I DO NOT WEAR SAFETY BELTS

BECAUSE...

Robert E. Scott
James O'Day

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16. Abstract

The most frequently stated reason for not wearing safety belts given in a recent survey of Michigan licensed drivers was that they might trap an occupant in a car which had either caught on fire or was immersed in water.

This report presents a series of analyses intended to explore the incidence of death from automobile fires and immersions and the association between belt usage and such deaths.

A number of sources of accident data are used in the study. The Fatal Accident Reporting System (FARS), the National Crash Severity Study (NCSS), and the National Accident Sampling System (NASS), all provided by the National Highway Traffic Safety Administration (NHTSA) are used to provide nationally representative statistics. The national data are augmented by data from the states of Michigan, Pennsylvania, and Washington for a number of analyses for which these sources provide specific advantages.

The analyses indicate that deaths from fire or immersion accidents are rare among traffic fatalities. The capability of self-rescue in an emergency such as fire or immersion is preserved by measures which increase the likelihood of remaining conscious. Not using restraints approximately doubles the probability of losing consciousness after a crash

The likelihood of death is over 40 times as great if one is ejected than if one remains in the car. In contrast to the low incidence of death from fire or immersion, 22 percent of the fatally injured passenger car occupants are ejected, and restraints nearly eliminate ejection.

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1.0 INTRODUCTION

In a recent telephone survey[1] of Michigan licensed drivers, respondents were asked which, of a number of items, they considered valid reasons for not wearing available restraints in passenger cars. The most frequently stated concern was that the belts might trap an occupant in a car which either caught on fire or which was immersed in water--thus leading to serious injury or death by fire or drowning.

Passenger car occupant fatalities usually result from injuries to the head, neck, chest, or abdominal region of the body. In a small number of cases deaths are associated with burn injuries or with drowning. With the advent of moderately complete and detailed data about traffic accidents and injuries, it is possible to get a better understanding of these phenomena, and thus of the validity of the fears expressed by so many.

To investigate the danger of fatality associated with these phenomena, and to compare these fatalities with others resulting from traffic accidents, statistics will be presented regarding:

(1) The frequency of fire and immersion accidents
(2) The frequency of entrapment
(3) The frequency of unconsciousness
(4) The frequency of ejection and the relation between ejection and fatality
(5) The frequency of ejection and restraint usage

In all cases, the statistics are limited to occupants of passenger cars. Ejection is examined because, as will become evident, it is a much greater danger than either fire or immersion. Both fire and immersion cases are often dramatic. The media coverage that such cases receive as a consequence may lead to the mistaken inference that they present a greater threat than other highway mishaps.

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[1] James O'Day and Lyle D. Filkins, Review of Telephone Survey of Michigan Residents on Seat Belt Usage and Attitudes, Fall 1982, University of Michigan Transportation Research Institute, March 1983

Unconsciousness effectively prevents self-rescue in cases of fire or immersion, and makes rescue by others more difficult. For this reason, the relation between unconsciousness and the use of restraints will be examined.

The analyses presented here are based on data from a number of sources. Three sources are from programs of the National Highway Traffic Safety Administration (NHTSA). The Fatal Accident Reporting System (FARS) provides files of all fatal accidents in the county, and thus a census of fire and immersion fatalities. The limitations are that detailed injury data are not included, and fatality rates, e.g., for persons ejected, cannot be derived because the non-fatal accidents are not represented. While they do not provide a census of accident data, the files of both the National Crash Severity Study (NCSS)[2] and the National Accident Sampling System (NASS)[3] are collections of rather detailed information about a random sample of traffic accidents occurring in the U. S.

In addition, the Michigan State Police traffic accident files have been used to obtain the incidence of passenger car fires in Michigan along with associated fatality and restraint usage.

