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CURRENT INFORMATION ON FREQUENCY OF INJURY AND DEATH BY CRASH CONFIGURATION AND SPEEDS

Final Report

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16. Abstract

Estimates are presented of frequencies of accidents, fatalities, injuries and injury severities in the United States in 1971 as a function of accident characteristics, vehicle speeds and weights, and road features. Alternative injury severity measures are studied, and the Abbreviated Injury Scale developed by AMA is recommended. Alternative plans for accident data and injury data collection are studied, and two are recommended for future implementation. One uses the National Electronic Injury Surveillance System, a sample of hospital emergency rooms, to obtain injury data, followed by the collection of corresponding accident reports from police agencies. The other uses a national sample of accident reports from state central files, followed by collection of injury data by interviews with persons identified on the accident reports. Each plan would have 10,000 cases of motor-vehicle accident injuries, and their annual costs would be under $400,000.

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INTRODUCTION

This report provides current information on the severity of injuries in motor vehicle accidents, and analyses of methods for creating accurate injury-severity estimates in the future. The research findings are intended to answer three basic questions:

1. What method of injury classification is preferred to provide a precise measure of injury severity for use in quantitative comparisons of motor-vehicle accident injuries?

2. What methods of data collection are preferred for making accurate national accident injury estimates and relating degree of injury to specific accident types?

3. What are the detailed procedures and costs required to carry out the preferred methods of data collection, and what are the amounts of data and estimation accuracies that can be provided?

Results were obtained through a system study of a large number of alternative data-collection plans with a variety of potential injury-severity measures. Based on the findings, recommendations are presented as guidelines for policy decisions to implement future accident-injury estimation programs.

MEASURES OF INJURY SEVERITY

Two measures of injury severity are currently used in highway safety analyses of injuries in motor-vehicle accidents. The most common is the "standard police scale", which has been used for many years on a large number of official state accident-report forms. The new Abbreviated Injury Scale (AIS) has been used in an increasing number of special studies in recent years.

The police scale has five code levels (K, A, B, C, O) signifying killed, severe visible injury, minor visible injury, complaint of pain, and none, respectively. Other terminology is used for the three injury levels - A,B,C,- in some states. The National Safety Council is recommending standardization of these three levels under the titles "incapacitating injury", "nonincapacitating evident injury", and "possible injury". At present,however, there is a great deal of non-uniformity in policies as to injury-severity reporting among police agencies, and there is a great deal of inaccuracy of reporting due to different interpretations of the police codes, poor accident-investigation training, and other demands at accident scenes.[1] Hence, the standard police scale is not a good injury-severity measure.

The AIS has been developed within the last few years by the American Medical Association "to provide a more definitive classification system for traumatic injuries particularly those caused by automobile collisions."[2] The AIS has eleven code levels: 0 for no injury, 1-5 for various injury severities, and 6-10 for various fatality causes. The five injury levels are described as minor, moderate, severe (not life-threatening), severe (life-threatening, survival probable), and critical (survival uncertain), respectively. Each category is defined by a list of the specific injuries which correspond. Thus, though the five AIS injury levels are clearly defined, they must be applied by people with training in injury diagnosis. Tests have shown reasonable accuracy and reliability in AIS application, even by non-physicians.[2] However, use of AIS is not widespread, and it probably will not replace the police scale.

Another injury-severity measure is used in the national Health Interview Survey, conducted by the U.S. Public Health Service. The three injury categories are "medically attended, without activity restriction"; "activity restricting, not bed

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1 Acquisition of Information on Exposure and on Non-Fatal Crashes, Volume II, Highway Safety Research Institute, May 12, 1971.

2 Field Application and Research Development of the Abbreviated Injury Scale, J. States, H. Fenner, E. Flamboe, W. Nelson, L. Hames, Society of Automotive Engineers Report 710873, 1971.

disabling"; and "bed disabling". In addition, the number of days of restriction or disablement are obtained. These data are collected in precise household samples, and are quite accurate and reliable. However, they cannot be related to characteristics of their corresponding motor-vehicle accidents, other than moving versus non-moving. In addition to the restriction and disablement categories, the survey data are sometimes categorized by days of hospitalization, lost work, or lost school time.

Besides the police scale, AIS, and health survey codes, it is often suggested that injury severity may be measured in terms of dollar cost.[3] Costs may be assigned to injuries not only for medical expenses but also for lost wages and projection of indirect losses due to reduced productivity.

NEEDS FOR INJURY SEVERITY DATA

At the present time there are no adequate national statistics available concerning the occurrence of injuries in motor-vehicle accidents, either in terms of frequencies or degrees of injury. Current frequency data is biased due to pronounced under-reporting of minor injuries. In the few sets of usable accident data which include the police scale, degree of injury is not precisely classified. Thus, there is no ready way to provide meaningful and precise estimates of injury data for use in research or informing the general public.

The true effectiveness of traffic safety efforts can be properly assessed only when injuries are described so as to permit a quantitative measure of change in injury occurrence resulting from traffic safety efforts. Hence, it is important to provide accurate statistical information that relates injuries and injury-severity levels to adequately classified details of crash situations. Some efforts have been made in this area in previous studies but more needs to be done.

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3 Societal Costs of Motor Vehicle Accidents, Preliminary Report, U.S. Department of Transportation, April 1972.

OBJECTIVES OF THE STUDY

In order to meet the needs stated above for injury-severity data, either a short term or long-term approach may be used. The short-term approach would use currently available data from a variety of sources and adjust it as necessary through extrapolations and other assumptions. The long-term approach would start by designing a new system for collecting and processing necessary injury accident data.

Based on the long-term approach, the primary objective of this study is to determine future methods for data collection and estimation of national statistics on the relationships between injuries and motor-vehicle accidents. The three basic questions stated at the beginning provide further detail of this objective. The results obtained with respect to this objective will indicate methods that should be used in the future for improved accuracy in injury counts and degrees of injury; implementation of the methods will set the stage for proper evaluation of countermeasures--for both accident prevention and loss reduction.

Based on the short-term approach, a secondary objective of the study is to obtain current data on motor-vehicle accident severities and injuries as a function of crash characteristics. Results obtained with respect to this objective will provide data that reflects current ability to estimate accurate injury counts and degrees of injury.

ORGANIZATION OF THE REPORT

Following this Introduction are the three main sections of the report: Methods of Injury Classification
Methods of Accident-Injury Data Collection
Procedures and Scope of Data Collection Programs

The three sections correspond to work-statement tasks 3, 4, and 5 respectively. (Task 6 is also covered implicitly by the third of these sections as a result of the findings).

The Appendices include the results of Tasks 1 and 2, which were previously issued in an interim report.

SUMMARY

Several alternative injury-severity measures were defined and evaluated in terms of objective criteria. The Abbreviated Injury Scale (AIS) was selected.

A large number of data collection combinations (independent severity measures, injury data methods, and accident data methods) were derived and evaluated, using practical criteria and cost estimates. Thirteen final alternatives were narrowed to two recommendations; each using both AIS and Days of Activity Restriction as injury severity measures. One plan uses a national sample of hospital emergency rooms for injury data, followed by retrieval of corresponding accident reports; an auxiliary sample of injuries from the Health Interview Survey is used to properly weight the AIS distributions. The second plan uses a sample of accident records from all states, followed by interviews to obtain injury data.

In the emergency room plan, injury data would be obtained from the existing National Electronic Injury Surveillance System, and additional staff procedures would emphasize liaison with local police jurisdictions to obtain accident data. In the other plan, samples of accident reports would be obtained through the cooperation of state driver-records officials, and additional staff procedures would emphasize mail, telephone or household contact with injured persons identified on the accident reports. In each case, a sample size of 10,000 is desirable, and the annual cost would be between $300,000 and $400,000.

METHODS OF INJURY CLASSIFICATION

This section describes the studies performed to determine what method of injury classification is preferred to provide a precise measure of injury severity for use in quantitative comparisons of motor-vehicle accident injuries. Initially, several alternative measures were defined and evaluated in an idealized sense, i.e., independent of data collection methods. Later, the results were verified in evaluation of comprehensive data-collection plans which included specific injury-severity measures.

ALTERNATIVE INJURY SEVERITY MEASURES

Guidelines for posing alternative injury-severity measures were aimed at two audiences: the general public and the highway safety research community. Because the ultimate injury statistics must be used at least partially for public information, it is desirable that the injury-severity measure itself be meaningful to the general public. And for research purposes, an AMA guideline was "to provide researchers with an accurate method for rating and comparing injuries received in automotive crashes and at the same time, to standardize language used to describe injuries."[4]

The following injury-severity measures were considered as alternatives for further evaluation:

1. Standard police scale
2. Abbreviated injury scale
3. Days in hospital
4. Days of lost work or school
5. Days of normal activity restriction
6. Dollar cost of all medical expenses
7. Dollar cost of medical treatment only
8. Loss function

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4 Rating the Severity of Tissue Damage: I. The Abbreviated Scale, Committee on Medical Aspects of Automotive Safety, Journal of the American Medical Association, January 11, 1971.

As explained in the Introduction, only the standard police scale and Abbreviated Injury Scale (AIS) are currently used in highway safety analysis. There are three discrete injury levels or codes in the police scale, and five in the AIS. In each case the code sequence indicates increasingly serious injuries, i.e., C,B,A and 1,2,3,4,5. Because their codes are essentially ordinal numbers, there is no mathematical relationship implied, e.g., code 4 does not mean twice as serious as code 2. Hence, average severities are not as meaningful as usually desired.

The three alternative measures expressed in units of Days are currently used in the national Health Interview Survey (HIS), but not for highway safety purposes. For clarity, their values are expressed as full days, e.g., two and a half days in the hospital would be coded as 3. In each case it is possible for an injury to be coded zero (0), e.g., many injuries would not restrict normal activity. It is also possible for very serious injuries to have extremely large values on these scales. The three "Days" scales are quite unique in that many injuries would have widely different values on the three scales. However, it was felt that any other scales using Days as units would be redundant. Finally, it was decided that the three HIS categories mentioned in the Introduction (medically attended, activity restriction, bed disabling) would not in themselves comprise a sufficiently precise ordinal scale. Though the "Days" scales are discrete scales, meaningful averages may be obtained within groups of cases.

The last three alternative measures deal with the costs of injuries on a continuous scale from zero to very large quantities. The distinction is made between dollar cost of "all medical expenses" and "medical treatment only" to allow consideration of biases due to varying policies in ambulance charges and length of hospital stay, while recognizing the difficulty in separating hospital care from direct treatment. While the Loss Function would be based on dollar cost, it could be a non-dimensional quantity; it is intended to account for indirect costs to a person or family, or society at large (family nursing duties, lost wages, inefficiency, reduced volunteer opportunities, etc.[3]). Loss functions of varying complexities could be derived, and in many cases would rely on average costs of certain components in the function, depending on societal roles, age, and sex. The three "cost" scales are essentially continuous scales, and average costs may be obtained within groups. Trends in these scales could be obliterated by monetary inflation.

EVALUATION OF ALTERNATIVE MEASURES

The first assessment of alternative injury-severity measures was performed by a process of elimination, wherein each alternative was considered independently based on general feelings regarding its advantages and disadvantages.

1. The <u>Police Scale</u> is currently in widespread use, and is automatically combined with the necessary corresponding accident data of police reports. Thus large amounts of required data would be very readily available. Though its existence is unknown to the general public, proper publicity and naming of its three levels would resolve this problem. However, the three levels are not sufficient to provide precision in distinguishing among injuries. Also, minor injuries are under-reported. Further, the inaccuracies and biases of the police scale[1] would be extremely difficult to resolve .
2. The <u>Abbreviated Injury Scale</u> has been very carefully designed to provide the potential for very accurate and unbiased responses by people trained in its application. As stated above for the police code, proper publicity of AIS could make it meaningful to the general public. Its five injury levels make it more precise than the police scale, and sufficient for analysis categorizations. Although it is not adaptable to collection on mass accident-data report forms, it is amenable to use in sampling plans which would eliminate

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[1]Op.cit.

[3]Op.cit.

underreporting biases and interpretation biases of the police scale. However, the AIS does depend on well-trained personnel, and its cost of data collection might be significant. Also, the accident data corresponding to AIS codes might have to be collected from an independent source prior to combination.

3. Days in Hospital as an injury scale is meaningful to the public and reasonably precise in terms of its fairly wide -- yet essentially finite -- scale length. If obtained from hospital records, its responses should be quite accurate, and moderately accessible on a sampling basis. However, the scale is quite biased in that Days in Hospital will be zero for a great majority of injuries, including some that might be considered severe. Thus, most responses would come from people involved rather than hospital records; and if responses from hospital cases also come from the people, they would be subject to error because of memory and time delays following discharge. Accident data would be collected separately.

4. Days of Lost Work or School as an injury scale is also meaningful to the public and reasonably precise. The scale is biased because victims of minor injuries often choose to work or attend classes without interruption, and because lost time does not apply on weekends or holidays. Also, many people do not have regular jobs or attend school, making the scale inapplicable. Estimates are obtainable only by contact with the workers or students. Accident data would probably be collected separately.

5. Days of Normal Activity Restriction as an injury scale would become meaningful to the general public if a simple definition were included in press releases. For example, the Health Interview Survey uses "cut down on normal activity" which includes not only work and school, but also shopping, play and other recreation,

visits and errands. The scale would be more precise than those for days of hospital, work or school because it would have fewer zero codes and a slightly longer range in its distribution. It is also less biased by confounding factors of choice regarding hospital stay or absence from work or school. However, it is dependent on the memory of people involved, and a few cases might still involve activity restriction at the time of data collection. Again accident data would probably be collected separately.

6. <u>Dollar Cost of All Medical Expenses</u> as an injury scale is very meaningful to the public. Some of its required data may be obtainable from hospitals or insurance records. Its wide scale range provides a potential for precision, although confounding variables in certain components of medical expenses (ambulance distance, willingness to stay in a hospital, insurance coverage fee, rate differences) reduce the precision, e.g. especially if the scale is divided into arbitrary cost categories. Because there may be several components of cost, it may be difficult to collect data in cases where costs are billed from several sources. Cost estimates by the injured persons would tend to be inaccurate. Accident data would be collected separately.

7. <u>Dollar Cost of Medical Treatment Only</u> as an injury scale should be fairly meaningful to the public on a relative basis, though some confusion would exist as to the distinction between "treatment" and other associated expenses (ambulance, hospital bed and meals, etc.). Ideally, it would be more precise than the "all medical expenses" scale because of fewer cost components, though unfortunately some difficulties would probably arise in separating components of hospital bills. One possibility here is no "treatment" expenses in spite of other "medical" expenses. Cost estimates by the injured persons would tend to be inaccurate. Accident data would be collected separately.

8. A Loss Function as a scale related to severity of injury would not be as meaningful to the public as the other cost scales because it would include indirect costs that would not have immediate personal relevance (e.g. projected lost wages over long periods). Because the scale would involve larger dollar amounts than the other two costs, it might have to be converted to a non-dimensional scale, allowing further loss in meaning. Biases due to different wage losses for the same type of injury would reduce the precision of the scale. However, meaning and precision in terms of economic consequences to society would be quite good. In terms of data collection, a Loss Function would require data from several sources, including inaccuracies of personal estimates. Accident data would be collected separately. An example of a loss function is given in Appendix A.

In the tentative elimination of alternatives, the first two to be dropped were the Police Scale and the Loss Function. The Police Scale was dropped because of its gross inaccuracies and lack of precision. The Loss Function was dropped because of the difficulties foreseen in obtaining necessary data from several sources, and lack of meaning and precision to the public.

Among the three "Days" scales, Days in Hospital and Days of Lost Work or School were tentatively dropped because they are less precise and more biased that the Days of Normal Activity Restriction scale.

Of the two "Cost" scales, Cost of All Medical Expenses was dropped tentatively because it would be less precise and have more components than Cost of Medical Treatment Only.

At this point the three leading alternatives as injury-severity measures were AIS, Days of Normal Activity Restriction, and Dollar Cost of Medical Treatment Only. However, it was clear that these results should be considered as strictly tentative because the assessments had been only subjective, and independent of specific data-collection plans.

It was decided that before further evaluations of the alternative injury-severity measures were performed, some progress should be made in defining and narrowing the alternative data-collection plans (see the following section). After considerable effort, the number of alternative data collection plans was reduced to thirteen, among which were included just the three injury-severity measures of the preceding paragraph: AIS, Days of Normal Activity Restriction, and Dollar Cost of Medical Treatment Only. Among the thirteen plans, AIS was used in five plans, Dollar Cost of Medical Treatment was used in five plans, and Days of Activity Restriction was used in three of the plans.

In the course of the evaluations of alternative data-collection plans, it was determined that the most appropriate approach toward a recommendation of either an injury-severity measure or a combination of data-collection methods (injury data plus accident data), was to select the optimum overall plan (including a single measure, single injury data method, and single accident data method, all comprehensively integrated). Thus, the recommended injury-severity measure would be the one included in an optimum overall plan.

Meanwhile, it was decided to conduct a quantitative ranking among the three leading measures above, independent of the data-collection methods. The purpose of this evaluation was to provide guidelines for future programs for estimating accident-injury statistics in case a data-collection plan recommended in the following section must be supplemented or replaced. Each of the six staff members working on the study ranked the three contenders 1st, 2nd, and 3rd according to general impressions with respect to the following criteria:

Precision - Ability of the measure to permit clearly distinguished groupings or categorizations and meaningful statistical interpretations.

Meaning - Ease of interpretation of the measure and probable impact upon the general public.

Validity - How closely the measure is related to actual severity of injuries.

Objectivity - Extent to which the measure employs objective observations rather than subjective judgments.

Staff evaluators ranked their preference 1, next 2, and worst 3. The following are the results of the rankings:

Evaluator	AIS	Days of Acticity Restriction	Cost of Medical Treatment
1	1	3	2
2	1	3	2
3	2	3	1
4	2	3	1
5	1	2	3
6	2	3	1
Total	9	17	10

The concensus in this tentative, independent evaluation was AIS first, Cost of Medical Treatment a close second, and Days of Normal Activity Restriction third. It must be repeated that these results are independent of the practicalities of data-collection methods, and they were not considered as criteria in the final selection of recommended data-collection plans.

