the emergency. Let Y_n denote the assignment of the n^{th} emergency. Y_n is a random variable which takes on the value (k,l), where k is the vehicle selected (k=1,2,...,r), and l is the type of service required (l=1,2,3).[9] In addition to the set of states (k,l), Y_n is allowed to take on the value zero when emergencies are not routed to one of the recovery vehicles--when they "bypass" the recovery system.

Observe that the selection of a particular (k,l) combination depends upon the type of emergency Z_n and upon the state of all r vehicles $(S_n^1, \ldots, S_n^r)$. That is, the probability distribution associated with the switch Y_n is a conditional distribution of the form $Pr\ (Y_n/Z_n, S_n^1, \ldots, S_n^r)$. Probabilities were assigned in this conditional distribution in a manner illustrated in the following example. Consider an over-simplified service area divided into four scout-car territories with two single-function ambulances assigned to the service region. The probability that a medical emergency occurs in the j^{th} scout car territory is denoted by b_j, j=1,2,3,4. The two ambulances are placed in territories 1 and 4.

A schematic diagram of the situation is presented in Figure 11-3.

---

[9]The type of service required takes on the value l=1 when the call is a police call, l=2 when the call is an ambulance call requiring less than one mile transit distance to the scene, and l=3 when the call is an ambulance call requiring more than one mile transit distance to the scene.

FIGURE 11-3

SAMPLE SERVICE AREA AND AMBULANCE ALLOCATION

b_1 Vehicle 1	b_2
b_3	b_4 Vehicle 2

It is assumed that all travel distances are less than one mile unless the vehicle travels between Scout-Car-Territories 1 and 4. In this latter situation, the transit distance is assumed to be greater than one mile. When both vehicles are idle and equi-distant from an emergency, a random vehicle selection mechanism is used.

For instance, consider Pr $(Y_n = (1,2) | Z_n = 0, s_n^1 = 0, s_n^2 = 0)$. Here both vehicles are idle. Thus, Vehicle 1 is dispatched on a "short" run if the emergency is in Territory 1 (with probability b_1). Vehicle 1 is also dispatched on a "short" run one-half of the time when the emergency is in regions 2 or 3. The resulting conditional probability is $b_1 + \frac{b_2 + b_3}{2}$.

The following switching matrices can be developed by using similar reasoning:

$Pr\{Y_n = (1,2) | Z_n = 0, s_n^1, s_n^2\}$

s_n^1 \ s_n^2	0	2	3
0	$b_1 + \frac{b_2 + b_3}{2}$	$b_1 + b_2 + b_3$	$b_1 + b_2 + b_3$
2	0	0	0
3	0	0	0

$Pr\{Y_n = (1,3) | Z_n = 0, s_n^1, s_n^2\}$

s_n^1 \ s_n^2	0	2	3
0	0	b_4	b_4
2	0	0	0
3	0	0	0

$Pr\{Y_n = (2,2) | Z_n = 0, s_n^1, s_m^2\}$

s_n^1 \ s_n^2	0	2	3
0	$b_4 + \frac{b_2 + b_3}{2}$	0	0
2	$b_2 + b_3 + b_4$	0	0
3	$b_2 + b_3 + b_4$	0	0

$Pr\{Y_n = (2,3) | Z_n = 0, s_n^1, s_n^2\}$

s_n^1 \ s_n^2	0	2	3
0	0	0	0
2	b_1	0	0
3	b_1	0	0

If the emergency is a police call $(Z_n=1)$, the following switching model was assumed: Since there is some probability that a police call will be serviced by a non-recovery vehicle even when one or more recovery vehicles are idle, a non-zero conditional probability was assigned to this event. Two dispatch "strategies" were assumed. In the first, a constant probability was assumed for all levels of recovery vehicle availability. In the second, it was assumed that when only one recovery vehicle is available in a multi-vehicle allocation, this vehicle is "protected" by not dispatching it to police calls except in a small number of cases. In the event a police call is accepted by the recovery system, it was assumed that it is equally likely that any available vehicle will service this call.

For the existing system, it is difficult to estimate exactly the probability that a police call will be serviced by one of the dual-function vehicles when one or more of these are available; it likely varies under alternative operating situations. Hence, this parameter was used as an independent variable, and results are presented for a range of potential values. Specifically, the probability of accepting a police call when two recovery vehicles are available ($\emptyset$) in a two vehicle system was allowed to vary from zero[10] (a single function system) to 0.5. Under the "non-protective" dispatch strategy with one available vehicle, this probability was assumed to be equal to the value for the two-vehicle case. In the protective dispatch strategy a constant value of 0.1 was assigned to the probability of accepting a police call when one vehicle is available ($\emptyset_2$).

Once an emergency has been assigned to a vehicle and the type of service has been selected, service on this emergency proceeds according to a negative exponential distribution. Consequently "service transition probabilities" of the form $\Pr(S_n^1, S_n^2, \ldots, S_n^r \mid Y_n - 1, S_{n-1}^1, \ldots, S_{n-1}^r, X_n)$ can be computed as products of exponential functions.

Furthermore, it can be shown that the stochastic process $(S_n^1, S_n^2, \ldots, S_n^r, Z_n)$ is a Markov chain. Transition probabilities for this chain can be easily found by manipulating the conditional switching probabilities, the service transition probabilities and the probabilities associated with the arrival process. From these transition

[10]The probability when four vehicles were available (in a four vehicle system) was developed by approximation techniques discussed in Section 11-3. The three-vehicle, dual-function system was not examined.

probabilities, equilibrium probability results describing the system performance as a function of alternative allocation and distribution policies can be derived. These are discussed in the next section.

11-3. MODEL ANALYSIS AND RESULTS

The analytical techniques of Section 11-2 were programmed into a Fortran IV computer program for use on the University of Michigan IBM 360/67 computing system. The resulting program was then utilized to generate numerical results for alternative systems. Four allocation policies were examined--recovery systems with one, two, three and four vehicles assigned to a police precinct.[11] The four-vehicle system leads to very time consuming and expensive computation. Hence the four-vehicle system was analyzed as a pair of two-vehicle systems operating independently in adjacent half-precincts. This approximation should closely represent actual operating policy in such a system.

Measures of system performance were discussed in Section 11-1, where it was noted that improvements in recovery vehicle availability and reductions in recovery vehicle service times are measures directly influenced by improved ambulance allocation and distribution. The numerical results computed from the recovery system model provide equilibrium vehicle state probabilities which are closely related to these measures, and these results can be used to develop the appropriate comparisons.

Recovery Vehicle Availability

Medical emergencies occurring when no recovery vehicles are available either must "wait" for a vehicle to finish its current service or must be served by a special vehicle from outside the system. A system which forces a large number of emergencies to wait for recovery vehicles to become available is undesirable since the resulting waiting times introduce potential uncontrollable degradations in the medical condition of victims. On the other hand, a system

[11]Numerical results were calculated only for Precinct 15; extrapolations of these results are discussed in Section 11-4.

which requires frequent external assistance is likely to incur substantial real and opportunity costs, as well as to cause inefficiencies in the system from which the extra vehicle is "borrowed".

Therefore, this section examines the probability that all recovery vehicles are busy, or equivalently, the probability that one or more recovery vehicles are available at the time of an ambulance call. The effects of alternative vehicle allocation, distribution and dispatch policies are sequentially considered.

Allocation Effects: Qualitatively, one expects that an increase in the number of recovery vehicles will decrease the probability that all vehicles are simultaneously busy. In fact, if enough vehicles are supplied to the recovery system we would expect that this probability should approach zero. Of course, the fixed and operating costs are both greater for a recovery system equipped with a larger number of vehicles, and consequently it is necessary to carefully explore the trade-off between vehicle availability and the allocation policy.

Quantitative results for the single-function ambulance system are presented in Table 11-2. (Results for the dual-function system are presented in the Section on Dispatch Effects.)

In all cases these results are for that vehicle distribution which maximizes the equilibrium idle probability. The model parameters are set at the maximum likelihood estimates.

Inspection of Table 11-2 reveals that increasing the number of recovery vehicles from one to two decreases the probability that all vehicles are busy by 0.1874. An increase to three vehicles further decreases this probability by only 0.0216. When four recovery vehicles are assigned to the police precinct, the probability is essentially reduced to zero.

When two recovery vehicles are assigned to a single function ambulance system, at least one will be available approximately ninety-eight percent of the time. The substantial decrease in vehicle availability when only one vehicle is assigned and the moderate improvement in availability when three are assigned provide further evidence

TABLE 11-2

PROBABILITY ALL RECOVERY VEHICLES BUSY AS FUNCTION OF ALLOCATION POLICY

Number of Recovery Vehicles (r)	Probability All Recovery Vehicles Busy
1	0.2109
2	0.0235
3	0.0019
4	0.0000

TABLE 11-3

VEHICLE AVAILABILITY AS FUNCTION OF DISTRIBUTION POLICY
r = 1

Policy	Probability All Recovery Vehicles Busy
I	0.2117
II	0.2109

in favor of a two-vehicle system.

Distribution Effects: The major effect of modifying the distribution of recovery vehicles should be to change the vehicle service times by altering the transit time to the scene. This effect will be discussed in the Section on recovery vehicle service times. In addition, by decreasing the vehicle service time, the improved distribution of vehicles may result in some increases in vehicle availability, and these effects will now be discussed. Results are presented here for the single-function recovery system only; results for the dual-function system are discussed in the Dispatch Effects Section.

Two distribution policies were examined for the single-vehicle recovery system. Policy I placed the vehicle in the scout car territory of minimum demand, and Policy II placed the vehicle in the territory of maximum demand. The equilibrium probability that the vehicle is busy is tabulated as a function of these distribution policies in Table 11-3. Note that Policy II of Table 11-3 is identical to the one-vehicle allocation policy in Table 11-2.

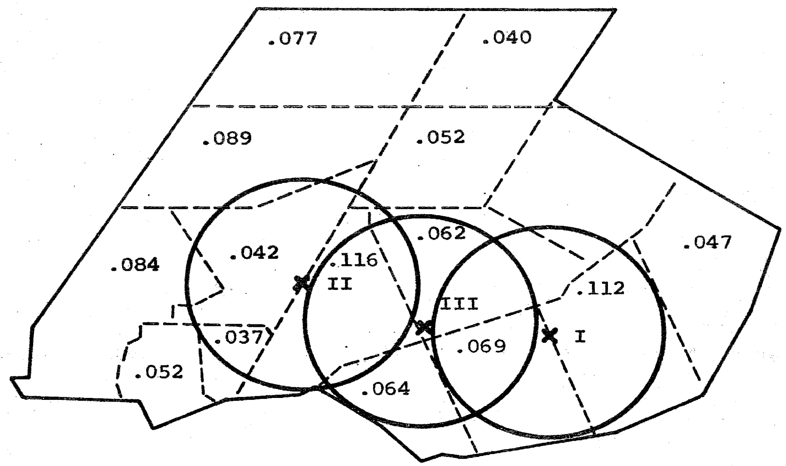
Three distribution policies were examined for the two-and three-vehicle recovery systems. Policy I (Figure 11-4) placed the vehicles in territories so as to maximize coverage in the areas of greatest vehicle demand. Policy II (Figure 11-5) placed the vehicles in territories so as to obtain uniform geographical coverage. Policy III placed all recovery vehicles at a single station to simulate system operation when a single, fixed ambulance station is utilized. (The chosen station coincides with the one-mile service region of the single-vehicle distribution (Policy II) discussed earlier and designated by Circle II in Figure 11-4.) The equilibrium probabilities that all vehicles are busy are tabulated as a function of the three distribution policies in Table 11-4.

Inspection of Tables 11-3 and 11-4 indicates that the effect of vehicle distribution on ambulance availability is essentially negligible for all allocation policies. Placement of the vehicle(s) in the regions of maximum demand (Policy I) results in the lowest probability that all recovery vehicles are busy. However, the improvement over other distribution policies is very small. Small differences also exist between the other distribution policies. Hence we can conclude the placement of recovery vehicles does not influence ambulance availability in any substantial way for the system under study.

<u>Dispatch Effects</u>: When an ambulance system accepts both police and ambulance calls for service, it is reasonable to expect that such a system configuration will service ambulance calls less efficiently than a comparable single-function system. We shall now examine the decrease in vehicle availability as a function of the percentage of police calls accepted for service by the recovery system. Comparisons are made of this decrease for recovery systems with one, two and four

FIGURE 11 - 4

THREE AMBULANCE DISTRIBUTION POLICY TO ACHIEVE COVERAGE OF AREA OF MAXIMUM DEMAND



Precinct 15

FIGURE 11 - 5

THREE AMBULANCE DISTRIBUTION POLICY TO ACHIEVE UNIFORM COVERAGE OF SERVICE AREA

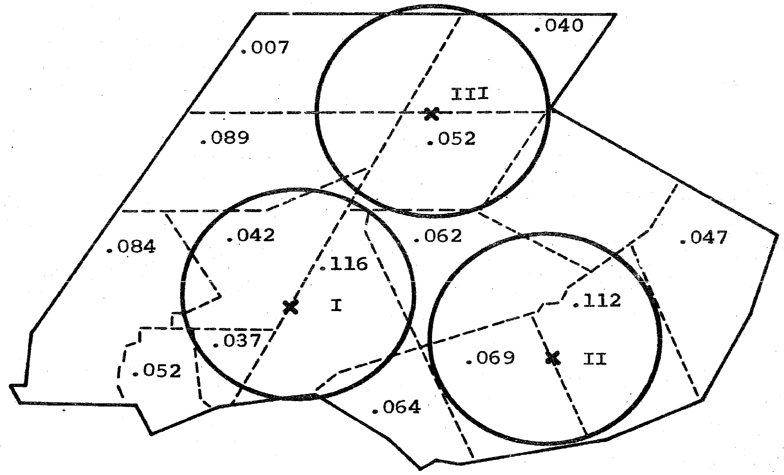


TABLE 11-4

VEHICLE AVAILABILITY AS FUNCTION OF DISTRIBUTION POLICY

r = 2; r = 3

Distribution Policy	Probability All Recovery Vehicles Busy	
	r = 2	r = 3
I	.0235	.0019
II	.0242	.0035
III	.0255	.0027

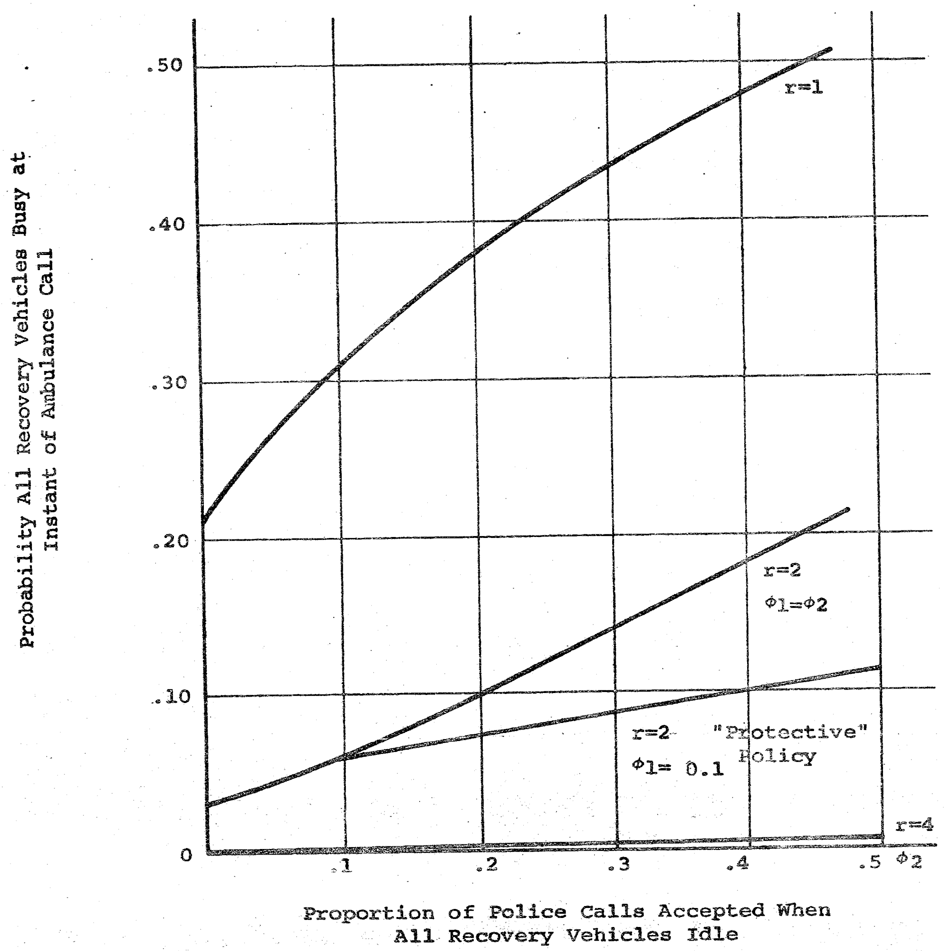
vehicles. Results for the three systems are presented in Figure 11-6, in which $\emptyset_2$ is the probability of accepting a police call where two vehicles are available and $\emptyset_1$ is the probability of accepting a police call when one vehicle is available (protective policy). The effect of the distribution policy may appear in the third or fourth decimal place; it does not appear to be significant in Figure 11-6.

In the same figure a monotonic increase can be observed in the probability that all recovery vehicles are busy at the instant of a medical emergency when there is an increase in the proportion of police calls serviced. This increase is present for all three allocation policies examined, but the rate of increase is lower for the systems with a larger number of recovery vehicles. In fact, almost no decrease in this measure of vehicle availability is present when four vehicles are assigned to the recovery system.

It has been shown that system performance can be substantially improved if one modifies the dispatch policy to "protect" the last available ambulance. Results for such a policy when r = 2 are also presented in Figure 11-6. This protective policy ($\emptyset_1$ = 0.1) results in at least a 0.89 probability that one or more vehicles are available, even when the system is accepting fifty percent of all police calls for service when both vehicles are idle. The equivalent probability is only 0.78 when the protective policy is not utilized. Hence, one can

FIGURE 11 - 6

VEHICLE AVAILABILITY AS FUNCTION OF ALLOCATION AND DISPATCH POLICY



conclude that a protective dispatch policy does assist in maintaining recovery vehicle availability when a dual-function system is utilized. However, some decrease in vehicle availability still is present whenever any police calls are accepted for service.

A protective dispatch policy may have a detrimental influence on the availability of vehicles to handle police calls. Since in general there are many more police squad cars than dual-function police ambulances, this is not believed to be a serious problem in the system being examined.

Recovery Vehicle Service Times

The recovery vehicle response time is the sum of two random variables: the waiting time for an ambulance to become available and the transit time to the scene of an emergency. It has also been observed that the transit time to the scene is one component of the recovery vehicle service time. Empirical analysis of ambulance service times in the City of Detroit has revealed that these times are exponential, identically distributed, random variables when one conditions both on transit distances of less than one mile and on transit distances greater than one mile. The mean service time for calls requiring less than one mile to the scene has been found to be approximately two minutes less than that for calls requiring transit distances greater than one mile to the scene.

Thus, transit times and subsequent system response times are lower in a system where a larger proportion of ambulance calls require less than a one mile transit distance to the scene. Consequently, system comparisons are based on the equilibrium probabilities that medical emergencies are being serviced as "short" (less than one mile transit distance) runs. The effects of alternative allocation and distribution policies and of alternative dispatch policies will now be considered.

Allocation and Distribution Effects: The effects of allocation and of distribution policies for the single-function ambulance system are considered simultaneously in this section. The basic numerical results are presented in Table 11-5.

TABLE 11-5

EFFECTS OF VEHICLE ALLOCATION AND DISTRIBUTION ON SERVICE TIMES

Allocation Policy	Distribution Policy	Probability One Or More Vehicles On Run Requiring Less Than One Mile Transit Distance
r = 1	I	0.0274
	II	0.0387
r = 2	I	0.0831
	II	0.0723
	III	0.0463
r = 3	I	0.1049
	II	0.1197
	III	0.0625
r = 4	I	0.15

Inspection of Table 11-5 indicates that the probability that one or more vehicles are serving "short" emergencies increases substantially with the number of vehicles, regardless of the distribution policy. With a single recovery vehicle, a difference of 0.0113 in this probability is introduced by shifting from a distribution policy which places the ambulance in the region of minimum demand (I) to a policy which places the ambulance in the region of maximum demand (II). In the two and three vehicle systems, similar differences exist between those policies providing maximum coverage in the region of maximum demand (I) and those designed to obtain uniform coverage of the entire service region (II). For these allocation policies, each of the two distribution plans results in a considerable improvement over a single-station policy (III).

It is possible that the effect of alternative allocation policies on the probability one or more vehicles are serving "short" emergencies is due to the substantially different vehicle availabilities associated with these policies.

Consequently, the conditional probabilities that a vehicle is serving a "short" emergency, given that the vehicle is "busy", were calculated for each vehicle for each allocation and distribution policy. Results are presented in Table 11-6.

By conditioning on the event that the vehicle is busy, the effects of differing allocation policies are essentially removed. Therefore, Table 11-6 can be utilized to study the effects of alternative distribution policies alone.

When r = 1, a 0.053 increase in the conditional probability of serving a short emergency occurs when the vehicle is assigned to the region of maximum demand. When r = 2, this probability is 0.182 when both vehicles are assigned to the same ambulance station. An average increase of 0.096 occurs when a uniform coverage distribution policy is utilized. Implementation of a distribution policy to increase coverage in the area of maximum demand results in an average increase of 0.054 over the uniform coverage policy.

When r = 3, the conditional probability is 0.229 when all three vehicles are assigned to the same station. An average increase of 0.145 can be obtained by implementing a uniform coverage policy. In this case, however, the maximum demand coverage policy results in a 0.046 decrease in the average probability.

From these results we can conclude that the distribution of recovery vehicles does affect the probability that one or more vehicles are on a short run and the probability that any recovery vehicle is on a short run, given that it is busy. Placing all recovery vehicles at a single station results in values for these probabilities which are substantially lower than those for alternative distributions. Placing the vehicle(s) in the regions of maximum demand results in the highest probabilities when r = 1 and r = 2. When r = 3, the uniform coverage distribution results in higher values for the relevant probabilities. However, no substantial difference exists between the latter two distributions for either multiple vehicle allocation policy.

Dispatch effects: The probabilities that one or more recovery vehicles are on short runs in a dual function system are examined in this section. These are plotted in Figure

TABLE 11-6

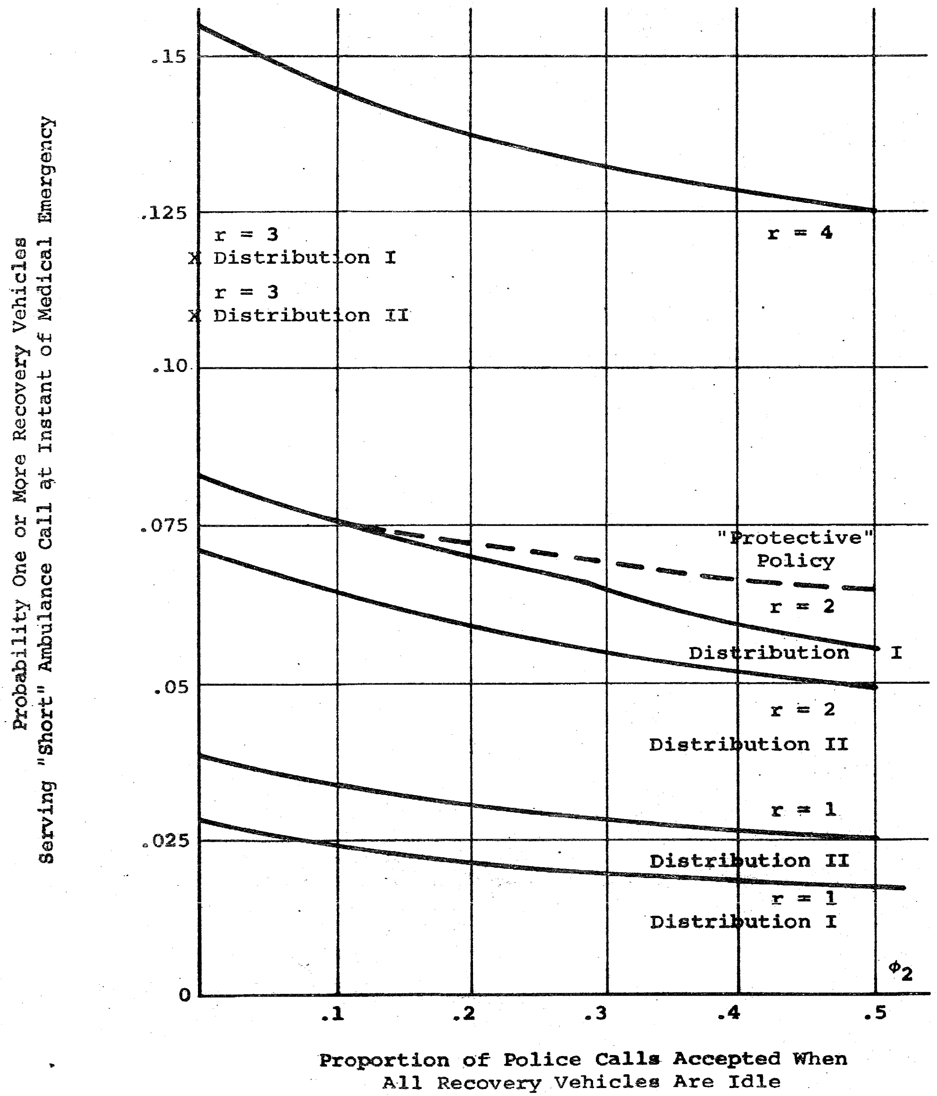
EFFECT OF ALLOCATION AND DISTRIBUTION POLICY ON CONDITIONAL PROBABILITY THAT EACH VEHICLE IS ON EMERGENCY REQUIRING LESS THAN ONE MILE TRANSIT DISTANCE

Allocation Policy	Distribution Policy	Vehicle Number	Probability on Short Emergency Given that Vehicle is Busy
r = 1	I	1	0.130
	II	1	0.183
r = 2	I	1	0.317
		2	0.346
	II	1	0.272
		2	0.284
	III	1	0.182
		2	0.182
r = 3	I	1	0.540
		2	0.380
		3	0.365
	II	1	0.510
		2	0.530
		3	0.382
	III	1	0.229
		2	0.229
		3	0.229

11-7 as a function of the proportion of police calls accepted for service when all vehicles are idle. A gradual reduction in this probability is observed as more police calls are accepted by the system. This result holds for all allocation and distribution policies. When no police calls are accepted ($\phi_2 = 0$), results are identical to those of Table 11-6. As we have seen, distribution policy III (placing all vehicles at a single station) is inappropriate in a dual-function system, and results are not presented for this distribution. In addition, the decrease in performance

FIGURE 11 - 7

VEHICLE UTILIZATION AS FUNCTION OF ALLOCATION DISTRIBUTION, AND DISPATCH POLICY



has not been calculated for the three-vehicle allocation.

If one adopts the protective dispatch policy discussed earlier, the reduction in the probability that one or more vehicles are serving "short" emergencies is not as rapid. Results for such a protective policy are shown by the dotted line in Figure 11-7. Nevertheless, some decrease in this probability is present whenever any police calls are accepted for service.

To study this problem in more detail, the conditional probability that each vehicle is serving a "short" emergency, given that it is busy, was calculated for the various allocation and distribution policies when r = 1 and r = 2. Results are presented in Figure 11-8. (Observe that semi-log plotting has been utilized in this figure.)

When the conditional probabilities are examined in this way, one observes that the degradation occurs at the same rate for each vehicle. This was not true for the decrease in vehicle availability studied in the Section on Dispatch Effects.

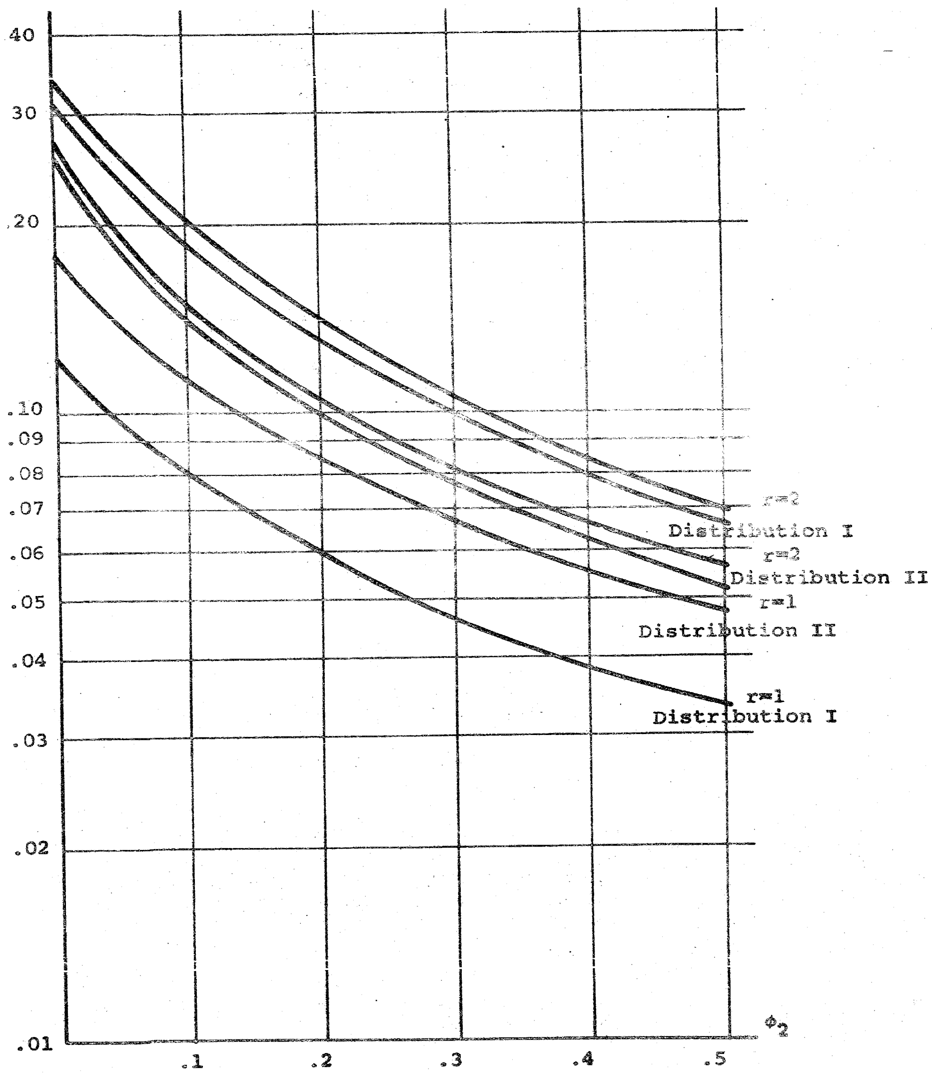
However, when one conditions on the event that the vehicles are serving medical emergencies, it was found that the conditional probability of serving a "short" emergency is constant regardless of the dispatch policy. From this one can conclude that the dispatch policy does not affect the relative proportion of time spent serving medical emergencies requiring less than a one mile transit distance and serving medical emergencies requiring more than this distance. Instead, the decline in those probabilities shown in Figures 11-7 and 11-8 result from the measure in the proportion of the vehicles' time which is required to serve police calls as more of these are accepted by the system.

11-4. EXTRAPOLATION TO CITY-WIDE OPERATION

In this section the results of this chapter are qualitatively extended to city-wide recovery system operation. It has been observed that a four-vehicle system provides essentially 100% vehicle availability in both the single- and dual-function operating modes. However, a two-vehicle

FIGURE 11 - 8

CONDITIONAL PROBABILITY OF SERVING A "SHORT" EMERGENCY AS FUNCTION OF DISPATCH POLICY



recovery system also has desirable performance characteristics, especially when the vehicles are placed at separate stations. When the two-vehicle system is operated in a dual-function mode, reasonable vehicle availability can be maintained by utilizing the "protective dispatch" policy discussed earlier.

With 2 recovery vehicles assigned to each precinct, 26 vehicles are required to provide city-wide service for 13 precincts. In this situation the vehicle to population ratio is 16 per million persons.

It is quite likely that this number can be reduced by allowing ambulances to cross precinct boundaries. For instance, under the assumption that emergency occurrences occur independently in adjacent precincts, the probability that all 4 recovery vehicles are simultaneously busy in these two precincts is about $(0.02)^2$ or 0.0004. Consequently, it may be possible to conserve recovery vehicles by operating in service areas larger than a police precinct.[12] For instance, it is conjectured that 3 vehicles for a service area the size of two police precincts can provide adequate availability without severely increasing transit times to the scene. In this case, city-wide service can be provided with 19 or 20 vehicles. Clearly, experimentation with such a system is desirable to validate this qualitative conjecture.

It should be observed that enlarging the recovery vehicle service areas may be constrained by other factors. For instance, the Detroit Police Department is looking with increased interest at the utilization of radio districts for command and control. These districts encompass about four precincts each. It is reasonable to assume that the radio district may serve as the basic service area in a dual-function police ambulance system. Furthermore, this larger service area may be desirable for coordination purposes in an independent single-function system.

---

[12] In this case the average transit distance to the scene will be increased. The effect of this increase on vehicle service times cannot be estimated from the data available to this study.

It should also be observed that this study is based upon the existing demand function for ambulance service in the City of Detroit. It has been stated elsewhere in this report that a substantial percentage of the urban medical emergencies analyzed in this study do not require emergency transportation to a hospital. If these non-emergencies can be screened from the emergency recovery system, it is possible that the number of required recovery vehicles can be significantly reduced. For instance, with the present screening process, one single-function ambulance operating in a precinct will be idle at the instant of a medical emergency 79% of the time. If the average intensity of emergency calls is reduced to one-half the present level, vehicle availability in the above recovery system increases to about 0.90.

CHAPTER TWELVE

ANALYSIS OF ATTENDANT TRAINING

CHAPTER TWELVE

ANALYSIS OF ATTENDANT TRAINING

2-1. ATTENDANT DIAGNOSIS

Evaluation Technique

The ability of the ambulance attendant to identify injuries was used as a measure of the effectiveness of training. The identification of injuries may be evaluated by comparing the injury and body area matrices used by the ambulance attendants with emergency admission check sheets. The matrices are not appropriate for non-traumas; evaluation of the diagnoses of these cases could be accomplished only when the attendant and emergency room personnel provided appropriate comments. Fortunately, some such indication of the problem was usually given.

Grading each of the attendant diagnoses as "correct" or "incorrect" as "accurate" or "inaccurate," or by any other binary scale, was not possible. Many injuries cannot be described uniquely by the injury matrix. For example, either head or face might be used to designate the location of a single injury. Furthermore, the same injuries may not be identified in each matrix if several distinct injuries are present. Thus it may be difficult to determine whether two dissimilar indications on the attendant's or emergency room forms represent an incorrect diagnosis or diagnoses of two different injuries.

The significance of the attendant diagnosis is related to the initial examination of the patient and the determination of appropriate treatment and care by the attendant. Therefore, an index scale was selected that would allow consideration of the treatment indicated by the attendant diagnosis when that diagnosis was not identical to that obtained by the emergency room.

The diagnosis index has eight levels given below:

1. Correct diagnosis.

2. Not correct, but related and indicative of appropriate aid or treatment.

Preceding page blank

squared = 9.49 at the 5% significance level with 4 degrees of freedom. Thus we may reject the hypothesis of independence at the 5% level and conclude that the differences in performance among the five units are significant. The training levels were also compared in pairwise combinations with 2 x 2 tables. No statistically significant difference was found between the police with academy training and the police who had received the advanced course, or between the commercial attendants and either the academy or advanced police. The differences between the police with the refresher training, 83% of whose diagnoses were "appropriate," and all other units were significant at the 5% level however.

The fire rescue squads diagnosed 51% of the patients appropriately, i.e., the number of appropriate diagnoses was about equal to the number that were incorrect. The difference between the fire rescue squads and each of the other units is significant at the 5% level. The minimum expected frequency in the contingency tables is 17, and corresponds to the expected number of incorrect diagnoses by the rescue squads under the assumption of independence. While this cell count is sufficient to justify the Chi-squared test, the apparent lower performance of the fire rescue personnel may not represent a valid comparison. Most of the medical emergencies referred to the Fire Department are non-traumas, and are more difficult to diagnose than the large number of cases of obvious traumatic injuries encountered by the Police Department. Furthermore, many of the patients conveyed by the police (and in this demonstration by the commercial ambulances), are found in situations that would indicate the probable mechanism of the injury and assist in the diagnosis. Examples are the victims of traffic accidents and beatings.