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[2] Phyllis A. Gimotty et al, Statistical Analysis of the National Crash Severity Study Data, The University of Michigan Highway Safety Research Institute, August 1980

[3] National Center for Statistics and Analysis, NASS Analytical User's Manual, 1981 File

2.0 FIRE AND IMMERSION ACCIDENTS

2.1 FATAL ACCIDENTS

An analysis has been made of the 1981 FARS data to determine the number of fire- and immersion-associated fatalities during that year. This analysis has been restricted to occupants who were 10 years old or older, because younger victims may not be capable of self-rescue, regardless of the influence of belts. The total number of such occupants during 1981 was 25,668, all but 737 of the passenger car fatalities that year.

FARS codes immersions only as the most harmful event associated with that particular vehicle, suggesting that the immersion was responsible for the fatal injury, perhaps by drowning. Among the 25,668 fatalities, 364 (or about 1.5%) occurred in connection with immersions. Only five of the immersion fatalities were wearing restraints (1.7%); this may be compared with 523 restraint users among the non-immersion fatalities (2.5%). Thus, restraint usage was lower among the immersion fatals than among other fatals. While this should not be considered as evidence that restraints prevent immersion fatalities, it certainly does not suggest that the use of restraints increases the danger.

Fire was present in the car for 3.6% of the fatalities which occurred during 1981. Restraints were reported used by only 2% of those occupants who died in connection with a fire. Again this compares with a usage rate of 2.5% for all fatalities, and as in the case of immersion, does not suggest that the use of restraints increases the danger of fires.

The state of Michigan does not report immersions directly in its accident files, but Michigan information is recorded in the national files of FARS. During 1981 Michigan accounted for 879 passenger car occupant fatalities, nine of which (0.8%) were reported in connection with immersions. None of these nine was restrained.

Fire occurred in the cars in which 43 occupants were killed in Michigan (4.6% of all car fatalities). None of these 43 occupants was using restraints.

Considering all of the Michigan passenger car fatalities for that year, 4.4% were using available restraints.

2.2 FATAL AND NON-FATAL FIRES IN MICHIGAN

Michigan is one of very few states which consistently reports vehicle fires and fuel leakage, and for this reason Michigan data have been used to make national estimates of fire frequency for NHTSA.

Michigan has reported fires, fuel leakage, and restraint usage since 1978. However, UMTRI has constructed rectangular occupant files only since 1980, and such files are necessary to conveniently study the consequences to individual occupants.

The results presented here are based on the aggregate of all accidents in Michigan in the period 1980 through 1982. Over this three-year period there were 3,060 occupants in passenger cars which caught on fire. Among these, 332 were using available restraints, and 2,404 were unrestrained. Another 324 either had no seat belts available to them, or their belt usage was unknown.

Of the 2,404 unrestrained occupants, 46 (or 1.913%) were killed. If the use of belts in the event of a fire posed an increased hazard by slowing or preventing escape, we might expect the proportion of fatalities to be higher among the restrained occupants. Actually the proportion was lower. Of the 332 restrained occupants only one was killed (for a proportion of 0.30%). The expected number of fire fatalities (if the probability of fatality were the same as for the unbelted persons) would have been six. Thus it appears that restraints are beneficial rather than a hazard in the event of a fire. Non-fatal injury categories are similarly underrepresented among restrained occupants in fires. Only uninjured occupants were more prevalent among the restrained group than among the unrestrained group.

During the same period (1980-1982) there were 113 restrained occupants of passenger cars killed in Michigan without car fires. Fourteen of these were in cars which had a reported fuel leak without a fire, eight were in cars which had a fuel leak which was accompanied by a fire not in the car, and 91 (or 80.5%) were in cars which neither burned or had a fuel leak.

It should be emphasized that in the three-year period in Michigan only one restrained person died in a car which burned. Furthermore it does not appear that the use of restraints increased fatalities in fire crashes; the evidence suggests the opposite.

3.0 ENTRAPMENT

In the NASS sample of police-reported accidents throughout the U.S. only 0.18% of all passenger car occupants were entrapped. In the NASS protocol, entrapment is coded only when the occupant is physically pinned in the vehicle by some deformed part of the car. Among those persons entrapped in passenger cars, 2.5% were using restraints; among those not entrapped, 12.5% were using restraints. This is not, of course, an indication that restraints prevent entrapment, but more likely an indication that people who do not wear restraints are more likely to be in accidents which lead to severe crush and consequent entrapment.