As reported in the next section, two-data collection plans were selected as final recommendations. Both plans were designed to permit collection of data for two injury-severity measures--AIS and Days of Normal Activity Restriction in each plan. In one of the plans, AIS is the only required measure whereas Days of Normal Activity Restriction is only possible in a secondary sample of very limited sample size. On this basis, and the concensus for AIS in the independent evaluation above, AIS is recommended as the primary injury-severity measure for future programs of accident-injury statistics estimation.

METHODS OF ACCIDENT-INJURY DATA COLLECTION

This section describes the studies performed to determine what methods of data collection are preferred for making accurate national accident-injury estimates and relating degree of injury to specific accident types. Initially, several alternative injury-data collection methods and accident-data collection methods were defined independently, followed by the determination of all feasible combinations of injury-data and accident data methods. Subsequently, it was determined which of the alternative injury-severity measures were feasible in the context of each data-collection combination. Alternative data-collection plans were narrowed down in number by practical considerations, and finally evaluated by an objective rating system.

COMBINATIONS OF DATA COLLECTION METHODS

A wide range of previously used techniques for data collection were considered in selecting the alternative methods for obtaining information, independently, on both injury-severity measures and motor-vehicle accident characteristics. In addition to past experience, guidelines included reasonable cost, potential accuracy, and applicability to required variables, i.e. to at least one alternative severity measure or to a typical set of accident variables.

The following injury-data collection methods were selected:

1. Emergency Room Sample, using National Electronic Injury Surveillance System
2. Household Survey, using National Health Interview Survey
3. Accident Report Sample
4. Accident Reports Corresponding to Injured Persons
5. Interviews with Injured Persons

6. Hospital Records Sample
7. Clinic or Physician Records Sample
8. Hospital Records of Injured Persons
9. Clinic or Physician Records of Injured Persons

And the following accident-data collection methods were selected:

1. Household Survey, using National Health Interview Survey
2. Accident Report Sample
3. Accident Reports Corresponding to Injured Persons
4. Interviews with Injured Persons

The Emergency Room Sample method would obtain injury-severity data from the 119 hospital emergency rooms in the National Electronic Injury Surveillance System (NEISS) sample. The system is in existence, under control of the Food and Drug Administration, and it could be augmented by the inclusion of a new injury measure. One disadvantage is a low proportion of minor injuries. Only those emergency room treatments relating to motor-vehicle accidentswould be used.

The Household Survey method could be used for either injury data or accident data, or both. Because of the low percentage of household members who have had recent injuries in motor-vehicle accide s, and the short time required in each interview, the cost efficiency of this method is poor unless it is combined with other surveys. The only appropriate existing survey for this purpose is the Health Interview Survey (HIS) which reaches 42,000 households annually. The HIS already includes some injury-severity data, and it is probably amenable to the addition of others. The addition of accident-related questions would be more difficult, but probably possible.

The two methods using official police accident reports (Accident Report Sample and Accident Reports Corresponding to Injured Persons) could also be used for either injury data or accident data. The Accident Report Sample method would require the establishment of a national sampling plan to provide statistical representation of all regions, perhaps on a state-by-state basis. In the Accident Reports Corresponding to Injured Persons method, the sample would not be defined from the population of available reports, but rather, by the identification of injured persons in one of the other data-collection methods. Both methods are subject to biases due to varying degrees of under-reporting among areas, especially with respect to minor injuries.

The Interviews with Injured Persons method is the fourth one which could be used for either injury or accident data. It does not define a sample, depending instead on the identification of injured persons in another data-collection method. Disadvantages include the difficulty in contacting subjects and inaccuracy of their estimates.

The two methods using hospital records for injury-severity data (Hospital Records Sample and Hospital Records of Injured Persons) would result in data biased against minor injuries, which are not likely to be treated in hospitals. For the Hospital Records Sample, the sampling plan would be the means of randomly identifying persons admitted within a nationally representative group of hospitals. Hospital Records of Injured Persons would be obtained for persons identified in an accident-data method. The two methods using clinic or physician records are analogous to the two hospital records methods, except they are more likely to be biased against serious injuries.

As various combinations of injury-data and accident-data methods were originally considered, it was apparent that many of them would not work. For example, it is impossible to use the Emergency Room Sample for injury data combined with the Household Survey for accident data, because they each define independent samples, and could not provide a set of cases with accident data corresponding to injury severity values. Another impossible combination is Interviews with Injured Persons for

Injury data and Accident Reports Corresponding to Injured Persons, because they each depend on another method for defining their sample. The 15 workable combinations are indicated in the two-way charts of Table 1, and listed in Table 2.

In addition to the 15 basic combinations of injury-data and accident-data collection methods, it was considered necessary to establish alternative double combinations of data-collection methods. The primary reason was to provide means for augmenting certain of the basic samples which alone would tend to be biased towards a certain severity of injury or accident, e.g. emergency room data would have an underrepresentation of minor injuries. In fact, all but four of the 15 basic combinations have an inherent underrepresentation of minor injuries and accidents, to various degrees, due to a tendency to forget minor accidents in the Household Survey,underreporting of minor accidents in the Accident Report Sample, and self-exclusion of persons with minor injuries from the Emergency Room Sample and Hospital Records Sample. However, the four combinations requiring Clinic or Physician Records have an underrepresentation of severe injuries. All of the double combinations of the 15 basic plans were considered in terms of augmenting their samples to reduce biases, and 50 double combinations were selected for further review as indicated in Table 3. These plus the 15 basic combinations are listed in Table 4.

Several triple combinations were considered, especially those involving emergency room data, hospital records, and clinic or physician records. None were selected because of the higher cost, and the fact thatthe National Electronic Injury Surveillance System (NEISS) to be used in the Emergency Room Sample is expected to be expanded in the future to include hospital, clinic, and physician's office samples.

Table 1. ANALYSIS OF DATA-COLLECTION COMBINATIONS

a) Both Methods Define Samples

Injury-Data Methods Which Define Samples	Accident Data Methods Which Define Samples	
	Household Survey	Accident Report Sample
Emergency Room Sample		
Household Survey	x	
Accident Report Sample		x
Hospital Records Sample		
Clinic and Physician Records Sample		

b) Injury Data Methods Define Sample

Injury-Data Methods Which Define Samples	Accident Data Methods Which Do Not Define Samples	
	Accident Reports Corresponding to Injured Persons	Interview with Injured Persons
Emergency Room Sample	x	x
Household Survey	x	
Accident Report Sample		
Hospital Records Sample	x	x
Clinic and Physician Records Sample	x	x

c) Accident Data Methods Define Sample

Injury-Data Methods Which Do Not Define Samples	Accident Data Methods Which Define Samples	
	Household Survey	Accident Report Sample
Accident Reports Corresponding to Injured Persons	x	
Interview with Injured Persons		x
Hospital Records of Injured Persons	x	x
Clinic and Physician Records of Injured Persons	x	x

Table 2.

ALTERNATIVE COMBINATIONS OF DATA-COLLECTION METHODS

	Injury-Data Collection Method	Accident-Data Collection Method	
1.	Household Survey	Household Survey	HS/HS
2.	Accident Report Sample	Accident Report Sample	ARS/ARS
3.	Emergency Room Sample	Accident Reports Corresponding to Injured Persons	ERS/ARCIP
4.	Emergency Room Sample	Interviews with Injured Persons	ERS/IIP
5.	Household Survey	Accident Reports Corresponding to Injured Persons	HS/ARCIP
6.	Hospital Records Sample	Accident Reports Corresponding to Injured Persons	HRS/ARCIP
7.	Hospital Records Sample	Interviews with Injured Persons	HRS/IIP
8.	Clinic or Physician Records Sample	Accident Reports Corresponding to Injured Persons	CPRS/ARCIP
9.	Clinic or Physician Records Sample	Interview with Injured Person	CPRS/IIP
10.	Accident Reports Corresponding to Injured Persons	Household Survey	ARCIP/HS
11.	Interviews with Injured Persons	Accident Report Sample	IIP/ARS
12.	Hospital Records of Injured Persons	Household Survey	HRIP/HS
13.	Hospital Records of Injured Persons	Accident Report Sample	HRIP/ARS
14.	Clinic or Physician Records of Injured Persons	Household Survey	CPRIP/HS
15.	Clinic or Physician Records of Injured Persons	Accident Report Sample	CPRIP/ARS

Table 3.

DOUBLE COMBINATIONS OF DATA-COLLECTION METHODS

Plan	Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
HS/HS	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARS/ARS	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ERS/ARCIP	3	d	d	-	-	-	-	-	-	-	-	-	-	-	-	-
ERS/IIP	4	d		1	-	-	-	-	-	-	-	-	-	-	-	-
HS/ARCIP	5	1		2		-	-	-	-	-	-	-	-	-	-	-
HRS/ARCIP	6	d	d	2		2	-	-	-	-	-	-	-	-	-	-
HRS/IIP	7	d			2		1	-	-	-	-	-	-	-	-	-
CPRS/ARCIP	8	d	d	2		2	2		-	-	-	-	-	-	-	-
CPRS/IIP	9	d			2			2	1	-	-	-	-	-	-	-
ARCIP/HS	10	1									-	-	-	-	-	-
IIP/ARS	11		1	d	d		d		d			-	-	-	-	-
HRIP/HS	12	1		d	d					d	1		-	-	-	-
HRIP/ARS	13		1	d	d				d			1	-	-	-	-
CPRIP/HS	14	1		d	d			d			1		1		-	-
CPRIP/ARS	15		1	d	d		d					1		1		-

1 One sample for both methods in combination.

2 Two independent samples in combination

d Dissimilar methods in combination

Table 4

Alternative Data-Collection Combinations

Basic Plans	Similar Combinations	Dissimilar Combinations
HS/HS	HS/HS & ARCIP	ERS/ARCIP//HS/HS
ARS/ARS	ERS/ARCIP & IIP	ERS/IIP//HS/HS
ERS/ARCIP	HRS/ARCIP & IIP	HRS/ARCIP//HS/HS
ERS/IIP	CPRS/ARCIP & IIP	HSR/IIP//HS/HS
HS/ARCIP	HS & ARCIP/HS	CPRS/ARCIP//HS/HS
HRS/ARCIP	HS & HRIP/HS	CPRS/IIP//HS/HS
HRS/IIP	HS & CPRIP/HS	ERS/ARCIP//ARS/ARS
CPRS/ARCIP	ARS & IIP/ARS	HRS/ARCIP//ARS/ARS
CPRS/IIP	ARS & HRIP/ARS	CPRS/ARCIP//ARS/ARS
ARCIP/HS	ARS & CPRIP/ARS	IIP/ARS//ERS/ARCIP
IIP/ARS	ARCIP/HRIP/HS	HRIP/HS//ERS/ARCIP
HRIP/HS	ARCIP & CPRIP/HS	HRIP/ARS//ERS/ARCIP
HRIP/ARS	IIP & HRIP/ARS	CPRIP/HS//ERS/ARCIP
CPRIP/HS	IIP & CPRIP/ARS	CPRIP/ARS//ERS/ARCIP
CPRIP/ARS	HRIP & CPRIP/HS	IIP/ARS//ERS/IIP
	HRIP & CPRIP/ARS	HRIP/HS//ERS/IIP
	ERS & HS/ARCIP	HRIP/ARS//ERS/IIP
	ERS & HRS/ARCIP	CPRIP/HS//ERS/IIP
	ERS & CPRS/ARCIP	CPRIP/ARS//ERS/IIP
	ERS & HRS/IIP	IIP/ARS//HRS/ARCIP
	ERS & CPRS/IIP	CPRIP/ARS//HRS/ARCIP
	HS & HRS/ARCIP	CPRIP/HS//HRS/IIP
	HS & CPRS/ARCIP	IIP/ARS//CPRS/ARCIP
	HRS & CPRS/ARCIP	HRIP/ARS//CPRS/ARCIP
	HRS & CPRS/IIP	HRIP/HS//CPRS/IIP

ALTERNATIVE DATA COLLECTION PLANS

The alternative data-collection plans were derived by considering the applicability of each injury-severity measure to each of the 65 data-collection combinations of Table 4. Five of the alternative injury-severity measures were retained for consideration as follows:

1. AIS
2. Days in Hospital
3. Days of Normal Activity Restriction
4. Dollar Cost of All Medical Expenses
5. Dollar Cost of Medical Treatment Only

The Police Scale was eliminated because of its gross inaccuracy. Days of Lost Work or School was eliminated because it does not apply to a large part of the injury population. The Loss Function was eliminated because of the difficulty in obtaining its components from several sources. In Table 5, the applicability of the remaining five measures is shown with respect to each of the injury-data collection methods, with an indication of the source of data (interviewer, subject, physician or record).

Based on the applicability of injury-severity measures to data-collection combinations, there are 131 alternative plans. Table 6 shows the 54 data-collection combinations to which both the AIS and Cost of Medical Treatment Only are applicable. Table 7 shows the 15 combinations to which Days in Hospital is applicable. Table 8 shows the 4 combinations to which both Days of Normal Activity Restriction and Cost of All Medical Expenses are applicable.

EVALUATION OF ALTERNATIVE PLANS

Evaluation of 131 alternative data-collection plans (Tables 6, 7, 8) was performed in two stages. In the first stage, alternatives were eliminated from consideration in a series of subjective and qualitative comparisons. In the second stage, the 13 final alternatives were evaluated by means of numerical ratings.

Table 5

FEASIBLE DATA SOURCES FOR INJURY SEVERITY MEASURES

Injury Data Collection Methods	Injury Severity Measures: AIS	Days Hosp.	Days Restrict.	All Med. Exp.	Med. Treat. Only
HS	interviewer	Subject	Subject	Subject	Subject
ARS	-	-	-	-	-
ERS	physician	-	-	-	record
HRS	physician	record	-	-	record
CPRS	physician	-	-	-	record
ARCIP	-	-	-	-	-
IIP	interviewer	Subject	Subject	Subject	Subject
HRIP	physician	record	-	-	record
CPRIP	physician	-	-	-	record

Table 6

COMBINATIONS USING AIS OR COST OF MEDICAL TREATMENT ONLY

HS/HS	HS/HS & ARCIP	ERS/ARCIP//HS/HS
ERS/ARCIP	ERS/ARCIP & IIP	ERS/IIP//HS/HS
ERS/IIP	HRS/ARCIP & IIP	HRS/ARCIP//HS/HS
HS/ARCIP	CPRS/ARCIP & IIP	HRS/IIP//HS/HS
HRS/IIP	HS&HRIP/HS	CPRS/ARCIP//HS/HS
HRS/ARCIP	HS&CPRIP/HS	CPRS/IIP//HS/HS
CPRS/ARCIP	IIP & HRIP/ARS	IIP/ARS//ERS/ARCIP
CPRS/IIP	IIP & CPRIP/ARS	HRIP/HS//ERS/ARCIP
IIP/ARS	HRIP & CPRIP/HS	HRIP/ARS//ERS/ARCIP
HRIP/HS	HRIP & CPRIP/ARS	CPRIP/HS//ERS/ARCIP
HRIP/ARS	ERS & HS/ARCIP	CPRIP/ARS//ERS/ARCIP
CPRIP/HS	ERS & HRS/ARCIP	IIP/ARS//ERS/IIP
CPRIP/ARS	ERS & CPRS/ARCIP	HRIP/HS//ERS/IIP
	ERS & HRS/IIP	HRIP/ARS//ERS/IIP
	ERS & CPRS/IIP	CPRIP/HS//ERS/IIP
	HS & HRS/ARCIP	CPRIP/ARS//ERS/IIP
	HS & CPRS/ARCIP	IIP/ARS//HRS/ARCIP
	HRS & CPRS/ARCIP	CPRIP/ARS//HRS/ARCIP
	HRS & CPRS/IIP	CPRIP/HS//HRS/IIP
		IIP/ARS//CPRS/ARCIP
		HRIP/ARS//CPRS/ARCIP
		HRIP/HS//CPRS/IIP

Table 7

COMBINATIONS USING DAYS IN HOSPITAL

HS/HS	HS/HS & ARCIP	HRS/ARCIP//HS/HS
HS/ARCIP	HRS/ARCIP & IIP	HRS/IIP//HS/HS
HRS/ARCIP	HS & HRIP/HS	IIP/ARS//HRS/ARCIP
HRS/IIP	IIP & HRIP/ARS	
IIP/ARS	HS & HRS/ARCIP	
HRIP/HS		
HRIP/ARS		

Table 8

COMBINATIONS USING DAYS OF NORMAL ACTIVITY RESTRICTION
OR COST OF ALL MEDICAL EXPENSES

HS/HS

HS/ARCIP

IIP/ARS

HS/HS & ARCIP

1. The first plans eliminated were all those including hospital records. It was determined that all were either unreasonably biased toward very severe injuries, or failed to contribute significantly to removal of bias in a double sample combination.

2. All plans involving clinic or physicians records as the sole source of injury data were eliminated. These plans were all heavily biased toward minor injuries.

3. The plans involving clinic or physicians records of injured persons, along with household survey data or interviews with injured persons, were eliminated. In these cases, the clinic or physicians data would not diminish the bias in injury data toward more severe injuries.

4. The plans using Days in Hospital and Cost of All Medical Expenses were eliminated due to lack of precision and overly large number of data sources, respectively.

5. The double plans with dissimilar combinations involving Emergency Room Sample were eliminated because none of these plans would provide an improvement in sample bias with respect to the ERS plans with similar double combinations.

6. The remaining plans with Clinic or Physician Record Sample were eliminated because none of them clearly remove a bias against minor and moderate injuries in their samples.

7. The plans using Interview with Injured Person for accident data were eliminated because of lesser accuracy and higher cost than similar plans using Accident Reports Corresponding to Injured Persons.

8. The plans using both Household Survey and Accident Reports Corresponding to Injured Persons for accident data were eliminated because of the inconsistent reliabilities of the two sources and failure of their combination to improve upon either alone.

At the conclusion of the above steps, there were 13 alternative data-collection plans remaining in contention, as listed in Table 9. The criteria used in evaluating the 13 alternatives are listed in Table 10.

A team of six researchers familiar with the 13 alternative data-collection plans performed the evaluations. Each team member derived her or his individual rating of each alternative on the basis of each of the 27 criteria. The ratings were on the scale 1,2,3,4,5 with 1 worst and 5 best. Weighting factors were applied to each rating, and averages were derived. Results are shown in Table 11. The four highest rated plans were selected for final evaluation.

