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ALCOHOL AND HIGHWAY SAFETY:

BEHAVIORAL AND MEDICAL ASPECTS

Project ABETS
University of Vermont
Burlington, Vermont 05401

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16. Abstract Drivers involved in fatal and serious injury highway crashes were compared with drivers: (1) using the same roads at similar times, but without crash involvement; (2) with recent drunken driving arrests; (3) with arrests for other serious traffic violations; and (4) with no crashes or citations in prior 5 years. Variables studied included presence of alcohol, drinking patterns, driving patterns, and social problems.

Among driver fatalities, 54% had alcohol, and 42% had 100 mg% or greater. Those with alcohol tended to be young to middle-aged males with histories of medium to heavy drinking and with fatty degeneration of the liver. Those without alcohol tended to be older and to be light drinkers. Regulated drugs were almost never found. 23% died of survivable injuries due to problems throughout the emergency care system.

Among roadblock drivers, 14% had alcohol, and 2% had 100 mg% or greater. 12% were heavy drinkers and were over-represented among those who had alcohol when stopped, and who had prior crashes or citations. At BACs of 100 mg%, risk of responsibility for a fatal crash was 7 times that without alcohol, and at 150 mg%, was 25 times greater.

Among clear-record drivers, 2% had alcohol, and 0% had 100 mg% or greater.

Almost all drunken drivers were males; most were heavy drinkers with excessive numbers of prior crashes and citations; many were laborers; and many were unmarried.

A discriminant function analysis correctly classified 95% of clear-record drivers and 87% of drunken drivers using four significant variables: lifetime citations, occupational level, beer frequency, and liquor quantity.

Three types of induced-intoxication experiments were conducted to study influences of alcohol upon driving-related behavior: small-group studies, laboratory experiments, and a closed-course pilot study using an instrumented car.

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SUMMARY

0. ABSTRACT

Drivers involved in fatal and serious injury highway crashes throughout Vermont were compared with drivers: (1) using the same roads at similar times, but without crash involvement; (2) with recent drunken driving arrests; (3) with arrests for other serious traffic violations; and (4) with no crashes or citations in the previous five years. Variables studied included presence of alcohol, drinking patterns, driving patterns, and social problems, especially those related to alcohol use.

Among driver fatalities, 54% had alcohol, and 42% had 100 mg% or greater. Regulated drugs other than alcohol were almost never found. Driver fatalities with alcohol tended to be young to middle-aged males with histories of medium to heavy drinking of both beer and liquor and with fatty degeneration of the liver. Those without alcohol tended to be older and to be light drinkers. Twenty-three percent of fatalities died of probably survivable injuries due to problems throughout the emergency care system.

Among roadblock comparison drivers, 14% had alcohol and 2% had 100 mg% or greater. Twelve percent were classified as heavy drinkers (5+ drinks per sitting) and they were over-represented among persons who had alcohol when stopped, and who had prior crashes or citations. Most drivers below legal age for drinking reported that they do drink, many heavily. Drinking, and heavy drinking, were more common among men than women. At a blood alcohol concentration of 100 mg%, risk of being involved in and responsible for a fatal crash was 7 times that without alcohol, and at 150 mg%, it was 25 times greater than the risk with no alcohol.

Among clear-record drivers (no crashes or citations in the previous five years), 2% had alcohol when tested at roadblocks and 0% had 100 mg% or greater.

Almost all drunken drivers were males, and most (60%) were heavy drinkers with excessive numbers of prior crashes and citations. Many were classified in the lower occupational level, and many were divorced, widowed, or separated.

A discriminant function analysis succeeded in correctly classifying 95% of clear-record drivers and 87% of convicted drunken drivers on the basis of four significant variables: number of lifetime citations, occupational level, frequency of beer consumption, and quantity of liquor consumption.

Three types of induced-intoxication experiments were conducted to study the influences of alcohol upon driving-related behavior: small-group studies, laboratory experiments, and a closed-course pilot study using an instrumented car. It was concluded that doses of alcohol which result in presumptive legal impairment may be associated with: (1) reductions in performance on both auditory and visual attention tasks which require the monitoring of multi-channel inputs; (2) decreases in responsiveness to stimulation of the retinal periphery; (3) alterations of visual perception in ambiguous situations; (4) increases in the likelihood of risky behavior in gaming or chance-taking situations; (5) differential mood and performance effects with respect to personality; and (6) reductions in driving accuracy and changes in automobile control-use patterns.

SUMMARY

1. SPECIFIC AIMS

Project ABETS (Aspects Behavioral and Environmental in Traffic Safety) was concerned with studying patterns of alcohol use in a rural setting, and their relation to highway crashes and citations. The investigation had four interrelated aims; the first two are medico-legal in orientation, while the last two are essentially behavioral:

1.1 To determine the distribution of blood alcohol concentrations: (a) in drivers fatally or seriously injured in Vermont highway crashes, and (b) in a corresponding sample of drivers using the roads under similar conditions of time and place but not involved in highway crashes at the time. No previous study had examined the role of alcohol in crashes within a rural setting, despite the fact that the majority of highway fatalities in the United States occur in low population-density areas.

1.2 To determine the relation between blood alcohol concentration and the degree of fat present in the livers of adults who were fatally injured in motor-vehicle crashes and who were age 25 or older.

1.3 To compare persons at selected points along the continuum of drivers in order to determine differences in psychological and biographical variables, particularly patterns of alcohol use and driving record. To what extent are drivers with alcohol who are not in crashes similar to or different from drivers in crashes or arrested for driving while impaired by alcohol?

1.4 To investigate the influence of selected blood alcohol concentrations on perceptual-cognitive performance, and to relate these effects to differences in psychological-biographical variables (especially driving record and patterns of drinking behavior).

Also, although not an original goal of the project, it was possible to determine the role of problems in emergency care in contributions to the deaths that occurred.

METHOD

2. EXPERIMENTAL PLAN

Because drinking-and-driving experiments cannot readily be conducted on public roads, two separate types of samples were required: drinker subjects and driver respondents. To the extent possible, however, the same or equivalent data sources were used for each type of sample in order to provide a basis for post hoc comparison and extrapolation.

2.1 Drinker subjects. Three types of induced-intoxication experiments were conducted with volunteer subjects. The results of these investigations are briefly outlined toward the end of this summary (Section 10).

2.2 Driver respondents. The experimental plan specifies eight driver samples, of which six can be considered as study groups and the other two as comparison groups. It is assumed that motorists from points along the full continuum of driving behavior are included in the total sample (2 crash, 2 citation, and 2 clear-record study groups, plus 2 roadblock comparison groups).

3. DRIVER RESPONDENTS

3.1 Fatally injured drivers (Crash-F). The first sample consists of the deceased drivers from all fatal crashes which occurred in Vermont during the 10-month period, July 1, 1967 through April 30, 1968. Although the forensic pathology portion of the study is concerned with all highway fatalities, including passengers and pedestrians, the rest of the study focused specifically on the behavior and characteristics of the drivers only.

3.2 Roadblock sample as comparison group for Crash-F (Roadblock-F). A roadblock was conducted at the site of each fatal crash on the same day of the week and at the same time of day, but within a few weeks following its occurrence (during the first year of study) or on the anniversary day (during the second year of study). The interviewing goal for each roadblock was six motorists travelling in the same direction as the crash vehicle had been.

3.3 Clear-record drivers (Clear-F). In order to study one particularly important portion of the population-at-risk more closely, a sample of drivers with clear records was selected from the roadblock comparison population (Roadblock-F). This sub-sample consisted of those roadblock motorists who met the following three criteria: (1) who stated during the roadblock interview that they had had no crashes or citations within the previous five years, (2) said that they would be available for further interviewing if called upon, and (3) whose no-crash-and-no-citation responses were subsequently confirmed by an official record check.

3.4 Hospitalization-crash drivers (Crash-H). In order to obtain information on drivers involved in serious, but not fatal-injury crashes, a hospitalization crash was selected from the Vermont Motor Vehicle Department files to match one of the fatal crashes as closely as possible for season, day of week, time of day, and type of road. A hospitalization (or serious-injury) crash was defined as one in which one or more persons received injuries sufficient to require treatment at a hospital.

3.5 Roadblock sample as comparison group for Crash-H (Roadblock-H). A roadblock was conducted at the site of each serious-injury crash which was selected for best match on exactly the same basis described above for Roadblock-F. Since both these roadblock comparison groups were matched to the fatal- and to the hospitalization-crash samples in terms of time and place of incident, they serve as an estimate of the actual population-at-risk. In other words, these two comparison groups consist of motorists who were driving at the same place at an equivalent time, but who were not involved in a crash.

3.6 Clear-record drivers (Clear-H). The drivers in Clear-H were selected from Roadblock-H on the same basis, noted above, as the Clear-F were selected from Roadblock-F.

3.7 DWI citation sample. One of the major concerns of the present study was the problem drinker on the highway. Accordingly, a sample was drawn from among in-state drivers in the Vermont Motor Vehicle Department files who had been cited and convicted of driving-while-intoxicated (DWI) during the previous year.

3.8 Non-DWI citation sample. In order to obtain a type of comparison group for the DWI's, (i.e., a group of individuals convicted for some serious motor vehicle violation, but with no official charge of alcohol involvement), a corresponding sample was selected from the Vermont Motor Vehicle Department files of motorists cited and convicted for other serious moving violations.

4. PROCEDURES

4.1 Roadblock procedures. Police officers stopped all relevant motor vehicles, with the exception of interstate trucks and buses.

The drivers were immediately referred to Project ABETS interviewers, after being informed that they had been stopped for research purposes only. The cooperating drivers (93%) then answered a limited number of the more important psychological-biographical questions selected from the extensive battery given to the drivers in the non-fatality study groups, namely, biographical data (items on age, sex, parents, earlier years, education, occupation, military service, home, marriage, religion, smoking history, and health); driving history (items on driving education, experience, occasions, companions, exposure and mileage, record of crashes and citations, and vehicle information); drinking history (items on preferred beverage, frequency, quantity, occasions, and companions).

A breath sample was requested toward the end of the interview, and was refused by only 1.3% of the respondants. Since the Mobat Sobermeter (SM2) requires subsequent laboratory analysis, it was used during the first year of study to obviate having immediately available data on the driver's blood alcohol concentration. During the second year, the Borkenstein Breathalyzer was used.

4.2 Non-fatality study groups. Each driver selected for Crash-H, Clear-F, Clear-H, Citation-DWI, and Citation-non-DWI was sent a letter in which he was invited to participate in the Project ABETS study and was offered $15.00, plus travel expenses. The cooperating motorists were asked to volunteer extensive information on their biographical background, driving history, drinking history, smoking history, and delinquency history, as well as data on selected attitude and personality instruments (e.g., the Schuster and Guilford Driver Attitude Survey and the Eysenck Personality Inventory).

4.3 Postmortem procedures. The postmortem examination of each deceased driver (as well as deceased passengers and adult pedestrians) included the determination of blood alcohol concentrations, extent of hepatic fat (determined microscopically), and an estimation of which injuries were probably crucial in bringing about death. Blood samples and, where possible, urine and bile samples from highway fatalities were also screened for drugs other than alcohol by means of thin-layer chromatography.

In addition, a retrospective case study of each deceased driver who was a Vermont resident was conducted by interviewing next-of-kin, close friends, and the investigating police officer in an attempt to obtain information on approximately the same psychological-biographical variables that were analyzed for the living drivers.

4.4 Alcohol determinations. Concentrations of alcohol in postmortem and induced-intoxication blood samples (both venous and digital capillary) were determined by gas chromatography and specific alcohol dehydrogenase methods. Breath samples from induced-intoxication subjects and roadblock respondents were obtained by means of Mobat Sobermeters (Luckey Laboratories, models SM-2 and SM-4) and Borkenstein Breathalyzers (Stephenson Corp., model 900).

Blood alcohol and breath alcohol concentrations less than 20 milligrams per 100 milliliters (mg%) were considered to fall within the range of instrument and random error for individuals who in fact had no alcohol present. Therefore, all concentrations under 20 mg% were grouped in the no-alcohol category.

RESULTS

5. BLOOD ALCOHOL CONCENTRATION

5.1 Distribution. Alcohol was found in the blood, breath, or urine of 54% of fatally injured drivers, 14% of roadblock drivers, 2% of drivers with clear records, and 100% of drivers arrested for DWI. Alcohol determinations were not available for drivers in serious injury crashes or for drivers with serious moving violations other than DWI. Blood alcohol concentrations of 100 mg% or higher (the range taken according to the federal standards as presumptive evidence of impairment in most states) were found among 42% of the fatally injured drivers, 2% of roadblock drivers, none of the clear-record drivers, but 100% of the DWI drivers.

5.2 Crash risk and blood alcohol concentration. When the data for the fatality and roadblock drivers are compared, it is apparent that blood alcohol concentrations below 50 mg% do not result in any appreciable increase in the probability both of being involved in and being responsible for a fatal crash. However, concentrations of 80 mg% or higher are incompatible with safe driving; and the higher the concentration, the higher the incompatibility--with small increases in blood alcohol concentration above 80 mg% resulting in disproportionately large increases in fatal crash risk. Thus, the risk of being responsible for a fatal crash at 80 mg% is about four times that with no alcohol present;

at 100 mg%, it rises to seven times; and at 150 mg%, it is twenty-five times the risk with no alcohol present.

6. COMPARISONS OF DRIVERS WITH NO ALCOHOL AND WITH HIGH ALCOHOL CONCENTRATIONS

Some differences exist between fatality, roadblock, and clear-record drivers without alcohol, and to a lesser extent between fatality, roadblock, and DWI drivers with high alcohol concentrations. With only rare exceptions, however, individuals with no alcohol are much more similar to each other across all samples, and individuals with high alcohol concentrations in turn are much more similar to each other across samples, as opposed to the large within group differences between persons with no alcohol and between those with high alcohol concentrations. The following results were obtained from comparisons between drivers with no detectable alcohol (below 20 mg%) and those with concentrations of 100 mg% or higher.

6.1 Sex. Between 21% and 27% of drivers with no alcohol were female, in comparison with 2%, 5%, and 17% female for the DWI, fatal crash, and roadblock groups respectively with high alcohol concentrations.

6.2 Age. Drivers with no alcohol were more likely to be under age 20 or over age 59 than were drivers with high alcohol concentrations. Furthermore, among drivers with blood alcohol concentrations of 100 mg% or higher who were fatally injured or had DWI arrests, those under age 25 had lower impairing blood alcohol concentrations on the average than did those age 25 or older. These data confirm the hypothesis that younger drivers with legally impairing amounts of alcohol who get into trouble on the highways generally do so at lower blood alcohol concentrations than do middle aged or older drivers who get into such trouble.

6.3 Marital status (age 25 or older). The distribution of marital status among roadblock subjects without alcohol was relatively similar to that among roadblock subjects with high alcohol concentrations. Among the fatalities, however, those with alcohol were much more likely to be in an unmarried state (single, widowed, separated, or divorced) than were those with no alcohol. Among drivers with 100 mg% or higher, the DWI and the fatally injured drivers were much more likely to be unmarried than were the roadblock drivers, with 11% of high alcohol roadblock, 27% of high alcohol fatality, and 49% of DWI drivers being in an unmarried state.

6.4 Occupational level (age 25 or older). Roadblock drivers without alcohol have lower reported occupational levels than do roadblock drivers with high alcohol concentrations. The reason for this apparent deviation from the expecte distribution is not known at present. Among drivers without alcohol, a significantly larger proportion (66%) of the clear-record drivers was listed in the highest category of occupational level, as compared with the roadblock group (31%) and the fatality group (21%). Among drivers with high blood alcohol concentrations, the DWI group had substantially fewer individuals who were listed in the highest occupational classification when compared with the roadblock and fatality drivers.

6.5 Reported alcohol consumption. A classification system based upon reported usual frequency and quantity of alcohol consumption per sitting was developed to reflect the likelihood that a driver would attain an impairing amount of alcohol in his blood. The resultant Quantity-Frequency Index (QFI) for preferred beverage is based upon that beverage which is consumed most frequently and in largest quantity, regardless of whether it is beer, liquor or wine.

Persons reported by themselves or by next-of-kin as non-consumers of alcohol comprised 21% of deceased drivers, 21% of serious injury drivers, 16% of roadblock drivers, 15% of clear-record drivers, 4% of DWI drivers, and 4% of drivers with serious non-DWI citations. Excluding these abstainers, drivers with no alcohol present were classified as medium (3-4 drinks per sitting) or heavy (5 or more drinks per sitting) drinkers among 0% of driver fatalities, 25% of roadblock drivers, and 26% of clear-record drivers. In contrast, among drivers with high alcohol concentrations, 66% of the fatality, 42% of the roadblock, and an astonishing 87% of the DWI drivers met the criteria for classification as medium or heavy drinkers on the QFI. In fact, 56% of the DWIs were reported just in the heavy drinking QFI category alone.

Frequent and excessive use of beer was highly correlated with blood alcohol concentrations of 100 mg% or higher. Thus, in comparison with fatality drivers without alcohol, over twice as many with high alcohol concentrations are reported to drink beer daily, and, in comparison with roadblock drivers without alcohol, almost twice as many with high alcohol concentrations report that they drink beer daily. Among those who drink beer, 80% of fatalities and 67% of DWIs with high alcohol concentrations are reported to drink it daily.

6.6 Drinking and driving patterns. Drivers without alcohol were much more likely to report that they never drive after drinking, whereas those with high alcohol concentrations much more often reported that they drive after drinking half the time or more on those occasions when they do drink.

6.7 Driving patterns. Regarding crashes during the previous five years, none of the clear-record drivers and 9% of the roadblock drivers without alcohol reported two or more such crashes; whereas among drivers with 100 mg% or higher, 22% of the DWI drivers and 13% of the roadblock drivers reported two or more such crashes. Regarding all previous license suspensions, 24%, 14%, and 7% of fatality, roadblock, and clear-record drivers without alcohol respectively had at least one suspension; whereas among those with high alcohol concentrations, 33%, 20%, and 59% of fatality, roadblock, and DWI drivers had one or more previous suspension. In fact, 41% of the DWI drivers had two or more previous suspensions during their lifetimes, the sort of record that could hardly be attributed to random factors.

Regarding previous citations for moving violations, roadblock drivers without alcohol were slightly less likely to have had any citations or to have had two or more citations during the previous five years than were those who had high alcohol concentrations. Among fatalities, however, relatively similar patterns with respect to citations appear between those with no alcohol and those who died with very high alcohol concentrations. Fatalities who died with no alcohol more often had citations and had two or more citations than did roadblock drivers with no alcohol. Fatality and roadblock drivers with high alcohol concentrations had rather similar patterns with respect to previous citations, but fully 68% of DWI drivers had previous citations during the five years preceding the current DWI conviction for which they were sampled, and 34% of them had two or more such citations during this period.

Regarding driving pattern data from the two groups for which no blood alcohol information is available (hospitalization crash, and non-DWI citation drivers), fully two-thirds of the respondents in each group reported having had one or more crash during the previous five years. Regarding license suspensions during lifetime, 11% of serious injury crash and 41% of non-DWI citation drivers were found to have one or more previous suspension according to official record check. Regarding citations during previous five years according to record check, 26% of serious injury crash and an appalling 73% of non-DWI citation drivers were found to have had one or more previous citation (excluding the one for which they were sampled).

7. COMPARISONS OF DRIVERS AGE 25 OR OLDER WITH HIGH ALCOHOL CONCENTRATIONS

One of the underlying questions of this study was whether roadblock drivers with alcohol represent the population from which DWI and fatally injured drivers with alcohol will probably come, or whether differences exist despite similarity of blood alcohol concentrations. We wish to know to what extent all drivers with impairing amounts of alcohol are similar, regardless of whether or not they have gotten into trouble. Because DWI drivers on the average are substantially older than the fatalities with alcohol, it was necessary to reduce the contribution of the age factor as a confounding element by examining only those drivers age 25 or older with high alcohol concentrations.

With only a few exceptions, the data suggest that there are major similarities between DWIs and driver fatalities who had alcohol. We must conclude that, to a substantial degree, these two subgroups of high alcohol drivers are probably drawn from a single population.

7.1 Blood alcohol concentration. The average blood alcohol concentration for the DWIs was greater than for the other two high alcohol subgroups, of which the fatality drivers in turn had a much greater average concentration than did the roadblock drivers (mean blood alcohol concentrations: fatality, 202 mg%; roadblock, 141 mg%;

DWI, 215 mg%).

7.2 Biographical variables. The DWI and high alcohol fatality drivers tended to be single, widowed, divorced, or separated much more often than the roadblock drivers with high alcohol concentrations. Substantially more DWI drivers were in lower occupational classifications and substantially fewer in upper occupational classifications when compared with the other two subgroups.

7.3 Reported alcohol consumption. Beer drinking was both frequent and heavy among all three subgroups, especially among the DWIs and the fatalities. Relative to liquor consumption, the reported abuse of beer is a significant variable with respect to highway safety and deserves much more attention in future countermeasure programs and research. Regarding the QFI based on preferred beverage, medium and heavy drinking (at least on a weekly basis) was reported for 77% of the fatality, 51% of the roadblock, and 80% of the DWI subgroups. These data confirm the impression that drivers with high blood alcohol concentrations at any given moment are most often repeating a drinking pattern which they have followed many times in the past and thus are not merely average social drinkers who happened only on this one occasion to have had "a few too many."

7.4 Driving patterns. The DWIs were significantly more likely to have had previous suspensions on the basis of record check than either of the other two subgroups. Furthermore, the DWIs differ significantly from both the fatality and roadblock subgroups in the proportion with record check citations, and with three or more record check citations during the previous five years.

In summary, the major differences between the high alcohol fatalities and the DWIs are that the DWIs tend to have lower reported occupational status and to have had more frequent previous contacts with the police.

8. COMPARISONS ON OTHER BIOGRAPHICAL, ATTITUDINAL, AND PERSONALITY VARIABLES

8.1 Quantity-Frequency Index. Because of its apparent importance, the QFI was cross-tabulated with some of the other selected variables in addition to those mentioned above. Regarding QFI and sex, the proportion of males to females increases as quantity and frequency of alcohol consumption increase. Regarding QFI and age, a surprisingly large proportion of the very young (i.e., teenage) drivers can be categorized as heavy and frequent drinkers; and the quantity of alcohol typically consumed apparently decreases with increasing age. Regarding QFI and marital status, the proportion of married drivers decreases significantly as reported alcohol consumption increases. Although no significant differences were observed with occupational level, there was some evidence that drivers with heavy QFIs are more likely to have had a greater number of job changes in recent years.

Regarding QFI and drinking and driving patterns, two observations add further credence that the blood alcohol concentration sample obtained at one point during the study is a reliable indicator of usual patterns of driving after drinking: (1) the higher the frequency of driving after drinking, the heavier and more frequent the reported usual alcohol consumption, and vice versa; and (2) the lighter and less frequent the reported usual alcohol consumption, the lower the frequency of driving after drinking, and vice versa. Regarding QFI and driving patterns, roadblock drivers with higher QFIs tended to have more citations in the previous five years than roadblock drivers with lower QFIs.

Thus, the analyses of the alcohol consumption data indicate that these variables are in fact useful in differentiating across the spectrum of drivers. Further encouragement for the utility of these variables is provided by the relation of the reported alcohol consumption data (QFI) to the actual consumption data (blood alcohol concentrations) and to the driving variables (both self-reported and official record check information).

8.2 Discriminant analysis. Of 12 variables tested, the four which were significant in discriminating between the clear-record drivers and the DWI drivers are, in order of importance: (1) number of lifetime citations, (2) occupational level, (3) frequency of beer consumption, and (4) quantity of liquor consumption. On the basis of a discriminant function using these four variables, 95% of the clear-record drivers could be correctly classified and 87% of the DWIs could be correctly classified. Thus, it was possible to determine classification hits and misses on the basis of a weighted function which incorporated components from an individual's driving record, from his socio-economic status, and from his reported patterns of alcohol use.

8.3 Driver Attitude Survey. Significant differences among the non-fatality treatment groups were found on two of the seven DAS scales: the deviance scale and the violation-attitude scale. However, subsequent Newman-Keuls tests indicated that the differences on these two scales should not be considered significant in terms of acceptable error rates.

Despite the lack of stable significant differences among groups, however, the mean differences between groups were evaluated for this exploratory phase of analysis by conducting two-tailed t tests. The DWI group had significantly higher scores than clear-record drivers on the deviance and violation-attitude scale. The non-DWI citation drivers had significantly higher scores than clear-record drivers on the deviance, violation-attitude, accident-attitude, alcohol-attitude, and personal relations scales. The serious injury crash group had significantly higher scores than clear-record drivers on the accident-attitude scale.

8.4 Personality variables. No significant or unequivocal differences between the non-fatality treatment groups were obtained on either the extroversion-introversion or the neuroticism-stability scales of the Eysenck Personality Inventory. The high amount of variance found on the attitudinal and personality scales accounts in part for the paucity of significant differences between groups. More sensitive, individualized analyses are therefore warranted and are being conducted. However, the preliminary results from the discriminant analysis, the DAS, and the personality inventory are interpreted as providing additional support for the working assumption that it is both possible and feasible to construct a weighted combination of demographic, drinking, driving, attitudinal, and personality variables which will enable future identification of a large proportion of high-risk problem-drinking drivers.

8.5 The DWI incident. Regarding the reason for contact with an enforcement agency, 47% of DWI citations resulted because the driver was involved in a crash and 44% because he was observed while driving aberrantly. Relatively very few contacts (9%) resulted from submitted complaints. Regarding type of chemical test, there was a far greater tendency to obtain a blood test (44%) than either a breath test (30%) or a urine test (25%).

Regarding time of day, the overwhelming majority of DWI citations (85%) were obtained during nighttime hours (18:00 to 05:59), as opposed to the relatively small proportion (13%) obtained during afternoon hours (12:00 to 18:59) and the minute proportion (2%) during morning hours (06:00 to 11:59). In fact, fully two thirds (68%) of these DWI citations were obtained in the peak 7-hour period from 19:00 to 01:59.

Concerning day of the week, the vast majority (70%) were obtained on Friday, Saturday, and Sunday; and the two prime weekend "nights" (18:00 to 05:59) account for approximately half of all DWI citations. Furthermore, the time period 14:00 to 17:59 accounted for virtually all daytime DWIs obtained on the weekends. Thus, it is clear that the risk which these impaired DWI drivers constitute for other drivers on the highways is substantially higher during the peak weekend hours than at any other time of the day or week.

9. POSTMORTEM EXAMINATION

9.1 Fatty changes of the liver. Microscopic examination of the liver was performed to replicate earlier studies indicating that persons age 25 or older with high alcohol concentrations more often have fatty changes (a presumptive sign of problem drinking) than do those without alcohol. Persons under age 25, even with alcohol in their blood, seldom had fatty changes of the liver that are microscopically visible. Among persons age 25 or older, however, the presence of alcohol is associated both with greater frequency and greater severity of hepatic fat. Regarding drinking habits, a history of medium or heavy drinking usually was associated with hepatic fat, whereas a history of light drinking was not.

9.2 Drug screening. A drug (phenobarbital) representing a possible hazard to driving safety was found in only one of 46 fatalities tested, and had been prescribed for hypertension. Drugs other than alcohol are not felt to present a serious problem with respect to highway safety.

9.3 Evaluation of emergency care. Reasons for death were examined in 163 fatalities. Twenty-three percent of these deaths occurred as a result of injuries that were believed to be either definitely or possibly survivable if the most competent care currently available in Vermont had been provided. Among persons who died after being removed from the crash site, about half died of survivable injuries. The problems of care that contributed to these deaths were distributed through both the pre-hospital and hospital phases of treatment.

10. DRINKER SUBJECTS: INFLUENCES OF ALCOHOL UPON DRIVING-RELATED BEHAVIOR

Three types of induced-intoxication experiments were conducted, namely: (1) small-group studies in which subjects drank together in a simulated cocktail-party atmosphere, but were tested separately; (2) laboratory experiments in which subjects both drank and were tested individually; and (3) a closed-course pilot study using an instrumented car to investigate the influences of alcohol upon actual driving behavior However, the latter study is not reported here since it was part of another contract and is accordingly reported elsewhere (U.S. DOT Contract FH-11-7469).

10.1 Small-group studies. Using a before-after paradigm, a series of concurrent individual experiments was conducted in satelite fashion relative to the small-group drinking situation. These investigations were concerned with influences of alcohol upon: (1) selective attention, within both auditory and visual sense modalities; (2) divided attention, in which a mental-arithmetic and an information-reduction task were done simultaneously; and (3) risk taking in a gaming situation. It was found that medium doses of alcohol were associated with: (1) performance deterioration on both auditory and visual selective-attention tasks; (2) decreases in the rate of transmitting visual information; and (3) increases in risky gaming behavior.

The influences of alcohol on mood were also examined; and it was found that with respect to personality variables, alcohol affects mood differentially.

Another investigation was conducted to compare the reliability of four different methods (two breath and two blood) of estimating blood alcohol concentration. The Borkenstein Breathalyzer was found to be more reliable and more conservative than the other three determination methods (venous blood, digital capillary blood, and Mobat Sobermeter SM2).

10.2 Laboratory experiments. Using a counterbalanced repeated-measures design, the first experiment was conducted to examine the influences of alcohol and foveal subtask difficulty upon extrafoveal sensitivity of the dark-adapted eye to photic stimulation. The reaction times of nine subjects were tested at three blood alcohol concentrations (0, 50, and 100 mg%) and under three levels of fixation-task difficulty in response to photopic targets at five selected points along the horizontal meridian of the extrafoveal portion of the nasal hemiretina. During test sessions, the peripheral signal-detection task was performed concurrently with the fixation task, which varied in difficulty, such that only one task-difficulty level was experienced in a given session. Detection and localization of a peripheral signal was indicated by release of a hand-held switch. Blood alcohol concentration was found to be directly associated with increases in reaction time. Reaction time also increased as a direct function of fixation-task difficulty. No main-effect interactions were obtained, i.e., no evidence was found for an alcohol-facilitated "tunnel-vision" effect. The implications for driving and for driving after drinking were discussed in terms of peripheral detection and divided attention.

The second laboratory experiment was concerned with the influences of alcohol upon primary suggestibility and conforming, using a counter-balanced repeated-measures design which incorporated two alcohol (ethanol, and bourbon) and two no-alcohol (placebo, and an explicitly identified no-alcohol drink) conditions. The target blood alcohol concentration was 75 mg% and the obtained mean was 78 mg%. In the autokinetic task, dark-adapted subjects were placed in a blacked-out room for brief periods to observe a pin-point of light and to estimate its movement. Half the subjects had received a strong instructional set to report movement, whereas the other half had received a weak instructional set. It was found that relative to the subjects with weak instructional set, those with strong set reported greater incidence of autokinetic movement and greater estimated linear extent in the identified no-alcohol condition; whereas the opposite relations obtained with high congener alcohol condition (bourbon).

All subjects received the Barber Suggestibility Scale after completion of the autokinetic task. Increased scores on the Barber Suggestibility Scale were found to be associated with the alcohol conditions.

The findings from this laboratory study have possible implications for driving after drinking in terms of "highway hypnosis," suggestibility, and conformity, as well as for attentional mechanisms.

10.3 Conclusions. The following general conclusions concerning the influence of alcohol upon perceptual-cognitive and motor behavior can be drawn from the induced-intoxication studies. Doses of alcohol which result in presumptive legal impairment may be associated with: (1) reductions in performance on both auditory and visual attention tasks which require the monitoring of multi-channel inputs; (2) decreases in responsiveness to stimulation of the retinal periphery; (3) alterations of visual perception in ambiguous situations; (4) increases in the likelihood of risky behavior in gaming or chance-taking situations; (5) differential mood and performance effects with respect to personality; and (6) reductions in driving accuracy and changes in automobile control-use patterns.

RECOMMENDATIONS

A series of recommendations were offered with specific references to: (1) highway safety action programs concerning alcohol, (2) research on alcohol and highway safety, and (3) future induced-intoxication research. The major elements of these recommendations can be summarized as follows:

11. HIGHWAY SAFETY ACTION PROGRAMS CONCERNING ALCOHOL

11.1 Since heavy users of alcohol were found to be over-represented among those responsible for fatal and serious injury highway crashes and among those convicted of driving-while-intoxicated or other serious moving uviolations, the Department of Transportation should continue its emphasis upon identification and control of drivers who are very heavy users of alcohol.

11.2 Since heavy beer drinkers were found to be over-represented among these crash and citation problem drinkers, (1) more research, administrative, and public education concern should be focused on the effects of beer, the frequent heavy users of beer, and the counteracting of the erroneous and contrived image of beer as a less harmful beverage than distilled spirits; and (2) eradication of the double standards for beer (as opposed to distilled spirits) which sanction and institutionalize the advertising and distributing of beer at a more permissive social level than distilled spirits.

11.3 Since young social drinkers were substantially represented among the problem drivers sampled, especially among those who were fatally injured after reportedly having consumed beer and/or liquor, due emphasis should be given to this fact by the Department of Transportation in its countermeasure program.

11.4 Since both problem drinkers and social drinkers are involved in crashes and violations attributable to alcohol, we urge further work to: (a) develop satisfactory administrative definitions of social drinking, problem drinking, and alcoholism which are capable of being used effectively by persons concerned with the problem at all levels, and (b) develop indicators or social signatures (or both) which are capable of distinguishing individuals who meet these definitions in order to apply selective countermeasures tailored to the specific needs of the individual and to the method most likely to bring about a lessening of his subsequent risk of crashes involving alcohol. Further, we recommend more highly focused research (using such techniques as cluster analysis and multiple discriminant analysis) on detailing the psychological-biographical characteristics which differentiate the various groupings of social drinkers and problem drinkers.

11.5 Since further support was found for the hypothesis that "the best single predictor of future behavior is past behavior," serious crashes and moving violations (such as driving-while-intoxicated) should not be considered merely isolated instances of behavior simply to be punished and then forgotten, but rather should be actively used as diagnostic and prognostic indicators requiring further individual evaluation, follow-up, and help--especially among younger drivers.

11.6 Since approximately one-fourth of the highway fatalities sampled were found to have died of injuries either definitely or possibly survivable had they received appropriate post-crash care (both pre-hospital and in-hospital), we recommend: (1) that blood alcohol concentrations be routinely performed on all individuals with serious enough injuries to require hospitalization, (2) that blood alcohol concentrations and complete post-mortem examination be performed on all individuals who are fatally injured in highway crashes in order to help assess the adequacy of emergency and other aspects of care, and (3) that continued attention be given to implementing and enlarging upon the emergency medical care standard of the National Highway Traffic Safety Administration.

12. RESEARCH ON ALCOHOL AND HIGHWAY SAFETY

12.1 Since studies which involve use of data obtained at roadblocks frequently differ in criteria for selecting respondents, the Department of Transportation should establish unequivocal operational criteria for conducting such roadside research surveys. Any subsequent departure from these established criteria should be clearly specified, and the concomitant limitations in applicability of results should be explicitly reported.

13. FUTURE INDUCED-INTOXICATION RESEARCH ON DRIVING-RELATED BEHAVIOR

13.1 Presumptively impairing doses of alcohol were found to reduce proficiency on both visual and auditory attention tasks requiring monitoring of multi-channel inputs. Thus, it would seem especially important for further understanding driving behavior to determine the influences of alcohol upon tasks which require selective responding to relevant information presented through different channels while simultaneously ignoring task-irrelevant information being presented concurrently.

13.2 Alcohol-associated reductions in responsiveness to stimulation of the retinal periphery should be examined more extensively, both in terms of other relevant parameters (such as brightness sensitivity, influences of training, etc.) and of other situations (such as actual driving).

13.3 The influences of alcohol upon mental loading tasks and upon concurrent driving behavior should be investigated systematically.