The fatality rate among non-entrapped occupants was 0.113%, as compared with 0.349% among those who were entrapped, suggesting that the entrapped occupants are in more severe crashes than the non-entrapped occupants.

In the 1981 FARS there are 26,425 passenger car occupants who were fatally injured. Of these 2,380, or 9%, were evidently entrapped, as evidenced by the code "extrication required" shown for them in the data. The number of persons extricated whose vehicles also caught on fire was 157, of whom seven (4.4%) were reportedly using restraints in the vehicle.

4.0 UNCONSCIOUSNESS AMONG OCCUPANTS OF CRASHED CARS

Previous sections have shown that even among fatalities in passenger cars, those associated with fires or immersions in water are rare. However, such events do occur. In either situation, i.e. a burning or submerged car, the time available for rescue may be very short. A person in such a circumstance would be very fortunate if a good Samaritan was present and capable of effecting a rescue.

The greatest likelihood of survival is provided by self-rescue. The capability to extricate ones self from a vehicle in such a situation is assured only if the victim remains conscious. Thus, any association between restraint usage and consciousness immediately aftr the crash directly relates to the capability for escape.

The injury coding detail in the NASS program provides a reasonable estimate of the incidence of unconsciousness among accident victims. Each injury to each occupant is described by four letters followed by numerical severity scale. The first letter denotes the region of the body injured and the second letter the aspect of the region. The third letter denotes the type of lesion such as fracture, contusion , laceration, etc., and the fourth letter the system or organ injured, e.g. brain,skeletal, heart, respiratory system. Brain injuries are coded using either of two scales.

One is used for anatomic injuries if the injury is verified by a CAT scan, EEG, surgery, x-ray, angiography, or autopsy. Those which are likely to result in unconsciousness immediately after impact include H_UB3+, H_CB3+, and H_LB4+, where the underscore represents any of the possible codes for that element.

If anatomic lesions are not substantiated, the coding is based on level of consciousness or length of unconsciousness. The codes which denote some duration of unconsciousness following impact are HWKB2+ (2+ indicating a severity of 2 or greater). The only exception to this would be the code HWKB (whole brain concussion) which would be coded with severity=2 without consciousness if the victim suffered amnesia or

was lethargic, stuporous, or obtunded. Even in these cases, however, the victim's capability for self-rescue might be compromised in a manner similar to that caused by unconsciousness.

The 10,125 (actual) passenger car occupants reported in the 1981 NASS can be classed as shown in Table 1.

Table 1

NASS Passenger Car Occupants
Level of Consciousness

State	Unweighted		Weighted	
	N	%	N	%
Conscious . . .	9,768	96.5	11,614,044	99.0
Unconscious but not certain fatal	337	3.3	117681	1.0
Certain Fatal .	20	0.2	4685	0.04
Total	10,125	100.0	11,736,410	100.0

A severity code of six denotes an injury which is currently nontreatable and is equivalent to certain death. Injuries of lesser severity may or may not lead to death, since the severity code does not address ultimate outcome. It can be seen that unconsciousness is not a frequent event (an estimate of just over 117,000 cases in the U.S. annually), but it occurs four or five times as often as do injuries of certain fatality to passenger car occupants.

Table 2 shows the relationship between consciousness and belt usage as determined from the NASS data. Note that both unconsciousness and nontreatable fatal injuries are of only half the incidence among restrained occupants as among the unrestrained. The increased unconsciousness among the unrestrained is not explained by ejected occupants. When ejectees are removed from the computations for

conscious and unconscious occupants, the only change in percentages is that the proportion who are unconscious among the unrestrained is lowered from 1.28% to 1.19%--hardly a consequential change.