In addition to the numerical ratings, cost estimates were also derived for the final evaluations of the four highest rated plans. The estimates are plotted in Figure 1 for various sample sizes. Cost-estimate components are given in Appendix B. The lowest cost plan is AIS:ERS/ARCIP/ For small sample sizes, the highest cost plan is AIS:ERS & HS/ARCIP; for samples sizes over 6,000 the AIS:IIP/ARS plan has the highest cost. Over the whole range, Days: IIP/ARS is just slightly cheaper than AIS:IIP/ARS.

A series of meetings were held by the research team to reach consensus on the plan or plans to be recommended among the four final alternatives. The first discussion was to eliminate AIS:ERS/ARCIP (in spite of its lowest cost) because of its underrepresentation of minor injuries and accidents in comparison to the other three plans. The next consideration was a possible elimination of either AIS:IIP/ARS or Days: IIP/ARS based on their only difference, i.e., their respective injury-severity measures. In this regard, it was decided instead to combine the plans, i.e., AIS & Days:IIP/ARS, such that both AIS and Days of Activity Restriction would be obtained as injury

Table 9

Alternative Plans for Second Stage of Evaluation

	Injury Measure	Injury Data Collection Procedure	Accident Data Collection Procedure
1.	AIS	Emergency Room Sample	Accident Reports Corresponding to Injuries
2.	AIS	Household Survey	Accident Reports Corresponding to Injuries
3.	AIS	Household Survey	Household Survey
4.	Days of Activity Restriction	Household Survey	Accident Reports Corresponding to Injuries
5.	Days of Activity Restriction	Household Survey	Household Survey
6.	Cost of Medical Treatment	Emergency Room Sample	Accident Reports Corresponding to Injuries
7.	Cost of Medical Treatment	Household Survey	Accident Reports Corresponding to Injuries
8.	Cost of Medical Treatment	Household Survey	Household Survey
9.	AIS	Interview Injured Person	Accident Report Sample
10.	Days of Activity	Interview Injured Person	Accident Report Sample
11.	Cost of Medical	Interview Injured Person	Accident Report Sample
12.	AIS	Household Survey and Emergency Room Sample	Accident Reports Corresponding to Injuries
13.	Cost of Medical	Household Survey and Emergency Room Sample	Accident Reports Corresponding to Injuries

Table 10

EVALUATION CRITERIA

1. Startup time for injury data method
2. Startup time for accident data method
3. Compatibility with existing injury data systems
4. Compatibility with existing accident data systems
5. Lack of bias in sample
6. Randomness of sample
7. Improvement potential of sample
8. Injury Data response rate
9. Accident data response rate
10. Reliability of injury data
11. Reliability of accident data
12. Speed of data collection
13. Efficiency of interaction of injury & accident collection
14. Continued viability of the plan
15. Continued existence and accessibility of data sources
16. Precision of injury data
17. Precision of accident data
18. Accuracy of injury data
19. Accuracy of accident data
20. Stability of injury variables
21. Stability of accident variables
22. Clarity of injury measure
23. Representativeness of injury measure
24. Sensitivity of plan to trends
25. Meaningfulness of injury measure to public
26. Meaningfulness of units on injury scale
27. Proportionality of injury measure to actual severity

Table 10a

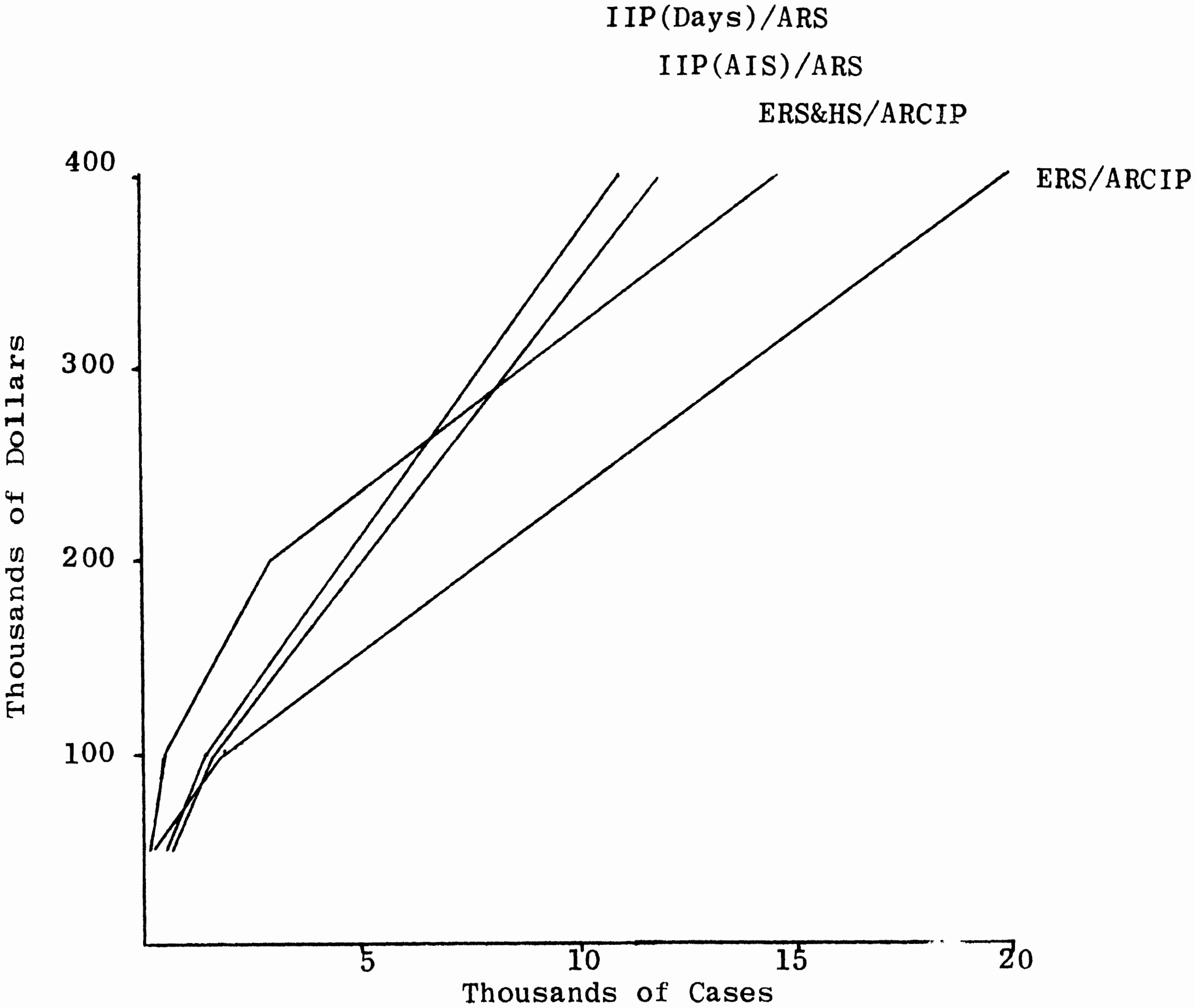
Weighting Factors for Evaluation Criteria

Criterion	Grouping Stages 1	2	3	4	Total
1	1/2	1/15	1/2	-	1/60
2	1/2	1/15	1/2	-	1/60
3	1/2	2/15	1/2	-	1/30
4	1/2	2/15	1/2	-	1/30
5	1/2	6/15	7/12	-	7/60
6	1/2	6/15	3/12	-	1/20
7	1/2	6/15	2/12	-	1/30
8	1/2	5/15	3/12	1/2	1/48
9	1/2	5/15	3/12	1/2	1/48
10	1/2	5/15	4/12	1/2	1/36
11	1/2	5/15	4/12	1/2	1/36
12	1/2	5/15	2/12	-	1/36
13	1/2	5/15	3/12	-	1/24
14	1/2	1/15	7/12	-	7/360
15	1/2	1/15	5/12	-	1/72
16	1/2	6/15	5/12	1/2	1/24
17	1/2	6/15	5/12	1/2	1/24
18	1/2	6/15	6/12	1/2	1/20
19	1/2	6/15	6/12	1/2	1/20
20	1/2	6/15	1/12	1/2	1/120
21	1/2	6/15	1/12	1/2	1/120
22	1/2	4/15	2/12	-	1/45
23	1/2	4/15	6/12	-	1/15
24	1/2	4/15	4/12	-	2/45
25	1/2	5/15	5/12	-	5/72
26	1/2	5/15	2/12	-	1/36
27	1/2	5/15	5/15	-	5/72

Table 11

EVALUATION RATINGS OF ALTERNATIVE PLANS

Rank	Plan No.	Measure	Injury Data	Accident Data	Avg.Rating
1	12	AIS	Household/ Emerg. Room	Acc. Report Corresponding	3.69
2	10	Days	Interview	Acc. Report Sample	3.66
3	9	AIS	Interview	Acc. Report Sample	3.63
4	1	AIS	Emerg. Room	Acc. Report Corresponding	3.59
5	13	Cost	Household/ Emerg. Room	Acc. Report Corresponding	3.50
6	11	Cost	Interview	Acc. Report Sample	3.47
7	4	Days	Household	Acc. Report Corresponding	3.35
8	2	AIS	Household	Acc. Report Corresponding	3.29
9	6	Cost	Emerg. Room	Acc. Report Corresponding	3.26
10	7	Cost	Household	Acc. Report Corresponding	3.24
11	5	Days	Household	Household	3.23
12	3	AIS	Household	Household	3.22
13	8	Cost	Household	Household	3.20



COSTS OF ALTERNATIVE PLANS

injury measures in the interviews. The resulting cost increases would be negligible. Similarly, it was decided to add Days of Activity Restriction to the Household Survey part of AIS:ERS/ARCIP. Thus, the two final alternatives both would provide two injury-severity measures.

In discussions comparing the two final alternatives, neither stood out as obviously better. Costs are not greatly different in the desirable range of about 10,000 cases. As a result the final decision was to recommend both plans for future accident-injury statistics estimation:

> An Emergency Room Sample (AIS data) plus an auxiliary Household Survey (Both AIS and Days of Activity Restriction), followed by collection of Accident Reports Corresponding to the Injured Persons.
>
> An Accident Report Sample, followed by Interviews with Injured Persons (both AIS and Days of Activity Restriction.)

PROCEDURES AND SCOPE OF DATA COLLECTION PROGRAMS

The two programs described below are recommended for future implementation.

EMERGENCY ROOM/HOUSEHOLD SAMPLES AND CORRESPONDING ACCIDENT REPORTS

The basic sample in this plan is derived from the National Electronic Injury Surveillance System (NEISS), a system sponsored by the Food and Drug Administration and based on data on injuries treated in a network of hospital emergency rooms. A secondary sample of data on motor-vehicle accident injuries would be collected in the Health Interview Survey, a national household survey conducted by HEW. This secondary sample would be reasonably unbiased in terms of its distribution of injury severities, and thus would be used to derive weighting factors for the basic sample (which would have an inherent underrepresentation of minor injuries). Accident reports corresponding to injured persons in the emergency room sample would be obtained by contacting the appropriate local police agencies. The injury severity measure in the emergency rooms would be AIS, and in the household survey both AIS and Days of Activity Restriction would be severity measures.

Established in 1971, NEISS is designed to provide for the first time a statistically valid means to assess community needs relative to hazards imposed upon the consumer. This same system will provide the intelligence for remedial program evaluation both on a national level and in special "test" areas.

Data garnered through NEISS will be statistically generalizable to the national scene and will provide a means to react quickly and responsibly where special health or safety hazards are detected as being causally related to consumer products. The data for NEISS will come initially from 119 statistically selected hospital emergency rooms located throughout the nation. These hospitals will represent all hospital emergency room treatments in the United States. For each statistically selected hospital, several valid alternates have been drawn in order to maintain the statistical integrity of the system. Eventually it is hoped that hospital in-patient data as well as other treatment centers will be incorporated, to broaden the scope of coverage over a wider range of severity.

The sequence of NEISS operations begins when an accident victim comes into the hospital emergency room for treatment of injuries. The emergency room admissions clerk queries the victim (or whomever brought in a child or unconscious patient) as to what product was involved in the injury and where the accident happened, writing this information directly on the emergency room record. The person on the hospital staff who has been designated and trained as a code/transmitter reviews the day's records for those injuries involving consumer products and transcribes coded equivalents for all relevant data onto a specially designed code sheet.

At the end of each day's coding, the coder/transmitter types the coded data into a Western Union model 33 teletypewriter which has been installed expressly for this purpose. While typing, a perforated paper tape is automatically punched, containing all the data on each case. When typing of the coded data is completed, the operator simply turns off the teletype and loads the perforated paper tape in a special "reader" on the machine.

During the late night hours of low telephone line traffic, a special switching device attached to the headquarters computer in Washington automatically polls each of the 119 hospital based terminals. This device turns each remote teletype machine on in turn, reads the perforated paper tape at high speed, edits the data for completeness and correctness and records the data in the computer. The central computer then prepares a daily summary register and detailed case printouts for headquarters review each morning.

Headquarters staff reviews the summary registers which present rank-ordered frequency distributions and rank-ordered relative severity distributions in order to determine changes in injury rate and investigative priorities.

Products ranking high in frequency or relative severity will generally constitute priority items. The appropriate records are consulted for case detail from which individual cases are selected for investigation. The hospital identification and case numbers are noted and typed into the headquarters teletype terminal which relays the information to the computer for later simultaneous transmission to the appropriate hospital and FDA field terminals. The FDA field investigator is thus apprised of headquarter's request for identifying particulars in specific cases and the hospital personnel re-access the records for name, address and telephone number of the victim. This information is then given, by phone, to the FDA field investigator who initiates contact with the victim (or their family) to request an investigatory visit.

If the victim declines an investigation request, no further attempt is made to follow up on that particular case. If the victim grants permission for an investigation she or he is visited at the earliest practicable time, ideally within 72 hours of the injury. At that point, a comprehensive interview is undertaken with concommitant verification of surveillance data, specific identification of the product, diagrams, photographs surrounding an acci--dent are collated to form the investigation report which is then sent to headquarters in Washington, D.C. for confidential staff review and analysis.

In discussions with Dr. Robert Verhalen, co-founder of NEISS within FDA, it was determined that the characteristics of the system are such that it would be compatible with a program for collecting data on motor-vehicle accident injuries on a national scale. This judgement is based on not only the national representativeness of the injuries recorded by NEISS, but also the flexibility of the system to both incorporate a new injury-severity measure and co-operate with another agency such as NHTSA in the processing and dissemination of data. Further, the general viewpoint of personnel presently associated with NEISS is favorable to expanded use of the system for a wide variety of injury-related programs.

With the exception of its injury-severity categories the procedures of NEISS are fully compatible with a method of injury-severity data collection from a sample of emergency rooms, as discussed in the preceding section. Officials in NEISS admit that their method of categorizing injuries does not provide a good measure of actual severity. Instead, it emphasizes the number of external injury points in the body. However it was felt that the AIS could easily be incorporated into the NEISS system for use in those cases of motor-vehicle accident injuries which might be selected for the sample. When NEISS is in full operation, it is anticipated that data on 720,000 injury cases will be collected each year. Of these, it is estimated that about 50,000 will be due to motor-vehicle accidents. Because this is far more than necessary for accurate national estimates, a secondary stage of sampling will help to reduce the sample size. This sampling will probably amount to nothing more than counting all motor-vehicle accident injuries in each of the 119 emergency rooms, and choosing every nth case according to an appropriate sampling fraction (e.g., every fifth case would provide 10,000 cases per year). The AIS would be applied only to those selected cases. Another difference is that AIS values would be determined by a physician, whereas the current NEISS categories are often determined by the emergency room admissions clerk. According to NEISS personnel, changes related to AIS (secondary sampling, physician cooperation, and new format for the recording forms) can be worked out between FDA and NHTSA.

Among the advantages of an emergency room sample, with respect to most of the other alternatives previously mentioned are its relatively simple sample design, its relatively small number of data sources, quick access following injury, and proximity of injury and accident data sources. NEISS incorporates all these advantages, and actually eliminates the necessity of designing a new sample, thus reducing start-up time and costs to NHTSA. Further NEISS provides the most rapid and efficient means for transmitting injury data to a central file. On the other hand, it is clear that an emergency room sample is the only data-collection alternative to which NEISS is applicable; and AIS is the only injury-severity measure that could be reasonably used within NEISS.

The primary caution about this recommended plan is that it depends on the continued existence and cooperation of two other government programs outside of the Department of Transportation. Both NEISS and the Health Interview Survey are administered within the Department of Health, Education and Welfare. Not only their long-term viability but also their routine day-to-day operations would be beyond the direct control of NHTSA. In addition, there is a possibility that some hospitals presently in the NEISS sample would balk at the additional data requirements for NHTSA. In that case, additional hospitals might be recruited by NHTSA solely to augment the sample of AIS-coded injuries.

The Health Interview Survey (HIS) has been conducted for many years and presently involves approximately 42,000 randomly selected households. It is estimated that only about 2400 of the people represented in the sample have suffered an injury due to a motor vehicle accident within the year preceding their household interview. In discussions with Dr. Ronald Wilson of the Center for Health Statistics it was determined that the continuing HIS sampling plan would be compatible with NHTSA needs for national representation of motor vehicle accident injuries, and that the HIS staff is accustomed to periodic adaptations of the survey to special needs of other agencies. Thus, an AIS question could be added to the standard form, provided that NHTSA requests the addition at least a year in advance. Current HIS data already includes Days of Normal Activity Restriction, but it is limited to the two weeks prior to the interview. A similar question could be added for the preceding six months, but any period longer than that lead to intolerable errors due to interviewees forgetting minor injuries. Thus, a sample of about 1200 injuries is the maximum to be expected from HIS. This is sufficient to provide accurate weighting factors for the emergency room data with respect to its distribution of AIS levels.

Accident data for this plan need be collected only for the cases identified in the emergency room sample. In each case, the NEISS headquarters will request name, address and telephone number for victims of motor vehicle accidents who have had their injuries coded on the AIS. Then, in conjunction with the FDA field staff, NHTSA personnel will contact the individuals to determine where their accident occurred, or the location may be obtained by other means (tracing ambulance driver, etc). The NHTSA staff person will then contact the appropriate police agency and gain access to the official accident report, either by phone, mail, or direct viewing at the police station. Accident variables to be obtained would probably include most of the following:

number of vehicles involved
location (urban/rural)
accident severity (injury/fatal)
configuration (head-on, rear, side, roll,
off road, object, pedestrian)
date and day of week
time (daylight/darkness)
road type
vehicle type
age and sex of injured person

Other accident variables could be added for special purposes, e.g., seated position, use of restraints, weather, other vehicle types, model years, number of others killed or injured. Upon receipt of the accident data, the NHTSA staff will combine it with the AIS code to provide a complete record for each injury case prior to data processing.

