MEMORANDUM
RM-5637-DOT
APRIL 1968

EMERGENCY MEDICAL CARE AND TRAFFIC FATALITIES

H. H. Mitchell, M.D.

PREPARED FOR:
NATIONAL HIGHWAY SAFETY BUREAU
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PREFACE

Under Contract FH-11-6698, The RAND Corporation has made a preliminary study of highway safety measures for the National Highway Safety Bureau (NHSB), Department of Transportation. The objective of the work was to review knowledge on the causes of motor vehicle accidents, to relate these causes to the production of injuries and to operational and environmental variables, and to define a program for developing a conceptual framework into which may be fitted safety-oriented research activities and their supporting resources.

The results of this study are contained in seven reports in the RAND Memorandum series:

RM-5631-DOT, Putting the Analysis and Evaluation of Traffic Safety Measures into Perspective, by Martin Wohl

RM-5632-DOT, A Conceptual Framework for Evaluating Traffic Safety System Measures, by Martin Wohl

RM-5633-DOT, Modeling the Traffic-Safety System, by Bruce F. Goeller

RM-5634-DOT, Vehicle Safety: Why the Market Did Not Encourage it and How it Might Be Made to Do So, by Alan Carlin

RM-5635-DOT, Alcohol and Traffic Accidents, by H. H. Mitchell, M.D.

RM-5636-DOT, Medical Problems and Physical Fitness as Related to Occurrence of Traffic Accidents, by H. H. Mitchell, M.D.

RM-5637-DOT, Emergency Medical Care and Traffic Fatalities, by H. H. Mitchell, M.D.

Of these seven reports, the first three address the general analytical features of the traffic-safety system and develop a conceptual framework for a system model. An evaluation framework is also provided, as well as suggestions for research to make the system analysis and evaluation scheme operational. The remaining four reports provide supporting data on economic, medical, and physiological factors related to traffic accidents.

SUMMARY

The payoff that improving emergency medical care would have on traffic accident fatalities cannot be accurately estimated on the basis of information currently available. By examining the statistical data of the military on traumatic injury certain useful impressions have been generated which relate to the problem of improving the salvage record for the traffic accident group. There are no clear conclusions to be drawn which relate salvage improvement to the amount of resources which might be allocated for this purpose.

CONTENTS

I. INTRODUCTION

This paper represents an attempt to assess, on a somewhat quantitative basis, the payoff that improving emergency medical care would have on traffic accident fatalities. (No serious discussion of disability among survivors of traumatic injury seems possible on the basis of information known to the author.)

It soon became apparent that a direct approach to the study of medical care of civilian traumatic injuries was not possible. No adequate statistical studies relating injury and treatment to outcome appear to have been published. Military records were examined as an alternative. The U.S. military statistics do give some record of the history of improved care on case fatality rates that are of interest to the traffic casualty problem. An examination of the military record also provides us with some information about results to be expected for various types of trauma in relation to the skill and resources applied to their care.

After presenting some of the military experience with traumatic injury, we turn to a description of the traffic casualty. Although the record is spotty, a statistical picture of the types of injuries which kill accident victims does emerge. Various other factors such as time lag to definitive care and multiple injury are also examined.

By juxtaposition of the experience of the military with traumatic injury and traffic fatality descriptions some insight can be gotten into the potential for lowering case fatality rates in terms of the resources needed to accomplish this.

The conclusions to be drawn from this study are by no means clear cut and a much more accurate description of the traffic accident victim in relation to his injury and his early post-traumatic medical history are urgently needed.

Any attempt to quantify the characteristics of current practice regarding emergency medical care of traffic accident cases is impossible. Only a few isolated bits of information are available.

II. MILITARY SURGICAL EXPERIENCE

A. OVERALL STATISTICS OF CASE FATALITY RATE

The percentage of U.S. wounded, dying of wounds, is presented in Table 1.[1] The remarkable reduction in deaths from 14.9 percent in the Mexican War to 1.0 percent or less in the current Vietnam War is an integrated reflection of improvements in surgical knowledge and application as well as increased use of resources to bring up to date care to the wounded soldier as quickly as possible.

Table 1

PERCENTAGE OF U.S. WOUNDED,[a] DYING OF WOUNDS

War	Years	Number Wounded	Case Fatality Rate	Average Time to Definitive Surgery[2]
Mexican	1846-48	3,400	14.9	?
Civil War (North)	1861-65	318,200	14.1	?
Sp. Amer.	1898	1,600	6.7	?
W.W. I (No gas)	1917-18	153,000	8.1	12-18 hours
W.W. II	1941-45	598,500	4.5	6-12 hours
Korea	1950-52	--	2.5	2-4 hours
Vietnam	1965-	--	1.0	1½-2 hours
Vietnam Experiment[3]	1965-66	1,368	0.36	15-20 minutes

[a] "Killed in Action" category excluded.

B. CASE FATALITY RATES BY ANATOMIC LOCATION

The surgical experience of the 5th Army during the years 1944 to 1945 is given in Table 2.[4] A high case fatality rate of 26 percent is recorded for intracranial injuries. The seriousness of abdominal injuries is indicated by the 20 percent case fatality rate.

As will be shown later, the wounds having the high fatality rates in the military experience are well represented in the automobile injury cases (e.g. in the Cornell Automotive Crash Injury Project 70.9 percent of the accident victims had head injuries and in the Eckert study over 20 percent of the accident victims had abdominal injuries).