Table 2

Level of Consciousness by
Restraint Use (NASS)

State	Restraint Characteristic (weighted)			
	Used		Not Used	
	N	%	N	%
Conscious . .	1,180,522	99.5	8,439,689	98.7
Unconscious .	6,255	0.53	109,281	1.28
Certain Fatal	316	0.027	4,274	0.05
Total	1,187,094	100.0	8,553,244	100.0

Thus preserving the capability to effect a self-rescue from a burning or submerged car by remaining conscious is best assured by using the restraints.

5.0 EJECTION

Occupant ejection is directly associated with fatal injury. Among the 26,425 passenger car occupants who were fatally injured in 1981, 5,834 (22%) were either partially or completely ejected from their cars. There has long been a belief that passenger car occupants are better off being ejected, thus escaping the dangers of such things as fire or drowning in entrapment.

In fact, ejection is very dangerous. Three accident data files at UMTRI which give ejection information have been used to compare fatality rates for ejected and non-ejected occupants of passenger cars. These are 1979 data from Pennsylvania, the NCSS data, and 1981 data from the state of Washington. Figure 1 gives the ratio of the fatality rate for ejected occupants to the rate for non-ejected occupants.

We would not expect the results to be identical in the three data sets, since they represent different reporting thresholds and thus severity levels. Nevertheless, the results are similar. In the Pennsylvania and NCSS crashes, ejected occupants are 40 times as likely to be killed as are non-ejected occupants, and 52 times as likely in the NCSS data. Nor can we take comfort in the belief that we are comparing rare causes of death and thus examining a trivial problem. Figure 2 gives the proportion of all fatalities that are represented by ejected occupants for the same three data sets and also for the 1981 FARS data--a census of all fatals. Nationally, 22 percent of the fatally injured passenger car occupants were ejected, and similar or higher proportions are obtained for each of the other three data sets.

The NASS and NCSS data permit a rather detailed look at the consequences of ejection. One method of examining ejection is to select vehicles which had two and only two occupants, one of whom was ejected and one of whom was not. The consequences to the occupants can then be compared. The virtue of using this technique is that each such pair of occupants is subject to the same crash severity and vehicle characteristics. That is, the pairs are matched on these parameters.