From the cost-estimates in Appendix B, the feasible sample sizes of injured persons in the emergency room sample are shown in Table 12 in conjunction with four alternative program cost levels on an annual basis. Also shown are the minimum significant differences possible between groups in two successive samples.

Table 12

COST, SIZE AND ACCURACY OF EMERGENCY ROOM SAMPLE PLAN

Cost	Sample Size	Group Size in first Sample	.95 Confidence Minimum Significant Difference of Second Sample
$50,000	200	5%	3.01%
		10	4.40
		20	6.15
		50	8.17
$100,000	500	5%	2.03%
		10	2.90
		20	3.99
		50	5.19
$200,000	3,000	5%	0.89%
		10	1.24
		20	1.67
		50	2.12
$400,000	14,700	5%	0.41%
		10	0.57
		20	0.76
		50	0.96

The sample size recommended is 10,000 at an annual cost estimated at $320,000. In this case, minimum significant differences for original group sizes of 5, 10, 20 and 50% would be .51, .67, .94, and 1.17% respectively. Thus, if a group such as injuries with AIS=5, were exactly 5% of the sample in one year, a statistically significant change in that same group would exist if the group were 5.5% or more of the sample in the following year.

ACCIDENT REPORT SAMPLES AND INTERVIEWS WITH INJURED PERSONS

The sample in this plan would have to be designed by the program staff to provide a national representation of official police accident report forms. Rather than sampling among all police agencies, it is recommended that data be collected from all 50 states and D.C., proportional to population, and that the sampling take place within the central accident files of each of the 51 jurisdictions. Names and addresses of all persons involved in each sampled accident would be obtained from the reports, and contact would be made with these people, primarily by telephone interview. In each interview, enough information would be obtained to provide an AIS code and the number of Days of Normal Activity Restriction.

As an existing source of accident data, the composite of official police accident reports throughout the country are quite compatible with the basic NHTSA needs for an annual accident-injury estimation program. Actually, the reports constitute the only existing source of accident data which provide a reasonable national representation of motor vehicle accident and injury occurrence. Though this source exhibits a slight bias due to under-reporting of minor accidents, the same is true of most other accident data collection methods that could be implemented. Not only do the accident reports exist they also are clustered by state, thus simplifying the sampling process. In all states, copies of local accident reports are forwarded from the various police agencies to a central office, usually in a department of highways, motor vehicles, or state police. In some states, the reports are stored only in hard copy form, but in a growing number of states the statewide data is compiled in a magnetic-tape computer file. Sampling of most state files, whether in drawers or computer storage would be by consecutive counting and selection of every nth case, based on an appropriate sampling fraction. Though state subsamples quotas would be proportional to population, the sampling fractions would vary depending on differences in state accident-reporting policies, urbanization, geography, etc.

Contacts with state liaison officials would be made by NHTSA to arrange periodic sampling and transmission of the accident data. Upon receipt of each segment of the data, names and addresses of people involved in the accident would be recorded on a master list, including not only those identifed by the police as injured, but also all other passengers noted. Initial attempts at contacting these people would be by phone from a central NHTSA staff office.

For those not contacted by telephone, attempts would then be made by mail. Finally, a small fraction of the sample would be contacted by personal visit by an NHTSA field staff member. In each contact, the basic required information is an AIS code for the person's injury, and an estimate of Days of Normal Activity Restriction. For the AIS code, the interviewer would make the estimate based on the injured person's descriptions of the injuries and treatment. Days of restriction would be the person's direct response after explanation by the interviewer. Upon receipt of injury data for each case, the NHTSA staff will combine it with the corresponding accident data to provide a complete record for each case prior to data processing.

From the cost-estimate data of Appendix B, Table 13 was constructed, showing feasible sample sizes and corresponding accuracies at four possible cost levels for an annual program.

Table 13

COST, SIZE AND ACCURACY OF ACCIDENT RECORD SAMPLE PLAN

Cost	Sample Size	Group Size in First Sample	.95 Confidence Minimum Significant Difference of Second Sample
$50,000	400	5%	2.24%
		10	3.22
		20	4.44
		50	5.80
$100,000	1,500	5%	1.23%
		10	1.73
		20	2.35
		50	3.00
$200,000	4,600	5%	0.72%
		10	1.01
		20	1.35
		50	1.71
$400,000	11,200	5%	0.47%
		10	0.65
		20	0.87
		50	1.10

As in the other plan, the recommended sample size is 10,000 and its annual cost would be about $370,000. Because there will be approximately 1.5 injured persons in each injury accident, it will only be necessary to sample around 6,700 accident reports to obtain 10,000 injury cases.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. No program now exists that is satisfactory to provide accurate, national estimates of motor-vehicle-accident injuries and injury severities, and their relationship to the accident characteristics.

2. The need exists for such a program as a means of evaluation of highway safety countermeasures.

3. Within such a program, the need exists for an injury-severity measure which is meaningful to the general public and capable of providing precise statistics on injury classification.

4. The standard police injury scale is the only existing injury-severity measure within mass accident data that is capable of providing nationally representative injury estimates.

5. The standard police injury scale is inadequate for a future program of accident-injury data collection because of its imprecision and gross inaccuracies.

6. Precision of the police injury scale could be improved by redefinitions.

7. Accuracy of data on the police injury scale could be improved by standardization of police-agency reporting policies and better accident investigation training for police.

8. The Abbreviated Injury Scale (AIS) is currently being used for a limited number of motor-vehicle-accident investigations for research purposes.

9. Several injury-severity measures based on days (in hospital, lost work, activity restriction, etc.) are currently used in a national household survey with a very limited relationship to motor-vehicle accidents.

10. Among existing and potential alternatives, the AIS is the preferred injury-severity measure, in an idealized sense, for future injury data collection programs. It has good precision, and accuracy potential. Though complex in application, its outward appearance of simplicity will make it understandable to the public.

11. An injury-severity measure using number of Days of Normal Activity Restriction is also potentially useful and acceptable for future programs.

12. A method of injury data collection using a national sample of hospital emergency rooms is probably the most accurate among available alternatives, though it would exhibit a bias against minor injuries.

13. A method of injury data collection using a national household survey is probably the least biased among alternatives, though it is relatively costly and subject to error of people's recollections.

14. Between the two feasible sources of accident data collection, police accident reports are superior to interviews with accident victims because the police reports are made immediately following the accidents by experienced personnel.

15. A method of accident-data collection using a national sample of accident reports is probably the best means of obtaining a reliable representation of accident characteristics (in spite of slight underrepresentation of minor accidents), and hence is an important alternative for identifying injured persons.

16. The National Electronic Injury Surveillance System (NEISS) presently exists as an effective and convenient means of injury data collection in a nationally representative sample of hospital emergency rooms.

17. The Health Interview Survey (HIS) presently exists as an effective and convenient means of injury-data collection in a nationally representative household survey.

18. Central accident-data files presently exist in all states as a conveniently clustered and potentially effective basis for nationally representative sampling of police accident reports.

19. Among all alternative plans considered for future implementation of a national program to provide accurate accident-injury statistics, two are superior:

a) A plan using NEISS for AIS injury data, weighted by the less-biased HIS distribution, followed up by collection of accident reports corresponding to NEISS injuries, with Days of Normal Activity Restriction also collected in the HIS data.

b) A plan using a sample of accident reports collected from state central files, followed by interviews with injured persons identified in the reports, for collection of both AIS and Days of Normal Activity Restriction.

Recommendations

1. NHTSA should initiate a national program of accident-injury data collection and estimation of injury statistics as related to accident characteristics, on an annual basis.

2. The NHTSA program should implement one of the two plans described above, in the final conclusion, and in more detail in the preceding section of the report .

3. More details of possible cooperative arrangements with the NEISS and HIS programs should be investigated before a final selection is made between the two plans recommended above.

4. More details of the potential for using a national accident report sample (for purposes other than injury data) should be investigated before a final selection is made between the two plans recommended above.

5. The number of injured persons to be sampled in the program should be approximately 10,000 to provide sufficient statistical significance.

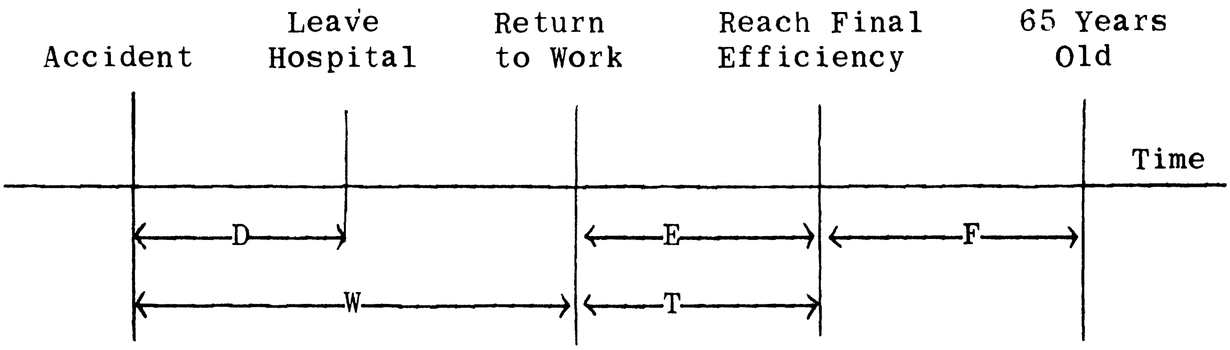
6. NHTSA should be prepared to pay between $300,000 and $400,000 annually for the program.

7. AIS should be considered as a leading contender for an injury-severity measure in future studies of motor-vehicle-accident injuries to augment or replace the programs recommended above.

8. Both AIS and Days of Normal Activity Restriction should be used in future programs if they are both compatible with the data collection plan.

for the remainder of the individual's working life. The contribution of this is calculated using the last term of the expression for L, where two assumptions are made: that there are 200 working days per year and that the working life of the individual stops at age 65.

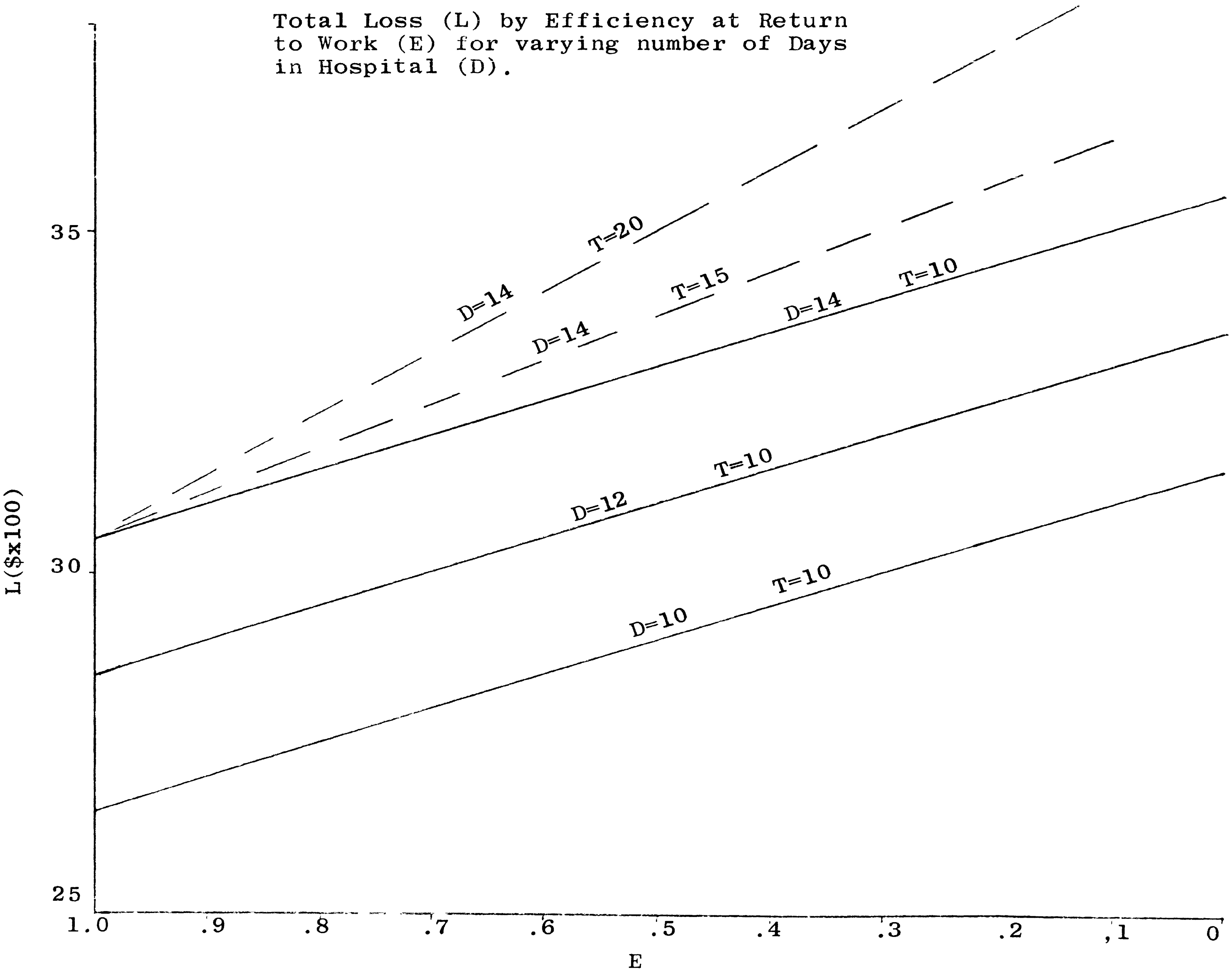
Some of the parameters for the loss calculation are put into better perspective by considering the time continuum on which they run. Above the time line are the critical events in the situation, and below the line are indications of where the significant parameters in the loss equation are operating.



To examine the behavior of this model, let us take some example cases. The first is a moderate injury case in which the victim is hospitalized for some period of time and returns to work after 20 days, achieving his full efficiency 10 days after that time. Some parameters which will be held constant during this examination are the cost of ambulance service at $150, the hospital charges per day at $100, and the cost of special medical attential at $500. For our first instance we also assume that the victim, whos age is irrelevant, has a daily rate of pay of $50 ($10,000 per year). Figure 1 shows a plot of the loss attributed to the accident as a function of the efficiency he exhibits when he returns to work for different length stays in the hospital. The result is a series of parallel lines, one for each value of D, the number of days in the hospital. The difference between the two end points of each line is a constant $500 in the total loss, a figure which is exaggerated due to the fact that a return to work with zero efficiency is a rather unlikely event. The difference is entirely attributable to the effect of the T parameter, the time it takes

Figure 1

Total Loss (L) by Efficiency at Return to Work (E) for varying number of Days in Hospital (D).



the victim to go from his initial efficiency to his final one. A change in the value of T has the effect of altering the slope of the lines in Figure 1 while preserving the same value for L at E = 1.0. This is shown by the two dotted lines in the upper portion of the figure.

We can conclude from Figure 1 that in cases where there is an eventual return to the level of efficiency existing prior to the accident, the greatest influence on the loss incurred comes from the amount of time spent in the hospital for relatively high values of the level of efficiency at the time of return to work. As this initial efficiency begins to decline, however, it becomes an increasingly important determinant of the total loss incurred.

The fact of permanent disability is, of course, one of the main concerns resulting from motor vehicle accidents, and we can study the effect of this by reference to Figure 2. This is a plot of the dollar loss resulting from the accident against the final efficiency (F) attained by the victim for different age groups. The efficiency at return to work (E) was held constant at .50 and the time after return to work at which the final efficiency was reached is 10 days. We see that when 100% efficiency is attained there is no difference in loss due to age, but as the value of F decreases, age of the victim is an increasingly important factor.

How important the accurate determination of F is to the loss formulation can be seen by studying Figure 2. An error in estimation of .2 for F yields a corresponding error in the loss function of a factor of 2. For a 40 year old victim, for example, a determination of = .8 results in a loss of $52,600 whereas F = .6 gives $102,300. The multiplicative constant decreases as age of the victim goes up and as the estimates are nearer to F = 1.0, but it can be seen that misestimation of this parameter poses a serious problem for the stability of the final result.

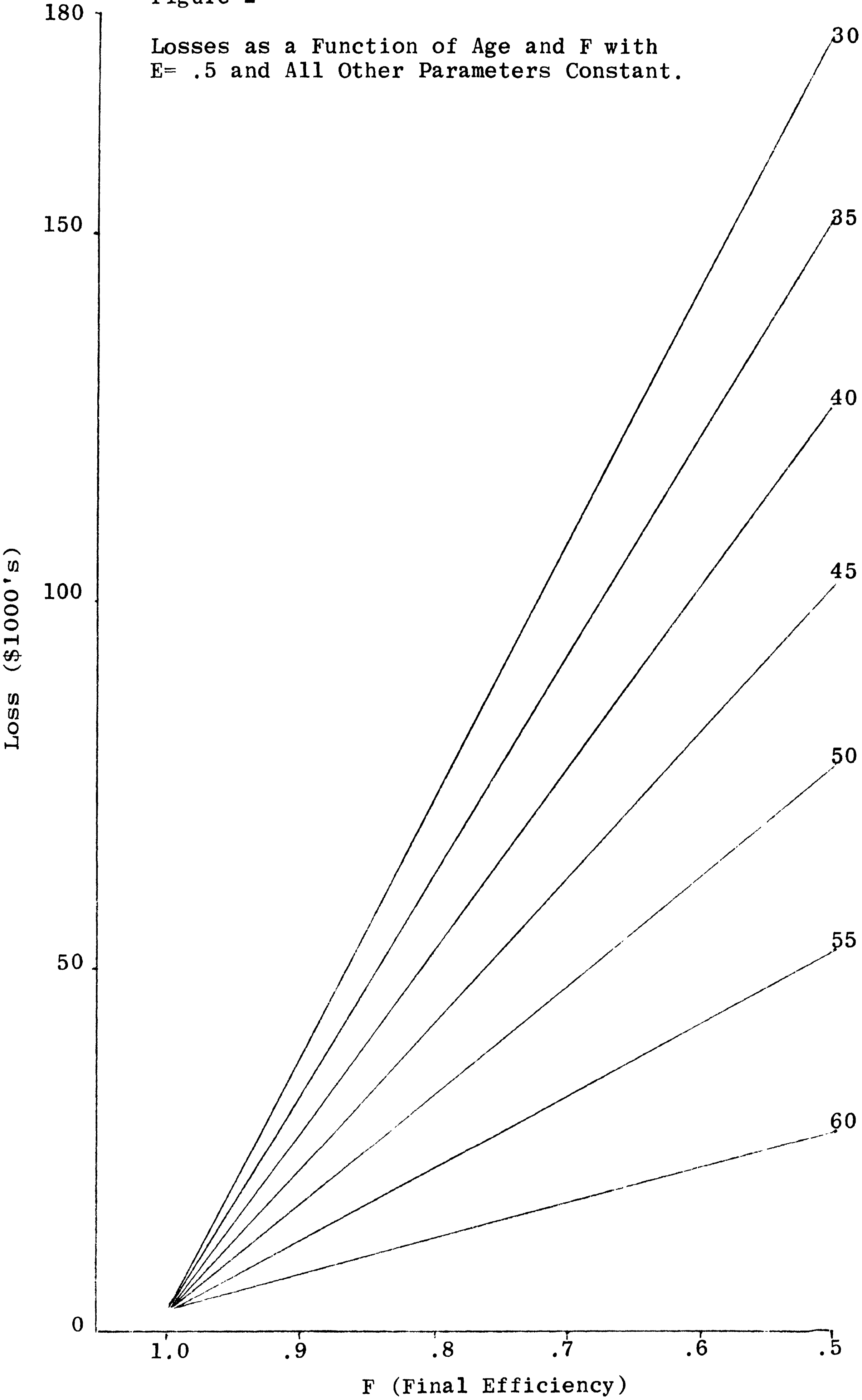


Figure 2

Losses as a Function of Age and F with E= .5 and All Other Parameters Constant.