Table 2

FATALITY OF WOUNDS BY ANATOMIC LOCATION
5TH ARMY, W.W. II, 1944-45

Anatomic Location	Fatality Percent
Head (intracranial)	26.00
Neck	0.87
Chest (intrathoracil)	7.80
Spine	7.10
Intra-abdominal	20.0
Upper Extrem.	< 1%
Lower Extrem.	< 1%

A breakdown of case fatality rates (Jan-June 1944, Mediterranean area, Southwest Pacific area, Pacific Ocean area) for thoracic wounds by organ of involvement is given in Table 3. The most significant point in this table is the 75 percent fatality rate for blood vessel wounding. (In the traffic accident cases a significant number of thoracic injuries involve rupture of the thoracic aorta. This will be discussed more fully below.)

Table 3

CASE FATALITY RATES FOR THORACIC WOUNDS, JANUARY-JUNE 1944
(Mediterranean, Southwest Pacific, Pacific Ocean Area)

	Case Fatality Rate	Number Wounded
Lungs	11%	524
Heart	33%	12
Other organs	12%	51
Bones	2%	163
Joints and Muscles	0%	10
Blood Vessels	75%	4
Thorax, generally	9%	2545
Total	9.4%	3309

Heaton[6] compared the surgical record of World War II with the Vietnam war experience. His study documents the improvement of results by region of wounding. Table 4 summarizes these findings. The increase in the death rate, in some categories, of Vietnam casualties over World War II casualties was due, at least in part, to the fact that mortally wounded cases reached the hospital by helicopter evacuation. (Several deaths probably would not have been counted if World War II evacuation methods had been used.)* It should be noted that the Vietnam experience recorded here (see Table 4) consists of a rather small number of cases (201 abdominal injuries, and 159 thoracic injuries).

*"Killed in action" classification is not included in the case fatality statistics.

Table 4

COMPARISON OF WORLD WAR II AND VIETNAM CASE FATALITY RATES BY REGION OF WOUNDING

	World War II	Vietnam
Abdominal wounds	24.0%	8.5%
Thoracic wounds	7.9%	9.4%
Penetrating head wounds	27.9%	31.0%
(of those reaching surgery)	(13.7%)	(7.7%)

C. SECONDARY CAUSES OF DEATH

Table 5[4] gives some statistics showing the relative importance of the disturbances brought about by the original traumatic injury. Shock and hemorrhage account for 68.6 percent of the deaths and pulmonary and intracranial difficulties account for 20.5 percent of the deaths. Thus, about 90 percent of the deaths were accounted for by these few mechanisms.

These data have considerable significance for the traffic fatality problem. Shock and hemorrhage, especially, can often be controlled by early intervention, thereby allowing considerable additional time for definitive surgery to be applied. Many early traffic deaths could be saved by a "medical corpsman equivalent" system. This would also allow for a better triage* system which could bring the accident case to expert surgical centers at greater distances from the site of injury.

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*Triage: sorting out and classification of the wounded.

Table 5

SECONDARY CAUSE OF DEATH AMONG WOUNDED, THIRD U.S. ARMY HOSPITAL ADMISSIONS, 1944-1945

Cause	Number	Percent
Shock or hemorrhage	1,286	68.6
Pulmonary disturbances and injuries	281	15.0
Intracranial disturbances and injuries	104	5.5
Peritonitis	59	3.1
Cardiac, arterial, and venous disturbances	58	3.1
Kidney dysfunction, anuria, etc.	54	2.9
Gas gangrene	22	1.2
Other	11	0.6
Total	1,875	100.0

D. MULTIPLE WOUNDING AND THE DEATH RATE

Beebe and DeBakey[4] state that multiple wounding undoubtedly carry higher fatality rates than single wounds. They were unable to quantify this to any extent because of variable reporting practices.

The Second Auxiliary Surgical Group reported some results which relate to this problem.[5] They analyzed a series of abdominal and thoraco-abdominal wound cases. The case fatality rate was 22.2 percent for the subgroup without associated wounds and 24.1 percent for the subgroup with associated wounds.

With regard to single or multiple injury within the thoraco-abdominal organs taken as a group, the effect of multiple injury is considerable. This data is presented in Table 6.[5]

Table 6

INFLUENCE OF MULTIPLICITY FACTOR ON CASE FATALITY RATES IN 3,129 RECORDED ABDOMINAL INJURIES

Number of Organs Injured	Case Fatality Rate
0	7.5
1	14.9
2	28.1
3	46.3
4	61.5
5	91.3
6	100.0

E. EFFECT OF INCREASED EXPERIENCE

From the records of the Second Auxiliary Surgical Group it is possible to show the effects of increased experience on the case fatality rates.[5] As Table 7 shows the general surgeons cut their operative case fatality rates considerably in the later time period. The improvement in the case fatality rates were attributed in large part to the establishment of uniform and consistent policies of management after March 1944. This study can only be considered anecdotal. It does suggest, however, that there may be a considerable payoff in civilian management of traumatic injury cases if the work of general surgeons is upgraded by application of appropriate standard procedures.