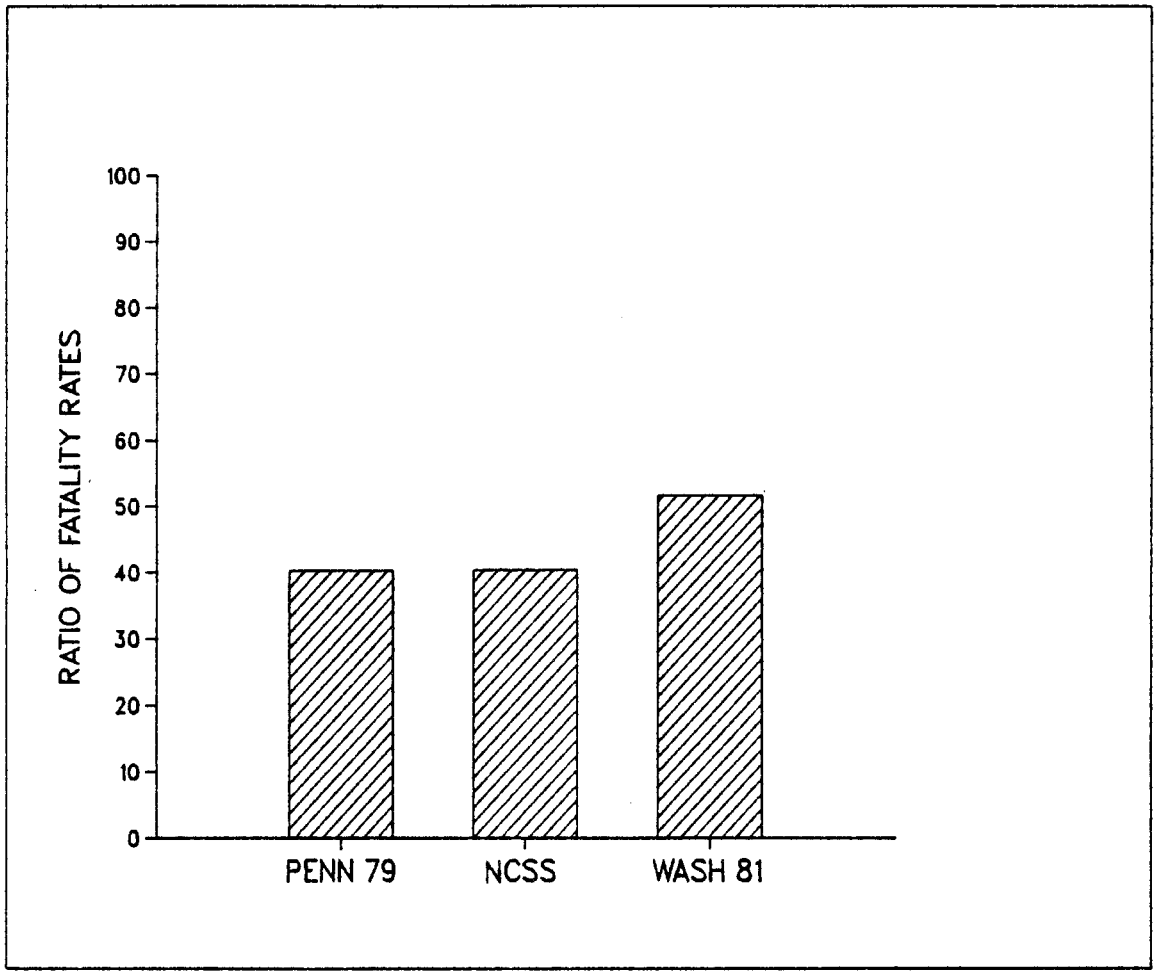

Figure 1. Ratio of Fatality Rates for Ejectees to Those for Non-Ejectees (from three data sets).

The influence of possible differences in crash severity on the analysis is minimized by such a matched pair technique. In a combination of the NCSS data, and the 1981 year of NASS data, there is a total of 98 cases of two occupants in a passenger car from which one was ejected while the other was not. All of these occupants were either drivers or right-front passengers, and ejections were approximately equally distributed between these seated positions. Injuries to these persons were reported on a "treatment" scale including (1) Fatally injured, (2) Hospitalized at least overnight, (3) Transported (to hospital) and released the same day, (4) Other treatment, and (5) No treatment required (i.e., essentially uninjured).