The most evident conclusion to be drawn from Figure 2 is that the age of the victim plays a large part in the determination of the loss due to the accident. While this makes considerable sense in economic terms, as a measure of injury severity, it does not. The formulation as it stands is a good description of the financial results of the accident, but if we want an index which deals more directly with the injury itself, we would like to eliminate age as a factor while retaining the concept of permanent loss of efficiency. A number of methods might be considered for doing this, all of which involve altering the last term of the loss equation. Among them are the following:

1) Impose a maximum time (say one year) for which losses due to permanent disability can accrue. This method takes the position that after the time limit has passed, the victim has been retained and is adjusted to his new position in life as a result of the injury. The last term in the loss equation then becomes (1-F) * P * 200.

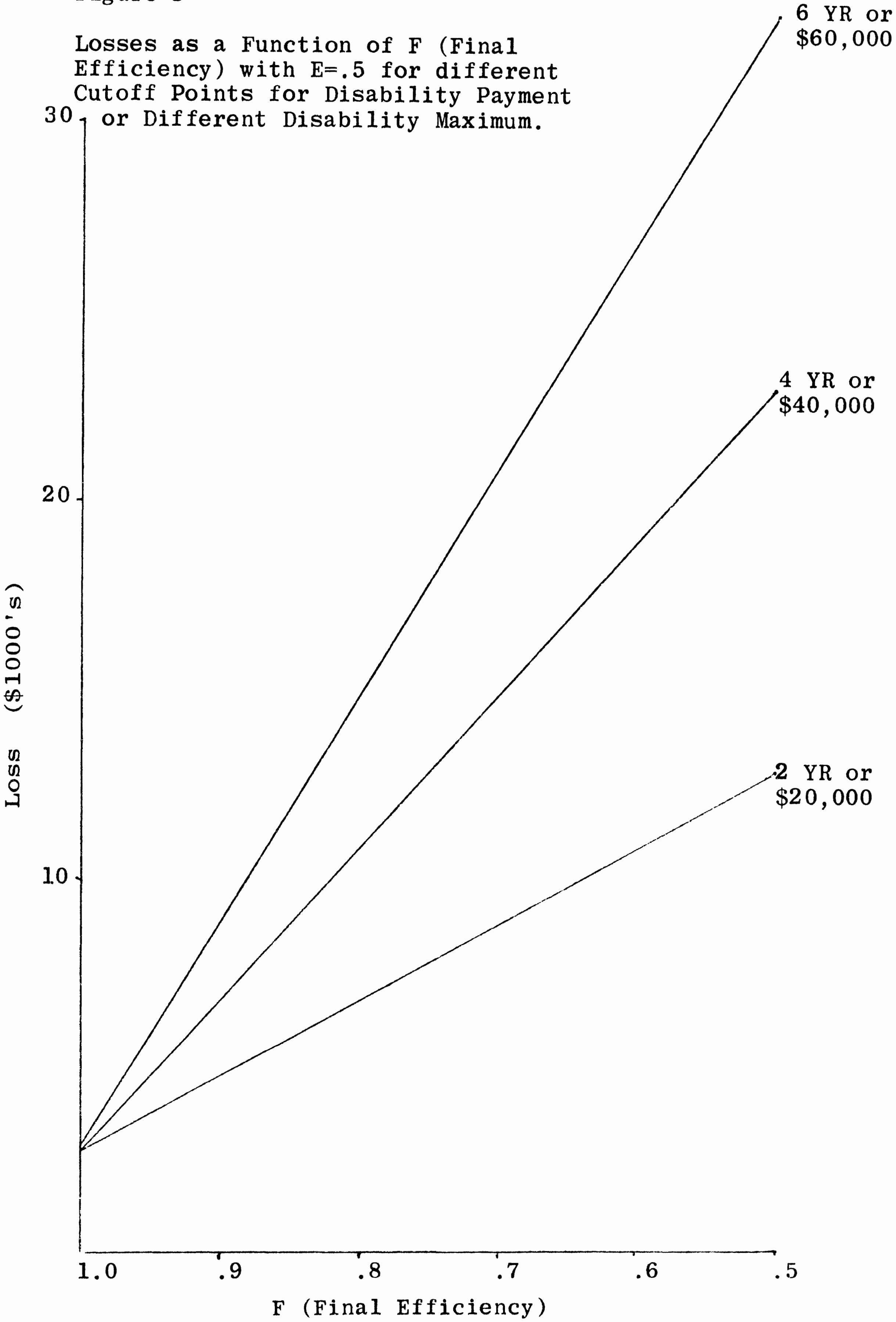
2) Assign a maximum loss value for permanent and total disability, M (say M = $100,000) and replace the last term of the loss equation with (1-F) * M. This method in essence, makes a lump sum payment to the victim depending on the magnitude of his disability.

The results of altering the model for both of the above methods produce identical results for the standard set of parameters used in the preceding analyses because of the value chosen for P ($50 per day) the curve for a 2-year limitation on disability loss accumulation corresponds exactly to that for a $20,000 maximum loss for total disability supplied by the last term in the formula. Similarly for 4 years and $40,000, etc. It can be seen from Figure 3 that the loss function rises more rapidly as these values increase with decreasing values for the F parameter.

If we pursue this idea of attaching a maximum value to the loss, we must ask what that value should be in order to remain consistant with other methods of producing these numbers. The values assigned to the average costs of permanent

Figure 3

Losses as a Function of F (Final Efficiency) with E=.5 for different Cutoff Points for Disability Payment or Different Disability Maximum.



and total disability in a study done by the National Highway Traffic Safety Administration are as follows:

1.	Wage losses	$139,000
2.	Medical costs	7,800
3.	Employer losses	1,000
4.	Insurance Administration	4,300
5.	Community services	7,000
6.	Miscellaneous	200
7.	Pain and suffering	50,000
8.	Home and family duties	35,000
9.	Losses to others	10,000
		$254,300

For purposes of our formulation we are interested only in the first item. The second item, medical costs, is handled by the first three terms of the formula, and the subsequent items are not considered at all. For total and permanent disability both E and F will be zero, making the last two terms irrelevant. What remains in the calculation of lost wages, W * P where W now is equal to (65-y) * 200.
Since the NHTSA figure is an average under the assumption that the useful working life an individual occurs between the ages of 20 and 65, we may assume that y = 65 - 45/2 = 42.5.
Our formula now tells us that:

$$L = 22.5 * 200 * P = \$139,000$$

and solving for P gives us a daily pay rate of $30.90 or an average yearly income of about $6,200. We can accept this as a reasonable figure and use $139,000 as our maximum wage loss or we can set the yearly income to another figure and calculate a new maximum.

So far we have looked at the loss function for medium and high degress of injury, conditions which are important because of the relatively high cost of these injuries to the victim and to society. For more frequent, however, are injuries at the low end of the scale, and we will define these for purposes of this analysis as those involving no loss of efficiency, i.e. E (and therefore F) is equal to 1.0. The last two terms of our equation for L drop out, leaving the only parameters of concern as A, D. H, S, W and P.

A summary of these low-level injuries is presented in Table 1, and it will be noted that the time lost from work and the fixed costs associated with the accident account almost completely for the cumulative amounts.

While the scaling of injury into dollar amounts as done by this model presents a reasonable and readily interpretable view of accident costs, it is not at this time proposed as a solution to the classification problem. Its complexity and novelty would make it difficult to introduce into as general and widespread use as is required of such a measure. Furthermore, the subjective estimates of the victim's loss of efficiency, while theoretically possible, are not now standard practice among the medical practitioners who would be required to provide these numbers. It is thought, therefore, that at this stage of development, the injury classification aspect of the problem should be handled in a more straightforward and commonplace manner.

Table 1

Dollar Costs of Low Level Injuries

	WORKING DAYS LOST																	
	0			1			2			5			10			20		
S	10	100	1000	10	100	1000	10	100	1000	10	100	1000	10	100	1000	10	100	1000
Days in Hosp.																		
0	10	100	1000	60	150	1050	110	200	1100	260	350	1250	510	600	1500	1010	1100	2000
1				160	250	1150	210	300	1200	360	450	1350	610	700	1600	1110	1200	2100
2							310	400	1300	450	550	1450	710	800	1700	1210	1300	2200
5										760	850	1750	1010	1100	2000	1510	1600	2500
10													1510	1600	2500	2010	2100	3000

APPENDIX B

COST ESTIMATES FOR ALTERNATIVE PLANS

The following cost estimates are for a full year of normal operation of the alternative data-collection plans, excluding data processing. An overhead of 50% on salaries is assumed. Travel costs for Plans 1 and 12 are for retrieval of accident reports, and for Plans 9 and 10 the travel costs are for interviews with injured persons. In each case travel is only required for a small portion of the difficult cases. Staff costs for Plans 1 and 12 are primarily for contacting police agencies to obtain accident reports, while in Plans 9 and 10 the staff costs are primarily for telephone interviewing.

Costs for sharing NEISS data are $0.02 per case for all 720,000 NEISS cases (hospitals are currently paid $0.60 per case). For the cases used by NHTSA and coded for AIS, the cost share ranges from $6 to $4 per case. Costs for sharing HIS data are $1 per case for all 42,000 HIS cases (current cost is about $40-$50 per case). For HIS cases actually used, cost is $5 per case.

Plan 1 - AIS:ER/ARCIP

Component	Number of Cases			
	250	1800	8000	20,000
<u>Salaries</u>				
Director	18	20	22	24
Clerical	4.4	7	8	8
Clerical			7	8
Clerical(2)				14
Staff		12	15	16
Staff		10	12	14
Staff (3)			32	38
Staff (6)				68
Overhead	11.2	24.5	43	95
NEISS basic	14.2	14.2	14.2	14.2
special	1.5	9	36	80
Travel	0.7	3.3	10.8	20.8
Total	$50K	$100K	$200K	$400K

Plan 9 - AIS:IIP/ARS

Component	Number of Cases			
	250	1800	8000	20,000
<u>Salaries</u>				
Director	16	20	22	24
Clerical	7	7	8	8
Clerical			7	7
Clerical				7
Staff	5.9	12	15	17
Staff		11	13	15
Staff		6	12	14
Staff (3)			30	37
Staff (8)				87
Overhead	14.4	28	54	108
Travel	6.7	16	39	76
Total	$50K	$100K	$200K	$400K

Plan 10 - Days:IIP/ARS

Component	Number of Cases			
	500	1600	5000	12,000
<u>Salaries</u>				
Director	18	20	22	24
Clerical	7	7	8	8
Clerical			7	7
Clerical				7
Staff	6	12	15	18
Staff		11	13	14
Staff		9	12	13
Staff (4)			39	48
Staff (9)				94
Overhead	15.5	29.5	58	116.5
Travel	4.5	11.5	26	50.5
Total	$50K	$100K	$200K	$400K

Plan 12 - AIS:ERS&HS/ARCIP

Component	Number of Cases			
	200	500	3000	14,700
<u>Salaries</u>				
Director	18	18.4	21	24
Clerical	7	7	8	8
Clerical				8
Clerical (2)			14	14
Staff			13	16
Staff			13	14
Staff			12	5
Staff (7)				84
Overhead	12.5	12.7	40.5	86.5
NEISS basic		14.2	14.2	14.2
special	3.5	2.5	15	66.15
HIS basic	7	42	42	42
special	1	2	3	3
Travel	1	1.2	4.3	15.15
Total	$50K	$100K	$200K	$400K

APPENDIX C

FREQUENCIES OF ACCIDENTS, FATALITIES, INJURIES AND INJURY SEVERITIES

This appendix presents estimates of the relative frequencies of motor-vehicle accidents, fatalities, injuries and injury severities in the United States in 1971. Estimates are presented as a function of accident severity, accident type and location, configuration, angle of impact, speed, vehicle weight, road type, alignment and gradient.

The basic source of data for the required tabulations is the 1971 National Accident Summary (NAS), compiled by NHTSA from official traffic accident records of 35 states:

- Alabama
- Arizona
- Connecticut
- Georgia
- Hawaii
- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- Missouri
- Montana
- Nebraska
- New Mexico
- New York
- North Carolina
- North Dakota
- Oklahoma
- Oregon
- Rhode Island
- South Carolina
- South Dakota
- Texas
- Utah
- Virginia
- Washington
- West Virginia
- Wisconsin
- Wyoming

The NAS data file, in its form as received from NHTSA, consisted of 511,869 records. Each record was defined by a unique combination of variable levels among eleven variables. For each record, there was a count of involvements, accidents, fatalities and injuries. Totals of all counts among all the records were as follows:

Involvements	6,186,879
Accidents	3,389,357
Fatalities	34,856
Injuries	1,596,797

In order to reduce the number of records in the NAS file to a manageable size, seven of the variables were eliminated. The 511,869 original records were regrouped in combinations of variable levels among the four remaining variables:

Accident Type/Location
1. Single Vehicle, Rural
2. Single Vehicle, Urban
3. Multi-Vehicle, Rural
4. Multi-Vehicle, Urban

Collision Type
0. Pedestrian
1. Non-Motor Vehicle
2. Fixed Object
3. Run-off-Road
4. Overturned
5. Other
6. Head-on
7. Angle Collision
8. Rear-End

Accident Severity
1. Fatality
2. Injury
3. Property Damage

Vehicle Type
1. Passenger Car
2. Truck
3. Bus
4. Motorcycle
5. Other
6. Pedestrian
7. Unknown

The result was a compressed file of only 674 records, but the totals of involvements, accidents, fatalities and injuries remained the same as originally.

The final step in modifying the NAS file was to extrapolate the counts of each record by weighting factors, in order to provide an approximate representation of accidents in the entire United States. The 674 records were divided into six groups, and weighting factors were derived, as follows:

1.	Rural, Fatal Accidents:	1.4782
2.	Rural, Injury Accidents:	1.4782
3.	Rural, Property-Damage Accidents:	1.4782
4.	Urban, Fatal Accidents:	1.6663
5.	Urban, Injury Accidents:	1.8250
6.	Urban, Property-Damage Accidents:	1.9737

These factors were then multiplied by the counts of involvements, accidents, fatalities and injuries in each record within the appropriate group.

Derivations of the weighting factors are as follows:

1. Rural, Fatal Accidents

   It is assumed that the frequency of reporting of rural, fatal accidents throughout the United States is proportional to the number of rural, vehicle miles driven.

   Thus, the weighting factor is the ratio of total U.S. rural miles driven to rural miles driven in the 35 states for which rural fatal accidents are reported.

   The following mileage data was obtained from "Fatal and Injury Accident Rates on Federal-Aid and Other Highway Systems/1970", U.S. Department of Transportation, Federal Highway Administration.

   Total U.S. rural miles driven: 543,332,000,000 miles
   Rural miles driven in 35 NAS states: 367,556,000,000 miles

   The weighting factor is 1.4782

2. Rural, Injury Accidents

It is assumed that the frequency of reporting of rural, injury accidents throughout the United States is proportional to the number of rural, vehicle miles driven.

Thus the weighting factor is the same as above, 1.4782.

3. Rural, Property Damage Accidents

It is assumed that the frequency of reporting of rural, property-damage accidents throughout the United States is proportional to the number of rural, vehicle miles driven.

Thus the weighting factor is the same as above, 1.4782.

4. Urban, Fatal Accidents

This weighting factor is the ratio of an estimate of total fatalities in urban traffic accidents in the United States to the original NAS count of fatalities in urban traffic accidents.

This approach is used instead of a mileage ratio because the original NAS fatality count excludes fatalities from a few of the urban areas in the 35 states, namely: Chicago, urban Kentucky except for Louisville, urban Missouri except for Kansas City and St. Louis, and urban West Virginia.

An estimate of total fatalities in traffic accidents in 1971 was obtained by personal communication from the National Safety Council: 53,718.

An estimate of total rural fatalities in traffic accidents in 1971 was obtained by multiplying the weighting factor for rural, fatal accidents (1.4782) by the NAS count of rural fatalities in 35 states (23,205), resulting in 34,304 rural fatalities.

Thus, an estimate of urban fatalities in traffic accidents may be obtained as the difference between the national total and estimated rural fatalities, i.e., 53,718-34,304=19,416 urban fatalities.

The NAS count of urban fatalities is 11,651. Thus, the weighting factor for urban, fatal accidents is 19,416/11,651=1.6663.

5. Urban, Injury Accidents

It is assumed that the frequency of reporting of urban, injury accidents throughout the United States is proportional to the number of urban, vehicle miles driven.