13.4 Since personality variables appear to be related to driving behavior, the differential influences of alcohol upon individuals with different personality characteristics should be further investigated. In particular, a sequence of studies should be conducted to investigate the physiological correlates of personality dimensions that have been shown to be susceptible to the influences of alcohol; and, concurrently, alcohol effects upon these same physiological correlates should also be examined.

13.5 Because of the obvious dangers in experimenting with drinking subjects on public roads in actual traffic, behavioral research in this area is effectively limited to: (1) closed driving courses, (2) driving simulators, or (3) laboratory experiments on assumedly relevant, but isolated components of the driving task. None of the published studies has investigated the same behavioral variables across all three of these conditions. The vast majority of this experimental literature is comprised of studies which fall in the third category, and these laboratory experiments on the effects of alcohol range from simulated driving tasks to simple sensory or psychophysical tasks. The second category of alcohol study, using the driving simulator, is next most frequent; however the relevance and the predictive validity of these simulator findings for actual driving behavior has yet to be conclusively demonstrated. In fact, a striking lack of correspondence between simulator "driving" and actual performance on the road has recently been reported.

Least frequent, but most pertinent are drinking-and-driving studies conducted with real cars on a closed driving course. Given the potential hazards and liabilities of drinking experiments conducted on public roads, the significance and strength of this type of research arises from the achieved compromise between the actual highway driving situation with its attendent traffic-associated dangers, and the secure, artificial, and cue-deprived environment of the driving simulator. That is, a real automobile (which is highly instrumented) should be used instead of a highly instrumented but contrived simulator; and a closed, but demanding course should be substituted for the public highway. Thus, the results of this type of study should prove more useful and valid for understanding everyday drinking-and-driving behavior.

INTRODUCTION

Highway crashes constitute one of our largest social problems in terms of human and economic losses. Alcohol contributes significantly to these losses, being implicated in approximately half of the fatal crashes in the United States, as well as an estimated annual minimum of 800,000 crashes of lesser severity (1968 Alcohol and Highway Safety Report). According to both common sense and fundamental research strategy, any single element found in such a large proportion of a given problem should receive high priority for careful investigation, but unfortunately such has not been the case until very recently. The history of the examination of and response to alcohol as a factor in highway crashes has in past years been one of action largely devoid of scientific grounding or evaluation.

It should be noted at the very outset that, despite frequent statements to the contrary, the problem, or situation requiring solution, is not "drinking-and-driving" per se. Rather the problem from the viewpoint of highway safety is highway crashes which are being caused by impairment from alcohol. In crashes with adult pedestrians, it is commonly the pedestrian rather than (or sometimes in addition to) the driver who has been drinking, and who is responsible for the crash. Furthermore, recent studies by Borkenstein, Crowther, Shumate, Ziel, and Zylman (1964), and others have documented that the presence of alcohol in the blood of drivers does not necessarily constitute a highway safety problem if the alcohol concentrations are low. The problem, therefore, is not drinking-and-driving, but rather the crashes that result when alcohol is used in amounts that are unsafe, that is, above concentrations usually reached through the ingestion of one or two drinks. As has been demonstrated in the action programs of the National Highway Safety Bureau the solution to the problem may lie as much in countermeasures aimed at the crash and postcrash phases and at other aspects of the precrash phase as it does in controlling the frequency of drinking and driving.

The magnitude of the crash problem involving alcohol has been clearly documented in the 1968 Alcohol and Highway Safety Report to the U.S. Congress. As with most social issues involving large numbers of persons, this problem cannot be defined in terms of one single dimension, even though alcohol is the common element. Several significant aspects of the problem are beginning to emerge from the relatively limited body of relevant research. First, "alcohol has been found to be the largest single factor leading to fatal crashes" (1968 Alcohol and Highway Safety Report, p. 8). Second, regarding the degree to which alcohol contributes to the actual initiation of crashes, drivers in serious or fatal crashes tend to have alcohol--and very high alcohol concentrations--in their blood much more often than do drivers using the roads under similar circumstances of time and place but who are not involved in crashes (1968 Alcohol and Highway Safety Report, p. 9).

We are aware of six previous studies that have attempted to compare the presence of alcohol in persons involved in crashes and in persons using the roads but not so involved. Holcomb (1938) reported on a study in which drivers not in crashes were tested to represent all 24 hours of each day of the week. To date, this is the only study reporting on the distribution of alcohol concentrations among drivers at all times of day and on all days of the week. However, it does not represent an accurate comparison with drivers in crashes because the latter are not randomly distributed according to hour and day.

Two other attempts were made during the 1950's. The comparison group used by Lucas, Kalow, McColl, Griffith, and Smith (1955) in Toronto also did not represent an adequate match with drivers in crashes because testing was done only during evenings. Vamosi's "Bratislava experiment" included in the event group drivers with traffic citations as well as those with crashes (Vamosi, 1963). It is not possible, therefore, to distinguish the comparison between drivers not in crashes and those who did crash from the comparison of drivers without citations and those who were cited.

It was not until Haddon, Valien, McCarroll, and Umberger published the classic paper of pedestrian fatalities in 1961 that a comparison group capable of passing rigorous scientific scrutiny was finally achieved. As the match to fatally injured pedestrians, they chose individuals who were walking at the site of injury on a subsequent date, but on the same day of the week and during the same hour of the day. To some extent, they also controlled for season since the uninjured pedestrians were tested within a few weeks after the fatal events. This same method was used by McCarroll and Haddon (1962) in a subsequent study of driver fatalities.

The only study concerned with an acceptable comparison group for persons in all types of crashes -- from the most minor reported crashes to the most severe -- is the Grand Rapids Study by Borkenstein et al. (1964). In this study it was necessary, because of the large size of the comparison group, to be able to schedule the comparison interviews in advance. The investigators did this by analyzing the distribution by time and place of reported crashes in Grand Rapids over the previous several years and by assessing with a fairly high degree of accuracy that subsequent crashes would be similarly distributed and, therefore, that the comparison sample could be collected at these times and places.

These and other studies have shown that about half of the drivers and adult pedestrians fatally injured in highway crashes have been drinking. The more severe the crash, the higher the probability that alcohol was involved -- and in substantial amounts (Borkenstein et al., 1964).

Another conclusion from recent research is that "alcoholics and other problem drinkers, who constitute but a small minority of the general population, account for a very large part of the overall problem" (1968 Alcohol and Highway Safety Report, p.i).[1] We know that most adults drive, that most drink, and that many do both. We also know that, of those who drive after drinking, some get into trouble and some do not. The basic question is: "Are there systematic differences between the drinking drivers who do not become involved in crashes or otherwise get into trouble on the highway and those who do?" This question was examined by University of Vermont staff at Project ABETS (Aspects Behavioral and Environmental in Traffic Safety) in order to validate earlier studies in California (Waller

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[1]The phrase "problem drinking" is operationally descriptive of behavior of individuals variously diagnosed to have alcoholism or pre-alcoholism, and of individuals whose heavy use of alcohol is sufficient to affect adversely their health, social, or economic functioning. We recognize that many physicians and others find relatively little difficulty in saying that an individual has a problem because of serious misuse of alcohol, but nevertheless that they are reluctant to state that the individual is alcoholic. By using the phrase "problem drinking", we are attempting to give recognition to the disfunction and to avoid quibbling about diagnostic terminology. In addition, the term "problem drinking" has more operational value because it identifies the two major components with which we are concerned, namely, drinking which has become a problem.

There is ample precedent for the use of the phrase in this context. According to Keller and McCormick's "A Dictionary of Words About Alcohol", a problem drinker is defined as "an excessive drinker whose drinking causes private or public harm and who is seen to cause problems for himself or others. The category includes alcoholics. Often a euphemism for alcoholic, used especially in business or industrial programs or to avoid implication of diagnosis." Also,"One who scores high on a scale of items intended to elicite admission of behavior suggesting alcoholism, incipient or actual."

& Turkel, 1966; Waller,1967) and Michigan (Selzer & Ehrlich, 1969) implicating problem drinkers.

This project is charged with determining "the extent to which drinking and driving problems involve alcoholics and other abnormal drinkers, and the ways by which these individuals can be identified." The subsequent federal objective "is to develop controlling procedures by improving operational practices and by providing a scientific test for alcohol-safety programs, policies, and legislation at state and local government levels" (Alcohol Safety, RFP 173, 1967).

Other questions about the role of alcohol in highway crashes are also being examined by Project ABETS. Although systematic studies have repeatedly and consistently identified alcohol as the most important human factor contributing to the occurrence of highway crashes, it is relevant that the only adequate study (McCarroll & Haddon, 1962) matching driver fatalities and uninvolved drivers includes only a very small sample of fatalities and that because of small sample size, important questions about driver characteristics could not be considered. Clearly, this excellent study needed to be repeated on a larger scale.

Furthermore, with only one exception, the role of alcohol in highway crashes has been studied only in urban areas,or over entire states in such a way that it has not been possible to distinguish the urban experience from that in rural regions. The exception is a study by Nielson (1967) in which limited data from six rural counties in California suggest that alcohol is as much of a problem in fatalities in these counties as in the more urban ones.

The question is hardly an academic one. Although the majority of the population in the United States is currently urban in residence, the majority of highway fatalities are rural in occurrence. Therefore, it is exceedingly important to study the problem where it most often occurs, especially because crashes occurring in rural environments may require control measures substantially different from those satisfactory for urban ones. Until the advent of Project ABETS, this had not been done.

Yet another question relating to rurality is the role of emergency care in determining whether the injured survive or not. It has been reported (Waller, Curran, & Noyes, 1964) that less adequate emergency care is an important factor in the excess crash mortality in rural areas. Although not specifically a part of the Department of Transportation contract, it was possible to examine the adequacy of emergency care in the fatalities studied, and the findings are also reported.

1.1 SPECIFIC AIMS

Project ABETS had four interrelated aims; the first two are medico-legal in orientation, while the last two are essentially behavioral:

1.1.1 To determine the distribution of blood alcohol concentrations: (a) in drivers fatally or seriously injured in Vermont highway crashes, and (b) in a corresponding sample of drivers who were using the same roads at the same place and at a similar time, but who were not then and there involved in a crash.[2]

1.1.2 As one indicator of problem drinking, to determine the relation between blood alcohol concentration and the degree of fat present in the

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[2] Among other reasons, the State of Vermont is an appropriate setting for such research because it complies with federal standards on alcohol, that is, it has implied-consent legislation, requires chemical tests, and has established the presumptive limit of impairment at 100 mg% (0.10 g%).

livers of adults who were fatally injured in motor-vehicle crashes and who were age 25 or older.

1.1.3 To compare persons at selected points along the continuum of drivers in order to determine differences in psychological and biographical variables, particularly patterns of alcohol use and driving record.

1.1.4 To investigate the influences of selected blood alcohol concentrations on perceptual-cognitive performance, and to relate these effects to differences in psychological-biographical variables (especially driving record and patterns of drinking behavior).

The interrelating of these four aims with the relevant contributions from forensic pathology, epidemology, social psychology, and experimental psychology has never before been attempted in any single study. Although various aspects of these aims have been studied piecemeal in the past, the fact that they are now investigated as part of a single project permits examination of these aspects within a particular individual to a much greater extent than was possible previously. Although the heaviest emphasis in the ABETS research reported here was primarily on forensic pathology and epidemiologic aspects of alcohol and highway safety, the major current outgrowths of this research are primarily behavioral. More specifically, three different but related levels of experimentation have emerged in the following forms: (1) a two-year grant to investigate the influences of beverage alcohol on perceptual-cognitive behavior, using induced-intoxication methods in the laboratory (Public Health Service Research Grant MH 17583-01); (2) a three-year research contract to investigate the influences of alcohol on driving behavior in an instrumented car on a closed course (National Highway Safety Bureau, U.S. Department of Transportation, FH-11-7469); and (3) a four-year demonstration project to test countermeasures for highway crashes involving alcohol (National Highway Safety Bureau, U.S. Department of Transportation, FH-11-7543).

Thus, the overall program at this point in time has emerged from the original four aims of Project ABETS to a three-level approach to the problem of alcohol and highway safety: in the laboratory, behind the wheel, and in the real world.

METHOD

The following topics are considered in this chapter: (1) the experimental plan, (2) the respondents and samples, and (3) procedures, as were involved in: autopsy, blood and breath alcohol toxicology, drug screening toxicology, roadblocks, and interviewing and testing. The methods of procedure for the induced-intoxication experiments are presented separately in Chapter 7 since there were numerous methodological variations from study to study.

2.1 EXPERIMENTAL PLAN

Because drinking-and-driving experiments cannot readily be conducted on public roads and because of the problems that might result if representative samples of citizens ranging across the full spectrum of drivers were encouraged to be subjects in induced-intoxication experiments, two separate types of samples were required: driver respondents and drinker subjects. To the extent possible, however, the same or equivalent data sources were used for each type of sample in order to provide a basis for post hoc comparison and extrapolation.

The experimental plan specifies eight different driver samples, of which six can be considered as study, experimental, or treatment groups and the other two as control or comparison groups (see Figure 2-1). It is assumed that the total sample (2 crash, 2 citation, 2 clear-record, and 2 roadblock comparison groups) includes motorists from points along the full continuum of driving behavior. In Table 2-1, the eight driver samples are arranged in matrix form to indicate the basis on which these groups provide information on presence or absence of alcohol in terms of

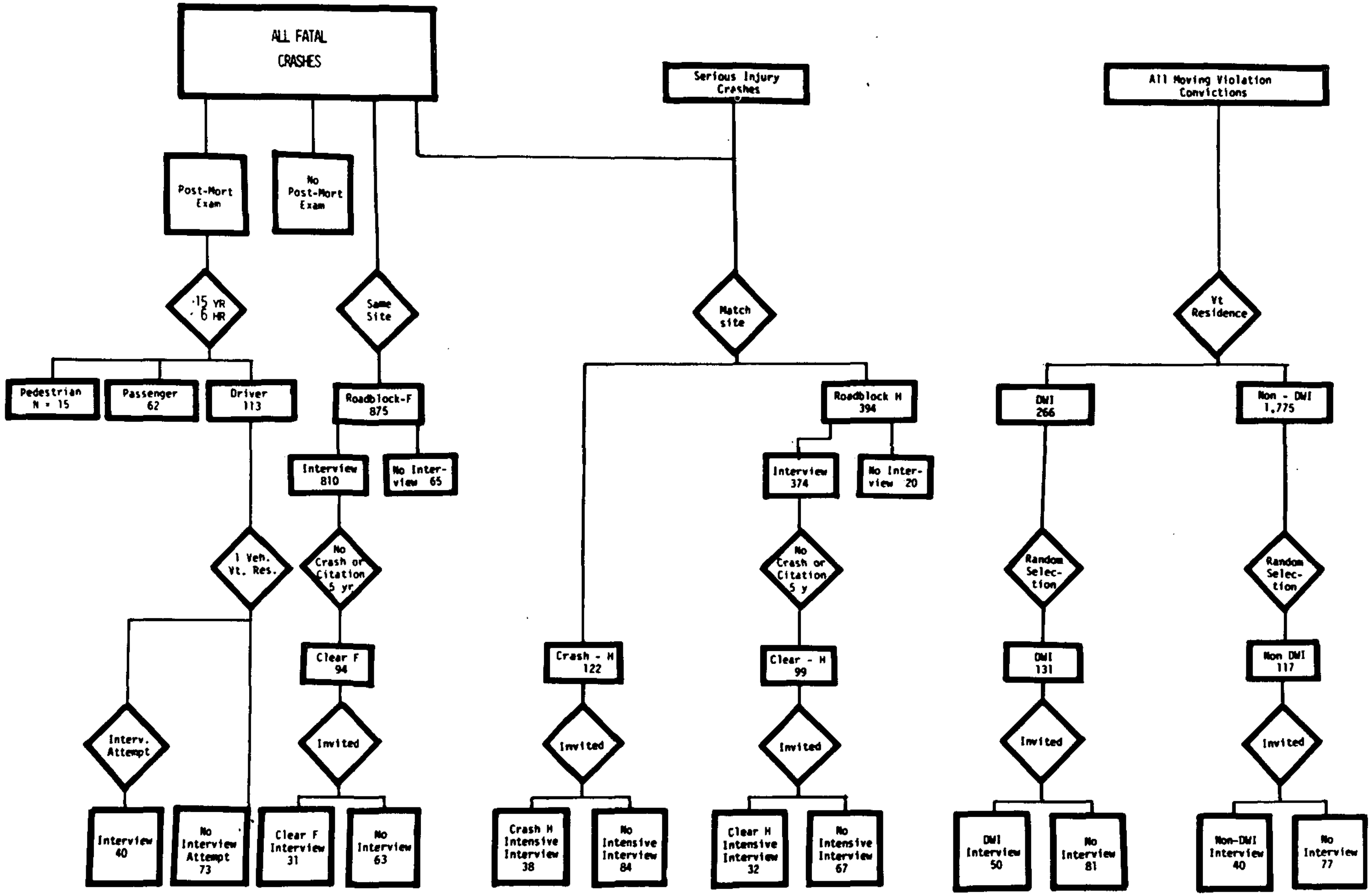

Figure 2-1 Overview of Experimental Plan For Driver Samples

Table 2-1

Driver Samples Arranged to Show Sources of Information on Alcohol Presence in Terms of Crash and Citation Criteria used to Select Samples

	Crash	No Crash	
		Citation	No Citation
Alcohol	Fatality Hospitalization	DWI	Roadblock - F Clear record - F Roadblock - H Clear record - H
No Alcohol	Fatality Hospitalization	Non-DWI	Roadblock - F Clear record - F Roadblock - H Clear record - H

the crash and citation criteria on which the drivers were originally selected.

2.2 RESPONDENTS

Brief descriptions of the sampling criteria and data sources for the driver respondents are presented in this section. A numerical summary of the availability and participation of individuals in each group is shown in Tables 2-2 and 2-3, starting with the size of the population or pool from which each sample was drawn and then indicating the number of respondents selected, contacted, interviewed, not interviewed, etc. The more procedural aspects of these samples are found in the next section. Because of inter-experimental variations, the drinker subjects are better discussed separately in the chapter on induced-intoxication studies.

2.2.1 Fatality crash. The first sample (Crash-F) can actually be considered a population, since it consists of the 46 deceased drivers from all 99 fatal crashes which occurred in Vermont during the 10-month period, July 1, 1967 through April 30, 1968. This period is designated Phase I. The names of these drivers were officially verified by the Vermont State Medical Examiner, the Vermont State Police, and/or the relevant State's Attorney. Although the forensic pathology portion of the study is concerned with all highway fatalities, including passengers and pedestrians, the rest of the study focused specifically on the behavior and characteristics of the drivers only. Thus, except for the fatality data presented in Chapter 3, which at times includes passengers and pedestrians, all subsequent references to the fatality-crash group refers to drivers only.

It should also be noted that, although living drivers who had survived a crash in which one or more other persons was fatally injured were initially included as "respondents", they were eventually omitted from

Table 2-2

Availability and Participation of Respondents Among Non-fatality Study Groups According to Frequency and Percent

	Crash-H		DWI		Non-DWI		Clear-F		Clear-H	
	N	%	N	%	N	%	N	%	N	%
Population or pool	1,431	-	266[a]	-	1,775	-	372	-	437	-
Subjects invited	122	9[b]	131	49[b]	177	7[b]	94	25	99	23[b]
Total interviewed										
at ABETS	26	21	11	8	12	10	31	33	32	32
at home or elsewhere	12	10	39	30	28	24	0	0	0	0
Total	38	31	50	38	40	34	31	33	32	32
Total not interviewed										
not readily available[c]	80	65	63	48	59	50	62	56	65	66
not available in daytime	4	3	9	7	17	15	0	0	0	0
refusals	0	0	9	7	1	1	1	1	2	2
Total	84	68	81	62	77	66	63	67	67	68

[a]This population of DWI motorists was limited to Vermont residents, thus excluding 133 non-Vermont residents cited for DWI.

[b]The percents in this row show the proportion of the population or pool selected for invitation. The percent in all other rows are based upon the number of subjects invited.

[c]Individuals who did not reply to the invitation letters were placed in this category: (1) if an investigation of their post office address showed that they had not been receiving mail at the listed address and that they had no other current address on file with the post office; or (2) if it was determined that they were deceased, had moved out of state, were in military service, were in prison, etc.

Table 2-3

Availability of Data Among Deceased Drivers and Roadblock Comparison Respondents According to Frequency and Percent

	Deceased drivers		Roadblocks			
			Fatality		Hospital	
	N	%	N	%	N	%
Population or pool						
Phase I	46	-	461	-	394	-
Phase II	67	-	414	-	-	-
Total	113	100	875	100	394	100
Total: Interview data						
Phase I	36	32	438	50.1	374	94.9
Phase II	4	3	372	42.5	-	--
Total	40[a]	35	810	92.6	374	94.9
Total: No interview data						
Not attempted						
Phase I	11[b]	10	0	0.0	0	0.0
Phase II	62[c]	55	0	0.0	-	--
subtotal	73	65	0	0.0	0	0.0
Refusals						
Phase I	0	0	23	2.6	20	5.1
Phase II	0	0	42	4.8	-	-
subtotal	0	0	65	7.4	20	5.1
Total	73	65	65	7.4	20	5.1

[a] All these deceased drivers for whom next-of-kin interviews were completed were Vermont residents who died within six hours of a single-vehicle crash.

[b] These 11 deceased drivers for whom no next-of-kin interviews were attempted include 10 non-Vermont residents, as well as 1 Vermonter who was fatally injured in a multiple-vehicle crash.

[c] These 62 deceased drivers for whom no next-of-kin interviews were attempted include 17 non-Vermont residents.

consideration because of the extreme resistance to being interviewed, which is understandable for psychological as well as for legal reasons since litigation was still pending in some of these cases. Despite these various limitations, the fatality-crash group is the most crucial single sample of the present study, if only because it constrained the subsequent selecting of respondents for all but the two citation samples.

2.2.2 Roadblock-F. In order to obtain a comparison group for the 79 Phase I fatality crashes, a roadblock sample was obtained at the site of each such crash on the same day of the week and at the same time of day. During Phase I, the roadblock was conducted within a few weeks of the occurrence of the fatality crash, but during Phase II, it was conducted on the anniversary day (as opposed to anniversary date, e.g., the third Thursday of November, rather than November 20th, since day-of-week is a more important factor in highway use than is day-of-month). The interviewing goal for each roadblock was six motorists travelling in the same direction as the crash vehicle had been. During Phase I, 438 motorists were interviewed at 65 fatality-crash roadblocks, whereas 372 were interviewed at 70 such roadblocks during Phase II.

2.2.3 Clear-record drivers (Clear-F). In order to study one particularly important portion of the population-at-risk more closely, a sample of 372 Vermont drivers with clear records was selected from the Phase I roadblock comparison population (Roadblock-F). This sample consisted of those roadblock motorists who met the following three criteria: (1) who stated during the roadblock interview that they had had no crashes or citations within the previous 5 years, (2) said that they would be available for further interviewing if called upon, and (3) whose no-crash-and-no-citation responses were subsequently confirmed by an official record check. From the total sample of 372 who met these criteria, a sub-sample of 94 was randomly selected to be invited for further interviewing. The size of this sub-sample was determined by estimating the rate of attrition necessary to obtain a sufficient number of usable respondents in this group to correspond approximately to the projected number of driver fatalities expected during Phase I, namely, 58.

2.2.4 Hospitalization crash (Crash-H). In order to obtain information on drivers involved in serious, but not fatal-injury crashes, a sample was selected from the Vermont Department of Motor Vehicle files of the 16,330 highway crashes reported in 1966 (the most recent complete year at the time). A hospitalization or serious-injury crash was defined as one in which one or more persons received injuries sufficient to require treatment at a hospital. Actual hospitalization was frequently difficult to document, but the injuries were assumed to have warranted hospitalization in such cases when broken bones, severe cuts, and/or prolonged unconsciousness were noted on the official accident report.

Thus, the resulting sample (N=1,431) consisted of 1,281 crashes involving one or more serious injuries and 150 crashes in which "nature of injuries" was checked "unknown" on the official accident report. The latter group was included to minimize missing false negatives in the pool of 16,330 crashes. This selected group of 1,431 cases was carefully sorted on the following variables to obtain the best possible match for each individual fatal-injury crash (Phase I) that was included in Crash-F: (1) time of year (December 16 - March 15, March 16 - June 15, June 16 - September 15, September 16 - December 15); (2) day of week (Monday - Thursday, Friday - Sunday); (3) time of day (6:00 am - 6:00 pm, 6:00 pm - 6:00 am); (4) type of road (US, state, county, gravel, etc.); and (5) actual geographic location. After a best match was obtained for each fatal-injury crash (N=95) half of the second-best matches (many of which were essentially equivalent to the first choice in terms of degree of match) were randomly selected and added to the best match cases to comprise the group of Vermont drivers to be invited for extensive interviewing, namely, 122.

2.2.5 Roadblock-H. In order to obtain a comparison group for Crash-H, a roadblock was conducted at the site of each serious-injury crash selected for best match (N=65) on exactly the same basis described above for Roadblock-F. A total of 374 motorists were interviewed at these 65 roadblocks during Phase I. (No roadblocks for Crash-H were conducted during Phase II).

Since both roadblock comparison groups were matched to the fatal- and hospitalization-crash samples in terms of time and place of incident, they serve as an estimate of the actual population-at-risk. In other words, these two comparison groups consist of motorists who were driving at the same place at an equivalent time of a crash, but were not themselves involved in a crash (at least not at that point in time-space).

2.2.6 Clear-record drivers (Clear-H). The 99 drivers invited for this sample were selected from 437 Roadblock-H respondents on the same basis as the Clear-F were selected from Roadblock-F (see above).

2.2.7 Driving-while-intoxicated (Citation-DWI). One of the major concerns of the present study was the problem drinker on the highway. A highly probable pool for such individuals is among those drivers who have officially come to the attention of enforcement agencies for driving after having consumed a large quantity of alcohol. Accordingly, a sample was drawn from among in-state drivers in the Vermont Motor Vehicle Department files who had been cited and convicted of driving-while-intoxicated (DWI) during the previous year (1966). Thus, from the pool of 266 such Vermonters, 131 were selected randomly, the number corresponding to the projected sample sizes of the two crash and the two clear-record groups.

2.2.8 Non-DWI citations. In order to obtain a type of comparison group for the DWI's (i.e., a group of individuals convicted for some serious motor-vehicle violation, but with no official charge of alcohol involvement), a corresponding sample of 117 in-state drivers was randomly selected from the Vermont Motor Vehicle Department files of 1,775 motorists cited and convicted for other moving violations in 1966.

Less than half of the 57 possible violations listed by the Motor Vehicle Department are commonly used in actual citations. Thus, of the more frequently used twenty, drivers were selected from the following categories on the assumption that these constituted the more serious and more flagrant types of violations: (1) careless and negligent driving, (2) leaving the scene of an accident, (3) driving while license suspended, (4) driving without a license, (5) operating without owner's consent, (6) violations of the law of the road, (7) failure to stop for a stop sign, and (8) vehicle operated with defective equipment. Three major exceptions should be noted: (1) "careless and negligent driving with accident resulting" was excluded because of the possibility that a driver so cited could appear in the Crash-H sample; (2) "exceeding the speed limit", because it is an extremely common and not necessarily flagrant violation; (3) "DWI", because it is treated as a separate sample above.

Regarding this last exception, it should not be assumed that the non-DWI citation driver had not necessarily been drinking. Rather, one can only assume that, in the event that they had been drinking, they were at least not cited and convicted for DWI. Thus, regarding driving after drinking or, more properly, problem drinking, there may well be many false negatives in the non-DWI citation group.

2.3 PROCEDURES FOR ROADBLOCK COMPARISON SAMPLES[1]

The roadblock procedures had the prior approval of the Vermont Governor's Office, Attorney General, State's Attorneys, and State Police. After the preliminary conferences necessary to obtain understanding and approval of our purposes and needs, liaison and briefings were continued with all these individuals during the course of the field work. Perhaps the most important point on which understanding had to be reached was that roadblocks were being conducted for research purposes, not for enforcement. Thus, special provisions and contingency arrangements were made to accommodate the occasional driver who might be stopped at a roadblock and might not pass the usual visual inspection for "sobriety." Fortunately, no ugly or unmanageable incidents occurred during any of the roadblocks, probably due in part to the high degree of courteous cooperation received from the police troopers, as well as to the consistent skillful efforts of several members of our own field staff.

Appropriate steps were taken to allow us to be able to assure respondents that they were immune from prosecution on information they voluntarily provided the research staff. This assurance was officially repeated in the text of a letter from the governor of Vermont which was handed to each respondent at the roadblocks (see copy of letter in Appendix).

2.3.1 Roadblock selection and scheduling. During the first phase of study, as noted above, a roadblock was scheduled for each fatality and serious injury crash site at the same time of day and day of week, but within the subsequent few weeks. This type of sequential scheduling placed inordinately great demands on a small staff attempting to cover a geo-

[1]A more complete discussion of roadblock procedures and methodological considerations is presented in Perrine (1971). See also Appendix A.

graphically large area (i.e., Vermont) during all possible hours of day and week and during all types of weather. It was impossible to plan more than a few weeks ahead; we simply had to wait for the occurence of a fatal crash, then select a matching serious-injury crash, and then try to work both into a chronologically crowded, but geographically scattered schedule. For economy of personnel and funds, as many roadblocks as possible were clustered and conducted consecutively in a given area, even though this procedure meant some trade off of maintaining consistent sequential time intervals between the crash and its roadblock.

During the second phase of the study, roadblocks were scheduled for the anniversary day of Phase-I fatal crashes or on the anniversary day for Phase-I serious-injury crashes. It should be noted here that a homogenity analysis of Roadblock-F and Roadblock-H respondents on 22 selected variables provided a substantive basis to supplement the economic basis for omitting roadblocks for serious-injury crashes during the second phase of the study.

Roadblocks were scheduled to begin 30 minutes prior to the actual time of the crash for which they were being conducted. If the interview quota of six motorists had not been reached by 30 minutes after the actual time of the crash, no additional motorists were to be stopped. A certain degree of deviation from this ideal requirement was expected due to weather, tight scheduling of adjacent roadblocks, human frailities, etc. The obtained deviations from the starting time requirements were: time of crash minus 060 minutes = 7%; -30 min. = 47%; -15 min. = 14%; time of crash (0) = 13%; +15 min. = 5%; +30 min. = 7%; +60 min. = 7%; and +120 min. = 1%. In summary, it may be noted that: (1) 47% of the scheduled roadblocks started on time (minus 30 minutes); (2) 74% started within 30 minutes prior to or at the time of the actual crash; and (3) 19% started within 60 minutes following the time of the actual crash.

2.3.2 Roadblock operation. If traffic flow was moderate or heavy, the interview quota was obtained by stopping six motorists travelling in the same direction that the crash vehicle had been travelling. However, when the flow was light it was decided in consultation with the state police that the reduced flow would seriously limit the likelihood of obtaining our quota, then vehicles from both directions were stopped until either six interviews were completed or until the allotted time (60 minutes) had elasped. Regardless of the number of fatalities or serious injuries that resulted from a given crash, only six interviews were attempted unless persons were fatally injured in more than one vehicle in that crash, in which case six interviews were scheduled for each vehicle in which a fatality occurred.

All motor vehicles, ranging from motorcycles and farm tractors through passenger cars to vans and trucks were stopped with the exception of interstate trucks and buses. The actual stopping of the motorists, as well as the on-highway safety, were the responsibility of the state or local police assigned to that particular roadblock. Except at light traffic-flow roadblocks, the decision concerning which particular vehicle to select was left to the police officer who was instructed to stop the next vehicle in the proper direction after having received a signal from the research staff that it was ready for the next motorist. Thus, there seems to be little probability of selected bias in determining which vehicle to stop versus which vehicle to allow to proceed without stopping.

Upon being halted by the police officer, the selected motorist was briefly informed that he had not been stopped for a driving violation, but rather as part of a research survey; he was then immediately referred to Project ABETS staff. An interview team, consisting of a male and a female, then approached the driver in his vehicle, handed him a copy of the letter from the governor introducing and supporting the study, and invited him to participate in the research project by joining them in the interview vehicle for 10 to 15 minutes. A consistent effort was made to establish rapport quickly and included offering coffee or soda to the driver and adult passengers, and candy to the children.

If a driver refused to be interviewed, his reasons were recorded, he was allowed to continue on his way, and the next motorist was stopped in his stead. In some cases, a motorist would not have time for a complete 15-minute interview, but would consent to a 5-minute abbreviated interview. Motorists who received the shortened form were considered to be part of the quota of six drivers and thus were not replaced.

During the interview, the motorist usually sat with the interviewer (typically the male member of the team), while the recorder (typically the female member of the team) sat alone either in the front or back seat or across the table when a mobile camper was used. A few interviews had to be conducted in the motorist's car, but this less desirable option was avoided if at all possible.

2.3.3 The roadblock interview. The driver was first reminded of the immunity from prosecution, anonymity, and confidentiality quarantees before proceeding with the questioning. The interview itself followed a fixed schedule of questions, beginning with innocuous warm-up items concerning seatbelt usage. The cooperating driver then answered a limited number of the more important psychological-biographical questions selected from the extensive battery given to the drivers in the non-fatality study groups (see next section). Thus, the following information was provided: biographical data (items on age, sex, parents, earlier years, education, occupation, military service, home marriage, religion, smoking history, and health); driving history (items on driving education, experience, occasions, companions, exposure and mileage, record of crashes and citations, and vehicle information); and drinking history (items on preferred beverage, consumption frequency and quantity, drinking occasions and companions).

A breath sample was requested toward the end of the interview and was obtained in most cases. During Phase I, the Mobat Sobermeter (SM2) was used to obviate having immediately available data on the driver's BACs, since this device required subsequent laboratory analysis. However, during the second phase, the Borkenstein Breathalyzer (Stephenson Corp., Model 900) was used because: (1) we had had many problems with the Sobermeter, (2) the SM2s were relatively expensive (approximately $5.00 a piece), and (3) we were no longer worried about the immediate availability of BAC data to the research staff at the roadblock (although the data were not available to the drivers). The Sobermeter and Breathalyzer devices and procedures are described below (see section 2.6.4).

At the end of the interview, the motorist was asked whether he would be willing to come in for more extensive interviewing if called upon. If he responded favorably, his name and address were recorded on a separate 3X5 card and he was reassured that his interview responses would remain anonymous, identifiable only by means of a code number. He was given a wallet-size card stating that he had participated in the Project ABETS survey; his code number was entered on the card, and he was asked to show it to an interview team if he happened to be stopped again at another roadblock. The motorist was then thanked for his cooperation and assistance, was given a few pages of mimeographed material explaining the nature and purposes of Project ABETS in more detail, and was dismissed. His re-entry into traffic was guided by the field staff or the police officers.

2.4 PROCEDURES FOR NON-FATALITY STUDY GROUPS

The sampling criteria and data sources for the five non-fatality study groups were presented above (see 2.2 Respondents). Each driver selected for each of the five groups (Hospitalization Crash, Clear Record-F, Clear Record- H, DWI, and non-DWI) was sent a letter in which he was invited to participate in Project ABETS and was offered $15.00, plus travel expenses if he came to Burlington, He was also given the option of being interivewed closer to home. Those drivers who replied favorably were scheduled as soon as possible; those who did not reply were sent as many as three follow-up letters.

Availability and participation data for the five non-fatality study groups are presented in Table 2-2. Except for the DWI drivers, no significant differences between groups were found in terms of the percent interviewed at ABETS versus at home or elsewhere, written refusals versus refusals at home, or unavailability in daytime versus other reasons for not being interivewed. Significantly more DWIs than other motorists, however, had to be tracked down for interviewing in their homes (30%).