Table 7

EFFECT OF INCREASED EXPERIENCE ON THORACIC SURGERY CASE FATALITY RATES

	Operative Case Fatality Rates	
	Prior to May 1, 1944	After May 1, 1944
Trained Thoracic Surgeons	8.28%	7.08%
General Surgeons	13.17%	8.82%

F. EFFECT OF TIME LAG TO SURGERY ON THE CASE FATALITY RATE

This is a difficult subject to study from the military records because variations in time lag among different groups alters the severity of the patients injuries as allocated between "killed in action" and "died of wounds."

Howard and DeBakey[7] plotted the cumulative case fatality rates for the wounded in several wars (Fig. 1) and concluded that "If we assume that treatment of the wounded in the Crimean War of 1854-56 saved very few lives and that the salvage in World War II approximates the salvage we can hope for today, we find the percentage of wounded in action who die within the first 24 hours is almost independent of surgical care, except perhaps for the control of hemorrhage. These figures indicate that care within 24 hours, and indeed care within 48 hours, keeps very few casualties from dying during the first 48 hours. And yet, improved surgical care resulted in lowering the total mortality of the Wounded in Action (W.I.A.) from approximately 17 percent in the Crimean War to approximately 4.5 percent in World War II."

The Second Auxiliary Surgical Group during World War II attempted to assess the time-lag consequences for the abdominally injured group.[4] These workers concluded that the case fatality rate increased about 0.5 percent per hour of delay for cases of approximately equal severity. According to them, however, the most fundamental determinant of mortality rate was the severity of the wounding as determined by the number of organs involved. (On the average adding one more organ of injury raises the case fatality rate about 15 to 20 percent in this series.)

A recent experiment[3] on rapid casualty evacuation in Vietnam using helicopters and an alerted hospital unit has recorded an amazing record. There were 1,368 casualties over a period of approximately 12 months. The mortality rate was 0.368 percent (5 deaths). The average time from wounding to the operating table was 15 to 20 minutes with as little as 7½ to 10 minutes for very critical patients.

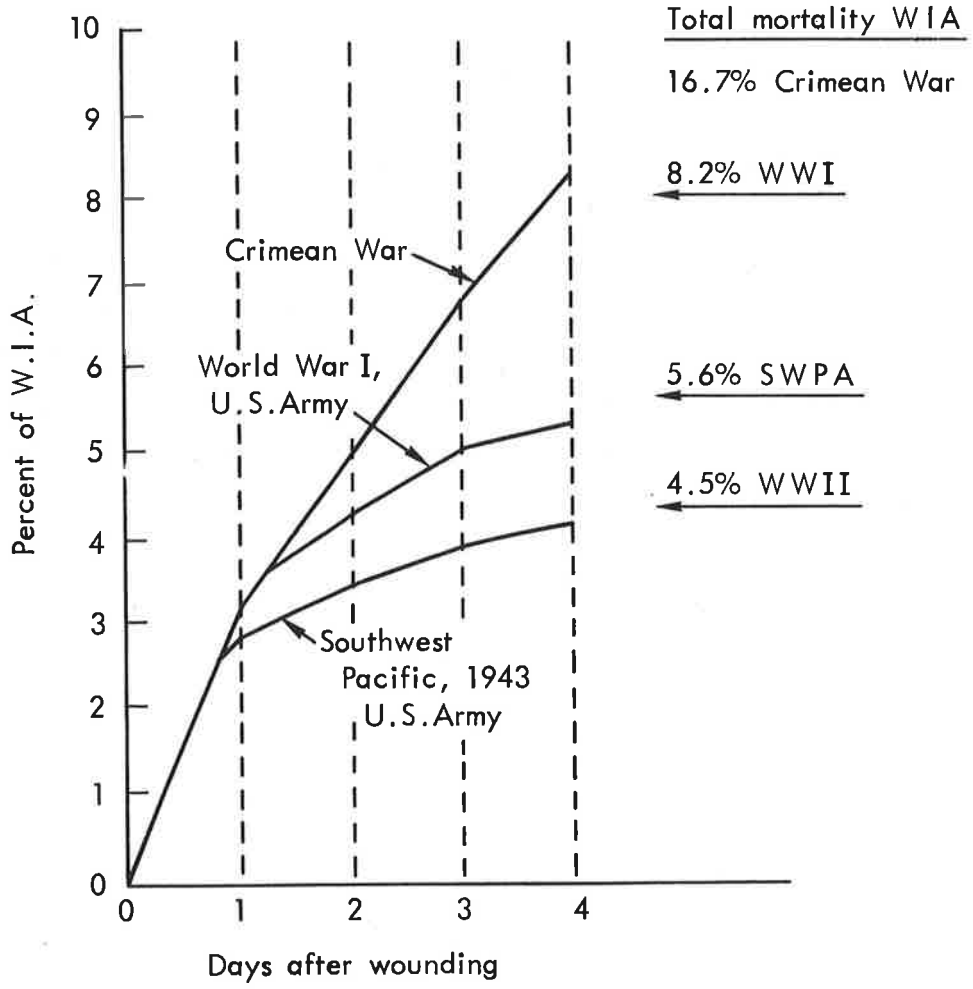

Fig. 1—Cumulative case-fatality rates for wounded in various wars

The surgeons working in this experimental set-up have stated that if they receive a man shot in the neck, thorax, or abdomen, he has an almost 100 percent chance of survival.