The original NAS injury count excludes injuries from a few of the urban areas in the 35 states, namely: Chicago, Wichita, urban Kentucky except for Louisville, Detroit, urban Missouri except for Kansas City and St. Louis, and urban West Virginia. Unfortunately, mileage data is not broken down for these areas. Therefore, the NAS injury counts were extrapolated—by means of both population ratios and a few National Safety Council estimates—in order to provide a complete estimate of injury accidents for the 35 states.

In order to estimate injury accidents in Chicago, Detroit and urban West Virginia, state-by-state estimates of injury accidents were used, as received from NHTSA and the National Safety Council. The NSC total for Illinois, Michigan and West Virginia was 206,420 injury accidents. The NAS count for the same states (excluding Chicago, Detroit and urban West Virginia) was 151,074 injury accidents. Thus, the estimate for these three urban areas is 55,346 injury accidents.

In order to estimate injury accidents in Wichita, urban Kentucky excluding Louisville, and urban Missouri excluding Kansas City and St. Louis, data was used from the 1970 Census of Population, U.S. Department of Commerce, Bureau of the Census. The population in these three urban areas was 3,386,002, compared to a population of 83,424,108 in the urban areas covered by the NAS injury reporting. Thus, by proportion of populations to the NAS estimate of injury accidents (656,245) the addition for these three urban areas is 26,634 injury accidents.

The total estimate for all urban areas within the 35 states is 738,225 injury accidents, and its partial weighting factor for the NAS count is 1.1249.

The other partial weighting factor is the ratio of U.S. total urban miles to urban miles in the 35 states:

577,373,000,000/355,896,000,000 = 1.6223.

Finally, the total weighting factor for urban, injury accidents is 1.8250.

6. Urban Property-Damage Accidents

It is assumed that the frequency of reporting of urban property-damage accidents throughout the United States is proportional to the number of urban, vehicle miles driven.

As in the previous grouping, the NAS count of property damage accidents excludes those from six urban areas. The NAS urban property damage accident count (1,607,832) was extrapolated in the same manner as for the previous grouping. For Chicago, Detroit and urban West Virginia, the additional count of property damage accidents was 186,669. For Wichita, urban Kentucky excluding Louisville, and urban Missouri excluding Kansas City and St. Louis, the additional count is 161,623.

The total estimate for all urban areas within the 35 states is 1,956,124 property-damage accidents, and its partial weighting factor is 1.2166. The other partial weighting factor is the previous mileage ratio, 1.6223. Thus, the total weighting factor for urban, property-damage accidents is 1.9737.

In the following sections, the required results of Tasks 1 and 2 are presented in the form of 50 tables. All of the tables are based on the National Accident Summary, and most are also based on special files. In those cases where special files are used, there are a few small inconsistencies in totals because of round-off errors stemming from proportioning procedures.

LIST OF TABLES

TABULATIONS OF ACCIDENT FREQUENCIES

This section presents Tables 1-19 as the results of Task 1. Each table includes estimates of both actual frequencies and relative frequencies (percentages) of reported traffic accidents in the United States in 1971, in various classes of accidents defined by 10 variables (accident severity, accident type, accident location, accident configuration, angle of impact, vehicle speed, vehicle weight, road type, road alignment, and road gradient).

Table 1 presents frequencies of accidents by accident severity (fatal accidents, injury accidents, and property-damage accidents).

Tables 2-10 each present univariate frequencies in three separate sub-tables (fatal accidents, injury accidents, and property damage accidents) by one of the nine other variables. Accident totals are given for each of the three accident-severity levels, and relative frequencies are given as percentages of those totals.

Tables 11-19 each present bivariate frequencies of accident severity vs. one of the nine other variables. Thus, the basic data in Tables 11-19 are the same as in Tables 2-10, respectively. However, the accident totals are given for each of the variable levels of the variables that are computed versus accident severity. The relative frequencies are percentages of the grand total of accidents in each table.

Tables 1-5 were produced directly by computer runs on the extrapolated NAS data file. (The five variables in these tables—accident severity, accident type, accident location, accident configuration, and angle of impact—are the only ones of the ten required variables which occur in the NAS data).

Tables 6-10 were produced indirectly from the NAS data by first making auxiliary computer runs on special HSRI files, and then weighting the results by frequencies of NAS accidents in appropriate groups. The five variables involved are vehicle speed, vehicle weight, road type, road alignment, and road gradient.

Three special accident-data files were used:

1. Washtenaw County, Michigan: 1968-1970
2. Oakland County, Michigan: 1970
3. Texas (5% sample): 1970

Table 6 (vehicle speed) was based on 12 independent computer runs of vehicle involvements in accidents by vehicle speed, from the Texas file. The 12 runs corresponded to 12 groups defined by all combinations of accident severity (fatal, injury, property damage), accident type (single vehicle, multi-vehicle), and accident location (rural, urban). The 12 speed distributions are presented below. Each of the 12 distributions was weighted by the number of vehicle involvements in the corresponding group of the extrapolated NAS file. The 12 NAS involvement sub-totals are also presented below. The 12 weighted distributions were added to produce Table 6. The speed data in the Texas file are intended to represent a police officer's estimate of vehicle travel speed prior to the accident. Thus, the data in Table 6 should be interpreted as speed prior to impact.

Table 7 is based on three runs of car involvements in accidents (fatal, injury and property damage) by vehicle weight, and three runs of truck involvements in accidents (fatal, injury, property-damage) by vehicle make and model in the Washtenaw file. Vehicle make and model data were subsequently converted to vehicle-weight data by reference to manufacturer's information. The six distributions by vehicle weight are presented below along with NAS distributions of vehicle type (car, truck, bus, motorcycle) involvements vs. accident severity. The NAS car and truck data was used as weighting factors on the six distributions. The motorcycle weights were assumed to be all in the lowest category (under 1500 lbs.). Data on bus weights in accidents could not be found, but NSC estimates indicate three times as many commercial buses in accidents compared to school buses; typical weights for those types are in the ranges 10,500-12,500 lbs. and 12,500-14,500 lbs., respectively. The results of Table 7 are the sums for the four vehicle types. All weights are unloaded (curb) weights.

Table 8 (road type) was based on 12 independent computer runs of accidents by road type, from the Oakland file. The 12 road-type distributions are presented below. Each of the 12 distributions was weighted by the number of accidents in the corresponding group of the extrapolated NAS file. The 12 NAS accident sub-totals are also presented below. Again, the 12 weighted distributions were added to produce Table 8.

Tables 9 (road alignment) and 10 (road gradient) were each based on 12 independent runs of accidents from the Texas file. The same 12 weighting factors were used as for Table 8, and the sets of weighted distributions were added to produce Tables 9 and 10.

1.

Frequency of Accidents, by Accident Severity

	Number	Percent
Fatal Accidents	45,914	.8
Injury Accidents	1,748,952	29.0
Property-Damage Accidents	4,241,580	70.3
Total	6,036,446	100.1%

2.

Frequencies of Fatal Accidents, Injury Accidents and Property Damage Accidents, by Accident Type

	Fatal Accidents		Injury Accidents		Property-Damage Accidents	
	Number	Percent	Number	Percent	Number	Percent
Single Vehicle Accidents	26,725	58.2	573,515	32.8	759,429	17.9
Multi-Vehicle Accidents	19,189	41.8	1,175,437	67.2	3,482,151	82.1
Total	45,914	100.0%	1,748,952	100.0%	4,241,580	100.0%

3.

Frequencies of Fatal Accidents, Injury Accidents and Property-Damage Accidents, by Accident Location

	Fatal Accidents		Injury Accidents		Property-Damage Accidents	
	Number	Percent	Number	Percent	Number	Percent
Rural Accidents	28,500	62.1	551,304	31.5	1,068,141	25.2
Urban Accidents	17,414	37.9	1,197,648	68.5	3,173,439	74.8
Total	45,914	100.0%	1,748,952	100.0%	4,241,580	100.0%

4.

Frequencies of Fatal Accidents, Injury Accidents and Property Damage Accidents, by Accident Configuration

	Fatal Accidents		Injury Accidents		Property-Damage Accidents	
	Number	Percent	Number	Percent	Number	Percent
Collision with Pedestrian	8,383	18.3	127,613	7.3	1,493	0.0
Collision with Non-Motor Vehicle	2,011	4.4	64,890	3.7	115,172	2.7
Collision with Fixed Object	4,753	10.4	136,167	7.8	286,171	6.7
Collision with Other Object	1,952	4.2	112,930	6.4	588,547	13.9
Run-Off-Road Accident	11,257	24.5	223,273	12.8	345,826	8.2
Overturn Accident	1,017	2.2	29,357	1.7	23,658	.6
Collision with Other Motor Vehicle	16,541	36.0	1,054,722	60.3	2,880,713	67.9
Total	45,914	100.0%	1,748,952	100.0%	4,241,580	100.0%

5.

Frequencies of Multi-Vehicle Fatal Accidents, Multi-Vehicle Injury Accidents and Multi-Vehicle Property-Damage Accidents, by Angle of Impact

	Multi-Vehicle Fatal Accidents		Multi-Vehicle Injury Accidents		Multi-Vehicle Property-Damage Accidents	
	Number	Percent	Number	Percent	Number	Percent
Head-on Collisions	6,228	37.6	82,225	7.8	139,106	4.8
Side Collisions	8,035	48.6	552,603	52.4	1,697,354	58.9
Rear-end Collisions	2,278	13.8	419,894	39.8	1,044,253	36.2
Total	16,541	100.0%	1,054,722	100.0%	2,880,713	99.9%

6.

Frequencies of Vehicle Involvements in Fatal Accidents Injury Accidents and Property-Damage Accidents by Vehicle Speed

MPH	Fatal Accidents Number	Fatal Accidents Percent	Injury Accidents Number	Injury Accidents Percent	Property-Damage Accidents Number	Property-Damage Accidents Percent
0	1,035	1.6	295,576	9.9	949,362	12.8
1-10	4,529	6.8	452,518	15.1	1,937,461	26.0
11-20	6,077	9.2	461,319	15.4	1,299,887	17.5
21-30	4,865	7.1	690,635	23.1	1,543,045	20.7
31-40	6,957	10.5	377,213	12.6	663,817	8.9
41-50	13,342	20.1	283,445	9.5	488,507	6.6
51-60	12,458	18.8	249,007	8.3	353,765	4.8
61-70	9,199	13.9	141,064	4.7	177,928	2.4
over 70	8,014	12.1	44,411	1.5	28,901	0.4
Total	66,296	100.0	2,995,188	100.1	7,442,673	100.0

6a.

Frequencies of Vehicle Involvements in Single-Vehicle Fatal Accidents, Injury Accidents, and Property-Damage Accidents, by Vehicle Speed

MPH	Fatal Accidents Number	Fatal Accidents Percent	Injury Accidents Number	Injury Accidents Percent	Property-Damage Accidents Number	Property-Damage Accidents Percent
0	0	0.0	365	0.1	1,908	0.3
1-10	710	2.7	36,022	6.4	106,729	14.2
11-20	1,806	6.9	60,639	10.7	66,593	8.9
21-30	2,192	8.4	115,450	20.4	120,670	16.1
31-40	4,384	16.8	72,145	12.8	104,517	14.0
41-50	3,737	14.3	86,808	15.4	131,841	17.6
51-60	5,375	20.5	100,956	17.9	129,521	17.3
61-70	2,672	10.2	63,872	11.3	73,059	9.8
over 70	5,281	20.2	29,048	5.1	14,366	1.9
Total	26,157	100.0	565,305	100.1	749,204	100.1

6b.

Frequencies of Vehicle Involvements in Multi-Vehicle Fatal Accidents, Injury Accidents, and Property-Damage Accidents, by Vehicle Speed

mph	Fatal Accidents		Injury Accidents		Property-Damage Accidents	
	Number	Percent	Number	Percent	Number	Percent
0	1,035	2.6	295,211	12.1	947,454	14.2
1-10	3,819	9.5	416,496	17.1	1,830,732	27.4
11-20	4,271	10.6	400,680	16.5	1,233,294	18.4
21-30	2,493	6.2	575,185	23.7	1,422,375	21.3
31-40	2,573	6.4	305,068	12.6	559,300	8.4
41-50	9,605	23.9	196,637	8.1	356,666	5.3
51-60	7,083	17.6	148,051	6.1	224,244	3.4
61-70	6,527	16.3	77,192	3.2	104,869	1.6
over 70	2,733	6.8	15,363	0.6	14,535	0.2
Total	40,139	99.9	2,429,883	100.0	6,693,469	100.2

7.

Frequencies of Vehicle Involvements in Fatal Accidents, Injury Accidents and Property-Damage Accidents, by Vehicle Weight

LBS	Fatal Accidents Number	Fatal Accidents Percent	Injury Accidents Number	Injury Accidents Percent	Property Damage Accidents Number	Property Damage Accidents Percent
0-1500	2,378	3.6	98,199	3.3	38,906	0.5
1501-2500	7,497	11.3	308,850	10.3	747,018	10.0
2501-3500	18,492	27.9	1,084,450	36.2	2,961,536	39.8
3501-4500	26,525	40.0	1,221,577	40.8	2,935,542	39.4
4501-5500	2,999	4.5	86,629	2.9	200,631	2.7
5501-6500	673	1.0	6,775	0.2	13,863	0.2
6501-7500	2,018	3.0	34,491	1.2	99,490	1.3
7501-8500	--	--	616	--	1,631	--
8501-10500	--	--		--	--	--
10501-12500	84	0.1	3,910	0.1	8,671	0.1
12501-14500	251	0.4	11,728	0.4	26,011	0.3
14501-16500	673	1.0	22,173	0.7	58,715	0.8
16501-18500	4,707	7.1	115,791	3.9	350,661	4.7
Total	66,297	99.9	2,995,189	100.0	7,442,675	99.8

8.

Frequencies of Fatal Accidents, Injury Accidents and Property-Damage Accidents, by Road Type

	Fatal Accidents		Injury Accidents		Property-Damage Accidents	
	Number	Percent	Number	Percent	Number	Percent
Rural Freeway	2,920	6.4	45,981	2.6	82,818	2.0
Rural Highway	5,862	12.8	138,285	7.9	287,298	6.8
Rural Road	19,717	42.9	367,038	21.0	698,025	16.5
Urban Freeway	3,423	7.5	83,301	4.8	171,823	4.1
City Street	13,991	30.5	1,114,347	63.7	3,001,616	70.8
Total	45,913	100.0	1,748,952	100.0	4,241,580	100.2

9.
Frequencies of Fatal Accidents, Injury Accidents and Property-Damage Accidents, by Road Alignment

	Fatal Accidents		Injury Accidents		Property-Damage Accidents	
	Number	Percent	Number	Percent	Number	Percent
Straight	38,042	82.9	1,560,360	89.2	3,885,346	91.6
Curve	7,872	17.1	188,592	10.8	356,234	8.4
Total	45,914	100.0	1,748,952	100.0	4,241,580	100.0

10.

Frequencies of Fatal Accidents, Injury Accidents and Property-Damage Accidents, by Road Gradient

	Fatal Accidents		Injury Accidents		Property-Damage Accidents	
	Number	Percent	Number	Percent	Number	Percent
Level	34,677	75.5	1,485,390	84.9	3,740,344	88.2
Slope	11,237	24.5	263,562	15.1	501,236	11.8
Total	45,914	100.0	1,748,952	100.0	4,241,580	100.0

11.
Frequency of Accidents, by Accident Type
vs. Accident Severity

	Fatal Accidents Number	Injury Accidents Number	Property-Damage Accidents Number	Total Number	Total Percent
Single-Vehicle	26,725	573,515	759,429	1,359,669	22.5
Multi-Vehicle	19,189	1,175,437	3,482,151	4,676,777	77.5
				6,036,446	100.0

12.

Frequency of Accidents, by Accident Location

vs. Accident Severity

	Fatal Accidents	Injury Accidents	Property-Damage Accidents	Total	
	Number	Number	Number	Number	Percent
Rural	28,500	551,304	1,068,141	1,647,945	27.3
Urban	17,414	1,197,648	3,173,439	4,388,501	72.7
				6,036,446	100.0

13.

Frequency of Accidents, by Accident Configuration vs. Accident Severity

	Fatal Accidents	Injury Accidents	Property-Damage Accidents	Total	
	Number	Number	Number	Number	Percent
Pedestrian	8,383	127,613	1,493	137,489	2.3
Non-Motor Vehicle	2,011	64,890	115,172	182,073	3.0
Fixed Object	4,753	136,167	286,171	427,091	7.1
Other Object	1,952	112,930	588,547	703,429	11.7
Run-Off-Road	11,257	223,273	345,826	580,356	9.6
Overturn	1,017	29,357	23,658	54,032	0.9
Other Motor Vehicle	16,541	1,054,722	2,880,713	3,951,976	65.5
				6,036,446	100.1

14.

Frequency of Multi-Vehicle Accidents,

by Angle of Impact vs. Accident Severity

	Fatal Accidents	Injury Accidents	Property-Damage Accidents	Total	
	Number	Number	Number	Number	Percent
Head-on	6,228	82,225	139,106	227,559	5.8
Side	8,035	552,603	1,697,354	2,257,992	57.1
Rear-end	2,278	419,894	1,044,253	1,466,425	37.1
				3,951,976	100.0

15.

Frequency of Vehicle Involvements in Accidents, by Vehicle Speed vs. Accident Severity

MPH	Fatal Accidents Number	Injury Accidents Number	Property Damage Accidents Number	Total Number	Total Percent
0	1,035	295,576	949,362	1,245,973	11.9
1-10	4,529	452,518	1,937,461	2,394,508	22.8
11-20	6,077	461,319	1,299,887	1,767,283	16.8
21-30	4,685	690,635	1,543,045	2,238,365	21.3
31-40	6,957	377,213	663,817	1,047,987	10.0
41-50	13,342	283,445	488,507	785,294	7.5
51-60	12,458	249,007	353,765	615,230	5.9
61-70	9,199	141,064	177,928	328,191	3.1
over 70	8,014	44,411	28,901	81,326	0.8
				10,504,157	100.1

16.