Before beginning the actual interview, each motorist was advised that the information he would provide would be confidential and anonymous, and he was guaranteed immunity from prosecution on the basis of his answers. He was told that the battery of questions and tests would probably require one and one-half to two hours to complete (although a few respondents took as long as three hours), and he was encouraged to ask questions about any of the items on the questionnaires or tests. The interviewer attempted to establish rapport while obtaining certain preliminary data from the respondent and also to determine at that time whether or not he was capable of completing the battery alone. If not, all questions were read aloud to the respondent.

2.4.1 The interview battery. The motorist was asked to volunteer information on his biographical background, driving history, drinking history, smoking history, and deliquency history, as well as data on selected attitude and personality instruments. Some of these motorists also participated in several perceptual-cognitive tasks (i.e., a risk-taking game, visual and auditory threshold determination, etc.), but these tasks were soon discontinued due to the great amount of additional time required and to the difficulty of sufficiently motivating the motorists to perform the tasks adequately.

More specifically, the respondent information was provided on precoded schedules and consisted of:

1. Biographical Data: 104 items on parents, earlier years, education, occupation, military service, home, marriage, religion, smoking history, and health.

2. Drinking History: 73 items on parents' drinking behavior and attitudes, as well as on respondent's current drinking: preferred beverage, frequency, quantity, occasions, companions, reactions, and problems.

3. Alcohol Attitude Scale: 24 Likert-type items.

4. Driving History: 39 items on driving education, experience, occasions, companions, exposure and mileage, record of crashes and citations, and vehicle information.

5. Test of Driving Skill: 29 four-alternative items, half of which involve error choices.

6. Driver Attitude Survey: 126 items developed by Schuster and Guilford (1962).

7. Semantic Differential: ratings of 20 concepts relating to drinking, drinking-and-driving, death, accidents, hostility, and risk taking.

8. Rules and Regulations Schedule: 29 items on the respondent's delinquency, vandalism, theft, gambling, aggression behavior, etc.

9. Eysenck Personality Inventory: Form B, 57 items.

Those motorists who were interviewed elsewhere or in their homes received an abbreviated battery comprised of: (1) Biographical Data (the shorter version designed for roadblock use), (2) Drinking History, (3) Driving History, (4) Driver Attitude Scale, and (5) Eysenck Personality Inventory. In order to minimize the influence of domestic distraction, these respondents were encouraged to listen to the tape-recorded questions through simple plastic earphones.

2.4.2 Driver Attitude Survey. The DAS is scored on seven scales, the descriptions of which are based upon Schuster and Guilford (1964) and McGurie and Kersh (1964):

D (deviance) scale: resembles F scale of MMPI; a high score indicates careless mistakes in answering, trouble in reading, lying, or some unusual biasing attitude.

F (faking attitude) scale: analogous to L (lie) scale of MMPI, is derived from socially acceptable responses to certain obvious driving items, and a high score indicated respondent was attempting to give what he thought was a correct answer.

X (misses) scale: should indicate false negatives, that is, a high score may mean that the respondent is crash and citation "prone," but was somehow missed as a "false negative" by the violation and accident attitude parts of the DAS.

V (violation attitude) scale: a high score indicates a tendency toward violation "proneness."

A (accident attitude) scale: a high score indicates a tendency toward accident "proneness."

AL (alcohol attitude) scale: a high score may indicate a tendency toward alcoholism.

P (personal relations) scale: a high score indicates skillfulness in interpersonal relations.

2.4.3 Eysenck Personality Inventory. The EPI is scored on three scales:

E scale: relates to the extraversion-introversion continuum, with the higher scores being associated with extraversion.

N scale: relates to a neuroticism-stability continuum, with the higher scores being associated with neuroticism.

<u>L scale</u>: an 18-item lie scale, adapted from the L scale of the MMPI; should detect individuals who are "faking good" by checking socially acceptable responses.

2.5 <u>PROCEDURES FOR POSTMORTEM EXAMINATION</u>

The postmortem examination of each deceased driver (as well as deceased passengers and adult pedestrians) included the determination of blood alcohol concentrations (see section 2.6.1), extent of hepatic fat, and an estimation of which injuries probably were crucial in bringing about death. In addition, a retrospective case study of each deceased driver who was a Vermont resident was conducted by interviewing next-of-kin, close friends, and the investigating police officer in an attempt to obtain information on approximately the same psychological-biographical variables that were analyzed for the living drivers (see section 2.2.1).

2.5.1 <u>Autopsy</u>. Complete postmortem examinations were performed on the cadavers of 163 persons who died as the result of Vermont highway crashes in the period from May 1, 1967 through March 15, 1969. Legal authority for this coverage was provided by the Office of the Attorney General of Vermont, through the various county State's Attorney's, and with the close cooperation of the Chief Medical Examiner (State Pathologist). In addition, several official sources were utilized to complete a profile of circumstantial information regarding nearly every traffic fatality. State and local police reports, ambulance logs, hospital emergency room and medical records, and Regional Medical Examiner reports (on file with the Chief Medical Examiner) were consulted to record such data as the type of crash, the position of the deceased, the time of the crash, the time of discovery, the initiation of first aid (if any), the type of therapy given, the time of hospital arrival and the time of death, etc. Such information was usually known to the examining pathologist before he began the autopsy.

Each autopsy was performed within twelve hours of death by a pathologist qualified in the medical specialty of anatomic pathology. Autopsy prosectors recorded the results of detailed external and internal examinations. The former included the enumeration of impact injuries, particularly those which could be correlated with the known cirsumstances of injury, e.g., "pattern injuries" associated with the internal environment of the vehicle involved (in cases of driver and passenger deaths). The latter included the examination of all organs, including the brain and spinal cord; particular emphasis was placed on the correlation of internal visceral injuries with external injuries. In addition, the examination of viscera included a search for evidence of pre-existent or concurrent natural disease. Brain specimens were examined after formalin fixation, in consultation with a qualified neuropathologist. Photographs of significant injuries were taken in all cases.

Copies of completed autopsy reports were filed with the Chief Medical Examiner, the Attorney General, the respective State's Attorneys and the respective investigating police agencies, as required by state statute. Death certificates were issued by the pathologist in each case, utilizing the information gained at autopsy.

2.5.2 Histology. Selected blocks of tissue were taken at autopsy; these were fixed in 10% neutral, buffered formalin. Representative blocks were processed through nonpolar solvents to paraffin embedding, and histologic sections were prepared by the usual methods. The standard hematoxylin and eosin stains were employed; selected sections were stained by special methods to demonstrate certain histopathologic features, including the following:

Special Stain (Luna, 1968)	Feature Demonstrated
Beilschowsky's ammoniacal silver	Nerve fibers
Lapham's pholoxine fast green	Myelin in brain

Laquer's	"Alcoholic hyalin" in liver
Lillie's oil red O	Fat (frozen section only)
Masson's trichrome	Connective tissue

2.5.3 Hepatic fat. In 122 autopsies selected on the basis of age, survival interval, and the absence of pre-existent natural disease, a special study was conducted to evaluate and quantitate the presence of hepatic steatosis. Hematoxylineosin stained sections of both major hepatic lobes were screened by light microscopy to determine the presence of intracellular fat. Selected tissue blocks were examined further, using Masson's and Laquer's stains to further describe the severity of hepatic fatty metamorphosis and concomitant parenchymal alterations, including cirrhosis and evidence of acute alcoholic necrosis or "hepatitis." Quantitation of hepatic steatosis was estimated by light microscopy, employing the criteria of Lieber and Rubin (1968). Each section was examined and classified independently by three pathologists, who subsequently conferred to reach a final classification. Lillie's oil red O stain was used in those cases in which quantitation was difficult.

2.5.4 Postmortem toxicology. Postmortem blood samples were taken during each autopsy; these were taken by aspiration into a chemically clean syringe from the left side of the cardiac circulation, i.e., from the left ventricle, atrium or the aorta. These specimens were delivered to sealed tubes containing sodium flouride sufficient to make a 1% solution. Speciments were refrigerated at 4°C in the interval before analysis (vide infra). Samples of urine (when present) were similarly aspirated from the urinary bladdar; these were stored at 4°C in chemically clear, sealed tubes. In selected cases, the contents of the gallbladder and stomach were preserved in a frozen state for subsequent toxicologic analysis. Similarly, when indicated by the antemortem history, selected blocks of liver, kidney, spleen, and brain were frozen for subsequent analysis.

2.5.5 Cause of death. Final pathologic diagnoses were assigned by the prosector after a final correlation of "gross" (naked eye) and microscopic findings. The final diagnoses were, therefore, syntheses of such individuated diagnoses; their hierarchy was assigned on the basis of their severity and primacy in contributing to the mechanism by which death was produced. In those instances with a post-traumatic survival interval during which a complicating disease process supervened, the cause of death was assigned to the specific injury which gave rise to the terminal, lethal complication. (For example, if a leg fracture gave rise to localized phlebthrombosis which led to pulmonary thromboembolism and the ultimate death of the patient, the cause of death was assigned to the impact injury and the associated leg fracture. This nosology is in accordance with recommended reporting procedure (Halpern 1961).

2.6 PROCEDURES FOR TOXICOLOGIC EXAMINATION

The following presents the methods employed in determining blood alcohol concentrations in deceased and living subjects, breath alcohol concentrations in living subjects, and the methodology for a comprehensive screening of deceased subjects for the presence of barbiturates, stimulants, tranquillizers, and narcotic drugs in body fluids and tissues.

2.6.1 Blood alcohol: Deceased subjects.[2] In all autopsied cases in which death occurred within six hours of the inciting highway crash and in which the deceased was age 15 years or older, postmortem blood samples were submitted to an enzymatic analysis to determine blood alcohol concentration (BAC). There

[2] In this text and elsewhere, the term "alcohol" should be considered to be synonymous with "ethyl alcohol" and "ethanol" unless otherwise modified.

were several additional instances in which postmortem blood samples were available but in which autopsies were not performed; these were included in our survey, as were a few cases wherein antemortem blood samples were available from persons who survived to reach a hospital emergency room, but who subsequently succumbed to their injuries and came to autopsy.

In theory, the enzyme alcohol dehydrogenase catalyzes the following reaction:

$$\underset{\text{(ethanol)}}{C_2H_5OH} + \text{BNAD} \longrightarrow \underset{\text{(acetaldehyde)}}{CH_3CHO} + \text{BNADH}$$

(BNAD and BNADH denote the cofactor niacin-adenine dinucleotide, beta configuration, in its oxidized and reduced states, respectively).

This is an equilibrium reaction which is reversible; such a reversal is prevented by the addition of semicarbazide, which reacts with the acetaldehyde as the latter is formed, thus removing it from the equation. The optical density at 340 mu (OD_{340}) of the BNADH formed is an accurate measure of the amount of ethyl alcohol that is present. Methanol and isopropanol do not react in this system. Higher, unbranched alcohols are weakly reactive but do not affect the total quantitative result (Bücher & Redetski, 1951; Sigma Chemical Co., 1963; Stewart & Stolman, 1961).

The equipment and reagents employed are listed below.[3] Using the method of Stiles, Batsakis, Kremer & Briere (1966), determinations of the equimolar

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[3] 1. NAD-ADH single determination vial, Sigma Stock No. 330-1.
2. Pyrophosphate Buffer, pH 9.2 Sigma Stock No. 330-30.
It was alternatively made up as follows:
 33.3 gm $NA_4P_2O_7 \cdot 10\ H_2O$
 8.25 gm semicarbazide
 0.5 gm glycine
Added to 900 ml distilled H_2O. Thirty ml of 2N NaOH were added and the pH adjusted to 9.2. The solution was then made up to 1000 ml.
3. Perchloric Acid - 2%

enzymatic reduction of BNAD to BNADH were conducted by computing the shift in OD_{340} before and after the action of alcohol dehydrogenase. A Beckman Model DK-2A, double beam, ultraviolet spectrophotometer was used. Results were expressed in milligrams of alcohol present in 100 milliliters (cubic centimeters) of whole blood (mg/100 ml or mg/ 100 cc).

2.6.2 Drug screening: Deceased subjects. In all autopsied cases in which deaths occurred before the delivery of medical attention and in which the deceased was 15 years of age or older, postmortem blood samples were submitted to thin-layer chromatographic analysis in a system designed to detect the presence of microgram quantities of a large number of drugs and their metabolities. When possible, urine and bile samples, obtained at autopsy, were also submitted to concurrent analysis.

The theory of the chromatographic method employed is based upon the differential migration of low molecular-weight compounds dissolved in non-aqueous solvents within the matrix of a film of silica gel. A two-dimensional technique provides for migration in two axes (at right angles), for the further differentiation permitted by the characterization of the compounds' migration in a second solvent system. The rate of migration in such systems is a characteristic of each compound, and is termed its R_f value; migration is accomplished over a standard period of time, usually one hour.

Further characterization of each compound under study is permitted by

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3 cont.
2.9 ml of 70% perchloric acid were diluted to 100 ml with distilled H_2O.

4. Ethanol Control
The specific gravity of a 1.0% solution of ethanol (ethyl alcohol) was determined using the pycnometer bottle method at standard temperature (20°C). Aliquots of this "stock" standard solution was diluted to 1:10 for use as "working" standard solutions.
5. American Society of Clinical Pathologists (ASCP) Standard Ethanol Solution (150 mg/100 ml).

the use of heat, certain "developing solutions", and "spray reagents." The latter react chemically with the compounds in the gel matrix and produce colors and/or ultraviolet (UV) flourescence under conditions of "development."

The system employed in this study required the apparatus and reagents listed below.[4]

Extracting and plating methods were those recommended by Sunshine, Rose, & LeBean (1963) and numerous other authors (Davidow, Petri, & Quame, 1968; Beckett & Moffat, 1968; Pippenger, Scott, & Gillen, 1969; Turner, 1965).

Prior to the analysis of biological materials, the system was validated against known compounds in concentrations of a few micrograms per 100 milliliters. This standardization provided the basic data against which unknown compounds in biological samples were compared for qualitative identification. The results of this preliminary analysis appear in Table 2-4.

These results are consonant with those of Sunshine et al.(1963) and Davidow et al. (1968), and were used in the identification of unknown compounds in the biological fluids studied.

Additional screening of biologic fluids were performed on selected spec-

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[4]1. Eastman Chromogram sheets (silica gel with flourescent indicator). (Distillation Products Industries, Division of Eastman Kodak Co., Rochester, N.Y.).
2. Chromatographic chamber.
3. Drying oven.
4. UV light source.
5. Air blower.
6. Chloroform, reagent grade.
7. Ethanol, 95%.
8. Developing solvent - chloroform: acetone (9:1).
9. Acetate buffer solution, pH 4.25.
10. Spray reagents:
    a. Ninhydrin, 0.1% in acetone
    b. Diphenylcarbazone, 0.01% in acetone-water.
    c. Mercuric sulfate, 0.25% in 10% sulfuric acid.
11. Iodoplatinate solution, 0.004%.
12. Dragendorff's reagent (bismuth subnitrate-potassium iodide), 0.005%.
13. Mandelin's reagent (ammonium vanadium in concentrated sulfuric acid), 1%.

Table 2-4

Preliminary Qualitative Analysis of
Known Drugs by Thin-layer Chromatography

Compound	R_f	Ninhydrin	$HgSO_4$	Heat	UV	Dragendorff's	Mandelin's
A. Analgesics							
1. Phenacetin	0.34					Brown	
2. Propoxyphene (Darvon^{R})	0.13					Red-brown	
3. Salicylic acid	0.00				Blue ring		
B. Antihistamines							
1. Chlorpheniramine	0.38					Brown-black	Pale blue
2. Cyclizine	0.55						Yellow
3. Diphenlydramine	0.52						Yellow
4. Meclizine	0.69						Brown
5. Methapyrilene	0.47						Green
6. Tripelennamine	0.50						Brown
C. Hypnotics & Sedatives							
1. Amobarbital	0.41		Purple-violet				
2. Barbital	0.35		PV				
3. Pentobarbital	0.49		PV				
4. Pentothal	0.68		Purple				
5. Phenobarbital	0.35		PV				
6. Secobarbital	0.53		Purple				
7. Glutethimide (Doriden^{R})	0.61		PV				
D. Stimulants							
1. Amphetamine	0.01	Pink	Purple	Purple			
2. Caffeine	0.20						
E. Tranquillizers							
1. Chlordiazepoxide (Librium^{R})	0.00				Pale orange		Yellow-brown
2. Meprobamate	0.10		PV, fades				Brown
3. Prochlorperazine (Compazine^{R})	0.00			Red	Purple-violet		Brown
4. Trifluoperazine (Stelazine^{R})	0.00				Blue		

imens when indicated by case history or by equivocal thin-layer chromatographic results. A ratio-recording, ultraviolet (UV) spectrophotometer was used both as a qualitative screening device and as an analytic instrument yielding quantitative results. In the former function, prepared extracts of biologic fluids were dissolved in solutions of varying levels of hydrogen ion concentration (pH); by scanning such solutions across the range of UV light emission from wave lengths of 190 to 320 millimicrons (MU), it was possible to characterize and identify nearly all of the compounds listed in Table 2-5 by their characteristic absorption spectra. By further variations of pH and elasped time in solution, certain compounds could be additionally characterized on the basis of known behavior in solution (e.g., glutethimide displays a shifting absorption spectrum in the first twenty minutes of its solution in mild alkali (Sunshine, Fike, & Landesman, 1966).

Several leading pharmaceutical corporations generously provided our laboratory with reagent-grade samples of their patented drug products without charge.[5] These pure samples were submitted to spectrophotometric analysis as described above; the resulting series of tracings formed the data base for an atlas of characteristic UV absorption spectra which was compiled and subsequently used in the final identification and quantitation of drugs in biologic specimens.

As noted above, quantitative analysis was possible in concurrent operations of the same apparatus: for all of the compounds under study, the absorbance

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[5] Prompt and courteous responses were received from the following: Abbot Laboratories, Inc.; Carnrick Laboratories, Inc.; Ciba Pharmaceutical Company; Delmar Chemicals, Limited; Hoffman-LaRoche, Inc.; and The Lilly Research Corporation.

of UV light waves occurs in direct, linear proportion to the concentration of the chemical compound in solution. In those instances in which qualitative (chromatographic or spectrophotometric) analysis indicated the presence of a drug, its concentration in the biological fluid was calculated in this manner, using the information gained in the preliminary testing of known, pure drugs in known calibrated concentrations, referred to above.

2.6.3 Blood alcohol: Living subjects. Samples of whole blood from volunteer human subjects were collected for the determination of blood alcohol concentration (BAC) in several studies of induced intoxication under controlled conditions. Blood specimens were drawn by two methods: phlebotomy and digital capillary puncture.

The venous blood collected by phlebotomy was drawn into sterile, chemically clear, disposable plastic syringes through similarly clear, fiber glass, 18 gague (French) needles; from these, 10 milliliter aliquots were promptly transferred to stoppered vacuum tubes containing 25 milligrams of sodium flouride (NaF) and 20 milligrams of potassium oxalate (preservative and anticoagulant, respectively). (The vacuum tubes were the product of Becton-Dickenson and Co., Rutherford, N.J., under their brand name, Vacutainer[R]). Alternatively, venous blood samples (10 milliliters) were drawn directly into Vacutainer[R] tubes through disposable 18 gague needles. Blood stored in such tubes under refrigeration was stable for several months.

Digital capillary blood samples were drawn into sterile, silicon-coated micropipettes which were component parts of the disposable Unopette[R] collection system (Becton-Dickenson and Co.). The volume drawn was predetermined at 20 microliters; this blood was transferred to a vial containing 1.3 milliliters of one percent NaF solution and, after sealing and mixing, was stable for the quantitative determination of ethanol for months at refrigerator temperatures.

In theory, there are sound reasons for a differentiation of in vivo venous BAC's from in vivo capillary BAC's, and a preference for the latter. The BAC values collected from autopsy data are derived from arterial blood samples, for reasons well outlined by Turkel and Gifford (1957). The practice of arteriotomy in living persons is a particularly painful and hazardous procedure, however, even when performed by skilled hands; it is not generally employed, and arterial BAC values are not available for living persons in this study.

Most studies using direct measurements of BAC in living subjects heretofore have relied heavily on data derived from venous blood specimens collected at various elapsed time intervals from the outset of dosage. The inherent disadvantages of this method derive from the known phenomenon of differential alcohol distribution during the _absorptive_ phase of its metabolism: _viz_., venous levels invariably lag behind arterial and capillary levels due to the sequestration of alcohol in interstitial blody fluids and somatic tissues (particularly skeletal muscle). The duration of this "lag phase" of absorption usually exceeds one hour; the discrepancy between arteriocapillary and venous BAC's during this period may be as much as 22 mg% (Harger, Forney, & Baker, 1956). This is particularly true when phlebotomy is performed on the veins of the antecubital fossa of the arm, at which site the venous blood sampled represents the afferent arc of a circuit which drains a sizable mass of skeletal muscle.

By contrast, digital capillary blood has been shown to contain essentially the same levels of alcohol as arterial blood (Haggard & Greenburg, 1934). Moreover, it can be assumed that the concentrations of dissolved solutes (including ethanol) in digital capillary blood more closely approximate

the concentrations of similar solutes in the blood within those capillary circuits of the brain, spinal cord, and peripheral nerves, as well as those other viscera in which the action of ethanol assumes pharmacologic, pathologic, and behavioral significance.

For these reasons, capillary blood sampling methods were employed whenever possible in this study.

The analysis of BAC in samples of venous blood from living persons was performed by the enzymatic technique described above. The flouridated capillary blood samples were analyzed by the same method, but in a miniaturized automated system devised by Mr. Harold Stowe of the Bureau of Laboratories, Vermont State Department of Health, and subsequently published by him (Stowe, 1969).

2.6.4 Breath alcohol: Living subjects. Two methods were used in the determination of blood alcohol concentration by the analysis of ethanol in expired breath: (1) Mobat Sober-Meter[R] method of Mr. M.J. Luckey (Luckey Laboratories, Inc., San Bernardino California), and (2) the Breathalyzer[R] method devised by Professor R.F. Borkenstein (apparatus available from the Stephenson Corporation, Eatontown, N.J.).

The Mobat Sober-Meter[R] system employs the well-known affinity of magnesium perchlorate for alcoholic vapors. Further, the system also attempts to adjust for faulty sampling of alveolar air by a concurrent analysis of carbon dioxide (CO_2) concentration in the breath sample received. Using the model "SM-2" apparatus, the subjects were directed to expire a minimum volume of air (determined by a calibrated ballon) through a pair of tubes containing magnesium perchlorate and "mikohbite", coupled in series. The latter tube had been previously weighed; the increase in its weight as determined by a subsequent weighing indicated the weight of CO_2 absorbed. The quantity of alcohol in the expired sample was determined by the alcohol dehydrogenase method given above, after distillation of the contents of the perchlorate tube, using the distillate as substrate. The concentration of blood alcohol was calculated from the formula (Luckey, 1966):

$$BAC = \frac{\text{grams alcohol}}{\text{grams CO2}} \times 0.2 \times 100$$

The Borkenstein Breathalyzer[R], Model 900, is a direct-reading device which is designed to collect only the end-expiratory air of the subject's breath (by means of a special piston assembly) and to direct it through a warm solution of acidic potassium dichromate (Borkenstein, 1955). Any reduction of the dichromate bleaches the solution and the optical density is thus decreased. The operator adjusts an indicator needle while balancing the photometric potentiometer (which had been previously calibrated to a null point). The degree of deflection of the potentiometer after reduction and the amount of "reducing substances" in the breath sample are directly proportional; BAC is read directly on the fact of the instrument in "percent blood alcohol" (Preston, 1968).

The Breathalyzer[R] method described above is not capable of unequivocal differentiation between ethanol, methanol, propanol or other higher alcohols, or for other "reducing substances". Many of the latter are known to react more slowly with dichromate, and it has been asserted that the difference in reaction rates is of an order of magnitude which makes them "readily distinguishable" from ethanol (Preston, 1968). In our use of the method, we encountered no significant-difficulties which could be ascribed to this technical defect.

NOTE: Blood alcohol and breath alcohol concentrations less than 20 milligrams/100 milliliters were considered to fall within the range of instruments and random error for individuals who in fact had no alcohol present. Therefore, all concentration under 20 mg% were grouped in the no-alcohol category.

Chapter 3

STUDIES OF FATALITIES

This Chapter contains four studies of fatalities from crashes that occurred in Vermont during 1967, 1968, and 1969. The first study is based on information about blood alcohol concentrations among 209 consecutive fatalities age 15 or older during a period of almost 21 months. Nineteen of these persons survived 6 hours or longer after injury and were, therefore, excluded from the analysis.

The next two studies also covered a period of 21 months but began and ended three months earlier. These two autopsy studies are based on somewhat smaller samples (163) than the first because several individuals were injured in Vermont but died in New Hampshire. Blood alcohol determinations frequently were obtained for these fatalities, but complete autopsies were not performed because these deaths were under New Hampshire jurisdiction. Occasionally in Vermont as well, blood alcohol determinations were obtained but autopsies were not performed because of extreme resistance by family members or a county official. These two studies, therefore, include almost all eligible fatalities from 12 of the 14 Vermont counties, and a majority of the fatalities from the remainder. These 12 counties represent 93% of the resident population of Vermont as of July 1, 1968.

The last study includes 46 consecutive drivers meeting certain criteria, defined later, who died during a period of almost nine months in 1968 and 1969.

3.1 ALCOHOL AMONG FATALITIES

A total of 190 persons age 15 or older who survived less than 6 hours after injury were studied during the period from July 1, 1967 through February 23, 1969. Their crashes occurred in all areas of the state of

Vermont, and during all seasons of the year. Drivers comprised 113 individuals, or 60% of the total, and passengers 62 persons (33%). Consistent with the fact that pedestrian fatalities are predominently a problem of urban areas, there were only 15 pedestrians studied, representing 8% of the total. Among the drivers, 88% were males and 12% females. Sixteen percent were under age 20, 25% age 20-24, 9% age 25-29, 14% age 30-39, 13% age 40-49, 12% age 50-59, and 12% age 60 or older.

3.1.1 Blood alcohol concentrations. The distribution of blood alcohol concentrations is shown in Table 3-1, both including those on whom no test was done, and assuming that the unknowns were distributed similarly to those individuals for whom concentrations were known. Individuals on whom no alcohol tests were performed were those who were taken to New Hampshire for treatment and who consequently died out of state, in some cases without a blood alcohol determination, and those from whom satisfactory samples could not be obtained because of exsanguination, breakage or spoiling of samples, etc. It is clear that alcohol, and high alcohol concentrations are found as often among highway fatalities in this rural state at least as often as they appear among such fatalities in urban areas.

3.1.2 Sex and blood alcohol concentration. Table 3-2 shows the distribution of alcohol concentrations according to sex. As has been reported elsewhere, (Waller, King, Nielson, & Turkel, 1969) fatally injured men are much more likely to have alcohol in their blood than are fatally injured women. Furthermore, they have higher concentrations. Among men who had been drinking, 71% had concentrations of 100 mg% or higher, in contrast to 40% among women who had been drinking.

Table 3-1

Distribution in Percent of Blood Alcohol Concentrations Among Fatally Injured Drivers, Passengers, and Pedestrians Who Survived Less Than Six Hours After Injury

Blood Alcohol Concentration (mg%)	Drivers		Pedestrians		Drivers & Pedestrians Combined		Passengers	
<20	43[a]	46[b]	60	64	45	48	53	62
20-49	4	5	7	7	5	5	10	11
50-99	7	8	0	0	6	7	8	9
100-149	12	13	7	7	12	13	8	9
≥150	27	29	20	21	26	28	6	8
Unknown	7	--	7	--	7	--	5	-
Total %[c] (N)	100 (113)	101 (105)	101 (15)	99 (14)	101 (128)	101 (119)	100 (62)	99 (53)

[a]Percents in each first column were determined with unknown included.
[b]Percents in each second column were determined with unknown excluded.
[c]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

Table 3-2

Distribution in Percent of Blood Alcohol Concentrations Among Males and Females Who Survived Less Than Six Hours After Injury

Blood Alcohol Concentration (mg%)	Males		Females	
<20	40[a]	44[b]	73	86
20-49	7	8	2	3
50-99	7	8	5	6
100-149	13	14	2	3
≥150	24	26	2	3
Unknown	8	--	15	-
Total %[c] (N)	99 (149)	100 (137)	99 (41)	101 (35)

[a]Percents in each first column were determined with unknown included.
[b]Percents in each second column were determined with unknown excluded.
[c]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

3.1.3 Age and blood alcohol concentration. Several reports (Freimuth, Watts, & Fisher, 1958; Waller et al., 1969) have noted that fatally injured persons under age 20 and age 60 or older tend to have alcohol less often and in lower concentrations than do those age 20 to 59. This was found in the present study as well,as can been seen in Table 3-3. Among persons under age 20 who had been drinking, 36% had concentrations of 100 mg% or higher, in comparison with 77% and 74% respectively among drinkers age 20-24 and 25-59. Only four persons age 60 or older had alcohol in their blood, but three of those had concentrations of at least 100 mg%. Table 3-4 shows blood alcohol concentration according to age for drivers only.

3.1.4 Crash responsibility and blood alcohol concentrations. Tables 3-5 and 3-6 show the relationship between blood alcohol concentration and responsibility for crash. Responsibility was determined according to the system first reported by McCarroll and Haddon (1962) in which only one driver-vehicle combination is assumed to be responsible in each crash. The driver-vehicle combination is assumed to be responsible if it is the only vehicle involved (excluding collisions with pedestrians), if it has struck a non-moving vehicle, or if it clearly played the major role in initiating the event. The combination is not responsible if it is a nonmoving vehicle, or if it did not play the major role in initiating the event. A few crashes are listed as being of unknown responsibility instead of recording both vehicles as responsible, a practice common among police and other law enforcement agencies.

In Table 3-5, blood alcohol concentration is treated as the independent variable, whereas in Table 3-6 responsibility is the independent variable. It is apparent (Table 3-5) that individuals with blood alcohol concentrations of 100 mg% or higher are significantly more often responsible for their

Table 3-3

Distribution in Percent of Blood Alcohol Concentrations According to Age Among Persons Who Survived Less Than Six Hours After Injury

Blood Alcohol Concentration (mg%)	Age <20		20-24		25-29		30-39		40-49		50-59		≥60	
<20	52[a]	61[b]	31	33	44	54	48	-	47	-	39	44	71	83
20 - 49	2	3	11	12	12	15	4	-	6	-	6	6	0	0
50 - 99	19	22	2	2	6	8	4	-	12	-	0	0	4	4
100 - 149	2	3	18	19	12	15	9	-	23	-	17	19	4	4
≥150	10	11	31	33	6	8	35	-	12	-	28	31	7	8
Unknown	14	-	7	-	19	-	0	-	0	-	11	-	14	-
Total %[c]	99	100	100	99	99	100	100	-	100	-	101	100	100	99
(N)	(42)	(36)	(45)	(42)	(16)	(13)	(23)	-	(17)	-	(18)	(16)	(28)	(24)

[a]Percents in each first column were determined with unknown included.
[b]Percents in each second column were determined with unknown excluded.
[c]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

Table 3-4

Distribution in Percent of Blood Alcohol Concentrations According to Age Among Drivers Who Survived Less Than Six Hours After Injury

Blood Alcohol Concentration (mg%)	Age													
	<20		20-24		25-29		30-39		40-49		50-59		≥60	
<20	50[a]	56[b]	29	31	50	63	31	-	47	-	38	42	77	-
20 - 49	0	0	4	4	10	12	0	-	7	-	8	8	0	-
50 - 99	17	19	4	4	10	12	6	-	13	-	0	0	8	-
100 - 149	6	6	18	19	0	0	13	-	27	-	15	17	0	-
≥150	17	19	39	42	10	12	50	-	7	-	31	33	15	-
Unknown	11	-	7	-	20	-	0	-	0	-	8	-	0	-
Total %[c] (N)	101 (18)	100 (16)	101 (28)	100 (26)	100 (10)	99 (8)	100 (16)	-	101 (15)	-	100 (13)	100 (12)	100 (13)	-

[a]Percents in each first column were determined with unknown included.
[b]Percents in each second column were determined with unknown excluded.
[c]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

Table 3-5

Distribution in Percent of Responsibility According to Blood Alcohol Concentration Among Drivers Who Survived Less Than Six Hours After Injury

Responsibility	Blood Alcohol Concentration (mg%) <20	20-99	100-149	$\geq$150	Total (N)
Single Vehicle	43	54	93	70	(63)
2 Vehicle- Responsible	37	15	7	27	(29)
2 Vehicle- Not Responsible	20	31	0	3	(14)
Responsibility Unknown	0	0	0	0	(0)
Total %[a] (N)	100 (49)	100 (13)	100 (14)	100 (30)	(106)

[a]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

Table 3-6

Distribution in Percent of Blood Alcohol Concentrations According to Responsibility Among Drivers Who Survived Less Than Six Hours After Injury

	Responsibility			
Blood Alcohol Concentration (mg%)	Single Vehicle	2 Vehicle-Responsible	2 Vehicle-Not Responsible	Responsibility Unknown
<20	33	62	71	0
20 - 99	13	7	21	0
100 - 149	21	3	5	0
≥150	33	28	7	0
Total %[a] (N)	100 (63)	100 (29)	99 (14)	0

[a]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

crashes and more often have single vehicle crashes than do those with no alcohol or with relatively lower concentrations ($p < .05$). Conversely, (Table 3-6) persons in single vehicle crashes or who are the responsible party in two vehicle crashes more often have concentrations of 100 mg% or higher than do those not responsible.

In contrast to the few other studies of this type (McCarroll & Haddon, 1962; Nielson, 1965, 1967), however, the majority of persons with no alcohol are responsible for their crashes. There are two possible explanations for this discrepancy. First, previous studies are based largely or entirely on urban data in which single vehicle crashes are uncommon except among persons with alcohol. In rural areas, the likelihood of single vehicle crashes is greater not only because of lesser traffic density but also because roads are narrower, more winding, and sometimes less adequately paved. Thus, environmental factors may play a greater role in rural crashes than in urban ones. However, according to the McCarrol and Haddon scheme, responsibility is assigned to the driver-vehicle combination in single vehicle crashes, thus ignoring the role of environment in crash initiation. While in general this may be a reasonable assumption in urban areas, we are not at all sure that it is equally appropriate for rural ones.

Secondly, as noted earlier, drivers under age 20 are substantially less likely to have alcohol and to have high alcohol concentrations than are drivers who are 20 or older. However, as shown elsewhere, teen-age drivers, largely for reasons other than alcohol, are more likely to be responsible for their crashes than are middle aged or older drivers. This also may be a factor to some small degree in the distribution of responsibility among persons with little or no alcohol in their system. Unfortunately, the sample of fatalities was too small to permit determination of the influence of age through the generation of age-specific tables of responsibility according to blood alcohol concentration.

3.1.5 Driving record and blood alcohol concentration. Blood alcohol concentrations of driver fatalities also were compared with their traffic citations recorded in the driver license files of the Vermont Department of Motor Vehicles during the five years previous to death, and with their lifetime records of license suspensions. No difference was found in either variable according to blood alcohol concentration. It is relevant, however, that one out of every fifteen responsible drivers had his license currently suspended at the the time of the crash in a limited study of both surviving and fatally injured drivers among the first 99 fatal crashes, resulting in 113 fatalities.

3.1.6 Alcohol use and blood alcohol concentration. It was possible through interviews of surviving relatives and friends to obtain drinking histories of 33 fatally injured drivers for whom blood alcohol concentrations were also available. We were concerned not only about the possibility of missing covert drinking unknown to friends or relatives, but also about a possible "halo effect" in such interviews, that is, a tendency to describe the deceased in more glowing terms than would be the case were he still alive. This problem has been noted in reporting by relatives of the occupation of the deceased, in which relatives not infrequently report that the individual had a more prestigious occupation than he himself had reported.