An examination of the types of injuries that were incorrectly diagnosed indicated that no particular injuries presented problems. Index Levels 4 and 6 (indication of a non-existent injury, transposition of injury or body area) were distributed throughout the types of injuries and body areas.

Actual injuries which were not recognized by the attendants (Level 5) were predominantly contusions or fractures, particularly of the extremities.

Improved performance resulting from the advanced police course and the training of the commercial ambulance personnel are not indicated in the diagnoses of injuries provided by the ambulance attendants. The reason is not clear but may be related to the differences in experience. The police patrolmen, who have received less training than the commercial ambulance attendants, have an average of approximately fourteen years in service while the commercial purveyors have high turnover rates. However, this would not explain the higher performance of the police who had received the refresher course.

12-2. TREATMENT CAPABILITY

Data Collection

The objective of any quasi-medical training program for emergency medical recovery system personnel is to increase the capability of providing appropriate treatment at the scene of the incident and in transit. Thus the recovery system is not only a transportation system but becomes an extension of the emergency medical care system in which the time from injury or embarrassment to initial treatment is reduced.

One measure of the effectiveness of the training program might be obtained by examining the aid which is administered by the attendant.

During the four week data-collection period in late November and early December, 1968, the emergency admission check sheet in Figure 6-3 was used. The bottom section of the sheet was used to obtain information on aid given by the attendant or rescue worker. Several problems were encountered with this section of the form. The responses possible were either "inadequate" or "inappropriate" treatment. No provision was included for the most frequent situation of no aid necessary and none given. More importantly, the emergency room physician had no convenient means of indicating when a specific treatment was both required and properly administered.

In addition to the documentation problems of the form, the officials of several hospitals were concerned with the medico-legal problems that might be associated with the requested data. In addition there was evidently some misunderstanding of the interpretation and subsequent use of the data.

As a result of all these problems very little data were collected in November/December, and the quality of the limited data did not justify evaluation.

The form shown in Figure 6-5 was used in both the April and August data-collection periods in 1969. The purpose and interpretation of the form were explained to key personnel from each emergency room. Six hospitals (including Detroit General) receive about 86% of the patients from the four test precincts. A committee composed of one physician from the emergency room of each of these hospitals and the consultant from Detroit General, was formed to discuss the data collection and establish appropriate and uniform interpretation. Each of the physicians then supervised the collection of data at his respective hospital.

During the months of April and August, data-collection at the five hospitals was very successful; the improved form substantially raised the response at the remaining seven hospitals.

Treatment Evaluation

The original plan for evaluation of the treatment included a statistical analysis of the data on the bottom tear-off section of the emergency admission check sheet--the tearing off inhibiting the identification of the patient. In April and August the check sheets were returned without detaching tear-off sections. The single form that had been separated, evidently by accident, was returned taped together.

The intact forms permitted matching the data on treatment required and attempted with the remainder of the data available on each case. Examination of all the composite data revealed two problems that would negate the originally proposed separate evaluation.

In many instances the emergency room physician is not aware of treatment that may have been provided at the

scene or in transit. This is particularly true of measures to guarantee adequate respiration and cardiopulmonary resuscitation. The physician may have no way, other than by direct communication, of knowing whether these measures were employed. The same problem was also encountered with control of hemorrhage and with splinting. The examining physician may not recognize the purpose or intent of a dressing that was applied earlier. If the emergency room is busy, splints and other encumbrances may have been removed before examination by a professional person.

The second problem encountered is related to, if not a consequence of, the first. If a technique is successfully used by the attendant to control hemorrhage or guarantee ventilation and is not recognized by the physician, the very need for those measures may go unnoticed. Even arterial hemorrhage may escape detection if successful control is accomplished early. Similarly, successful resuscitation may mask previous respiratory embarrassment.

After recognition of these problems, the evaluation was modified by hand editing of the data. All information available on both the ambulance attendant and emergency admission check sheets, including comments and notes, was considered. The following procedure was employed for editing.

If no incongruity was found between the first-aid data on the emergency room sheet and the information provided by the attendant, no corrections were made. When the attendant indicated he had used first-aid measures that were not recognized in the emergency room, a new category of "Attempted, outcome unknown" was added. The need or lack of need of the treatment was determined by the information on the emergency room matrix. In these cases the matrix was marked "not attempted" and either "needed" or "not needed" by the emergency room personnel. The requirement for treatment given in the emergency room was retained.

The "Aid to injured" matrix on the ambulance attendants' check sheet (Figure 6-4) provided the primary information on treatment by the attendant. "Control of heavy bleeding" was interpreted as "control of severe bleeding." Either "cleared airway," "administer oxygen," "artificial respiration" or combinations of these were considered attempts to guarantee adequate respiration. "Neck/spine immobilization" was considered synonymous with "use of backboard," and "cardiac massage," in combination with either "artificial respiration" or "administered oxygen," was interpreted as "cardiopulmonary resuscitation."

Bandaging and action to control light bleeding were often indicated on the attendant's form with lacerations the most frequently diagnosed injury. Consequently, a sixth treatment category, "control light bleeding" (or bandaging), was added to the emergency admission treatment matrix. If a laceration diagnosed on either the attendant or emergency room sheet did not result in severe bleeding, a need to control light bleeding was assumed. If the attendant gave any indication he employed such measures or applied a dressing, the treatment was considered "attempted/successful."

The results obtained from the corrected April and August data collections are given in Attachments 12-A through 12-E. The totals given in the right column are weighted averages which were computed by dividing the total number of "treatment needed" indications by the total number of treatment patients. The latter quantity (treatment patients) is equal to the product of the number of patients and the number of types of treatment evaluated. Control of light bleeding--or bandaging--was not included in the totals since the large number of cases in this category would mask the results for the more serious problems.

Examination of the results indicates that the commercial ambulance attendants attempted to control light hemorrhaging or dressed minor open wounds for 96% of the patients for which this treatment was appropriate. All other units, the police and fire rescue squads, ranged from 12-18%. Measures to control severe bleeding were employed by the commercial attendants in 95% of the cases, and in 70% by the police with refresher training and 100% by the police with advanced training. While the results for both the police with advanced training and the commercial attendants appear better than for other units, both the advanced-trained police and the fire rescue squads conveyed only a small number of patients (6 and 5 respectively)

requiring this treatment; thus the results are not conclusive.

The commercial attendants provided respiratory assistance to 77% of the patients that the emergency room personnel indicated needed assistance. The academy police provided assistance to 48% of the patients. The results for other police units were lower; but, again, these conveyed fewer than 10 patients requiring aid. The fire rescue squads conveyed 45% of the total number of patients requiring respiratory assistance and they provided aid in 90% of these cases. The assistance provided by police officers was predominantly "clearing airways." Although police administered oxygen 7 times in April, they evidently did not use oxygen in August. The commercial attendants cleared airways and administered oxygen with about equal frequency. The fire rescue squads administered oxygen to over 70% of all the patients they conveyed.[1]

The commercial attendants splinted long bones on 12 of the 22 patients--or 55%--requiring such treatment. The police with refresher and advanced training splinted 0 and 38%, respectively of their patients. However, the police with refresher training conveyed only 2 patients requiring such treatment and the advanced police carried only 8. The academy police encountered 23 cases needing splinting and used the technique on 3 of these cases or 13%. Two of these cases were splinted by police from precincts having the necessary equipment (precinct 15 in April and 7 and 15 in August), and the third was splinted with improvised materials.

Results on the use of backboards or neck/spine immobilization are inconclusive because a total of only 11 patients required this measure for medical reasons.

The emergency rooms indicated that cardiopulmonary resuscitation was needed in 23 cases in April and August. These were all from a total of 96 patients DOA. Of the

---

[1]As has been noted the fire rescue squads responded primarily to victims with suspected cardiac or respiratory problems.

TABLE 12-3

SUMMARY OF TREATMENT PROVIDED BY AMBULANCE ATTENDANTS
NEED DETERMINED BY EMERGENCY ROOM PERSONNEL

Per Edited Data

Physician Decision			CLB	CSH	GAR	SLB	UoB	CPR
Police:	Academy	Attempt[a]	-	53.9	47.7	13.0	50.0	42.9
		Success[b]	-	85.0	62.5	66.7	100.0	0
	Refresher	Attempt	-	70.0	33.3	----	-----	0
		Success	-	80.0	100.0	----	-----	----
	Trained	Attempt	-	100.0	37.5	37.5	0	0
		Success	-	80.0	100.0	100.0	-----	----
Medics		Attempt	-	94.7	76.9	54.5	60.0	80.0
		Success	-	66.7	100.0	100.0	100.0	0
Fire		Attempt	-	60.0	90.4	0	50.0	90.0
		Success	-	100.0	90.9	-----	-----	0

a. % of cases needing treatment in which treatment was attempted.

b. % of cases in which treatment was attempted and the outcome was known (success or unsuccess) and in which the outcome was success.

DOA patients, only 13 were evidently alive when the ambulance arrived at the scene of the indicent, and 4 of the 13 received cardiopulmonary resuscitation.

Of the 23 cases in which a need for CPR was indicated, fire rescue squads conveyed 10, and attempted CPR in 9. The commercial ambulances carried 5 of the cases and used CPR on 4 of these. The police carried the remaining 8 cases and 3 received CPR.

No patient conveyed in the April and August data-collection periods was revived by CPR. During the month of July two police officers who had received the advanced training successfully revived two patients who had evidently suffered both pulmonary and cardiac arrest. One of the patients was a victim of a traffic accident and the other was a CVA patient.

The results given in Attachments 12-A through 12-E are summarized in Table 12-3 with the exception of treatment to control light bleeding.

The data presented are based on a physician's determination of the need for treatment. The cases in which the attendants attempted treatment that was subsequently unrecognized by the emergency room physicians--"attempted, outcome unknown"--are not included. A second level of editing was used to consider such cases. If "not needed--not attempted" was indicated on the emergency room check sheet, the measure was considered needed and successfully attempted. If "needed--not attempted" was indicated, the case was classified as "needed--attempted unsuccessful." Thus the requirements for the treatment are determined by either the ambulance attendants or the emergency room personnel. The treatment was considered successful if attempted but the need was not recognized by the emergency room under the assumption that a problem originally existed but was successfully managed early so that no clear evidence was present by the time the patient arrived at the emergency room.

The results of the second level of editing are given in Table 12-4. The figures for control of light bleeding would be the same as given in Attachments 12-A through 12-E. Since no emergency room information was collected on this type of injury, the procedure used for this measure on the earlier tables was equivalent to the second level of editing.

The rationale used to obtain Table 12-4 may be appropriate for "control of light bleeding," "control of severe bleeding," and "guarantee adequate respiration," but it is not for the other first-aid measures. For example, the fire rescue squads are shown to have given CPR to 95% of the patients requiring the resuscitation with 52.6% success, while no patients were actually revived by this technique. The Fire Department results for "guarantee adequate respiration" are also inappropriate because the rescue squads gave oxygen to many patients who had no respiratory problems.[2]

The results of the second level editing in general show an increase in the frequency with which treatment was attempted and a corresponding increase in the success of the treatment.

The relative performance of the units is not significantly changed, however.

While Table 12-3 summarizes the treatment given by attendants with several levels of training, the statistical significance of the results, considering the numbers of cases involved, is not evident. The significance of the differences can be examined by using contingency tables. The data used to obtain Table 12-3 can be grouped into (1) the number of cases in which any treatment was needed and was given by the attendant and (2) the number of cases for which no treatment was given although it was needed. The contingency table for treatment required is given in Table 12-5. A chi-squared test indicates a significant difference between the units at the 5% confidence level. Thus we may assume the existence of a difference in the performance of the units.

Table 12-6 gives the results of omitting "control light bleeding" and considering only the more critical treatments.

---

[2]Note the percent of cases not requiring the treatment in which it was given is included in Attachment 12-E.

TABLE 12-4

SUMMARY OF TREATMENT PROVIDED BY AMBULANCE ATTENDANTS
NEED DETERMINED BY EMERGENCY ROOM PERSONNEL AND ATTENDANTS

			CLB	CSH	GAR	SLB	UoB	CPR
Police:	Academy	Attempt	22.8	77.5	61.5	12.5	60.0	42.8
		Success	22.8	80.6	56.2	66.7	33.3	0
	Refresher	Attempt	12.0	70.0	60.0	0	----	----
		Success	12.0	57.1	100.0	----	----	----
	Trained	Attempt	38.1	100.0	66.7	44.4	50.0	0
		Success	38.1	71.4	100.0	100.0	100.0	----
Medics		Attempt	96.3	97.2	90.6	61.5	81.8	80.0
		Success	96.3	72.2	65.5	43.8	77.8	0
Fire		Attempt	37.5	60.0	97.7	0	75.0	95.0
		Success	37.5	100.0	95.3	-----	66.7	52.6

Again, the results are significant at the 5% confidence level.

Similar tests of the success with which treatment was attempted by the five units fail to show significant differences at the 5% level. This is likely a consequence of limited sample size and hence the small cell counts.

Although the chi-squared tests indicate a difference of performance among the units, they do not provide a pairwise comparison or indicate which units contribute to the difference. Pairwise tests indicate significant differences between the commercial ambulance attendants and the police with academy training plus those with advanced police training and all police grouped together, but not between the commercial attendants and the police who had received the refresher course. The comparisons were based on the frequency with which treatment was attempted. Again the small cell counts do not allow a reliable test of the success of their efforts. The differences between the commercial attendants and the police units are statistically significant when "control light bleeding" is excluded, and are even greater when this treatment is included.

TABLE 12-5

TREATMENT REQUIRED
CONTROL OF LIGHT BLEEDING INCLUDED

Unit	Treatment Attempted (percent)	Treatment Not-Attempted (percent)
Police		
Academy	30.0	70.0
Refresher	27.9	72.1
Advanced	41.2	58.8
Commercial Ambulance	83.9	16.1
Fire Rescue Squads	79.4	23.7

Chi-squared = 106.1, chi-squared at 5% level with 4 degrees of freedom = 9.49.

TABLE 12-6

TREATMENT REQUIRED
CONTROL OF LIGHT BLEEDING EXCLUDED

Unit	Treatment Attempted (percent)	Treatment Not-Attempted (percent)
Police		
Academy	41.6	58.4
Refresher	50.0	50.0
Advanced	46.0	54.0
Commercial Ambulance	73.4	26.6
Fire Rescue Squads	85.0	15.0

Chi-squared = 20.2, chi-squared at 5% level with 4 degrees of freedom = 9.49.

Intercomparison of the three police groups fails to indicate significance at the 5% confidence level either with or without "control light bleeding."

The data from the fire rescue squads are not used in chi-squared 2 x 2 treatment comparisons because of the small counts.

Failure of an attendant to recognize or diagnose an injury would likely result in lack of appropriate treatment. Although the relation between diagnosis and treatment attempted was not thoroughly investigated, a limited examination of the results for each of the training levels indicates that most of the injuries which were not treated were recognized and diagnosed correctly. Evidently, lack of required treatment was not directly related to diagnostic performance.

12-3. CONCLUSIONS FROM EMPIRICAL EVALUATION OF TRAINING

The five levels of attendant training represented in the demonstration project have been examined with regard to the ability of the attendant to identify the gross nature of medical problems ("diagnosis"). The frequency and success of their utilization of first-aid skills when the measures were appropriate have also been evaluated.

The police who had received the refresher first aid course identified the injury or illness with the greatest reliability. Their performance was significantly better than the other police units or the commercial ambulance attendants. No significant differences were found among the other training levels. While the measured performance of the fire rescue squads was lower than other units, the characteristics of the kind of medical emergencies encountered by the Fire Department prevent reliable comparison with any of the other training levels.

The application of first-aid skills by the attendants is summarized in Table 12-7. In this table all police training levels have been combined. If bandaging of minor lacerations ("control light bleeding") is excluded, the police treated less than one half of the patients requiring treatment, while the commercial attendants treated nearly three fourths. The fire rescue squads

TABLE 12-7

SUMMARY OF TREATMENT PROVIDED BY ATTENDANTS

Unit	Excluding Control Light Bleeding		Including Control Light Bleeding	
	Treatment Required, Percent Attempted	Treatment Attempted, Percent Successful	Treatment Required, Percent Attempted	Treatment Attempted, Percent Successful
Police	44	78	32	89
Comm. Amb.	73	82	84	95
Fire Rescue	85	81	79	82

treated 85%. This latter figure reflects the use of oxygen on patients with respiratory embarrassment or suspected cardiac problems. When bandaging of minor lacerations is included, the differences are greater and the result for the commercial attendants increased to 84% while the police and fire rescue squads dropped slightly. The changes reflect the fact that the commercial attendants dressed minor wounds more frequently than either the police or fire rescue squads.

Chi-squared tests of the data represented in Table 12-7 indicate that the differences among the three police levels are not significant at the 5% level with or without inclusion of "control light bleeding." The commercial ambulance attendants provided treatment significantly more frequently than either the academy or advanced police and significantly differed from the police with refresher training when "control light bleeding" is included. The differences between the commercial attendants and fire rescue squads are not significant with or without "control light bleeding."

The results of comparing diagnosis and treatment with training do not appear consistent. While "appropriate"

diagnoses were provided with the greatest reliability by the police officers who had received the refresher course, appropriate first-aid skills were used for a greater proportion of patients by the commercial attendants and fire rescue squads. While both the "diagnosis" and "treatment" are indirect measures of the medical benefits of emergency medical care training, evaluation of the diagnostic capability is a surrogate of treatment or the initial management. Therefore the data on aid given by the attendant seem to be the more valuable measure of attendant training.

Several observations are possible which suggest that the evaluation of training may be subject to biases and confounding factors. The result of the measurement of treatment provided does not monotonically follow the training represented. Furthermore, the result is not consistent with the measured "diagnostic" capability, and failure to treat injuries or medical problems was not positively correlated with failure to recognize the acute problems.

The differences in training represented in the programs are not large. Although the police officers who had completed the eighteen hour "advanced" class had covered the use of oxygen, CPR and the back and neck boards, (skills generally not available to officers who had attended the police academy several years ago), police officers encountered few cases requiring these measures. The significant differences in treatment provided by the attendants predominantly involved cases of minor and severe hemorrhage, and management of these problems was included in the training of all units.

Appropriate treatment was provided with the greatest reliability by the uni-functional units, those units with no function at the scene other than providing emergency medical care. Both the fire rescue squads and the commercial attendants were uni-functional in this context. While the fire rescue squads have other duties within the Fire Department, the incidents for which data were collected in this program required only emergency medical care. One might conjecture that the performance of the units was more closely related to the service function of the unit than to the training of the crews. Furthermore, the case experience of the units was different.

TABLE 12-8

REQUIREMENT FOR TREATMENT

First-Aid Measure	Requirement Indicated by Physicians (in percent of patients)	Requirement Indicated by Physicians or Attendants (Excluding Fire Department) (in percent of patients)
Control Light Bleeding	---	22.4
Control Severe Bleeding	7.2	9.9
Guarantee Adequate Respiration	8.4	8.8
Splint Long Bones	5.1	6.6
Use of Backboard	1.6	2.4
Cardiopulmonary Resuscitation	2.1	---
Cardiopulmonary Resuscitation (Excluding Fire Department)	1.4	1.4

Both the fire rescue squads and the contract commercial attendants historically have responded to only true medical problems. The police officers, by contrast, have encountered nearly all the "nuisance" cases and this difference in exposure may influence their response to dispatches to medical emergencies.

Only a small portion of the cases serviced by the public agencies in Detroit require any of the six treatments evaluated in the project. Table 12-8 gives the percentage of the patients requiring the indicated treatment. The figures are based on 1,090 patients for whom both the ambulance and emergency room forms are available. The requirements for treatment listed in the first column were determined by the physicians in the emergency rooms and correspond to the data of Table 12-3. The second column lists the requirements determined by either the physicians or the ambulance attendants and corresponds to Table 12-4. The data for patients conveyed by the fire rescue squads were omitted from the second column because of the false indication of need for oxygen and CPR mentioned earlier.

PARAMEDIC TRAINING

Several questions were included on the emergency room check sheets used in April and August to investigate the inadequacy of a "standard" training level, the relation between treatment at the scene and speed of transport and specific paramedic capabilities.

Legislation enacted by the State of Michigan in 1968 sets minimum standards on the training of ambulance attendants.[3] Since this bill was written partially in response to Highway Safety Program Standard 4.4.11, 1967, many other states are presently establishing similar standards and the training requirements of the Michigan act are exemplary of those found in many areas of the country.

The minimum first-aid training required under the act is the advanced course offered by the American Red Cross

[3]This act is discussed in detail in Chapter 3.

or by the United States Bureau of Mines or an equivalent course. The advanced Red Cross course entails twenty-six hours of instruction and includes material on all the first-aid measures discussed in Section 12-3 with the exception of cardiopulmonary resuscitation. All of the attendants in the demonstration program, while not necessarily in possession of current certificates, had received training at least equivalent to the Red Cross course. Since control groups with less training were not available, the "standard" could not be empirically evaluated. As the Red Cross training is important both as a contemporary "standard" and as a relevant control level, it was evaluated subjectively by including a question on the adequacy of such training on the Emergency Room Check Sheet.

One of the primary tasks of the project was to examine and demonstrate the time required for several alternative response systems to deliver the patient to a place at which definitive treatment could be provided. Minimization of the time to the hospital is not clearly consistent with the optimum management of all patients, however, particularly if haste precludes the provision of appropriate treatment at the scene. An obvious example is presented in the case of a patient with fractured limbs which are not time-critical but should be splinted at the scene. Classic examples are cases of obstructed airway or respiratory failure. Cases which are time-critical and life threatening but in which survival en-route to the hospital is expected are much more difficult to evaluate. The ultimate condition of these patients might be improved if they are treated at the scene even at the expense of time. Such cases present the possibility of trade-offs between initial treatment and speed of delivery to the hospital. Thus, the relation between the requirement for speed of delivery and treatment at the scene, is of specific interest. Two questions on the emergency room forms are addressed to these questions.

In recent years, considerable discussion has been devoted to expansion of the use of paramedic personnel in health services. Interest has been fostered by the training of large numbers of paramedics in the military who ultimately become available for concerns in the civil sector. In addition, with the present shortage of physicians, utilization of this potential resource is considered an important goal for improving health services. Two techniques that have been mentioned frequently in discussions of patient salvage are the administration of intravenous fluids and endotracheal intubation. While these procedures are not presently available to ambulance attendants and are not allowed by many legal interpretations, they could be performed by trained paramedic personnel. A subjective evaluation of the need for these specific measures was attempted by soliciting the opinions of emergency room physicians.

The five questions on the Emergency Room Check Sheet relating to the above discussion are:

1. Is American Red Cross First-Aid Standard Training sufficient and adequate for ambulance attendants to handle this case?

2. Would an IV fluid started on the scene by properly trained personnel have improved patient's condition?

3. Was speedy arrival at the hospital of importance in this case?

4. Would an endotracheal intubation on the scene by properly trained personnel have improved the patient's condition?

5. Would highly trained ambulance attendants (with 50 to 75 hours of training by physicians) be in a position to cope with this case so as to eliminate the need for fast transportation?

Each question could be answered with yes, no, or not applicable. The questions were discussed by the physicians of the medical evaluation team and the interpretation of each was established so that consistent responses could be obtained from all hospitals. The first two questions are self-evident and need no explanation except that a brief synopsis of the Red Cross course was prepared for posting in each emergency room for the benefit of those who were not familiar with the course content. "Speedy arrival at the hospital" (Question 3) was defined as arrival within ten minutes of the time of arrival at the scene as opposed to protracted delay while a high level of treatment is given by the attendant at the scene.

The question on endotracheal intubation was to be answered affirmatively only when normal methods of respiration assistance would not be sufficient. The normal methods would include procedures commonly used for maintenance of airways and techniques of artificial respiration, including mouth-to-mouth, ambu-bags, oxygen, positive pressure, etc.

The highly trained attendant with 50 to 75 hours of instruction by physicians would represent a level of training higher than any included in the demonstration program, but this amount of training was not viewed (by the physicians questioned) as sufficient for providing the capability of either IV fluid therapy or endotracheal intubation.

The results of the April and August data collection are presented in Table 12-9. The data given in Table 12-9 are based on all emergency room forms. The response to the first question (Was the Red Cross course adequate?) was negative at St. John's Hospital much more frequently than at other hospitals. The ratio of the proportion of the negative responses at St. John's to the proportion at all other hospitals (3.3:1) plus the nature of some of the injuries that received a negative response indicate that the question may have been interpreted incorrectly at that hospital. The results support the conjecture that Red Cross training was not suffucient to negate the need for further definitive treatment of those cases marked "No" at St. John's. This apparent interpretation was not consistent with that of other hospitals where the adequacy of only the initial management by the recovery system was considered. Therefore, data from St. John's are not included in the figures given for the first question in Table 12-9.

The response to Questions 1 and 2 were nearly the same in April and August and the differences between the two months are not significant. The differences between April and August are significantly different for the last three questions. Although the results for Question 3 on speed to the hospital do not differ markedly, the question on endotracheal intubation was answered "yes" twice as frequently in April as in August. The reasons for the differences between April and August are not evident. However, later discussion will indicate that the last two questions may have been more difficult to answer subjectively.

The figures given in Table 12-9 included all emergency room forms, approximately 32% of which are not matched with corresponding ambulance forms. However the responses to the questions cannot be related to other parameters of an incident unless the ambulance form is available. Results from only the matched emergency room forms are presented in Table 12-10. The patients who were DOA at the hospital have also been excluded from the latter table since these cases warrant separate consideration and will be discussed later.

The results given in Table 12-10 are similar to those given in Table 12-9. The major differences, primarily in the lower number of affirmative responses to the questions on IV fluids and intubation, result from the exclusion of the DOA's and not from differences in the matched and unmatched sample.

There are significant differences between the cases carried by the fire rescue squads and those carried by the Police Department. A lower percentage of the Fire Department patients could be treated adequately with Red Cross training, while IV fluids, intubation and speed of delivery would have been beneficial to a higher proportion of the patients. These differences reflect the generally more serious nature of the cases serviced by the Fire Department and in particular the greater incidence of respiratory insufficiency among these patients. Note that the positive response to the question on intubation was given over seven times as frequently for patients of the fire rescue squads as for those of the police.

The five emergency room questions regarding training, speed and paramedic measures may be divided into two groups for more detailed examination. Questions 1, 3 and 5 are interrelated and will be discussed together. Questions 2 and 4 both relate to true paramedic capabilities and will be discussed independently.

TABLE 12-10

RESPONSE TO EMERGENCY ROOM QUESTIONS
REGARDING TREATMENT FOR 1073 PATIENTS WITH MATCHED FORMS
(patients DOA excluded)

	UNIT	YES	NO	NON-APL.
Is American Red Cross First-Aid Standard Training sufficient and adequate for ambulance attendant to handle this case?	Fire	46.8	25.0	28.2
	Police Comm.	64.4	18.7	16.8
	TOTAL	62.3	20.2	19.3
Would an I.V. fluid started on scene by properly trained personnel have improved patient's condition?	Fire	11.4	51.8	36.8
	Police Comm.	5.1	57.3	37.6
	TOTAL	6.4	56.1	37.5
Was speedy arrival at hospital of importance in this case?	Fire	51.6	37.6	10.8
	Police Comm.	26.6	61.4	12.0
	TOTAL	32.0	56.3	11.7
Would an endotracheal intubation on the scene by properly trained personnel have improved patient's condition?	Fire	11.5	57.5	31.0
	Police Comm.	1.5	58.6	39.9
	TOTAL	3.6	58.5	37.9
Would highly trained ambulance attendants (with 50 to 75 hours of training by physicians) be in a position to cope with this case so as to eliminate the need for fast transportation	Fire	19.6	33.8	46.6
	Police Comm.	28.5	31.2	40.3
	TOTAL	26.7	31.8	41.5

TABLE 12-9

RESPONSE TO FIVE EMERGENCY ROOM FORM QUESTIONS REGARDING TREATMENT
(in percent of patients)[a]

	Month	Yes	No	Non-Apl.
Is American Red Cross First-Aid Training sufficient and adequate for ambulance attendants to handle this case?[b]	April	61.4	17.0	21.6
	August	58.9	17.1	24.0
	TOTAL	60.1	17.1	22.8
Would an I.V. fluid started on scene by properly trained personnel have improved patient's condition?	April	7.5	44.7	57.8
	August	6.4	53.5	40.1
	TOTAL	7.0	48.9	44.1
Was speedy arrival at the hospital of importance in this case?	April	34.7	49.1	16.2
	August	29.2	56.1	14.7
	TOTAL	32.0	52.5	15.5
Would an endotracheal intubation on the scene by properly trained personnel have improved the patient's condition?	April	3.8	45.1	51.1
	August	1.9	54.5	43.6
	TOTAL	2.9	49.6	47.5
Would highly trained ambulance attendants (with 50 to 75 hours of training by physicians) be in a position to cope with this case so as to eliminate the need for fast transportation?	April	27.1	40.1	32.8
	August	18.3	24.7	57.0
	TOTAL	22.9	32.7	44.4

a. Figures given are the response as a percent of available data.

b. Data from St. John's have not been included in the figures given for the first question.

The responses to the three questions regarding training and speed are given in Table 12-11 for both traffic and non-traffic cases. A larger fraction of the traffic accident victims could be treated adequately by attendants who have received only the Red Cross training. Speed is important to a smaller fraction of the traffic accident victims.

When the questions are examined in combination, several paradoxical observations can be made. Speed to the hospital was indicated as necessary for 325 of the 1,018 patients included in Table 12-11. Highly trained attendants would be able to eliminate the need for fast transportation in 271 of the cases. However, only 87 of the 271 cases, or 32% required speedy arrival. There were 117 cases with a requirement for speed that could not be negated by highly trained attendants.

The apparent paradox is that 175 of the 271 cases that received a positive response to the question on 50-75 hour training did not require speedy transportation. This discrepancy can only be explained by assuming that the last question was answered "yes" whenever 50-75 hours training of the ambulance attendant were deemed sufficient to render speed unnecessary. The intent of the question was to identify those cases that required speed with existing training but would not if highly trained attendants were employed. The assumption suggested above is supported by the fact that Red Cross training was listed as sufficient for 162 of the 175 cases in which speed was not necessary.

The number of cases in which speed was necessary with existing competence, but might not be necessary if attendants were trained with 50 to 75 hours of instruction is then 87 out of the total of 1,018 cases or 8.5%. Of these 87, Red Cross training was marked sufficient for 41 and not sufficient for 75. It must be concluded that adequacy of Red Cross training was conditional on the achieved service time and that for the 75 cases Red Cross training was not adequate even with short service times.

The conclusions, or, more properly, inferences given above are based on second-and-third level interpretation of responses to questions 1, 3 and 5. They are given

TABLE 12-11

EMERGENCY ROOM RESPONSE TO QUESTIONS REGARDING TRAINING AND SPEED FOR TRAFFIC AND NON-TRAFFIC VICTIMS

	Traffic			Non-Traffic		
	Yes	No	N.A.	Yes	No	N.A.
Is American Red Cross First-Aid Standard Training sufficient and adequate for ambulance attendant to handle this case?	66.3	16.1	17.6	57.5	22.2	20.3
Was speedy arrival at the hospital of importance in this case?	27.2	59.8	13.0	34.1	54.5	11.4
Would highly trained ambulance attendants (with 50 to 75 hours of training by physicians) be in a position to cope with this case so as to eliminate the need for fast transportation.	28.5	28.5	43.0	25.8	33.4	40.9
Number of Cases		323			695	

because they justify what are otherwise apparent inconsistencies to these questions. They are valid only if care was exercised in answering each question with consideration of the interrelationship between them.

The responses to the five questions are repeated in Table 12-12, where they are listed for all patients except those DOA at the hospital, those DOA, and those that expired in the hospital (EIH). The data represent all emergency room forms while the response to Question 1 given in Table 12-9 did not include information from St. John's Hospital. St. John's data was included in Table 12-12 since that hospital received nearly 20% of the fatalities.

Administration of intravenous fluids at the scene could be accomplished by properly trained attendants although enabling legislation would be required in many states. Those who could benefit from IV's are primarily those with severe hypovolemic shock resulting from traumas, and some patients with myocardial infarction. Although severe burns may result in shock which could effectively be treated by IV fluids or whole blood, the shock does not develop rapidly enough to warrant IV's at the scene, unless the time from injury to professional medical care will exceed ½ to 1 hour.

The reviewing physicians indicated that intravenous fluid therapy initiated at the scene would have improved 88 (5.6%) of the patients who were not DOA. Since the four demonstration precincts contain approximately 38% of the population of the city, the number improved by IV's might be extrapolated to approximately 1,400 patients annually in the city. This is a substantial number of prospective recipients.

If those patients who expired in the hospital as well as the DOA patients are excluded, the condition of about 5% of the patients involved in non-fatal cases would have been improved by IV fluids.

The result from EIH cases is 36.4% or over seven times the proportion for non-fatalities. We can not, however, estimate the possible reduction in mortality that might result from this therapy.

The diagnoses of the 12 EIH patients who might have benefited from IV's are:

(1) Cardiac and G.I. Bleeding
(2) Multiple Contusions
(3) Diabetic Acidosis
(4) Fracture of Skull
(5) CVA
(6) Cirrhosis, Bleeding Esophagus
(7) Pulmonary Edema
(8) (9) Drug Ingestion
(10) (11) (12) Cardiac

TABLE 12-12

EMERGENCY ROOM RESPONSE TO QUESTIONS REGARDING TRAINING AND TREATMENT FATALITIES AND NON-FATALITIES

	PATIENT	YES	NO	NON-APL.	NO. PAT.*
Is American Red Cross First-Aid Standard Training sufficient and adequate for ambulance attendant to handle this case?	All Patients Exc. DOA	59.8	20.6	19.6	1579
	DOA	11.0	41.0	48.0	73
	EIH	27.3	60.6	12.1	33
Would an I.V. fluid, started on scene by properly trained personnel have improved patient's condition?	All Patients Exc. DOA	5.6	55.9	38.5	
	DOA	17.8	32.9	49.3	
	EIH	36.4	45.4	18.2	
Was speedy arrival at hospital of importance in this case?	All Patients Exc. DOA	27.9	58.8	13.3	
	DOA	31.5	21.9	46.6	
	EIH	78.8	21.2	0	
Would an endotracheal intubation on the scene by properly trained personnel have improved patient's condition?	All Patients Exc. DOA	1.7	56.7	41.5	
	DOA	23.9	31.0	45.1	
	EIH	18.2	60.6	21.2	
Would highly trained ambulance attendants (with 50 to 75 hours of training by physicians) be in a position to cope with this case so as to eliminate the need for fast transportation?	All Patients Exc. DOA	21.4	29.6	49.0	
	DOA	8.2	45.2	46.6	
	EIH	12.1	57.6	30.3	

*Number of patients without data missing on the Emergency Room Check Sheet.

While these diagnoses include several cases with problems not included in the list of primary problems that would require immediate IV fluids mentioned earlier, they are the diagnoses given in the emergency room and are not based on autopsy study.

Table 12-12 indicates that 17.8% of the patients DOA might have been improved by IV fluids, but the results for the DOA's must be regarded as very inconclusive. They would suggest that these patients might have been salvaged. Of the 96 DOA's conveyed in April and August, only 13 were evidently alive upon the arrival of the ambulance. An unidentified number were dead long before the arrival of the ambulance. If the judgment of the ambulance attendant is accepted, 13 out of 96, or roughly 13%, is the maximum number of prospective recipients; and this is undoubtedly a high estimate. These considerations are probably reflected in the emergency room data. Note that the affirmative responses to the questions on IV fluids, speedy arrival and highly trained attendants are lower for DOA's than for EIH. This is likely the result of a significant number of "hopeless" cases.

The benefit of providing intravenous fluid therapy at the scene is derived from the reduction of time from onset of illness or trauma to treatment. The fact that such treatment will precede transportation or other procedures is not significant. The value of this capability in rescue crews is directly related to elements of the medical emergency service time. Prior to the data collection, the hospital personnel were not informed of the typical service times in Detroit. Neither were the emergency room personnel completing the forms always informed on the temporal history of each case. Such fore-knowledge might have modified the responses.

The earliest any treatment could be initiated by a paramedic would be following the time of arrival of an ambulance at the scene. The time saved by treatment at the scene can be estimated by the time interval from arrival at the scene to arrival at the hospital which is equal to time on scene plus transit time to hospital. The empirical cumulative distribution of this time interval for the police, commercial ambulances and the fire rescue squad is shown in Figure 12-1. The time from dispatch to the arrival at the emergency room is shown in Figure 12-2.