Frequency of Vehicle Involvements in Accidents, by Vehicle Weight, vs. Accident Severity

LBS	Fatal Accidents	Injury Accidents	Property Damage Accidents	Total	
	Number	Number	Number	Number	Percent
0-1500	2,378	98,199	38,906	139,483	1.3
1501-2500	7,497	308,850	747,018	1,063,365	10.1
2501-3500	18,492	1,084,450	2,961,536	4,064,478	38.7
3501-4500	26,525	1,221,577	2,935,542	4,183,644	39.8
4501-5500	2,999	86,629	200,631	290,259	2.8
5501-6500	673	6,775	13,863	21,311	0.2
6501-7500	2,018	34,491	99,490	135,999	1.3
7501-8500	--	616	1,631	2,247	--
8501-10500	--	--	--	--	--
10501-12500	84	3,910	8,671	12,665	0.1
12501-14500	251	11,728	26,011	37,990	0.4
14501-16500	673	22,173	58,715	81,561	0.8
16501-18500	4,707	115,791	350,661	471,159	4.5
				10,504,161	100.0

17.
Frequency of Accidents, by Road Type vs. Accident Severity

	Fatal Accidents Number	Injury Accidents Number	Property-Damage Accidents Number	Total Number	Total Percent
Rural Freeway	2,920	45,981	82,818	131,719	2.2
Rural Highway	5,862	138,285	287,298	431,445	7.1
Rural Road	19,717	367,038	698,025	1,084,780	18.0
Urban Freeway	3,423	83,301	171,823	258,547	4.3
City Street	13,991	1,114,341	3,001,616	4,129,954	68.4
				6,036,446	100.0

18.
Frequency of Accidents, by Road Alignment vs. Accident Severity

	Fatal Accidents Number	Injury Accidents Number	Property-Damage Accidents Number	Total Number	Total Percent
Straight	38,042	1,560,360	3,885,346	5,483,748	90.8
Curve	7,872	188,592	356,234	552,698	9.2
				6,036,446	100.0

19.
Frequency of Accidents, by Road Gradient vs. Accident Severity

	Fatal Accidents Number	Injury Accidents Number	Property-Damage Accidents Number	Total Number	Total Percent
Level	34,677	1,485,390	3,740,344	5,260,411	87.1
Slope	11,237	263,562	501,236	776,035	12.9
				6,036,446	100.0

TABULATIONS OF FATALITY AND INJURY FREQUENCIES

This section presents Tables 20-50 as the results of Task 2. Each table includes estimates of both actual frequencies and relative frequencies (percentages) of reported traffic accident casualties in the United States in 1971 in various classes defined by the same 10 variables as in the previous section. Additionally, the injury frequencies are further divided by injury severity.

Table 20 presents frequencies of casualties in two classes, fatalities and persons injured. Tables 21-29 present frequencies of fatalities in various classes, and Tables 30-50 present frequencies of persons injured in various classes.

Tables 20-24 were produced directly by computer runs on the extrapolated NAS data file. All of the remaining tables were produced indirectly from the NAS data by first making auxiliary computer runs on special HSRI files, and then weighting the results by frequencies of NAS fatalities or injuries in appropriate groups. The Washtenaw, Oakland and Texas files mentioned in the previous section were again used.

The procedure for Tables 25-29 were similar to those described in the previous section for Tables 6-10. Each (except 26) was based on four independent computer runs corresponding to groups of fatalities defined by the combinations of accident type (single vehicle, multi-vehicle)and accident location (rural,urban). Table 26 was based on runs of fatalities in cars and in trucks, by make and model, where make and model data was then transformed to vehicle weight. Again, the Texas file was used for speed, alignment and gradient distributions, the Washtenaw file for vehicle weight, and the Oakland file for road type. All of the auxiliary distributions are presented below , along with the NAS counts of fatalities (i.e., weighting factors) in the four groups. In Table 25 it is noted that there are no fatalities in vehicles at zero speed, even though Table 6 showed some fatal accidents involving vehicles at zero speed. The explanation is that the fatalities occurred in a second vehicle which was moving prior to the accident. With a higher sample size, there probably would be a small percentage of fatalities involved at zero speed.

Table 30 was based on four runs of injury-severity frequencies in the Texas file. The four distributions (accident type vs. location groups) were weighted by corresponding NAS counts of persons injured and added.

Table 31 was based on one run of injury-severity frequencies versus accident severity in the Texas file. The three accident-severity distributions for A, B, and C injuries were used to proportion the respective A, B, and C injury totals of Table 30.

Tables 32 and 33 were based on the data described above for Table 30. For Table 32, the four weighted distributions were added separately in two groups, single vehicle and multi-vehicle. For Table 33, the four weighted distributions were added separately in two different groups, rural and urban.

Table 34 was based on seven runs of injury-severity frequencies in the Texas file. The seven distributions (the seven accident-configuration groups) were weighted by corresponding NAS counts of persons injured.

Table 35 was based on three runs of injury-severity frequencies in the Texas file. The three distributions (the three multi-vehicle angle-of-impact groups) were weighted by corresponding NAS counts of persons injured.

Table 36 was based on four runs (accident type vs. location groups) of injury-severity frequencies in the Texas file. Each run was a bivariate of persons injured in a vehicle by injury severity vs. vehicle speed. The four distributions were weighted by corresponding NAS counts of persons injured in a vehicle.

Table 37 was based on three runs of persons injured in cars (A, B, and C injuries) by vehicle weight, and three runs of persons injured in trucks (A, B, and C injuries) by vehicle make and model in the Washtenaw file. Vehicle make and model data was subsequently converted to vehicle-weight data. The six distributions by vehicle weight are presented below, along with vehicle-type distributions for A, B, and C injuries in the Texas file. The latter were used to proportion the A, B and C totals of Table 36 by vehicle type. The resulting car subtotals and truck subtotals were further proportioned by the vehicle-weight distributions. Motorcycle weights were assumed to be all in the lowest weight category (under 1500 lbs.), and other vehicle types were neglected. The results of Table 37 are the sums for cars, trucks and motorcycles.

Tables 38, 39 and 40 were each produced from single runs of persons injured by injury severity vs. road type, road alignment and road gradient, respectively. The Oakland file was used for the road-type runs and the Texas file for road alignment and gradient. In each case the distributions of road characteristic for A, B and C injuries were used to proportion the respective A, B and C injury totals of Table 30.

20.
Frequency of Fatalities and Persons Injured

	Number	Percent
Fatalities	53,703	1.9
Persons Injured	2,794,521	98.1
Total	2,848,224	100.0

21.
Frequency of Fatalities, by Accident Type

	Number	Percent
Single Vehicle Accidents	29,202	54.4
Multi-Vehicle Accidents	24,501	45.6
Total	53,703	100.0

22.

Frequency of Fatalities, by Accident Location

	Number	Percent
Rural Accidents	34,284	63.8
Urban Accidents	19,419	36.2
Total	53,703	100.0

23.
Frequency of Fatalities, by Accident Configuration

	Number	Percent
Collision with Pedestrian	8,560	15.9
Collision with Non-Motor Vehicle	2,333	4.3
Collision with Fixed Object	5,368	10.0
Collision with Other Object	2,345	4.4
Run-Off-Road Accident	12,747	23.7
Overturn Accident	1,074	2.0
Collision with Other Motor Vehicle	21,276	39.6
Total	53,703	99.9

24.

Frequency of Fatalities in Multi-Vehicle Accidents, by Angle of Impact

	Number	Percent
Head-on Collision	8,941	42.0
Side Collisions	9.620	45.2
Rear-end Collisions	2,715	12.8
Total	21,276	100.0

25.
Frequency of Fatalities in Vehicles,
by Vehicle Speed

MPH	Number	Percent
0	0	0
1-10	2,045	4.3
11-20	2,501	5.3
21-30	3,403	7.2
31-40	5,673	12.0
41-50	10,093	21.4
51-60	10,958	23.3
61-70	6,498	13.8
over 70	5,956	12.6
Total	47,127	99.9

26.
Frequency of Fatalities in Vehicles,
by Vehicle Weight

LBS.	Number	Percent
0-1500	2,089	4.4
1501-2500	6,951	14.7
2501-3500	14,828	31.5
3501-4500	17,438	37.0
4501-5500	1,390	2.9
5501-6500	358	0.8
6501-7500	1,073	2.3
7501-8500	--	--
8501-10500	--	--
10501-12500	34	0.1
12501-14500	103	0.2
14501-16500	358	0.8
16501-18500	2,504	5.3
Total	47,126	100.0

27.

Frequency of Fatalities, by Road Type

	Number	Percent
Rural Freeway	3,906	7.3
Rural Highway	8,778	16.3
Rural Road	21,601	40.2
Urban Freeway	2,440	4.5
City Street	16,979	31.6
Total	53,704	99.9

28.
Frequency of Fatalities, by Road Alignment

	Number	Percent
Straight	42,803	79.7
Curve	10,900	20.3
Total	53,703	100.0

29.
Frequency of Fatalities, by Road Gradient

	Number	Percent
Level	40,615	75.6
Slope	13,088	24.4
Total	53,703	100.0

30.

Frequency of Persons Injured,
by Injury Severity

	Number	Percent
A Injury	823,365	30.5
B Injury	1,016,464	37.6
C Injury	860,229	31.9
Total	2,700,058	100.0

31.

Frequencies of Persons Injured at Each Injury Severity Level
by Accident Severity

	A Injury		B Injury		C Injury	
	Number	Percent	Number	Percent	Number	Percent
Fatal Accidents	43,651	5.3	21,521	2.1	8,679	1.0
Injury Accidents	779,714	94.7	994,943	97.9	851,550	99.0
Total	823,365	100.0	1,016,464	100.0	860,229	100.0

32.

Frequencies of Persons Injured at Each Injury Severity Level
by Accident Type

	A Injury		B Injury		C Injury	
	Number	Percent	Number	Percent	Number	Percent
Single Vehicle	289,189	25.1	317,200	31.2	139,913	16.3
Multi-vehicle	534,176	64.9	699,264	68.9	720,316	83.7
Total	823,365	100.0	1,016,464	100.0	860,229	100.0

33.

Frequencies of Persons Injured at
Each Injury Severity Level, by Accident Location

	A Injury		B Injury		C Injury	
	Number	Percent	Number	Percent	Number	Percent
Rural	320,017	38.9	409,341	40.3	177,733	20.7
Urban	503,348	61.1	607,123	59.7	682,496	79.3
Total	823,365	100.0	1,016,464	100.0	860,229	100.0

34.

Frequencies of Persons Injured at Each Injury Severity Level, by Accident Configuration

	A Injury		B Injury		C Injury	
	Number	Percent	Number	Percent	Number	Percent
Pedestrian	54,240	6.6	56,847	5.7	26,077	2.9
Non-Motor Vehicle	27,090	3.3	38,942	3.9	8,466	1.0
Fixed Object	79,175	9.7	71,054	7.2	38,282	4.3
Other Object	62,259	7.6	62,259	6.3	42,025	4.7
Run-Off-Road	124,493	15.2	142,444	14.4	55,588	6.2
Overturn	12,647	1.5	21,889	2.2	6,323	0.7
Other Motor Vehicle	458,697	56.0	597,897	60.3	713,362	80.1
Total	818,601	99.9	991,332	100.0	890,123	99.9

35.

Frequencies of Persons Injured at Each Injury Severity Level, by Angle of Impact in Multi-Vehicle Accidents

	A Injury		B Injury		C Injury	
	Number	Percent	Number	Percent	Number	Percent
Head-on	75,466	16.5	71,909	12.0	25,664	3.6
Side	270,566	59.0	345,724	57.8	319,475	44.8
Rear-end	112,665	24.6	180,264	30.1	368,223	51.6
Total	458,697	100.1	597,897	99.9	713,362	100.0

36.

Frequencies of Persons Injured in Vehicles at Each Injury Severity Level, by Vehicle Speed

MPH	A Injury Number	A Injury Percent	B Injury Number	B Injury Percent	C Injury Number	C Injury Percent
0	18,717	2.5	45,776	4.7	144,188	17.8
1-10	57,265	7.7	101,331	10.3	117,450	14.5
11-20	100,913	13.6	136,418	13.9	123,474	15.3
21-30	147,848	19.9	222,531	22.6	193,230	23.9
31-40	119,295	16.0	128,410	13.1	78,301	9.7
41-50	89,427	12.0	126,631	12.9	68,114	8.4
51-60	107,051	14.4	128,415	13.1	45,726	5.7
61-70	81,177	10.9	72,222	7.3	28,063	3.5
over 70	22,495	3.0	21,404	2.2	10,247	1.3
Total	744,188	100.0	983,138	100.1	808,793	100.1

37.

Frequencies of Persons Injured in Vehicles at Each Injury Severity Level, by Vehicle Weight

LBS.	A Injury Number	A Injury Percent	B Injury Number	B Injury Percent	C Injury Number	C Injury Percent
0-1500	52,201	7.0	61,577	6.3	20,507	2.5
1501-2500	85,803	11.5	129,872	13.2	87,224	10.8
2501-3500	270,974	36.4	343,022	34.9	302,415	37.4
3501-4500	271,972	36.5	366,727	37.3	326,059	40.3
4501-5500	12,209	1.6	15,880	1.6	18,546	2.3
5501-6500	3,940	0.5	4,834	0.5	2,079	0.3
6501-7500	5,253	0.7	8,056	0.8	9,353	1.2
7501-8500	1,313	0.2	--	--	--	--
8501-10500	--	--	--	--	--	--
10501-12500	--	--	--	--	--	--
12501-14500	--	--	--	--	--	--
14501-16500	7,880	1.1	9,667	1.0	6,236	0.8
16501-18500	34,147	4.6	43,503	4.4	36,374	4.5
Total	744,188	100.1	983,138	100.0	808,793	100.1

38.

Frequencies of Persons Injured at Each Injury-Severity Level
by Road Type

	A Injury		B Injury		C Injury	
	Number	Percent	Number	Percent	Number	Percent
Rural Freeway	27,321	3.3	26,227	2.6	23,054	2.7
Rural Highway	98,225	11.9	115,201	11.3	110,364	12.8
Rural Road	229,462	27.9	279,423	27.5	195,958	22.8
Urban Freeway	31,874	3.9	38,482	3.8	35,317	4.1
City Street	436,483	53.0	557,131	54.8	495,536	57.6
Total	823,365	100.0	1,016,464	100.0	860,229	100.0

39.
Frequencies of Persons Injured at Each Injury-Severity Level,
by Road Alignment

	A Injury		B Injury		C Injury	
	Number	Percent	Number	Percent	Number	Percent
Straight	716,732	87.0	885,972	87.2	807,270	93.8
Curve	106,633	13.0	130,492	12.8	52,959	6.2
Total	823,365	100.0	1,016,464	100.0	860,229	100.0

40.
Frequency of Persons Injured at Each Injury-Severity Level,
by Road Gradient

	A Injury		B Injury		C Injury	
	Number	Percent	Number	Percent	Number	Percent
Level	677,865	82.3	859,110	84.5	752,820	87.5
Slope	145,500	17.7	157,354	15.5	107,409	12.5
Total	823,365	100.0	1,016,464	100.0	860,229	100.0

41.

Frequency of Persons Injured, by Accident Severity
vs. Injury Severity

	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Fatal Accidents	43,651	1.6	21,521	0.8	8,679	0.3	73,851	2.7
Injury Accidents	779,714	28.9	994,943	36.8	851,550	31.5	2,626,207	97.3
							2,700,058	100.0

42.

Frequency of Persons Injured, by Accident Type vs. Injury Severity

	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Single Vehicle	289,189	10.7	317,200	11.7	139,913	5.2	746,302	27.6
Multi-Vehicle	534,176	19.8	699,264	25.9	720,316	26.7	1,953,756	72.4
							2,700,058	100.0

43.

Frequency of Persons Injured, by Accident Location vs. Injury Severity

	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Rural	320,017	11.9	409,341	15.2	177,733	6.6	907,091	33.6
Urban	503,348	18.6	607,123	22.5	682,496	25.3	1,792,967	66.4
							2,700,058	100.0

44.

Frequency of Persons Injured, by Accident Configuration vs. Injury Severity

	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Pedestrian	54,240	2.0	56,841	2.1	26,077	1.0	137,164	5.1
Non-Motor Vehicle	27,090	1.0	38,942	1.4	8,466	0.3	74,498	2.8
Fixed Object	79,175	2.9	71,054	2.6	38,282	1.4	188,511	7.0
Other Object	62,259	2.3	62,259	2.3	42,025	1.6	166,543	6.2
Run-Off-Road	124,493	4.6	142,444	5.3	55,588	2.1	322,525	11.9
Overturn	12,647	0.5	21,889	0.8	6,323	0.2	40,859	1.5
Other Motor Vehicle	458,697	17.0	597,897	22.1	713,362	26.4	1,769,956	65.6
							2,700,056	100.1

45.

Frequency of Persons Injured in Multi-Vehicle Accidents, by Angle of Impact vs. Injury Severity

	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Head-on	75,466	4.3	71,909	4.1	25,664	1.4	173,039	9.8
Side	270,566	15.3	345,724	19.5	319,475	18.0	935,765	52.9
Rear-end	112,665	6.4	180,264	10.2	368,223	20.8	661,152	37.4
							1,769,956	100.1

46.

Frequency of Persons Injured in Vehicles,
by Vehicle Speed vs. Injury Severity

MPH	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
0	18,717	0.7	45,776	1.8	144,188	5.7	208,681	8.2
1-10	57,265	2.3	101,331	4.0	117,450	4.6	276,046	10.9
11-20	100,913	4.0	136,418	5.4	123,474	4.9	360,805	14.2
21-30	147,848	5.8	222,531	8.8	193,230	7.6	563,609	22.2
31-40	119,295	4.7	128,410	5.1	78,301	3.1	326,006	12.9
41-50	89,427	3.5	126,631	5.0	68,114	2.7	284,172	11.2
51-60	107,051	4.2	128,415	5.1	45,726	1.8	281,192	11.1
61-70	81,177	3.2	72,222	2.8	28,063	1.1	181,462	7.2
Over 70	22,495	0.9	21,404	0.8	10,247	0.4	54,146	2.1
							2,536,119	100.0

47.