Light, medium, and heavy drinking respectively were defined as usual consumption per sitting of one - two, three - four, and five or more drinks per sitting. The difficulties of reconstructing drinking histories of deceased individuals are exemplified by the observation that three of seven individuals reported by others to be nondrinkers in fact died with measurable amounts of alcohol in their blood. However, it is also relevant that all three were below legal age for alcohol consumption in Vermont and, therefore, probably were not known by surviving relatives to be drinkers. Nevertheless, as seen in Table 3-7, persons with blood alcohol concentrations of 100 mg% or higher were significantly more likely to be medium or heavy drinkers than were those with concentrations below this range. None of the 12 persons with no alcohol, and 1 of the 18 persons with concentrations under 100 mg% were reported to be medium or heavy drinkers, in contrast to 11 persons reported to be medium or heavy drinkers among the 15 individuals with alcohol concentrations of 100 mg% or higher. Among the 9 individuals with concentrations of 150 mg% or higher, 5 were reported to be medium drinkers and 4 heavy drinkers.

Table 3-7

Distribution in Percent of Reported Usual Drinking Quantity According To Blood Alcohol Concentration at Death Among Drivers Who Survived Less Than Six Hours After Injury[a]

Reported Drinking Quantity	Blood Alcohol Concentration <100 mg%		>100 mg%	
Non Drinker	32[b]	40[c]	5	7
Light (1-2 drinks/sitting)	37	48	29	43
Medium (3-4 drinks/sitting)	0	0	19	29
Heavy (≥5 drinks/sitting)	11	13	14	21
Unknown	21	--	33	--
Total %[d] (N)	101 (19)	101 (15)	100 (21)	100 (14)

[a]Two drivers included who survived six hours or longer but for whom blood alcohol determinations were obtained in the emergency room shortly after injury.
[b]Percents in each first column were determined with unknown included.
[c]Percents in each second column were determined with unknown excluded.
[d]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

3.2 RELATION BETWEEN BLOOD ALCOHOL CONCENTRATION AND HEPATIC FAT

In 1961, Haddon et al. hypothesized that fatty degeneration and cirrhosis of the liver might be found with some frequency among highway fatalities who died with alcohol in their blood as supporting evidence that many of these individuals in fact are not social drinkers. It was not until 1966, however, that Waller and Turkel reported on a study to examine this question. This study was repeated subsequently by the same investigators using a much larger sample (Waller et al., 1969). In both cases fatty infiltration was found to be closely related to the presence of high blood alcohol concentrations.

Because of questions that have arisen concerning attempts to replicate the original study, the criteria used by Waller and Turkel are explicitly noted here. First, the analysis was limited to persons who died within six hours after injury because absence of alcohol in persons surviving beyond this time may mean only that they have metabolized alcohol that had been present, and not that they did not have alcohol present in the first place. In addition, fatty changes among persons with delayed deaths may be a result of post injury stress rather than pre-injury state.

Second, the analysis was limited to fatalities age 25 or older. The reason for this limitation was the presumption that fatty changes visible microscopically will be related predominatly to the effects of frequent, heavy ingestion of alcohol over many years rather than to the acute effects of alcohol. Therefore, persons under age 25, even with large amounts of alcohol in their blood and with serious drinking problems, would be expected to have fatty changes rather seldom. This was borne out in both studies.[1]

Third, all degrees of fatty infiltration and cirrhosis were identified, in contrast to some of the subsequent studies which have included only moderate to severe infiltration and frank cirrhosis. The rationale behind inclusion of all degrees of infiltration was the assumption that frequent, heavy drinkers in their late twenties or early thirties (driver fatalities are predominately young) might be anticipated to have some visible hepatic changes significantly more often than the occasional or light drinkers, but that they might not as yet have severe changes very often. The basic question was not only whether those with alcohol in their blood, more often had fatty changes, but also what proportion of those with alcohol could be characterized as frequent, heavy drinkers. Therefore, the inclusion of lesser degrees of infiltration was felt by the original investigators to be warranted.

Finally, they hypothesized and demonstrated that persons with relatively low blood alcohol concentrations (i.e., less than 100 mg%) would have fatty changes about as often as those with no alcohol present, suggesting that most of them were social drinkers. In contrast, persons with higher concentrations could be expected more often to have visible fatty changes.

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[1] A recent paper by Rubin & Lieber (1968) suggest that heavy alcoholic consumption of limited duration can produce reversible fatty changes. However, on February 10, 1970 Lieber, on personal communication to Waller indicated that these changes are submicroscopic in size and can be determined only by sophisticated chemical analysis. He stated that his own study and the Waller-Turkel assumption are compatible.

In the present study an attempt was made both to replicate and to improve on the original study. Whereas in the original study gross necropsy data only were available for some livers, in the present study all livers were examined microscopically. Furthermore, an attempt was made to grade the degrees of fatty infiltration according to predetermined criteria comparable to the system reported by Rubin & Lieber (1968). These criteria are as follows:

0 - normal liver, no fat

+- - normal with rare fat droplets

1+ - large and small fat droplets in scattered cells

2+ - large and small fat droplets in many cells

3+ - extensive fatty metamorphasis with coalescent cells

No attempt has been made in the present study to examine separately persons with low blood alcohol concentrations. It is not felt, however, that this would affect the conclusions to any substantial degree. In the first place, the overwhelming majority of fatalities with alcohol have concentrations of 100 mg% or higher, thereby making the sample of persons with low concentrations so small that it would neither affect the total picture nor be profitable to examine alone. Secondly, in this study, unlike the Waller and Turkel study, postive blood alcohol concentrations under 20 mg% have been assumed to fall within the range of laboratory error for bloods that in fact have no alcohol present. They are lumped, therefore, in the no alcohol category. Such low concentrations represent the range commonly reached by ingestion of one or even two drinks in the average male.

The sample studied comprised 163 highway fatalities necropsied between April 1, 1967 and December 31, 1968. Of these, 31 were excluded because they survived six hours or longer or had incomplete data available. Another 12 cases were excluded because they were under age 15. Among the remaining 120 fatalities, 53 were age 15 - 24 and 67 were age 25 or older. Blood alcohol concentrations and hepatic fat were compared for these two age groups separately.

Table 3-8 shows these comparisons for drivers, passengers, and pedestrians combined. It is clear that persons under age 25, even with alcohol in their blood, seldom have fatty changes of the liver that are microscopically visible. Among persons age 25 or older, however, the presence of alcohol is associated both with greater frequency and greater severity of hepatic fat.

Information about blood alcohol concentration, hepatic fat, and drinking history was available for 13 individuals age 25 or older. Although the numbers are quite small, it is relevant that all four individuals with histories of medium to heavy drinking patterns were found to have both 2+ or 3+ fatty livers and alcohol in their blood when they died. Of the nine persons age 25 or older reported to be light drinkers or nondrinkers, five had no alcohol and no fat, one had 1+ fat but no alcohol, one had alcohol but no fat, and two had alcohol and fat (2+ and 3+). Two of the three persons under age 25 reported to be medium or heavy drinkers had alcohol at death and both had fatty livers (1+ and 2+). Thus five of seven medium to heavy drinkers, no matter what their age, had fatty livers, whereas none of eight non-drinkers and four of 12 light drinkers had hepatic fat.

Table 3-8

Distribution in Percent of Hepatic Fat According to Age and Blood Alcohol Concentration Among Persons Who Survived Less Than Six Hours After Injury

Degree of Hepatic Fat	Age			
	15-24		$\geq$25	
	Blood Alcohol Concentration		Blood Alcohol Concentration	
	<20 mg%	$\geq$20 mg%	<20 mg%	$\geq$20 mg%
0/$\pm$	95	82	59	42
1+	5	9	12	4
2+	0	9	20	35
3+	0	0	10	19
Total %[a] (N)	100 (19)	100 (34)	101 (41)	100 (26)

[a]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

Also of interest is the fact that, even among persons with alcohol, no instances of frank cirrhosis were found. The Waller and Turkel paper does not identify the relative frequencies of fatty infiltration alone or of cirrhosis. However, frank cirrhosis was not at all uncommon among persons in that study who had high blood alcohol concentrations. The reason for this difference in two studies that had otherwise similar results is not clear..

Table 3-9 shows the distribution of fatty degeneration of the liver among all persons necropsied at the Mary Fletcher Hospital, Burlington, Vermont during 1965. It was not possible to make a meaningful comparison of persons age 15 - 24 and those age 25 or older because of the paucity of deaths to young persons in the hospital population. However, it is apparent that, in so far as fatalities within the hospital are representative of all fatalities, the distribution of hepatic fat among highway fatalities who had no alcohol in their blood is more similar to that of persons dying within the general population, most of whom died of nontraumatic causes, and most of whom can be expected to be social drinkers, than it is to the fatalities with alcohol.

3.3 EVALUATION OF EMERGENCY HEALTH SERVICES

As noted earlier, the adequacy of emergency care has been recognized as an important factor in determining whether or not persons injured in highway crashes survive, and whether or not the survivors incur prolonged disability. Until recently, however, those concerned with highway safety programs had paid relatively little attention to this aspect of the crash sequence despite the fact that quality of ambulance service in urban areas was reported to be spotty at best (Hampton, 1960), and that

Table 3-9

Distribution in Percent of Hepatic Fat Among All
Necropsies Performed at the Mary Fletcher Hospital, 1965

	Degree of Hepatic Fat				Total	
	0/±	1+	2+	3+	%[a]	(N)
All Ages	78	7	3	11	99	(296)
15-65 yrs.	76	9	3	13	101	(117)

[a]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

the higher injury-fatality ratio in rural crashes was shown to be attributable at least in part to inadequacies of emergency care in areas with low population density (Waller et al., 1964). The seeds for improvement have now been planted in one of the highway safety standards of the Department of Transportation requiring planning, implementation, and evaluation of an emergency care program for persons injured on the highway.

The predominantly rural location of fatalities studied by Project ABETS offered an excellent opportunity to determine the extent to which more adequate emergency care could have prevented some of these deaths from occurring. Sufficient information about emergency care provided was available for 163 fatalities, age 15 and older. Table 3-10 shows the frequency with which major anatomical areas were injured among these 163 individuals, as well as the relative frequency with which injuries to particular areas were the prime cause of death. In instances where multiple severe injuries occurred to a single individual, injuries to only one area were designated as lethal. In these cases, lethal head injury, if present, was listed as the prime cause of death since it is impossible for a decerebrate human to remain alive, and other injuries, therefore, are largely irrelevant. In similar manner, where simultaneous severe injury occurred to chest and abdomen, death was attributed primarily to the chest injuries because these probably would have resulted in death first if the individual had either chest or abdominal injuries alone.

The distances in miles between crash sites and nearest ambulance and hospital are shown in Table 3-11. Elapsed times between crash and discovery, crash and initial care by someone with at least first aid

Table 3-10

Frequency in Percent of Nonlethal and "Lethal" Injuries to Various Anatomic Sites

Anatomic Site	Injury			Total	
	None	Not Lethal	Lethal	%	(N)
Head	37	21	42	100	(163)
Chest	23	45	32	100	(163)
Abdomen	39	49	12	100	(163)
Spine	82	12	6	100	(163)
Extremities	57	39	4	100	(163)
Other	a	a	4		
Total %[a]			100		

[a]Percent not determined

Table 3-11

Distribution in Percent of Distances Between Crash Sites and Nearest Ambulance and Hospital

Miles	Nearest Ambulance	Nearest Hospital
0-4	47	27
5-9	34	28
10-14	13	23
15-19	1	12
20 or more	1	8
Unknown	4	3
Total %[a] (N)	100 (163)	101 (163)

[a]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

training,[2] crash and arrival at the hospital, and crash and death appear in Table 3-12. Although over 90% of crashes were discovered within a half hour of occurrence, almost half of the individuals who survived long enough to receive some sort of aid had to wait at least half an hour for such care, and only about a third of these persons arrived at the hospital within the first 30 minutes. About a quarter of these individuals who survived beyond the first few minutes did not reach the hospital until over an hour had elapsed. However, as will be noted later, delay in discovery and treatment, while important, were not the major reasons why people died of survivable injuries.

Table 3-13 shows where the individuals died and whether their injuries were survivable or not. Fifty-nine percent of fatalities occurred at the crash site, 11% enroute to the hospital, and 30% after hospitalization. It is important in reading this table and Table 3-14 to understand that these assessments of survivability were made by the pathologists participating in the study on the basis of observations made at time of necropsy. In some instances, it is abundantly clear either that survival was not possible within the context of medical knowledge or skills in existence anywhere at this time, or that with current knowledge or skills the individuals should not have died. However, in many cases observations at necropsy are not sufficient to determine the likelihood of survival. These cases are listed as being of undetermined or possible survivability, although Dr. John Davis, the Chief of Surgery of the University of Vermont Medical School, on reviewing them was of the opinion that a number of these deaths probably were preventable had better care been provided.

[2] For purposes of discussion it is assumed that each ambulance has at least one person trained in first aid, an assumption that subsequently has been shown to be incorrect in a few instances.

Table 3-12

Distribution in Percent of Time Elapsed Between Crash and Discovery, Death, First Treatment, and Hospitalization

	Time								Total	
	Immediate	<1/2 hr.	1/2-1 hr.	1-2 hrs.	2-3 hrs.	3-5 hrs.	6 hrs. or longer	Unknown	%[a]	(N)
Crash to Discovery	80	12	1	0		2		6	101	(163)
Crash to Death	34	26	6	6	4	2	18	2	98	(163)

	Time									Total	
	Not Applicable, Death Intervened	<5 min.	5-14 min.	15-29 min.	30-59 min.	60-89 min.	90-119 min.	120 min. or longer	Unknown	%[a]	(N)
Crash to first treatment by trained first aider	63	1	9	12	6	2	0	1	5	99	(163)
Crash to arrival at hospital	63	0	3	9	15	6	1	2	2	101	(163)

[a]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

Table 3-13

Distribution in Percent of Survivability of Injuries According to Location of Death

Survivability of Injuries	Location of Death			Total	
	Crash Site	Enroute to Hospital	In Hospital	%	(N)
No	92	67	51	77	(126)
Definite	5	17	16	10	(16)
Possible	3	17	33	13	(21)
Total %[a] (N)	100 (96)	101 (18)	100 (49)	100	(163)

[a]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

Table 3-14

Distribution in Percent of Crucial Factors Determining Death in Deaths from Definitely or Possibly Survivable Injuries

Crucial Factors	Survivability		Total	
	Definite	Possible	%	(N)
Delay in discovery	31	9	18	(7)
Delay from discovery to arrival of ambulance	0	0	0	(0)
Delay in arrival of ambulance at hospital	19	5	11	(4)
Inclement weather	0	0	0	(0)
Inappropriate or absent treatment at crash site or enroute to hospital	6	9	8	(3)
Inappropriate or absent treatment in hospital	31	41	37	(14)
Therapeutic misadventure	6	9	8	(3)
Combination of factors	6	27	18	(7)
Total %[a]	99	100	100	
(N)	(16)	(22)		(38)

[a]Total percents may not equal 100 because row entries were rounded to the nearest whole percent.

The factors that appeared to be most crucial in determining death among the definitely and possibly survivable cases are shown in Table 3-14. In this table environmental conditions existing at the scene and enroute to the hospital which might have hampered even a highly competent rescue team were taken into consideration. Despite this conservative approach, 16 deaths, or 10% of the 163 fatalities, were felt to have been definitely unwarranted if medical care had been functioning at a level reasonable to expect in the United States today, and another 13% were possibly unwarranted.

It is furthermore quite disheartening to realize that of 67 individuals who died after leaving the scene of the crash, almost half were felt to have died of injuries that were either definitely or possibly survivable. This figure is even more startling when it is realized that the estimation of survivability was based on anatomic data only, and that the surgeon who reviewed these cases felt that the evaluation was too conservative.

It is also relevant that these deaths resulted from inadequate care at several points in the emergency care system, not only in the prehospital phase alone, or in the hospital phase alone. The effects of good care by the police and ambulance crew can be negated by a poor emergency room, just as a good emergency room is of little use if the patient is dead or moribund on arrival. Illustrative case abstracts of five deaths that were definitely felt to be preventable appear below.

#1 Male passenger, 53 years, compound fracture of right tibia with exsanguination. No attempt was made to achieve hemostasis at the scene or in transit. DOA at hospital, 35 minutes after crash (a distance of 25 miles). No other major injuries.

#2 Male pedestrian, 65 years, compound fracture of right tibia with exsanguination. No attempt was made to achieve hemostasis, although a fracture of the right arm had been splinted at the scene. DOA at hospital, 50 minutes after crash, 30 minutes of which was in transit (25 miles).

#3 Male passenger, 24 years, cerebral concussion with aspiration of vomitus, resulting in transient systemic hypoxia, including cerebral cortical necrosis, edema and herniation at the time of death, 7 days later. No attempt was made to clear his airway at scene or in transit. No significant organic craniocerebral trauma or other injury.

#4 Male operator, 62 years, found at the scene of a minor crash in a confused state, with but a few minor bruises. Died 18 hours after hospital admission. Cause of death was subacute pneumococcal meningitis of 2-3 days duration. No record of medical workup for CNS disease, e.g., lumbar puncture, which would have led to diagnosis and appropriate antibiotic therapy.

#5 Male motorcycle operator, 18 years, died 2 days after crash. Necropsy revealed linear parietal skull fracture with acute epidural hematoma. No record of x-ray examination of skull and no neurosurgeon in attendance.

3.4 TOXICOLOGY: DRUG SCREENING

As early as 1957, Leake pointed out the potential hazards of the abuse of amphetamines by truck drivers, but cited no survey data. Perry and Morganstern (1966) considered the problems of the driving patient given prescription drugs by his physician and, at that point in time, found little to be alarmed about except the possibility of inadvertent overdosage of barbiturate hypnotics with or without the combined effect of alcohol.

In a questionnaire survey based on 10,000 traffic crash injuries in Mainz and Frankfort, Germany, Wagner (Keilholz & Poldinger, 1967) found an incidence of approximately 4% in which sedatives or hypnotics had been used by injured motorists, with and without the concurrent use of alcohol. Keilholz, Goldberg, Obersteg, Poldinger, Ramseyer, and Schmid (1969) proceeded with further tests in a controlled driving study, demonstrating the "multiplier effect" (synergism) of hypnotics or tranquillizers plus low blood concentrations of alcohol (BAC less than 80 milligrams per 100 milliliters). Similarly, Lindauer, Milner, and Patman (1969) described the potentiation of alcohol by concurrent therapeutic doses of amitriptyline, an antidepressant drug commonly prescribed for ambulatory out-patients; their study evaluated driver behavior in a simulated driving task and found significant errors introduced by 0.8 grams of amitriptyline in combination with BAC's averaging 80 milligrams per 100 milliliters. These studies served to focus attention on the question of drug use and/or abuse, the problem of their synergism with alcohol, and the influence of such behavior on traffic statistics.

The first major effort to survey the "real world" by objective, toxicologic analysis was that of Finkle, Biasotti, and Bradford (1968), who, in a survey of 180 drivers arrested for driving while intoxicated in northern California, reported an incidence of 21% in which chromatographic evidence of drugs was also present in specimens of the driver's blood or urine. The drugs discovered in that survey included barbiturates and tranquillizers among the regulated drugs (comprising 17% of the total) and antihistamines, salicylates, and the common xanthine alkaloids (e.g., caffeine) in the nonregulated category (4% of the total). They noted further that 51% of the drugs discovered were found in association with BAC's of less than 50 milligrams per 100 milliliters.

The data reported by Finkle et al. (1968) were based upon a selected population of living drivers who were arrested because they had signs or symptons of acute intoxication. In this portion of the present study we have undertaken to assess the magnitude of the problem in this state using similar qualitative laboratory screening methods applied to the deceased segment of the driving population. This study also differs from the Finkle study in that it was not limited to persons who had signs or symptoms of impairment. Rather, it included all fatalities meeting the criteria described below.

A total of 46 persons died in highway crashes in Vermont between July 1, 1968 and March 15, 1969 in which the following criteria were met: (1) a complete autopsy was performed within 24 hours of death; (2) the deceased person was 15 years of age or older; and (3) death occurred before the administration of parenteral or oral medication. The last criteron was necessary to avoid the confusion introduced by intercurrent medication, professionally administered, during the terminal hours of life.

A total of five persons were found to have died with detectable levels of drugs in their blood, urine, or bile. This represents slightly less than 11% of the 46 deceased persons studied in the period specified above. A summary of findings in these five persons appears in Table 3-15.

In only one case (No. 207) does more than one drug appear, and only one of these, phenobarbital, represents a documented hazard in highway safety. In this instance, the deceased was under treatment as an outpatient for symptomatic essential hypertension, and there is no reason to suspect drug abuse. Moreover, alcohol was not present. The remainder of the drugs detected are not classified as "regulated drugs" and represent no hazard to highway safety.

Within the limits of the sampling method employed, it would appear that drug use or abuse does not constitute a major problem in the pattern of Vermont fatal highway crashes.

It may be noted that the results of this survey are nearly identical to those found under the direction of a multi-agency committee and reported by Sullivan (1967), the population sample of which included drivers fatally injured in single vehicle crashes in California.

Table 3-15

Evidence of Drugs by Thin-layer Chromatography of Biologic Fluids
5 Cases at Autopsy, July 1968 - March 1969

Code No.	Drug Detected	Source of Specimen[a]			BAC (mg/100 ml)	Comment
		Blood	Urine	Bile		
142	Salicylate	X	X	0	11	Age 16, driver.
165	Caffeine	X	-	-	25	Age 31, pedestrian.
175	Salicylate	X	X	0	0	Age 43, driver.
179	Salicylate	X	-	X	0	Age 48, driver.
207	Salicylate Phenobarbital	X X	X X	X X	0	Male, 51 years, with essential hypertension; treated with barbiturates by personal physician.

[a] "X" indicates presence of drug; "0" indicates no evidence of drug; "-" indicates no specimen.

Chapter 4

ROADBLOCK COMPARISON GROUPS

A total of 1184 persons were interviewed during 1967 and 1968 through roadblocks set up at locations, times of day, and days of the week of crashes that had resulted either in death or hospitalization of at least one person. The roadblock samples for the fatal crashes and those resulting in hospitalization were compared and were found to represent similar populations with respect to 22 different variables (see Table 4-0). Therefore, the two samples have been combined, analyzed, and reported as a single sample. Furthermore, since unknowns and non-responses to specific questions have been excluded from most tables for ease of presentation, the reported sample, therefore, varies from table to table and is somewhat less than 1184.

4.0.1 <u>Biographical information</u>. Males comprised 80% of the roadblock sample. Eleven percent of the roadblock subjects were under age 20, 16% age 20-24, 13% age 25-29, 18% age 30-39, 20% age 40-49, 12% age 50-59, and 9% age 60 or older. Among the roadblock subjects 27% were single, 67% married, 3% divorced, 6% separated, and 2% widowed. For purposes of analysis, the latter three categories have been grouped together. Twenty-seven percent of roadblock subjects were categorized as upper occupational level, 32% middle occupational level, 27% lower occupational level, and 14% were coded as "other".

4.1 <u>PATTERNS OF ALCOHOL USE</u>

4.1.1 <u>Blood alcohol concentration at roadblock</u>. Blood alcohol concentrations were available for 1125 (95%) of 1184 roadblock subjects. The remaining 5% of whom no concentrations are available include 1.3% refusals, and 3.6% samples not taken for other reasons or samples inadequate for analysis.

Table 4-0

Twenty-two Variables on which Roadblock Samples for Fatal Injury Crashes were Compared with Roadblock Samples for Serious Injury Crashes

Variable	d.f.	Chi square	P
Biographical			
Sex	2	1.60	.30
Age	2	1.48	.50
Marital status	2	8.14	.02
Number of times married	2	13.76	.01
Occupational level	8	6.92	.70
Number of employers:last 5 yr	5	8.44	.20
Number of moves: last 5 yrs.	4	3.87	.50
Education	5	7.54	.20
Religion	3	0.26	.95
Military status	2	3.66	.20
Alcohol			
Breath alcohol concentration	2	1.17	.50
Drinking frequency	3	5.20	.20
Driving history			
Crashes: lifetime	1	0.02	.90
Crashes: last 5 yrs.	3	1.50	.70
Citations: lifetime	1	0.54	.50
Citations: last 5 yrs.	2	5.29	.10
License suspensions	2	1.38	.70
Annual mileage	4	2.59	.70
Vehicle			
Model year of car	7	7.65	.50
Type of car	5	1.39	.95
Size of car	6	7.63	.30
Condition of car	4	1.44	.90

Fourteen percent of roadblock subjects had blood alcohol concentrations of 20 mg% or higher (Table 4-1). Seven percent had concentrations of 50 mg% or higher, the concentration above which many investigators feel the average driver begins to be substantially impaired for the task of driving. Concentrations of 100 mg% or higher were found in 2% of roadblock subjects. According to experimental data, virtually all persons, no matter what their previous drinking habits, can be expected to show significant decrement of driving ability at or above this concentration (Goldberg, 1950). Concentrations of 150 mg% or higher were found in only 1% of roadblock subjects.

Fifteen percent of males and 9% of females had blood alcohol concentrations of 20 mg% or higher, a difference that was significant at the .02 level. Eight percent of males and 4% of females had concentrations of 50 mg% or higher, whereas 2% of males and almost 2% of females had concentrations of 100 mg% or higher. The relatively similar proportions of males and females with high blood alcohol concentrations might suggest similar distribution of heavy drinking among both sexes or, possibly more likely, that women who drive, especially at times and places of most frequent alcohol use, have different characteristics with respect to drinking than do women not on the roads under these circumstances.

Nine percent of persons under age 20, 15% of persons age 20-59, and 6% of those age 60 and older had alcohol in their blood when stopped (Table 4-2). Concentrations of 50 mg% or higher were found among 4%, 8%, and 3% respectively of roadblock subjects age under 20, 20-59, and 60 and older.

4.1.2 <u>Recent alcohol consumption.</u> Nineteen percent of roadblock subjects stated they had consumed alcohol during the previous two hours and 11% had

Table 4-1

Distribution in Percent of Blood Alcohol Concentration According to Sex Among Drivers Stopped at Times and Places Similar to Serious Crashes

Blood Alcohol Concentration (mg%)	Males		Females		Total	
< 20	79.8[a]	83.9[b]	86.3	90.9	81.1	85.2
20-49	7.5	7.9	4.7	5.0	6.9	7.3
50-99	5.6	5.9	2.1	2.3	4.9	5.2
100-149	0.9	1.0	1.7	1.8	1.1	1.2
≥150	1.2	1.2	0	0	0.9	1.0
Unknown	4.9	-	4.7	-	4.9	-
Total %[c] (N)	99.9 (951)	99.9 (903)	99.5 (233)	100.0 (222)	99.8 (1184)	99.9 (1125)

[a] Percents in each first column were determined with unknown included.
[b] Percents in each second column were determined with unknown excluded.
[c] Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

Table 4-2

Distribution in Percent of Blood Alcohol Concentrations According to Age Among Drivers Stopped at Times and Places Similar to Serious Crashes

Blood Alcohol Concentration (mg%)	Age													
	≤20		20-24		25-29		30-39		40-49		50-59		≥60	
<20	87.1[a]	90.6[b]	80.0	84.4	83.0	89.2	80.6	82.9	77.4	81.6	83.0	87.1	87.3	94.1
20 - 49	5.3	5.5	7.9	8.3	5.7	6.1	8.1	8.3	8.1	8.5	5.4	5.7	2.7	2.9
50 - 99	2.3	2.4	4.7	5.0	2.5	2.7	5.2	5.4	7.2	7.6	4.8	5.0	2.7	2.9
100 - 149	1.5	1.6	0.5	0.6	0	0	1.9	1.9	1.3	1.3	2.0	2.1	0	0
≥150	0	---	1.6	1.7	1.9	2.0	1.4	1.5	0.8	0.9	0	0	0	0
Unknown	3.8	---	5.3	---	6.9	---	2.8	---	5.1	---	4.8	---	7.3	---
Total %[c]	100.0	100.1	100.0	100.0	100.0	100.0	100.0	100.0	99.9	99.9	100.0	99.9	100.1	99.9
(N)	(132)	(127)	(190)	(180)	(159)	(148)	(211)	(205)	(235)	(223)	(147)	(140)	(110)	(102)

[a] Percents in each first column were determined with unknown included.
[b] Percents in each second column were determined with unknown excluded.
[c] Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

done so within the previous hour. Among the individuals who had been drinking within the previous two hours, about half had some alcohol in their blood when stopped, and 29% had concentrations of 50 mg% or higher. Among individuals who admitted to drinking within the previous hour, 32% had blood alcohol concentrations of 50 mg% or higher (Table 4-3). Among individuals who denied having consumed alcohol during the previous 24 hours 2 1/2%, in fact, had alcohol in their blood and 1% had concentrations of 50 mg% or higher.

Thirty percent of roadblock subjects who responded to the question said that they had consumed beer within the previous 24 hours and 10% admitted to 3 or more bottles on that occasion. Blood alcohol concentrations of 20 mg% or higher were found among 30% of individuals who admitted to 1-2 bottles of beer, 58% of those who admitted to 3-4 bottles of beer, and 58% of those who said they had 5 or more bottles of beer during the previous 24 hours (Table 4-4).

Sixteen percent of individuals who responded to the question admitted to drinking hard liquor during the previous 24 hours and 5% had 3 or more shots during this time. Blood alcohol concentrations of 20 mg% or higher were found in 27% of those who had taken 1-2 shots, 50% of those with 3-5 shots, and 54% of persons with 5 or more shots in the previous 24 hours (Table 4-4).

4.1.3 Frequency and quantity of alcohol consumption. The stated frequency and usual quantity per sitting of alcohol consumption is shown for each sex in Table 4-5. This classification system will be referred to subsequently as the frequency-quantity index (FQI). It was designed to reflect the likelihood that a person would attain an impairing amount of alcohol in his blood. In developing this index separate drinking histories were taken for

Table 4-3

Distribution in Percent of Blood Alcohol Concentrations According to Reported Time of Most Recent Drinking Among Drivers Stopped at times and Places Similar to Serious Crashes

Blood Alcohol Concentration (mg%)	Most Recent Drinking Previous to Roadblock							
	>24 hrs.		3-24 hrs.		1-2 hrs.		<1 hr.	
<20	93.2[a]	97.5[b]	73.5	78.0	54.0	58.6	39.3	40.0
20 - 49	1.5	1.6	11.4	12.2	14.0	14.9	27.4	27.8
50 - 99	.7	.8	6.4	6.7	14.0	14.9	21.3	22.2
100 - 149	.1	.1	1.4	1.5	6.0	6.9	5.1	5.0
≥150	.0	.0	1.4	1.5	4.0	4.6	5.1	5.0
Unknown	4.4	--	5.9	--	8.4	--	1.7	--
Total %[c]	99.9	100.0	100.0	99.9	100.4	99.9	99.9	100.0
(N)	(720)	(688)	(174)	(164)	(95)	(87)	(117)	(115)

[a]Percents in each first column were determined with unknown included.
[b]Percents in each second column were determined with unknown excluded.
[c]Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

Table 4-4

Distribution in Percent of Blood Alcohol Concentrations According to Reported Quantity of Beer and Liquor Consumed in Previous 24 Hours Among Drivers Stopped at Times and Places Similar to Serious Crashes

Blood Alcohol Concentration (mg%)	Reported Quantity Consumed (Number of Drinks)															
	Beer								Liquor							
	0		1-2		3-4		≥5		0		1-2		3-5		>5	
<20	83.2[a]	89.7[b]	75.4	78.6	53.3	55.3	32.8	35.3	74.0	80.1	68.2	73.2	39.3	42.9	62.5	62.5
20 - 49	5.2	5.6	12.3	12.7	22.2	23.4	21.3	23.5	10.4	11.2	11.4	12.2	21.4	23.8	0.0	0.0
50 - 99	3.4	3.6	6.1	6.4	12.2	12.8	27.9	29.4	5.3	5.7	11.4	12.2	17.9	19.0	12.5	12.5
100 - 149	1.0	1.2	.9	1.1	5.6	6.4	1.6	2.9	1.4	1.5	2.3	2.4	7.1	9.5	12.5	12.5
≥150	0.0	0.0	.9	1.1	2.2	2.1	9.8	8.8	1.4	1.5	0.0	0.0	3.6	4.8	12.5	12.5
Unknown	7.2	--	4.4	--	4.4	--	6.6	--	7.6	--	6.8	--	10.7	--	0.0	--
Total %[c] (N)	100.0 (501)	100.1 (465)	100.0 (180)	99.9 (173)	99.9 (48)	100.0 (46)	100.0 (37)	99.9 (35)	100.1 (511)	100.0 (472)	100.1 (88)	100.0 (82)	100.0 (23)	100.0 (21)	100.0 (13)	100.0 (13)

[a] Percents in each first column were determined with unknown included.
[b] Percents in each second column were determined with unknown excluded.
[c] Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

Table 4-5

Distribution in Percent of Reported Usual Frequency and Quantity of Alcohol Consumption According to Sex Among Drivers Stopped at Times and Places Similar to Serious Crashes

Frequency	Qualtity	Males	Females	Total
Never	None	13.8	24.0	15.7
Monthly	Light	14.8	27.1	17.2
Weekly	Light	15.5	14.0	15.2
Daily	Light	22.9	16.7	21.7
Monthly	Medium	5.7	6.8	5.9
Weekly	Medium	6.6	5.0	6.3
Daily	Medium	8.7	4.5	7.9
Monthly	Heavy	2.6	0.0	2.1
Weekly	Heavy	4.7	1.4	4.0
Daily	Heavy	4.8	0.5	3.9
Total %[a] (N)		100.1 (923)	100.0 (221)	99.9 (1144)

[a]Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

beer, wine, and liquor. The FQI reflects the beverage among these three that is consumed most frequently and in largest quantity. Light drinking is defined as 1-2 drinks per sitting, medium drinking as 3-4 drinks per sitting, and heavy drinking as 5 or more drinks per sitting.

Several observations are apparent from Table 4-5; first that the overwhelming majority of adult drivers drink, second that most drinkers consume small quantities per sitting and that only 1 in 10 drivers can be categorized as a heavy drinker, and third that men are more likely to be drinkers and to be heavy drinkers than are women.

The relationship between FQI and age is shown in Table 4-6. First, and most important, is that only 19% of drivers under age 20 report that they do not drink despite the fact that in Vermont consumption of alcoholic beverages is illegal for persons under age 21. Also important, fully 22% of persons under age 20 and 29% of those age 20-24 can be classified as heavy drinkers, in contrast to 9% and 1% respectively among persons age 25-59 and 60 or older.

Table 4-7 and 4-8 show the relationship between FQI and breath alcohol concentrations among drivers at roadblocks. It is apparent that high blood alcohol concentrations are substantially over-represented among heavy drinkers, especially those who drink heavily at least several times a week. For example, 24% of drivers in the highest FQI category had breath alcohol concentrations of 50 mg% or higher (Table 4-7) and these persons, who comprised 4% of all roadblock drivers, comprised 27% of those with alcohol concentrations of 150 mg% or higher (Table 4-8).