FIGURE 12 - 1

DISTRIBUTION OF TIME FROM ARRIVAL AT SCENE TO ARRIVAL AT HOSPITAL

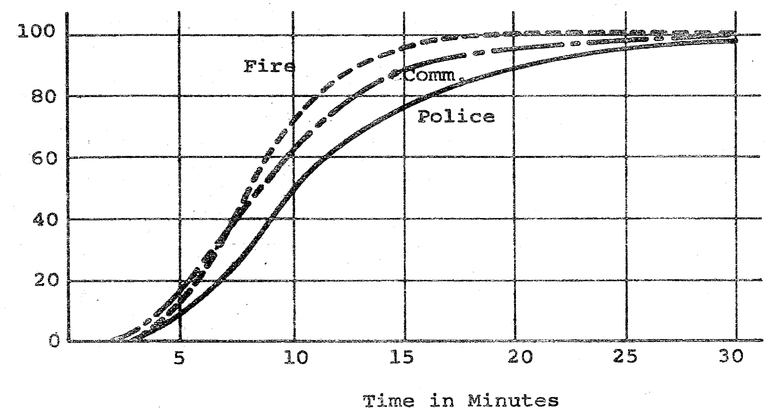
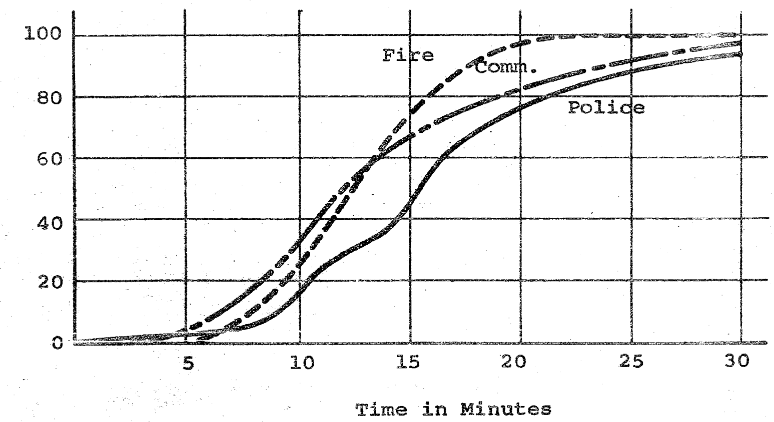


FIGURE 12 - 2

DISTRIBUTION OF TIME FROM DISPATCH TO ARRIVAL AT HOSPITAL



The mean time from arrival at the scene to arrival at the hospital is 9 to 13 minutes. This represents a typical reduction in time to treatment that might be achieved if paramedic attendants gave IV fluids. The earliest any responding agency is aware of an incident is an average of about 16 to 21 minutes before arrival at the emergency room.[4] If IV treatment at the scene is to be of value, the saving of about 10 minutes must be important.

The implications of the time elements obtained in the demonstration program to the administration of IV fluids were discussed with several members of the Medical Evaluation Team and with the Project Medical Consultant. While the responses were definite, they were not unanimous. Several members indicated that the treatment would be very valuable to many patients, even if started only 5 minutes before arrival at the hospital, but that the treatment should not be used by rescue personnel if the measure would result in an additional delay of 5 minutes. One of the physicians was of the opinion that such a capability would not be of general value in the city of Detroit. He could cite a recent case, however, in which an IV at the scene might have saved a life.

Evidently, physicians associated with emergency rooms in which IV therapy can be started very rapidly are inclined to believe that the added delay likely to be associated with treatment at the scene negates the value of such a capability in a large city with many emergency rooms. On the other hand, those physicians who have experienced some delay in triage, examination and treatment in the emergency room endorse the value of IV fluid therapy by paramedics.

The critical questions that must be answered before final evaluation of this attendant capability in an urban environment can be given relate not to the service time but to the time required for a properly trained attendant to reach the decision to administer fluids and initiate

[4]This was derived by adding a dispatch delay of 3 minutes to the data in Figure 12-11. See Section 10-1.

the treatment under field conditions. While military paramedics may start IV fluids in 2 to 3 minutes, a much longer time is often required in emergency rooms. The techniques to be used should also be investigated. For example, cutdowns may prove more appropriate under field conditions than more traditional methods even though they are not aseptic. If they can be started at the scene in 1 to 2 minutes or enroute to the hospitals, IV fluids may substantially improve the condition of a significant number of patients. This is particularly true of those cases which will not reach the hospital for 15 to 20 minutes. The rescue worker may be able to identify these cases before they leave the scene. It should be emphasized, however, that the time to start the treatment must include the time necessary to establish the need for fluids, reach the decision to administer them and unpack the equipment or kit.

In contrast to the response on intravenous fluid therapy, in only a very small percentage of the cases was a positive response given on endotracheal intubation (Table 12-12.) The positive response for all patients except DOA's was 1.7%. A much greater percentage was indicated for those who expired in the hospital (18.2%), and those who were DOA (23.9%). The positive response for all non-fatalities is less than 1.4% or only 21 patients.

There is reason to suspect that the number of patients who would have benefited from endotracheal intubation is lower than the result given above. As was mentioned regarding intravenous fluids, only 13% of the patients DOA at the hospital were evidently alive upon the arrival of the ambulance. Many of the remaining patients might have been effectively treated by strenuous mouth-to-mouth ventilation. Information on the aid rendered by the attendant is not available unless an ambulance form was collected. However, matching forms are available on 34 of the patients for which intubation was checked "yes." This is 75% of all patients receiving a positive indication for the technique. Of the 34 patients, only 18 had received any form of respiratory assistance other than clearing the airway. Oxygen was given to 14, and artificial respiration was given to 4. Oxygen alone, even under positive pressure, does not assure actual ventilation of the lungs. Mouth-to-mouth ventilation may be of much more value if partial or complete obstruction of the larynx or upper airway is present. This was attempted on 4 patients or less.

ATTACHMENTS

CHAPTER TWELVE

ATTACHMENT 12-A

Preceding page blank

APPLICATION OF FIRST-AID MEASURES
POLICE-ACADEMY TRAINING
(APRIL/AUGUST)

	Control Light Bleeding (C.L.B.)	Control Severe Bleeding	Guarantee Adequate Respir.	Splint Long Bones	Use of Backbd.	Cardio Pulmon. Resus.	Total (exclud. C.L.B.)
Percent of Cases Requiring Treatment*	33.0	10.8	6.4	6.3	1.1	2.9	5.3
Percent of Cases Req. Treatment in Which Treatment was:							
(1) Attempted, Outcome Unknown	0	2.6	13.0	0	25.0	0	5.2
(2) Attempted Successfully	22.8	43.6	21.7	8.7	25.0	0	26.0
(3) Attempted Unsuccessfully	0	7.7	13.0	4.3	0	42.9	10.4
(4) Attempted TOTAL	22.8	53.9	47.7	13.0	50.0	42.9	41.6
Not Attempted	77.2	46.1	52.3	87.0	50.0	57.1	58.4
Percent of Cases not Requiring Treatment in Which It was Attempted	0	3.7	1.2	0	0.6	0	0.4

*Based on a total of 361 patients.

APPLICATION OF FIRST-AID MEASURES
POLICE-ADVANCED TRAINING
(APRIL/AUGUST)

	Control Light Bleeding (C.L.B.	Control Severe Bleeding	Guarantee Adequate Respir.	Splint Long Bones	Use of Backbd.	Cardio Pulmon. Resus.	Total (exclud. C.L.B.)
Percent of Cases Requiring Treatment*	26.4	3.9	5.0	5.1	2.0	0.6	3.7
Percent of Cases Req. Treatment in Which Treatment was:							
(1) Attempted Outcome Unknown	0	16.7	0	0	0	0	6.9
(2) Attempted Successfully	28.1	66.7	37.5	37.5	0	0	3.8
(3) Attempted Unsuccessfully	0	16.7	0	0	0	0	3.8
(4) Attempted Total	38.1	100.0	37.5	37.5	0	0	46.0
Not Attempted	61.9	0	62.5	62.5	100.0	100.0	54.0
Percent of Cases Not Requiring Treatment in Which It Was Attempted	0	0.7	5.0	0.6	2.0	0	1.6

*Based on a total of 154 patients

ATTACHMENT 12-C

331

APPLICATION OF FIRST-AID MEASURES
POLICE-REFRESHER TRAINING
(APRIL/AUGUST)

	Control Light Bleeding (C.L.B.)	Control Severe Bleeding	Guarantee Adequate Respir.	Splint Long Bones	Use of Backbd.	Cardio Pulmon. Resus.	Total (exclud. C.L.B.)
Percent of Cases Requiring Treatment*	23.9	9.3	5.7	1.9	0	0	3.4
Percent of Cases Req. Treatment in Which Treatment was:							
(1) Attempted Outcome Unknown	0	20.0	0	0	0	0	11.1
(2) Attempted Successfully	12.0	40.0	33.3	0	0	0	33.3
(3) Attempted Unsuccessfully	0	10.0	0	0	0	0	5.6
(4) Attempted Total	12.0	70.0	33.3	0	0	0	50.0
Not Attempted	88.0	30.0	66.7	100.0	100.0	100.0	50.0
Percent of Cases Not Requiring Treatment in Which It Was Attempted	0	0	4.0	0	0	0	0.8

*Based on a total of 108 patients.

ATTACHMENT 12-B

330

ATTACHMENT 12-E

333

APPLICATION OF FIRST-AID MEASURES
FIRE RESCUE SQUADS
(APRIL/AUGUST)

	Control Light Bleeding (C.L.B.)	Control Severe Bleeding	Guarantee Adequate Respir.	Splint Long Bones	Use of Backbd.	Cardio Pulmon. Resus.	Total (exclud. C.L.B.)
Percent of Cases Requiring Treatment*	3.4	2.1	16.9	0.4	0.8	4.2	5.0
Percent of Cases Req. Treatment in Which Treatment Was:							
(1) Attempted Outcome Unknown	0	0	11.9	0	50.0	40.0	21.7
(2) Attempted Successfully	37.5	60.0	71.4	0	0	0	55.0
(3) Attempted Unsuccessfully	0	0	7.1	0	0	50.0	13.3
(4) Attempted Total	37.5	60.0	90.4	0	50.0	90.0	90.0
Not Attempted	62.5	40.0	9.6	100.0	50.0	10.0	10.0
Percent of Cases Not Requiring Treatment In Which It Was Attempted	0	0.4	66.0	0	1.3	5.3	13.4

*Based on a total of 238 patients.

ATTACHMENT 12-D

332

APPLICATION OF FIRST-AID MEASURES
COMMERCIAL AMBULANCE ATTENDANTS
(APRIL/AUGUST)

	Control Light Bleeding (C.L.B.)	Control Severe Bleeding	Guarantee Adequate Respir.	Splint Long Bones	Use of Backbd.	Cardio Pulmon. Resus.	Total (exclud. C.L.B)
Percent of Cases Requiring Treatment*	22.9	8.2	5.8	9.5	2.2	2.2	5.6
Percent of Cases Req. Treatment in Which Treatment Was:							
(1) Attempted Outcome Unknown	0	36.8	61.5	22.7	40.0	60.0	39.1
(2) Attempted Successfully	96.3	42.1	15.4	31.8	20.0	0	28.1
(3) Attempted Unsuccessfully	0	15.8	0	0	0	20.0	6.3
(4) Attempted Total	96.3	94.7	76.9	54.5	60.0	80.0	73.5
Not Attempted	3.7	5.3	23.1	45.5	40.0	20.0	26.5
Percent of Cases Not Requiring Treatment in Which It Was Attempted	0.5	8.5	4.3	1.4	2.7	0	3.3

*Based on a total of 231 patients

CHAPTER THIRTEEN

THE HELICOPTER-AMBULANCE DEMONSTRATION

Preceding page blank

CHAPTER THIRTEEN

THE H[illegible]ICOPTER-AMBULANCE DEMONSTRATION

The helicopter-ambulance demonstration was an integral part of the Detroit Emergency Medical Demonstration Project. However, it was an experiment clearly distinguishable from those involving the ground ambulances. While the air ambulance, operating throughout the city, could supplement the ground service being provided, it was a different method of transportation requiring additional arrangements for vehicle and hospital coordination. It was a method of medical transport with which Detroit lacked practical experience. Despite the fact that the U.S. Coast Guard had for some years made air rescues on nearby Lake St. Clair and that a commercial firm was supplying air-ambulance services in the outlying metropolitan area, the question of the feasible provision of helicopter-ambulance services in Detroit's completely urban environment could only be answered by actual demonstration.

Implementation of the helicopter-ambulance demonstration involved a primary mission in which the craft was dispatched while in flight for medical transport service during the city's peak traffic hours. After landing at the scene of an injury, a para-medic crewman provided treatment and the patient would then be transported to a hospital for further treatment. If the helicopter crew were the first to detect an injury-accident, they could choose either to land and carry out the primary mission or, if unable to land, report the incident for conveyance by ground ambulance. The secondary mission of the crew, while in flight, was to observe and report traffic conditions and tie-ups.

City personnel were responsible for the preparations required for the helicopter-ambulance demonstration. As already stated, the helicopter-ambulance was an innovation for the city of Detroit, and one of the first prepartory tasks dealt with obtaining authorization for landings within the city limits. A second task was to develop temporary landing sites, or "helistops," at

Preceding page blank

various hospitals so that patients could be transported by air to the emergency-room door. Other safety precautions were taken in anticipation of several problems that could arise. These preparations are further discussed in the first section of this chapter.

The operational phase of the helicopter demonstration is discussed in the second section of this chapter. The discussion includes a description of the helicopter and its scope of services, the equipment carried, the crew, the communication process, a narrative description of a typical operation and the various log systems established for documentation purposes. A brief description of the other tasks assigned to the helicopter is also included. Statistical data for the helicopter functions are included in the last section. Costs and benefits are discussed in Chapter 14.

13-1. THE PREPARATION PHASE

Changing Detroit's Ordinance

A helicopter landing on Detroit streets? The city ordinance prohibited it.[1] At the time the project began, it was unlawful for any person to land aircraft including helicopters, within the City of Detroit except at officially designated airports or heliports. Two additional exceptions were recognized: (1) a landing could be made with prior approval of the Detroit Aviation Commission, and (2) emergency landings (due by connotation, to mechanical failure) could also be made. Thus, it was necessary to have the ordinance changed so that medical emergency landings and evacuations would be authorized within the city limits.

The Director of the Detroit Aviation Commission was contacted to obtain his approval of the air-ambulance project. When this was received, an amendment to the

---

[1]Code of the City of Detroit, Chapter 4, Article 1, Section 4-1-6, "Emergency Landing of Helicopters." Background: The ordinance was first enacted in the early sixties after a pilot had landed a helicopter in a parking lot without authorization or precaution.

existing ordinance was drawn up with the assistance of legal counsel for the city. The change proposed would extend the meaning of the words "emergency landings" to include helicopter-ambulance rescues under the direction of, or through coordination with, the Police Department. The proposed amendment was approved by Common Council. The resultant ordinance permitting the air-ambulance experiment is included as Attachment 13-A.

The intent of the amendment also covers the transport of surgeons and specialists for emergency cases and any medical goods or aids necessary. The amendment was enacted almost a full five months before the project helicopter was put into the air.

Developing Hospital Helistops

Until the demonstration project began, hospitals in the city of Detroit did not have helipads or helistops. The second step in preparing for the helicopter demonstration was to develop landing sites at one or more Detroit emergency hospitals.

Although initial visits to selected hospitals in the demonstration area were concerned primarily with cooperation in the ground-ambulance demonstration, city personnel surveyed the hospital grounds beforehand to determine the availability of space for helicopter landings. In discussions with hospital administrators, the helicopter portion of the experiment was mentioned. Several of the hospital administrators accepted the concept of an air ambulance; they readily indicated that their future construction plans included helipads or roof-top landing sites. Other administrators reacted skeptically, mentioning the liability and noise problems. In general, there was an expressed reluctance to be the first Detroit hospital to establish even a temporary landing site.

Hospitals found to have space suitable for a helistop were visited a second time to obtain their participation in the helicopter portion of the experiment. A minimum project requirement of two helistops had been established: one located on the eastside and another on the westside were considered adequate to cover the city for the demonstration period.

The pilot and owner of the helicopter firm that participated in the project accompanied city personnel on these second visits. He explained Michigan regulations on developing a temporary landing site and provided other technical information. Administrators were still reluctant, however, because the landing site would require the reservation of space being used, in most instances, for parking or some other purpose. Two principal benefits for the hospitals were suggested as resulting from participation in the project: If the hospitals were considering development of helipads in the future, the demonstration air ambulance represented an opportunity--for a limited time period--to gain actual experience in their use and thereby better evaluate their worth. Secondly, the helicopter would also enable hospitals to more readily transfer patients for more definitive care if necessary. For example, a severly burned patient at one of the cooperating hospitals could be transported to a burn center some distance from the city. Special medical supplies, equipment or specialists could be flown in.

The goal of establishing two landing sites within the city was met and exceeded. Altogether, six hospitals with landing sites participated in the program. One of these was Botsford Hospital, which though located beyond the city's western limits, was included since it already had a helipad. It was, in fact, the only hospital at the start of the helicopter demonstration with a helipad ready to be used. Other hospitals, with the assistance of project staff, proceeded to develop sites. Saratoga Hospital on the east side made space available and ultimately used project funds to set up fencing. Shortly after the publicity attending the first evacuation--to Saratoga on May 2, 1969--several other hospitals indicated a desire to participate. Noteworthy among these were St. John Hospital (east side), which indicated immediate plans for fencing, paving and lighting of the landing area; Holy Cross Hospital (east side), which agreed to reserve a site on the adjacent grounds; and Mt. Carmel Hospital (west side), which cordoned off a parking area directly adjacent to their emergency room to provide one of the best situated landing sites. East and west side landing sites were now confirmed but at that time none were obtained in the central city, although a large proportion of trauma victims were normally transported to one of two hospitals in this area.

Considerable effort was given to developing a helistop at one or both of these hospitals. In the case of Detroit General Hospital, which is located at the edge of the central business district and is recognized as one of Detroit's major emergency care centers, space was simply not available. The possibility of using vacant urban renewal property nearby was investigated, but this was scheduled for construction during the demonstration period. Ultimately, permission was obtained to use the frontage of the Wayne State University Medical School which is two blocks from the hospital. Temporary fencing was erected there and the hospital's small corps of ambulance attendants were put on notice to transfer helicopter patients from the landing site to the emergency room. The second hospital, Henry Ford, has a multi-story parking structure which would have been ideal for a roof-top pad except that there was no way to transfer patients from the roof to the elevator on the floor below. A third central city hospital, St. Joseph's, had expressed a desire to participate in the helicopter portion of the demonstration. However, the proposed landing area, a basketball court behind the convent, was surrounded by trees and wires and was thus considered too hazardous for landings.

A list and a map of those hospitals with helistops can be found in Chapter 4, Figure 4-1. At the project's conclusion four hospitals continued to maintain landing sites: These were St. John, Detroit General, Saratoga and Botsford. The sites were not restricted to project use. A helistop was used, for example, by out-of-state physicians for picking up kidneys from a deceased Detroit patient for a transplant operation in Ohio. In addition, local Coast Guard officials expressed their intention to use the landing sites when necessary.

Safety Precautions for the Helicopter Demonstration

Because the helicopter would be landing on well-traveled streets, the depressed surface of the freeways, parking lots, playgrounds, vacant property, and a number of other possible sites, it was recognized that various safety procedures would have to be established prior to the demonstration. Certainly the helicopter could not land on major traffic arteries or the other places mentioned without traffic or crowd-control assistance on the ground. The task of providing such assistance was assigned to the Police Department because a ground crew of patrolmen were usually at the scene of an accident or could be dispatched there within a few minutes. Operationally this arrangement worked quite well.

At the outset, a memorandum describing the purpose and operation of the helicopter demonstration and detailing the assistance which ground patrol officers were expected to provide was circulated throughout the entire Police Department. (See Attachment 13-B.) The memorandum briefly defined acceptable landing sites, suggested methods of traffic control (including the mandatory stopping of traffic in both directions for expressway landings) and described the precautions necessary to keep onlookers from being injured or becoming a hinderance to the evacuation. Procedures were also outlined for conveying a helicopter crew member--a medic or police observer--to a rendezvous if he had to be left at the scene of the accident to make room for the patients evacuated. The memorandum instructions proved effective. A check of the records of traffic accidents for the days, times and vicinities of the landings produced no complaint of secondary accidents attributable to traffic back-ups caused by street or expressway landings.

The pilot was the only person who could determine whether a given landing was safe and feasible, and for this reason he alone was given the responsibility for this decision. For those cases in which a landing was not possible, reliance was placed on the ground vehicles. During the test, ground ambulances were dispatched to the scenes of injury accidents whenever the helicopter was unable to land.

Other preliminary preparations included several days of shakedown flights. At the same time, hospital landing sites were inspected, other potential landing sites checked and a refueling procedure at the City Airport established. The test flights also allowed the pilot time to familiarize himself with the police radio communication process and the precinct boundaries as seen from the air.

The Police Department supplied the crew of the helicopter with a series of precinct maps indexed with streets and addresses so that the pilot could pinpoint a specific home if necessary. Also during the preparatory flights, the pilot further studied the "flight pattern zone," an area within an approximate 2½ - mile radius of the airport in which special flight measures must be taken by all aircraft.

13-2. THE OPERATIONAL PHASE OF THE HELICOPTER DEMONSTRATION

The Helicopter and Its Scope of Service

As mentioned in Chapter 4, Superior Ambulance Company was awarded the contract for both the ground and air-ambulance service. The firm provided a medically equipped helicopter modified to carry patients, and a staff with considerable experience in injured patient air-transport. In addition it had available a second, similarly equipped helicopter for project flights in the event that the first helicopter had to be grounded for repairs. The firm's aircraft, experience and trained attendants were readily adaptable to the demonstration project.

The Helicopter: The helicopter used for the project was a Bell 47 J, which was modified to accomodate a maximum of two stretcher patients. Bubble doors were installed in place of standard ones to allow the stretchers to be set up laterally behind the pilot's position. At capacity the helicopter could carry three persons: the pilot and two patients; the pilot, an attendant and one patient; or--before picking up a patient--the pilot, an attendant and an observer. The seating arrangement was modified with the addition of an attendant's seat facing the stretcher area so that the attendant could treat patients while in flight. The remaining two seats were for the pilot and the observer. The observer's chair was easily detachable whenever the stretchers had to be used.

The Scope of Service: The air-ambulance demonstration flights began on April 22, 1969, and continued through October 17, 1969. (One additional flight was scheduled in November for a special project.) The contracting firm was responsible for providing a pilot and an attendant and for the maintenance of the craft and equipment. Although original plans called for flight hours Monday through Friday from 4:00 to 6:00 p.m., the time was extended to encompass the peak traffic period from 3:00 to 7:00 p.m. While 450 flight hours were planned as the minimum to be flown, a total of 487.2 hours were actually flown in 131 missions. A standby medical evacuation system was not included in the project in a formal sense because the air base of the firm was some twenty miles from the center of Detroit. Operationally, however, if air-ambulance service was needed outside the regular flight hours of the project, it could be arranged by phone in a relatively short time. Varying time schedules were also set to test the helicopter's in-flight capability during different times of the day, at night and on weekends.

Briefly described, the primary mission of the air-ambulance and its crew was to fly during the assigned hours, land at injury accidents where possible, and treat and transport the injured victims. The size of the transport work-load was random, depending on the occurrence of injury accidents within the assigned flight hours and on the feasibility of landing at the scenes. If the crew observed or was dispatched to an injury accident or where it was impossible to land, the situation was referred to ground units for transport. In addition to responding to medical emergencies, the crew of "Medic-5" (the communication code name for the unit) could report to the scene of a crime. The pilot could monitor police calls, and could choose to use the helicopter to provide air support or medical assistance.

The secondary mission of the helicopter was one of accident detection and traffic surveillance. During flight hours, traffic tie-ups and similar incidents were reported to the Police Communication Center for broadcast to the public in radio traffic reports. Tertiary missions were also assigned to the crew of the helicopter in order to test some of its other capabilities. These projects, for the most part, did not interfere with the primary mission and will be discussed later.

The Helicopter Medical Equipment

The medical equipment carried by the helicopter falls into two categories: (1) equipment carried for in-flight treatment and (2) two duplicate emergency kits for treatment at the scene of an accident. The in-flight kit was carried in the cabin while the duplicate emergency kits were carried in the luggage storage compartment of the helicopter. It should be noted that the Monopulse unit (including a cardioscope, pacemaker, and defibrillator) and the heart lung resuscitator could be placed in the helicopter cabin for patient care if requested in advance. This special equipment was ordinarily not carried for the project flights.

A complete list of the equipment carried can be found in Attachment 13-C.

Staff

Three helicopter pilots flew the medical missions during the Detroit project. Each pilot had received his training in the U.S. armed services, and two had flight experience in Viet Nam. Altogether, the men had over 13,500 hours of flight experience. Each of the pilots held commercial licenses as well as several other ratings. Each of the three pilots successfully completed landings and medical evacuations during the course of the project. It bears re-emphasis that the pilots had command control over the landings; and this, it would seem, contributed to the safe landings achieved in the city under varied and often trying circumstances.

The helicopter medic was permanently assigned to the helicopter and was the attendant on all project flights with few exceptions. His experience and background also were extensive. He had served in World War II and the Korean War as a medic first in the Marine Corps and then the Navy. For much of his eleven-year military career, he was a Chief Navy Hospital Corpsman. In his civilian career as a medic, he had over sixteen years of experience in industrial first-aid and in the ambulance business. Prior to the demonstration project, he had made over two hundred runs in the helicopter.

The third crew member of Medic-5 was a Motor Traffic Bureau police officer assigned as an observer at the request of the project staff. The decision to use the observer was based on experience during the first week of shake-down cruises. The officer performed several roles which contributed to the smooth execution of the helicopter demonstration. He was familiar with the city's streets as well as the police communication process. He could assist the pilot in pinpointing the location of accidents and in monitoring and decoding radio dispatches. Whenever a medical evacuation landing was necessary, the officer would assist in deploying the police ground units to the best advantage; and after the copter had landed, he would direct traffic or aid the medic in treating and loading the patient. After the patient had been secured in the helicopter, the police observer remained behind and helped the other patrolmen direct traffic. Once traffic flow was restored, he was driven to a rendezvous point to rejoin the helicopter crew. The police observer was also available to advise the pilot on other police missions which the crew might choose to assist. Occasionally, Police Communication Center personnel replaced the Motor Traffic Bureau officer for familiarization purposes.

The police observer performed several other functions. He was equipped with a camera to photograph the circumstances of medical pickups or any unusual occurrence. In keeping with normal police practice, the officer also kept a daily record of the various events occurring during flight hours. This record was quite useful for review purposes and as part of the documentation on which the analysis of the helicopter-ambulance's operation was based.

The Helicopter's Communication Process

The police radio equipment installed in the helicopter was the primary means for dispatching the crew of Medic-5 to injury accidents. This equipment was part of the larger radio network used for dispatching police resources. In a sense the dispatch of the helicopter was analogous to that of a police ambulwagon except that completion of an assignment depended upon the feasibility of landing.

The Communication Equipment: A hand-carried police PREP (Personal Radio Equipped Personnel) radio was installed in the cabin of the helicopter by police technicians. The radio unit was upgraded through several modifications: the addition of earphones to carry both police UHF and

aviation VHF transmissions and of lip mikes with noise canceling devices. An antenna secured to a landing brace completed the helicopter's radio communication package.

In addition to the police radio equipment, the pilot also had a public address unit which he used when he detected a traffic tie-up caused by an accident. Drivers with movable vehicles were directed to the shoulder of the road from the air. The public address system also enabled the Medic-5 crew to determine without landing if an injury had occurred by requesting hand signal information from bystanders. If, however, a police radio-equipped vehicle was on the scene, a communication link could be established by radio.

During the course of the project, experience indicated that an intercom system for the pilot, the medical attendant and the police observer was desirable. Technicians began work on installation, but this was not completed before the last of the demonstration flights.

The Radio's Capabilities: The helicopter's portable radio had both direct and indirect capabilities. The primary direct link was between the crew members and police officers at the Communication Center. This two-way communication capability was utilized to dispatch the helicopter or to report observations made in flight. The indirect capability was involved in helicopter communications with ground vehicles equipped with a police PREP radio. The pilot first had to designate a channel and report the designation through the trunkline to the police dispatcher, who would in turn notify the ground unit. Once the ground unit and the helicopter were on the same channel, a direct communication link was established. This air-to-ground communication capability enabled the helicopter crew to check on the extent of injuries and the need for a landing, and then to direct the ground forces in providing the necessary safety measures.

Indirectly, the helicopter crew could also report fires to the Fire Department. The information would be reported to the police dispatcher, who would relay it to the fire dispatcher by police phone. Similarly, hospitals could be indirectly notified of an incoming helicopter patient. Notification would be given the police dispatcher, who would in turn alert the hospital emergency room via police phone.

The helicopter's PREP radio also provided another indirect source of information in that it enabled the Medic-5 crew to monitor police city-wide and district dispatches. This capability provided flexibility; the pilot could choose to initiate a run himself whenever a ground vehicle was dispatched for medical conveyance or when he judged that he could provide air support at the scene of a crime. In responding to monitored calls, the crew remained prepared to provide medical assistance and to convey injury victims to the hospital.

Operational Sequence - An Example

The following is a description of an actual homicide case that occurred during the demonstration period. It describes the sequence of procedures typically followed by the Medic-5 crew in the twenty-three evacuations undertaken as part of the demonstration.

It was approximately 3:00 p.m. on August 20, 1969. The helicopter, with pilot and attendant aboard, landed at the usual rendezvous point, an open space next to the river in the Central Business District to pick-up the police observer before starting on its regular four-hour flight over the city. Once the officer was on board, the unit notified the police Dispatch Center that it was "in service." In the absence of a dispatch, the pilot navigated along the ribbon of freeway, reporting traffic conditions for public information radio broadcast.

At 3:15 p.m. the pilot used the helicopter's public address system to direct the occupants of a stalled vehicle to push it to the shoulder of the road, and he indicated that assistance was on the way. The directions were followed and traffic flow was re-established. Subsequently, the Medic-5 crew followed the Westbound Lodge Freeway, continuing normal surveillance and monitoring city-wide police calls.

At 3:45 p.m. with the craft at Six Mile Road in the northwest section of the city, a dispatch was received; a man had been stabbed and required immediate attention and conveyance to a hospital. The location was given as 12th Str[illegible] and Blaine in the central city, an estimated five or six air miles from the helicopter. Police vehicles were simultaneously dispatched to the scene to investigate.

Within four minutes the helicopter was circling the scene, a densely populated residential and small business area. Police officers were already there as well as a large gathering of people. In the next minute the pilot confirmed the injury report and requested the ground force to secure the landing area. It was indicated that the injured man was lying in the doorway of a small candy store. The landing site was a vacant lot kitty-corner from the store and about three hundred feet away. Telephone wires prohibited a street-landing closer to the building. The ground unit secured the area and the helicopter set down; the time was 3:50 p.m., five minutes from the time of dispatch. The attendant, with equipment bag in hand, hurried to the injured man.

The victim was bleeding profusely from three stab wounds in the back and was having difficulty breathing, which led the attendant to suspect that he was bleeding internally as well. The attendant quickly cleared the airway and tried to control the bleeding by packing the wounds with sponges. While completing the bandaging he intermittently tried artificial respiration to improve the patient's breathing. The pilot, in the meantime, notified Mt. Carmel Hospital to expect the patient and gave a description of the wounded man's condition.

Police officers helped the attendant carry the patient on a stretcher from the store entrance to the air-ambulance. The patient was secured on the litter and the attendant immediately rechecked the airways; as the helicopter took off, he was establishing resuscitation with a mechanical unit. It was now 4:00 p.m.; the total time at the scene had been ten minutes. The police observer was left at the scene and would later rendezvous with the Medic-5 crew at the hospital.

The flight to the hospital was direct and took five minutes. During the flight, the attendant continuously checked the patient's respiration and the resuscitating unit because he was still breathing with difficulty. According to the attendant's narrative, the patient's respiration stopped twenty to thirty seconds before landing at the hospital.

At 4:05 the helicopter landed at Mt. Carmel Hospital where the helistop is directly adjacent to the emergency room. Hospital personnel were on hand to transfer the victim into the emergency room without delay. Cardio-pulmonary resuscitation and defibrillation were immediately attempted but to no avail. The patient was pronounced legally dead from exsanguination approximately fifteen minutes later.

During the interval at the hospital, the pilot and the attendant completed forms on the conveyance. The police observer had rejoined the crew, and as Medic-5 resumed flight, the crew radioed back in service at 4:50 p.m.

Documentation For The Air-Ambulance

As was the case with the city vehicles in the demonstration, the helicopter-ambulance was a multi-purpose craft: it was used for emergency evacuation but also for traffic and accident observation, police work and occasionally for other purposes. Consequently, several sets of data were maintained for these functions. However, documentation of the emergency medical capability of the helicopter was a primary concern. The attendant on board the helicopter documented the treatment given on the ambulance attendant forms. Landings for medical evacuation were noted by the pilot. The information supplied by the latter, however, related primarily to the source of notification (i.e., whether the crew itself detected the accident or received a dispatch from the police), the circumstances of the landings made and the conditions and difficulties encountered during operations, particularly as affecting the feasibility of landing.

Other documentation pertained to the use of the helicopter for traffic reporting, police work, pollution control and other functions. As mentioned before, narratives on these activities as well as medical conveyances were maintained by the police observer when he was on board.

His Police Daily Activity Log sheets record the involvement of the helicopter in many diverse situations: reporting traffic conditions and resolving tie-ups, pursuing stolen vehicles and attending the scenes of reported bank robberies and other crimes.

City personnel also maintained a separate daily log of the helicopter's activity. The pilot was de-briefed each morning, when time permitted, so that pertinent items could be recorded and be immediately available for reference. The log was invaluable when information had to be quickly summarized or used for publicity. Furthermore, it served as a record of total flight hours.

Other Helicopter Projects

Early in the planning stages of the emergency medical demonstration project, it had become apparent that the helicopter-ambulance would have the capability of performing additional functions during what would otherwise be patrol periods without materially affecting its ability to perform as an emergency vehicle. Accordingly, various city agencies were asked to submit projects related to their duties where it was felt the helicopter could be effectively used. The result was the performance by the helicopter of a variety of supplementary tasks which made for a more cost-effective use of the resource and illustrated its value and versatility for a city. As indicated above, the tasks were performed in conjunction with projects or assignments in such areas as traffic safety, police work and air pollution control. Use of the helicopter for these additional tasks, of course, necessitated that its flight schedule be planned in advance. Coordination between the city and the ambulance firm enabled the pilot to be notified of any additional task usually a week in advance. Each of these tasks is separately discussed below.

Traffic Safety Related Tasks: In recognition of the traffic safety problems posed by holiday weekend traffic, it was arranged by project staff to have the helicopter in operation during the peak traffic hours of the Memorial Day, Fourth of July and Labor Day weekends. Special events at these times, such as the Memorial Day Parade, the Fourth of July Freedom Festival (jointly celebrated by some 500,000 Detroiters and Canadians in Downtown

Detroit with a fire works display) and the State Fair, which is held during the Labor Day weekend, have complicated holiday traffic problems in past years. The purpose of the helicopter flights during these periods was to observe traffic and issue reports for public information and to monitor special event activities. The information obtained enabled police to re-route traffic around congested areas. When the helicopter crew reported an area to be clear, normal traffic flow was re-established.

Another traffic task for the helicopter was to assist in an experiment being conducted by The University of Michigan's Highway Safety Research Institute and involving the measurement of rush-hour traffic flow on the expressway and the notification of drivers of alternative routes. The helicopter was used to study, survey and video-tape traffic densities on a specific section of the John C. Lodge Freeway. Already installed on the section were traffic sensing devices which triggered ramp meters and alternative route signs whenever traffic became too dense for proper flow. Observation and films made from the helicopter aided traffic engineers in operating and testing the metering devices and the alternative route signs. The engineers also used the film to assess the effect of the increased traffic on the surface streets designated as alternate routes.

The City of Detroit's Department of Streets and Traffic also made use of the helicopter for aerial observation and photography in several of its traffic engineering studies. These studies included:

1. A study of traffic re-routing during closure of the Edsel Ford Freeway.

2. A study of freeway lane closure during peak traffic hours.

3. A survey of street segments or intersections having unusual geometric characteristics.

4. A study of crowd movements and parking practices in conjunction with a major sporting event at Tiger Stadium.

A complete description of these projects and their results is included as Attachment 13-D. It should be noted that the helicopter was not fitted as an ambulance when it was assigned for these four projects.