It is, perhaps, worthwhile to comment on the implications of this Vietnam experience and the previous statements of Howard and DeBakey on the ineffectiveness of early care on fatality rates. In the Howard and DeBakey figures the early care got only as low as 6 to 12 hours. It is thus a reasonable assumption that a considerable payoff in saving of lives exists if delay to early care is appreciably shortened below 6 to 12 hours. This in effect was shown for the Korean War experience. In this war the delay period was shortened to 1½ to 2 hours. For Vietnam the delay period has been shortened still further with consequent lowering of fatality rates (other factors also contributed, e.g. more whole blood, better hospital facilities, etc.).

III. CHARACTERIZATION OF TRAFFIC INJURIES

A. OVERALL STATISTICS OF CASE FATALITY RATE

Some overall statistics for recent years can be gleaned from "Accident Facts," a publication of the National Safety Council. The overall case fatality rates for several years is given in Table 8.[8]

It should be noted that for the overall military statistics the "killed in action" are not included in the case fatality rates. For traffic fatalities, however, the "killed instantly" category is included. Not very much can be inferred from the data in Table 8. But it does suggest that the trend of constantly lowering military case fatality rates may not be as easily established for traffic casualties.

Table 8

CASE FATALITY RATE FOR TRAFFIC INJURIES

Year	Number of Injured	Number of Deaths	Case Fatality Rate (%)
1947	1,182,697	32,697	2.8
1952	1,387,794	37,794	2.7
1957	1,438,702	38,702	2.7
1963	1,643,600	43,600	2.7

Schwimmer and Wolf[9] reported data on 26,131 automobile occupants involved in rural injury producing accidents. Seventy-five percent of these were injured. This study showed that if one eliminates the non-dangerous (to life) injuries, then about 44 percent of the remainder become fatalities. The data on these cases is summarized in Table 9.

Table 9

PERSONS INJURED IN AUTOMOBILE ACCIDENTS
CLASSIFIED BY DEGREE OF INJURY

	Number	Percent
Total Injuries	19,749	100
Fatal	759	4
Dangerous (to life)	961	5
Major (non-dangerous)	4,336	22
Minor	12,074	61
Degree not recorded	1,619	8

B. CASE FATALITY RATES BY ANATOMIC LOCATION

Using Automotive Crash Injury Research (ACIR) material the case fatality rates by anatomic location (based on 1956 to 1959 data) is shown in Table 10.[10]

Table 10

CASE FATALITY RATES FOR TRAFFIC INJURIES
BY ANATOMIC LOCATION

Region	Case-Fatality Rate
Head	4.9
Neck (and cervical spine)	15.3
Thorax (and dorsal spine)	6.1
Abdomen, pelvis (and lumbar spine)	3.6
Upper Extrem.	0.1
Lower Extrem.	0.1

McFarland[11] (also using ACIR data) summarized 3,450 injured cases by frequency and seriousness of injury in relation to area of body injured (see Table 11). If we calculate the case fatality rates after eliminating the injuries which were regarded as non-dangerous to life (also eliminating those not reported) we get some estimate

of the threat to life by region of injury for those classified as seriously injured (see Table 12).

Table 11

FREQUENCY AND SERIOUSNESS OF INJURY IN MOTOR VEHICLE ACCIDENTS IN RELATION TO AREA OF BODY INJURED[a]

Area of Injury	Frequency[b]	Seriousness of Injury				
		Minor	Non-dangerous	Dangerous	Fatal	Not Reported
Head	70.9%	56.2%	18.6%	3.7%	5.0%	16.6%
Neck and cervical spine	3.6%	44.0%	17.6%	5.6%	13.4%	19.4%
Thorax and dorsal spine	18.2%	50.7%	20.1%	6.4%	4.9%	17.8%
Abdomen, pelvis and lumbar spine	12.7%	46.0%	18.9%	12.9%	3.5%	18.7%
Upper extremities	20.0%	71.7%	20.2%	0.5%	0.1%	7.5%
Lower extremities	33.6%	75.4%	17.1%	0.3%	0.1%	7.0%

[a]Based on 3,450 injured occupants of 2000 cars involved in personal-injury accidents, data from Cornell Automotive Crash Injury Research Project.

[b]Because of multiple injuries, percentages total more than 100.

Table 12

CASE FATALITY RATE BY BODY REGION AFTER ELIMINATING NON-DANGEROUS INJURIES FROM PATIENT POPULATION

Area of Injury	Case Fatality Rate
Head	57 %
Neck and cervical spine	71
Thorax and dorsal spine	43
Abdomen, pelvis and lumbar spine	21
Upper extremities	17
Lower extremities	25

Perry[12] analyzed 127 fatal accident cases and reported the primary cause of death by anatomic location. His results are given in Table 13.

Table 13

PRIMARY CAUSE OF DEATH BY ANATOMIC LOCATION

Region	Number of Fatal Cases	Percent of Total Deaths
Head	58	45.6
Chest	16	12.6
Abdomen	12	8.6
Spine	3	2.3
Upper Extrem.	0	0
Lower Extrem. and pelvis	18	14.1
Genito-urinary	1	1.3
Multiple injury	19	14.9

Eckert[13] reported on the distribution of injury by anatomic location for a series of traffic deaths and reported the data separately for automobile occupants and pedestrians (see Table 14).

Table 14

DISTRIBUTION OF INJURY BY ANATOMIC LOCATION (TRAFFIC DEATHS)

Region	121 Pedestrians		165 Automobile Occupants	
	Number	%	Number	%
Head	61	50	54	33
Neck	4	3	15	9
Chest	50	41	52	32
Abdomen	29	24	37	22
Pelvis	29	24	5	3
Upper Extrem.	13	11	13	8
Lower Extrem.	64	53	30	18

Huelke[14] reported on a study (1920-1962) involving 235 deaths (all injured inside vehicle). His results are shown in Table 15.