4.1.4 Drinking habit according to beverage. Fifty-eight percent of individuals stated that they are beer drinkers. Sixty-nine percent of these drink 1-2 bottles of beer per sitting, 17% 3-4 bottles per sitting,

Table 4-6

Distribution in Percent of Reported Usual Frequency and Quantity of Alcohol Consumption According to Age Among Drivers Stopped at Times and Places Similar to Serious Crashes

		Age						
Frequency	Quantity	<20	20-24	25-29	30-39	40-49	50-59	≥60
Never	None	20.4	10.9	8.4	16.2	16.4	14.8	27.9
Monthly	Light	25.7	9.3	16.1	13.3	19.1	19.7	22.1
Weekly	Light	12.1	15.8	16.1	16.7	14.7	15.5	14.4
Daily	Light	5.3	16.4	21.3	24.6	25.8	30.3	26.0
Monthly	Medium	6.8	7.1	7.1	7.9	4.4	4.2	2.9
Weekly	Medium	6.1	10.9	7.1	4.4	7.5	2.1	3.8
Daily	Medium	6.1	10.9	7.7	8.4	7.5	9.9	1.9
Monthly	Heavy	3.9	2.7	4.5	1.5	0.4	1.4	1.0
Weekly	Heavy	9.1	9.8	4.5	2.9	1.3	0	0
Daily	Heavy	4.5	6.0	7.1	3.9	2.7	2.1	0
Total %[a] (N)		100.0 (132)	99.8 (183)	99.9 (155)	99.8 (203)	99.8 (225)	100.0 (142)	100.0 (104)

[a]Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

Table 4-7

Distribution in Percent of Breath Alcohol Concentrations
According to Reported Usual Frequency and Quantity of Alcohol
Consumption Among Drivers Stopped at Times and Places Similar to Serious Crashes

Blood Alcohol Concentration (mg%)	Frequency and Quantity									
		Light			Medium			Heavy		
	Non Drinker	Monthly	Weekly	Daily	Monthly	Weekly	Daily	Monthly	Weekly	Daily
< 20	97.2	95.7	89.6	81.2	80.0	76.1	73.5	91.3	70.7	68.9
20-49	2.3	2.7	6.7	7.5	10.8	10.4	16.9	4.3	14.6	6.7
50-99	0.6	.5	1.8	8.9	4.6	8.9	8.4	0	12.2	15.6
100-149	0	1.1	1.2	1.7	1.5	4.5	0	0	0	2.2
≥150	0	0	0.6	0.8	3.1	0	1.2	4.3	2.4	6.7
Total %[a]	100.1	100.0	99.9	100.1	100.0	99.9	100.0	99.9	99.9	100.1
(N)	(176)	(188)	(164)	(239)	(65)	(67)	(83)	(23)	(41)	(45)

[a]Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

Table 4-8

Distribution in Percent of Reported Usual Frequency and Quantity of Alcohol Consumption According to Breath Alcohol Concentration Among Drivers Stopped at Times and Places Similar to Serious Crashes

Frequency	Quantity	Blood Alcohol Concentration (mg%) <20	20-49	50-99	100-149	≥150	Percent FQ Group Comprises Among All Drivers
Never	None	18.2	5.3	1.8	0	0	15.7
Monthly	Light	19.2	6.6	1.8	15.4	0	17.2
Weekly	Light	15.7	14.5	5.5	15.4	9.1	15.2
Daily	Light	20.7	23.7	38.9	30.8	18.2	21.7
Monthly	Medium	5.5	9.2	5.5	7.7	18.2	5.9
Weekly	Medium	5.4	9.2	11.1	23.1	0	6.3
Daily	Medium	6.5	18.4	13.0	0	9.1	7.9
Monthly	Heavy	2.2	1.3	0	0	9.1	2.1
Weekly	Heavy	3.1	7.9	9.2	0	9.1	4.0
Daily	Heavy	3.3	3.9	13.0	7.7	27.3	3.9
Total %[a] (N)		99.8 (937)	100.0 (76)	99.8 (54)	100.1 (13)	100.1 (11)	99.9 (1091)

[a]Total percents may not equal 100 because row entries were rounded out to the nearest decimal point.

and 14% 5 or more bottles per sitting. Among the light beer drinkers for whom blood alcohol concentrations were available, 86% had no alcohol present when stopped and 6% had 50 mg% or higher, whereas among those who drink five or more bottles at a sitting 73% had no alcohol when stopped and 18% had 50 mg% or higher (Table 4-9). Forty-four percent of subjects under age 20, 32% of subjects age 20-59, and 14% of subjects age 60 or older state that they drink 3 or more bottles of beer per sitting.

Forty-two percent of individuals state that they drink liquor. Sixty-six percent of these drinkers state they drink 1-2 shots per sitting, 26% 3-5 shots per sitting, and 8% 6 or more shots per sitting. Among individuals who drink 6 or more shots per sitting, 8% had blood alcohol concentrations of 50 mg% or higher when stopped at the roadblock. Thirty-six percent of persons under age 20, 36% of persons age 20-59, and 9% age 60 or older state that they drink 3 or more shots per sitting.

Among those who drink beer, 24% state they drink once a month or less, 35% approximately once a week, and 41% daily. Thirteen percent of the individuals who drink beer daily had blood alcohol concentrations of 50 mg% or higher when stopped. Forty-eight percent of liquor drinkers state they imbibe once a month or less, 26% approximately once a week, and 26% every day. Among those who drink liquor every day, 8% had 50 mg% or higher when stopped.

4.1.5 Usual place where drinking occurs. Sixty-six percent of roadblock subjects who drink said they usually drink at home, 11% that their most frequent drinking place is at homes of friends or relatives, and 23% at other places. As can be seen in Table 4-10, subjects under age 20 are much more likely to report that they drink away from home than are drivers age 20 or older. The importance of this fact to the highway safety problem among teen-agers cannot

Table 4-9

Distribution in Percent of Blood Alcohol Concentrations
According to Reported Usual Quantity per Sitting of Beer or Liquor Consumed
Among Drivers Stopped at Times and Places Similar to Serious Crashes

Blood Alcohol Concentration (mg%)	Reported Quantity Consumed (Number of Drinks)											
	Beer						Liquor					
	1-2		3-4		≥5		1-2		3-5		≥6	
<20	81.2[a]	85.6[b]	67.2	70.9	69.5	72.5	83.3	88.7	78.5	84.3	65.8	75.0
20 - 49	8.4	8.9	12.1	12.7	9.5	9.9	5.2	5.5	8.5	9.1	14.6	16.7
50 - 99	4.2	5.3	11.2	11.8	10.5	11.0	3.9	4.2	4.6	4.9	4.9	5.5
100 - 149	0.8	0.9	2.6	2.7	1.0	1.1	1.2	1.3	0.8	0.8	0	0
≥ 150	0.2	0.2	1.7	1.8	5.3	5.5	0.3	0.3	0.8	0.8	2.4	2.8
Unknown	5.1	--	5.2	--	4.2	--	6.1	--	6.9	--	12.2	--
Total %[c] (N)	99.0 (474)	100.9 (450)	100.0 (116)	99.9 (110)	100.0 (95)	100.0 (91)	100.0 (330)	100.0 (310)	100.1 (130)	99.9 (121)	99.9 (41)	100.0 (36)

[a]Percents in each first column were determined with unknown included
[b]Percents in each second column were determined with unknown excluded
[c]Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

Table 4-10

Distribution in Percent of Reported Usual Place of Drinking According to Age Among Drivers Stopped at Times and Places Similar to Serious Crashes

Usual Place of Drinking	Age						
	<20	20-24	25-29	30-39	40-49	50-59	≥60
Own Home	28.7	41.7	54.4	58.1	57.9	66.9	53.5
Home of Relative or Friend	20.2	14.3	13.9	3.8	6.0	4.1	4.4
Elsewhere (bar, restaurants, private club, car, college fraternity, other)	51.2	43.9	31.7	38.1	36.1	29.1	42.1
Total %[a] (N)	100.0 (129)	99.9 (189)	100.0 (158)	100.0 (210)	100.0 (233)	100.0 (148)	100.0 (114)

[a]Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

be over emphasized. In fact, one study of teen-age drinking in an abstinence setting found that 41% of teen-agers who drink had their first exposure to alcohol while in an automobile with friends (Globetti, 1967). It is relevant that several communities in Vermont are officially "dry" not only for persons under the age of 21 but for all persons in those communities.

Among young subjects, 9% of those who say they usually drink at home had alcohol present when stopped, in comparison with 16% of those who usually drink at homes of relatives or friends, and 23% of those who drink elsewhere. In contrast, approximately 17% of older subjects had alcohol present no matter where they said their usual place of drinking was. Conversely, among the younger subjects who had no alcohol, 50% said they usually drink at home, 20% at homes of friends or relatives, and 30% elsewhere, whereas among those with alcohol present, 29% said they drink at home, 21% at homes of relatives or friends, and 50% elsewhere.

4.2 DRIVING PATTERNS

4.2.1 Self-reported driving record during previous five years. Among individuals under age 20, 52% had clear records, 7% citations only, 22% crashes only, and 20% had crashes plus citations. Among persons age 20-59, 61% had clear records, 11% had citations only, 9% crashes only, and 18% crashes plus citations. Among persons age 60 and older, 68% had clear records, 6% had citations only, 21% crashes only, and 6% crashes plus citations.

4.2.2 Annual mileage. Thirty-six percent of roadblock drivers under age 20 said they drive less than 5,000 miles a year, 20% between 5,000 and 10,000 miles, 17% between 10,000 and 15,000 miles, and 36% drive 15,000 miles or more per year. Among subjects 20-59, 8% said they drive under 5,000 miles a year, 11% between 5,000 and 10,000 miles, 25% from 10,000 to 15,000, whereas 56% drive 15,000 miles or more per year. Among drivers age 60 or older, 10% drive under 5,000 miles a year, 25% between 5,000 and 10,000 miles, 30% drive 10,000 to 15,000 miles per year, and 36% drive 15,000 or more per year.

4.2.3 Purpose of trip at time of roadblock. Among roadblock subjects under age 20, 17% were driving to work or school, 8% on household chores, 67% for recreational purposes, and 4% for other purposes. Among subjects age 20-59, 31% were driving to work or school, 12% for household chores, 48% for recreational purposes, and 10% for other reasons. Among subjects age 60 or older, 23% were driving to work, 24% for household chores, 40% for recreational purposes, and 13% for other reasons.

4.2.4 Number of passengers. Thirty-nine percent of roadblock drivers had no passengers, 37% had one passenger, and 24% had two or more passengers. No significant difference in the presence or absence of passengers was observed between male and female drivers. Drivers with clear records during the previous 5 years were twice as likely to have at least one passenger under the age of sixteen with them than were drivers who had previous crashes, citations, or both.

4.2.5 Seat belt usage. Twenty-two percent of roadblock vehicles had at least one person using a seat belt at the time the vehicle was stopped. No significant difference was observed in this according to age or sex. Twenty-five percent of drivers said they never use seat belts, 2% use them most frequently for short trips, 46% for long trips, 12% under other circumstances, and 15% state that they always use seat belts.

4.3 RELATIONSHIPS BETWEEN DRINKING AND DRIVING PATTERNS

4.3.1 Stated habits with respect to drinking and driving in combination.

Fourteen percent of roadblock subjects state that they do not drink at all. Among those individuals who say they do drink, only 29% say they never combine drinking and driving, 41% say they drive after less than half the occasions at which they drink, and 30% drive after at least half of the occasions at which they drink. Among the individuals who had no alcohol in their blood, 28% say they drive after at least half of their drinking occasions, whereas 45% of those with alcohol present say they combine drinking and driving this often. Conversely, 6% of the individuals who say they never combine drinking and driving had alcohol present when stopped, whereas 23% of those who admit to combining these two activities half the time or more had alcohol when stopped.

Males significantly more often than females said that they drive after at least half of their drinking occasions, and young males more often than older males said they combine these two activities half the time or more.

A distinct trend was noted for drivers with high FQIs to combine drinking and driving (Table 4-11). Whereas two-thirds of drivers among monthly light drinkers never combine drinking and driving and only 15% combine these activities on at least half of their drinking occasions, only 4-5% of drivers among weekly and daily heavy drinkers never drive after drinking, and over half say they combine the two activities most of the time.

Table 4-11

Distribution in Percent of Reported Frequency with which Drinking Is Followed by Driving According to Reported Usual Frequency and Quantity of Alcohol Consumption Among Drivers Stopped at Times and Places Similar to Serious Crashes

Frequency of Driving after Drinking	Frequency & Quantity								
	Light			Medium			Heavy		
	Monthly	Weekly	Daily	Monthly	Weekly	Daily	Monthly	Weekly	Daily
Never	66.7	28.7	18.4	35.8	16.7	3.4	33.3	4.7	4.4
Less than half of drinking occasions	18.2	49.1	50.2	40.3	38.9	43.2	37.5	44.2	42.2
Half or more of drinking occasions	15.1	22.2	31.4	23.9	44.4	53.4	29.2	51.2	53.3
Total %[a]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.1	99.9
(N)	(193)	(167)	(245)	(67)	(72)	(88)	(24)	(44)	(45)

[a]Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

4.3.2 Driving record and recent alcohol consumption. Among 614 individuals with clear driving records, 12% had alcohol present, whereas among 471 persons with non-clear driving records during the previous five years, 17% had alcohol present ($p<.05$). Conversely, 42% of individuals with no alcohol present reported they had crashes or citations during the previous five years, whereas 51% of those with alcohol present had such records during the previous five years. These differences held for persons age 20-59 but not for younger or older groups. No appreciable difference was noted in the annual mileage of individuals who had alcohol present as compared to those who did not. Therefore, the observed difference in driving records could not be explained by unequal driving exposure.

Among individuals who had not had alcohol within the previous 24 hours, 40% had crashes or citations during the previous five years, whereas among those who had had alcohol in the previous two hours, 50% had such records. Conversely, 16% of individuals with clear records had had alcohol within the previous two hours, whereas 22% of those with crashes or citations had had alcohol during this time period.

4.3.3 Driving record and frequency and quantity of alcohol consumption. Drivers in lower FQI categories were less likely to report crashes or citations than were those in the highest categories. For example, 72% of non drinkers had no crashes and 82% had no citations (Table 4-12). In contrast, 59% of drivers who were daily heavy drinkers had no crashes and 53% had no citations. These differences could not be explained by greater driving exposure among drivers in higher FQI groups because all groups had relatively similar distributions of annual miles travelled.

4.3.4 Driving record and usual place where drinking occurs. Clear

Table 4-12

Distribution in Percent of Drivers Reporting Crashes or Citations During Previous Five Years According to Reported Usual Frequency and Quantity of Alcohol Consumption Among Drivers Stopped at Times and Places Similar to Serious Crashes

Frequency	Quantity	Percent With Crashes	Percent With Citations	(N)
Never	None	27.8	18.1	(177)
Monthly	Light	32.1	14.4	(196)
Weekly	Light	27.6	18.0	(174)
Daily	Light	37.1	23.7	(245)
Monthly	Medium	33.8	19.4	(68)
Weekly	Medium	46.5	33.8	(71)
Daily	Medium	35.6	33.0	(90)
Monthly	Heavy	41.7	29.2	(24)
Weekly	Heavy	48.9	33.3	(45)
Daily	Heavy	40.9	46.7	(45)

driving records during the previous five years were reported by 55% of persons who state they usually drink at home, 50% of those who usually drink at homes of friends or relatives, and 52% of those who state they usually drink elsewhere. For persons under the age of twenty, the comparable figures were respectively, 38%, 44%, and 51%. For those age 20 and older the comparable figures are 58%, 52%, and 54%.

4.3.5 Presence of alcohol and purpose of trip. Among individuals who had no appreciable amount of alcohol present in their blood, 29% stated that they were driving for purposes of work or school, 12% for household chores, 49% for recreational purposes, and 10% for other reasons. Among those with alcohol present, 19% said they were driving to work or school, 11% for household chores, 62% for recreational purposes, and 8% for other reasons, differences which were statistically significant. Examined conversely, alcohol was present among 9% of the individuals who said they were driving for purposes of work or school, 13% of those who were driving for household chores, 17% of those driving for recreational purposes, and 11% of those driving for other reasons.

4.3.6 Number of passengers and presence of alcohol. No appreciable difference was observed in the number of passengers present according to the presence or absence of alcohol in the blood of the driver. However, considering the number of people who are at risk of being injured when crashes occur involving alcohol, it is of interest that 29% of drivers who had alcohol in their blood had two or more passengers present with them when they were stopped at the roadblock and only 36% of drivers with alcohol were alone in their cars.

4.3.7 Seatbelt usage and presence of alcohol. Twenty-three percent of cars in which the driver had no alcohol present had at least one person using the seatbelt, whereas 18% of cars in which the driver had alcohol present had at least one person using the seatbelt. This difference was not significant, however, at $p \leq .05$. Among males age 25 or older who had no alcohol present, 22% said that they never use a seatbelt, 30% reported using a seatbelt less than half the time, and 47% stated that they use a seatbelt half the time or more. In contrast, among males age 25 or older who had alcohol present, 32% said they never use a seatbelt, 37% that they use it less than half the time, and 31% that they use it half the time or more. These differences were statistically significant.

4.4 DRINKING PATTERNS AND BIOGRAPHICAL VARIABLES

4.4.1 Presence of alcohol and marital status. No significant difference was observed in the proportions of persons with alcohol according to current marital status. Nor was any difference observed in presence or absence of alcohol according to number of times married. Twenty-seven percent of subjects had no previous marriages, 65% had been married once, and 8% had been married two or more times. Blood alcohol concentrations were also compared for individuals whose parents were separated or divorced and those whose parents were not. Eleven percent of individuals had parents who were separated or divorced. No difference in proportions of persons with alcohol present was observed according to marital status of parents.

4.4.2 Presence of alcohol according to occupational history. Presence of alcohol is closely related to age and sex, which are also related to occupation. In order to avoid the confounding of variables, therefore, the association between alcohol and occupation was limited only to males ages 25-59. No significant difference was observed in proportions of persons with alcohol according to occupational level as defined within these three categories; nor was any difference observed in proportion with alcohol according to the number of jobs held within the previous 5 years. Among individuals who have held jobs, 52% of drivers had held one job during that time period, 26% two jobs, and 22% three or more jobs.

4.4.3 Presence of alcohol and highest educational level achieved. Eighteen percent of individuals had attended or completed elementary school only, 51% had attended or completed high school, and 30% had gone beyond high school. No difference was observed in proportions of persons with alcohol at time of roadblock according to educational level.

4.4.4 Presence of alcohol and residence. Thirty-four percent of roadblock subjects live on farms or in the country, 40% in villages or small towns, and 26% in suburbs or cities.[1] Among farm residents 9% had blood alcohol concentrations of 20-49 mg% when stopped and 4% had concentrations above this range. Among those living in small villages and towns, 6% had concentrations of 20-49 mg% and 8% had concentrations above this range, whereas 6% of those living in suburbs or cities had the lower blood alcohol concentration and 9% had concentrations above this range. These differences in blood alcohol concentrations were statistically significant at the .05 level.

Blood alcohol concentrations were also compared according to the number of times subjects had moved within the previous 5 years. Fifty-one percent had not moved within the previous 5 years, 23% had moved once, and 26% had moved two or more times. No difference was observed in proportions with alcohol present according to the number of times moved.

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[1] The largest metropolitan area in Vermont totals about 60,000 persons.

4.4.5 Presence of alcohol and other biographical variables. Presence of alcohol at time of roadblock was also considered according to religion, church attendance, and birth order. No significant differences were observed in drinking patterns according to these variables.

4.5 DRIVING PATTERNS AND BIOGRAPHICAL VARIABLES

4.5.1 Driving record and marital status. Among single subjects age 25 or older 52% had clear records, whereas 64% of married subjects in this age range and 53% of divorced, separated, or widowed individuals had clear records. These differences were statistically significant at $p < .05$. The major reason for this difference was that smaller proportions of married individuals had citations than did either of the other two groups.

Among subjects age 25 or older, 50% of individuals who had never married had clear records, in comparison with 63% of those with one marriage, and 67% of individuals with two or more marriages. Greater proportions of single subjects had citations only, crashes only, or crashes plus citations during the previous five years than did individuals who were married one or more times. Fewer individuals who were married two or more times had citations only, and more of them had crashes and citations then did those married only once. Those married once and more than once were similar on proportions with crashes only. Among individuals whose parents were divorced or separated, 46% had clear records, whereas among those whose parents were not divorced or separated 58% had clear records, a difference which was statistically significant.

4.5.2 Driving record and occupational history. Among individuals classified in the upper occupational level 58% had clear records during the previous five years in comparison with 53% for those in middle occupational classification and 52% for those in the lower occupational group. This difference was not observed for the three occupational levels among individuals age 25 or older.

Among individuals 25 or older, those who held one job during the previous five years had clear driving records almost twice as often as did individuals with three or more jobs in the previous five years ($p<.001$), (Table 4-13). Conversely, individuals with three or more jobs during the previous five years represented only 10% of those with clear records but 21% of individuals who had had crashes, citations, or both during the previous five years. Among persons age 25-59, those with one job during the previous five years comprised 61% of those with clear records, 44% of those with citations only, 45% of persons with crashes only, and 35% of those with crashes and citations. Within this same age range persons who had held three or more jobs during the previous five years comprised 12% of individuals with clear records, 33% of those with citations only, 28% of those with crashes only, and 34% of individuals with crashes and citations.

4.5.3 Driving record and highest educational level achieved. Among persons who had attended elementary school only, 65% had clear driving records, whereas 58% of those who had attended or completed high school and 50% of individuals who had gone beyond high school had clear records ($p <.001$). These differences appear to be explained almost entirely by the driving records of males. For example, among males over the age of 25, 69% of those with only elementary education had clear records, whereas 58% and 52% respectively of those with high school and post-high school education had clear records. The reason for these differences is not known.

Two possible explanations are that persons with higher education

Table 4-13

Distribution in Percent of Persons Reporting Clear Driving Records and Crashes or Citations During the Previous Five Years According to Number of Jobs Held During This Time Among Drivers Age 25-59 Stopped at Times and Places Similar to Serious Crashes

	Number of Jobs in Five Years		
Driving Record	1	2	3 or more
Clear	64.6	57.0	38.3
Crashes Only	18.2	20.0	23.4
Citations Only	8.7	7.9	18.1
Crashes and Citations	8.4	15.2	20.2
Total %[a] (N)	99.9 (379)	100.1 (165)	100.1 (94)

[a]Total percents may not equal 100 because row entries were rounded to the nearest decimal point.

drive more miles annually or that persons with lower education are located predominantly in the farming and very rural areas of the state. Persons with high annual mileage and, as noted below, those with residence in suburbs or cities are significantly more likely to have crashes, citations, or both during the previous five years than are those with lower mileage or those who live in farming or small towns.

4.5.4 Driving record and residence. Sixty-two percent of persons living in farm or country, 57% of those living in villages or smalll towns, and 51% of those in suburbs or cities had clear records during the previous five years. Also as shown in Table 4-14, individuals age 25-59 who had moved during the previous five years were significantly more likely to have citations, crashes, or both than were those that had not moved during the previous five years. They are explained mostly by the records of the male drivers. For example, 66% of male drivers in this age group who had not moved had clear records, whereas 56% of those with one move and 45% with two or more moves had had clear records.

4.5.5 Driving record and other biographical variables. Driving record was also considered according to religion, church attendance, and birth order. The differences observed according to these first variables were not statistically significant. However, a difference was observed according to birth order. Among individuals age 20-59, 58% of the only children, 54% of first borns, and 40% of those not first born had clear records during the previous five years. These differences were explained by the larger proportion of individuals with crashes only among those who were not first born. Whereas, 15% and 17% respectively of only children and first borns reported crashes during the past five years. Twenty-three percent of those who were

Table 4-14

Distribution in Percent of Persons Reporting Clear Driving Records and Crashes or Citations During the Previous Five Years According to Number of Moves in Residence During This Time Among Drivers Age 25-59 Stopped at Times and Places Similar to Serious Crashes

	Number of Moves in Five Years		
Driving Record	None	1	2 or more
Clear	67.7	56.8	52.2
Crashes Only	16.9	20.7	19.6
Citations Only	6.7	13.0	10.3
Crashes and Citations	8.7	9.5	17.9
Total %	100.0	100.0	100.0
(N)	(356)	(169)	(184)

not first born reported crashes only. Among the only children and first borns 12% had citations only, whereas, 7% of those who were not first born had citations only. Crashes and citations were reported by 13%, 14%, and 14% respectively of those who were only children, first born, and not first born.

Chapter 5

NON-FATALITY STUDY GROUPS

This chapter is limited to a description of the data obtained on selected variables within each of the five non-fatality study groups, whereas comparisons between and among all groups are presented in the next chapter. Respondents in the non-fatality study groups were interviewed and tested more extensively than were other respondents. The composition of the five study groups and the interview material were described earlier (see Method chapter). The findings are presented below in the following order: DWI-Citation, Non-DWI Citation, Hospitalization Crash, and Clear-record.

The data from the selected variables presented in this chapter represent but a portion of the total information gathered. The reported variables were selected on two criteria: (a) assumed importance, and (b) availability of comparable data from all drivers within each of the six study groups. Thus, comparability within the five non-fatality study groups was limited by the fact that those respondents interviewed at home received a shortened battery. Furthermore, with respect to the next chapter, comparisons between and among groups were limited by the fact that, for the driver fatalities, data were not available on all variables. Those variables which met these criteria are organized and presented in terms of the following topical headings: (1) biographical information, (2) patterns of alcohol use, (3) relationship between drinking and driving patterns, and (4) driving patterns. Personality and attitudinal results are more meaningfully discussed in terms of group comparisons and therefore are presented in the next chapter.

5.0.1 Statistical considerations. The selected variables and the intervals (or code categories) used for the present analyses are listed in Table 5-1. One special case should be noted, namely, the four "class intervals" for occupational level shown in Table 5-1 were determined by collapsing the original occupation categories as follows: (1) upper occupational level: professional; semi-professional; manager, proprietor, or executive; farm owner; or sales; (2) middle occupational level: farm manager; craftsman or foreman; clerical worker, operatives; service; or protective; (3) lower occupational level: farm laborer or farm foreman; laborer (except farm); and (4) other, including housewife, student, and retired.

The median values on each of the selected variables are presented in Table 5-2 for all study and comparison groups. Medians are reported rather than means because some of the distributions are quite heavily skewed.

It should also be noted that relatively few cross-tabulations were attempted with data from the non-fatality study groups because of the small number of subjects involved in some subgroupings. Furthermore, the numbers and percents presented for cross-tabulation results will frequently differ from those presented for single-tabulation results because complete data were not available on all variables for all subjects.

Finally, the statistical significance of within-group differences in the following text was assessed with a confidence-limit technique developed by Wilks (1940) to determine the critical differences between percentages.

5.1 DRIVING-WHILE-INTOXICATED CITATIONS

The most salient group of living drivers consisted of those cited and convicted of driving-while-intoxicated (DWI). These drivers were also of

Table 5-1

Selected Biographical, Drinking, and Driving Variables and Minimum Code Categories used in Present Analyses

Biographical item	Code categories
Sex	male, female
Age	(a) < 20, 20-24, 25-29, 30-39, 40-49, 50-59, 60+ (b) < 20 20-24, 25-59, 60+ (c) <25, 25-59, 60+
Marital status	single, married, other (wid-sep-div)
Occupational level	upper, middle, lower, other
Number of employers in last 5 years	0, 1, 2 or more
Drinking patterns	
Frequency: "How often do you usually drink beer (or liquor, or wine)?"	(1) monthly or less, (2) weekly or less, or (3) daily or several/week
Quantity: beer "How much beer do you usually drink at one time?"	(1) 2 bottles or less, (2) 3 to 4 bottles, or (3) 5 bottles or more
liquor "How much liquor do you usually drink at one time?"	(1) 2 shots or less, (2) 3 to 5 shots, or (3) 6 shots or more
Frequency-Quantity Index: (for more preferred beverage)	(a) 9 groups (3X3) from: 1=monthly-light through 9= daily-heavy (b) 4 groups; collapsed version of (a): light, light-medium, medium, and heavy
Drinking-and-driving: "During the past year, how often have you driven after having had anything to drink?"	(1) never, (2) less than half the time, or (3) half the time or more
Driving history (self-report & official record check)	
Crashes: lifetime "How many accidents have you reported in your lifetime?"	(1) none, (2) one, or (3) two or more
Crashes: 5 years "How many accidents have you reported in the last 5 years?"	(1) none, (2) one, or (3) two or more
Citations: lifetime "How many violations have you been convicted of in your lifetime?"	(1) none, (2) one, or (3) two or more
Citations: 5 years "How many violations have you been convicted of in the past 5 years?"	(1) none, (2) one, or (3) two or more
License suspensions: "How many times has your license been suspended?"	(1) none, (2) one, or (3) two or more

Table 5-2

Medians and Modes of Selected Biographical, Drinking, and Driving Variables for Study and Comparison Groups

Variable	Crash		Comparison		Clear		Citation	
	Fatal	Hosp	RB-F	RB-H	Clear-F	Clear-H	DWI	Non-DWI
Biographical item								
Sex	male	male	male	male	male	male	male	male
Age	30	21	34	36	38	37	36	25
Marital status	M	M	M	M	M	M	M	S
Occupational level[a]	middle	middle	middle	middle	upper	upper	lower	lower
Number of jobs 5/yrs[b]	2	2	2	1	2	2	2	2
Drinking history								
Frequency								
beer	daily	mnthly	weekly	mnthly	mnthly	mnthly	daily	weekly
liquor	mnthly	mnthly	mnthly	never	mnthly	mnthly	mnthly	mnthly
wine	never	never	never	never	mnthly	mnthly	never	never
Quantity								
beer	light	light	light	light	light	light	med	med
liquor	light	light	light	never	light	light	med	med
wine	never	never	never	never	light	light	never	never
Frequency-Quantity Index[c]								
beer	dl-lt	wk-lt	wk-lt	mo-lt	mo-lt	mo-lt	dl-md	mo-md
liquor	mo-lt	mo-lt	mo-lt	never	mo-lt	mo-lt	mo-md	mo-lt
wine	never	never	never	never	mo-lt	mo-lt	never	never
Drinking frequency (last 24 hrs.)								
beer (bottles)	nk[d]	0	0	0	0	0	6	1
liquor (shots)	nk	0	0	0	0	0	1	0
wine (ounces)	nk	0	0	0	0	0	0	0

Table 5-2 (cont)

Medians and Modes of Selected Biographical, Drinking, and Driving Variables
For Study and Comparison Groups

Variable	Crash		Comparison		Clear		Citation	
	Fatal	Hosp	RB-F	RB-H	Clear-F	Clear-H	DWI	Non-DWI
Time of last drink (last 24 hrs)	nk	>24 hr	>24 hr	>24 hr	>24 hr	>24 hr	<1/2 hr	3-24 hr
Drinking-and-driving frequency	nk	<1/2	<1/2	<1/2	<1/2	<1/2	<1/2	1/2+
Blood alcohol concentration (mg%)	50	nk	none	none	none	none	200	nk
Driving history (self-report)								
crashes, 5/yrs	nk	1	0	0	0	0	0	1
crashes, all yrs	nk	1	1	1	0	0	1	2
citations, 5/yrs	nk	0	0	0	0	0	0	1
citations, all yrs	nk	0	0	0	0	0	1	1
suspensions	nk	0	0	0	0	0	1	1
Driving record (official check)								
citations, 5/yrs	0	0	0	0	0	0	1	1
citations, all yrs	0	0	0	0	0	0	2	1
suspensions	0	0	0	0	0	0	1	0

[a]Respondents who were coded "other" (housewives, students, retired, etc.) were excluded from this determination.
[b]Respondents who had had no jobs in the previous 5 years were excluded.
[c]FQI is an ordered variable:

mo-lt = monthly light	mo-md = monthly medium	mo-hv = monthly heavy
wk-lt = weekly light	wk-md = weekly medium	wk-hv = weekly heavy
dl-lt = daily light	dl-md = daily medium	dl-hv = daily heavy

[d]nk = not known

primary importance for the present research which was charged with determining "the extent to which drinking and driving problems involve alcoholics and other abnormal drinkers, and ways by which these individuals can be identified." There is ample reason to suspect that "alcoholics and other abnormal drinkers" are over-represented in the DWI population.

5.1.1 Biographical variables. Regarding race, it should be noted for comparability with other studies that blacks constitute less than 1% of the Vermont population and, therefore, that the complete absence of blacks among drivers in the present study is not surprising statistically.

Distributions of sex, age, marital status, occupational level, and number of employers in the previous five years are presented in Tables 5-3 and 5-4 for the six study groups, as well as for the roadblock comparison groups.

Regarding sex, examination of Table 5-3 shows very clearly that DWI citations are a male phenomenon, with only one female (2%) in the sample. However, a selective bias in not citing female drivers for DWI is possible. Regarding age, nearly two-thirds (62%) of the DWI drivers were 25 to 59 years old, whereas 22% were under 25, and 16% were over 60. The median age was 36 years. These data seem consitent with the alcoholism literature in which it is well-documented that the vast majority of alcoholics are over 30 years of age. The marital-status distribution shows that 36% of the DWI drivers were single, 48% married, and 16% either widowed, divorced, or separated.

The only indicator of socio-economic status reported here is occupational level (Table 5-4), and examination of the distribution shows that 42% of the DWIs were in the lower category (i.e., were laborers), whereas 32% were in the middle category, 10% in the upper category, and 16% in other (see 5.0.1 for explanation of categories).

Table 5-3

Sex, Age, and Marital Status by Frequency and Percent
Among the Six Study Groups

Biographical item	Crash				Roadblock		Clear-record		Citation			
	Fatality		Hospital				Comb F+H		DWI		Non-DWI	
	N	%	N	%	N	%	N	%	N	%	N	%
Sex												
Male	100	88	26	68	951	80	46	73	49	98	39	97
Female	13	12	12	32	233	20	17	27	1	2	1	3
Total	113		38		1184		63		50		40	
Age												
<20	18	16	10	26	132	11	11	17	4	8	14	35
20-24	28	25	10	26	190	16	4	6	7	14	15	38
25-29	10	9	3	8	159	13	6	10	9	18	4	10
30-39	16	14	3	8	211	18	12	19	9	18	2	5
40-49	15	13	1	3	235	20	13	21	9	18	3	7
50-59	13	11	8	21	147	12	9	14	4	8	2	5
60+	13	11	3	8	110	9	8	13	8	16	0	0
Total	113		38		1184		63		50		40	
Marital Status												
Single	30	41	15	39	324	27	15	24	18	36	21	53
Married	40	57	20	53	786	67	47	75	24	48	17	42
Wid-Div-Sep	2	3	3	8	70	6	1	1	8	16	2	5
Total	72		38		1180		63		50		40	

Table 5-4

Occupational Level and Number of Employers in Previous Five Years by Frequency and Percent

Biographical Item	Crash				Roadblock		Clear-record		Citation			
	Fatality		Hospital				Comb F+H		DWI		Non-DWI	
	N	%	N	%	N	%	N	%	N	%	N	%
Occupation												
Upper	15	26	6	16	282	25	31	51	5	10	3	8
Middle	20	35	13	34	404	37	14	23	16	32	5	13
Lower	13	23	6	16	275	25	5	8	21	42	24	60
Other	9	16	13	34	145	13	11	18	8	16	8	20
Total	57		38		1106		61		50		40	
#Employers												
One	10	25	15	40	511	47	25	40	22	44	13	33
Two	12	30	8	21	253	23	15	24	11	22	8	17
Three+	12	30	10	27	255	23	14	22	14	28	13	35
None	6	15	4	11	75	7	9	14	3	6	6	15
Total	40		37		1094		63		50		40	

5.1.2 The DWI incident. The suspicion that "abnormal" drinking preceded the contact with police and the subsequent citation is substantiated by the data on blood alcohol concentration (Table 5-5) and on typical frequency and quantity of alcohol consumption (Tables 5-7, 5-8, 5-9, and 5-10).