For several years Detroit officials have considered the possibilities of establishing a rapid transit system. At the time of the Emergency Medical Demonstration project, city officials were weighing the merit of purchasing the monorail system used at the Canadian EXPO Exhibition. When Montreal transit experts visited Detroit, the helicopter was put into service so that city and Canadian transportation experts could inspect from the air the various street corridors on which the monorail could be established in the city.

Police-Related Helicopter Uses: As indicated earlier, the pilot of the helicopter had the option to respond to police calls which he was monitoring; he could also be dispatched for medical and non-medical police cases. Directly and indirectly the helicopter became involved in several police cases during project flight hours. These cases included bank robbery alarms, automobile thefts, and crowd control situations. To illustrate the last case, the helicopter was dispatched to assist the police in controlling several large bands of roving teenagers who had gathered during the State Fair festivities. The groups had reportedly been vandalizing residential areas near the fair grounds. The helicopter was used as an observation-communications platform to coordinate police ground activities in dispersing the groups. It was used similarly for other public demonstrations.

In another instance Medic-5 was instrumental in breaking an abortion ring. As part of a coordinated police effort, the pilot picked up and delivered a warrant to the scene of the reported abortion, a motel in the outlying area of the city. As police officers on the scene served the warrant and made arrests, the Medic-5 crew were on standby to provide medical assistance and transport for the patient if necessary. The arrests were successfully made, but the ambulance service was not needed.

The Police Department's Research and Development Bureau also conducted tests of the visibility of various roof-top marking materials for identifying police cars. The roof-tops of several police vehicles were marked with different kinds of tape materials and their visibility was tested at night. A red reflection tape proved the most effective; visibility was rated as good for distances of four to six hundred feet in areas with street lighting. The pilot could use a police car's identification number to request the dispatcher to establish a channel for direct communication between the helicopter and the ground vehicle.

Police projects were not confined to the Detroit Police Department. During the course of the demonstration, the Wayne County Sheriff's Office requested helicopter assistance in the search for the body of a drowned fisherman. The man reportedly had drowned two weeks earlier and it was thought that the body was hidden by marshes in the downriver area. The helicopter completed, in less than two hours a search that would have been difficult to accomplish by any other means. The body, however, was not found.

Air Pollution Control Uses: The Air Pollution and Control Division of the Wayne County Department of Health also requested the use of the helicopter for a small number of flight hours for two air pollution control projects. The first project involved using the helicopter to fly over pollution emission sources so that a technician on board could gather samples of particulate matter at various altitudes over a limited area. The second project involved aerial photography of an industrial corridor running from Detroit to the outlying county area downriver. The tests proved quite successful and the technicians rated the helicopter much superior to a fixed-wing craft for their purposes.

Other Uses: Other projects in which the helicopter was used were incidental and chiefly photographic in nature. Various photographs of the city's renewal areas and central business district were taken during flight hours for urban planning purposes. Incidental publicity uses were found for much of the material developed. Although there were several requests for passenger transport, these were denied because they were outside the scope of the project.

13-3. DATA COLLECTION

The helicopter flight program started on April 22, 1969 and lasted through October 17, 1969. From April 22 until September 22, flight hours were from 1500 to 1900 hours on all weekdays except for specific weekend flights as noted earlier. After September 22, flights were scheduled only on Fridays from 1500 to 1700 and from 2300 to 0300 hours, thus providing night experience.

Preliminary plans for the helicopter demonstration included both precinct patrol and city-wide service. While the commercial ambulances were operating in Precinct 7 in April and in Precinct 16 during the August data-collection period, the helicopter was to operate on patrol in each of the two precincts. The service times achieved by the helicopter were to be compared directly with corresponding elements of the land vehicle service process by dispatching both units-ground and air-simultaneously.

The helicopter did not commence operation until April 22, allowing only seven days of operation in Precinct 7 before the contract ground ambulances were moved to Precinct 16. Furthermore, Precinct 7 is partially in the control zone of Detroit City Airport, which prevents uninterrupted operation in the precinct. Consequently, the helicopter was assigned to city-wide patrol. During the early weeks of the operation, it became evident that utilization for medical emergencies would be low, that dispatches would be comparatively infrequent and that patrol restricted to a precinct would severly limit the collection of experimental data.[2] The helicopter program was then modified to delete single precinct patrol. It also became evident early in the program that if the helicopter was kept on standby, the ground units would effectively compete and the helicopter might never be requested to actually land and convey. Therefore a patrol flight profile was used for the remainder of the project.

The documentation of the helicopter patrol missions and

[2]The problems relating to frequent dispatch of the helicopter are described in section 7-3.

evacuations is described in Chapter 6. The attendant used the Ambulance Attendant's check sheet shown in Figure 6-4 for providing information on each emergency medical rescue flight. Operational information was provided by the pilot on the Helicopter check sheet shown in Figure 6-6. The latter form was also used for all dispatches by Police Traffic Central for non-medical incidents. These included traffic checks, bank alarms, crowd control assignments, etc. The form was also completed for all incidents, such as fires or traffic accidents, detected and reported by the flight crew. Reports of stalled cars were usually recorded on the back of the form.

A total of 286 of the Helicopter check sheets were collected during the demonstration. While twenty-seven landings were successfully accomplished in the city, only twenty-three resulted in patient evacuations. Air evacuation was not used in the other four cases although the helicopter landed in each case.

The data obtained from the patrol flights will be discussed in the following sections.

DATA ANALYSES

Service Time

Statistics of the service time elements associated with the twenty-three evacuations are shown in Table 13-1. These elements are all equivalent to those of the land vehicles discussed in Chapter 10. Also shown in the table are comparable figures for the 227 conveyances by police ambulwagons during the same hours in April and August. The distances that were flown (based on straight line map measurement) are shown in Table 13-2.

The time to the scene is the time from receipt of the radio call to time of landing and includes any time spent hovering over the landing area while awaiting clearance from officers on the ground. The time to the hospital similarly includes any delay in takeoff or landing. Actual flying time between points is given by the flight time.

TABLE 13-1

STATISTICS OF TWENTY-THREE AIR EVACUATIONS

	Helicopter		Police (1500-1900 Hr.)	
	Mean (min.)	Variance ($min.^2$)	Mean (min.)	Variance ($min.^2$)
Time to Scene	4.9	8.8	4.7	7.5
Time at Scene	7.8	14.5	5.6	40.3
Time to Hospital	3.4	1.4	8.0	24.4
Time at Hospital	20.9			
Total Service Time	37.0			
Flight Time to Scene	4.0			
Flight Time to Hospital	3.4			
Total Flight Time	7.4			
Dispatch to Arrival at Hospital	16.1	24.6	18.3	72.2

TABLE 13-2

HELICOPTER FLIGHT DISTANCE FOR TWENTY-THREE AIR EVACUATIONS

	Mean (st. mi.)	Minimum	Maximum
Distance to Scene	3.9	0	11.0
Distance to Hospital	4.3	0.8	7.0

The area of operation of the helicopter was the entire city of 140 square miles. The police ambulwagons operated in precincts with an average area of fourteen square miles.

Four elements of the helicopter service process can be compared with figures for the police in Table 13-1. If the standard t-test is used to test the significance of the differences, the results for the time at the scene, the time to the hospital and the time from dispatch to arrival at the hospital are all significant to the 5% confidence level. However, the t-test assumed the variances of the parent populations are equal. But there are no observations or basic mechanisms of the process that would suggest the variances should be equal in these cases. If the sample variances are used as consistent estimators of the population variances, the sample means are asymptotically normal,[3] the differences in the means may be tested by the normal distribution. Then the only difference that is significant at the 5% level is the time to the hospital. Both tests have limitations for the present application. In any case the significance is weak except for the time to the hospital. Nevertheless, several conclusions are justified.

The time to the hospital is less for the helicopter even though only four helistops were available. On the other hand, the helicopter spent longer at the scene than the ambulwagons, while the resulting times from dispatch to arrival at the hospital were comparable. The longer time spent at the scene by the helicopter may have resulted from the more thorough examination and care given by the paramedic attendant.

This would suggest a bias in favor of the land vehicle. The time on the scene may also be characteristic of the transportation mode. In general the helicopter cannot approach the patient as closely as the land vehicle so he must be carried further on foot. In addition, more time is required to load and secure the patient and get into motion.

Three elements of the service process are particularly important. The time to the scene is a measure of the minimum time before treatment can be provided by an attendant. The time from dispatch to arrival at the hospital is the delay associated with the response system before definitive treatment can be provided. Lastly, the total vehicle service time determines the total patient load that can be serviced by a single vehicle and is closely associated with the system performance indicators to which Chapter 11 is addressed.

[3]The second condition is a form of the Central Limit Theorem.

The results given in Table 13-1 indicate that the times to the scene are not greatly different for the police and the helicopter. The mean difference (0.2 min.) is not significant in either a statistical or pragmatic sense. The total vehicle service times and the time from dispatch to arrival at the hospital are compared with all police conveyances and with those of the commercial ambulances and fire rescue squads in Table 13-3.

TABLE 13-3

VEHICLE SERVICE TIMES

	Police	Commercial Ambulances	Fire Rescue Squads	Helicopter
Total Vehicle Service Time	33.3	27.8	18.4	37.0
Dispatch to Arrival at Hospital	17.5	14.3	13.1	16.1

The results for the air evacuations are similar to those for the police ambulwagons. Thus a helicopter operating in Detroit with the present mix of emergency rooms and helistops cannot service a greater load than a single surface vehicle.

The situation would be quite different in cities that serve all emergencies with a small number of emergency rooms, or those that use specialized trauma centers. Then the land vehicles would have to travel a much greater distance to the hospital and the helicopter could offer significant time advantages which were not evident in Detroit. The helicopter might also have a greater relative advantage when the surface conditions preclude efficient land transportation, for instance, following heavy snowfall or severe ice storms. Although the demonstration flight program was confined to summer months, automobile travel is restricted by these conditions on only a few days per year in Detroit.

TABLE 13-4

INJURIES OF HELICOPTER PATIENTS

INJURY TYPE \ BODY AREA INJURED	HEAD	FACE	NECK	THORAX	SPINE	ABDOMEN	PELVIS	UPPER EXTREMITIES	LOWER EXTREMITIES
Fracture	2	2			1		1		7
Sprain/Strain/ Dislocation									4
Traumatic Amputation									
Contusion/Crushing	8	5		1			2	5	6
Laceration	5	4		1		1			
Concussion	4								1
Internal	1		1	2	1	6			1
Burn									
Asphyxiation									
Drowning									
Poisoning									
Electrocution									
Other									

Treatment and Injuries

The injuries of the twenty-three patients conveyed by helicopter are shown in Table 13-4. The data is from the ambulance attendant's forms. Since only five of the air evacuations occurred in August (none in April), emergency room forms are available for only nine patients.

The first aid given by the attendant and the condition of the patients upon the arrival of the helicopter are given in Table 13-5.

The helicopter attendant was a paramedic with much more experience than other attendants in the project. He examined patients at the scene much more thoroughly and provided indicated or precautionary first-aid more reliably than others.

TABLE 13-5

ACTION BY HELICOPTER ATTENDANT AND CONDITION OF PATIENT

I. Action or First-Aid	
Removal From Vehicle	5
Cleared Airway	2
Control Light Bleeding	6
Control Heavy Bleeding	3
Administer Oxygen	2
Bandaging	8
Splinting Limbs	4
Neck/Spine Immobilization	3
Artificial Respiration	2
Cardiac Massage	1
II. Condition of Victim	
Conscious	20
Incoherent	4
Apparent Death Before Arrival	1
Apparent Death After Arrival	1

Most of the patients were not seriously injured. There were a few exceptions, however. Note that one patient died before arrival of the ambulance. The victim was the driver of a car involved in a rear-end collision who may have died before the accident. The condition of the patient upon arrival of the attendant suggested a possible coronary. Cardiopulmonary resuscitation was attempted at the scene without success. One patient died during flight. This was the stabbing case which has been described in detail.

The use of the helicopter can not be related directly to mortality in any of the cases conveyed. The two fatalities are mentioned above. It is not clear that either patient could have been salvaged by alternative treatment or transportation. One other case involved life-threatening injuries. A 51 year old female victim of a traffic accident suffered fractures of the femur and tibia, lacerations of the head, loss of memory, and rupture of the urinary bladder. The patient was conveyed to Detroit General Hospital which provided the diagnosis given above. The project medical consultant at the hospital indicated that fatal exsanguination might have resulted if conveyance had been delayed. However, it is not evident that transportation by land vehicles would have been incompatible with survival.

Evacuation by helicopter was not refused by any patient per se. One patient requested transportation to a hospital which did not have a helistop, and was then conveyed by land vehicle. Three other landings did not result in evacuation by helicopter. The first dispatch of the helicopter during the demonstration was for transfer of a patient from Herman Kiefer Hospital to Detroit General. The case was reported to the Police Communication Center as a critical poisoning and the helicopter was dispatched immediately. Upon arrival the attendant found the patient was not in serious condition, but was a combative psycho. The attendant declined transportation and the patient was conveyed in the police ambulwagon that had furnished ground support for the landing. The other two instances resulted from operational considerations. A child who had received minor injuries in a pedestrian accident was transported by an ambulwagon when it became evident that take-off would be delayed by a crowd around the helicopter. In the fourth instance, the helicopter had to land two blocks from the scene of an accident because of wires, trees and buildings. Two patients were conveyed by land vehicles before the crew reached the scene on foot.

Operational Capability

During the demonstration program the helicopter successfully landed on expressways, surface streets, and in off-street areas. On a single Friday afternoon two landings were accomplished on Woodward Avenue, a main thoroughfare in the central business district, during afternoon rush-hour traffic.

The location of incidents and general landing points for the twenty-three air evacuations are shown in Table 13-6. The average distance from the landing site to the patient location is given in Table 13-7.

TABLE 13-6

SUCCESSFUL HELICOPTER EVACUATIONS

Type of Incident	Location of Landing	Number
Expressway Accidents		8
	On expressways	8
	Off expressways	0
Surface Street Accidents		10
	On street	6
	Off street	4
Non-Traffic Accidents		5
	On Street	3
	Off Street	2

TABLE 13-7

AVERAGE DISTANCE FROM LANDING SITE TO PATIENT

Incident	Average Distance (ft.)
Traffic Accidents	
Expressway	86
Surface Street	212
Other	168
TOTAL	158

The average distance for the ten accidents on surface streets is high because one landing was in a park 200 yards from the accident. Without that single case the average would have been 170 feet rather than 212.

In addition to the landings which resulted in conveyances, four were accomplished without subsequent air evacuation.

Two of these were on surface streets and two were off-street landings. Thus a total of eight landings were made on expressways, eleven on surface streets, and eight off-street.

The helicopter was dispatched to ten incidents for which a landing was desirable but could not be made. The problems encountered are given in Table 13-8. In seven of th 10 cases a suitable landing site was noted one to four blo ks from the scene. Thus, landings were desirable at thirty-seven of the locations to which the helicopter was dispatched, and were successfully accomplished at twenty-seven of these or 73%. Ground support for traffic and crowd control was available in each case. The only information the police officers who provided the ground support were given prior to the flight program was the notice which is Attachment 13-B.

TABLE 13-8

LANDING DESIRABLE BUT NOT SUCCESSFUL

No clear area because of:	
Trees and wires	1
Trees, wires, buildings	9
TOTAL	10
Number of above at which man could have been lowered	9
Number which would not have been possible with trained ground controller	10

While more information would certainly be desirable and feasible in an operational system, it should be noted that the landing capability in an urban environment would not have increased even with the assistance of trained

ground controllers.[4]

The helicopter was dispatched to many locations at which emergency medical aid was not necessary and therefore a landing was not attempted. In each case the pilot provided his personal assessment of the feasibility of landing. Thirty-six of the incidents were located on surface streets, and the pilot judged that a landing was possible at thirty-five. He also indicated a landing was possible at ninety-one of the ninety-seven expressway incidents to which he was dispatched. The total at which he could have landed is then 95%. This figure is based on subjective judgment and may not be as reliable as the result based on actual landing attempts.

Non-Medical Patrol Utilization

While the helicopter was on emergency medical patrol under the operational control of the Police Department, it could be used for other functions compatible with the patrol and the ambulance configuration. A summary of the utilization is given in Table 13-9.

TABLE 13-9

HELICOPTER UTILIZATION

Action	Number of cases
Report stalled car	239
Medical conveyances	23
Dispatched to accident, no conveyance	46
Detected accident, no conveyance	85
Detected accident, conveyed injured	1
Used PA system	8
Dispatched to fires	8
Detected fires	10
Law enforcement related functions	102

[4]This statement is based on the 37 landings attempted during the demonstration, admittedly a limited sample, but representative of urban conditions.

The medical conveyances were discussed in previous sections. The accidents to which the helicopter was dispatched but resulted in no conveyance (by helicopter) were largely minor accidents with no injury or with minor injuries that did not require emergency evacuation. Officers on the scene usually indicated assistance was not required. Occasionally the PA system was used to inquire if assistance was needed. In no case was a PA inquiry answered affirmatively. However, the PA system did prove effective; both for inquiries and for instructing drivers to move disabled cars out of traffic lanes.

The flight crew detected ten fires while on patrol (all minor) and reported them to the Fire Department through the Traffic Central operator. On eight occasions the helicopter was dispatched to fires. In the first case, the crew was asked to report on traffic conditions in the vicinity, and to assist in locating a group of people harassing firemen by throwing objects. On two occasions they were asked to provide reconnaissance at general alarms at Detroit General Hospital. Nothing was seen in either case. The other dispatches to fires were to provide general reconnaissance and to report on traffic conditions and clear routes in the vicinity of the fire.

The functions related to law enforcement were both incidents to which the helicopter was dispatched, and incidents to which response was self initiated upon monitoring police radio traffic. The cases are listed in Table 13-10.

In none of the cases of crime (bank alarm, robbery, chase, shooting, etc.) were members of the crew able to make visual contact with suspects. The self-initiated response was started because police utilization was low and the crew wanted to provide more assistance.

TABLE 13-10

LAW ENFORCEMENT UTILIZATION

	Incident	Number
Dispatched	Traffic checks	4
	Robbery	4
	Bank alarm	5
	Assist in chase or search	5
	Assist in crowd control	4
	Miscellaneous	5
	TOTAL	57
Monitored radio and responded	Bank alarm	23
	Robbery	11
	Chase	2
	Accident	3
	Shooting	3
	Miscellaneous	3
	TOTAL	45

ATTACHMENTS

CHAPTER THIRTEEN

ATTACHMENT 13-A

ORDINANCE NO. 386-G
CHAPTER 4
ARTICLE 1
EMERGENCY HELICOPTER LANDINGS

AN ORDINANCE to amend Chapter 4, Article 1 of the Code of the City of Detroit by amending Section 4-1-6, to provide for emergency helicopter landings.

IT IS HEREBY ORDAINED BY THE PEOPLE OF THE CITY OF DETROIT:

Section 1. That Chapter 4, Article 1 of the Code of the City of Detroit be amended by amending Section 4-1-6, to read as follows:

Sec. 4-1-6. It shall be unlawful for any person to land any aircraft, including helicopters and lighter-than air craft, within the city at any point, except officially designated airports or heliports, without first obtaining the approval of the Detroit Aviation Commission; provided, that the prohibition of this section shall not apply to emergency landings or to ambulance equipped helicopters as dispatched by or through authorized police personnel operating as part of a coordinated ground air rescue mission.

Section 2. All ordinances or parts of ordinances in conflict herewith are hereby repealed only to the extent necessary to give this ordinance full force and effect.

(JCC p. 2561, October 22, 1968)
Passed October 29, 1968.
Approved November 1, 1968.
Published November 6, 7, 8, 1968.
Effective December 1, 1968.

THOMAS D. LEADBETTER
City Clerk

Preceding page blank

ATTACHMENT 13-B

DETROIT POLICE DEPARTMENT
Office of the Deputy Superintendent

Notation No. 1891
May 14, 1969

TO ALL MEMBERS OF THE DEPARTMENT:

Subject: Functions of "Medic-5" (helicopter)

The Detroit Police Department, in conjunction with Superior Ambulance Company, is currently involved in the part-time use of a helicopter as a flying ambulance. This study which is financed entirely through a grant from the Federal Department of Transportation and is being conducted by the Mayor's Community Renewal Project and the University of Michigan's Highway Safety Research Institute will be in operation through August, 1969. Presently, "Medic-5" is operating from 3:00 p.m. to 7:00 p.m. for air rescue and traffic control, Monday thru Friday.

Urban physical obstructions will restrict the demonstration of the helicopter-ambulance primarily to:

1. Limited rescue of accident victims

2. Traffic control

AREA OF OPERATION

1. Helicopter unit will range city-wide, ordinarily following a freeway route during rush traffic hours.

2. Committed to any area by dispatcher to perform a defined investigative mission.

PERSONNEL

1. Pilot

2. Para-medic or attendant

3. Police observer

Preceding page blank

Notation No. 1891
May 14, 1969

RADIO EQUIPMENT AND SYSTEMS

1. Equipped with a PREP radio capable of operating on both the City-Wide "A" (red color coding) and "B" (white color coding) channels.

   A. Normally the pilot and observer will monitor the "A" channel, but may switch to "B" channel upon direction of Traffic Central so as to communicate with the ground unit.

2. Ambulance company frequency

HOSPITALS PRESENTLY EQUIPPED WITH HELICOPTER LANDING SITES

1.	Botsford General	(Grand River & Middlebelt)
2.	Holy Cross	(E. Outer Drive, East of Van Dyke)
3.	Mount Carmel	(W. Outer Drive, Schaefer)
4.	Saratoga	(Gration & Rossini)
5.	St. John	(Moross & Chandler Park Drive)
6.	Detroit General	(Near Wayne State Medical School where a city ambulance will be dispatched to handle the victims)

When dispatched to a scene to meet "Medic-5" (Helicopter) officers shall observe the following procedures. (During the hours stated, officers may request helicopter assistance via radio.)

1. Enroute to scene, listen for radio instructions.

   A. May be dispatched for reasons other than injured victims.

2. When equipped with PREP radio*

   A. Dispatcher may direct ground unit to switch channels so as to communicate with the pilot. i.e., 16-5, switch to F-2 ON (refer to radio equipment and systems).

3. Prepare landing site

   A. An area of 80' square is needed to effect a helistop.

   B. On the freeway, ground unit will stop traffic in both directions.

   C. Effect crowd control.

4. Should the observer and/or medic remain at the scene, they will obtain transportation from a ground unit originally dispatched to a rendezvous point determined by the pilot.

*If ground unit is not PREP equipped, they will be instructed by the pilot via helicopter PA system.

The pilot has requested that the following rules be observed and enforced by all persons involved in helicopter operations. It should be emphasized that the rotors cannot be stopped rapidly and are not high enough to insure clearance of pedestrians.

1. Never approach or depart helicopter from the rear without receiving signal from pilot.

2. Always approach with extreme caution while the main rotor blades are in motion.

3. Do not carry litters in a vertical position. They may hit the main rotor blades.

4. Due to the turbulance caused by the main rotor blades, do not leave any unsecured equipment lying in the area while helicopter is landing or taking off, such as blankets, etc.

5. Keep sightseers well clear of helicopter at all times, especially clear of tail rotor. This is a blind spot for the pilot.

Due to the city-wide range of the helicotper, officers may at times be called upon to assist this unit; therefore, all ers will familiarize themselves with the above procedures.

CHARLES H. GENTRY
Deputy Superintendent

HELICOPTER MEDICAL EQUIPMENT

In/flight Equipment	Ground Emergency Kit
Airway Equipment	
Adult and child resuscitation airways	additional set of four
Tubing (various sizes)	
Suction unit, battery operated	
Resusci-bag	
Demand valve resuscitator	
Oxygen masks (assorted sizes)	
Oxygen bottle, "D" size with shoulder case and wrenches	replacement cylinder
Tongue forceps	additional set
Tracheotomy kit	
Bandaging Equipment	
	Large roller type
Gauze pads (assorted sizes)	Gauze pads (assorted sizes)
	Compress type dressings
Tape (assorted sizes)	Tape (assorted sizes)
	Tourniquet
Bandage shears	Bandage shears
	Antiseptic spray
	Padded eye shields
Splinting	
Spine board - long	Spine board - short
	Cervical collars
	Inflatable leg splints
	Inflatable arm splints
	Triangular bandages with safety pins
	Elastic bandages (assorted sizes)

Other	
Carrying kit, clear plastic, with pockets attached to cabin wall	
Hypo needles and syringes	
Flashlight	Penlight
Emesis basin	
Blankets	1 spare
Pillows and pillow cases	
Hand towels	
Pole litter and disposable covers	Additional covers
Sphygmomanometer	
Stethoscope	Emergency surgical instrument set Sterile distilled water Spirits of ammonia

When requested:

1. Monopulse 807 B, cardioscope, pacemaker and defibrillator
2. Heart lung resuscitator

ATTACHMENT 13-D

City of Detroit
Department of Streets and Traffic

USE OF A HELICOPTER IN TRAFFIC ENGINEERING STUDIES

The City of Detroit Department of Streets and Traffic submitted a list of possible projects related to traffic engineering covering the following study areas:

1. Analysis of high accident intersections.
2. Traffic flow studies along selected routes.
3. Surveillance and evaluation of traffic maintenance requirements on construction projects.
4. Observation and evaluation of traffic re-routing around construction and maintenance areas.
5. Surveillance of traffic during peak traffic hours.

While it was not possible to conduct studies covering all the study areas described above, the following is a description and evaluation of four studies conducted using the project helicopter:

I. <u>A study of re-routing of traffic during the closure of the eastbound Edsel Ford Freeway between Wyoming Avenue and Livernois Avenue</u>.

The purpose of this study was to determine the effect of a freeway closure on the surrounding street system and to evaluate the effectiveness of traffic control procedures used to establish an alternative surface street route for traffic diverted from the freeway. It was also proposed to study the feasibility of dispatching police control personnel on the basis of need as determined by a police observer in the helicopter.

The freeway was closed between the hours of 10:00 p.m. July 16 and 5:00 a.m. July 17, 1969. Helicopter observations were made from one-half hour before closure to three hours after closure.

y personnel included, in addition to the pilot, a Senior fic Investigator and a Police Motor Traffic Bureau patrolman he helicopter, and two special project traffic investigators ground vehicle.

study design required that both the helicopter and the nd vehicle follow the prescribed detour route making obser- ons at pre-determined checkpoints along the route. During flight, the personnel in the helicopter observed other ets in the area of the detour route and recorded any unusual rrences which could be attributed to the freeway closure.

btain a quantitative comparison between the helicopter and nd vehicle, time checks were made by the observers and the l time to travel the length of the detour route was recorded. as found that the ground vehicle required approximately 17 tes to traverse the detour during heavy traffic periods and inutes during light traffic. The distance on the ground approximately 4 1/2 miles. The helicopter could observe same route in approximately 4 minutes, independent of detour fic. The air distance was approximately 1 1/2 miles shorter the ground distance. This time comparison of the two ods indicates that it would require the services of four nd vehicles and eight observers to duplicate the time erage of the helicopter during the heavy traffic periods. e the greatest need for this service is during heavy traffic iods, these are the only periods which should be evaluated

quantitative analysis focused on the time to cover a specific te. Probably of greater importance for this type of project, ever, is the ability of the personnel in a helicopter to erve many routes and checkpoints simultaneously and to pond to changing situations. This is unique and cannot be pared to any ground surveillance system. Therefore, no efit factor can be assigned to this feature for purpose a quantitative comparison between ground and air surveillance.

ments from the investigators connected with the project duced the following conclusions:

1. The helicopter provides a useful service in this type of operation.

2. Greater use could be made of the helicopter for operation control if better air-to-ground communication were possible.

3. The helicopter is most needed during the initial period of closure. Its use from approximately 1/2 hour before closure to 1 1/2 or 2 hours after provides the greatest benefit.

4. If the helicopter were regularly available, techniques could be developed which would make greater use of it during the closing operations and would eliminate many of the complicated checking procedures presently used.

It was determined before the study that since two observers were needed, the aircraft used would not be in ambulance configuration.

II. The use of a helicopter to observe and photograph the effect of a lane closure on peak-hour traffic.

In this study, the congestion caused by the closure of the median lane of the Edsel Ford Freeway in the vicinity of the Jeffries Freeway was photographed from the helicopter and documented with the commentary of an observer on board. This information would be used in planning future projects of this type.

The ability of the helicopter to cover long segments of freeway in a very short time and to provide elevation sufficient for inclusion of substantial portions of the freeway in a single photograph cannot be duplicated by ground vehicles. Somewhat similar data can be collected by taking photographs from freeway overpasses; however, the quality of the data and the travel time between overpasses required to cover sizable segments of freeway make this alternative so inferior to the helicopter as to make pointless any further comparison of the two methods.

III. The use of a helicopter to photograph street segments or intersections having unusual geometric characteristics.

The purpose of this study was to collect photographic data concerning design features and/or operating characteristics of a sampling of street segments and intersections with unusual geometric configurations.

Photographs were taken at twenty-five widely separated locations throughout the city in a period of 2 1/2 hours, including a stop for refueling. It is estimated that to collect ground level photographs at these locations would have required a minimum of five days, and the resultant photographs would be greatly inferior to those collected from the helicopter. At some locations, elevated shots from buildings may have been possible; however, difficulties in obtaining permission to use the buildings and the time lost in selecting the proper location within them and in getting equipment to these locations generally limit the usefulness of this method.

The photographs, along with the observations of the engineer in the helicopter, can be used to evaluate design standards by providing information related to intersection queues, vehicle paths as shown by dirt and oil patterns, approach densities indicated by vehicle platoon sizes, lane usage and many other operational features that vary by location or time of day. It is very difficult to estimate the personnel that would be required to collect this information on the ground. It would seem that a minimum of four man-hours per location, including travel time between locations, would be reasonable. A total of approximately 100 man-hours would be required to duplicate this study with ground transportation.

IV. <u>A study of crowd movements and parking practices in conjunction with a major sporting event on Tiger Stadium</u>.

The purpose of this study was to investigate the pattern of traffic arrival at the stadium and the parking practices in the vicinity of the stadium.

To conduct the study, a photographer and traffic engineer were flown in a pre-determined pattern and photographs were taken at selected check points. A screen line was established along Grand Boulevard on the west, the Edsel Ford Freeway on the north, and the Chrysler Freeway on the east and the river on the south. As the helicopter passed over the screen line, photographs were taken in the direction of the stadium along twelve major arterial routes crossing this screen line. In addition photographs were taken in a radial pattern from a point over the stadium so as to cover all locations in the area where stadium parking existed. The first series of photographs was taken approximately one hour before game time. This was repeated three times at approximately twenty-minute intervals until game time. During the flight, if an unusual condition was noted, additional photographs were taken.

From the photographs and the observations of the traffic engineer, it is possible to determine a time/volume relationship that will be useful in the design of access routes to a new facility or in the determination of methods for improving access to the existing facility. The photographs of the parking conditions can provide valuable information about parking needs and characteristics.

It is estimated that to collect equivalent traffic flow data by ground-count would require a minimum of twelve traffic checkers as against the one checker used in the air-count. To collect equivalent parking data would probably require at least twenty-four checkers. This indicates that a considerable quantitative benefit results from using a helicopter for this type of study. This benefit, moreover, is probably significantly outweighed by others not easily measured, such as the ability to discern unusual situations or study driver behavior and the ability--with proper air-to-ground communication--to direct ground control forces.

Several factors prevented testing the use of the helicopter in all the study areas initially identified as suitable. Enough experience has been gained, however, to allow the following general comments to be made regarding the role of the helicopter in traffic engineering studies:

1. The helicopter provides the greatest benefit in studies concerned with a large area or involving checkpoints widely separated geographically.

2. The ability of an observer in a helicopter to locate unusual or unanticipated traffic conditions associated with special events is of great value and nearly impossible to duplicate on the ground.

3. Low-level aerial photographs as taken from a helicopter provide valuable information concerning roadway geometrics that is impossible to obtain by other methods.

4. In most cases, it is best to have both an observer and a photographer in the aircraft for traffic engineering studies. This precludes the use of the ambulance-adapted helicopter such as was used in the emergency medical project since there would be no room for the attendant. Its configuration also severely limits the use of the aircraft for photographic purposes.

5. The value of the helicopter as a traffic surveillance vehicle should not be under-estimated since, with the volume of traffic on the present street system and the cost of highway improvements, any procedure that increases the efficiency of the existing system can be of great benefit in terms of reduced road-user delay and maximum return from roadway expenditures.

CHAPTER FOURTEEN

COST ANALYSIS

CHAPTER FOURTEEN

COST ANALYSIS

14-1. INTRODUCTION

In this chapter the costs of certain elements of an emergency medical response system are developed. Cost estimates for the use of various types of personnel, ambulance vehicles and base stations are determined in addition to the anticipated costs of equipping ambulance vehicles and training the various types of personnel to the level required by the Michigan Ambulance Act.[1]

The basic cost information for these system elements is presented in Section 14-2. Thereafter, the costs of Detroit's police/fire emergency medical response system are estimated, both as the service is presently provided (Section 14-3) and as would be required by the ambulance act (Section 14-4). The operational effects and costs of reducing the number of police vehicles operated in the present system are discussed in Section 14-5. In subsequent sections (14-6 through 14-9) the operating requirements and costs are estimated for several alternative methods of providing emergency service: (1) a municipal ambulance department, (2) a commercial ambulance contract (3) a fire department ambulance service and (4) a municipal helicopter-ambulance.

The cost information was obtained from several city departments and from the commercial ambulance company which was hired to perform during the demonstration portion of the project. In gathering this information, careful attention was given to insuring the comparability of the data since the cost figures for providing certain services are not necessarily recorded on the same basis by the various sources. In some instances costs could only be estimated.

The cost elements of the city hospital ambulance division have been included in the analysis despite the fact that

---

[1]The requirements of the Ambulance Act are presented and discussed in detail in Chapter Three.

Preceding page blank

The services performed by this division are not truly of an emergency nature. It is felt that the costs of its operation reflect the probable costs of operating a municipal emergency ambulance department if one were to be established.

The cost of providing the entire service by contract with commercial ambulance companies will be estimated by extrapolating the commercial service project costs incurred in several precincts to the entire city.

2. COST ELEMENTS

Personnel Costs

The first step involved the analysis of the personnel costs for four types of personnel: (1) police, (2) fire, (3) city ambulance and (4) commercial ambulance personnel. Since comparison of the various wages alone would lead to incorrect conclusions because of the substantial effect that scheduling practices and fringe benefit packages have on personnel costs, all three factors were analyzed. This approach will permit determination of the annual per-man cost, and the staffing requirements and cost of providing a full service year of coverage with each of the four types of personnel.

Average Annual Salary

Patrolman: Patrolmen are scheduled to work 8 hours a day, 5 days a week. The starting salary is $8,000 with an annual step increment of $700 up to a maximum of $10,800 per year. Since not all Patrolmen are at the maximum salary, it has been assumed that the present percentage of patrolmen at each salary level will remain constant. Computed in this manner, the average annual salary for Patrolmen is $10,205.

City Ambulance Attendant/Operator (City AA/O): City AA/O's are scheduled the same as patrolmen. The Ambulance Attendant's salary range is $6,691 to $6,761; the Ambulance Operators are paid on an hourly basis with a range of $3.59(5) to $3.64(5). Most employees hold both titles and are paid as an "Operator" when driving and as an "Attendant" when not. For simplification, and since each crew is composed of an Attendant and an Operator, the wage and benefit

costs of both classifications have been averaged.

As with Patrolmen, not all City AA/O's are at the maximum rate for their classification. We have again assumed that the proportion at each salary level will remain constant. The average annual (combined) salary is $7,143.

Fire Fighter et al.: Field fire personnel are scheduled on a 24-hour day for an average of 56 hours per week or 2,912 hours per year. The starting salary, progression and maximum salary for a Fire Fighter is the same as for a Patrolman. Assuming that the present proportion at each level will remain constant, the average annual salary for Fire Fighter is $10,353.

The average annual salaries for the remaining fire classifications under consideration are: Fire Fighter Driver, $11,188; Fire Sergeant, $11,534; Fire Lieutenant, $12,626; and Fire Captain, $13,638.