Frequency of Persons Injured in Vehicles,
by Vehicle Weight vs. Injury Severity

LBS.	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
0-1500	52,201	2.1	61,577	2.4	20,507	0.8	132,781	5.2
1501-2500	85,803	3.4	129,872	5.1	87,224	3.4	302,899	11.9
2501-3500	270,974	10.7	343,022	13.5	302,415	11.9	916,411	36.1
3501-4500	271,972	10.7	366,727	14.5	326,059	12.8	964,758	38.0
4501-5500	12,209	0.5	15,880	0.6	18,546	0.7	46,635	1.8
5501-6500	3,940	0.2	4,834	0.2	2,079	0.1	10,853	0.4
6501-7500	5,253	0.2	8,056	0.3	9,353	0.4	22,662	0.9
7501-8500	1,313	0.1	--	--	--	--	1,313	0.1
8501-10500	--	--	--	--	--	--	--	--
10501-12500	--	--	--	--	--	--	--	--
12501-14500	--	--	--	--	--	--	--	--
14501-16500	7,880	0.3	9,667	0.4	6,236	0.2	23,783	0.9
16501-18500	34,147	1.3	43,503	1.7	36,374	1.4	114,024	4.5
							2,537,623	99.8

48.

Frequency of Persons Injured, by Road Type vs. Injury Severity

	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Rural Freeway	27,321	1.0	26,227	1.0	23,054	0.9	76,602	2.8
Rural Highway	98,225	3.6	115,201	4.3	110,364	4.1	323,790	12.0
Rural Road	229,462	8.5	279,423	10.3	195,958	7.3	704,843	26.1
Urban Freeway	31,874	1.2	38,482	1.4	35,317	1.3	105,673	3.9
City Street	436,483	16.2	557,131	20.6	495,536	18.4	1,489,150	55.2
							2,700,058	100.0

49.

Frequency of Persons Injured, by Road Alignment
vs. Injury Severity

	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Straight	716,732	26.5	885,972	32.8	807,270	29.9	2,409,974	89.3
Curve	106,633	3.9	130,492	4.8	52,959	2.0	290,084	10.7
							2,700,058	100.0

50.

Frequency of Persons Injured, by Road Gradient
vs. Injury Severity

	A Injury		B Injury		C Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Level	677,865	25.1	859,110	31.8	752,820	27.9	2,289,795	84.8
Slope	145,500	5.4	157,354	5.8	107,409	4.0	410,263	15.2
							2,700,058	100.0

Auxiliary Data for Table 6

Vehicle Involvement Distributions by Speed in Texas File

	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	over 70
Fatal, Single Vehicle, Rural	-	-	1	2	4	6	13	6	10
Fatal, Single Vehicle, Urban	-	2	4	4	8	4	1	1	4
Fatal, Multi-Vehicle, Rural	2	4	6	2	3	18	12	16	5
Fatal, Multi-Vehicle, Urban	1	8	7	6	5	10	9	2	3
Injury, Single Vehicle, Rural	-	6	5	25	39	89	135	91	44
Injury, Single Vehicle, Urban	1	89	158	276	135	95	60	29	9
Injury, Multi-Vehicle, Rural	32	65	68	44	70	84	98	59	9
Injury, Multi-Vehicle, Urban	522	690	651	1060	453	201	70	18	10
Prop. Dam., Single Vehicle, Rural	3	18	27	68	141	243	284	175	32
Prop. Dam., Single Vehicle, Urban	5	672	378	635	335	252	129	34	13
Prop. Dam., Multi-Vehicle, Rural	116	274	211	180	185	215	186	106	13
Prop. Dam., Multi-Vehicle, Urban	2998	5633	3710	4482	1396	579	201	33	10

Corresponding Vehicle Involvements in NAS

	Fatal Acc.	Injury Acc.	Prop. Dam. Acc.
Single Vehicle, Rural	16,217	254,099	385,149
Single Vehicle, Urban	9,941	311,206	364,056
Multi-Vehicle, Rural	25,264	612,293	1,340,088
Multi-Vehicle, Urban	14,875	1,817,589	5,353,380

Auxiliary Data for Table 7

Vehicle Involvement Distributions by Weight in Washtenaw File

Lbs.	Fatal Car	Fatal Truck	Injury Car	Injury Truck	Property Damage Car	Property Damage Truck
up to 1500	-		23		30	
2500	15		738		1292	
3500	37		2581	7	5108	10
4500	45	6	2657	178	4489	417
5500	6		207		347	
6500		1		11		17
7500		3		56		122
8500				1		2
10500						
12500						
14500						
16500		1		36		72
18500		7		188		430

Vehicle Type Involvements in NAS

	Car	Truck	Bus	Motorcycle
Fatal	51,478	12,106	335	2,378
Injury	2,597,188	293,789	15,638	88,574
Prop. Dam.	6,513,859	872,574	34,682	21,560

Auxiliary Data for Table 8

Accident Distributions by Road Type in the Oakland File

	Rural Freeway	Rural Highway	Rural Road	Urban Freeway	City Street
Fatal, Single Vehicle, Rural	5	5	42		
Fatal, Single Vehicle, Urban				8	24
Fatal, Multi-Vehicle, Rural	5	16	24		
Fatal, Multi-Vehicle, Urban				3	22
Injury, Single Vehicle, Rural	156	174	1012		
Injury, Single Vehicle, Urban				168	1420
Injury, Multi-Vehicle, Rural	149	969	1601		
Injury, Multi-Vehicle, Urban				317	5292
Prop.Dam.Single Vehicle, Rural	218	263	1225		
Prop.Dam.Single Vehicle, Urban				187	2206
Prop.Dam.Multi-Vehicle, Rural	213	1466	2698		
Prop.Dam.Multi-Vehicle, Urban				497	9252

Corresponding Accident Counts in NAS

	Fatal Acc.	Injury Acc.	Prop.Dam. Acc
Single Vehicle, Rural	16,464	256,653	389,756
Single Vehicle, Urban	10,261	316,862	369,673
Multi-Vehicle, Rural	12,036	294,651	678,385
Multi-Vehicle, Urban	7,153	880,786	2,803,766

Auxiliary Data for Tables 9 and 10

Accident Distributions by Road Alignment and Gradient in the Texas File

	Alignment		Gradient	
	Straight	Curve	Level	Slope
Fatal, Single Vehicle, Rural	38	6	34	10
Fatal, Single Vehicle, Urban	28	6	30	4
Fatal, Multi-Vehicle, Rural	26	11	25	12
Fatal, Multi-Vehicle, Urban	29	1	20	10
Injury, Single Vehicle, Rural	315	130	340	105
Injury, Single Vehicle, Urban	868	150	897	121
Injury, Multi-Vehicle, Rural	243	28	214	57
Injury, Multi-Vehicle, Urban	1,944	84	1,790	238
Prop. Dam., Single Vehicle, Rural	790	239	814	215
Prop. Dam., Single Vehicle, Urban	2,730	359	2,712	377
Prop. Dam., Multi-Vehicle, Rural	689	101	664	126
Prop. Dam., Multi-Vehicle, Urban	10,101	515	9,607	1,009

Corresponding Accident Counts in NAS

(same as for Table 8)

Auxiliary Data for Table 25

Fatality-in-Vehicle Distributions by Speed in Texas File

	mph								
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	over 70
Single Vehicle, Rural	-	-	1	2	7	10	14	6	11
Single Vehicle, Urban	-	2	4	4	8	4	1	1	4
Multi-Vehicle, Rural	-	3	1	2	1	15	13	11	3
Multi-Vehicle, Urban	-	2	3	4	4	4	8	3	2

Corresponding Fatality Counts in NAS

Single Vehicle, Rural	15,680
Single Vehicle, Urban	7,406
Multi-Vehicle, Rural	15,944
Multi-Vehicle, Urban	8,097

Auxiliary Data for Table 26

Fatality-in-Vehicle Distributions by Weight in Washtenaw File

Lbs.	Cars	Lbs.	Trucks
up to 1500	0	3500-4500	6
2500	15	5500-6500	1
3500	32	6500-7500	3
4500	33	14500-16500	1
5500	3	16500-18500	7

Fatalities-in-Vehicle by Vehicle Type in NAS

Car	38,461	
Truck	6,439	
Bus	137	(assumed distributed as in Table 7)
Motorcycle	2,089	(assumed all under 1500 lbs.)

Auxiliary Data for Table 27

Fatality Distributions by Road Type in Oakland File

	Rural Freeway	Rural Highway	Rural Road	Urban Freeway	City Street
Single Vehicle, Rural	6	7	55		
Single Vehicle, Urban				9	36
Multi-Vehicle, Rural	7	21	21		
Multi-Vehicle, Urban				1	35

Corresponding Fatality Counts in NAS

Single Vehicle, Rural	18,166
Single Vehicle, Urban	11,036
Multi-Vehicle, Rural	16,118
Multi-Vehicle, Urban	8,383

Auxiliary Data for Tables 28 and 29

Fatality Distributions by Road Alignment and Gradient in the Texas File

	Alignment		Gradient	
	Straight	Curve	Level	Slope
Single Vehicle, Rural	47	6	43	10
Single Vehicle, Urban	28	6	30	4
Multi-Vehicle, Rural	67	40	71	36
Multi-Vehicle, Urban	69	8	50	27

Corresponding Fatality Counts in NAS
(same as for Table 27)

Auxiliary Data for Table 30

Persons Injured Distributions by Injury Severity in the Texas File

	A Injury	B Injury	C Injury
Single Vehicle, Rural	203	280	96
Single Vehicle, Urban	390	342	192
Multi-Vehicle, Rural	192	233	117
Multi-Vehicle, Urban	724	987	1,280

Corresponding Injury Counts in NAS

Single Vehicle, Rural	361,104
Single Vehicle, Urban	385,198
Multi-Vehicle, Rural	545,987
Multi-Vehicle, Urban	1,407,769

Auxiliary Data for Table 31

Persons-Injured Distributions (per Accident Severity) by Injury Severity in Texas File

	A Injury	B Injury	C Injury
Fatal Accidents	80	39	17
Injury Accidents	1429	1803	1668

Auxiliary Data for Tables 32 and 33 (same as for Table 30)

Auxiliary Data for Table 34

Persons Injured Distributions (per Accident Configuration) by Injury Severity in Texas File

	A Injury	B Injury	C Injury
Pedestrian	104	109	50
Non-Motor Vehicle	32	46	10
Fixed Object	273	245	132
Other Object	80	80	54
Off-The-Road	215	246	96
Overturn	26	45	13
Other-Motor Vehicle	1,913	2,480	2,865

Corresponding Injury Counts in NAS

Pedestrian	137,164
Non-Motor Vehicle	74,498
Fixed Object	188,511
Other Object	166,544
Off-the-Road	322,525
Overturn	40,859
Other Motor Vehicle	1,769,957

Auxiliary Data for Table 35

Persons-Injured Distributions (per Angle of Impact) by Injury Severity in Texas File

	A Injury	B Injury	C Injury
Head-on	297	283	101
Side	1,206	1,541	1,424
Rear-end	410	656	1,340

Corresponding Injury Counts in NAS

Head-on	173,039
Side	935,765
Rear-End	661,153

Auxiliary Data for Table 37

Persons-Injured in Vehicle Distributions by Injury Severity vs. Vehicle Weight in Washtenaw File

	A		B		C	
Lbs.	Car	Truck	Car	Truck	Car	Truck
up to 1500	6		2		13	
2500	253		229		316	1
3500	299		602	1	1105	1
4500	709	24	533	40	1085	29
5500	36		28		68	
6500		3		3		2
7500		4		5		9
8500		1				
10500						
12500						
14500						
16500		6		6		6
18500		26		27		35

Vehicle Type Distributions by Injury Severity in Texas File

	A	B	C
Car	1244	1478	1456
Truck	171	247	178
Motorcycle	99	113	35
Other	4	6	16

Auxiliary Data for Table 36

Persons-Injured-in-Vehicle Distributions by Injury Severity vs. Vehicle Speed in Texas File

	mph								
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	over
A Injuries									
Single Vehicle, Rural	0	4	4	9	8	25	76	58	26
Single Vehicle, Urban	0	26	51	118	94	57	32	26	4
Multi-Vehicle, Rural	3	12	26	5	23	36	40	38	4
Multi-Vehicle, Urban	30	69	113	204	128	46	29	6	5
B Injuries									
Single Vehicle, Rural	0	2	3	19	27	52	98	58	25
Single Vehicle, Urban	1	42	84	157	52	48	30	13	8
Multi-Vehicle, Rural	13	20	21	14	26	46	54	33	4
Multi-Vehicle, Urban	62	132	175	299	140	73	20	5	2
C Injuries									
Single Vehicle, Rural	0	2	0	2	7	32	26	14	14
Single Vehicle, Urban	0	28	40	62	34	19	17	7	1
Multi-Vehicle, Rural	19	10	14	13	13	15	18	14	2
Multi-Vehicle, Urban	239	189	189	311	100	57	16	8	0

Corresponding Injury Counts in NAS

Single Vehicle, Rural	336,673
Single Vehicle, Urban	275,389
Multi-Vehicle, Rural	538,574
Multi-Vehicle, Urban	1,385,491

Auxiliary Data for Table 38

Persons-Injured Distributions by Injury Severity vs. Road Type in Oakland File

	Rural Freeway	Rural Highway	Rural Road	Urban Freeway	City Street
A Injuries	168	604	1411	196	2684
B Injuries	107	470	1140	157	2273
C Injuries	188	900	1598	288	4041

Auxiliary Data for Tables 39 and 40

Persons-Injured Distributions by Injury Severity vs. Road Alignment and Gradient in Texas File

	Alignment		Gradient	
	Straight	Curve	Level	Slope
A Injuries	1472	219	1393	299
B Injuries	1677	247	1627	298
C Injuires	1692	111	1577	225

APPENDIX D

ABBREVIATED INJURY SCALE

Injury Category	Description	Severity Code
No Injury	None	Zero
MINOR	General	1
	Aches all over	
	Minor lacerations, contusions, and abrasions.	
	All 1^o or small 2^o or 3^o burns.	
	Head and Neck	
	Cerebral injury with headache; dizziness; no loss of consciousness.	
	"Whiplash" complaint with no anatomical or radiological evidence.	
	Abrasions and contusions of ocular apparatus (lids, conjunctiva, cornea, uveal injuries); vitreous or retinal hemorrhage.	
	Fracture of the nose.	
	Chest	
	Muscle ache or chest wall stiffness.	
	Abdominal	
	Muscle ache; seat belt abrasion; etc.	
	Extremities	
	Minor sprains and fractures and/or dislocation of digits.	
MODERATE	General	2
	Extensive contusions; abrasions; large lacerations; avulsions (less than 3" wide).	
	10-20% body surface 2^o or 3^o burns.	
	Head and Neck	
	Cerebral injury with or without skull fracture, less than 15 minutes unconsciousness, no post-traumatic amnesia.	

Injury Category	Description	Severity Code
	Undisplaced skull or facial bone fractures.	
	Compound fracture of the nose.	
	Lacerations or the eye and appendages; retinal detachment.	
	Disfiguring lacerations.	
	"Whiplash"-severe complaints with anatomical or radiological evidence	
	Chest	
	Simple rib or sternal fractures.	
	Major contusions of chest wall without hemo or pneumothorax, or respiratory embarrassment.	
	Abdominal	
	Major contusion of abdominal wall.	
	Extremities	
	Compound fractures of digits.	
	Undisplaced long bone or pelvic fractures.	
	Major sprains of major joints.	
SEVERE (not life-threatening)	General	3
	Extensive contusions; abrasions; large lacerations exceeding involvement of two extremities, or large avulsions (greater than 3" wide).	
	20-30% body surface 2^o or 3^o burns.	
	Head and Neck	
	Cerebral injury with or without skull fracture, with unconsciousness more than 15 minutes; without severe neurological signs; brief post-traumatic amnesia (less than 3 hours).	
	Displaced closed skull fractures without unconsciousness or other signs of intracranial injury.	

Injury Category	Description	Severity Code
	Loss of eye, or avulsion of optic nerve.	
	Displaced facial bone fractures, or those with antral or orbital involvement.	
	Cervical spine fractures without cord damage.	
	<u>Chest</u>	
	Multiple rib fractures without respiratory embarrassment.	
	Hemo or pneumothorax.	
	Rupture of diaphragm.	
	Lung contusion.	
	Thoracic spine fracture without neuro-involvement.	
	<u>Abdominal</u>	
	Contusion of abdominal organs.	
	Extraperitoneal bladder rupture.	
	Retroperitoneal hemorrhage.	
	Avulsion of ureter.	
	Laceration of urethra.	
	Lumbar spine fractures without neurological involvement.	
	<u>Extremities</u>	
	Displaced simple long-bone fractures, and/or multiple hand and foot fractures.	
	Single open long-bone fractures.	
	Pelvic fracture with displacement.	
	Dislocation of major joints.	
	Multiple amputations of digits.	
	Lacerations of the major nerves or vessels of extremities.	

Injury Category	Description	Severity Code
	General	
SEVERE (life-threatening, survival probable)	Severe lacerations and/or avulsions with dangerous hemorrhage.	4
	30-50% body surface 2^o or 3^o burns.	
	Head and Neck	
	Cerebral injury with or without skull fracture, with unconsciousness of more than 15 minutes, with definite adnormal neurological signs; post-traumatic amnesia 3-12 hours.	
	Compound skull fracture.	
	Chest	
	Open chest wounds; flail chest, pneumomediastinum; myocardial contusion without circulatory embarrassment; pericardial injuries.	
	Thoracic spine fracture with paraplegia	
	Abdominal	
	Minor laceration of intra-abdominal contents (to include ruptured spleen, kidney, and injuries to tail of pancreas).	
	Intraperitoneal bladder rupture.	
	Avulsion of the genitals.	
	Lumbar spine fractures with paraplegia.	
	Extremities	
	Multiple closed long-bone fractures.	
	Amputation of limbs.	

Injury Category	Description	Severity Code
CRITICAL (survival uncertain)	<u>General</u> Over 50% body surface 2^o or 3^o burns. <u>Head and Neck</u> Cerebral injury with or without skull fracture with unconsciousness of more than 24 hours; post-traumatic amnesia more than 12 hours; intracranial pressure (decreasing state of consciousness, bradycardia under 60, progressive rise in blood pressure or progressive pupil inequality). Cervical spine injury with quadriplegia. Major airway obstruction. <u>Chest</u> Chest injuries with major respiratory embarrassment (laceration of trachea, hemomediastinum etc.). Aortic laceration. Myocardial rupture or contusion with circulatory embarrassment. <u>Abdominal</u> Rupture, avulsion, or severe laceration of intra-abdominal vessels or organs, except kidney, spleen or ureter. <u>Extremities</u> Multiple open limb fractures.	5
FATAL (within 24 hours)	Fatal lesions of single region of body, plus injuries of other body regions of severity Code 3 or less.	6