Data from additional variables concerning the DWI cases are presented in Tables 5-5 and 5-6, namely: (1) reason for contact with enforcement agency, (2) time of day that contact was made with enforcement agency, (3) the day of the week that contact was made, and (4) the type of chemical test used to determine the alcohol concentration. Each variable is discussed below separately and in conjunction with any significant or especially relevant variables as determined by cross-tabulations.

The distributions of blood alcohol concentration are presented in Table 5-5 for the 103 DWI drivers who were selected and invited for interviewing and for whom test data were available. Separate distributions for those drivers interviewed and for those drivers invited but not interviewed are presented in order to evaluate possible differences which may be attributable to selective sampling. In the case of blood alcohol concentration, the two distributions are essentially equivalent (except that the range was greater in the not-interviewed group, i.e., one individual below 100 mg% and two individuals above 350 mg%).

Inspection of the blood alcohol concentration data in Table 5-5 clearly leads to the conclusion that the DWI drivers had indeed consumed great quantities of alcohol prior to testing. Furthermore, the blood alcohol concentrations of half these drivers was at least 200 mg% which greatly exceeds the amount usually attained in the course of typical social drinking (30 to 70 mg%). It is especially interesting to note that the distribution of blood alcohol concentrations does not commence with a high frequency of cases at the presumptive legal limit (100 mg%), but rather that the frequencies

Table 5-5

Distribution in Frequency and Percent of Blood Alcohol Concentration, Type of Chemical Test, Reason for Contact with Enforcement Agency, and Day of Citation Among DWI Drivers Selected and Invited for Interviewing

Variable	Interviewed			Not interivewed			Total invited		
	N	% (N=50)	% (N=41)	N	% (N=80)	% (N=62)	N	% (N=130)	% (N=103)
Blood alcohol concentration									
0 - 49	0	0	0	0	0	0	0	0	0
50 - 99	0	0	0	1	1	2	1	1	1
100 - 149	8	16	20	10	13	16	18	13	18
150 - 199	11	22	27	21	26	34	32	25	31
200 - 249	11	22	27	17	21	27	28	22	27
250 - 299	9	18	22	7	9	11	16	12	16
300 - 349	2	4	5	4	5	6	6	5	6
350 - 399	0	0	0	1	1	2	1	1	1
400 - 449	0	0	0	1	1	2	1	1	1
450 - 500	0	0	0	0	0	0	0	0	0
Total	41	82	101	62	77	100	103	81	101
No test	4	8		8	10		12	9	
Refused	5	10		10	13		15	12	
Total	50	100		80	100		130	102	
Type of Test									
Blood	19		48	26		42	45		44
Breath	10		25	21		34	31		30
Urine	11		28	15		24	26		25
Total	40		101	62		100	102		99
Reason for Contact									
Crash	24	48		37	47		61	47	
Observed	19	38		38	48		57	44	
Complaint	7	14		4	5		11	9	
Total	50	100		79	100		129	99	
Day of the Week									
Monday	4	8		7	9		11	8	
Tuesday	2	4		3	4		5	4	
Wednesday	2	4		11	14		13	10	
Thursday	3	6		7	9		10	8	
Friday	11	22		16	20		27	21	
Saturday	18	36		21	27		39	30	
Sunday	10	20		14	18		24	19	
Total	50	100		79	101		129	100	

increase gradually from 100 mg%, peak near the middle of the distribution (mean = 203 mg%; median = 200 mg%), and then decrease again (see Table 5-5 and Figure 6-8). It may well be that drivers are typically not cited for DWI unless the arresting officer has extremely good reason to believe that the driver is very intoxicated, i.e., that the results of a subsequent chemical test for alcohol will unequivocally corroborate the officer's decision to write a DWI citation.

Of particular interest is the relation of age to the functional level of alcohol impairment. Accordingly, blood alcohol concentration and age data were cross-tabulated and yielded one of the few statistically significant differences between observed and expected values among all the analyses of the DWI incidents ($X^2 = 17.43$, df = 9, $p < .05$). This finding stems from the fact that proportionately more younger drivers (cited for DWI) were apprehended with relatively lower blood alcohol concentrations. Thus, of the DWI drivers under 20, 89% were below the median blood alcohol concentration of 200 mg%, and 44% were under 150 mg%. Of all DWI drivers under 25, 65% were below 200 mg% and 38% were below 150 mg%. Or, in other terms, of all DWI drivers with blood alcohol concentrations less than 150 mg%, 53% were under 25 years of age, 32% were between 25 and 39 years of age, and 15% were over 40; whereas, of DWI drivers with blood alcohol concentrations of 250 mg% or more, 4% were under 25 years of age, 39% were between 25 and 39 years of age, and 57% were over 40. Since approximately half (47%) of all DWI citations result from an investigated crash, it is especially noteworthy that proportionately more younger drivers (under 25) were cited because of such circumstance, namely, 61%. Thus, it would seem that driving competence of younger -- and therefore less experienced drivers may well be substantially impaired at relatively lower levels of alcohol.

The distributions of DWI citations cross-tabulated according to time of day and reason for contact with an enforcement agency are presented in Table 5-6. Regarding reason for contact, slightly more citations resulted from the driver having been involved in a crash (47%) than having been observed while driving aberrantly but without a crash (44%); however, relatively very few contacts resulted from submitted complaints (9%). The latter finding may indicate an unfortunate if understandable reluctance on the part of the average citizen to tattle on a drunken driver. This aspect of citizen involvement in reporting drunken drivers should be strongly emphasized as a point to consider and develop in any public education countermeasure program.

Regarding time of day that contact was made with an enforcement agency; the data presented in Table 5-6 are generally consistent with those of other investigators, namely, that the overwhelming majority of DWI citations (85%) are obtained during nighttime hours (1800 to 0559), as opposed to the relatively small proportion (13.2%) obtained during afternoon hours (1200 to 1759) and the minute proportion (1.6%) during morning hours (0600 to 1159). In fact, fully two-thirds (68%) of these DWI citations were obtained in the peak 7-hour period from 1900 to 0159.

Concerning the day of the week on which the DWI incident occurred, the present data (Table 5-5) also confirm the findings of other investigators, namely, that the vast majority of DWI citations (70%) are obtained on weekends (Friday, Saturday, and Sunday). In fact, cross-tabulating time of contact by day of the week reveals that 24% of all DWI citations were obtained on Friday "nights" (1800 Friday through 0559 Saturday), and similarly, 23% were obtained on Saturday "nights" (1800 Saturday through 0559 Sunday); thus, the two prime weekend "nights" account for approximately half (47%) of all DWI citations.

Table 5-6

Distribution of DWI Citations According to
Time and Reason for Contact with Enforcement Agency

Time	Crash		Observed		Complaint		Total	
	N	%	N	%	N	%	N	%
0600 - 0659								
0700 - 0759								
0800 - 0859								
0900 - 0959	1	2					1	1
1000 - 1059								
1100 - 1159					1	9	1	1
1200 - 1259	1	2					1	1
1300 - 1359								
1400 - 1459	2	3					2	2
1500 - 1559	2	3	1	2	1	9	4	3
1600 - 1659	1	2					1	1
1700 - 1759	4	7	5	9			9	7
1800 - 1859	4	7	1	2	1	9	6	5
1900 - 1959	4	7	3	5	3	27	10	8
2000 - 2059	6	10	9	16			15	12
2100 - 2159	6	10	5	9	1	9	12	9
2200 - 2259	5	8	3	5			8	6
2300 - 2359	7	11	5	9			12	9
0000 - 0059	10	16	6	11	1	9	17	13
0100 - 0159	5	8	9	16			14	11
0200 - 0259	2	3	4	7	2	18	8	6
0300 - 0359	1	2	5	9			6	5
0400 - 0459			1	2	1	9	2	2
0500 - 0559								
Total	61	101	57	102	11	99	129	102

Furthermore, of 19 DWI citations obtained during daytime hours (0600 to 1759), 84% were obtained on the weekends and only 16% obtained weekdays; whereas, of 110 DWI citations obtained during nighttime hours (1800 to 0559), 67% were obtained on weekends, and 33% on weekdays. Or in other terms, of the 39 weekday DWIs, only 8% were obtained during daylight hours (0600 to 1759) and 92% were obtained during the nighttime hours; whereas, the distribution for the 90 weekend DWIs indicated proportionately twice as many daytime citations (18%) and a correspondingly somewhat lower proportion of nighttime citations (82%). The latter findings would seem to indicate that the DWI citations are more evenly distributed throughout the 24-hour day on weekends than on weekdays; however, finer inspection of the data indicates that virtually all the daytime DWIs obtained on the weekends were obtained between the hours of 1400 and 1759.

It is, of course, possible that these time distributions of DWI arrests reflect heavier deployment of police officers or greater suspicion regarding alcohol by officers at these times. However, if one assumes this not to be the case, these day-and-time of contact findings have clear implications for the distribution of enforcement personnel. In order to get the greatest leverage on the alcohol component of highway crashes greater coverage should be given to weekend nighttime hours rather than to weekday daytime hours (the latter commencing about 0500) if increased surveillance and protection are desired. It is also clear that the risk which these impaired DWI drivers constitute for other drivers on the highways is substantially higher during the peak weekend hours than at any other time of the day or week.

Regarding type of chemical test, there was a far greater tendency to obtain a blood test (44%) than either a breath test (30%) or a urine test (25%). However, these data must be interpreted with caution since there are numerous pragmatic and idiosyncratic influences which would lead to deciding which of the three chemical tests to elect in a particular instance. In any case, cross-tabulating type of test by blood alcohol concentration yielded statistically significant differences between observed and expected values ($X^2 = 41.56$, df = 6, $p < .001$). This finding is attributable to the fact that the blood alcohol concentrations indicated by the breath tests (i.e., the Intoximeter) were significantly lower (mean = 175 mg%) than those from either the urine tests (mean = 223 mg%) or the lower blood tests (mean = 216 mg%). In fact, among those DWI drivers in the upper half of the distribution of blood alcohol concentrations (i.e., exceeding 200 mg%), 61% provided a blood sample, 29% a urine sample, and 10% a breath sample. Or in other terms, the proportion of DWI drivers who exceeded 200 mg% within each test type were: 71% of those who provided a blood sample, 54% of those who provided a urine sample and 16% of those who provided a breath sample.

The fact that urine tests show higher alcohol concentrations than the other two tests is perhaps because the conversion ratio of 1.3 (i.e., urine reading equals 1.3 times equivalent blood reading) which was used is widely recognized to be only an approximation, since on any given determination the true ratio may range from about 1.1 to 1.6. No difference should exist, however, between blood and breath determinations. Whether these differences indicate that, upon being arrested, DWI drivers with relatively low blood alcohol concentrations elect the breath test in preference to the blood test, or whether the Intoximeter produced systematically and significantly lower values than the blood test cannot be determined from the present data, but remains an especially important challenging question for future investigation.

5.1.3 Patterns of alcohol use. The data on reported drinking patterns were very consistent with the results of the chemical tests and provided further confirmation for the very heavy consumption of alcohol by the drivers in this DWI group. Regarding typical frequency of alcohol consumption, the distribution of responses to the questions, "How often do you usually drink beer (or liquor, or wine)?" are presented in Table 5-7, Figure 6-1, and Figure 6-3. Beer is apparently the most preferred beverage among the DWI drivers, with 96% reporting that they drink beer, whereas 74% reported drinking liquor and only 30% reported drinking wine. Regarding stated frequency of usual consumption, significantly ($p < .01$) more DWIs reported drinking beer daily or several times a week (67%) than monthly or less (8%). Furthermore, when they do drink beer, significantly more ($p < .01$) DWI drivers stated that they consume a heavy quantity of beer (50% reported 5 bottles or more) than those who report consumption of a light quantity (13% reported 2 bottles or less) (see Table 5-8 and Figure 6-2). Among DWIs who drink beer, 7 out of 8 consume at least 3 bottles per sitting, which occurs at least several times a month.

Liquor is reported as being consumed less frequently than beer, and significantly fewer ($p < .01$) DWIs drink liquor daily (24%) than beer (67%) (see Table 5-7 and Figure 6-3). However, when they do drink liquor, the DWI drivers reportedly consume prodigious quantities; 33% report that they usually drink 3-5 shots of liquor at one time, whereas, 47% report an astounding consumption of half a pint or more at a sitting (see Table 5-8 and Figure 6-4). Thus, among DWI drivers who drink liquor, 80% typically drink 3 or more shots at a sitting.

As noted in the chapter on roadblock comparison groups, a classification system based on reported usual frequency and quantity of alcohol consumption per sitting was developed to reflect the likelihood that a person would attain an impairing amount of alcohol in his blood. The resultant Frequency-Quantity Index (FQI) is based upon that beverage which is consumed most fre-

Table 5-7

Drinking Patterns According to Reported Usual Consumption
Frequency of Beer, Wine, and Liquor Among the Six Study Groups

Reported Consumption	Crash				Roadblock		Clear-record		Citation			
	Fatality		Hospital				Comb F+H		DWI		Non-DWI	
	N	%	N	%	N	%	N	%	N	%	N	%
Beer frequency												
Never[a]	(9)	-	(11)	-	(334)	-	(19)	-	(2)	-	(7)	-
Monthly	4	17	10	42	163	24	17	39	4	8	6	18
Weekly	3	13	6	25	241	35	13	30	12	25	9	27
Daily	17	71	8	33	276	41	14	32	32	67	18	55
Total	24		24		680		44		48		33	
Liquor frequency												
Never[a]	(12)	-	(9)	-	(408)	-	(16)	-	(13)	-	(15)	-
Monthly	12	57	17	65	241	48	28	60	17	46	20	80
Weekly	6	29	4	15	133	26	12	26	11	30	4	16
Daily	3	14	5	19	132	26	7	15	9	24	1	4
Total	21		26		506		47		37		25	
Wine frequency												
Never[a]	(29)	-	(24)	-	(744)	-	(24)	-	(35)	-	(28)	-
Monthly	2	40	10	91	115	67	32	82	8	53	10	83
Weekly	1	20	1	9	27	16	5	13	5	33	1	8
Daily	2	40	0	0	30	17	2	5	2	13	1	8
Total	5		11		172		39		15		12	

[a]Drivers who reportedly never drink were excluded from determination of percents in this table. They were also excluded from all subsequent analyses of drinking patterns unless otherwise noted.

Table 5-8

Drinking Patterns according to Reported Usual Consumption Quantity of Beer, Wine, and Liquor among the Six Study Groups

Reported Consumption	Crash				Roadblock		Clear-record		Citation			
	Fatality		Hospital				Comb F+H		DWI		Non-DWI	
	N	%	N	%	N	%	N	%	N	%	N	%
Beer quantity												
Light	15	63	12	50	474	69	34	77	6	13	12	36
Medium	5	21	8	33	116	17	6	14	18	38	12	36
Heavy	4	17	4	17	95	14	4	9	24	50	9	27
Total	24		24		685		44		48		33	
Liquor quantity												
Light	13	62	18	69	329	66	33	70	7	19	12	50
Medium	5	24	4	15	129	26	12	26	12	33	8	33
Heavy	3	14	4	15	41	8	2	4	17	47	4	17
Total	21		26		499		47		36		24	
Wine quantity												
Light	4	80	11	100	153	88	36	92	4	27	9	75
Medium	0	0	0	0	17	10	3	8	7	47	2	17
Heavy	1	20	0	0	3	2	0	0	4	27	1	8
Total	5		11		173		39		15		12	

quently and in largest quantity, regardless of whether it is beer, liquor, or wine. Light drinking is defined as 1-2 drinks per sitting, medium drinking as 3-4 drinks per sitting, and heavy drinking as 5 or more drinks per sitting. Distributions of drinking patterns according to frequency-quantity and quantity-frequency for preferred beverage are presented in Table 5-9 for all six study groups.

Due to the importance of quantity of alcohol consumption, regardless of frequency, additional distributions of drinking patterns according to quantity and to a modified Quantity-Frequency Index for preferred beverage are presented in Table 5-10 (as well as the distribution according to frequency for preferred beverage). The modification consisted of reducing the nine-category QFI of Table 5-9 to a four-category QFI, in which respondents classified as having a light QFI in the four-category system include all those in the nine-category system who were classified as light-monthly and light-weekly, whereas those classified here as light-medium include the light-daily and medium-monthly categories; the mediums include the previous medium-weekly and medium-daily categories; and the heavies include the previous heavy-monthly, heavy-weekly, and heavy-daily categories. It should be noted again that all FQI and QFI data are determined on the basis of the most preferred beverage, defined as the one which was consumed most frequently and in largest quantity.

Examination of the DWI data in Tables 5-9 and 5-10 shows several important relationships (see also Figures 6-5 to 6-7). First, almost one-third (31%) of the DWI drivers can be categorized as heavy-daily drinkers, and almost two-thirds (60%) of them are reportedly heavy drinkers, regardless of frequency. In other words, 91% of DWI who admitted they drank stated that they usually consume three or more drinks per sitting, whereas 60% reported a typical consumption of five or more drinks per sitting. Second, in Table 5-10, significantly more DWI drivers were found in the heavy QFI category

Table 5-9

Drinking Patterns According to Reported Usual Frequency-quantity and Quantity-frequency Index for Preferred Beverage Among Six Study Groups

Index	Crash				Roadblock		Clear-record		Citation			
			Hospital				Comb F+H		DWI		Non-DWI	
	N	%	N	%	N	%	N	%	N	%	N	%
Frequency-quantity												
Monthly-light	6	23	8	31	197	20	15	28	0	0	3	9
-medium	1	4	3	11	68	7	6	11	2	4	3	9
-heavy	1	4	2	8	24	2	0	0	2	4	4	12
Total	8	31	13	50	289	29	21	39	4	8	10	30
Weekly-light	2	8	2	8	174	18	7	13	1	2	5	15
-medium	0	0	2	8	72	7	5	9	7	15	4	12
-heavy	2	8	2	8	46	5	2	4	12	25	3	9
Total	4	16	6	24	292	30	14	26	20	42	12	36
Daily-light	6	23	2	8	248	26	12	22	3	6	3	9
-medium	5	19	3	11	90	9	5	9	6	13	6	18
-heavy	3	12	2	8	45	5	2	4	15	31	3	9
Total	14	54	7	27	383	40	19	35	24	50	12	36
FQ Total	26		26		964		54		48		34	
Quantity-frequency												
Light-monthly	6	23	8	31	197	20	15	28	0	0	3	9
-weekly	2	8	2	8	174	18	7	13	1	2	5	15
-daily	6	23	2	8	248	26	12	22	3	6	3	9
Total	14	54	12	46	619	64	34	63	4	8	11	33
Medium-monthly	1	4	3	11	68	7	6	11	2	4	3	9
-weekly	0	0	2	8	72	7	5	9	7	15	4	12
-daily	5	19	3	11	90	9	5	9	6	13	6	17
Total	6	23	8	30	230	23	16	29	15	32	13	38
Heavy-monthly	1	4	2	8	24	2	0	0	2	4	4	12
-weekly	2	8	2	8	46	5	2	4	12	25	3	9
-daily	3	12	2	8	45	5	2	4	15	31	3	9
Total	6	24	6	24	115	12	4	8	29	60	10	30
QF Total	26		26		964		54		48		34	

Table 5-10

Drinking Patterns According to Reported Usual Frequency and Usual Quantity and to a Modified 4-Category Quantity-frequency Index for Preferred Beverage Among the Six Study Groups

Index	Crash				Roadblock		Clear-record		Citation			
	Crash-F		Crash-H				Comb F+H		DWI		Non-DWI	
Quantity-frequency	N	%	N	%	N	%	N	%	N	%	N	%
Light	8	31	10	39	371	38	22	41	1	2	8	24
Light-medium	7	27	5	19	316	33	18	33	5	10	6	18
Medium	5	19	5	19	162	17	10	19	13	27	10	29
Heavy	6	23	6	23	115	12	4	7	29	60	10	29
Total	26	100	26	99	964	100	54	100	48	99	34	100
Quantity												
Light	14	54	12	46	619	64	34	63	4	8	11	32
Medium	6	23	8	31	230	24	16	30	15	31	13	38
Heavy	6	23	6	23	115	12	4	7	29	60	10	29
Total	26	100	26	100	964	100	54	100	48	99	34	99
Frequency												
Monthly	8	31	13	50	289	30	21	39	4	8	10	29
Weekly	4	15	6	23	292	30	14	26	20	42	12	35
Daily	14	54	7	27	383	40	19	35	24	50	12	35
Total	26	100	26	100	964	100	54	100	48	100	34	99

than in the medium ($p < .05$), the light-medium ($p < .01$), or the light ($p < .01$) category. Also, significantly fewer DWI drivers were found in the monthly-light FQI category than in the weekly-light ($p < .05$) or in the daily-light category ($p < .01$).

5.1.4 Relation between drinking and driving patterns. Excluding the five DWI respondents who claim that they never drive after drinking, 45% of the remainder reported that they drive after drinking half the time or more, whereas 55% reported that they do so less than half the time (see Table 5-11).

5.1.5 Driving patterns. Distributions of crashes in the previous five years according to self-report are presented in Table 5-12 for all but the deceased-driver group. Unfortunately, no comparable data could be obtained for crashes in the previous five years according to official record checks because of the Vermont Motor Vehicle Department practice of purging accident reports three years after the time of the crash.

Examination of the DWI crash data in Table 5-12 indicates that slightly over half of these respondents (62%) reported having had no crashes during the five-year period, whereas 18% reported having had one crash and 20% reported having had two or more crashes. The differences between the former category and each of the latter two are both statistically significant ($p < .01$).

Distributions of license suspensions during all years according to official record check are also presented in Table 5-12. Among DWI respondents, 40% had never had their license suspended, 16% had had it suspended one time, and 44% had had two or more suspensions.

Distributions of citations received during the previous five years and during all previous years according to official record checks are presented in Table 5-13 for the six study groups. It should be noted that

Table 5-11

Drinking and Driving Patterns by Frequency and Percent

Frequency of driving after drinking	Crash		Roadblock		Clear-record		Citation			
	Hospital				Comb F+H		DWI		Non-DWI	
	N	%	N	%	N	%	N	%	N	%
Never drive after drinking	9	35	277	29	17	33	5	11	2	6
Less than 1/2 the time	14	54	385	40	23	45	23	49	15	45
1/2 the time or more	3	12	292	31	11	22	19	40	16	48
Total	26		954		51		47		33	

Table 5-12

Crashes in Previous Five Years According to Self-report and License Suspensions According to Official Record Check by Frequency and Percent

	Crash[a]				Roadblock		Clear-record		Citation			
	Fatality		Hospital				Comb F+H		DWI		Non-DWI	
	N	%	N	%	N	%	N	%	N	%	N	%
Crashes/5 yrs.												
None	-	-	13	34	757	66	62	98	31	62	14	35
One	-	-	11	29	288	25	1	2	9	18	9	23
Two or more	-	-	14	36	109	9	0	0	10	20	17	42
Total	-		38		1154		63		50		40	
Suspensions												
None	74	75	34	89	766	86	58	92	20	40	24	60
One	13	13	3	8	82	9	5	8	8	16	9	23
Two or more	12	12	1	3	46	5	0	0	22	44	7	18
Total	99		38		894		63		50		40	

[a] Excluding the crash for which the driver was sampled.

Table 5-13

Citations Received During Previous Five Years and All Previous Years According to Official Record Check by Frequency and Percent

	Crash				Roadblock		Clear-record		Citation[a]			
	Fatality		Hospital				Comb F+H		DWI		Non-DWI	
	N	%	N	%	N	%	N	%	N	%	N	%
Citations/ 5 yrs.												
None	73	73	28	74	737	82	63	100	15	30	11	28
One	15	15	6	16	116	13	0	0	16	32	15	38
Two or more	12	12	4	11	45	5	0	0	19	38	14	35
Total	100		38		898		63		50		40	
Citations/ all yrs.												
None	65	66	27	71	642	72	54	86	9	18	10	25
One	17	17	6	16	154	17	7	11	8	16	12	30
Two or more	17	17	5	13	100	11	2	3	33	66	18	45
Total	99		38		896		63		50		40	

[a]Excluding the citation for which the driver was sampled

the DWI citation which led to a driver being sampled was excluded from the frequencies presented in Table 5-13. Examination of the citations received by the DWI drivers during the previous five years showed that 30% had had none, 70% had had one or more, and 38% had had two or more. The data for citations during all previous years show an even more astounding picture in which only 18% had never received a citation, but 82% had received one or more, and 66% had received two or more. Thus, the number of previous citations seems to be well worth further examination as a basis for identifying drivers who may have an elevated likelihood of receiving a DWI citation.

5.1.6 Summary. A statistical impression of the "typical" DWI driver in this sample can be fabricated by examining the medians and modes of the selected variables (see Table 5-2). However, this fabrication should not be taken too literally (see Note at end of this chapter). Thus, he would be a 36-year-old, married, laborer who has worked for two employers during the past five years. He was very reluctant to come in for interviewing and had to be tracked down individually through one obsolete address. In terms of his patterns of alcohol use, the average DWI drinks beer daily and liquor at least monthly, but drinks little wine. When he drinks, he typically downs 3 to 4 bottles of beer or 3 to 5 shots of liquor. When interviewed, he had had something to drink within the previous hour-and-a-half, and had had six bottles of beer and/or one shot of liquor during the previous 24 hours. Furthermore, he says that he drives after drinking more than half the time. In terms of his driving record, he has already had at least one crash, two previous citations, and one license suspension. His DWI citation probably resulted from a crash which occurred on a Saturday night between 8:00 pm and midnight. His subsequent blood test showed a blood alcohol concentration of 200 mg%.

5.2 NON-DWI CITATIONS

In an attempt to provide a relevant frame of reference or counterpart for the DWI respondents, a sample of motorists was drawn from the population of those who had been convicted of some serious moving violation (see description in Method chapter). Some of these individuals had probably been drinking at the time of arrest, and at least a few were no doubt legally impaired, but unfortunately no chemical tests are performed in such cases and thus no blood-alcohol-concentration data are available.

5.2.1 Biographical variables. It is clear that non-DWI citations are also a male phenomenon, with only one female (3%) in the sample (see Table 5-3). Furthermore, the age distribution indicates that the young drivers are significantly ($p < .01$) over-represented among non-DWI respondents, with almost three-quarters (73%) under 25 years of age and only 27% from 25-59 years of age. None of these respondents was sixty years or older, which is an interesting contrast to the proportion of DWI drivers who were sixty or over (16%), and which may reflect the contribution of heavy alcohol consumption to deviant driving behavior. It would follow from the relatively large proportion of young drivers among non-DWI citation respondents that proportionally many would be single (53%) and proportionally few would be widowed, divorced, or separated (5%), with the remainder being married (42%). Age may also be a contributing factor to the high proportion (60%) of these drivers found in the lower occupational level, as opposed to 13% in the middle level and only 8% in the upper occupational level (see Table 5-4).

5.2.2 Patterns of alcohol use. As a group, the non-DWI citation drivers do not report as heavy consumption of alcohol as do the DWIs. However, they are apparently far from being teetotalers. Referring to Table 5-7, 83% of non-DWI citation respondents reported that they drink beer, 63% reported drinking liquor, and 30% reported drinking wine. Regarding the frequency of drinking beer, half (55%) stated that they drink it daily or several times a week, whereas 18% report drinking it as infrequently as monthly or less. When they do drink beer, the non-DWI citation drivers are more or less equally distributed over the three categories of consumption quantity, that is, approximately one-third each in light, medium, and heavy.

Liquor is reported as being consumed much less frequently than beer, and significantly fewer ($p < .05$) non-DWIs drink liquor daily (4%) than drink beer daily (55%) which is probably attributable to the large proportion of younger drivers in this group. Also, significantly fewer ($p < .01$) drink liquor daily (4%) than drink it monthly (80%). When they do drink liquor, more non-DWIs reported consuming a light amount (50%) than either medium (33%) or heavy (17%) amounts. Thus, half (50%) report typically drinking three or more shots of liquor at a sitting.

Referring to the FQI and QFI for preferred beverage (Tables 5-9 and 5-10), relatively few of the non-DWI citation drivers are reportedly heavy-daily drinkers (9%), whereas approximately one-third (30%) of them are reportedly heavy drinkers regardless of frequency. Approximately equal proportions of these drivers are found in each third of the FQI distribution, as well as in each third of the QFI distribution. Additional confirmation of this central tendency is found in Table 5-10, in which almost half (47%) of the non-DWI citation drivers are found in the two combined middle categories (light-medium, and medium). Therefore, as a group, these drivers seem to cluster in the middle of the distribution of reported consumption of alcohol.

5.2.3 Relation between drinking and driving patterns. Approximately half (48%) of the non-DWI citation drivers reported that they drive after drinking half the time or more, which is a significantly greater ($p < .05$) proportion than those (6%) who claim that they never drive after drinking (see Table 5-11).

5.2.4 Driving patterns. Referring to the self-reported numbers of crashes in the previous five years, 35% of non-DWI drivers claimed to have had none, 23% claimed to have had only one, but an astounding 42% reported having had two or more crashes during this period (see Table 5-12). Thus, some two-thirds of the non-DWI citation drivers had had one or more crash during the previous five years, a proportion which is especially significant when the relatively low median age of this group is considered, namely, 25 years (see Table 5-2).

Regarding previous license suspensions, according to an official record check, almost two-thirds of the non-DWI citation drivers were found to have had none, whereas 23% had had one suspension and 18% had had two or more suspensions (see Table 5-12). Thus, over one-third (41%) of these drivers with serious moving violations had had one or more previous license suspension.

Examination of the distributions of previous citations according to official record checks (Table 5-13) shows that during the previous five years, only about one-fourth of the non-DWI drivers received no other citation than the one for which they were sampled, whereas 38% had had one such citation and 35% had had two or more such citations. A similar distribution was obtained for other citations in all previous years, except that 3% of these respondents no longer qualified for the "none" category and the proportion with "two or more" showed a 10% increase. It is especially noteworthy that three-fourths of these non-DWI drivers were repeaters, having already come to the attention of enforcement agencies and been convicted of one or more violation during the previous five years (73%), or during all their years of driving (75%). These findings have strong implications concerning the optimal target population for future countermeasure programs in view of the relatively large proportion of younger drivers in the non-DWI citation sample. Thus, as with the DWI drivers, this variable would seem to warrant further investigation as a potential predictor variable

5.2.5 Summary. A statistical profile can also be artificially constructed for the assumedly "typical" respondent in this sample, one who was convicted of a serious, non-DWI, moving violation (but see Note at end of chapter). Examination of the medians in Table 5-2 indicate that this driver would be a 25-year-old, single, male laborer who has worked for two employers during the past five years. He was also very reluctant to come in for interviewing and had to be tracked down individually through one obsolete address. In terms of his patterns of alcohol use, the typical non-DWI citation driver prefers beer which he usually drinks at least once a week. He also drinks liquor at least monthly, but normally does not drink wine. When he drinks, he typically has 3 to 4 bottles of beer at a sitting and/or 3 to 5 shots of liquor. When interviewed, he had had something to drink within the previous twenty-four hours. Furthermore, he said that he drives after drinking about half the time or more. In terms of his driving record, he has already had two crashes, one previous citation, and one license suspension. Thus, when he was cited for the moving violation, the odds are about 50/50 that he had had something to drink, but probably not enough for him to have reached legal impairment.

5.3 HOSPITALIZATION CRASH

The drivers in this group were involved in the serious-injury crashes that were selected to approximate time and place of the fatal crashes which were studied (as described in the Method chapter). Unfortunately, no chemical tests are routinely performed on such drivers and thus no blood-alcohol-concentration data are available for Crash-H respondents.

5.3.1 Biographical variables. Referring to the sex distribution in Table 5-3, two-thirds of the Crash-H drivers were male and the remaining one-third were female. Regarding age, the median was 21 years, and slightly more than half of these drivers (52%) were under age 25, with 40% in the 25- to 59-year-old category, and 8% in the 60-or-over category. Regarding marital status, about half of the Crash-H drivers were married (53%), whereas 39% were single and 8% widowed, divorced, or separated. Regarding occupational level, one-third of the respondents were categorized as "other," which reflects the relatively large number of females in this sample who were housewives. Only 16% of the Crash-H drivers were categorized as being in the lower occupational level, with 34% in the middle level, and 16% in the upper level.

5.3.2 Patterns of alcohol use. Liquor is apparently the most preferred beverage among the Crash-H drivers, with 74% reporting that they drink liquor as opposed to 69% who report drinking beer and 31% who report drinking wine (see Tables 5-7 and 5-8). Regarding the stated frequency of usual liquor consumption, significantly more ($p < .01$) Crash-H drivers reported drinking liquor monthly or less (65%) than either weekly (15%) or daily (19%). When they do drink liquor, significantly more ($p < .01$) Crash-H drivers stated that they consume a light quantity of liquor (69% reported 1 or 2 shots) than those who reported consuming a medium quantity (15% said 3 to 5 shots) or a heavy quantity of liquor (15% said one-half pint or more).

Beer is reported as being consumed more frequently than liquor, however, with 33% reporting daily, 25% reporting weekly, and 42% reporting monthly use of beer. When they do drink beer, 50% of Crash-H drivers reportedly drink light quantities (2 bottles or less), 33% drink medium quantities (3 or 4 bottles), and 17% drink heavy quantities (5 bottles or more). Thus, among Crash-H drivers who drink beer, 50% typically drink 3 bottles or more at a sitting.

Examination of the FQI and QFI data in Tables 5-9 and 5-10 shows that a large proportion of Crash-H drivers are relatively moderate drinkers. Somewhat more Crash-H drivers reported a light or light-medium QFI for preferred beverage (58%) than those who reported a medium or heavy QFI (42%). None of the within-group differences in FQI or QFI is significant.

5.3.3 Relation between drinking and driving patterns. About one-third (35%) of the Crash-H drivers claim that they never drive after drinking, whereas about half (54%) report that they drive less than half the time after drinking and 12% report driving after drinking half the time or more (see Table 5-11).

5.3.4 Driving patterns. Referring to the crash data for the previous five years (Table 5-12), 34% of Crash-H drivers reported having had no crash other than the one for which they were sampled, 29% reported having had one other crash, and 36% as having had two or more other crashes. Thus, about two-thirds of these drivers had apparently been involved in two or more crashes during the previous five years, including the one for which they were sampled.

The license-suspension distribution in Table 5-12 shows that, on the official record check, the overwhelming majority (89%) of the Crash-H drivers were found to have had no license suspensions, whereas significantly fewer ($p < .01$) were found to have had either one suspension (8%) or two or more suspensions (3%).

Referring to the official record check data in Table 5-13, three-fourths of the Crash-H drivers were found to have received no citations either in the previous five years or in all previous years combined, whereas 16% were found to have had one or more citation in either period and the remainder (11% and 13% respectively) to have had two or more citations during these periods. Thus, about one-fourth of the Crash-H drivers had been convicted of some serious moving violation, excluding any which may have resulted from the crash for which they were sampled.

5.3.5 Summary. A statistical impression of the "typical" hospitalization-crash driver can be fabricated for this sample also, although the midpoints of the distributions of selected variables are not as clear-cut here as they were for the DWI and non-DWI citation drivers (but see Note at end of chapter). Thus the "average" Crash-H driver would be male, age 21, and married; he would probably be a blue-collar or clerical worker and have worked for two employers during the past five years. He was quite willing to come in for interviewing or, alternatively, to be interviewed in his easily located home. In terms of his patterns of alcohol use, the "average" Crash-H driver drinks beer and liquor monthly, but wine seldom, if ever. When he drinks, he usually has 1 to 2 bottles of beer and/or 1 to 2 shots of liquor at one sitting. When interviewed he had not had a drink in the previous 24 hours; and he drives after drinking less than half of the time. In terms of his driving record, he has already had one previous crash, but no citations or license suspensions.