Commercial Ambulance Attendant/Driver (Com AA/D): Personnel are usually scheduled on a 24-on / 24-off basis. During each 24-hour shift, they are paid for 19 hours (as permitted by the Fair Labor Standards Act) since all personnel are usually able to obtain 5 hours of uninterrupted sleep. If not, they are paid for the additional time, but interruption occurs infrequently. In general then, each man provides 24 hours of "coverage" and receives 19 hours pay. On this schedule each employee covers an average of 84 hours a week (4,368 hours per year) and receives an average of 66.5 hours of pay. In accordance with the FLSA, all hours in excess of 40 each week must be paid at the rate of one and one half the base rate. However, since these hours are part of the regularly scheduled hours, we are considering time-and-a-half payment for the hours worked over 40 to be part of the employees annual salary and not overtime. The average hourly base rate is estimated to be $1.90. (The minimum hourly base rate by law is $1.60.) As a general rule there is no differential paid between Commercial Attendant and Driver as there is between the City Attendant and Operator. Each Com AA/D may be expected to receive $151.53 per week or $7,879 per year.

Project Schedule: Because of a shortage of personnel during the demonstration period of the project, the ambulance contractor scheduled project crews to work on a 48-on/24-off schedule. This allowed the contractor to staff two project ambulances with only three crews instead of the usual four. Although this schedule is not ordinarily used, it seemed to be so well accepted by the personnel that the cost of this scheduling practice is included. On this schedule each Com AA/D covers an average of 112 hours each week (5,844 hours a year) and is paid for an average of 88.7 hours each week. As before, all hours over 40 are paid at the time-and-a-half rate. The average weekly wage is $214.88 and the average annual salary is $11,174.

Shift Premium: Fire personnel, Patrolmen and City AA/O's received shift premiums for all hours worked on the afternoon and midnight shifts, 10¢ and 15¢ respectively. Since one-third of the time actually worked each year (see Table 14-4) would be worked on each of the three shifts, the average shift premium would be: for fire personnel, $183; Patrolman, $148; and City AA/O, $152. Commercial ambulance companies do not usually pay a shift premium.

Holiday Pay: The city recognizes eight holidays each year and all city employees receive a premium equal to their regular hourly rate for all hours worked on these days. Department records indicate that the average Patrolman works 4.3 of these holidays each year; fire personnel work 64 hours or roughly 2.7 holidays and City AA/O's work 3.8 holidays. On the basis of these figures, the average holiday premium received each year by Fire Fighters is $228; by Patrolmen, $170; and City AA/O's, $104. Commercial ambulance companies do not usually pay a holiday premium.

Longevity Bonus: Certain employees annually receive a bonus, the amount of which is based on the number of years of service and on their salary. This bonus has maximum and minimum limits. Because of the complexity of the interrelationships of the factors involved (as is the case with several other costs to be computed below), it was decided to simplify the analysis by computing the ratio of total longevity bonuses paid to the total annual payroll for each group.

The rates paid to higher ranking fire personnel are proportional to the differences between their salaries and that of Fire Fighter. Although some commercial companies report

giving an annual bonus to some of their employees, as a rule they do not.

	Ratio	Avg. Bonus
Fire Fighters	0.0062[2]	$ 64
Patrolman	0.0143	146
City AA/O	0.0166	119

Overtime: Ordinarily, overtime pay would be included in the cost of system operations. The overtime worked by the City AA/O's and the Com AA/D's reflect normal system operating characteristics of peaking work loads and/or employee shortage. This is not true of the Patrolmen or Fire Fighters. The overtime worked by the police is essentially due to the particular nature of their work and is not indicative of ordinary system operations. Conversely, Fire Fighters never work overtime by department policy. Because of this, overtime costs would have interferred with the comparative nature of the analysis and it was decided that the inclusion of the overtime cost factor would bias the comparative nature of the analysis.

Pension: The average annual pension cost per city employee was computed by determining the ratio of the total annual pension cost to the total annual payroll. The police and fire pension plan differs substantially from that of the City AA/O's and other city employees. A common ratio was computed for the police and fire because separate costs were not available.

	Ratio	Avg. Cost
Fire Fighter	0.4856	$5,027
Patrolman	0.4856	4,956
City AA/O	0.1361	972

The increased pension costs of higher ranking fire personnel

[2] Comparison of the differences among the ratios and the average annual salaries would seem to indicate that the differences in longevity payments are based primarily on the average length of service for all employees of each of the three groups.

TABLE 14-1

PERSONNEL COST COMPARISON: INDIRECT COSTS

CITY OF DETROIT	Pension	FICA	Hospitalization	Life Insurance	Workmans Comp.	Uniform Allow.	Misc.	Total Indirect
Patrolman	$4,956	--	$404	$50	$78	$72	$17	$5,577
Ambulance Attendant/Operator	972	$343	404	32	78	40	26	1,895
Fire Department								
Fire Fighter	5,027	--	404	50	78	39	14	5,612
Fire Fighter Driver	5,434	--	404	50	78	39	15	6,020
Fire Sergeant	5,600	--	404	50	78	39	15	6,186
Fire Lieutenant	6,133	--	404	50	78	--	17	6,682
Fire Captain	6,621	--	404	50	78	--	18	7,171
COMMERCIAL								
Ambulance Attendant/Driver 24 - 24 Schedule	500	374	--	45	45	55	--	1,019
48 - 24 Schedule	500	374	--	45	45	55	--	1,019

SOURCES: Various City of Detroit Annual and Special Reports, and Superior Ambulance Service, Inc.

are proportional to the difference between their salaries and that of Fire Fighter.

The cost of providing a pension plan for the commercial ambulance service was estimated to be $500 per employee by two insurance companies. This estimate was based on each company's most popular life insurance related pension package. This amount correlated well with the information received from the contractor.

F.I.C.A.: The employers' contribution amounts to 4.8% of each employees annual salary, up to a maximum contribution of $374.40. The police and fire are not covered by F.I.C.A.

Hospitalization Insurance: City employees may join one of several hospitalization plans and the city pays the equivalent of the cost of the Michigan Blue Cross-Blue Shield Variable Fee Plan. The annual city cost for full family ward coverage per employee is $403.78. Commercial ambulance companies as a rule do not provide this benefit.

Life Insurance: The city has two plans: one mandatory, the other optional. For the first the city pays $14.56 per year per employee. It has been assumed that all employees take advantage of the optional insurance coverage in the groups under consideration. The amount of coverage and the cost is based on the employee's salary.

Police and Fire	$34.80
City AA/O	17.40

The cost of providing $10,000 coverage under a group policy for the commercial ambulance service is estimated to be $45 per employee. (See Pension Costs above.)

Workman's Compensation Insurance: The city is self-insured. City records indicate that the present cost per employee is $78 a year. The commercial contractor claims a cost of $45.

Uniform Allowance: In computing the cost for police and fire personnel, the amount allocated by each department was divided by the number of employees covered for this purpose to obtain average cost per man: Patrolman-$72, Fire Fighter-$39. City AA/O's receive a flat $40 per year

TABLE 14-2

PERSONNEL COST COMPARISON: TOTAL COST PER EMPLOYEE

CITY OF DETROIT	Annual Salary	Shift Premium	Holiday Pay	Longevity Bonus	Total Direct	Total Indirect	Total Cost Per Employee
Patrolman	$10,205	$148	$170	$146	$10,669	$5,577	$16,246
Ambulance Attendant/Operator	7,143	152	104	119	7,518	1,895	9,413
Fire Department							
Fire Fighter	10,353	183	228	64	10,828	5,612	16,440
Fire Fighter Driver	11,188	183	246	69	11,686	6,020	17,706
Fire Sergeant	11,534	183	254	71	12,042	6,186	18,228
Fire Lieutenant	12,626	183	278	78	13,165	6,682	19,847
Fire Captain	13,638	183	300	84	14,205	7,171	21,376
COMMERCIAL							
Ambulance Attendant/Driver							
24 - 24 Schedule	7,879	--	--	--	7,879	1,019	8,898
48 - 24 Schedule	11,174	--	--	--	11,174	1,019	12,193

SOURCES: Various City of Detroit Annual and Special Reports and Superior Ambulance Service, Inc.

for this purpose. The commercial ambulance company estimated the cost per employee at $55 per-year.

Miscellaneous Indirect Costs: These costs include the city costs for employee income protection insurance and the payment of retirement sick leave. The latter cost was determined by computing the ratio of retirement sick-leave payments to total payroll costs for the year.

In order to determine the staffing requirement or ratio necessary to obtain a full service year of coverage (8,760 hours) for each of the four groups of employees, the number of hours of paid leave time was determined and deducted from the total number of hours paid per employee. The remainder is the number of duty hours expected of each employee per year.

Regular Vacation: The number of hours subtracted for vacation will depend on the number of hours of coverage each employee would have provided had he been on duty.

Bonus Vacation: Extra time off is given for good attendance records, years of service, good driving records, etc. Since some of the employees will receive only a partial bonus, or none at all, the total time off has been averaged.

Sick Leave: For each city group the total time lost due to work-related injuries and personal illness has been averaged. Lost time due to personal illness is infrequently paid for by commercial ambulance companies and exact figures or even good estimates of time lost due to personal illness are not available. Since time off for this purpose is not paid by the commercial companies, the money is not earned by the employees. Such time lost for personal illness should more properly have been deducted in in the computation of the average annual salaries. Because of this the average annual salary for the Com AA/D will be somewhat less than has been calculated. However, since the time is not paid and the necessary coverage is usually provided by having another employee work overtime, and since a substantial portion of the time worked is ordinarily at the overtime rate, any increased cost to the employer for a full service year will be nominal.

Holidays: As indicated above under Holiday Pay, city employees in the groups under consideration normally work a portion of the eight recognized holidays. The premium pay received has been included in the computation of average annual salaries. For the remainder of the holidays not worked, employees are paid at their regular rate. Since they are not on duty, a time correction must be made.

Swing Holidays, Excused Time and Holiday Compensatory Time: For city personnel, other time off with pay has been approved for various reasons and purposes. These hours of paid time off may be taken anytime after they are earned, subject to department approval.

TABLE 14-3

PERSONNEL ANNUAL PAID LEAVE TIME COMPARISON

	Commercial Attendant/Driver		City of Detroit Personnel		
	24-24 Schedule	48-24 Schedule	Patrolman	Ambulance Attd/Oper	Fire Fighter
cation					
Regular	168.0	224.0	160.0	103.2	192.0
Bonus	48.0	48.0	6.6	9.6	38.4
ck Leave	--	--	82.4	85.6	396.0
lidays	--	--	29.6	33.6	128.0
ing Holidays	--	--	8.0	8.0	24.0
cused Time	--	--	12.0	12.0	12.0
liday "C" Time	--	--	--	--	64.0
tal Leave Time	216.0	272.0	298.6	252.0	854.4

urces: Various City of Detroit Annual and Special Reports and Superior Ambulance Service, Inc.

The type of emergency service under study requires that continuous coverage be provided 24 hours of every day of the year, i.e., 8,760 hours per year. Dividing the number of hours in a full service year (8,760) by the number of hours of actual coverage each employee can be expected to provide annually gives the staffing requirement for each group. This is the number of employees which normally will be needed to provide continuous coverage of one position. Multiplying this staffing requirement by the individual employee's average annual salary gives the annual cost of continuous coverage of one position. (See Table 14-4.)

For example, although Patrolmen are scheduled 2,080 hours a year, each receives an average of 299 hours of paid leave time annually. This means that each one will provide only 1,781 hours of actual coverage. Because of this 4.9 Patrolmen will be needed to provide a full service year of coverage. Since each Patrolman costs the city $16,246 a year, the cost for continuous coverage of one position will be $79,605. The annual cost to the city for staffing one ambulwagon or two-man scout car will be double $79,605 or $159,210. Similarly the annual cost for staffing a two-man ambulance with City AA/O's would be $90,364.

Personnel Cost Summary and Comments:

1. Patrolmen and Fire Fighters receive similar wage and fringe benefit packages. Consequently, the annual total cost per employee is practically the same.

2. Fire Fighters provide 15% more hours of coverage annually than do Patrolmen.

3. Although City Ambulance Attendant/Operators work about 50 hours more per year than do Patrolmen (because of the difference in vacation time benefits,) the salary costs are only 70% and the pension costs are only 20% those of patrolmen.

4. Although Commercial Attendant/Drivers annually work 2.3 times the number of hours worked by the City AA/O's, they receive only 5% more in wages annually. In addition, their fringe benefit costs are half those of the City AA/O.

TABLE 14-4

PERSONNEL COMPARISON--FULL SERVICE YEAR COVERAGE:[a]
COST AND STAFFING REQUIREMENTS

	Annual Cost Per Employee	Employees Required for Full Service Year	Full Service Year Cost
COMMERCIAL:			
Ambulance Attendant/ Driver			
24-24 Schedule	$8,898	2.1[b]	$18,686
48-24 Schedule	12,193	1.6[b]	19,509
CITY OF DETROIT:			
Patrolman	16,246	4.9	79,605
Ambulance Attendant/ Operator	9,413	4.8	45,182
Fire Fighter	16,440	4.3	70,692

[a]Full service year coverage: 24 hours a day, every day, or 8,760 hours per year.

[b]Staffing requirement does not include correction for absenteeism (see Text).

SOURCES: Various City of Detroit Annual and Special Reports; Superior Ambulance Service, Inc.

5. The total cost per/hour for the four types of personnel are:

Patrolman	$9.12(1) mills
Fire Fighter	7.98(8) mills
City AA/O	5.14(9) mills
Comm AA/D	2.14(3) mills

6. There are additional opportunity costs associated with using police and fire personnel to perform emergency transportation service. These costs result whenever they are unable to respond immediately to requests for police or fire service. The size of these costs is unknown.

7. There is another opportunity cost incurred by the police in performing this function. When not occupied on a run or other definite assignment, they maintain patrol, thereby providing a crime deterrent or "halo" effect. The cost due to the loss of police presence is also unknown. There is no similar cost for use of fire personnel.

8. There is a fiscal advantage in the use of existing city personnel such as policemen and firemen for the emergency medical transport function in that this service is provided without any increase in total personnel expenditures. The use of personnel exclusively for this service would entail an increase in cost.

Vehicle Costs

In this section the fixed and the variable operating costs are developed for four types of vehicles used by the city: (1) the fire rescue trucks, (2) the police ambulwagons (i.e. dual-purpose station wagons), (3) the police two-man scout cars, and (4) the hospital ambulances.

Fire Rescue Trucks: The fire rescue trucks are used by the Fire Department to perform three basic functions: (1) the transportation of fire personnel to the scene of fires,

(2) extrication and rescue operations, which are frequently combined with (3) the care and transport of certain emergency victims (i.e. those suffering from difficulty in breathing, stroke or heart attack). The trucks are used for these specific types of emergency cases because the equipment they carry is appropriate for life support. Each truck is capable of transporting three patients on canvas stretchers.

At the present time there are a total of eleven trucks in the department vehicle pool, providing service from seven locations. Formerly, the operational life expectancy of each vehicle was 7 to 9 years. Increased use of these trucks for all three functions has reduced this to between 5 and 7 years which for this analysis, has been averaged to 6 years. Acquisition cost is presently $28,800 per unit with an estimated resale or salvage value of $500. During 1968, these vehicles traveled a total of 117,022 miles for a per-truck average of 10,638 miles. These figures and those for the other vehicle types are presented for comparison in Tables 14-5, 14-6 and 14-7.

Police Ambulwagons and Two-Man Scout Cars: The police ambulwagons are rear door opening station wagons which are used for a number of police functions in addition to the transport of accident and illness victims. Except for this latter function, they are operationally equivalent to the two-man scout cars. Each ambulwagon is capable of transporting two victims on litters when the rear seats are folded down. For other police functions the two litters can be folded and carried on the floor behind the rear seat. This provides as much room for police functions as is available in the two-man scout. Analysis of the operating costs of the two-man scout have been included in order to estimate the savings that would occur if all or part of the ambulwagons were replaced with scouts.

Normally a pool of 110 ambulwagons is maintained, but only a portion of these would be "on the road" at any one time. Each unit costs $2,450, excluding the two folding stretchers. The operational life expectancy averages 18 months and the average resale value is $250. During 1968, ambulwagons traveled a total of 3,827,237 miles for a per-vehicle average of 34,793 miles.

Normally, a pool of 315 scout cars is maintained. Each unit costs $2,050 and has an operational life expectancy of 18 months also, with an average resale value of $200. During 1968, the scouts traveled a total of 9,935,662 miles for a per-vehicle average of 31,542 miles.

Hospital Ambulances: Although the ambulance service provided by the Detroit General Hospital Ambulance Division is not part of the emergency system under study, the vehicles used by this division bridge the gap between the police dual-purpose station wagon and the five-man fire rescue truck. These ambulances are considered in this analysis because of several operational advantages that occur from their use. Compartment size and configuration make this vehicle much more suitable for victim transport and equipment storage than are the ambulwagons. At the same time, the ambulance is smaller than the rescue truck and can be operated with only two men. In the present configuration each unit can transport two victims, one on a cot and the other on a padded bench. Some compartments for equipment storage are presently specified and more could easily be added if so desired.

There are a total of six ambulances in the division motor pool. Each ambulance costs $7,550 and has an operational life expectancy of three years. The average resale value is $400. During 1968 these ambulances traveled a total of 110,562 miles for a per-vehicle average of 18,427 miles.

Operating Costs, Fixed and Variable: It should be emphasized that the operational life expectancy and the average annual depreciation for each vehicle type listed in Table 14-5 is based on the present level of vehicle usage. Any changes in the system which would appreciably change the annual mileage traveled by each type of vehicle must result in changes in this expectancy and cost.

Other annual fixed operating costs such as licensing and insurance have not been included. Licenses cost $1/vehicle/year. Since all city vehicles are covered by a blanket policy, only gross changes in the number of vehicles would affect the cost significantly.

All ambulwagons, scout cars and hospital ambulances are maintained by the Department of Public Works. Variable operating cost and mileage records are kept according to individual vehicle, type of vehicle and operating department. The costs and mileages analyzed below are those reported by the DPW for the year July 1, 1968, through June 30, 1969.

The fire rescue trucks are maintained by the Fire Department and the variable costs and mileages for these vehicles are those reported for the calendar year 1968. Overhead costs are not recorded by the Fire Department for its vehicles. However, when the Fire Department Garage repairs vehicles for other departments, the billing includes an additional charge for overhead which is based on a percentage of the labor and parts costs. An overhead cost for the fire rescue trucks has been computed based on this same percentage and has been included below so that the operating costs of all four vehicle types could be compared.

Maintenance costs reported by the DPW include labor and parts; those reported by the DFD include labor, parts and tire purchases.

Operating costs include gas, oil and tire rental charges for DPW-maintained vehicles (tire rental charges are based on tire size and mileage driven); DFD records include gas and oil only.

Overhead costs are computed by the DPW on the basis of 135% of the labor cost; DFD computes this as 51.28% of the maintenance cost (which includes labor, parts and tires as stated above).

Operating and maintenance costs (as defined above) as well as the total variable operating cost per mile have been computed for each vehicle type.

Having determined the annual fixed operating costs and the variable operating cost per mile for each type of vehicle, it is possible to compute the total annual operating costs.

As stated previously, the police ambulwagons and the two-man scouts perform identical functions with the exception that the ambulwagons transport most emergency medical victims. The average annual mileage traveled by each scout car is 31,542 miles and by each ambulwagon,

TABLE 14-5

VEHICLE COMPARISON:
ANNUAL FIXED OPERATING COST

	Police Scout Car	Police Ambulwagon	Ambulance (Internat.)	Fire Rescue Truck
Purchase Price	$2,050	$2,450	$7,550	$28,800
Resale Value	200	250	400	500
Oper. Life (yrs.)	1.5	1.5	3.0	6.0
Annual Depreciation:				
Vehicle	$1,232	$1,465	$2,381	$4,698
Radio*	140	140	120	110
	$1,372	$1,605	$2,501	$4,808
Size of Pool	315	110	6	11
Total Depreciation:				
	$432,180	$176,550	$15,006	$52,888

*Annual depreciation on radio equipment listed includes equipment depreciation at $100 per year plus installation and removal costs of $60 pro-rated over the operational life of each vehicle.

SOURCES: Various City of Detroit Records and Reports.

34,793 miles (total mileage by type, above, divided by the number of vehicles in each pool). However, it is reasonable to assume that the average number of miles traveled annually by both should be nearly the same since the functions are basically identical.

TABLE 14-6

VEHICLE COMPARISON:
VARIABLE OPERATING COSTS PER MILE

	Police Scout Car	Police Ambulwagon	Ambulance (Internat.)	Fire Rescue Truck
;TS PER MILE:	5.4¢	5.8¢	10.8¢	21.7¢
Operating	2.7	2.8	3.4	3.0[a]
Maintenance	1.4	1.6	4.0	12.3[a]
TAL MILEAGE:	9,935,662	3,827,237	110,562	117,022
RIABLE COSTS:	$535,480	$223,168	$11,912	$25,338
Maintenance	140,316	61,686	4,396	14,390
Operating	273,182	107,032	3,712	3,569
Overhead	121,982	54,450	3,804	7,379

[a]When comparing the operating and maintence costs presented re, it must be remembered that the fire rescue truck operating st is low and the maintenance cost high in relation to the hers because of the difference in recording tire costs by the W and the DFD.

URCES: Various City of Detroit Records and Reports.

In order to simplify comparison of the average annual operating costs of these two types of vehicles, the mileages and the number of vehicles of both types have been totaled together so that the same average annual mileage can be assumed for both. Because of a higher variable operating cost for the ambulwagons than for the scouts, this assumption decreases the difference between the average annual operating costs. As a consequence, estimated savings of $362 per year for each ambulwagon replaced by a two-man scout will be on the conservative side. (See Table 14-7.)

TABLE 14-7

VEHICLE COMPARISON:
TOTAL ANNUAL OPERATING COST

	Police Scout Car	Police Ambulwagon	Ambulance (Internat.)	Fire Rescue Truck
TOTAL OPER. COST /VEHICLE/YEAR	$3,121	$3,483	$4,491	$7,116
Annual Fix. Cost /Vehicle	1,372	1,605	2,501	4,808
Annual Var. Cost /Vehicle	1,749	1,878	1,990	2,308
AVG. MILES/YR.	32,383-ASSUME-SAME	32,383	18,427	10,638
VAR. COST/MILE	5.4¢	5.8¢	10.8¢	21.7¢

SOURCES: Various City of Detroit Records and Reports.

Vehicle Cost Summary and Comments

1. Compared to the purchase price of the ambulwagon, the hospital ambulance costs 3 times and the rescue truck costs almost 12 times as much.

2. The present annual fixed operating costs for the ambulance and the truck are 1½ and 3 times that of the ambulwagon. These costs presume that the present level of usage for each vehicle type remains constant. Any changes in the system which would appreciably change the average annual mileage traveled by one type of vehicle would also change this cost and the operational life expectancy.

3. Using the operating cost per mile of the scout as the base, ambulwagons cost 7% more per mile to operate.

Ambulances cost 2 times as much and the trucks 4 times as much per mile to operate.

Equipment Cost

As indicated previously, Michigan Public Act 258 (1968) requires that certain equipment be carried in every vehicle used as an ambulance. Analysis of this cost element consists of determing the cost of two basic equipment packages: (1) the package presently carried by the ambulwagon and (2) the package required by statute.

Ambulwagon Package: Each wagon is equipped with two folding cots and one blanket. (This package is strictly a "transportation equipment" package. It is so rudimentary that it can be reasonably questioned whether these items should be considered emergency medical equipment.) The acquisition cost of each cot is $90.00 and each cot has an operational life expectancy of six years provided that the fabric is replaced once during this time at the additional cost of $27.00 for labor and material. Blankets cost $5.00 each and can be expected to last only one year because of damage and loss.

Capital cost per vehicle	$185.00
Annual fixed operating cost per vehicle	44.00*
Annual variable cost	None

*Annual fixed operating cost is the depreciation and replacement cost of the two folding cots and blanket with which each ambulwagon is equipped. (See Table 14-8.)

Michigan Minimal Equipment Package: A list of the equipment required by the statute is included in Attachment A of Chapter 3. On the basis of the cost of equipment used in the experimental portion of the project, the capital cost of equipping each vehicle to the required level has been computed in Table 14-9. Certain equipment is reusable and will last for various periods of time. Although some other studies have estimated the operational life expectancy of this equipment to be close to ten years, it is not believed that this estimate realistically allows for equipment damage and loss. Consequently, smaller periods of time have been assumed as indicated in the table.

TABLE 14-8

EMERGENCY EQUIPMENT COSTS:
POLICE AMBULWAGON PACKAGE

ANNUAL FIXED OPERATING COSTS/VEHICLE

	Folding Cots	Blankets	
Purchase Price (ea.)	$ 90.00	$5.00	
Repair Cost (ea.)	27.00	0.00	
Total Investment	$117.00	$5.00	$122.00
Operational Life Expectancy	6 Yrs.	1 Yr.	
Annual Depreciation (ea.)	$ 19.50	$5.00	
No. Units Required/Vehicle	2	1	
ANNUAL FIXED OPERATING COST/VEHICLE	$ 39.00	$5.00	$44.00

Some of the equipment required by statute is of an expendable nature. This type of equipment is listed in Group II of Table 14-9. Since usage depends upon the types and frequencies of injuries occurring annually in the total system, the cost figures presented here are for the entire city and are not based on per-vehicle cost as are the other cost elements developed in this section.

On the basis of very limited experience in first-aid equipment usage during project operations in the 7th and 15th Precincts, an annual cost of $2,500 - $3,000 for the entire city has been extrapolated. This cost does not include the additional variable cost of providing fresh linen in accordance with the requirements of the statute. The cost of linen has been estimated by presuming that the number of victims transported annually will remain at the level of 45,000-50,000. If disposable-type linen were used, the estimated annual cost of linen would be $14,500.00-17,000.00. The various costs for this package are as follows:

TABLE 14-9

CAPITAL AND ANNUAL FIXED OPERATING COSTS PER VEHICLE FOR MICHIGAN MINIMAL EMERGENCY EQUIPMENT

	Number Required	Cost	Life Expec.	Depreciation per year
PRECIABLE EQUIPMENT:				
Half-ring Splint	1	$ 20.00	5 years	$ 4.00
Spine Board[a]	1	50.00	5 "	10.00
Bag-mask Resuscitation Unit and Masks	1	30.00	5 "	6.00
Suction Apparatus	1	42.00	5 "	8.40
Oxygen Regulator	1	25.00	5 "	5.00
Bandage Shears	1	1.50	½ "	3.00
Pillows	2	5.00	2 "	2.50
Folding Cots	2	180.00	6 "	39.00
Total Annual Fixed Operating Cost per Vehicle:				$77.90
PENDABLE EQUIPMENT:				
Airways		$ 3.60		
Oxygen Tanks		1.76 (refill)		
Bandages, etc.		10.50		
Linen		5.00		
Board-type Splints		6.00		
(Inflatable Splints)		(30.00)		
Miscellaneous		2.00		
Total Capital Costs per Vehicle:		$382.36 - $406.36[b]		

[a]Although the statute specifies separate backboard and neck-
ards, the single-unit folding boards are an acceptable substi-
te; they also cost less and require less space.

[b]Capital cost varies according to the type of splints used.

Capital Cost/Vehicle	$382.36-$406.36
Annual Fixed Operating Cost/Vehicle	78.00
Annual Variable Operating Cost Linen and First-Aid Equipment	$17,000.00-$20,000.00
(Avg. per victim)	($0.40)

Training Costs

The several first-aid and emergency medical training programs for which comparative costs were developed are: (1) the first-aid training presently given police and fire personnel, (2) the minimum training program standards required by statute and (3) the training program given to the commercial ambulance personnel that operated in several precincts during the demonstration.[3]

Method of Determining Training Cost: Costs were established by determining the number of man-hours each type of employee spends in training (both the initial training period and subsequent review training). Once the average number of hours was determined, the cost was calculated on the basis of each employee group's average hourly cost.

	Hours Worked Annually[4]	Total Annual Employee Cost[4]	Average Cost per Hour
Patrolman	1,781	$16,246	$9.12
Fire Fighter	2,058	16,440	7.99
City AA/O	1,828	9,413	5.15

[3]There were two training programs established for police officers as part of the demonstration project in order to test the effectiveness of various levels of training. The costs incurred in both of these programs are not felt to be representative of the costs that would be encountered if either were established on a continuing basis. As a result these costs were not developed here.

[4]There figures were taken from Table 14-4.

No cost was assumed where (1) the training is also appropriate for the performance of other assignments (i.e., the training is not specifically given in order to permit the trainee to function as part of the emergency medical recovery system) or (2) the training can be provided on the job in such a manner that it does not interfere with the performance of the employee's regular duties.

Present Police and Fire Training: The Police and Fire Academies provide the same number of hours of instruction to each recruit. The number of hours devoted to testing differ between the academies. Both departments provide review training to all field personnel amounting to two hours per year.

	HOURS OF TRAINING				COST
	Academy Training			Annual	
	Instruction	Testing	Total	Review	
Patrolmen	15	6	21	2	NONE
Fire Fighter	15	1	16	2	NONE

Both departments have indicated that they would continue to provide academy and review training even if their personnel were no longer assigned to perform emergency medical duties. Since both departments feel that such training is essential for the proper performance of their other duties, no cost for it will be considered in this analysis.

Minimum Standards: Although there are a number of training programs which meet the statutory requirements, for the purpose of determining costs we have assumed the American Red Cross Advanced First-Aid program. Normally twenty-six hours of instruction are required to obtain an Advanced Certificate: ten hours for the initial, standard course, and sixteen hours for the advanced course. Insofar as the graduates of both academies are eligible for an Advanced Certificate at the present time (they simultaneously teach the subject matter of both courses, thereby meeting the requirements in only sixteen hours,) there

would be no cost chargeable for their initial training by the above criteria. If groups other than police and firemen were assigned to the emergency system, their initial training would probably require the full twenty-six hours and the initial training costs would be chargeable.

Once the Advanced Certificate is obtained, it can be renewed every three years provided that eight hours of retraining are received within that period. However, following graduation from the academies, neither the Police or Fire Departments apply to the American Red Cross for renewal certificates. It would appear that compliance with the statute could be achieved for police and fire personnel by increasing the number of hours of retraining to three each year, by maintaining accurate records of employee retraining and by applying for renewal of certificates. The hours of retraining have been increased from two to three a year for several reasons: (1) the requirement that eight hours of retraining be given every three years (instead of the present six) and (2) additional training hours will be needed to teach the proper use of equipment required by statute which is not included in the course content for the Advanced Certificate. The costs for initial and review training of police and fire personnel are presented below. These costs have also been developed for City Ambulance Attendant/Operators as indicative of the training costs for a division whose exclusive mission is the care and transport of emergency victims.

	INITIAL TRAINING		ANNUAL REVIEW TRAINING	
	Hours	Cost	Hours	Cost
Patrolman	21	NONE	3	$9
Fire Fighter	16	NONE	3	NONE
City AA/O	26	$134	3	NONE

No cost has been charged for the Police and Fire Academy training. The annual additional hour of training has been charged for the police as being the additional time required for training if their services in the emergency system are continued. This additional time is not charged for the Fire Department since the additional training can be provided at the station houses without limiting the ability to perform their regular duties. Similarly, no charge has been assumed for the City AA/O's review training; however, there is a cost for the initial training.

Commercial Ambulance Personnel: The contractor for the demonstration portion of the project requires that his personnel attend a 20-session National Ambulance Training Institute course every year. The contractor's cost per session is $25 per man or $500 per man for the complete course. Texts are $5 per man additional. Training is conducted on the employees' days off. Since each session lasts two hours and must be paid at the overtime rate, the wages for each employee are $114. The total annual cost for training per individual employee is $619.

Summary of Training Costs

1. No emergency medical training cost should be assumed where

   - the training is also appropriate for the performance of assignments other than that of emergency medical care and transport,

   - the training can be provided on the job in such a manner that it does not interfere with the full performance of the employee's regular duties.

2. New graduates of the Police and Fire Academies meet the training requirements of the statute at no additional cost.

3. Compliance with the law can be maintained by

   - some minor increase in the cost of the annual retraining given the police only,

   - an unknown increase in the administrative costs resulting from the maintenance of accurate records of employee retraining, and the routine application for certificate renewals.

Base Station Costs

During the demonstration period, data were collected on the response characteristics of both base-station vehicles and patrol vehicles. The commercial ambulances were base-operated and stationed in precinct and fire houses. Although there seemed to be no significant problems as a result of operating emergency vehicles from these city facilities, it is worthwhile to compare these costs with the costs of establishing and operating a separate facility exclusively for emergency medical care vehicles.

TABLE 14-10

COST COMPARISON: USE OF SEPARATE v. EXISTING BASE FACILITIES

	SEPARATE FACILITY	EXISTING FACILITY
CAPITAL COSTS:	$970-2,395	$175-475
Renovation	500-1,000	0-200
Desk and Chair	100	None[a]
Lounge Chairs	75	None[a]
File Cabinet	40	40
Bunk Beds	100	0-100
Garment Rack	20	None[a]
Utility Cabinet	30	30
Phone Installation (Police)	75-1,000+[b]	75
Office Supplies	30	30
ANNUAL FIXED OPERATING COSTS:	$2,837-4,037	$ 7-17
Rental	1,800-3,000	None[a]
Utilities	800	None[a]
Maintenance	200	None[a]
Equipment Depreciation	37	7-17

[a]It is assumed that the existing equipment is sufficient and that the operating costs of the existing facility are not increased.

[b]The reason for the wide variation in the installation costs of a police phone is the uncertainty regarding the proximity of an available facility to an existing line.

If it is assumed that a total of twenty separate base locations are needed to provide adequate service to the city, the increase in the annual fixed operating cost of the emergency response system is estimated to range from $56,740 to $80,740 per year. The capital cost of establishing twenty separate base locations is estimated to range from $19,400 to $47,900.

14-3. COST OF THE PRESENT EMERGENCY RECOVERY SYSTEM

In the previous section some of the cost elements of the present emergency system have been established, based on the most recent cost information available. Operating statistics from the Police and Fire Departments are presently available only through 1968. Therefore, for the purpose of developing the cost of the present emergency recovery system, it has been assumed that the demand for service is that reported for the year 1968. As shown in Figure 2-3, following the tremendous peak load in 1965, the demand (the recognized or screened demand) has apparently stabilized in the area of 45-50,000 transports per year.

Cost of the Police Operations

Police Personnel Cost: $556,974. This cost is determined by multiplying the number of man-hours contributed by the police to the transport of emergency victims during 1968 by the average cost per hour for Patrolman:

61,065 x $9.12(1) = $556,974

Police Vehicle Cost: $52,408. The total vehicle cost is the sum of the variable and the fixed operating costs. There is both a direct and indirect component to the variable operating cost attributable to the system. The direct component was computed by using the total mileage traveled by all police vehicles in 1968 for the transportation of emergency victims (212,391 miles) and the variable operating cost per mile reported for the ambulwagon (5.8¢) in Table 14-6. Although the ambulwagons did not transport all of these victims, they did transport the major portion and the assumption that they carried all the victims simplifies the computation of the cost. The total direct component is 212,391 x $0.05(8) or $12,319.

The indirect component results from the fact that if the police did not have the responsibility for emergency transport, the ambulwagons would not be needed. Instead, an equal number of two-man scouts would be used for the performance of regular police functions. Because of the difference in the total operating cost per mile between the ambulwagon and the scout, as reported in Table 14-6, the mileage traveled to perform other police functions is more costly for ambulwagons than for scouts. This additional cost should properly be charged to the operation of the emergency transport system. The ambulwagons traveled a total of 3,827,237 miles during 1968, as reported in Table 14-6. If, as has been assumed above for simplification of the analysis, all of the 212,391 miles traveled by police vehicles in emergency medical cases were traveled by the ambulwagons, then the remaining mileage was for the purpose of police activities. Since the difference in the costs per mile is 0.4¢, the additional indirect variable operating cost charge to the system for these 3,614,846 miles is $14,459.

As reported in Table 14-5, the annual fixed operating cost of a two-man scout is $1,372 and of an ambulwagon is $1,605, a difference of $233 per year. This difference in per-vehicle costs must also be charged to the system. Since the city maintains 110 ambulwagons, the cost is $25,630.

The sum of the police vehicle costs is $52,408.

Police Equipment Cost: $4,840. Because of the type of equipment presently carried by the ambulwagons, there is only an annual fixed operating cost. This cost per vehicle times the number of vehicles in the ambulwagon pool is the equipment cost per year.