Table 15

INVOLVEMENT OF BODY REGIONS IN SERIES OF 235 DEATHS
(All injured inside vehicle)

Region	Percent (of cases)
Head	69.4
Thorax	56.6
Abdomen	40.9
Lower Extrem.	32.3
Upper Extrem.	14.9
Pelvis	14.0
Neck	11.9

Injury to the chest is an important part of the overall pathological picture in traffic accidents. It has been suggested* that rupture of the aorta accounts for a significant number of automobile fatalities where injury to the chest occurs. Two studies on traumatic rupture of the aorta suggest that this injury is indeed serious and that death usually occurs rapidly.

Strassman[15] reported on 72 cases of traumatic rupture of the aorta with the following results (see Table 16). Eighty-eight percent of his cases died within 3 hours.

Table 16

TRAUMATIC RUPTURE OF AORTA

Number of Cases (72)	Time to Death
59	< 1 hour
6	1-3 hours
3	5-7 hours
4	12-18 hours

*Personal Communication. Also in "Crash Injuries" by J. Kulowski: In series of 24 motorists who died within 4 hours, 11 had mediastinal hemorrhage.

Parmley[16] reported on a series of 275 accidents in which non-penetrating rupture of the aorta occurred. The automobile accounted for 156 cases (114 ruptured aortas and 42 cases of rupture plus cardiac injury). Two hundred and thirty-seven cases out of the 275 cases were dead on arrival at the hospital and 38 cases survived for varying periods of time (12 died within 24 hours; 16 more died within 2 weeks). Only 2 cases were cured.

The abdomen is significantly represented as a region of injury in automobile deaths and Rout and Christenson[17] analyzed a series of accidents from the point of view of abdominal involvement. There were 1988 patients in their series and 45 deaths occurred. Twenty deaths (44 percent) were associated with abdominal injury. Five cases were dead on arrival, 3 cases lived less than one hour, 7 cases lived more than one hour and died. An additional 5 cases died after operation. Seven cases that went to operation survived.

As we have seen, head injuries are implicated as a primary or significant cause of death in a large percentage of traffic accident cases.

In the McCarrol study[18] on fatal pedestrian accidents, head injuries accounted for most of the deaths in the "one body area" injured classification.

Braunstein[19] in 1957 estimated that approximately 30,000 traffic accident cases would require neuro-surgical care and that many of these occur where trained neurosurgeons are not readily available. His analysis of the types of head injury occurring in his series of cases leads him to a pessimistic conclusion regarding the outcome of these cases.

C. MULTIPLE AREA INVOLVEMENT

Traumatic injury cases are more likely to be serious and fatal when more than one body area is involved in the injury. Three studies are reported here which indicate the amount of multiple involvement in cases resulting from automobile accidents.

McCarrol[18] in a study of 200 pedestrian automobile accident deaths found 161 cases (80 percent) with significant injury to two or more body areas. More than 50 percent of the individuals with injury to two or more body areas died within two hours whereas only 15 percent of single area injury cases died within two hours.

Huelke[14] in a study of 235 deaths from automobile injury (vehicle occupants) reported 70 percent of cases with multiple area involvement. His data are shown in Table 17.

Table 17

MULTIPLE AREA INVOLVEMENT IN 235 AUTOMOBILE DEATHS

Number of Body Areas Involved	Percent of Cases
1	30.6
2	25.1
3	25.1
4	13.2
5	4.7
6	1.3

Jamieson[20] reported on the complexity of injury in 1000 cases (188 deaths in this series). His results are shown in Table 18. Unfortunately he did not indicate the deaths by multiple area of injury classification.

Table 18

MULTIPLE AREAS OF INVOLVEMENT IN 1000 AUTOMOBILE CASES
(Major Regional Injury)

Number of Regions	Percent of Cases[a]
1	41.6
2	14.7
3	8.7
4	4.7
5	2.7
6	.8
7	.4
8	.2

[a] 26% of cases not classified as to region of injury.

D. TIME TO DEATH AFTER ONSET OF INJURY

Several reports in the literature have made some attempt to indicate the time distribution of deaths after occurrence of injury. These studies indicate that a considerable fraction of those destined to die by automobile accident are killed immediately and another significant fraction die within 24 hours.

Haddon et al.[21] reported on the time distribution of deaths for 50 adult pedestrians fatally injured by motor vehicles (Manhattan, May-Nov 1959). The data from this report and an attempt to graphically present this are given in Table 19 and Fig. 2.

Perry[12] reported on a series of 127 fatal cases and indicated that 52 percent of the deaths occurred within 24 hours of admission to the hospital. (This study probably eliminated the known dead at the scene of the accident.) Table 20 and Fig. 3 show the results of this study.