5.4 CLEAR-RECORD DRIVERS

This group was comprised of drivers from the roadblock comparison groups who had had no crash or citation in the previous five years. Since the data from the Clear-F and Clear-H groups were so similar, the results for both groups are reported here in a single section, and only the few outstanding differences are noted.

5.4.1 Biographical variables. Referring to the sex distribution in Table 5-3, three-fourths of clear-record drivers were male and the remaining one-fourth were female. Regarding age, the median was 38 years, and approximately one-fourth (23%) of these drivers were under 25, with 64% in the 25- to 59-year-old category and 13% in the 60-or-over category. Regarding marital status, the vast majority of the clear-record drivers were married (75%), whereas 24% were single and less than 2% were widowed, divorced, or separated. Regarding occupational level, half of the respondents (51%) were categorized as upper level, 23% as middle level, only 8% as lower level, and 18% as other (see Table 5-4).

5.4.2 Patterns of alcohol use. As a group, the clear-record drivers reported a lighter consumption of alcohol than the other groups already examined in this chapter. Liquor is slightly more preferred than beer (75% and 70% respectively), and a relatively large proportion (62%) report at least occasional consumption of wine (see Table 5-7). Regarding the stated frequency of usual liquor consumption (see Figure 6-3), significantly more ($p < .01$) clear-record drivers reported drinking liquor monthly or less (60%) than either weekly (26%) or daily (15%). When they do drink liquor, significantly more ($p < .01$) clear-record drivers stated that they consume a light quantity of liquor (70% reported 1 or 2 shots) than those who reported consuming either a medium quantity (26% said 3 to 5 shots) or a heavy quantity (4% said 6 shots or more) (see Table 5-8 and Figure 6-4).

Beer is reported as being consumed more frequently than liquor, however, with 32% reporting daily, 30% reporting weekly, and 39% reporting monthly use of beer (see Table 5-7 and Figure 6-1). When they do drink beer, significantly more clear-record drivers reportedly drink light quantities (77% said 2 bottles or less) than either medium quantities (14% said 3 or 4 bottles) or heavy quantities (9% said 5 bottles or more) (see Table 5-8 and Figure 6-2). Thus, among clear-record drivers who drink beer, 23% typically drink 3 bottles or more at a sitting.

Further confirmation for the relatively light consumption of alcohol reported by the clear-record drivers is found in the FQI and QFI data for preferred beverage (see Tables 5-9 and 5-10 and Figure 6-7). Three-fourths (74%) of the clear-record drivers are found in the combined QFI categories of light (41%) and light-medium (33%), whereas 19% are found in the medium category and only 7% in the heavy QFI category. The proportion in the latter category is significantly less than in either of the first two (light, and light-medium). Thus, <u>among clear-record drivers who reportedly drink, only 23% stated that they typically have three or more drinks at a sitting</u>.

5.4.3 <u>Relation between drinking and driving patterns</u>. One-third (33%) of clear-record drivers claim that they never drive after drinking, whereas 45% report that they drive less than half the time after drinking and 22% report driving after drinking half the time or more (see Table 5-11 and Figure 6-10).

5.4.4 Driving patterns. No crashes should be listed for any clear-record driver in Table 5-12 since absence of crashes was one of the criteria for their being sampled. (Thus, one individual was apparently either sampled in error or was involved in a crash in the elapsed time between the roadblock and the intensive interview.) Similarly, official record checks had confirmed that none of these respondents had received citations during the previous five years. However, a few had received citations in all previous years combined, namely, 11% had received one citation and 3% had received two or more citations (see Table 5-13 and Figure 6-13). Thus, 86% of these respondents who had not received a citation in the previous five years had also not received a citation during all their years of driving. Similarly, 92% of these clear-record drivers had never had their licenses suspended, as opposed to the 8% whose licenses had been suspended once (see Table 5-12 and Figure 6-12).

5.4.5 Summary. A statistical profile of the assumedly "typical" clear-record driver can also be artificially fabricated by examination of the medians in Table 5-2 (but see Note at end of chapter). Thus, the "average" clear-record driver would be male, age 38, and married; he would be in the upper occupational level and would probably be a semi-professional, a manager, proprietor, executive, farm owner, or some sort of salesman, and would have worked for two employers during the past five years. He was most willing to come in for interviewing. In terms of his patterns of alcohol use, the "average" clear-record driver drinks beer and liquor monthly or less, and wine on occasion. When he does drink, he usually has 2 bottles of beer and/or 1 to 2 shots of liquor at a sitting. When interviewed, he had not had a drink in the last 24 hours; and he drives after drinking less than half of the time. In terms of his driving record, he has never had a crash, citation, or license suspension during all his years of driving.

NOTE: Regarding the statistical profiles presented in the section summaries of this chapter, it is especially important to warn against literal acceptance of these fabricated impressions as representing any sort of true picture of the typical DWI driver, typical non-DWI citation driver, or typical driver of any other kind since the frequency distributions may deviate substantially from the usually assumed bellshaped curve, i.e., the distribution may be skewed or, worse yet, it may be bimodal or multimodal, in which case even a median cannot be taken as a "typical" statistic for the group.

GROUP COMPARISONS

Many of the within-group findings reported in previous chapters become especially meaningful when viewed in juxtaposition to findings from other points along the continuum of drivers as sampled in this study. Therefore, selected comparisons between and among relevant combinations of study and comparison groups are presented together in this chapter.

As in the preceeding chapter on non-fatality study groups, this chapter is also limited to selected variables chosen on the same two criteria: (a) assumed importance, and (b) availability of comparable data from all drivers within each of the groups. Those variables which met these criteria are analyzed on three different levels and are presented in three separate sections of this chapter. First, the groups are compared as they originally came to our attention, that is, widely divergent in age and distribution of blood alcohol concentrations, two extremely important intervening variables with respect to other biographical correlates.

Second, those groups for which alcohol information is available are compared after taking into account the divergency in alcohol concentrations, which has been done by using alcohol-specific tables, e.g., fatalities with alcohol are compared only with roadblock and DWI drivers with alcohol.

Third, age is also taken into consideration by limiting the comparison of groups at this level only to persons who were age 25 or older and who had high alcohol concentrations. For ultimately, we wish to answer the questions: "In what way are fatalities with alcohol similar to or dissimilar from DWIs or roadblock drivers with alcohol?" "Do enough similarities exist so that identification of one group can be used to predict which individuals are likely to be found in another group?"

Finally, a fourth section of this chapter contains separate discussions of some important data which do not lend themselves readily to consideration at these three levels of treatment, e.g., driver attitudes and personality variables.

Thus, in this chapter, selected data from all eight samples are organized and presented under the following topical headings: (1) general comparisons of groups, in terms of biographical information, alcohol use, blood alcohol concentration, drinking and driving, and driving patterns; (2) comparisons of drivers having no detectable alcohol with drivers having high alcohol concentrations, in terms of biographical information, alcohol use, drinking and driving, and driving patterns; (3) comparisons of drivers who were age 25 or older and who had high alcohol concentrations, in terms of biographical information, alcohol use, blood alcohol concentration, drinking and driving, and driving patterns; and (4) specific comparisons of groups, in terms of Quantity-Frequency Index of alcohol consumption, multivariate discriminant analysis, Driver Attitude Survey, and personality variables.

Simple within-group tabulations of data from the selected variables were presented in previous chapters (and will be specifically referenced in the following sections), whereas cross-tabulations are presented in this chapter. The same statistical considerations obtain in this as in the preceding chapter (see Section 5.0.1).

Due to the complexity of the comparisons, groups, and variables in this chapter, the most important summary points in each subsection have been underlined and are usually located near the subsection heading as an aid to the reader.

6.1 GENERAL COMPARISONS OF GROUPS

6.1.1 BIOGRAPHICAL VARIABLES

Regarding race, it was noted earlier that, since blacks constitute less than 1% of the Vermont population, the complete absence of blacks in the present study is not statistically surprising.

6.1.1.1 Sex. The distributions of male and female drivers in each group are presented in Table 5-3. Males were significantly over-represented in all study and comparison groups ($p < .01$). Furthermore, significantly more males were found among citation drivers (DWI, 97%, and non-DWI, 97%) than among drivers in any other group studied. However, because all groups were so predominantly composed of males, subsequent comparisons are not sex-specific.

6.1.1.2 Age. Younger drivers were found relatively more often in the non-DWI citation groups and both crash groups, whereas drivers in the middle age category were found relatively more often in the DWI, roadblock, and clear-record groups.

Many analyses in this chapter are based on age dichotomized at 25 years which was decided for several reasons: (1) to minimize age-dependent confounding on such variables as marital status; occupational level; number of jobs in the last five years; and citations, suspensions, and crashes in the past five years, as well as in all previous years; and (2) to compensate for the relatively small number of respondents in some subcategories.

The age distributions in each group are presented in Table 5-3, according to frequency and percent. The differences between the observed and the expected ages were significant ($p<.01$). The proportion of drivers in each age category was essentially the same among the roadblock, clear-record, and DWI drivers, whereas the younger driver was over-represented in the fatal injury, serious injury, and non-DWI citation groups. In fact, significantly more drivers under 25 years of age were found in the serious injury crash and non-DWI citation groups than in any other group ($p <.01$). Furthermore, cross-tabulation on age and sex indicated that almost all the younger drivers (under 25) in the two crash groups were male (fatal injury, 95%; and serious injury, 85%). As reported in the preceding chapter, significantly more drivers under age 25 (than over) were found within the non-DWI citation group ($p< .01$), whereas significantly more drivers in the middle age category (25-59) were found within the roadblock, the clear-record, and the DWI groups ($p< .01$).

Comparison of the age distributions in the two crash groups with their corresponding roadblock groups indicated that significantly greater proportions of these younger drivers are seriously or fatally injured than the proportions found in the estimated population-at-risk (fatally injured, $p< .05$; seriously injured, $p< .01$). In addition, significantly more younger drivers were found in the serious injury crash group than in the clear-record sample drawn from the respective roadblock comparison group for this crash sample ($p< .01$). Furthermore, significantly more drivers under 25 appear in the non-DWI citation group than in the DWI group ($p< .001$), and correspondingly, significantly fewer drivers in the middle age category were found in the non-DWI citation group than in the DWI citation group ($p< .01$).

6.1.1.3 Marital Status. Among persons age 25 to 59, significantly more DWIs (42%) did not have the assumedly stabilizing influence of a spouse compared with 14% of roadblock drivers.

The distributions of single, married, and (combined) widowed, separated, and divorced drivers in each group are presented in Table 5-3 for all ages combined, according to frequency and percent.

Since marital status tends to be age-related, however, cross-tabulations on these two variables were obtained in order to provide more precise data on the differences between groups than is apparent in Table 5-3. Among road-block drivers under 25 years of age, 70% were single, 30% married, and 0.3% widowed, separated, or divorced; and similar distributions of these younger drivers were found in the other samples. However, among roadblock drivers in the middle age category (25-59), 12% were single, 86% married, and 2% widowed, separated, or divorced. The strongest deviation from this pattern in the middle age category was found among DWIs, namely, twice as many were single (26%), fewer were married (58%), and proportionately many more were widowed, separated, or divorced (16%). Thus, combining the first and third categories, 42% of DWIs were not currently married.

6.1.1.4 Occupational level. Even when dichotomized at age 25, the DWI and non-DWI drivers are significantly over-represented in the lowest occupational category (i.e., laborers).

The distributions within each group for all ages combined are presented in Table 5-4. The coding of the four categories of occupational level is explained in Section 5.0.1 (Statistical Considerations).

Since occupational level also tends to be age-related, all groups were cross-tabulated on these two variables. Among younger drivers (under 25), the most important between-group differences were found in the lower occupational and the "other" categories. Thus, younger drivers in the lower occupational level constituted 36% of the fatal crash, 25% of the hospitalization crash, 23% of the roadblock, 13% of the clear-record, 36% of the DWI, and 55% of the non-DWI citation groups; whereas in the "other" category, the younger drivers constituted 27% of the fatal crash, 45% of the hospitalization crash, 33% of the roadblock, 60% of the clear-record, 27% of the DWI, and 24% of the non-DWI groups.

Among drivers in the middle age category (25-59), the most important findings include the lack of differences between the proportions found in the upper and middle occupational level in both crash groups and in their corresponding roadblock comparison groups (approximately one-third in each occupational category). By contrast, 63% of clear-record drivers in the 25-to-59-year category, but only 13% of the DWIs and 0% of non-DWI citation drivers were in the upper occupational level. On the other hand, 27% of roadblock drivers and 5% of clear-record drivers (25 to 59) were in the lower occupational level (i.e., laborers), in contrast to 45% of DWI and 73% of non-DWI drivers. Whether this relative disproportion represents a selective bias on the part of the police or whether it represents an accurate indication of the actual driving behavior of laborers, or both (as suggested by Sheffield Edwards) cannot be determined from the present data, but remains an important question to be pursued in future research.

Regarding the number of employers during the preceeding five years, no significant differences were found within or between groups, and no significant differences were found when this variable was cross-tabulated by age.

6.1.2 PATTERNS OF ALCOHOL USE

Major consideration is given to alcohol variables on the assumption that they provide a pivotal basis for differentiating drivers who get into trouble on the highway with alcohol from drivers who do not. The indicators of alcohol use discussed in this section are: (1) reported alcohol consumption, and (2) the alcohol-consumption index. The obtained blood or breath alcohol concentrations are measures of actual alcohol consumption on one occasion while driving (and therefore presumably an indication of other occasions) and are treated separately in the next subsection.

6.1.2.1 Reported alcohol consumption. DWIs drink beer significantly more heavily than drivers in any other group and significantly more frequently than all except deceased drivers and non-DWI citation drivers. The proportion of DWI drivers (80%) who typically drink at least three shots of liquor at a sitting was significantly greater than that in any other group ($p < .01$).

Each interviewed driver was asked how often he usually drinks beer (or liquor, or wine). Unless he stated that he never drinks alcoholic beverages, he was then asked how much beer (or liquor, or wine) he usually drinks at one time. Distributions of the resulting responses are presented in Table 5-7 for reported frequency of drinking and in Table 5-8 for reported quantity consumed.

The proportions of drivers in each group who responded "never" for all three beverages were: deceased drivers, 21%; hospitalization crash, 21%; roadblock, 16%; clear-record, 15%; DWI, 4%; and non-DWI, 4%. Since these individuals reported zero frequency of alcohol consumption, they were considered abstainers and excluded from subsequent analyses of alcohol use, except blood alcohol concentration. It is interesting to note the relatively small proportion of drivers for whom the empirical blood alcohol data were inconsistent with the verbal reports: 0.5% of roadblock drivers (who were between 20 and 99 mg%), 4% of DWIs (who were between 150 and 249 mg%), and 9% of next-of-kin reporting on deceased drivers (who were between 50 and 99 mg%--and were all under the legal age for consuming alcohol).

As was mentioned in Chapter 5 and earlier in this chapter, the analyses in this section (for all except the DWI sample) include both individuals who did not have alcohol and individuals who had alcohol at the time they were stopped or at the time of their index event. Because of this mixture, the possibility of bimodality on the alcohol related variables cannot be excluded. In fact, as the reader will note in reviewing the figures that follow, there is consistent indication that with respect to alcohol patterns, the DWI sample represents one population, the roadblock and clear-record driver preponderately represent a different population, and the fatalities appear to have been drawn from both populations. It is precisely for this reason, therefore, that a special section within this chapter has been devoted to alcohol-specific comparisons between those groups for whom we have the validating criterion of blood or breath alcohol concentration. (That is, alcohol-specific data are available for the roadblock, clear-record, deceased driver, and DWI groups, but not for serious injury or non-DWI citation groups.)

Regarding <u>beer</u>, the differences between the observed and the expected frequencies and quantities of consumption were significant ($p < .01$). Although usual <u>frequency</u> of alcohol consumption is probably not as important for highway safety as usual quantity of consumption, it is nevertheless noteworthy that the highest proportions of daily beer drinkers were found among deceased drivers (71%) and DWIs (67%), proportions which were significantly higher ($p < .01$) than those found in the serious injury crash, the roadblock, and the clear-record groups (see Figure 6-1 and Table 5-7).[1]

The DWI drivers were also outstanding on usual beer quantity (see Figure 6-2 and Table 5-8). That is, the 50% of DWIs who reportedly drink 5 bottles or more at a sitting was significantly greater than the proportion of such heavy beer drinkers in any other group ($p < .01$, except $p < .05$ for non-DWIs). In contrast to the DWIs (and to a lesser extent, the non-DWI citation group), most beer drinkers in the other groups reported consuming light quantities of beer (1 to 2 bottles per sitting).

Regarding liquor, the differences between the observed and the expected quantity (but not frequency) were significant ($p < .01$). Distributions of frequency of liquor consumption are presented in Figure 6-3 and Table 5-7. In terms of quantity, the DWI data were again most striking, with almost one-third of the liquor drinkers among them reporting that they usually consume a pint or more at a sitting (see Figure 6-4 and Table 5-8).

Group comparisons of the wine data are not presented here due to the small proportion of drivers in most groups who reported drinking wine.

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[1]For simplicity and clarity of presentation, the figures in Chapter 6 include only those groups for which blood alcohol data were available, i.e., deceased drivers, roadblock, clear-record, and DWI. However, information on the two excluded groups (i.e., hospitalization crash and non-DWI) is of course available in tabular form in Chapter 5.

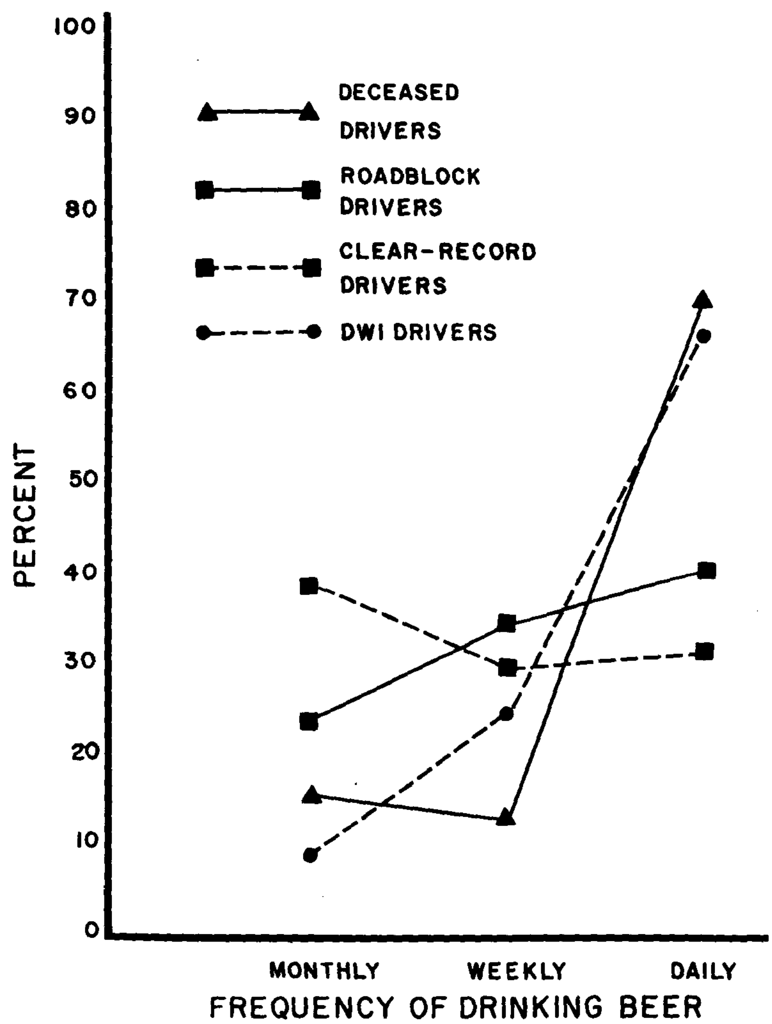

Figure 6-1 Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical monthly, weekly, or daily frequency of beer consumption.

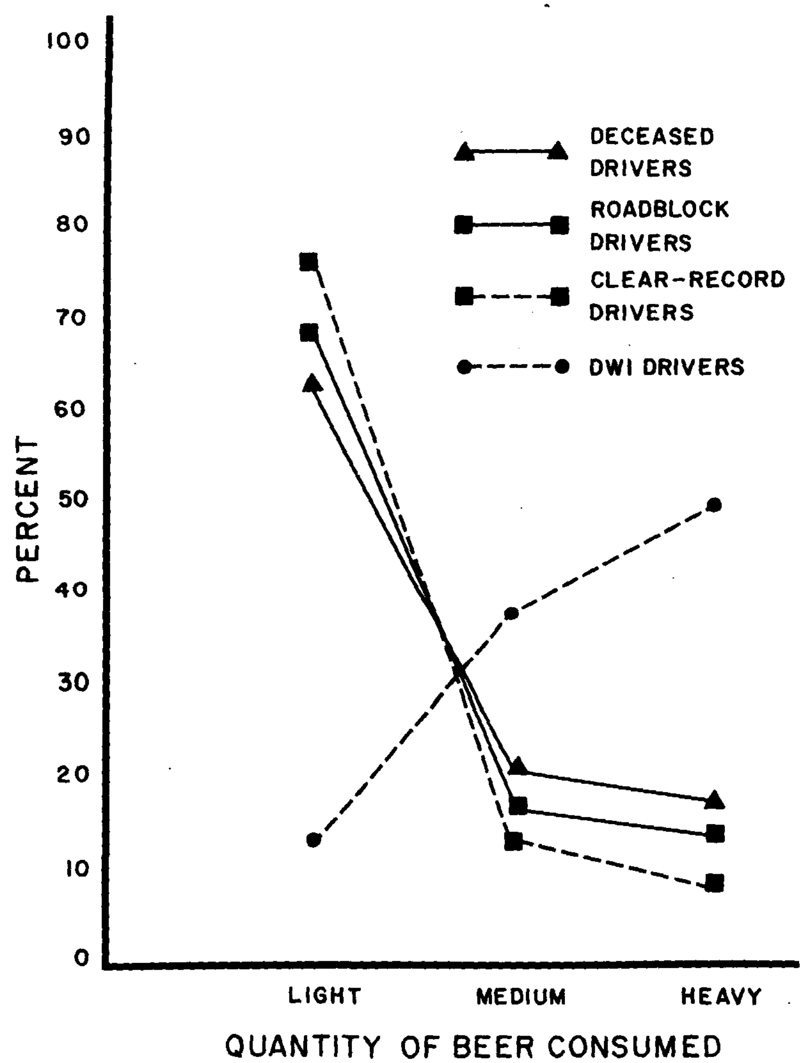

Figure 6-2 Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical light, medium, or heavy quantity of beer consumption.

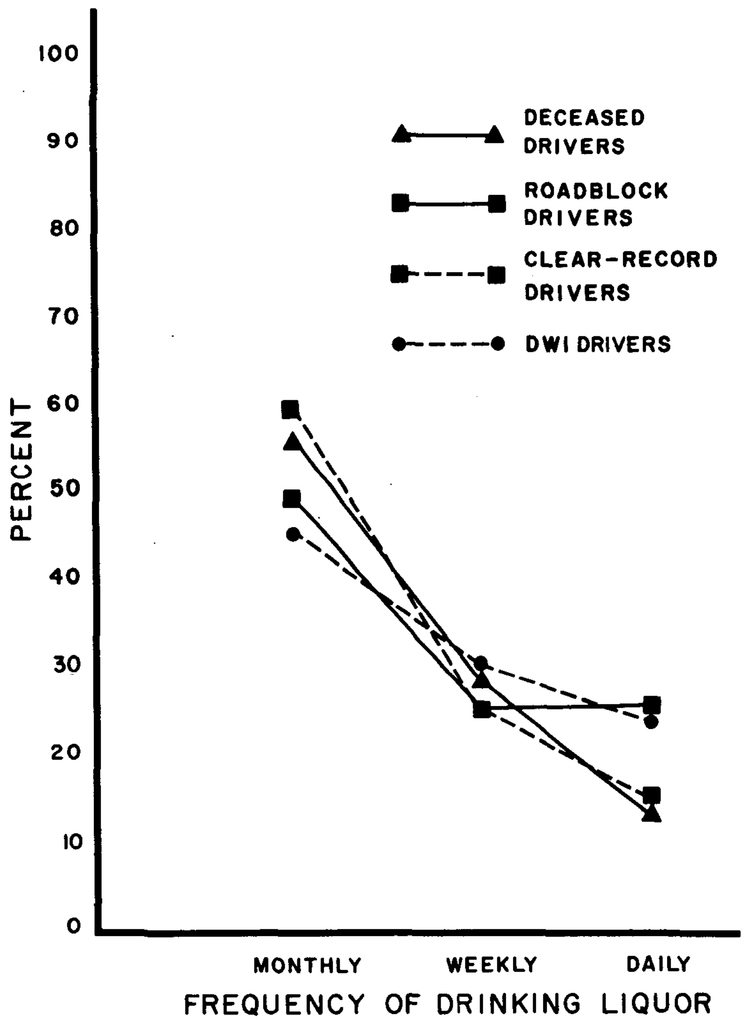

Figure 6-3 Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical monthly, weekly, or daily frequency of liquor consumption.

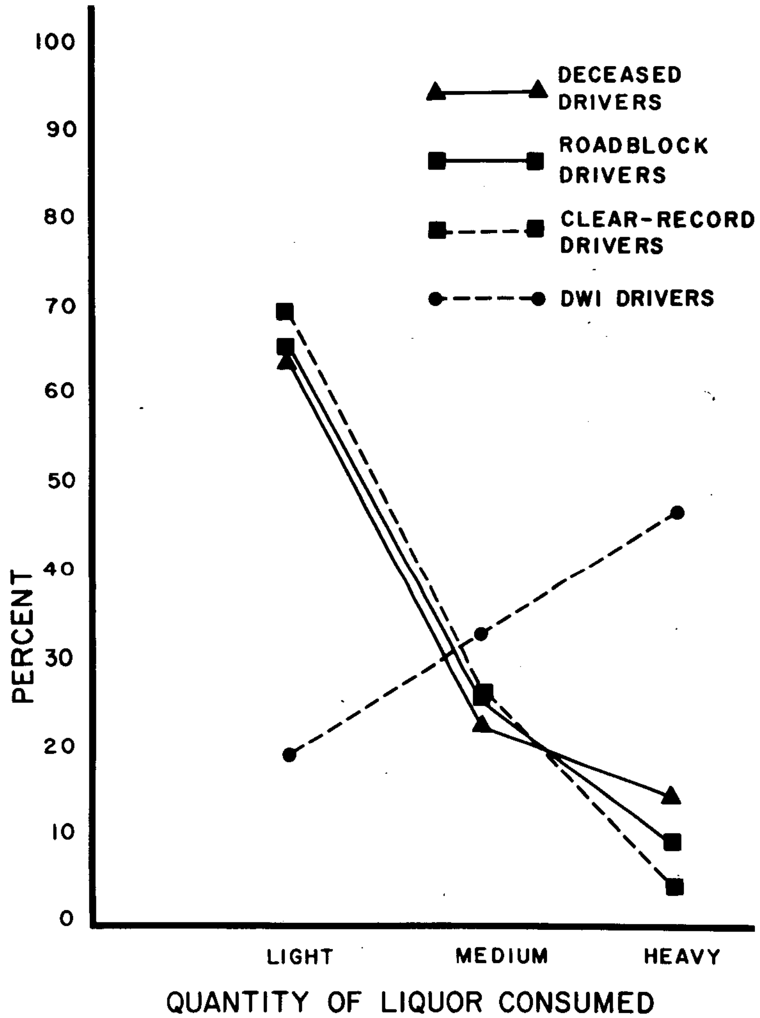

Figure 6-4 Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical light, medium, or heavy quantity of liquor consumption.

6.1.2.2 The alcohol-consumption index. The DWI patterns of drinking are distinctly different from the typical patterns in the other groups, especially in any consideration involving the usual quantity of consumption.

As noted in the previous chapter, a classification system based on reported usual frequency and quantity of alcohol consumption per sitting has been developed to reflect the likelihood that a driver would attain an impairing amount of alcohol in his blood. The resultant Quantity-Frequency Index (QFI) for preferred beverage is based upon that beverage which is consumed most frequently and in largest quantity, regardless of whether it is beer, liquor, or wine. Distributions of drinking patterns according to QFI for preferred beverage are presented in Table 5-9 for all groups. Additional distributions of drinking patterns for preferred beverage are presented in Table 5-10 according to frequency (see Figure 6-5), to quantity (Figure 6-6), and to a modified Quantity-Frequency Index (Figure 6-7). (Further details concerning these tables are presented in Section 5.1.3.) The results of cross-tabulating QFI with all other selected variables are presented below in Section 6.4.1.

6.1.3 BLOOD ALCOHOL CONCENTRATIONS

6.1.3.1 Distribution of blood alcohol concentration. Chemical test data were obtained from six of the eight samples of drivers. However, as in previous chapters, the data from both roadblock samples have been combined, as have the data from both clear-record samples since very few differences within the two sets of samples were found on key variables. Accordingly, the data are presented in terms of four groups: (1) fatally injured drivers, (2) roadblock drivers, (3) clear-record drivers, and

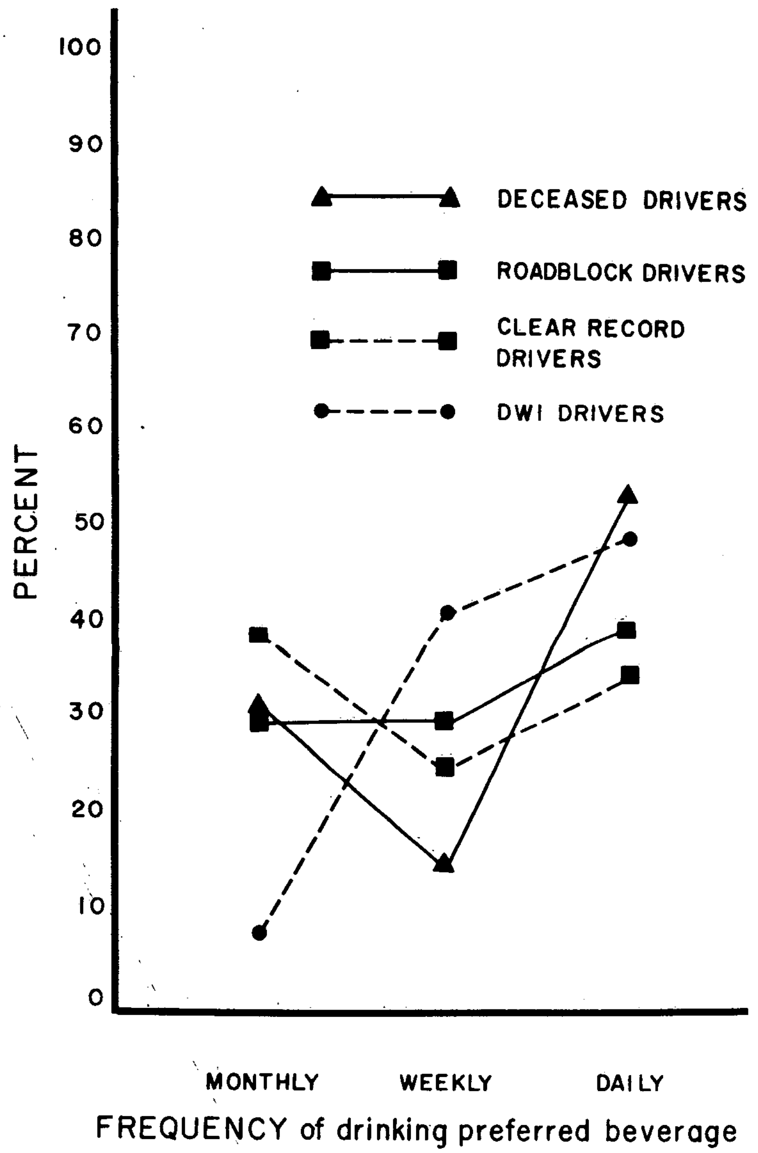

Figure 6-5 Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical monthly, weekly, or daily frequency of preferred beverage consumption.

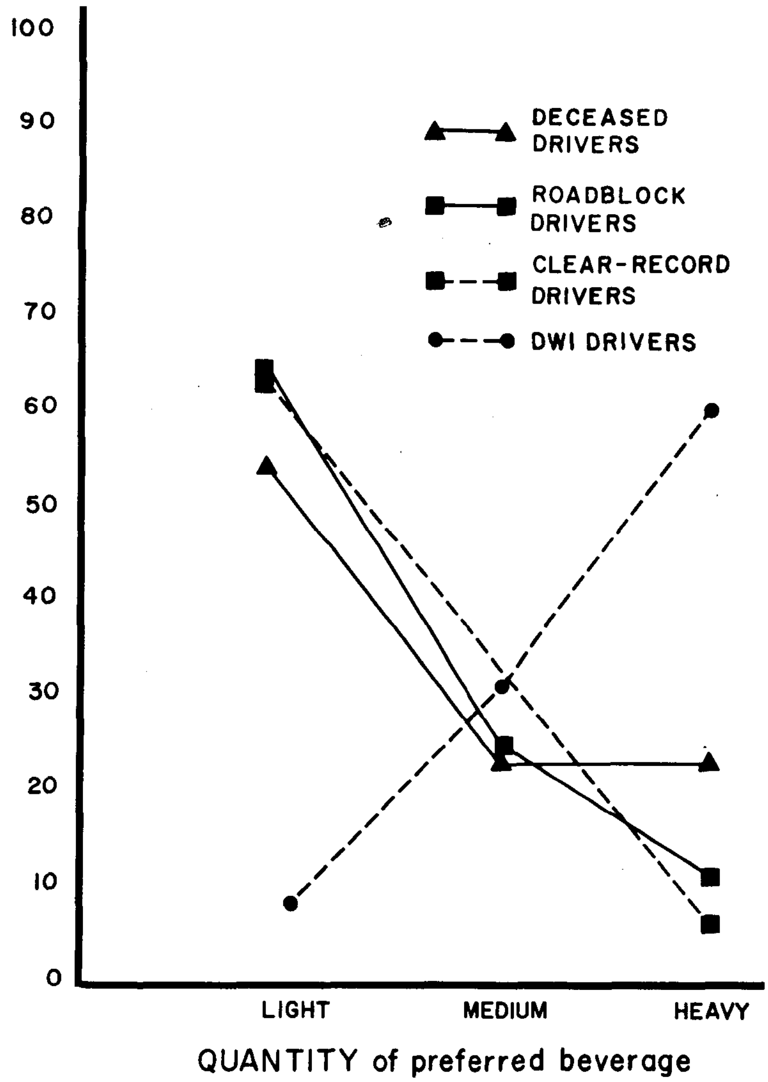

Figure 6-6 Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical light, medium, or heavy quantity of preferred beverage consumption.