$44 x 110 = $4,840

Police Training Cost:	NONE
Police Base Cost:	NONE
Police Opportunity Cost:	UNKNOWN
Total Cost of the Police Operations:	$614,222
Cost/Run (Police):	$17.67

The cost per run for the police operations is the total police cost divided by the total number of runs made.

$614,222 ÷ 34,757 = $17.67

Cost of the Fire Operations

Fire Personnel Cost: $0.00 to $123,677. There is a question whether a cost for fire personnel is a valid charge to the emergency medical response system. Squad staff would not be reduced nor would they be reassigned to perform other duties if the emergency medical response function were transferred to another agency. A test for a true cost is the occurrence of savings or other benefits if the function is discontinued. The cost of the fire operations will be computed both with and without a personnel cost component.

At all times there are a total of 5 men which operate each rescue truck. To accomplish this, the complete staff assigned to each squad includes a captain, two lieutenants, a sergeant, three drivers, and the equivalent of 14.3 fire fighters as indicated in Table 14-11.

TABLE 14-11

A DETROIT FIRE RESCUE SQUAD: STAFF AND COSTS

Title	Number of Positions	Hours Worked per Year	Cost
Captain	1	2,058	$21,376
Lieutenant	2	4,116	39,694
Sergeant	1	2,058	18,228
Fire Fighter Driver	3	6,174	53,118
Fire Fighter	14.3[a]	29,394	235,092
Total:	21.3	43,800[b]	$367,508

[a]Of the 14.3 fire fighters needed to staff each squad, 11 are regularly assigned to that squad. The balance are detailed to the squad from engine and ladder companies as needed to produce a full crew of five men.

[b]This is the total number of man-hours required to maintain a five-man staff continuously for a year.

The total number of man-hours worked annually by all seven rescue squads is seven times 43,800 man-hours per squad or 306,[illegible] man-hours.

Similarly, the total personnel cost for all seven squads is seven times $367,508, or $2,572,556.

The total number of hours contributed to emergency medical transport by the Fire Department during 1968 was 2,948. Since each transport was made with a crew of five men, the total number of man-hours contributed to emergency transport was 14,740.

Because of the various classes of personnel that comprise a rescue squad, a cost per man-hour was not used outright to establish the personnel cost of emergency transport. This cost is related to the overall personnel cost of all squads ($2,572,556) as the number of man-hours contributed to emergency transport (14,740) is related to the total number of man-hours worked by all the squads (306,600).

$$\frac{\$2,572,556 \times 14,740}{306,600} = \$123,677.$$

Fire Vehicle Cost: $51,050. The cost for fire vehicles was computed on the same basis as for the police vehicles. The variable operating cost for the emergency transport function is

76,315 x $0.21(7) = $16,560.

The annual fixed operating cost for this function is

$$\frac{\$52,888 \times 76,315}{117,022} = \$34,490.$$

The total vehicle cost is the sum of the variable and fixed operating costs above, or $51,050.

Fire Equipment Cost:	NONE
Fire Training Cost:	NONE
Fire Base Cost:	NONE
Fire Opportunity Cost:	UNKNOWN
Total Cost of the Fire Operations:	$51,050 to $174,727
Cost/Run (Fire):	$4.25 to $14.56

The cost per run for the fire operations is the total cost (with and without the questionable cost for personnel) divided by the total number of runs made during 1968.

$51,050 ÷ 12,003 = $4.25
or $174,727 ÷ 12,003 = $14.56 (incl. fire personnel)

Total System Cost

The cost of the total emergency recovery system is the combined cost of both the Police and Fire Department operations. Again, the total will vary considerably depending on whether the fire personnel cost is included.

$614,222 + $51,050 = $665,272
or $614,222 + $174,727 = $788,949 (incl. fire personnel)

Cost/Run: (Police and Fire combined): $14.23 to $16.87

The cost per run is the total system cost divided by the total number of runs made by both departments during 1968.

$665,272 ÷ 46,760 = $14.23
or $788,949 ÷ 46,760 = $16.87 (incl. fire personnel)

14-4. COST OF THE PRESENT SYSTEM AS MODIFIED TO MEET THE NEW STATUTORY REQUIREMENTS

In Section 14-3 the cost of operating the present emergency response system was estimated. The cost of modifying this system to meet the requirements of Michigan Public Act 258 (1968) will be estimated in this section.

As discussed in Chapter 3, the statute regulates the licensing and operation of ambulances and the licensing and qualifications of ambulance drivers and attendants. Dual-purpose police and fire vehicles and their personnel must also meet these standards. In brief, the statute requires the following:

- All vehicles used as ambulances must be licensed annually.
- Certain emergency medical equipment must be carried by each vehicle.
- At least one of the police officers and firemen in each vehicle operated as an ambulance by local units of government must be licensed annually as an ambulance attendant or attendant-driver.
- In order to be licensed, these persons must have received a certain level of training and maintain this level by regular review training.
- All applicants for licensing must pass an annual physical examination.
- Fresh linen must be provided for each victim transported.

It is apparent that the implementation of these requirements must result in additional capital and operating costs, not the least of which would be the administrative costs required to maintain additional records, apply for vehicle and personnel licenses, control stock and maintain proper personnel assignments. In the following five sections these increased capital and annual operating costs will be estimated.

Capital Cost

In order to bring the present system into compliance with the statute, additional emergency medical equipment and storage containers would have to be purchased. Containers for the equipment and linens would be needed in each vehicle and shelves and cabinets for the storage of replacement stock would be needed in each precinct and rescue squad base station. (The costs reported in Table 14-10 for the use of an existing municipal facility are not directly applicable here since they were estimated on the basis of using each facility in a different manner than is the case under the present police/fire system structure. Additional police phones and office equipment would not be required under this latter system.)

Equipment: The capital cost of equipping each vehicle in accordance with the statutory requirements was reported in Table 14-9 as ranging from $382 to $406 per vehicle. There are 110 ambulwagons and 11 rescue trucks presently used for emergency response and transport. Using the lower per-vehicle cost, the capital cost for the purchase of the additional equipment would be $46,222.

Equipment Containers: In the demonstration portion of the project, diaper bags were used for the storage of the first-aid equipment in the ambulwagons and the oxygen tanks were simply carried in the trunk. The diaper bags, which cost approximately $5 each, worked well for this purpose. However, an additional container for the storage of the oxygen tanks and equipment is recommended, at an estimated additional cost of $5 per vehicle. (This latter container would not be needed in the rescue trucks.) At $10 per vehicle for 110 ambulwagons and $5 per vehicle for 11 rescue trucks, the total capital cost for vehicle equipment containers is estimated to be $1,155.

It would appear that adequate storage space could be provided at each of the thirteen precinct stations with two utility cabinets and at each of the seven rescue squad stations, with one cabinet (the difference being due to the difference in the number of vehicles to be supplied from either type of station). At $30 per cabinet, the capital cost for base-station equipment containers is $990. The total capital cost for equipment containers--diaper bags, utility cabinets and vehicle equipment containers--is $2,145.

Additional Operating Costs

Compliance with the statute would also result in increases in the annual operating costs of the system. Specifically, these increases would occur in the categories of training, licensing and physical examination of personnel and in equipment and administrative costs. In order to estimate these additional costs, it will first be necessary to establish: (1) the number of vehicles (police and fire) to be operated in the emergency system at any one time, (2) the size of the vehicle pool required to operate this number of vehicles and (3) the number of patrolmen and firemen that must be trained and licensed to insure that each vehicle operated complies with the statutory standards. At the present time the police maintain a pool of 110 ambulwagons. Since there are usually 20 undergoing maintenance and/or repair, the average number of operating ambulwagons is 90. Similarly, the Fire Department maintains 11 rescue trucks but only operates 7 at any one time. For the purpose of this analysis it will be assumed that the Police and Fire Departments would continue to maintain and operate the same number of vehicles in the emergency medical response system.

As reported in Chapter 3, the statute requires that only the person acting as the ambulance attendant must be licensed as an attendant or attendant-driver. The driver of the vehicle need not be licensed under the statute. In other words, at all times, at least one of the men in each ambulwagon or rescue truck must be qualified and licensed by the state.[5] Table 14-4 indicates that the number of patrolmen and firemen needed to be staffed in order to provide continuous coverage of each position is 4.9 and 4.3 respectively. According to these figures, it would be sufficient to train and license 4.9 patrolmen and 4.3 firemen for each police and fire vehicle operated as an ambulance. However, these figures are realistic only for situations in which there is essentially unlimited flexi-

[5] To obtain a license, each applicant must be trained to the level of the American Red Cross Advanced First-Aid Course or its equivalent and must have a currently valid certificate attesting to this fact. Licensees must apply for license renewal annually at a fee of $1.00 and each issuance is contingent upon the applicant's having passed a physical examination.

bility in personnel assignment. The requirement that at least one of the crew on each vehicle be licensed as an attendant or attendant-driver creates a constraint on personnel assignment, within which allowance must be made for other staffing problems associated with scheduling, illness, injury and vacation. Therefore, it has been estimated that these minimum staffing figures should be increased by a factor of 2-1/2 in order to insure that a licensed person be aboard each vehicle operated as an ambulance at all times.[6] According to this estimate, 12 patrolmen should be trained and licensed for each police ambulwagon operated and 11 firemen for each fire rescue truck. On the basis of the number of vehicles to be operated and the number of patrolmen and firemen to be trained and licensed for each of these vehicles, it has been assumed that the number of patrolmen to be licensed would be 1,100 and the number of firemen, 75. These figures will be used in estimating the operating cost increases indicated below.

Training: In Section 14-2 under training costs, it was reported that to bring a patrolmen up to the level of training required would cost an additional $9 a year. There was no additional cost reported for training the firemen for the reasons explained in that same section. Therefore, since an estimated minimum of 1,100 patrolmen would have to be trained, the annual cost for this additional training would be $9,900.

Licensing: Both vehicles and personnel must be licensed annually. Although local governmental units are exempted from paying a fee for the vehicle license, the fee for each attendant license is $1.00. Since a total of 1,175 police and firemen would need to be licensed, the additional annual cost to the present system for license fees would be $1,175.

[6]This correction factor of 2-1/2 could be reduced substantially if the personnel assignment policy of both the Police and Fire Departments were changed to permit unlimited assignment of licensed patrolmen and firemen across precinct and rescue squad boundaries. In other words, the size of the correction factor applied is proportional to the restrictions that are placed on the assignment of personnel.

Physical Examinations: Each applicant for licensing must have passed a physical examination prior to application or reapplication. It is assumed that it would cost an average of one hour of work time for each patrolman and fireman to leave his assignment, be examined and return to his assignment. The total hourly cost for patrolman is approximately $9 and for firemen, $8. The additional cost for the examinations would thus be $9,900 for the police and $600 for the Fire Department for a total increase of $10,500.

The city employs a number of physicians who might be available to perform the physical examination without any additional cost to the city. If not, an extra cost of $4 to $7 per examination might be required. The additional cost to the system for physician services is then estimated to range from $0 to $8,225. The total additional cost to the system for physical examinations, covering both employee lost time and physician services, would be in the range of $10,500 to $18,725.

Administrative Costs: The time required to manage the operations of the system would also be increased by the requirements of the statute. Additional records of personnel training and emergency supplies would have to be maintained. Applications for Red Cross certificates and vehicle and personnel licenses would have to be prepared. The time for physical examinations would have to be arranged. It is estimated that the administrative costs may be increased by $10,000 per year for the police operations and $2,000 per year for the fire operations for a total annual cost to the system of $12,000.

Equipment: The additional cost of bringing the vehicle equipment package up to the requirements of the statute was reported in Section 14-2 under equipment costs. This cost would be the result of increases in both the fixed and variable annual operating costs for equipment.

The increase in the annual fixed operating cost per vehicle was indicated in Table 14-9 at $78. This cost did not include the equipment containers required, which are estimated to have a life expectancy of two years. This would increase the cost per vehicle to $83 for each of 110 ambulwagons and $80.40 for each of the 11 rescue trucks. The increase in this cost for the police would be $9,130 and for the fire operations, $884. If the replacement schedule for the utility cabinets is assumed to be 10 years, the annual fixed cost would be $99. The total increase in the annual fixed operating cost of the equipment would therefore be $10,113.

The increase in the annual variable operating cost for the entire system was estimated to be in the range of $17-20,000 per year in Section 14-2 under equipment costs. On the basis that 50,000 victims would be transported annually by the system (36,000 by the Police and 14,000 by the Fire Department,) the increase in this operational cost to the Police and Fire Departments would be $12,240 to $14,400 and $4,760 to $5,600 respectively.

The total increase in the annual equipment operating cost is therefore estimated to be in the range of $27,113 to $30,113 per year.

Cost of the Police Operations

The police personnel, vehicle, base and opportunity costs would remain the same as those reported in Section 14-3. for the present system:

Police Personnel Cost:	$556,974
Police Vehicle Cost:	$52,408
Police Base Cost:	NONE
Police Opportunity Cost:	UNKNOWN
Police Equipment Cost:	$26,288 to $28,448

The total annual equipment operating cost is the sum of the fixed and variable costs. The fixed cost would include the cost of the present package, reported in Section 14-3 un the "cost of police operations": $4,840, plus the increases, reported in Section 14-4 under additional operating costs, of $9,130 for vehicle-carried equipment and $78 for the station equipment cabinets. The total fixed cost would be $14,048. The variable cost would be the increase, reported immediately above of $12,240 to $14,400. The total equipment operating cost would therefore be $26,288 to $28,488.

Police Training Cost: $9,900

(See Section 14-4 on Training)

Michigan Ambulance Attendant License Cost: $1,100

(See Section 14-4 on Licensing)

Cost of Physical Examination: $9,900 to $17,600

(See Section 14-4 on Physical Examination)

Personnel	$9,900
Physician	$0 to $7,700

Additional Administrative Costs: $10,000

(See Section 14-4 on Administrative Costs)

Total Cost of the Police Operations: $666,570 to $676,430

(The total cost of the present police operations, as reported, is $614,222 per year. The additional cost of bringing the police operations into compliance with the statute is estimated to range from $52,348 to $62,208 per year with a resultant increase in the average cost per police run of $1.79 based on the larger amount.)

Cost of the Fire Operations

The fire personnel, vehicle, training, base and opportunity costs would remain the same as those reported for the present system.

Fire Personnel Cost:	$0.00 to $123,677
Fire Vehicle Cost:	$51,050
Fire Training Cost:	NONE
Fire Base Cost:	NONE
Fire Opportunity Cost:	UNKNOWN
Fire Equipment Cost:	$5,665 to $6,505

The total annual equipment operating cost is the sum of the fixed and variable costs.

The fixed costs would include the cost increases reported of $884 for vehicle-carried equipment and $21 for station equipment cabinets. The total fixed cost is $905 per year.

The variable cost is that reported of $4,760 to $5,600 per year.

Michigan Ambulance Attendant License Cost:	$75

(See Section 14-4 on Licensing)

Cost of Physical Examinations:	$600 to $1,125

(See Section 14-4 on Physical Examination)

Personnel	$600
Physician	$0 to $525

Additional Administrative Costs:	$2,000

(See Section 14-4 on Administrative Costs)

Total Cost of the Fire Operations:	$59,390 to $184,432

(The total cost of the present fire operations was reported in Section 14-3 as $51,050 to $174,727 per year. The additional cost of bringing the fire operations into compliance with P.A. 258 (1968) would range from $8,340 to $9,705 per year with a resultant increase in the average cost per run of the Fire Department of $0.81 based on the larger amount.)

Total System Cost

The cost of operating the present police and fire emergency recovery system, as modified to bring it into compliance with the statutory requirements, would be the cost of the present system, $665,272 to $788,949, as reported in Section 14-3 under Total System Cost, plus the cost of the

additional operating expenses, which are estimated to range from $60,688 to $71,913.

If the operation of the emergency recovery system is charged for the time contributed by Fire Department personnel, the cost of the modified system would be in the range of from $849,637 to $860,862 per year. If not, the cost would be in the range of $725,960 to $737,185 per year. (For a breakdown of police and fire cost comparisons, see Table 14-12.)

Effect on Quality of Treatment:

(See the discussion in Section 14-7, "Quality of Treatment: Attendant Training and Function v. Cost.")

TABLE 14-12

COST COMPARISON: PRESENT SYSTEM MODIFIED TO STATUTORY REQUIREMENTS

	Cost of Present System	Cost After Modification	Cost of Modification
L SYSTEM:			
CAPITAL COST	-------	$ 48,367	$48,367
ANNUAL OPERATING COST	$665,272	$725,960	$60,688
CE PORTION:			
CAPITAL COST	-------	$ 43,900	$43,900
ANNUAL OPERATING COST	$614,222	$666,570	$52,348
Personnel	556,974	556,974	NONE
Vehicle	52,408	52,408	NONE
Equipment	4,840	26,288	21,448
Administration	-------	10,000	10,000
Licensing			
Fees	-------	1,100	1,100
Training	-------	9,900	9,900
Physical Exams	-------	9,900	9,900
PORTION:			
CAPITAL COST	-------	$ 4,467	$ 4,467
ANNUAL OPERATING COST	$ 51,050	$ 59,390	$ 8,340
Personnel	-------	---------	NONE
Vehicle	51,050	51,050	NONE
Equipment	-------	5,665	5,665
Administration	-------	2,000	2,000
Licensing			
Fees	-------	75	75
Training	-------	---------	NONE
Physical Exams	-------	600	600
Base Station	-------	---------	NONE

Figures in this table are based on the minimum cost in the imated cost range.

14-5. COST OF POLICE OPERATIONS--EFFECTS OF REDUCING THE NUMBER OF AMBULWAGONS

In Chapter 11 of this volume, "Allocation and Distribution of Recovery Vehicles," it is reported that, for single precinct operations, the use of four ambulwagons would provide essentially 100% vehicle availability for response to medical emergencies. Although caution is required in extending observations made in a single precinct to a city-wide system, it is useful to consider these observations as basis for operational experimentation. Vehicle availability is an important consideration in the proper operation of this system since it is undesirable to have significant numbers of medical emergencies wait for vehicles to become available.

In the Section on additional operating costs under 14-4, it has been reported that the police have, on the average, 90 ambulwagons operationally available with an additional 20 undergoing maintenance and repair. Since there are thirteen precincts in the city, the average number of ambulwagons available for operation is 7 per precinct. If an average of only 4 ambulwagons were operated in a precinct and an additional pool of 20 vehicles were provided to allow for routine maintenance and repair, the police would need to operate only 52 vehicles and the total ambulwagon pool could be reduced to 72.

Capital Cost of Vehicle Equipment and Containers

As indicated in the Section on capital costs, 14-4, equipping the present 110 ambulwagons in accordance with the statute would require an initial capital expenditure of $43,120 ($42,020 for medical equipment and $1,100 for equipment containers). In equipping only 72 vehicles, this cost would be reduced by $15,092 to a cost of $28,028. The cost of the base station equipment would not be changed.

Annual Operating Costs

Reduction in the number of ambulwagons operated from 90 to 52, a decrease of 42%, would also have the effect of reducing by the same percentage the number of patrolmen who would have to be licensed. The annual operating costs for training, license fees and physical examinations would similarly be decreased by 42% of the amounts estimated for the police operations in the Section on additional operating costs.

Police Training: $5,742, a reduction of $4,158.

License Fees: $638, a reduction of $462.

Physical Examinations: The cost for personnel lost time would be $5,742 and for physician services, $0 to $4,466, for a total cost of $5,742 to $10,208. This amounts to an annual reduction of $4,158 to $7,392.

Police Administrative Costs: The additional cost of implementation of the statutory requirements would be an estimated $7,000, a reduction of $3,000 due to the decrease in the number of men and vehicles required for operation.

Police Personnel Cost: This cost would remain the same: $556,974, since the personnel contributed time would remain unchanged. Although the number of patrolmen operating the system would be less, the time contributed by each ambulwagon crew would be increased.

Police Opportunity Cost: Since the opportunity cost is assumed to be proportional to the amount of time contributed to the operation of the system by the police, this cost, although it is uncertain, would remain the same.

Police Vehicle Cost: The direct component of the annual variable operating cost would remain unchanged since it is assumed that the number of miles traveled in the transport of emergency victims would remain the same. This component was computed to be $12,319. It is assumed that the total mileage traveled annually by the ambulwagon pool for all activities would be reduced proportionally to the reduction in the number of vehicles. If the mileage traveled by the ambulwagons in the transport of emergency victims remained the same, the only portion of the mileage that would be reduced would be that traveled by these vehicles in the performance of other police functions. Since the pool would be decreased by 35%, from 110 to 72, the total pool mileage would be decreased from 3,827,237 reported for 1968 to 2,487,704, and the number of miles traveled for the other police activities would be reduced to 2,275,313. This would decrease the indirect component of the annual variable operating cost to $9,101. The reduction in the

number of ambulwagons would also lower the annual fixed operating cost to $16,776. The sum of all direct and indirect annual vehicle operating costs would be $38,196.

Police Equipment Cost: Since the number of ambulwagons would be reduced from 110 to 72, or to 65% of the size of the present pool, the annual fixed operating cost for vehicle equipment and containers would be decreased to $9,081. The annual fixed cost for base station equipment would remain the same: $78.

There would be no change in the number of victim transports; therefore, the annual equipment variable cost would also remain the same: $12,240 to $14,400. The total annual equipment operating cost would be in the range of $21,399 to $23,559.

TABLE 14-13

COST COMPARISON:
EFFECT OF REDUCING THE NUMBER OF AMBULWAGONS PER PRECINCT

	Present Number: 7 per Precinct	Reduced Number: 4 per Precinct	Reduction in Cost
CAPITAL COSTS	$43,900	$28,808	$15,092
Vehicle Equipment	43,120	28,028	15,092
Station Equipment	780	780	NONE
ANNUAL OPERATING COSTS	$666,570	$635,691	$30,879
Personnel	556,974	556,974	NONE
Vehicle	52,408	38,196	14,212
Equipment	26,288	21,399	4,889
Administration	10,000	7,000	3,000
Licensing			
Fees	1,100	638	462
Training	9,900	5,742	4,158
Physical Exams	9,900	5,742	4,158

Figures in this table are based on the minimum cost in the estimated cost range.

Summary: The estimated reductions in the capital and annual operating costs that would result by decreasing the average number of ambulwagons operated per precinct from seven to four is presented in Table 14-13. Examination of the figures reveals that, although the initial capital cost would be reduced 34%, there would be only a 4.6% reduction in the total estimated annual operating cost for the police operations. The reason for this is the fact that the major portion (roughly 85%) of the total annual operating cost is the cost of personnel.

Discussion of the Effects of Further Reducing the Number of Ambulwagons Operated

It is appropriate to consider the operating costs of the system if the average number of ambulwagons used per precinct were reduced to less than four. First, however, some of the operational aspects which must be considered in reducing the number of ambulwagons will be summarized.

Effect on Mileage Traveled: Since reduction in the number of ambulwagons operated per precinct would increase the area for each ambulwagon to service, some increase in the average annual mileage traveled by each ambulwagon in the transport of emergency patients might be expected. The exact amount of this increase in mileage is not known. For the purpose of this analysis, no increase in the mileage has been assumed where the reduction in the number of ambulwagons operated per precinct does not result in the frequent dispatch of ambulwagons across precinct boundaries.[7]

Effect on Response Times: It is reported in Chapter 11 that any alteration of the transit distance to the scene within a precinct will not substantially affect the ambulwagon response time (the time spent waiting for the ambulwagon to become available, if any, and the transit time to the scene).

Effect on Vehicle Availability: As stated before, any system which forces a significant number of medical emergencies to wait for an ambulance to become available is undesireable; therefore, a reasonable level of vehicle

7For example, no increase in the average annual mileage was assumed in the Section on Police Vehicle Costs, in which there was a hypothetical reduction in the number of ambulwagons operated per precinct from seven to four.

availability must be maintained. It has been reported in Chapter 11 that, when four ambulwagons per precinct are opera. d, the probability that all four vehicles will be busy at the instant of an ambulance call is practically zero, regardless of the proportion of police calls assigned to these vehicles when all are idle. It is also postulated in Chapter 11 that, when two vehicles per precinct are operated, a reasonable vehicle availability could be maintained by utilizing a "protective dispatch" policy, and it is conjectured that this number could be further reduced by allowing the ambulwagons to cross precinct boundaries.

Use of "Protective Dispatch" Policy and Boundary Crossing: As is reported in Chapter 8, the "Analysis of the Medical Emergency Occurrence Process," it is still uncertain whether there is a daily cycle in the occurrence of medical emergencies. However, it does appear that the variability of the process is slightly greater than that for a truly random sequence, and that the events tend to cluster more frequently. It is not surprising, then, that in the operation of the present police emergency recovery system, police dispatchers on occasion hold ambulwagons in reserve during peak police-call periods and also dispatch ambulwagons across precinct lines. It is proposed in Chapter 11 that a system incorporating a "protective dispatch" policy and precinct boundary crossing be adopted as a means of reducing the number of vehicles operated in the system while maintaining an acceptable level of vehicle response availability. This proposed system would function as follows: Assuming two adjacent precincts with two ambulwagons operating in each, whenever any combination of two of these four vehicles were on an assigned run (medical or police), at least one of the remaining vehicles would be reserved for assignment only to medical emergencies. This reserved or "protected" vehicle would then be available to respond to medical emergencies in either precinct and would remain on reserve status until at least one of the busy vehicles returned to patrol status. The basic question to be answered here is whether it is economically feasible to operate a system which must rely on a protective dispatch policy in order to maintain an acceptable level of vehicle availability. Since the frequent placement of vehicles on reserved status would obviously increase the amount of personnel time chargeable to the operation of the system, the savings anticipated as a result of the reduction in the number of vehicles will first be considered without inclusion of the personnel costs.

TABLE 14-14

ESTIMATED SAVINGS WITH THE AVERAGE NUMBER OF AMBULWAGONS OPERATED PER PRECINCT REDUCED FROM FOUR TO TWO

	4 Per Precinct	2 Per Precinct	Savings
CAPITAL COSTS	$28,808	$14,794	$14,014
ANNUAL OPERATING COSTS (LESS PERSONNEL)			
Licensing	$12,122*	$ 6,061*	$ 6,061
Administrative	7,000	5,500	1,500
Equipment	21,399*	16,859*	4,540
Vehicle	38,196	24,833	13,363
TOTAL (LESS PERSONNEL)	$78,717	$53,253	$25,464

*The lower cost in the cost range has been assumed here.

As reported above, aside from a $14,014 saving in the capital cost, the reduction in the average number of ambulwagons operated per precinct from four to two would result in an annual operating saving (exclusive of personnel costs) of $25,464. Using the annual police personnel

operating cost of $556,974 for the four-ambulwagon-per-precinct system as a baseline, it is apparent that this saving would be offset if the protective dispatch system resulted in an increase of the annual police personnel operating cost of $25,464, or 4.6% of $556,974. As can be seen from examination of the probability figures presented in Chapter 11, the amount of time for which the ambulwagons and their crews would be expected to be on reserve status in the proposed protective dispatch system would entail a personnel cost substantially in excess of the amount saved by reducing the number of vehicles. Actual computation of the probabilities, using the data collected in the 15th Precinct, reveals that for each of the two precinct areas, one of the ambulwagons can be expected to be on reserve status over 20% of the time.

It would definitely appear that reliance on a system which depends on a protective dispatch policy in order to maintain an acceptable level of vehicle availability for medical emergencies is not cost-effective and that the minimum average number of ambulwagons that can be operated efficiently per precinct is four.

14-6. COST OF OPERATING A MUNICIPAL EMERGENCY AMBULANCE DEPARTMENT

In the previous systems that have been considered, emergency medical service was provided by the use of dual-purpose vehicles and of personnel whose primary mission is to provide some other municipal service. The capital and annual operating costs of a system whose sole purpose is emergency medical care and transport will now be considered. It will first be necessary to estimate the number of vehicles which would be required in order to insure a system having an acceptable level of vehicle response availability.

Number of Vehicles Required

In Chapter 11 "Allocation and Distribution of Recovery Vehicles," it is estimated that 19 to 20 vehicles would be required. This estimate is based on emergency medical occurrence data collected in the 15th Precinct. It was first computed that the percentage of time that a single-function vehicle would be immediately available for response to a medical emergency would increase as a function of the number of such vehicles operated in a precinct.

No. Operated Per Precinct	Percent of Time Immediately Available
1	79
2	98
3	99.8

It has also been established that the use of two vehicles provides a substantial improvement in vehicle availability while only a small increase is realized by the operation of three vehicles.

Use of two vehicles per precinct would require 36 vehicles for the entire city. However, it is further observed in Chapter 11 that for any two adjacent precincts, each having two vehicles in operation, the probability that all four vehicles would be simultaneously busy is 0.04%. From this it is conjectured that it might be possible to further reduce the number of vehicles operated and still maintain an adequate level of availability by operating three vehicles for a service area the size of two precincts. The number of vehicles required for the city would then be 19 to 20. As has been stated before, the extrapolation of single precinct observations to the entire city must be done cautiously; further experimentation would be required to validate this conclusion.

Additional insight can be gained by examining emergency ambulance operations in other urban areas. For example, the City of Chicago has operated an ambulance division within its fire department for a number of years. If it is assumed that the number of ambulances operated in that city reflects the number needed to provide a proper level of service, then comparison of its population, area and emergency medical demand characteristics with those of the city of Detroit may provide another basis for estimating the number of ambulances required.

TABLE 14-15

COMPARISON OF EMERGENCY MEDICAL SERVICES REQUIREMENTS: DETROIT AND CHICAGO

	Detroit	Chicago
Population	1,600,000	3,500,000
Area (square miles)	140	213
Number of emergency medical runs, 1967	49,056*	68,931
Number of ambulances	20 (estimated)	28

*Police and fire rescue runs.

The above figures indicate that the City of Chicago has a lower demand for emergency medical services per capita. This may be due to a wide variety of factors. More importantly, it would appear that the estimate of 20 ambulances for Detroit correlates well with the size of the area and the number of calls to be serviced.

In the above comparison, it was reported that the City of Chicago operates 28 ambulances. Actually, in 1967 only 25 ambulances were operated. However, several years ago Chicago replaced the sedans used by the battalion chiefs with station wagons equipped with folding litters, oxygen and first-aid packs. These vehicles are used to back up the ambulances (the frequency of use of these vehicles is not reported). In 1969, the Chicago Fire Department reportedly increased the number of ambulances to 28. Since this increase is assumed to be based on the demands for service experienced during 1967 and 1968, it is felt that the use of the 28-ambulance figure reported above is reasonable and meaningful for purposes of comparison.

In the following analysis it has been assumed that a minimum of 20 vehicles would be required to provide proper service, and that a total vehicle pool of 24 would have to be maintained in order to insure that 20 vehicles would be operational at all times.

Capital Costs

Vehicles: Since either an ambulance or station wagon could be used for response to medical emergencies, the cost for both will be computed. The vehicles under consideration are the hospital ambulance and the ambulwagon, which were discussed in the Section 14-2 on Vehicle Costs. As reported in that section, each ambulance costs $7,550 and each ambulwagon $2,450. In addition, each of the 24 vehicles would require installation of radios at a cost of $1,100 each. The capital cost for the ambulances would be $207,600 and for the ambulwagons, $85,200.

Equipment: As derived from Table 14-9, the cost of equipping each of the 24 vehicles to the statutory requirements is $382. In addition, each of the ambulances would require one folding stretcher at $90 each and each of the ambulwagons would require two folding stretchers. (The purchase price of the ambulance includes a wheeled cot.) The capital cost for equipment for the ambulances would be $11,328 and for the ambulwagons, $13,488.

Base Stations: Although the vehicles could be operated from curb-side locations, personnel comfort and supply storage would probably require establishing a base station for each of the 20 vehicles operated. The capital and annual costs for using an existing city facility or a separate facility are reported in Table 14-10. The total capital cost for developing 20 existing municipal facilities as base stations would range from $3,500 to $9,500 and for 20 separate facilities, from $19,400 to $47,900.

Annual Operating Costs

Personnel: Since each of the 20 vehicles operated would require a crew of 2 men, a total of 40 positions would have to be staffed continuously. It has been assumed that personnel equivalent to the City Ambulance Attendant/Operators would be employed. As reported in Table 14-4, each position to be staffed would require employment of a minimum of 4.8 men at a total annual cost of $9,413 per man or $45,182 per year for each position. The cost of employing 192 men a year would be $1,807,296.

(This does not include the cost required to maintain a small relief pool of employees or the costs for administration of the department.)

Vehicles: The estimated annual operating costs for both the ambulances and the ambulwagons will be computed. Use of these vehicles for the exclusive purpose of providing emergency medical service would change the average annual vehicle mileage and therefore the operational life expectancy or replacement schedule upon which the vehicle fixed operating costs are based. The reported total annual mileage traveled by all police and fire vehicles in 1968 for the transport of emergency victims was 288,706. If it is assumed that the mileage characteristics of the system would not change substantially as a result of the change in operations to an exclusive emergency ambulance department, then the average annual mileage anticipated for each of the 24 response vehicles would be 12,000 miles. It is estimated then that the new replacement schedule for the ambulances would be five years and for the ambulwagons, four years. Using the same method of computation as in Table 14-5, the annual fixed operating cost for the ambulances would be $37,200 ($1,550 per vehicle) and for the ambulwagons, $16,080 ($670 per vehicle). The annual variable operating cost for 288,706 miles for the ambulances would be $31,180 and for the ambulwagons, $16,745. The total annual operating costs for the ambulances would be $68,380 and for the ambulwagons, $32,825.

Equipment: The annual fixed operating cost for the ambulance package is $2,340 and for the ambulwagon package, $2,808. The annual variable cost would remain the same, $17,000 to $20,000, for a total annual equipment operating cost of $19,340 to $22,340 for the ambulances and $19,808 to $22,808 for the ambulwagons.

Licensing: The annual cost for license fees would be $192 and for physician services for physical examinations, $0 to $1,344. There would be no cost for training.

Base Stations: On the basis of the costs reported in Table 14-10, the annual cost for using existing city facilities for base stations would range from $140 to $340. For use of separate facilities, the cost per year would range from $56,740 to $80,740.

TABLE 14-16

MUNICIPAL EMERGENCY AMBULANCE DEPARTMENT
COST COMPARISON - USE OF AMBULANCES v. AMBULWAGONS

	Ambulances	Ambulwagons	Cost Difference
PITAL COSTS	$ 222,428	$ 102,188	- $120,240
Vehicle	207,600	85,200	- 122,400
Equipment	11,328	13,488	+ 2,160
Base Stations[a]	3,500[b]	3,500[b]	NONE
NUAL OPERATING COSTS[c]	$1,895,348	$1,860,261	- $ 35,087
Personnel	1,807,296	1,807,296	NONE
Vehicle	68,380	32,825	- 35,555
Equipment	19,340[b]	19,808[b]	+ 468
Licensing	192[b]	192[b]	NONE
Base Stations[a]	140[b]	140[b]	NONE

[a]Costs are for the use of existing City facilities.
[b]Lowest cost in cost range.
[c]Total annual operating cost does not include the costs of ministration.

Effect on the Police and Fire Annual Operating Costs

There are direct operating costs incurred by the Police and Fire Departments as the result of their present involvement in the transport of emergency medical victims. The establishment of a separate municipal emergency ambulance department would therefore result in a cash saving in the operations of these two departments which could be applied to the operation of the new department. This would help reduce the additional cash outlay that the creation of such a department would require.

Vehicle Operating Costs: During 1968 the fire rescue trucks reportedly traveled a total of 76,315 miles in responding to medical emergencies. Since the computed annual

variable operating cost per mile for these vehicles is $0.21(7), a saving of up to $16,560 would be realized. However this saving presumes that the reduced operation of the trucks would result in a reduction in the personnel staffing of the Fire Department maintenance garage since a portion of the variable cost supports this operation. If this did not result, it is still estimated that the reduced truck usage would result in an annual saving of $9,000 in gas, oil, parts and tires. The annual saving in the variable operating cost of the fire rescue trucks is estimated to range from $9,000 to $16,560. It has been estimated by the Fire Department that the average operational life expectancy for these trucks has been reduced by two years because of the greater load placed upon them recently. Examination of the increases in the emergency medical runs and the fire runs made by the department in the last several years would seem to indicate that removal of the medical function would increase the average replacement schedule for these trucks back to eight years from the present six. This increase would result in an annual saving in the fixed operating costs of $13,970.

As for the Police Department, in the Section on Vehicle Costs under 14-2, it was estimated that an average annual saving of $362 would be realized for every ambulwagon replaced by a two-man scout. This estimate was based on the higher purchase price and operating cost per mile of the ambulwagon. An additional annual saving of $44 for each ambulwagon replaced by a scout would be realized because the folding litters with which they are presently equipped would no longer be required. The total annual savings to the Police Department would be $44,660. The combined annual savings of both departments would then range from $67,630 to $75,190.