Table 19

POSTACCIDENT SURVIVAL OF FIFTY ADULT PEDESTRIANS FATALLY INJURED BY MOTOR VEHICLES, MANHATTAN, MAY-NOV 1959

Length of survival	Number of Cases
< 1 hour and dead on arrival	13
1 < 2 hours	3
2 < 3 hours	4
3 < 4 hours	1
4 < 5 hours	--
5 < 6 hours	1
6 - 11 hours	1
12 - 23 hours	5
1 day	5
2 days	1
3 days	2
4 days	3
5 - 7 days	5
8 - 14 days	4
15 - 30 days	--
> 30 days	2
Total	50

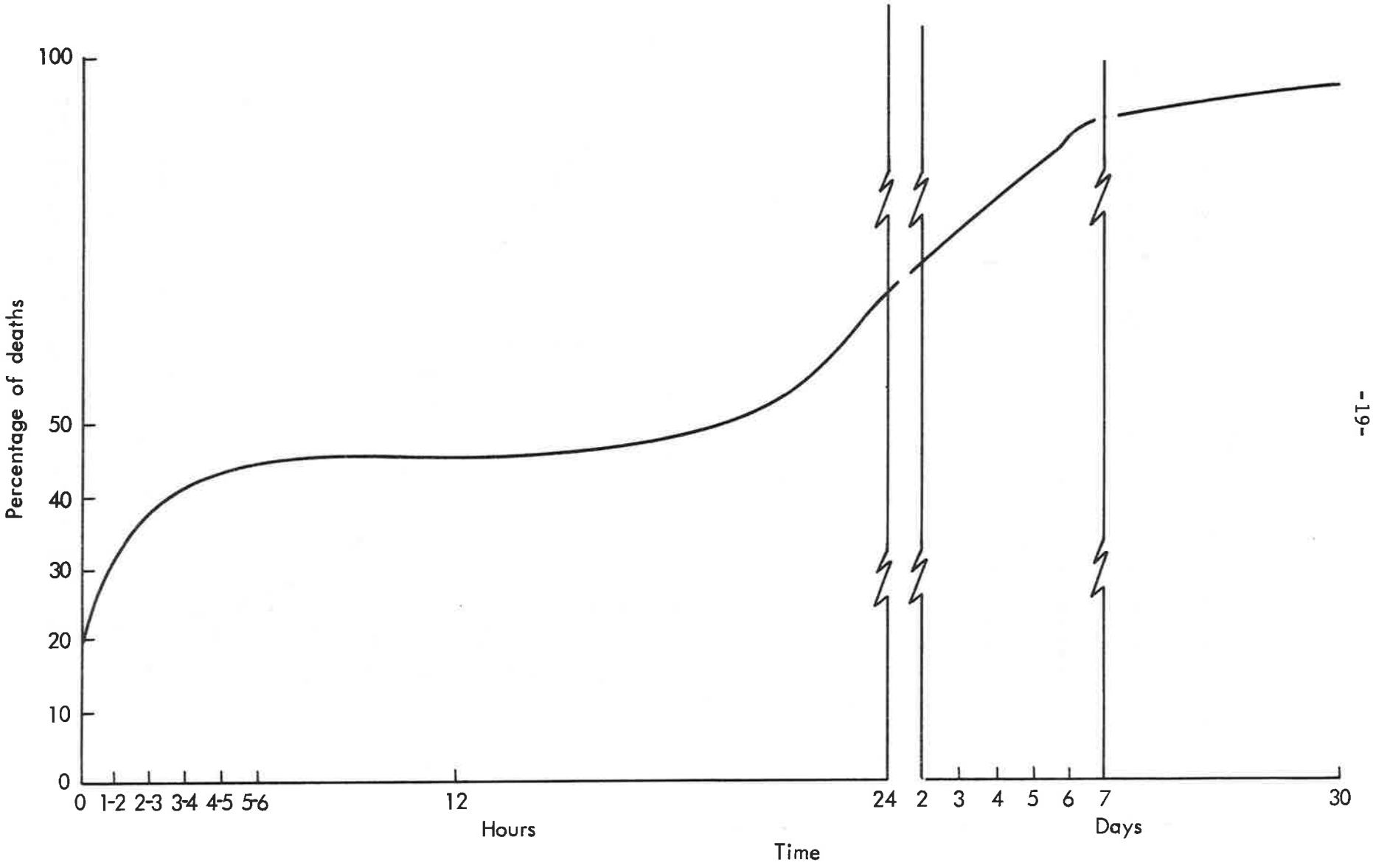

Fig. 2—50 adult pedestrians fatally injured by motor vehicles, Manhattan, May–Nov. 1959

Table 20

TIME TO DEATH, 127 FATAL AUTOMOBILE ACCIDENT CASES

Time to Death	Percent of Cases
Dead on arrival	3
Less than 1 hour	7
1 - 6 hours	23
6 - 24 hours	19
1 - 7 days	27
7 + days	21