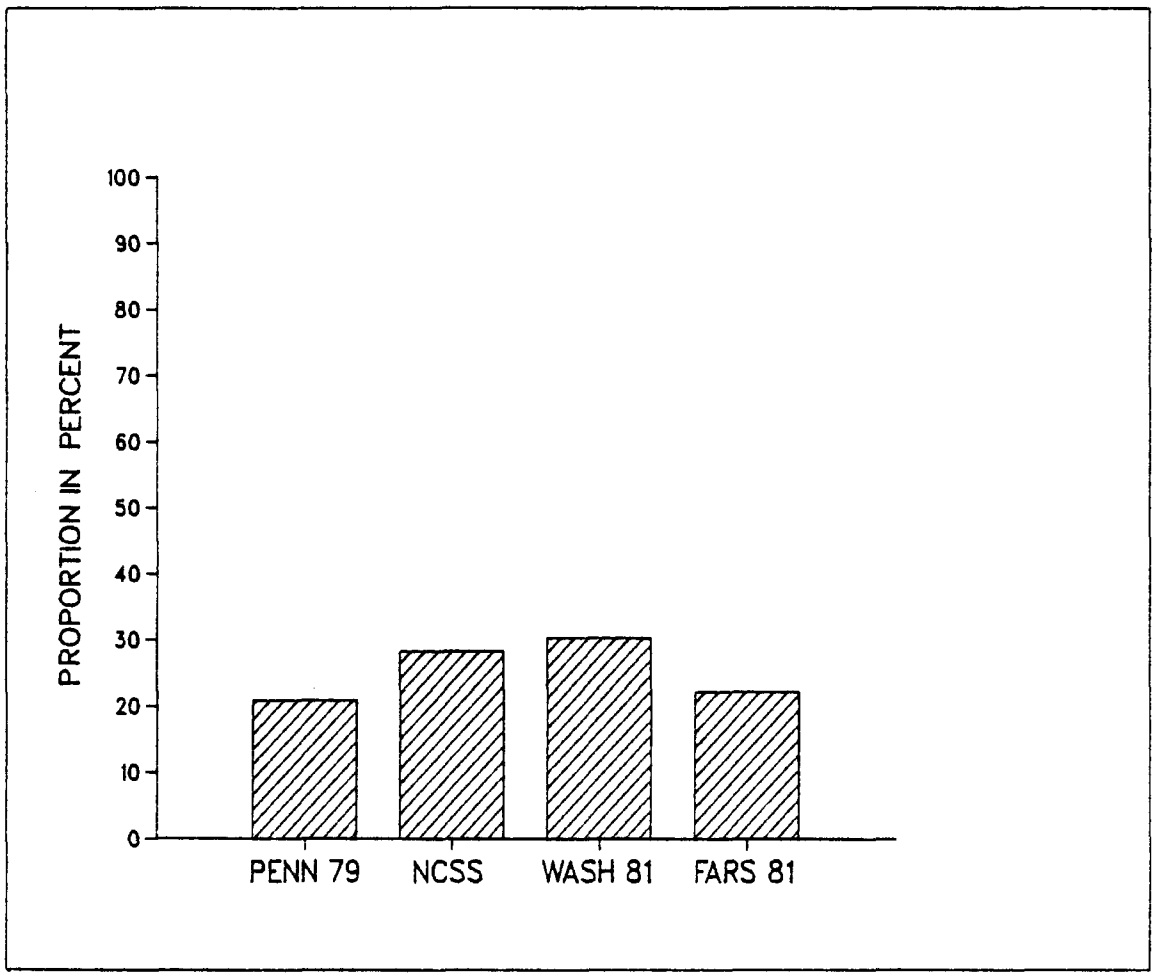

Figure 2. Proportion of Fatalities That Are Ejections

For the 196 occupants in this matched pair comparison (98 ejectees and 98 non-ejectees), the injury distributions may be compared. Of most interest is the fact that there were no fatalities among those not ejected, while there were 21 fatalities among the ejectees. There are certainly numerous fatalities among non-ejected car occupants (i.e., among the 78% who are not ejected at all), but in cases in which one of two occupants was ejected, it seems very unlikely that the other occupant will receive a fatal injury.

Figure 3 shows the distribution of treatment level for each set of the matched pairs. While the greatest difference is obviously in the fatals, hospitalization at least overnight was also more common among

the ejected occupants. Only "other" treatments, which include treated and released from a hospital, seeking own treatment, no treatment needed, etc., are more likely among the non-ejected occupants.