Personnel Costs: As has been stated previously, Fire Department rescue squad staff would not be reduced nor would staff be reassigned to perform other duties if the emergency medical response function were transferred to another agency. The use of fire personnel between fire runs for the emergency function does not presently appear to interfere with the Fire Department's ability to respond to these fire runs. Consequently, there would be no saving in the Fire Department's personnel costs nor would any other operational benefit accrue.

This same reasoning does not apply to the operations of the Police Department. Patrolmen, when not on an assigned police run, have a number of other functions which they perform. The removal of the emergency medical service from their operations would have one of two possible consequences: reduction in the work force, or retention of all personnel to improve service. Increasing demands for police services would make selection of the first alternative unlikely. During 1968, police personnel reportedly spent a total of 61,065 man-hours responding to medical emergencies. Transfer of this function to another agency would be equivalent, theoretically speaking, to adding 34.3 patrolmen to the department. (The actual number would be less than this since many of the medical emergency runs made require some other police activity which is also provided by the patrolmen making the medical response.) This is the number of patrolmen required to staff seven positions or 3.5 two-man scout cars continuously for one year.

However, after deduction of the maximum annual vehicle saving that might be expected in the police and fire operations from the estimated annual operating cost of a municipal emergency ambulance department, the additional annual cost of such an agency to the city would be $1,785,071. At first glance the removal of the emergency medical function from the Police Department seems attractive in that it would release a number of patrolmen for other activities and thereby increase the department's ability to perform other police functions. Nevertheless, if the city were to continue present operations, utilizing the Police and Fire Departments, and incur the additional annual expense of upgrading the system to the statutory level, the difference between this cost and the cost of operating a municipal ambulance department would be sufficient to hire an additional 108 patrolmen.

Effect on Quality of Treatment

(See the discussion on the Effect on Quality of Treatment under Section 14-7.)

14-7. COST OF CONTRACTING WITH COMMERCIAL AMBULANCE COMPANIES FOR EMERGENCY SERVICE

During the demonstration phase of the Emergency Medical Services Project, two well-equipped commercial ambulances staffed by qualified personnel were hired for a period of six months. Both ambulances were required to be operational twenty-four hours a day and to respond in selected precincts to medical emergencies normally serviced by the police ambulwagons. In order to maximize the amount of operational data collected by these ambulances, an exclusive services contract was negotiated to insure the highest level of response availability. Base stations for each of the ambulances were established in existing city facilities (fire engine houses and precinct stations) at minimal expense. The presence of the commercial ambulances and personnel was well accepted by the city personnel housed in and/or working in these same facilities. In fact, the operations of this "mini-system" seemed to have such potential as to make it appropriate to consider the costs of contracting with commercial ambulance companies to provide service to the entire city.

Cost of Commercial Service--Exclusive Service Contract

The cost of the contract for the exclusive services of these two ambulances for a period of six months was $66,504. This cost should be equivalent to the cost of hiring one ambulance for a period of one year. On the basis of the present level of demand for service, it was estimated in Section 14-6 that a total of 20 ambulances, responding exclusively to medical emergencies, should be able to provide service of an acceptable quality to the entire city. Using the costs encountered during the project, the anticipated cost of contracting for the exclusive services of 20 commercial ambulances for one year would be $1,330,080. This figure presumes that the city would pay the cost of developing and maintaining the 20 base stations required. As reported in the previous section, if existing municipal facilities were used, the capital cost for developing this number of base stations would range from $3,500 to $9,500 with negligible annual operating costs thereafter. If the costs of establishing and operating base stations were made the responsibility of the contractor(s), the cost of the contract would undoubtedly be higher. It is possible that one or more of the ambulances could be operated from the business premises of the contractor(s), depending on the number of companies contracted with. However, most of the base stations would have to be created because proper dispersal of the vehicles is required in order to maintain the desired system operating characteristics. As reported in the previous section, the additional costs to the city would be reduced by savings estimated at $67,630 to $75,190 per year which would occur in the Police and Fire Departments as a result of relocating responsibility for the service. Assuming the maximum annual savings of $75,190, the increased annual cost to the city for contracting this service would still be substantial: $1,254,890.

Hypothetically, if the city were to continue present operations utilizing the Police and Fire Departments and incur the additional annual expense of upgrading the system to the statutory level, the difference between this cost and the cost of contracting for this service with commercial companies would be sufficient to hire an additional 75 patrolmen. However, the cost of contracting for the service is $530,181 less per year than the cost of operating a municipal ambulance department. (Review of the comparative wage data presented in Table 14-4 indicates that this reduction in cost would be primarily due to lower personnel costs experienced by the commercial ambulance companies.)

Comments on Commercial Service Contracts

Without apparent exception, present public opinion places a high value on an ambulance service which has a rapid response time. The response time achieved (once the emergency has been detected and reported) depends on the time spent waiting for an ambulance to become available, if any, and the time required for the ambulance to travel to the scene of the emergency. It has been observed that the response time will vary depending on the allocation and distribution of ambulances in the area to be serviced and on the emergency occurrence and service process characteristics of that same area (see Chapter 11). It would be possible to respond to all the emergency medical calls generated in the City of Detroit with only five vehicles, regardless of whether they were operated in a single-function or dual-function mode. However, a large number of emergencies would be required to wait long periods of time before assistance arrived. The costs of operation would be attractively low, but the quality of service in terms

of response times would not be acceptable to the community. Therefore, once the parameters of the present emergency occurrence and service process for the City of Detroit were established, a geographical dispersion of the vehicles was presumed and a vehicle allocation defined for each of the systems discussed above so that the response times achieved would approximate those now provided by the police/fire emergency medical response system. On this basis, the same number of ambulances would be required under an exclusive service commercial contract as would be required for a municipal emergency ambulance department. A contract cost reduction might be achieved by eliminating the requirement for exclusive service, thereby allowing the contractor to use these same vehicles for his regular, non-emergency business. However, a change in vehicle allocation would probably be required in order to maintain the same response time characteristics, which perhaps would cancel any savings made. If this effect on vehicle allocation were not recognized, the quality of service would be diluted, perhaps below the level desired and thought to be contracted for. The terms of such contracts should establish operational criteria which may be monitored to insure that the quality of service desired and purchased is maintained. For this type of contract it may be necessary to analyze the occurrence and service process for both emergency and non-emergency calls just as such analysis was required for the police and medical emergency calls in the police dual-function system (see Chapter 11). For areas with reasonably high population densities, it would appear that exclusive service contracts, whose terms clearly specify the ambulance allocation and distribution required would be the most desirable and the easiest to monitor. However, for small and/or less densely populated areas, exclusive service contracts might be too expensive in terms of the estimated annual load; other types might be more appropriate. Nevertheless, the quality of the service desired should always be carefully considered.

Quality of Treatment: Attendant Training and Function v. Cost

During the planning phase that preceded the demonstration, it was felt that some of the training programs to be studied were of a higher level and of better quality than others, and that they would be more effective in terms of patient care and prognosis. As discussed in Chapter 12, it had been postulated that the relative effectiveness of the training programs would be reflected by variations in the incidence of correct diagnosis and of proper treatment provided by the attendants. However, analysis of the data received revealed the lack of a consistent relationship of the incidence of correct diagnosis and the incidence of appropriate treatment with the various levels of training. Failure to provide treatment was not positively correlated either with failure to recognize and diagnose or with the level of training received. In fact, most of the injuries which were not treated were recognized and diagnosed correctly. These results suggest that the incidence of correct diagnosis and proper treatment is affected by factors other than the level of training received by the various groups of personnel.

Of the various personnel units studied during the demonstration, it is found that the incidence of appropriate treatment was greatest for those units composed of fire rescue squad and commercial ambulance personnel; the incidence of treatment was lower for units composed of police personnel, regardless of the level of training received. The observed difference in the number of functions performed by the police and fire personnel at medical emergencies seems to best explain these findings. Fire rescue personnel have only one function: that of providing emergency medical care. Depending on the particular circumstances, police personnel may have a variety of other functions to perform at an emergency scene which could conceivably distract them from the medical care function with a resultant reduction in the incidence of treatment. This explanation applies equally to the reported difference in treatment provided by the commercial ambulance personnel. (In this respect, the treatment incidence reported for the commercial personnel duplicates that which would be expected for the personnel in a municipal ambulance department.) Therefore, it is reasonable to conjecture that treatment at the scene is affected more by the responding personnel's function at the scene than by the differences, if any, in the training levels that were studied. If it is presumed that there is some difference in treatment as a result of the variations in training, then it follows that this difference in treatment is probably small since it is masked by the effect of function at the scene. Of course, the results of the demonstration are also consistent with a presumption that there is no difference in

treatment for the range of training levels studied; that only the function of the personnel at the scene causes the change in the treatment reported for the various groups of personnel.

Despite the fact that the evidence for the above statements is not conclusive, it would be appropriate to judiciously apply these observations to the design of an operative emergency response system. The degree to which these observations are applied in any proposed system must be consistent with the evidence supporting the observation and must be balanced against the cost of implementation and the estimated benefit in patient condition.

It would appear, then, that the levels of training examined in the demonstration are, for all practical purposes, equally satisfactory in terms of victim treatment at the scene. There is no evidence that the greater costs experienced in providing some of the training programs studied in the demonstration are justified in terms of improved performance. In addition, as observed in Chapter 12, the more dramatic or sophisticated emergency medical techniques and procedures (which are associated with substantially higher levels of training than were studied during the demonstration) are infrequently indicated. Even when indicated their use must be viewed in conjunction with the relatively short emergency response times characteristic of this, and probably all, urban areas. Given that the responding personnel will be trained to a level within the general range studied in the demonstration program (this range includes the level of training required by the state statutory standards,) it would appear that the incidence of appropriate treatment would be most improved if the number of functions for which the ambulance unit is responsible at the scene is restricted to emergency medical care only.

In terms of the personnel to be used, comparison of the costs estimated for the alternate emergency systems which have been considered clearly indicates that the amount of "non-productive" time that must be financed to insure adequate response availability for any system providing ambulance service exclusively (such as the municipal department and commercial contract systems) would result in costs far in excess of those to be experienced through use of existing personnel in a non-exclusive system. This is true even where the existing personnel to be used are costly in terms of both salary and fringe benefits.

Although an exclusive ambulance system might be advocated on the basis that the personnel tend to provide a higher incidence of appropriate treatment, this benefit must be balanced against: (1) The greater costs involved. (2) The uncertain value that this benefit has in terms of patient condition and prognosis. (3) The finding that existing personnel, used in a non-exclusive system, can also provide equivalent treatment if their function at the scene is similarly restricted.

If consideration is given only to those observations which have been made above on training, function and system cost characteristics, it appears that an ideal emergency medical response system would be one utilizing personnel: (1) who are already employed to perform other municipal services, (2) whose function at the scene is solely emergency medical care, and (3) who have been trained in accordance with the statutory standards. Of course, there are other findings and observations which have been made during the demonstration and which should also be considered. These will be summarized and incorporated into a proposal for an alternate emergency response system in the section immediately following.

-8. COST OF OPERATING A FIRE DEPARTMENT AMBULANCE SERVICE

As a result of several observations made in analyzing the costs of various methods of providing emergency medical services and the operational cost implications of compliance with Mich. P.A. 258 (1968), and on the basis of certain project findings, it appears logical to consider the cost of assigning the entire emergency medical service to the Fire Department. The observations and findings which led to this conclusion are:

1. In complying with the statutory requirements, certain cost and operational benefits could be realized by reducing the number of vehicles operated in the system and restricting their use to emergency medical service only:

   a. The capital and fixed operating costs for medical equipment could be lowered.

   b. The number of personnel to be qualified could be reduced with a resultant decrease in both the direct and administrative costs for training and licensing.

   c. Personnel and supply logistics could be simplified and better management control achieved.

   d. The amount of personnel time required to maintain the vehicle compartment at the level of cleanliness required by the statute could be reduced to the minimum. Where vehicles are used frequently for non-ambulance activities (particularly police activities,) the amount of time required would be substantial.

   e. The operating costs of the vehicles used in the present police/fire system are inappropriate for use in their major areas of activity, thereby adding significantly to the cost of emergency medical service. The rescue trucks are too expensive to operate for ambulance service and the operation of a large fleet of ambulwagons, used primarily for regular police activities, also adds significantly to the operating costs of that department.

2. It is not necessary to continue to operate a large number of multi-purpose vehicles on continuous patrol in order to achieve rapid response times. Equal response performance can be achieved, and the number of vehicles reduced, by changing to a fixed-base operation. Of course, this will require the establishment of a number of base stations.

3. Examination of the response time characteristics for several vehicle distribution policies reveals that a simple geographic dispersal of the vehicles would be the most suitable. This policy will require that a base station be established for each vehicle operated.

4. The minimum number of ambulance vehicles required in

order to insure adequate service for the City of Detroit is estimated to be twenty. However, this number would be sufficient only if these vehicles and crews were used exclusively for emergency medical response. If, as is recommended, a non-exclusive service is adopted (i.e., the ambulance personnel are used for activities other than emergency medical response,) an additional number of vehicles will be required. This additional number of ambulance vehicles will depend on the operating characteristics of the service to which the emergency medical response function is attached. It is estimated that a minimum of 22 vehicles would be required if this function were attached to the city's fire-fighting service. In view of the savings which could accrue by reducing the number of vehicles operated, it is interesting to observe that this is the least number of vehicles that would be required in any non-exclusive service.[8]

5. It has been observed that the costs of operating a fixed-base system could be minimized through the use of existing municipal facilities as base stations. In recognition of this and the number and distribution of stations required, use of fire department facilities is the most appropriate choice.

6. The present policy of using existing municipal manpower resources to provide emergency medical response in a non-exclusive service results in a far less expensive system. The amount of "non-productive" personnel time that would have to be financed in order to insure adequate response availability in any system providing ambulance service exclusively would increase costs significantly.

---

[8]As reported in Section 14-5, if the present police/fire system were continued, the minimum number of vehicles required in the police subsystem would be 52. This assumes that the fire subsystem will continue to operate 7 rescue trucks for a total allocation of 59 vehicles. Although the present police/fire system is also a non-exclusive system, it differs from the proposed system in that the vehicles operated are dual-purpose. In the proposed fire department system, the vehicles used for medical response would be single-purpose (for medical response only).

7. Substantial system savings could be made as a result of using existing manpower resources more efficiently. The responsibility for the emergency response service should be assigned to a department in which it's performance would cause the least possible interference with the performance of other departmental activities. A review of existing city services revealed that the activity of an ambulance service is identical to, and very compatible with, a fire-fighting service--much more so than with a police service. The use of police officers for emergency medical response interferes with their ability to perform routine police functions. As a result of this interference, a substantial personnel cost must be added to the operation of the present police/fire system--as well as an "opportunity" cost.

8. There is no evidence to suggest that the level or quality of treatment is increased through the use of personnel whose sole function is that of emergency medical care. Equal levels of treatment can be provided by personnel who also perform other services between emergency medical responses. There is evidence to suggest that the level of treatment (measured as the incidence of appropriate treatment) is higher if the function of the ambulance crew at the scene is restricted to emergency medical care only, with incidental functions, such as crowd and traffic control, performed by other personnel. The results of the demonstration suggest that the personnel used for emergency medical response can perform other functions in addition to emergency medical care without a deterioration in the level or quality of treatment, provided that they are not expected to perform or be concerned about these other functions simultaneously with that of emergency medical care. This restriction on the number of functions to be performed by responding ambulance personnel has been incorporated into the operations of the proposed Fire Department ambulance service in order to maximize the quality of treatment provided.

9. Any proposed modification of the present police/fire system requires a re-evaluation of the communications subsystem. As observed previously for other system

elements, the costs of operation can be minimized by the use of existing base communications equipment, personnel and facilities. It has been reported in Chapter 2 that the number of requests received for emergency medical response is large and that there is a need for proper screening. The only existing facility in Detroit capable of screening this volume of calls is the police IMPACT Center, where the majority of calls are presently received and screened. Since emergency medical response is frequently required in conjunction with police service, reception of both types of calls at a common location expedites the coordination of both services, an additional advantage to the operation of the proposed system. The continued use of the IMPACT Center for notification and screening also removes the need to re-educate the public generally along with other organizations which contribute to the notification process. The proposed change in the operation of the system would require a change in the location of the vehicle selection and dispatch function. Since the proposed system places the entire emergency medical response system (with the exception of screening) within the Fire Department and requires that this service and that of fire fighting be intimately coordinated, the vehicle selection and dispatch function must necessarily be located within that department also. Under the present police/fire system, the fire communication center handles one-forth of all emergency medical dispatches. Provided that the screening function were located in the IMPACT Center, the fire communication center would appear to have sufficient reserve capability to assume the vehicle selection and dispatch functions for these additional 22 vehicles. A means of exchanging information between the police IMPACT and fire communication centers already exists in the present system through the use of direct phone lines. It would appear that the modified communication subsystem, consisting of screening at the IMPACT Center and transfer of information to the fire communications center by direct police phone for use in the vehicle selection and dispatch functions, would not result in any additional delay in the notification-dispatch sequence.

Discussion - Operating Characteristics of the Proposed System

At the present time there are 51 engine companies, 30 ladder companies and 7 squad companies operated in the city. Because of the greater number of potential locations available for use as ambulance bases and because of greater manpower availability, it would appear that the emergency medical response function would be most suitably located in engine company facilities. In the Section on the number of vehicles required under 14-6, it was estimated that 20 vehicles would be required to maintain an acceptable level of response availability for a municipal ambulance department. Since the operation of a dual-function fire-fighting ambulance service would require fire personnel to respond to fires as well as to medical emergencies, it is estimated[9] that a total of 22 vehicles should be operated with a total vehicle pool of 26 to allow for maintenance and repair.

Operationally, the system could work as follows: Between fire runs, the ambulance detail (two men) at each of the engine/ambulance (E-A) stations would respond to medical emergencies as dispatched by the fire communications center. Whenever fire runs were received at one of the E-A stations, the firemen detailed to the ambulance would respond to the fire on the engine with the rest of the company; ambulance coverage for that area would be provided during this period by adjacent E-A stations.

In the event that the ambulance detail was already occupied with an ambulance run when a fire alarm was received which would ordinarily be serviced by their company, at least two options are available under the present fire

[9]The Detroit Fire Department 1968 Annual Report reveals that the total number of runs made by the engine companies was 50,996 and that the total hours of service for all these runs was 8,458.6 hours. The pertinent averages obtained from these figures are: Time per Run--10 minutes; Runs per Company--962 per year or 2.6 per day; Service Time per Company--26.4 minutes per day, or less than 2 percent of the total available time. However, the time spent by the average engine company in controlling fires in that company's immediate area is less than 1 percent of the total available time since more than one engine responds to an alarm.

service operations: (1) the alarm could be assigned to an adjacent engine company, or (2) the manpower shortage on the engine could be offset by simultaneously dispatching the ambulance detail from an adjacent E-A station. This detail would respond to the fire scene in their ambulance and would assist the responding "short" engine company as fire-fighting personnel. If the first option were selected, the net effect would be that 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 stations 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 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 as reported above.) It would appear, then, that the shift of the entire public-supported ambulance function to some of 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.

Because the personnel used for the ambulance service are already housed in the engine houses, no additional facilities for personnel will be required. However, there may be insufficient garage space in the station for the ambulance, in which cases the vehicle will have to be parked outside, increasing the opportunity for vandalism. While this is not seen as a major problem, the average time between dispatch and arrival at the scene will not be sufficient to permit the heating system of the vehicle to bring the compartment temperature to a proper level for victim transport during cold weather. It is considered important that the compartment, and the equipment within it, be constantly maintained at the proper temperature level. Although continuous running of the motor and heating system would maintain the temperature, this would

be a costly solution. The installation of a small, electric heater in the patient compartment, with appropriate connectors for convenience in attaching an electric line, would appear to provide a solution at reasonable cost. The expansion of existing garage areas would, of course, be a most expensive solution.

Capital Costs[10]

Vehicles: Either ambulances or station wagons could be used as is also the case for the proposed municipal ambulance department. Costs for both are computed here on the same basis as was done in that analysis. The total cost for 26 ambulances would be $224,900 and for the same number of ambulwagons, $92,300. Both figures include the cost of radios.

Equipment: The cost to equip each ambulance would be $472 and for each ambulwagon, $562. The total cost for 26 ambulances is therefore $12,272 and for 26 ambulwagons, $14,612.

Base Stations: The estimated cost of establishing an ambulance base in 22 fire engine houses would be $175 to $475 each for a total of $3,850 to $10,450.

Annual Operating Costs[10]

Personnel: Since this service would be provided with existing fire personnel without interfering with their ability to respond to fire calls, no personnel cost for this system is assumed.

Vehicles: The operating costs per vehicle estimated for the proposed municipal ambulance department would apply here also. The total cost for the 26 ambulances would be $71,480 and for the 26 ambulwagons, $34,165.

Equipment: The annual fixed operating cost for the ambulance package is $2,535 and for the ambulwagon package,

[10]The capital and operating costs developed in these sections are based on figures developed in Section 14-6.

$3,042. The annual variable operating cost of the system would remain the same, $17,000 to $20,000. The total annual equipment operating cost for the ambulances would be $19,535 to $22,535 and for the ambulwagons, $20,042 to $23,042.

Licensing: Each of the 22 vehicles operated would require that at least one of the personnel assigned be licensed in accordance with the statute. As reported in Table 14-4, at least 4.3 firemen are required for every position staffed continuously. In the Section on additional operating costs under Section 14-4, it is recommended that this minimum number be increased by a factor of 2.5 to preserve scheduling and assignment flexibility. The number of men required to be licensed is therefore 237 and the license fee cost is $237. Annual physical exams would also be required for each of these men at a cost of $0 to $7 per man. This cost would range from $0 to $1,659. The total annual licensing cost would then range from $237 to $1,896.

Base Stations: On the basis of the costs reported in Table 14-10, the annual operating cost estimated for all 22 base stations would range from $154 to $374.

A summary of the capital and annual operating costs of a Fire Department ambulance service is presented in Table 14-17. The costs of using either ambulances or ambulwagons and the cost differences are presented for comparison.

Cost Comparison - Police/Fire v. Fire Ambulance Service

Table 14-18 summarizes the capital and annual operating costs of a combined police/fire ambulance system versus the costs of operating a Fire Department ambulance system. The cost figures for both systems include the additional costs that would be experienced in complying with the requirements of Mich. P.A. 258 (1968). The police/fire system costs assume that the number of police vehicles operated has been reduced to an average of four per precinct, as discussed in Section 14-5.

Capital Costs: As can be seen from the Table, the capital costs estimated for the police/fire system in order to bring it into compliance with the statutory standards would be limited to the purchase of medical equipment for the response vehicles and storage cabinets for the precinct and rescue squad stations. The capital costs for a

fire ambulance service include these costs (which are less since the number of vehicles to be equipped has been red‑uced) and, in addition, the cost of acquiring a fleet of 26 ambulwagons.

TABLE 14-17

FIRE DEPARTMENT AMBULANCE SERVICE
COST COMPARISON--USE OF AMBULANCES v. AMBULWAGONS

	Using Ambulances	Using Ambulwagons	Cost Difference
CAPITAL COSTS	$241,022	$110,762	- $130,260
26 Vehicles	224,900	92,300	- 132,600
Equipment	12,272	14,612	+ 2,340
22 Base Stations[a & b]	3,850	3,850	NONE
ANNUAL OPERATING COSTS[c]	$ 91,406	$ 54,598	- $ 36,808
Personnel	0	0	NONE
26 Vehicles	71,480	34,165	- 37,315
Equipment[b]	19,535	20,042	+ 507
Licensing[b]	237	237	NONE
22 Base Stations[a & b]	154	154	NONE

[a]Costs are for use of existing city facilities.
[b]Lowest cost in the cost range.
[c]Total annual operating cost does not include the costs of administration.

Annual Operating Costs: Table 14-18 excludes the personnel and administrative costs of both systems. As has been stated previously, there is no cost assumed for the time contributed to the operation of the emergency medical response system by fire personnel. Utilization of fire personnel for this function need not interrupt or interfere with their fire-fighting functions. On the other hand, the personnel cost for the use of police personnel has been estimated at $556,974 per year, equivalent to

TABLE 14-18

COMPLIANCE WITH STATUTORY REQUIREMENTS
CAPITAL AND ANNUAL OPERATING COST COMPARISON
PRESENT POLICE/FIRE OPERATION v. FIRE DEPARTMENT AMBULANCE SERVICE

	Police - Fire System				
	Fire Rescue	Police[a]	Total	Fire Ambulance Service	Cost Difference
CAPITAL COSTS	$ 4,467	$28,808	$ 33,275	$110,762	+ $77,487
Vehicles	0	0	0	92,300	+ 92,300
Equipment	4,257	28,028	32,285	14,612	- 17,673
Base Stations[c]	210	780	990	3,850	+ 2,860
ANNUAL OPERATING COSTS (EXCLUDING PERSONNEL AND ADMINISTRATIVE COSTS)					
	$56,790	$60,233	$117,023	$ 54,598	- $62,425
Vehicle	51,050	38,196	89,246	34,165	- 55,081
Equipment[c]	5,644	21,321	26,965	20,042	- 6,923
Licensing[c]	75	638	713	237	- 476
Base Stations[c]	21	78	99	154	+ 55

[a] Cost of Police operations based on average use of four ambulwagons per precinct.
[b] Costs assume use of ambulwagons.
[c] Lowest cost in the cost range.

the services of 34.3 patrolmen annually. These figures do not reflect the additional time (or cost) that would be required for annual licensing and training, maintenance of vehicle cleanliness and medical supply replenishment. There would also appear to be a substantial difference in the amount of administrative effort and support services required for the operation of the two systems. This difference is due to the larger number of vehicles and personnel involved in the police operations. This increases the complexity of the system logistics far beyond that estimated for the fire ambulance service.

Discussion - Budget Appropriations

In the previous sections of this chapter, the total estimated costs of various alternative methods of providing an emergency medical response service have been described. However, it is obvious that, where such a service already exists and the costs of operation are presently budgeted, complete changes or modifications in the method of providing this service will involve the realignment of existing appropriations. Discussion here will be limited to the changes that would result through implementation of either the police/fire service or the fire ambulance service presented above.

Capital Expenditures: The additional expense of purchasing the required vehicles and/or equipment will be the same as reported for the capital costs of both systems in Table 14-18.

Operational Expenses: Additional operating expenditures would be required for the police/fire system equal to the sum of the equipment, licensing and base station costs listed in Table 14-18, i.e., $27,777. Due to the reduction in the number of police ambulwagons operated in this system as compared to the number presently operated, the police vehicle budget would be reduced by $14,212 annually. (This presumes that the number of ambulwagons removed from service would be replaced by an equal number of two-man scouts. These savings reflect the lower fixed and variable operating costs of the scouts.) In effect, this reduces the costs of operation of the system from the $27,777 reported above to $13,565 annually. The annual operating expense of the fire ambulance system will also be the sum of the equipment, licensing and base station costs reported in Table 14-18, plus the additional vehicle operating costs. However, as reported in Section 14-6, under Effects on Police and Fire Annual Operating Costs, the use of these vehicles for the emergency medical response service will reduce the police and fire vehicle operating costs by an estimated $67,630 to $75,190 annually. The capital and annual operating expenses of both systems are summarized in Table 14-19.

TABLE 14-19

CAPITAL AND ANNUAL OPERATING EXPENSES*
COMPLIANCE WITH STATUTORY REQUIREMENTS
POLICE/FIRE AMBULANCE SERVICE v. FIRE AMBULANCE SERVICE

	Police/Fire Service	Fire Ambulance Service
CAPITAL EXPENSES:	$33,275	$110,762
ANNUAL OPERATING EXPENSES:	27,777	54,598
Vehicle Savings	-14,212	- 67,630
TOTAL	$13,565	-$ 13,032

*Costs presented are for the lowest cost in the cost range and presume the use of ambulwagons in both service systems.

It is interesting to observe that, not only would the establishment of a Fire Department ambulance service release up to 34 patrolmen for other police activities, but it could also be operated for $26,587 a year less than the police/fire system.

14-9. COSTS AND BENEFITS OF A HELICOPTER AMBULANCE

General Advantages

The advantages of an air ambulance have been demonstrated

in military and rural uses. In both cases the speed with which the helicopter can respond to an emergency and transport an injured person to definitive treatment has been acknowledged as a primary advantage. Other advantages are the craft's directional flexibility and its ability to overcome various types of ground obstacles. Use of the air ambulance in an urban environment also promised to obtain these advantages, although they would be influenced by the characteristics of the injury occurrence process in the city, the lesser distances involved, the multiplicity of nearby medical facilities and the comparative lack of landing sites. In this section the costs and benefits of the helicopter will be compared with those of Detroit's existing ground emergency response system.

Demonstration Results

The helicopter-ambulance operated throughout Detroit's 140-square-mile area. For nearly six months, on Monday through Friday for four hours a day, the helicopter flew missions arising from either a dispatch or the crew's detection of an injury accident. In the course of the demonstration, twenty-three injury victims were transported by Medic-5; the injuries ranged from broken bones sustained in a freeway car crash to the fatal stab wounds described in the example given previously.

Before the costs and benefits of the air ambulance are considered, several observations based on demonstration experience should be made regarding the feasibility of city landings, the detection-notification process and the times and distances of response and transport.

Landings: It was demonstrated that a helicopter-ambulance can operate and land in an urban setting such as Detroit's. During the test, landings were made successfully on freeways, surface streets and at residential locations. Some of these were made within the City Airport's flight pattern zone and required special flight and communication measures. Landings on freeways and major streets were accomplished with little difficulty, provided a police ground crew controlled traffic at the scene. In these instances, the helicopter set down in the cleared area ahead of the accident site. However, in residential areas, overhead wires, parked cars on narrow streets, trees and other obstacles significantly restricted landings and lessened the probability of providing the service. In the city, then, air-ambulance service could supplement ground-ambulances but not replace them.

The Detection-Notification Process: Medic-5 was dependent upon the city-wide police emergency reporting system for dispatches to the scenes of injury accidents. The helicopter operation was thus subject to the same restrictive characteristics of this system. It was difficult and sometimes impossible for the police officer screening calls to identify time-and treatment-critical patients.[11] Cases where time was of paramount importance for the patient's condition could not be distinguished from others in which emergency transport service was requested. The same level of response as for serious injury cases was available for cases merely involving taxi service to the hospital. As a consequence, it was not possible to make selective use of the helicopter for only the cases in which it might have particular value. In fact, only two patients of the twenty-three conveyed by the helicopter were considered time-or treatment-critical. One of these, described in the example given earlier, died in transit. The second patient received treatment at the scene which lessened the importance of speed of conveyance to the hospital. As an in-flight patrol vehicle, the helicopter crew had the potential for detecting and responding to an injury accident either when it occurred or shortly thereafter. Potentially, therefore, this capability could produce a time saving medically beneficial to an injured person provided treatment and conveyance were rendered immediately after landing. However, the landings were delayed until ground units could arrive at the scene to secure the area.[12] Thus, use of the time

[11]Based on the medical evaluations of the nearly 1,700 patients conveyed by ground ambulances in the demonstration, it is estimated (in Chapter 8,) that a speedy arrival at the hospital for treatment was of value in approximately 25%, or 425, of the cases. Not all of the latter group could be considered time-or treatment-critical--i.e., where timely treatment was a matter of life and death; the evidence available, however, does not allow a precise statement of how many were so.

[12]Note: Emergency ground vehicles can usually travel the city's freeways even under traffic-jam conditions. The raised shoulder of the expressway serves as an emergency lane.

saving potential could result in a time delay. If a ground crew is necessary at the scene of an accident to secure the landing site, the response time for the air ambulance theoretically becomes no greater than that for a ground ambulance.

Response to the Scene and Conveyance to the Hospital: If one excludes consideration of on-the-scene treatment factors, ambulance response and conveyance times are the two most important components affecting the patient's medical condition before arrival at the hospital. Military and rural helicopters have lessened these times significantly when the distance to a treatment center has been great. In the city this apparent advantage is substantially reduced. For the 23 patients transported, the helicopter averaged 4.9 minutes in transit to the scene for an average of 3.9 miles. By comparison, the police ambulwagons and the fire rescue squads respectively averaged 4.7 and 4.2 minutes for 1.7 and 2.3 miles. Helicopter conveyances were made to five of the six hospitals with helistops. The conveyances averaged 3.4 minutes for 4.3 miles while those of the police and rescue squads, with 14 hospitals to rely on, respectively averaged 7.3 and 4.8 minutes for 3.1 and 2.6 miles.[13] In an exclusively urban setting, then, the time advantage of a helicopter-ambulance is minimal.

Medic-5 also had the potential for responding to medical cases with unique circumstances. For example, the air ambulance could be used when ground vehicles were immobilized by flooded freeways or extremely heavy snow to transfer a patient requiring special treatment or to transport a specialist, special medical equipment or supplies. However, this capability was not demonstrated during the experiment. Other by-products of the project, however, were of medical benefit to the community. The helistops developed for the demonstration have enabled the Coast Guard and other agencies to use Detroit hospitals for their helicopter medical and rescue work. As an example,

[13]See Tables 10-2 and 3, 10-7 and 8, and 13-1 and 2 in this volume.

a project helistop was used by an out-of-state helicopter to pick up and deliver transplant organs (for a kidney transplant) to an Ohio hospital during the demonstration period.

Benefits and Costs

Benefits of the Helicopter: The primary benefit of the helicopter is the saving of time. The extent of the benefit is directly related to the medical condition of the patient and the distance he has to be conveyed. The more time-critical the patient, the greater the benefit the helicopter represents; the farther the distance to a treatment facility, the greater the benefit. But in the demonstration, the margin by which this time benefit exceeded those of the ground ambulances in the system was minimal. On the basis of the conveyance cases, it can be stated that the helicopter did not prove more beneficial than the ambulances in the ground system.

Costs of the Helicopter: The cost of the air ambulance was based on actual flight hours. The charge of $110.00 per flight hour included the wages of the pilot and the attendant and the maintenance costs. A total of 487.2 hours were flown by the craft for a total project cost of $53,592.00. Three approaches can be considered in estimating the cost per patient of the project ambulance service. Each patient conveyed by the air ambulance can be assigned:

1. his portion of the total cost, direct and indirect.

2. the costs for the service time of his case.

3. costs for the flight time used in his case.

As suggested by the first supposition, if each of the twenty-three patients conveyed were to be arbitrarily assigned an equal portion of the total helicopter project cost, the cost to each would be $2,330.08. However, this figure reflects both the direct and indirect costs incurred for servicing the twenty-three patients plus the patrol time.[14] This patrol time proved of little value for the

emergency medical evacuations, and accordingly the costs of the operation without this function should be considered.

If the second approach is used, the costs developed are only for service time. This is the time spent specifically on the twenty-three conveyance cases. In each case, it starts at the time of dispatch and includes transport of the patient to the hospital and the preparations for resuming operations. All flight time spent on patrol is excluded from the second approach. Hospital service time for the Detroit project averaged 37 minutes per case. At $1.83 per minute, the cost for the service time is $67.71 per patient. This cost covers both flight time and nonflight time spent at the scene and at the hospital. The Medic-5 crew averaged 7.8 minutes at the scene and nearly 21 minutes at the hospital. The cost based on service time, as compared to that for the ground ambulances, is considerably higher.

In the third alternative, in which charge is made for only the flight time, the cost would be restricted to the time spent in getting to the scene and in going to the hospital, In the demonstration, this combined flight time averaged 8.3 minutes. At $1.83 per minute, the flight cost per patient would be $15.21.

Benefits as Related to Costs: Medical evaluations by physicians did not indicate that a life was saved because of the faster transport times in the helicopter cases.

---

[14]To some extent, the charge could be reduced by subtracting the costs attributable to the helicopter's use for traffic control, police and other non-medical projects. Estimation of the costs for each of the supplemental uses, however, would require considerably more informational and analytical resources than were available in this study. This estimate, it should be added, would have to take into account the fact that all of the non-medical work, with few exceptions, was done while the helicopter was on patrol status and functioning as an air ambulance capable of ready response. If the information available is viewed in this perspective, it is apparent that a rather minor fraction of the total cost is validly assignable to non-medical uses.

TABLE 14-20*

COSTS AND SERVICE TIMES OF AMBULANCE TYPES

	Average Service Time	Costs Per Run
Police Ambulwagons	33.3 min.	$17.67
Fire Rescue	18.4 min.	14.56
Helicopter	37 min.	67.71

*From Sections 10-6 and 14-3.