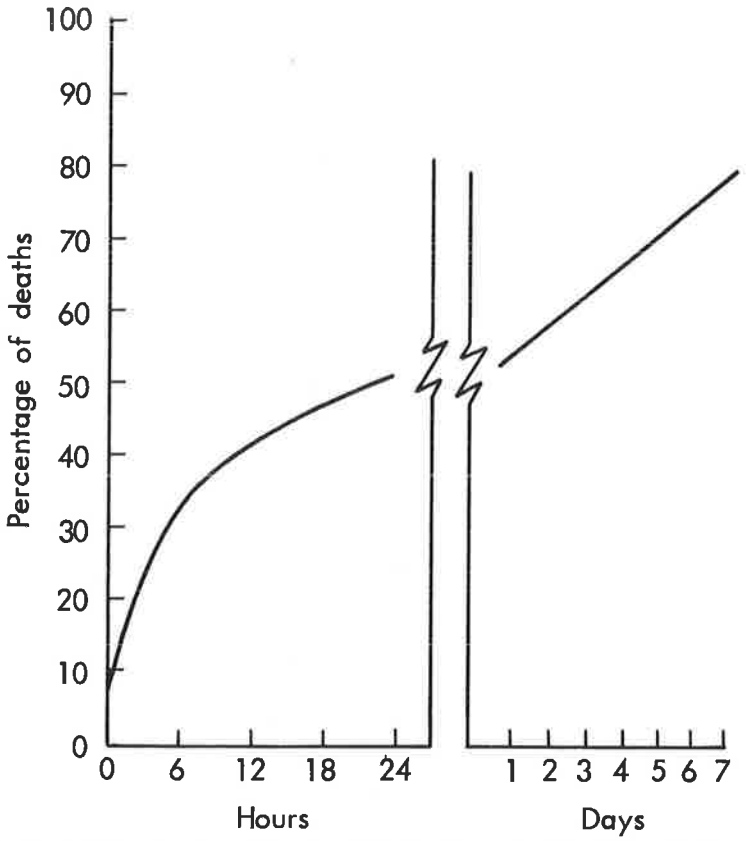

Fig. 3—Time to death, 127 cases (Table 22)

Gissane and Bull[22] reported on the time distribution of deaths for 500 persons killed in road accidents (Birmingham, England). Their results are shown in Table 21. In this series over 50 percent of the deaths occurred within six hours.

Table 21

TIME DISTRIBUTION OF 500 PERSONS KILLED IN ROAD ACCIDENTS

Time	Number Killed	Percent
Instantly	169	33.8
Up to 6 hours	104	20.8
6 to 12 hours	33	6.6
12 and over	194	38.8

One excerpt from this report is worth quoting. "In our research studies of over 10,000 road injuries admitted to our hospital, one in six was serious and one in twelve of the serious injuries was fatal, and this in a hospital specially organized to meet the fast tempo of skilled surgical care and provided with all auxiliary services. These are much higher severity and fatality rates than we experience following any other type of injury producing accident."

E. EFFECT OF DELAY IN DEFINITIVE CARE ON THE CASE FATALITY RATE

As far as we have been able to discover there are no direct studies of traffic accidents that concern themselves with this problem. Waller,[23] in California, analyzed the differences between urban and rural fatalities and attempted to estimate the significance of time lag by indirect methods.

The Waller study showed that rural accident victims tend to be less severely injured than urban victims but that they have a higher death rate. (The anatomic distribution of injury was same in both types.) People died in rural accidents sooner after injury and with less serious trauma than those who died in urban accidents. For those injuries where prompt emergency care would not be expected

to make much difference, the urban and rural death rates were about the same.

Waller also made an estimate of "presumed salvageability"* and concluded that only 38 percent of rural deaths were not salvageable whereas 53 percent of urban deaths were not salvageable. In approximately 25 percent of both urban and rural deaths, salvageability could not be estimated from the record. It was concluded that delay in receiving both first aid and more definitive medical care was a factor in the greater loss of salvageable cases for the rural accident series.

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*"Presumed salvageability is an estimate of the individual's probable chances for survival if immediate and adequate emergency medical care and first aid had been available. Two criteria were used in assessing salvageability. First, on the basis of clinical judgment, injuries in a sample of 1960 certificates were grouped into categories of probably not salvageable, possibly salvageable, probably salvageable, and salvageability unknown. For instance, death from external hemorrhage was considered as probably salvageable while that from brain laceration was considered probably not salvageable.

Next, several series of cases of automotive trauma requiring hospitalization were reviewed in the medical literature after a previous decision that a death rate of approximately 25 percent in a group of patients with a given type of injury would classify that injury as probably salvageable, while a death rate of 50 percent would be considered as indicating the injury was of the possibly salvageable category, and one of 75 percent would classify the injury as not salvageable. In every instance except one there was agreement between the clinical estimate and the more objective criterion of actual percent of deaths occurring from a specific type and location of injury. Where a vague cause of death, such as 'multiple trauma,' was listed, the injury was classified as salvageability unknown. Because autopsy records, although in existence, were not readily available it was not possible to obtain more specific information about these deaths at the present time. This will be done before further studies are undertaken. The salvageability scale based on these criteria was then applied to the death certificates for 1961."

IV. CURRENT STATUS OF EMERGENCY MEDICAL CARE OF THE INJURED

In a guest editorial in the Hospital Tribune, July 10, 1967, entitled "Improving the Care of the Injured," Dr. C. F. Frey of the University of Michigan Medical School summed up the current status of emergency medical care of the injured.

> There is now no standard system for care of the injured person in this country. Usually the patient is removed from the scene of the accident in an ambulance, usually operated by employees of mortuaries, police, and fire departments, and by volunteer community groups. Few states regulate ambulance equipment. Uniform standards for training ambulance attendants have not been established. Injured patients in transit to hospitals are seldom given medication or treatment other than oxygen. Drugs and biologicals are generally unavailable, and, if they are, the ambulance attendants rarely have the skill or training to administer them.
>
> Existing medical facilities in the vicinity of most accidents rarely provide ideal care for a patient with serious injuries. Patients are usually delivered to facilities where the personnel of emergency suites and operating rooms are available only on a stand-by basis. Large volumes of blood and the multidisciplinary approach necessary in the treatment of severe injuries are often not available. Unfortunately, many accidents happen in rural areas, where medical resources are limited. Seventy percent of fatal highway accidents occurred in communities with a population of less than 2,500.