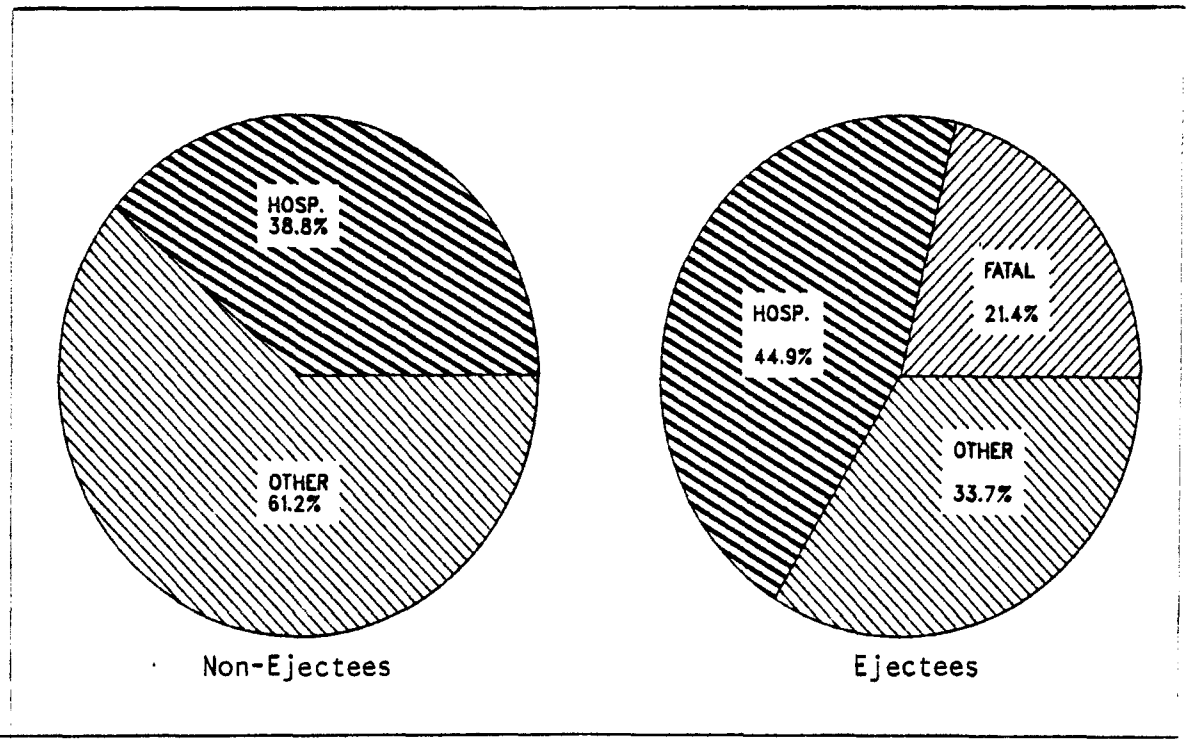

Figure 3. Treatment Distribution for Matched Pair Ejectees and Non-Ejectees

Detailed reading of these case reports reveals that many "ejection" accidents do not involve massive crushing of the vehicle or sudden stopping (as into a barrier). Rather these accidents are likely to involve rollover or other violent rotational motion, with the occupant ultimately being ejected through a door or window portal. There seems to be little question that one is better off remaining in the vehicle in such crashes.

Both analyses presented above indicate that although occupants may occasionally be "thrown clear," ejection is a very dangerous phenomenon and a frequent cause of death.

6.0 EJECTION VS. RESTRAINT USAGE

In the NCSS data, there is information presented on seat-belt usage by each occupant of a passenger car or light truck. Assessment of belt usage was made by a combination of police reports, interviews with the subjects, and a followup investigation of injuries and vehicle damage. While each of these items was presented in the data file, the most reliable seems to be the investigator's judgment (based on all of the information available).

Using this measure of belt-wearing, it was determined that only two persons (of some 16,000 actual persons in accidents) were ejected with seat belts worn. One of these was the driver of a 15-year-old car in which the seat belt bolts pulled through the rusty floorboards, and the other was using a passive (shoulder belt only) system and was ejected through the rear door/window of a car struck in the rear. With those exceptions, the evidence from NCSS is that

(1) People who wear seat belts do not get ejected, and
(2) People who are not ejected (in accidents in which another person is ejected) are unlikely to sustain fatal injuries.

7.0 CONCLUSIONS

Several conclusions can be drawn from the analyses that have been presented here. These are listed below.

(1) Death from either fire or immersions is rare. Fires account for less than 3.6 percent of the fatalities of passenger car occupants, while immersions account for only 1.5 percent.

(2) When either immersion or fire occurs, the likelihood of losing consciousness, and thus the capability of self-rescue, is approximately doubled when restraints are not used.

(3) The virtue of being thrown clear is a myth. The likelihood of death is more than 40 times as great if one is ejected than it is if one remains in the car. Furthermore, ejection is a common cause of death, accounting for 22 percent of the fatalities of passenger car occupants in the U. S. in 1981.

(4) In a comparison of ejected and unejected occupants of the same car, more than one-fifth of the ejected persons were killed while none of the persons remaining in cars was fatally injured.

(5) Ejection is nearly eliminated by using the restraints that are currently installed in automobiles.