For the two time-critical cases, the probably time saving in using the helicopter rather than the ground ambulances was small, while the comparative benefit in terms of the patient's condition cannot be documented. For the less serious injury cases, the helicopter time savings more clearly did not constitute a significant benefit. Furthermore, the value of the helicopter was further reduced by the uncertainty of being able to land. In sum, as used in the context of this project, the helicopter-ambulance produced time and medical benefits that were minor or negligible and not commensurate with the costs.

For test purposes the demonstration utilized the helicopter in a patrol/ready-response mode of operation, which was shown to be not cost-effective. It is apparent from the analysis that a standby/transfer type of service would be more appropriate for an urban setting. In this mode of operation, there would be no patrol status; thus, a major portion of the operating cost would be eliminated. In addition, the use of the craft would be sharply restricted to those cases in which it was clearly beneficial. The helicopter crew would not respond to random emergencies and thus would be less likely to confront uncertainties of landing. Moreover, there would be little possibility of providing air-ambulance service for the random case where ordinary ground conveyance would suffice. The craft would be called into service to transfer patients whose condition had been identified and most likely diagnosed by a physician. The transfer would usually be over a

considerable distance to a special medical facility. The cost of the standby/transfer mode clearly would be less than for the patrol/ready-response mode. (A commercial firm provides air-ambulance service on a standby/transfer basis for the entire Detroit metropolitan area for $30.00 a run plus $1.00 per mile.)

Under the standby approach, the helicopter could be hired as needed from the commercial firm. An alternative would be for a municipality, when acquiring a helicopter for police work or some other purpose, to give consideration to the occasional use of the craft for ambulance transfer service. Here, the extra costs of a conversion kit and the required medical equipment and the flight operating costs would constitute the cost of providing the service. The demand for this service, even in a city the size of Detroit, would be infrequent except in disaster periods, at which time the helicopter value could be considerable. However if the standby/transfer approach were put into effect, it seems clear that it would enable an optimum proportion to be achieved between the costs and the benefits of the helicopter-ambulance.

APPENDIX A

A MODEL OF THE DETECTION AND REPORTING PROCESS

APPENDIX A

A MODEL OF THE DETECTION AND REPORTING PROCESS

This appendix presents the development of a model of the detection and reporting process. The model is not comprehensive and is not intended as a basis of system design or implementation. It does provide considerable insight regarding the benefits of a secondary reporting capability with reduced reporting delay.

Assume an exponential probability distribution for the Detection delay[1] of the first detection or

$$P\ \{t_D \leq T\} = 1 - e^{-\alpha T}$$

$P\ \{t_D \leq T\}$ is the probability the delay (time) to the first detection, td, is less than T and $1/\alpha$ is the mean time to the first detection. The probability density function is then the simple exponential

$$P\ (t_D) = \alpha e^{\alpha t_D} \qquad t \geq 0$$

$$P\ (t_D) = 0 \qquad t \leq 0$$

with the mode at zero. While the mode at zero may not seem realistic, the above distribution results from an assumption of a Poisson distribution of detections. A Poisson distribution of calls does appear reasonable since the distribution of calls might be random with a small probability of a call in an arbitrarily short time interval but independent on the location of the interval. The actual distribution has not been derived empirically. One might expect a minimum detection delay, and that the expected number of calls or detections per unit time will eventually decrease with increasing time. Both phenomena violate the implicit requirements of a Poisson process. The model developed here is only valid if minimum detection delay is short, and the probability of events in successive intervals are independent for the length of time

[1]Defined in Section 5-2.

required for the first few detections and reports.

The reporting delay will be described by a similar distribution, or

$$P\ \{t_R \leq T\} = 1-e^{-\beta t_R}$$

or the average reporting time is

$$\overline{t}_R = \frac{1}{\beta}$$

and

$$P\ (t_R) = \beta e^{-\beta t_D}$$

The notification delay is

$$t_N = t_D + t_R$$

The detection and reporting processes require separate actions on the part of the observer and would appear to be independent. The distribution of t_N can be found by convolution of $p\ (t_D)$ and $p\ (t_R)$. Thus

$$P\ (t_N) = \frac{\alpha\beta}{\beta-\alpha}\ (e^{-\alpha t_N} - e^{-\beta t_N}) \qquad \alpha \neq \beta$$

The probability that the first notification occurs with a delay of less than T is then

$$P\ \{N \leq T\} = \int_o^T P\ (t_N)\ dt_N$$

$$= 1 - \frac{1}{\beta-\alpha}\ (\beta e^{-\alpha T} - \alpha e^{-\beta T})$$

and the average time to the first notification is

$$\overline{t}_N = \frac{1}{\alpha} + \frac{1}{\beta}$$

The density function of the first notification is

$$P\ (t_N) = \frac{\alpha\beta}{\beta-\alpha}\ (e^{-\alpha T} - e^{-\beta T})$$

A specific example is shown in Figure A-1 for $\alpha=\frac{1}{2}$ and $\beta=1/3$ min. This figure represents an average detection time of 2 min. and an average reporting time of 3 min. The average notification time is then 5 min.

We may extend the model to several systems operating in parallel. If n notification systems are all functioning independently, the probability that an accident is reported by at least one of the systems with a delay less than T is

$$P\ \{D \leq T\} = P\ \{D_1 \leq T\} + P\ \{D_2 \leq T\} \ldots P\ \{D_n \leq T\}$$

$$- P\ \{D_1 \leq T,\ D_2 \leq T\} - P\ \{D_1 \leq T,\ D_3 \leq T\} \ldots$$

$$- P\ \{D_{n-1} \leq T,\ D_n \leq T\}$$

$$+ P\ \{D_1 \leq T,\ D_2 \leq T,\ D_3 \leq T\} \ldots$$

where the subscripts denote a particular system. The assumption of independence allows us to compute the joint distribution by the produce of the marginals or

$$P\ \{D_i \leq T,\ D_j \leq T\} = P\ \{D_i \leq T\}\ P\ \{D_j \leq T\}$$

Computation of $P\ \{D \leq T\}$ is lengthy for even modest values of n. If n=3, and we let $\gamma_i = \beta_i - \alpha_i$

$$P\ \{D \leq T\} = 1 - \frac{\beta_1\beta_2\beta_3}{\gamma_1\gamma_2\gamma_3}\ e^{-(\alpha_1 + \alpha_2 + \alpha_3)\ T}$$

$$+ \frac{\alpha_1\alpha_2\alpha_3}{\gamma_1\gamma_2\gamma_3}\ e^{-(\beta_1 + \beta_2 + \beta_3)\ T} - \frac{\alpha_1\beta_2\alpha_3}{\gamma_1\gamma_2\gamma_3}\ e^{-(\beta_1 + \alpha_2 + \beta_3)\ T}$$

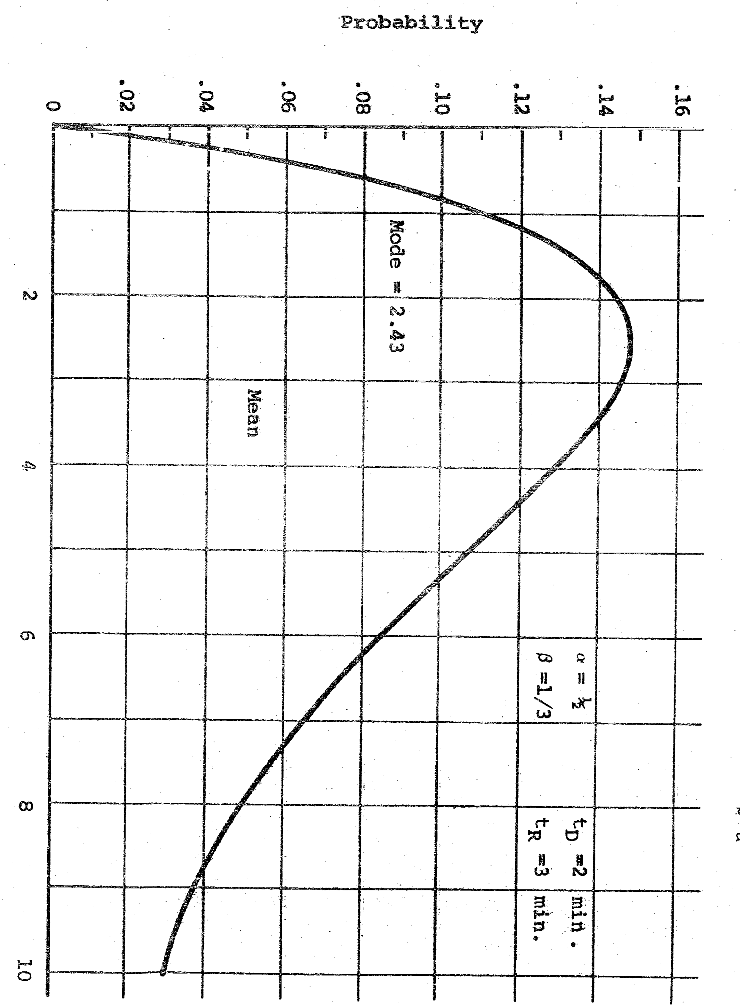


FIGURE A - 1
PROBABILITY DENSITY FUNCTION
OF NOTIFICATION TIME

Notification Time Density Function - Single System $P(t) = \frac{\alpha\beta}{\beta-\alpha}(e^{-\alpha T} - e^{-\beta T})$

$$+ \frac{\beta_1\alpha_2\beta_3}{\gamma_1\gamma_2\gamma_3} e^{-(\alpha_1+\beta_2+\alpha_3)T} - \frac{\alpha_1\beta_2\alpha_3}{\gamma_1\gamma_2\gamma_3} e^{-(\alpha_1+\beta_2+\beta_3)T}$$

$$+ \frac{\alpha_1\beta_2\beta_3}{\gamma_1\gamma_2\gamma_3} e^{-(\beta_1+\alpha_2+\alpha_3)T} + \frac{\beta_1\beta_2\alpha_3}{\gamma_1\gamma_2\gamma_3} e^{-(\alpha_1+\alpha_2+\beta_3)T}$$

$$- \frac{\alpha_1\alpha_2\beta_3}{\gamma_1\gamma_2\gamma_3} e^{-(\beta_1+\beta_2+\alpha_3)T}$$

The simplicity of the model, coupled with unreliable estimates of the parameters, probably does not justify its use for n greater than 3. Even at this level it should be used only when the differences in the parameters are great enough to result in one system dominating. Then the model may be used to investigate the change in performance that might result from inclusion of a particular system. If two or more systems have similar parameters they could be grouped with little loss of validity, and thus the entire set of systems could be partitioned into a smaller set.

If n = 2 the result is

$$P\{D \le T\} = 1 - \left[\frac{\beta_1}{\gamma_1} e^{-\alpha_1 T} - \frac{\alpha_1}{\gamma_1} e^{-\beta_1 T}\right]\left[\frac{\beta_2}{\gamma_2} e^{-\alpha_2 T} - \frac{\alpha_2}{\gamma_2} e^{-\beta_2 T}\right]$$

The expected value (mean) of the time of first notification can be found from

$$\overline{T}_N = E(T_N) = \int_0^\infty P(t)\, dt$$

where
$$P(t) = \frac{\delta p\{D \le T\}}{\delta t}$$

The mean for n = 2 is given by

$$\overline{T}_N = \frac{1}{(\gamma_1\gamma_2)}\left[\frac{\beta_1\beta_2}{(\alpha_1+\alpha_2)} + \frac{\alpha_1\alpha_2}{(\beta_1+\beta_2)} - \frac{\beta_1\alpha_2}{(\delta_1+\beta_2)} - \frac{\alpha_1\beta_2}{(\beta_1+\alpha_2)}\right]$$

If the reporting delays of both systems are very short, i.e. $\alpha_1 >> \beta_1$ and $\alpha_2 >> \beta_2$ each system approaches a simple exponential distribution and the mean time to notification is:

$$\overline{T}_N = \frac{1}{\alpha_1+\alpha_2}$$

The converse is true if the detection delays are long compared to the reporting delays.

The reduction in notification delay that might result from the employment of a communication system with a small reporting delay can be examined by comparing the results for a single and dual system as shown in Figure A-2. Curve 1 represents a single system with an average detection delay of 2 min. and an average reporting delay of 3 min. This system might represent the use of public phones by private citizens and will be considered the "base" system. If a second capability, such as a fleet of radio equipped vehicles, is superimposed on the base system, the reporting delay of the second system would be smaller but the detection delay would be longer because of the reduced number of detectors performing the surveillance function. The result for the combined system is shown by curves 2 and 3. Both of the latter curves were computed for the same base system parameters, but with a mean reporting delay of ½ min. for the radio equipped vehicles. Curves 2 and 3 assume detection delays of 20 min. and 10 min. respectively for the radio system.

It must be emphasized that the parameters used in Figure A-2 are arbitrary choices. While they appear consistent with project experience, they do not represent empirical results and are not directly supported by measurement. They do provide some insight into the sensitivity of notification delay to system parameters however. The mean notification delays for the three curves are:

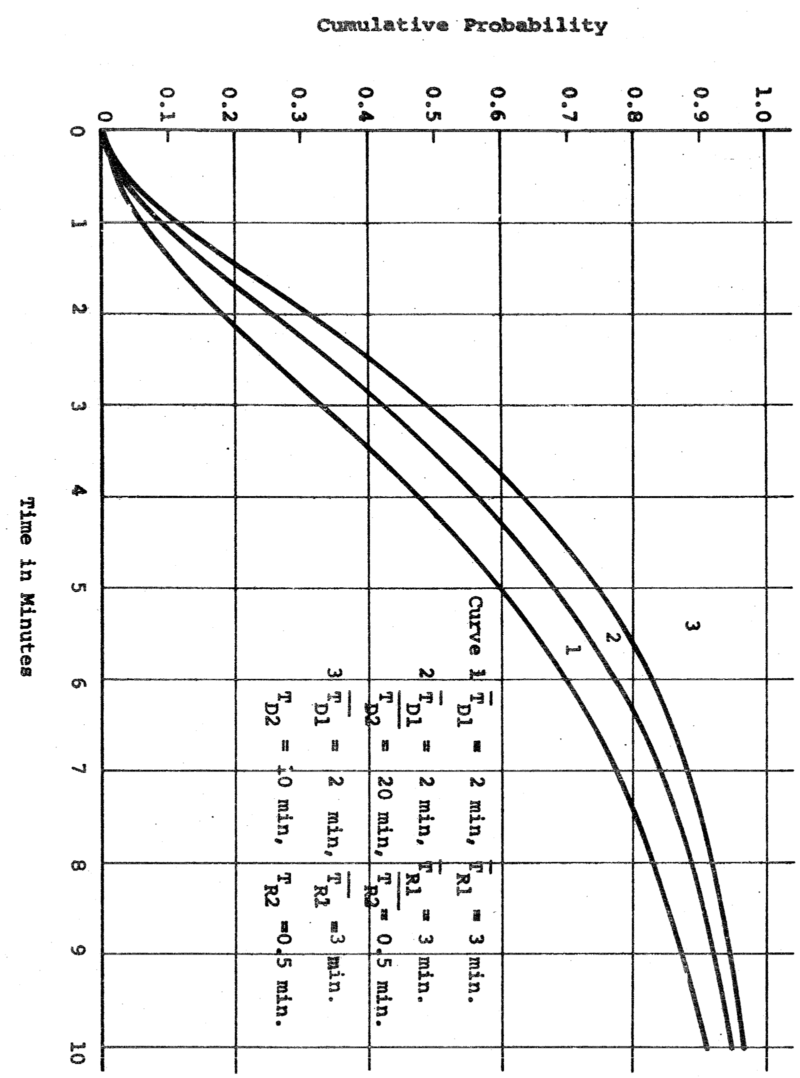
Curve 1, $\overline{T}_N$ = 5 min.

2, $\overline{T}_N$ = 4.29 min.

3, $\overline{T}_N$ = 3.73 min.

FIGURE A - 2

PROBABILITY OF NOTIFICATION VS. TIME



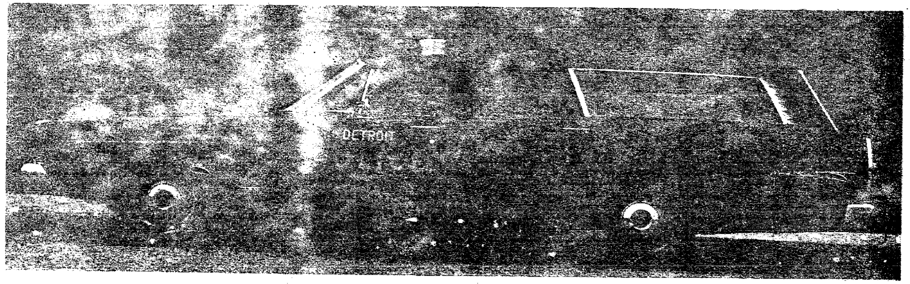
8

ıs an auxiliary system with a ½ min. reporting delay and min. detection delay superimposed on the base system would łuce the mean notification delay by 0.7 min., reducing the :ection delay of the second system to 10 min. would result a net reduction of 1.3 min.

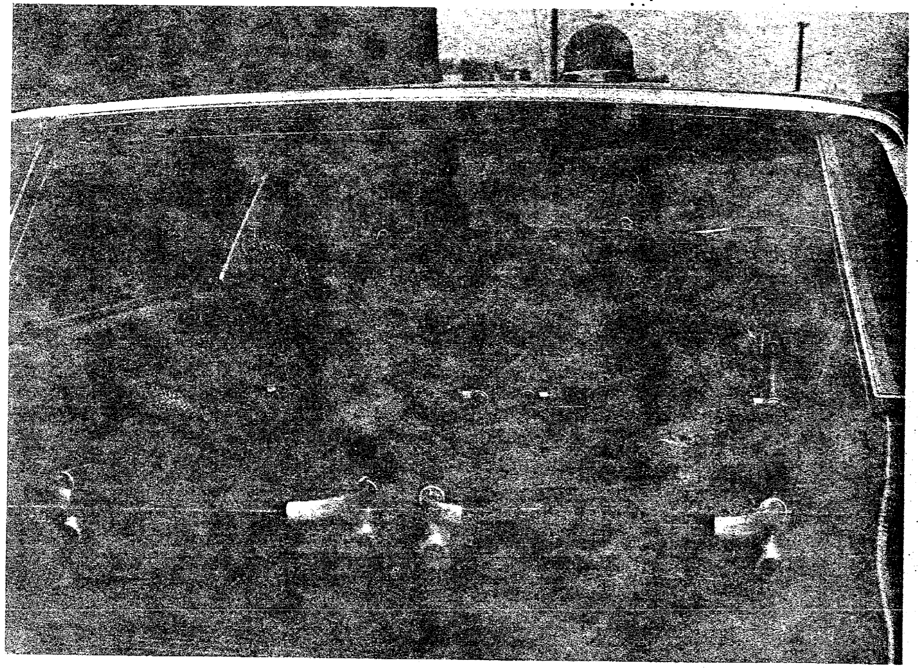
APPENDIX B

PHOTOGRAPHS

478

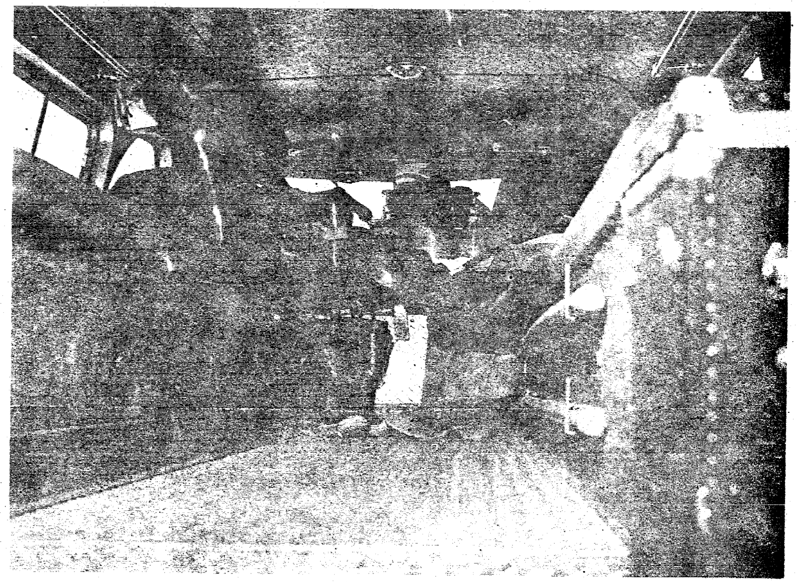


In Detroit, the police station wagon is used to transport seventy-five percent of the emergency illness and accident runs.

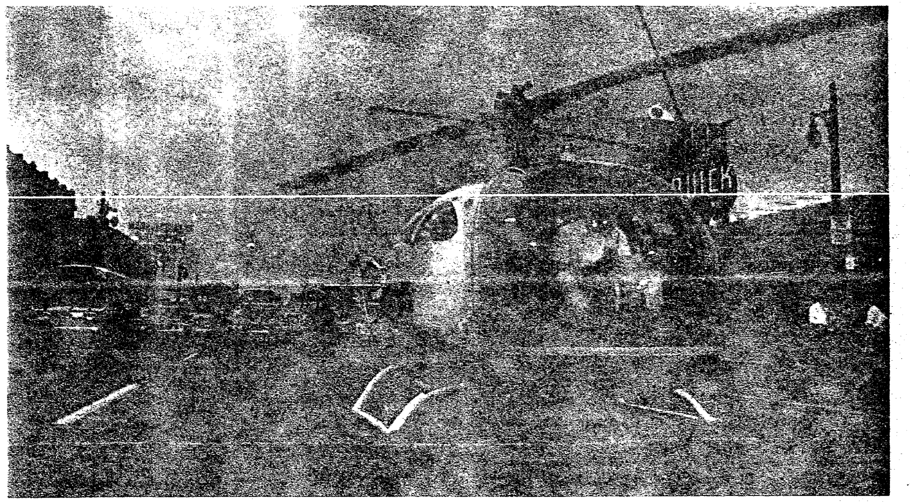


Patient space in the police station wagon is limited and treatment in transit is difficult. Adding first-aid equipment interferes with the police function of the vehicle. Because the vehicle is constantly in use for police patrol, desirable sanitation requirements for the patient area and additional ambulance-type equipment are difficult to maintain.

The fire rescue squad responds to respiratory, cardiac, and extrication cases as well as to fires. Five fire-fighters staff the $28,000 custom-made rescue vehicle.



Interior of the rescue vehicle has adequate patient and treatment space. Patients can be carried on the seats on either side of the aisle.



Helicopter-ambulance landing at the scene of a traffic accident. Landing was on Grand River, a major traffic artery, during the rush hour. Delay of traffic in both directions was accomplished by one motorcycle patrolman.

Patrolman and observers assist in placing victim aboard helicopter-ambulance. A hospital already had been notified of the pending arrival and suspected injuries.

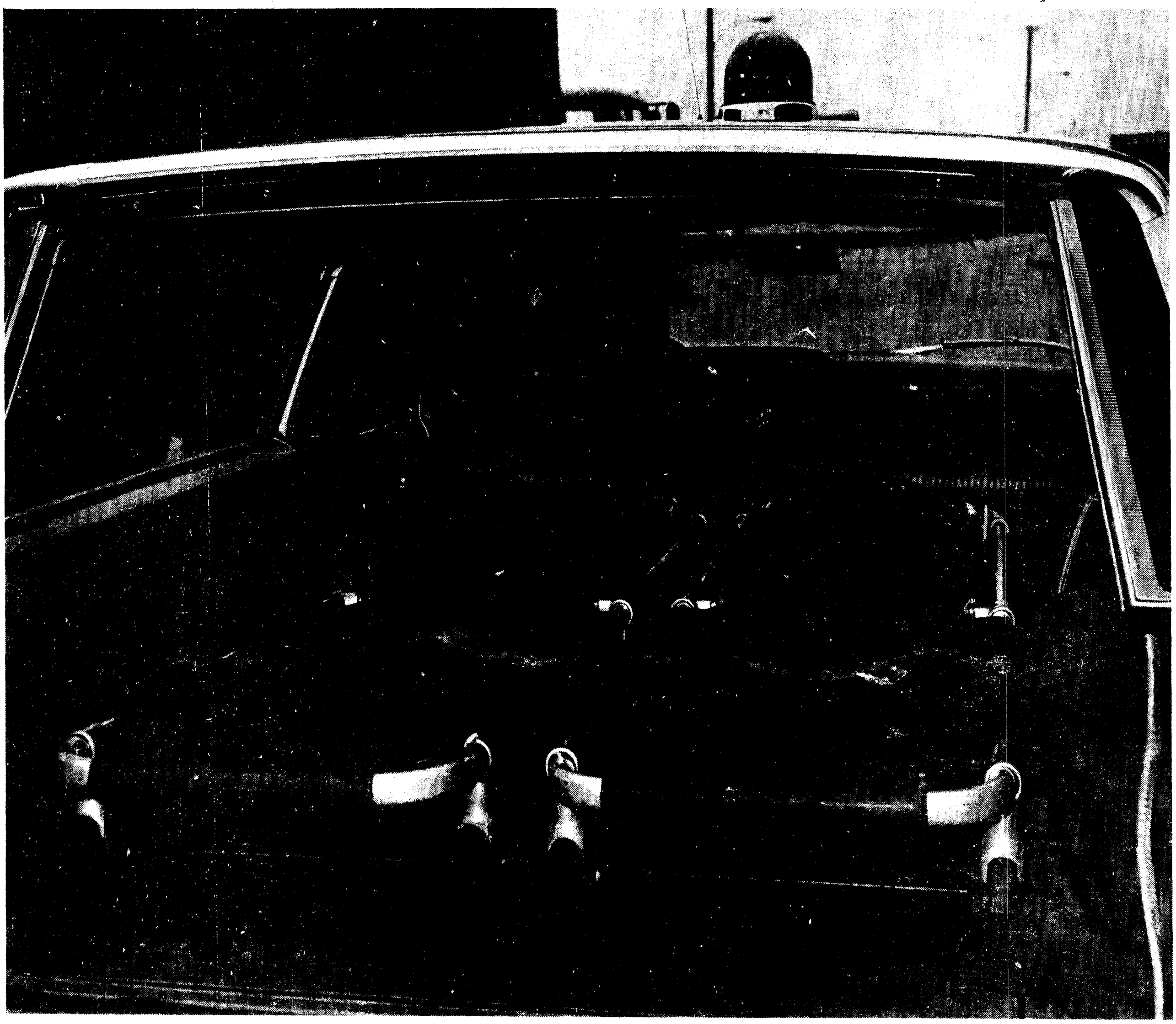
Because of suspected back injuries the victim was removed from the vehicle on an aluminum backboard, part of the ambulance's standard equipment.

This page is reproduced again at the back of this report by a different reproduction method so as to furnish the best possible detail to the

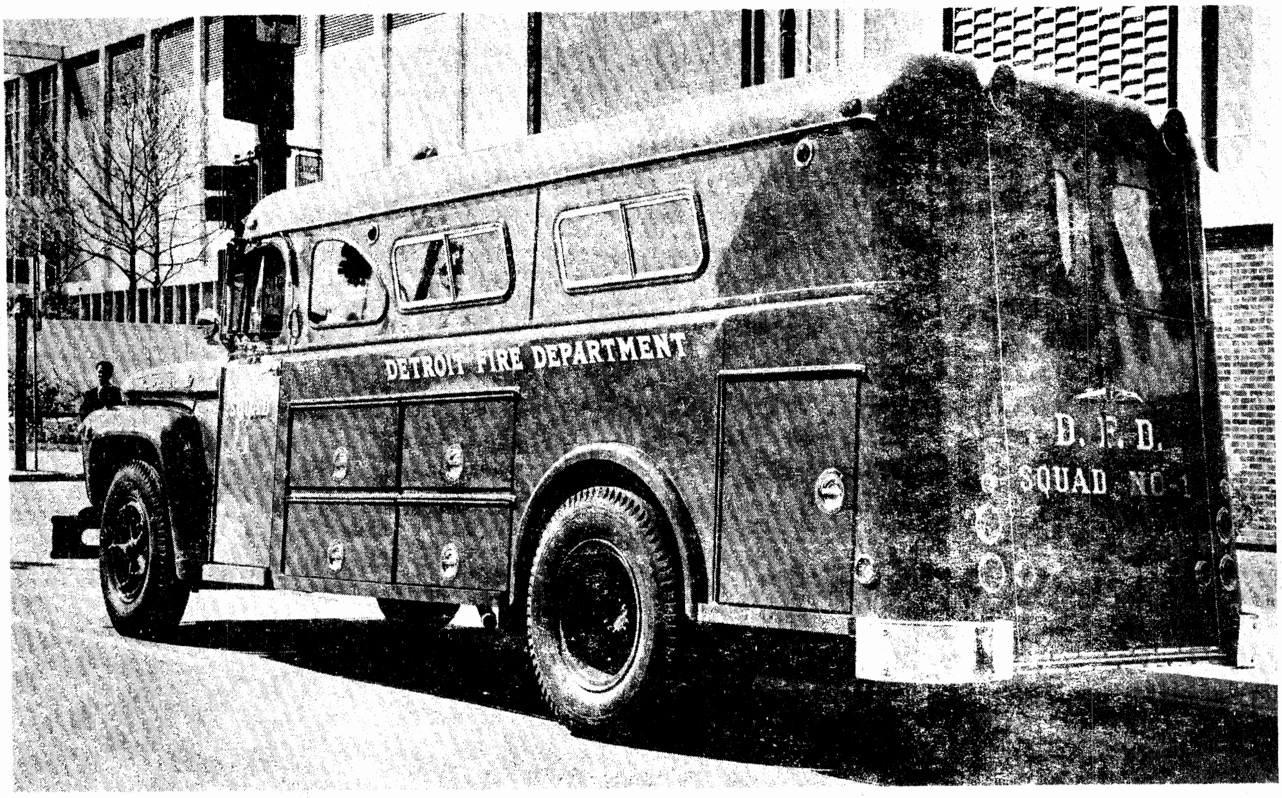
481

THE FOLLOWING PAGES ARE DUPLICATES OF ILLUSTRATIONS APPEARING ELSEWHERE IN THIS REPORT. THEY HAVE BEEN REPRODUCED HERE BY A DIFFERENT METHOD TO PROVIDE BETTER DETAIL.

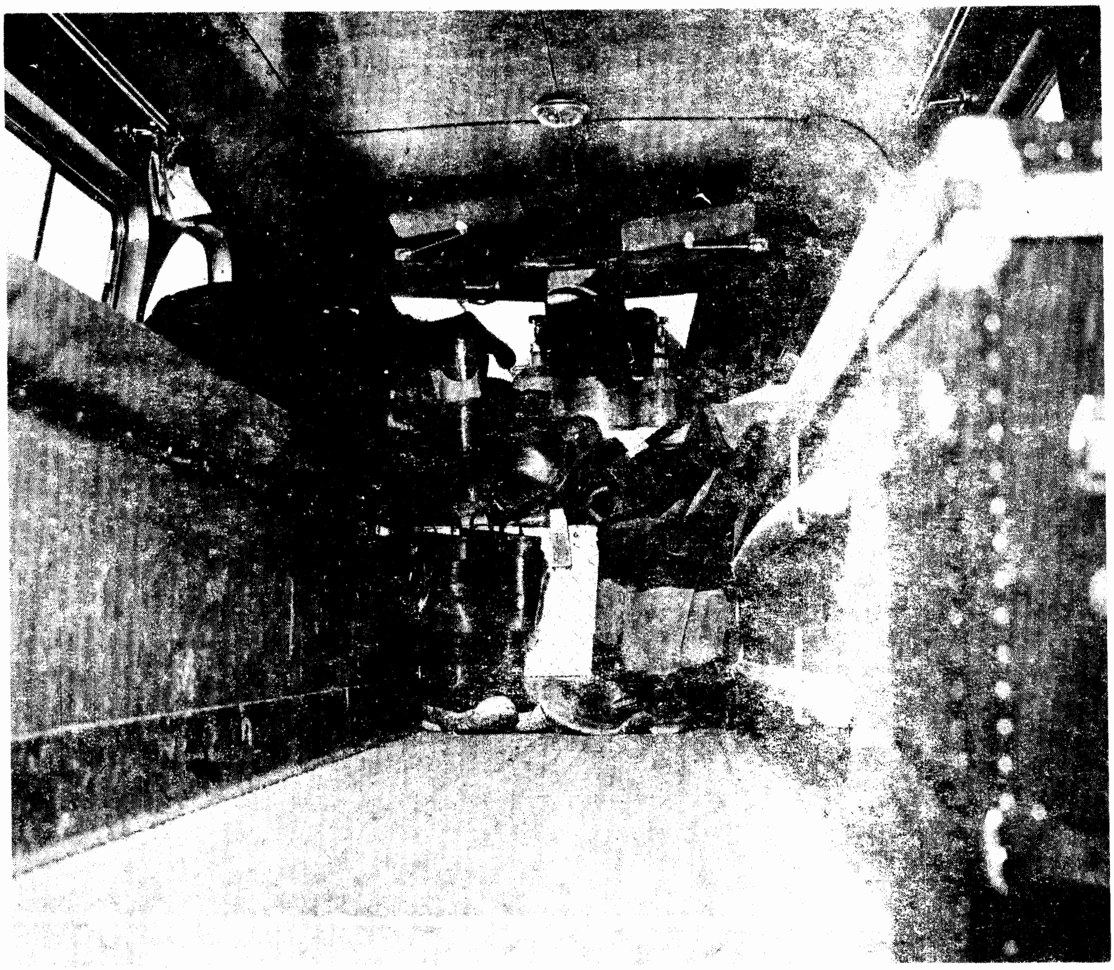
In Detroit, the police station wagon is used to transport seventy-five percent of the emergency illness and accident runs.



Patient space in the police station wagon is limited and treatment in transit is difficult. Adding first-aid equipment interferes with the police function of the vehicle. Because the vehicle is constantly in use for police patrol, desirable sanitation requirements for the patient area and additional ambulance-type equipment are difficult to maintain.



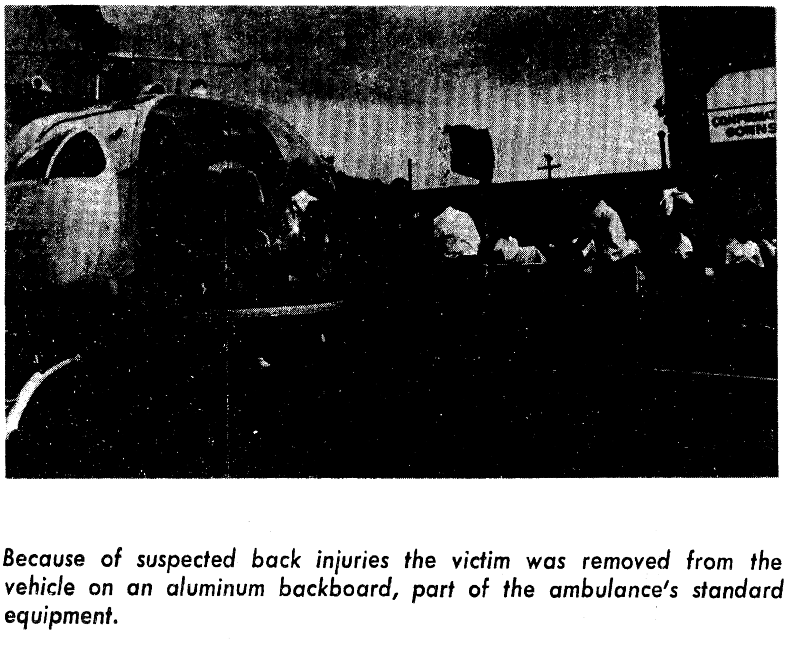
The fire rescue squad responds to respiratory, cardiac, and extrication cases as well as to fires. Five fire-fighters staff the $28,000 custom-made rescue vehicle.



Interior of the rescue vehicle has adequate patient and treatment space. Patients can be carried on the seats on either side of the aisle.

Helicopter-ambulance landing at the scene of a traffic accident. Landing was on Grand River, a major traffic artery, during the rush hour. Delay of traffic in both directions was accomplished by one motorcycle patrolman.

Patrolman and observers assist in placing victim aboard helicopter-ambulance. A hospital already had been notified of the pending arrival and suspected injuries.



Because of suspected back injuries the victim was removed from the vehicle on an aluminum backboard, part of the ambulance's standard equipment.

This page is reproduced again at the back of this report by a different reproduction method so as to furnish the best possible detail to the