Aside from the general statements such as Frey's there are a few studies which attempt to give some idea of the effect of the lack of emergency care on the results being obtained in handling emergencies.

Joliet[24] in 1962 reported the results of an American College of Surgeon's Study on emergency care: (a) The victim was transported by a police car 46 percent of the time, (b) 25 percent of ambulances lacked proper equipment, and (c) many ambulance attendants were not well trained.

Fitts[25] reported on an analysis of 950 fatal injuries in Philadelphia, Pennsylvania during 1961. The average time between reporting of injury and patient arrival at the hospital was 15 minutes. Delay when it existed was based on patient not being able to summon help, etc. In this series of cases (15 percent of total were

motor vehicle accidents) there were 51 instances where the possibility of one or more errors in patient care existed. These were chiefly doctor errors and more experienced physicians might have salvaged some of these cases (how many ?).

In a report summarizing auto accident emergency care at the Methodist Hospital, Memphis, Tennessee, Lougheed[26] stated that:

1. Over a 5-year period almost none of the seriously injured patients received adequate or effective pre-admission first-aid treatment.

2. Only 3 of the 616 consecutive cases studied received any type of effective first-aid. Two hundred and eight or 30 percent required some type of major first-aid.

3. Over 25 percent of the seriously injured patients had lesions of the chest and most were in some respiratory distress.

D. M. Bruser[27] in an analysis of 1000 consecutive accident deaths in the Winnipeg (Canada) area stated that:

(a) 14 persons died because of avoidable delays in treatment.

(b) 4 died because of faulty observations by inexperienced hospital personnel.

(c) 4 died from treatment complications.

(d) 3 died because of delay due to bad weather or the isolated scene of the accident.

Aside from the instant deaths (figure not well known) we could envision a system of medical care which would make considerable inroads into the case fatality rate for traffic casualties but it would become increasingly expensive as we continually tried to lower the death rates. An ideal system would require communications and transport that would get appropriate first-aid to the injured almost immediately and transportation to expert definitive surgery in a matter of minutes (see "Vietnam Experiment" above).

A more realistic system could be envisioned which provided a signal device to locate the accident. Following this rapid helicopter or ambulance dispatch to the scene would occur thereby providing trained personnel for the salvage of those who currently die because

of controllable hemorrhage, respiratory difficulty, early shock, etc. Following first-aid a triage system for sending the injured to special trauma centers would be possible. This could be done for many cases since control of shock, hemorrhage and respiratory difficulties by first-aid considerably extends the time allowed for definitive surgery to be effective.

V. CONCLUSIONS AND SUGGESTIONS

1. The military surgical experience over a period exceeding 100 years has shown a steady overall drop in case fatality rates among the wounded. The current Vietnam experience is showing a case fatality rate of about 1 percent. This is an integrated result incorporating improved medical knowledge and increased resources at the service of the wounded soldier.

2. The World War II experience shows relatively high case fatality rates for wounds to the head, chest and abdomen. If we assume the equivalent experience for traffic injuries, the outlook for improving current case fatality rates does not seem bright, i.e., the high case fatality body areas for military wounded are well represented in the traffic accident group.

3. One small study during World War II attempted to show the effects of increased experience on the case fatality rates of thoracic injuries. The improvement was considerable.

4. On the basis of military experience through World War II the conclusion was drawn that there was not much effect on the early (24 to 48 hour) death rates based on improved care. As a large percentage of traffic deaths occur within 48 hours of injury this is a pessimistic conclusion.

   However, the results of the Vietnam experimental group using helicopter evacuation to reach definitive care within minutes indicates that if time lag is sufficiently low, case fatality rates can be dropped almost to zero for the military trauma cases. This is optimistic regarding traffic casualties if given the resources to approach their time record.

5. The overall case fatality rates for traffic injuries has remained relatively constant at under 3 percent. This compares favorably with the overall military case fatality rates of 4.5 percent for World War II and 2.5 percent for Korea. Of course the two groups are not directly comparable but the figures do raise the suggestion

that the easy part of the salvage among traffic casualties is probably already being accomplished. Further lowering of the case fatality rate may be difficult.

6. The case fatality rates for seriously injured traffic accident cases is extremely high. Analysis indicates that multiple injuries, head injuries and rapidly fatal thoracic injuries contribute to this.

7. The studies reported on "time to death" of traffic injuries suggest that a considerable percentage of those destined to die under current conditions of care do so immediately to within 24 hours. This also suggests that improving the case fatality rates will be a difficult task.

8. One study by Waller suggests that case fatality rates for rural injuries can be improved if quality of care were equal to that currently given urban casualties. This study also estimates considerably increased salvageability for urban and rural deaths if immediate and adequate medical care were available.

9. A few semi-quantitative evaluations of emergency medical care indicate that poor care based on delay and error are not uncommon and account for some unknown proportion of fatalities.

10. Suggestions:
    (a) More detailed research on medical description of the traffic casualty from scene of accident forward.
    (b) Investigate costs of various programs such as first-aid training, helicopter ambulances, etc. and get data to estimate their statistical effect on the injured group.
    (c) Large scale statistical studies on the surviving group regarding residual impairment.

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