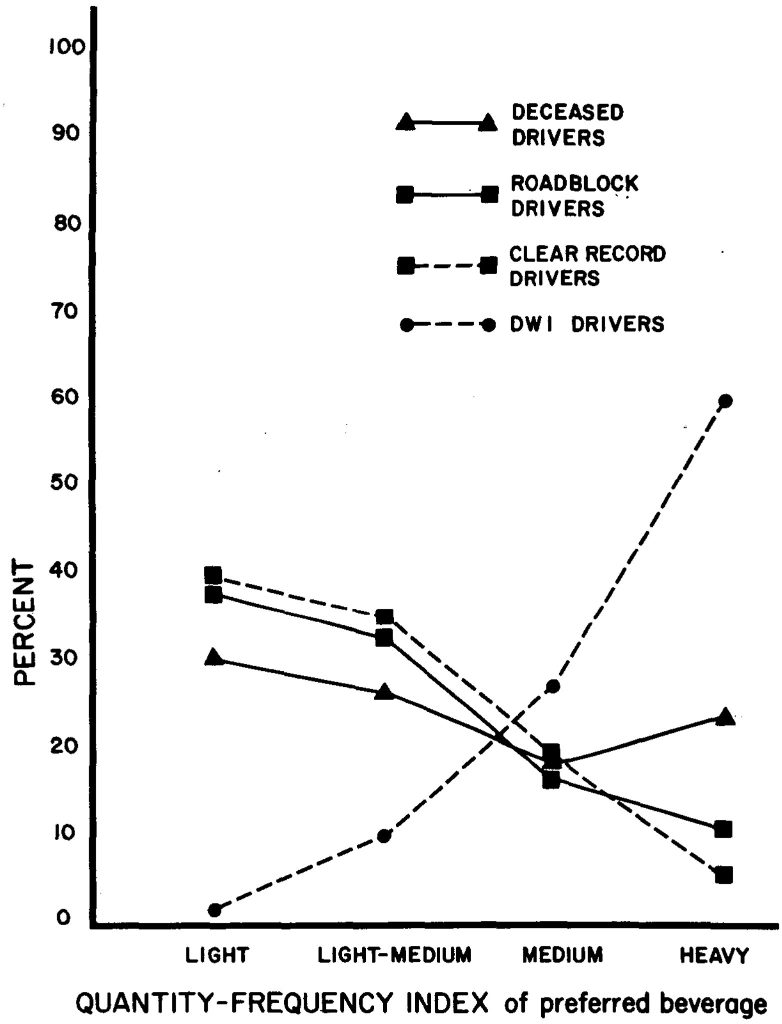

Figure 6-7 Proportion of roadblock, clear-record, DWI, and deceased drivers with light, light-medium, medium, or heavy Quantity-Frequency Index for preferred beverage.

(4) DWI drivers. The distributions of blood and breath alcohol concentrations are presented in Table 6-1 and Figure 6-8.

The distribution of blood alcohol concentrations among <u>deceased drivers</u> appears to be bimodal, that is, appears to comprise two different distributions. The first includes the lower blood alcohol concentrations and is probably similar to that of the roadblock drivers, whereas the second includes the higher blood alcohol concentrations and appears more congruent with that of the convicted DWI drivers. However, this suspicion of bimodality cannot be proved conclusively with data from only one dimension, that of blood alcohol concentration; therefore, this question is pursued in latter subsections of this chapter. In any case, detectable alcohol (20 mg% or higher) was found in 54% of deceased drivers; the presumptive limit for impairment of 100 mg% was reached or exceeded by 42% of deceased drivers; and the presumptive limit of states with 150 mg% laws was reached or exceeded by 28% of deceased drivers.

In seeking a definition for <u>problem drinker</u>, the National Highway Safety Bureau has recommended, as duplex de facto evidence, a blood alcohol concentration in excess of 150 mg% <u>plus</u> one other selected characteristic (such as a previous conviction or crash involving alcohol), or, as simplex de facto evidence, a blood alcohol concentration in excess of 250 mg% as a solitary criterion. Thus, in these terms, 28% of the total sample of driver fatalities would qualify as problem drinkers if they also had additional characteristics, but the 8.5% of these fatally injured drivers who exceed 250 mg% would definitely be labelled problem drinkers. However, if analysis is limited only to driver fatalities <u>with</u> alcohol, 52% of these deceased drinking drivers would qualify as problem drinkers by the duplex 150 mg% criterion

Table 6-1

Blood or Breath Alcohol Concentrations among All Driver Fatalities, Responsible Driver Fatalities, Roadblock Drivers, Clear-record Drivers, and DWI Drivers.

Blood alcohol concentration (mg%)	Driver fatalities						Roadblock		Clear-record		DWI	
	All		Responsible		Not responsible							
	N	%	N	%	N	%	N	%	N	%	N	%
< 20	49	46	39	42	10	71	969	86.1	55	98	0	0
20 - 49	4	4	2	2	2	14	78	6.9	1	2	0	0
50 - 99	9	8	8	9	1	7	54	4.8	0	0	0	0
100 - 149	14	13	14	15	0	0	13	1.2	0	0	8	20
150 - 199	13	12	12	13	1	7	9	.8	0	0	11	27
200 - 249	8	8	8	9	0	0	2	.2	0	0	11	27
≥ 250	9	8	9	10	0	0	0	0.0	0	0	11	27
Unknown	7	--	5	--	2	--	59	-----	7	--	9	--
Total	113	99	97	100	16	99	1184	100	63	100	50	101

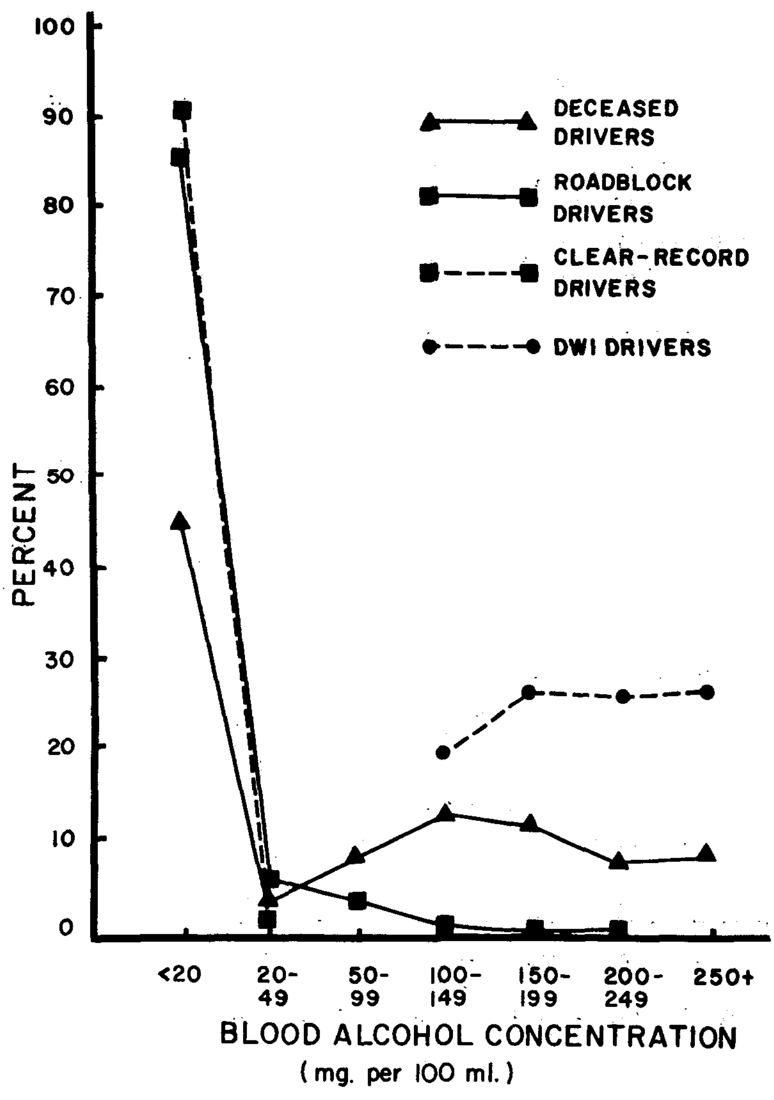

Figure 6-8 Distribution of blood alcohol concentration (in milligrams per 100 milliliters) for roadblock, clear-record, DWI and deceased drivers.

and 16% by the simplex 250 mg% criterion.

The data from the roadblock drivers are the best estimates of the population-at-risk, although these samples were deliberately biased in the direction of presence of alcohol by matching the time and place of contact to the times and places of previous fatal or serious crashes. In contrast to the deceased drivers, relatively few roadblock motorists were found with detectable alcohol (14%), only 2% exceeded the 100 mg% presumptive limit of impairment, only 1% exceeded the higher presumptive limit of 150 mg% which some states still have, and none of these drivers qualified as a problem drinker on the basis of the single 250 mg% criterion. If analysis is limited to the roadblock drivers with detectable alcohol, 7% would qualify as problem drinkers by the duplex 150 mg% criterion and 0% by the simplex 250 mg% criterion. It is of more than passing interest that this estimate of 7% problem drinkers among the roadblock drivers is quite consistent with numerous previous estimates by others of the proportion of problem drinkers among the general adult population, which the roadblock drivers most closely represent.

The data from the clear-record drivers were very unambiguous, with 98% showing no detectable alcohol and the remaining 2% appearing in the lowest category of blood alcohol concentration, namely, 20-49 mg%.

In striking contrast, 100% of the convicted DWI drivers were legally impaired, by definition, since they exceeded 100 mg%; but fully 80% would also have been convicted in states with 150 mg% laws (and might also qualify as problem drinkers), and 27% qualified as problem drinkers on the basis of the simplex criterion of 250 mg%.

By way of summary and comparison, the proportion of drivers who were legally impaired (100 mg% or greater) were: fatally injured, 42%; roadblock, 2%; clear-record, 0%; and DWI, 100%. The proportion of drivers in each sample who would be considered problem drinkers: (1) under the recommended duplex 150 mg% criterion were: fatally injured, 28%; roadblock, 1%; clear-record, 0%; and DWI, 80%; and (2) under the recommended simplex 250 mg% criterion were: fatally injured, 8.5%; roadblock, 0%; clear-record, 0%; and DWI, 27%. However, if the analysis is limited only to drivers with detectable alcohol (20 mg% or higher), the following proportions would be considered problem drinkers: (1) under the duplex 150 mg% criterion: fatally injured, 52%; roadblock, 7%; clear-record, 0%; and DWI, 80%; and (2) under the simplex 250 mg% criterion: fatally injured, 16%; roadblock, 0%; clear-record, 0%; and DWI, 27%. All differences between groups are statistically significant, except the differences between the roadblock and clear-record drivers.

Two very compelling questions emerge from these clear-cut differences in distributions: "Which roadblock drivers with high blood alcohol concentrations will be tomorrow's DWIs and fatalities, and which of today's DWIs will be tomorrow's high-alcohol driver fatalities?"

6.1.3.2 Crash risk and blood alcohol concentration. The most important single question in comparing the groups in this study is the relation between the blood alcohol concentration of the fatally injured drivers and of the drivers exposed to similar circumstances of time and place, but not involved in a crash. Previous studies in urban areas had demonstrated that risk of crashing begins to rise at blood alcohol concentrations between 50 and 99 mg%, but then rises sharply at concentrations above 100 mg%. Such was the conclusion of the present study as well. Concentrations of 80 mg% or higher are incompatible with safe driving; and the higher the concentration, the greater the incompatibility, with small increases in blood alcohol concentration above 80 mg% resulting in disproportionately large increases in crash risk.

The proportions of driver fatalities, responsible driver fatalities, and roadblock drivers within each 10 mg% class interval of blood alcohol concentration are presented in Table 6-2. On the basis of these data, Table 6-3 and Figure 6-9 show risk of crashing at each concentration when the risk with no alcohol is set at 1.0. Clearly, low blood alcohol concentrations do not appear to be significant with respect to the occurrance of highway crashes. But just as clearly, concentrations of 80 mg% or higher are incompatible with safe driving; and the higher the concentration, the greater the incompatibility.

6.1.4 DRINKING AND DRIVING PATTERNS

All respondents were asked to report the relative frequency of driving after drinking. The results are presented in Table 5-11 and Figure 6-10, and the differences between the observed and the expected frequencies were significant ($p < .01$). It is interesting to note the indication of this behavior in the population-at-risk provided by the roadblock drivers, who were rather evenly distributed across the three collapsed code categories: "never drive after drinking", "do so less than half the time", and "do so half the time or more."

Since the present report is primarily concerned with the contribution of alcohol to highway unsafety, the following discussion is focused on the upper end of the frequency distribution, that is on those individuals who stated that they drive after drinking "half the time or more" (which

Table 6-2

Blood or Breath Alcohol Concentrations among All Driver Fatalities, Driver Fatalities Responsible for Crashes, and Drivers Stopped at Times and Places Similar to Severe Crashes.

Blood or breath alcohol concentration	All driver fatalities		Driver fatalities responsible for crash		Roadblock	
(mg%)	N	%	N	%	N	%
< 20	49	46.2	39	42.4	969	86.1
20 - 29	2	1.9	2	2.2	32	2.8
30 - 39	1	.9	0	0.0	25	2.2
40 - 49	1	.9	0	0.0	21	1.9
50 - 59	2	1.9	2	2.2	12	1.1
60 - 69	0	0.0	0	0.0	8	0.7
70 - 79	1	.9	1	1.1	17	1.5
80 - 89	2	1.9	1	1.1	8	0.7
90 - 99	4	3.8	4	4.3	9	0.8
100 - 109	3	2.8	3	3.3	3	0.3
110 - 119	4	3.8	4	4.3	4	0.4
120 - 129	1	.9	1	1.1	2	0.2
130 - 139	4	3.8	4	4.3	1	0.1
140 - 149	2	1.9	2	2.2	3	0.3
150 - 159	2	1.9	2	2.2	3	0.3
160 - 169	3	2.8	3	3.3	0	0.0
170 - 179	2	1.9	2	2.2	4	0.4
180 - 189	3	2.8	2	2.2	2	0.2
190 - 199	3	2.8	3	3.3	0	0.0
≥ 200	17	16.0	17	18.5	2	0.2
Unknown	7	-	5	-	59	-
Total	113	99.8	97	100.2	1184	100.2

Table 6-3

Risk of Fatal Crash and of Responsible Fatal Crash
According to Blood Alcohol Concentration.

Blood alcohol concentration (mg%)	Fatal crash	Responsible fatal crash
< 20	1.0	1.0
20 - 39	1.4	0.9
40 - 59	1.8	1.5
60 - 79	0.8	1.0
80 - 99	5.9	6.0
100 - 119	20.2	21.9
120 - 139	25.3	32.0
140 - 159	13.5	17.0
160 - 179	33.7	34.1
180 - 199	60.8	66.1
≥ 200	(346.4)[a]	(438.2)[a]

[a]Based on the only person, among 1125 roadblock subjects, with breath alcohol concentration of 200 mg% or higher.

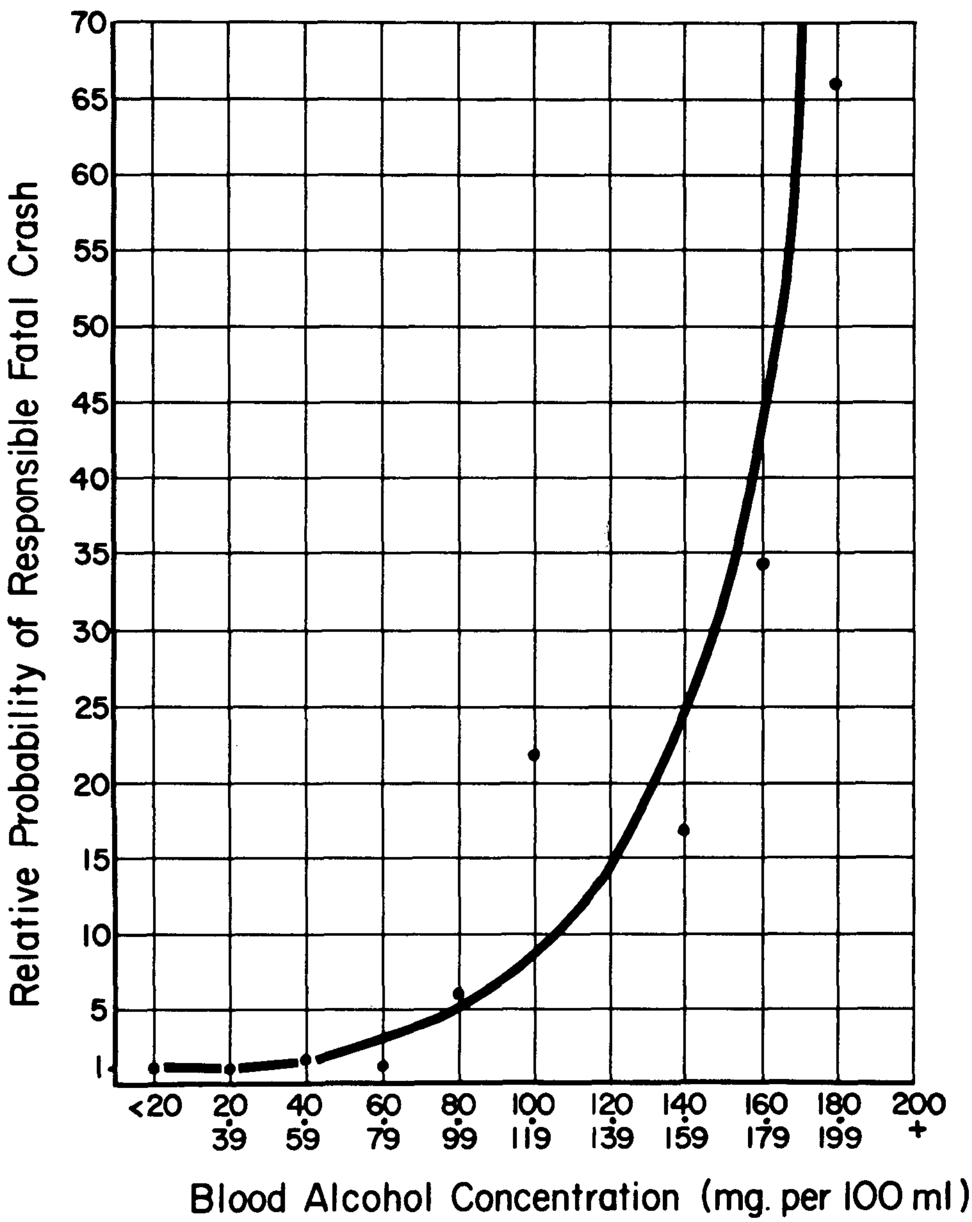

Figure 6-9 Relative probability of having a fatal crash as a function of blood alcohol concentration (in milligrams per 100 milliliters).

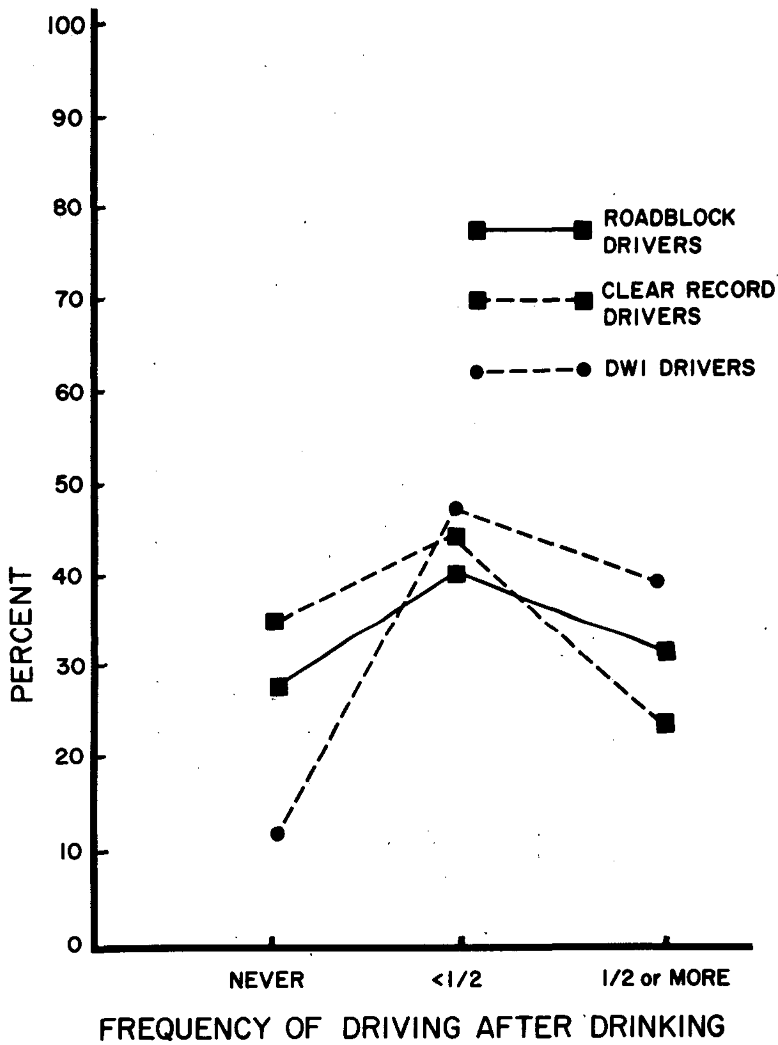

Figure 6-10 Proportion of roadblock, clear-record, and DWI drivers reporting typical frequency of driving after drinking.

represents a combination of three original response categories, namely: "about half the time", "more than half the time", and "all the time"). The proportion of non-DWI citation drivers was four times as large as the proportion of hospitalization crash drivers, twice as large as the proportion of clear-record drivers, and slightly more than one and a half times as large as the proportion of roadblock drivers. The proportion of DWI drivers who reported higher frequencies of driving after drinking was approximately three times as large as the proportion of hospitalization crash drivers, twice as large as the proportion of clear-record drivers, and one and a half times as large as the proportion of roadblock drivers. Thus, drivers in the DWI and non-DWI citation groups were clearly outstanding among--and significantly different from ($p< .01$)--drivers in the other samples who also reported driving after drinking half the time or more.

6.1.5 DRIVING PATTERNS

6.1.5.1 Crashes. Distributions of crashes in the previous five years according to self-report are presented in Table 5-12 and Figure 6-11. Data for the clear-record and deceased drivers were omitted from analysis because: (1) the lack of having had a crash during the previous five years was one of the criteria for selecting clear-record drivers, and (2) equivalent self-report data were naturally unavailable for deceased drivers. It should also be noted that the crash for which a serious injury driver was sampled was not included in the data.

Significant differences were obtained between the observed and the expected frequencies of those drivers in the four analyzed groups (roadblock, serious injury, DWI, and non-DWI citation) who reported having had no crash (vs one or more crashes) during the previous five years ($p< .001$).

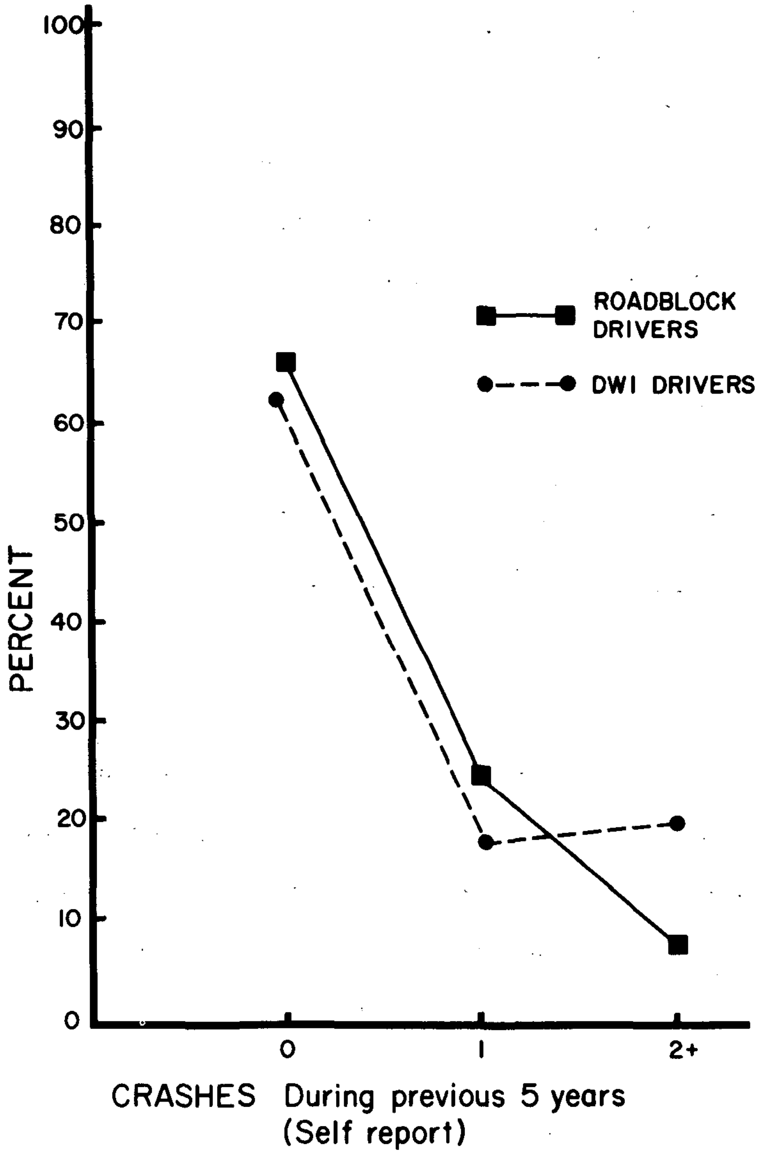

Figure 6-11 Distribution of crashes during the previous five years as reported by roadblock and DWI drivers.

With number of previous crashes dichotomized at none vs some, the proportions among hospitalization crash and non-DWI citation drivers were identical (one-third had none, and two-thirds had one or more previous crash), whereas the opposite proportions were found among roadblock and DWI drivers (two-thirds had none, and one-third had one or more previous crash). The proportions of drivers reporting one or more previous crash in both serious injury and non-DWI citation samples differed significantly from the proportions in both roadblock and DWI samples ($p < .01$). However, the latter two groups did differ from each other in proportion of individuals who reported having had two or more previous crashes during the five-year period, with proportionally twice as many DWI drivers (20%) as roadblock drivers (9%) who claimed to have had this amount.

6.1.5.2 License suspensions. Distributions of suspensions during all previous years according to official record check are presented in Table 5-12 and Figure 6-12. Clear-record drivers were included in these analyses and results since their selection criterion did not include this variable. (Although 8% of clear-record drivers had received one license suspension during all previous years of driving, none of these drivers had received two or more license suspensions.)

When the eight specific samples were combined into four general groups (crash, roadblock, clear-record and citation), significant differences were obtained between those drivers with no suspensions vs those with one suspension vs those with two or more suspensions ($p < .001$). Within all but the DWI group, significantly more drivers were found to have had no suspensions than to have had two or more suspensions ($p < .01$). Among drivers with two or more suspensions, significantly more were found in the DWI group (44%)

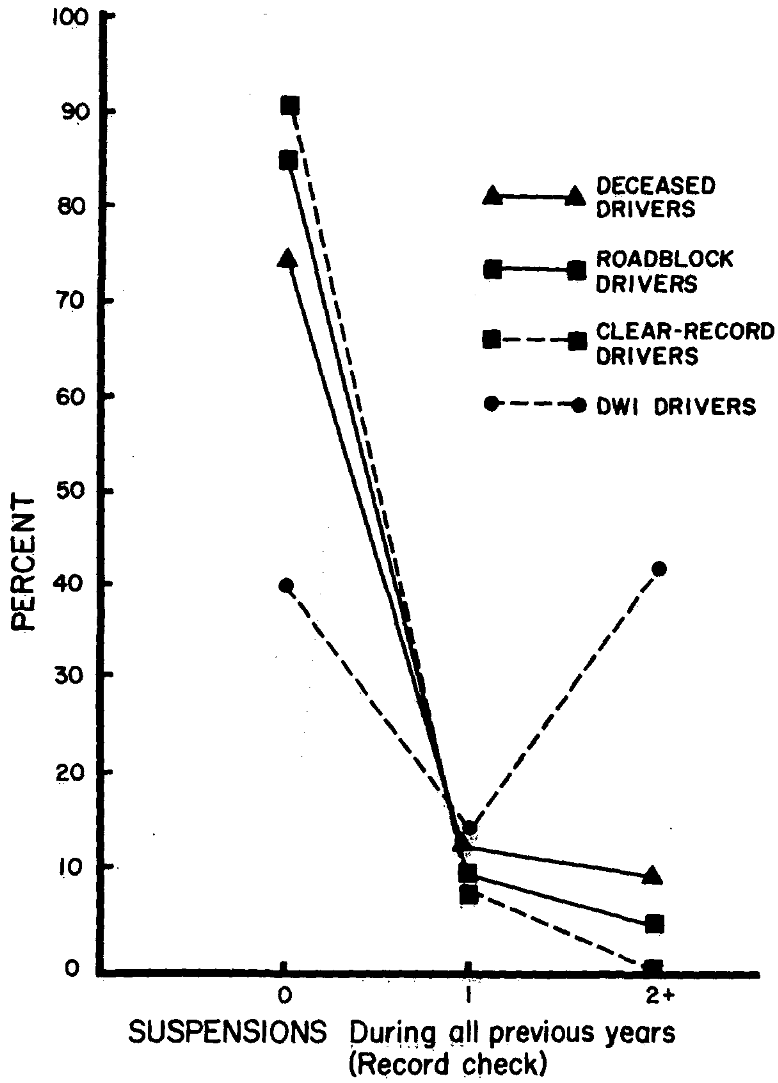

Figure 6-12 Distribution of license suspensions during all previous years according to official record check for roadblock, clear-record, DWI, and deceased drivers.

than in any of the other five groups (p <.01; for non-DWI, p <.05). Thus, the proportion of DWI drivers with two or more previous license suspensions was four times greater than the proportion of driver fatalities in this category (12%), nine times greater than the proportion of roadblock drivers in this category (5%), and two-and-one-half times greater than the proportion of non-DWI citation drivers in this category (18%).

6.1.5.3 Citations. Distributions of the serious moving citations received during the previous five years according to official record checks are presented in Table 5-13 and Figure 6-13. It should be noted that the citations which led to a particular DWI or non-DWI citation driver being sampled was excluded from the data.

Significant differences were obtained between the observed and the expected frequencies of those drivers in the four groupings mentioned above who had had no citation (vs one or more) during the previous five years (p < .001). Within each crash group, significantly more drivers were found to have had no citations during the previous five years than either one citation or more than one citation (p <.01). By contrast, within each citation group, significantly more drivers were found to have had two or more prior citations during the previous five years than to have had none (p <.01). Significantly fewer individuals with no prior citations were found in each citation group than in any other group (p< .01). Thus, the DWI and non-DWI citation drivers were clearly outstanding in their accumulation of previous citations; in fact, the proportion of these citation drivers with two or more prior citations (DWI, 38%; and non-DWI 35%) was three times as large as the proportion of crash drivers and seven times as large as the proportion of roadblock drivers in this category.

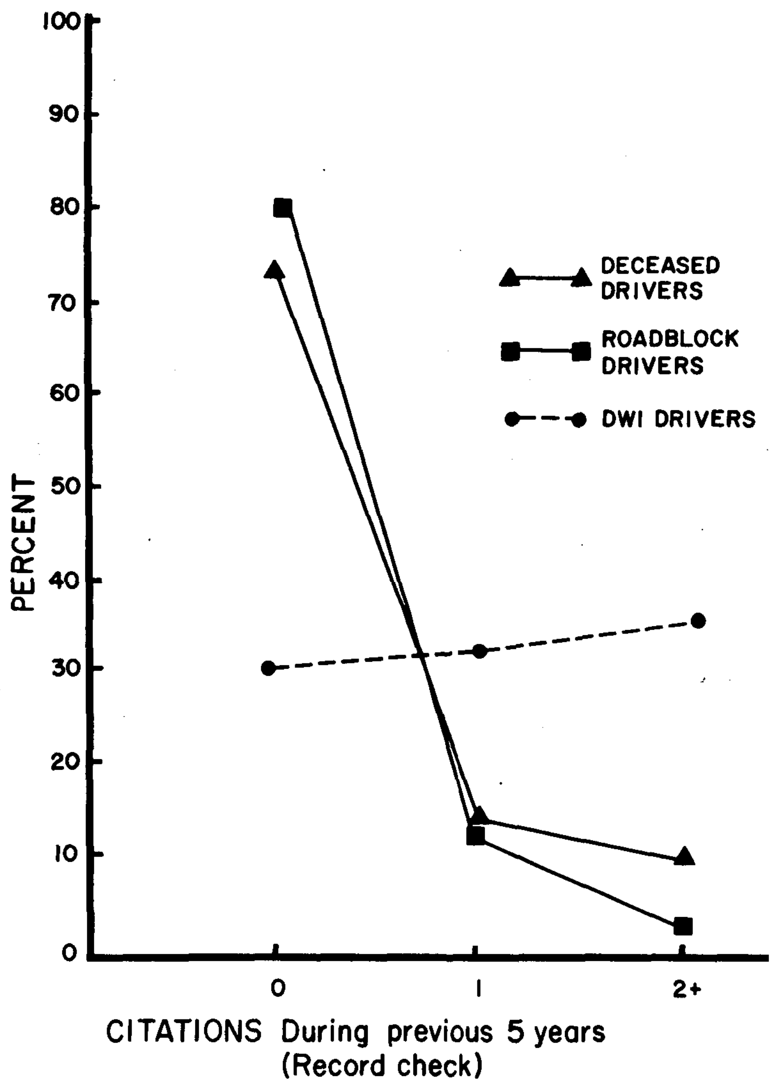

Figure 6-13 Distribution of citations for serious moving violations during previous five years according to official record check for roadblock, clear-record, DWI, and deceased drivers.

In conclusion, the driving history data generally tend to support the popular assumption that past driving behavior is the best single predictor of future driving behavior. However, a major question which awaits further investigation concerns the extent to which this assumption holds within individual, as opposed to within group. In other words, with an event as relatively rare as a crash, to what extent can predictions be made which are individual specific, as opposed to predictions simply based upon group membership?

6.2 COMPARISONS OF DRIVERS WITH NO ALCOHOL AND WITH HIGH ALCOHOL CONCENTRATIONS

This section contains several comparisons of those individuals who had blood or breath alcohol concentrations below 20 mg% (i.e., no detectable alcohol) and of those with concentrations of 100 mg% or higher (i.e., high alcohol concentration). The numbers of drivers with blood alcohol concentrations which fell between these two groups (i.e., 20 to 99 mg%) were so small in all but the roadblock sample that it was not feasible to analyze this lower detectable alcohol segment in an attempt to identify real similarities or significant differences. With two exceptions (marital status and occupation), the comparisons in this section (unlike those in the section following) do not take into consideration differences between the groups in distribution according to age and sex.

The tables and text in this section include three types of comparisons: (1) drivers without alcohol vs those with high alcohol concentrations within each of the four groups for which alcohol data were available (i.e., fatal crash, roadblock, clear-record, and DWI), (2) between groups among drivers without alcohol, and (3) between groups among drivers with 100 mg% or higher.

The exceptions to this pattern of analysis occur for clear-record and DWI drivers, because no driver with a clear record had a blood alcohol concentration of 100 mg% or higher, and no driver in the DWI group had a blood alcohol concentration under 20 mg%.

As will be noted in the analyses that follow, some differences do exist between fatality, roadblock, and clear-record drivers without alcohol, and to a lesser extent between fatality, roadblock, and DWI drivers with high alcohol concentrations. With only rare exceptions, however, individuals with no alcohol are much more similar to each other across all samples, and individuals with high alcohol concentrations in turn are much more similar to each other across samples, as opposed to the large within-group differences between persons with no alcohol and between those with high alcohol concentrations.

6.2.1. BIOGRAPHICAL VARIABLES

6.2.1.1 Sex. Females represented relatively similar proportions of the fatality, roadblock, and clear-record drivers with no alcohol (Table 6-4). Among drivers with high alcohol concentrations, females comprised very small proportions of the fatalities and DWI drivers, but a larger proportion of the roadblock drivers; in fact, essentially the same proportion as among the roadblock drivers with no alcohol.

6.2.1.2 Age. The relation between age and blood alcohol concentration for the four groups under study is shown in Tables 6-5 and 6-6. As seen in the first of these tables, among the fatally injured drivers, the very youngest and very oldest groups had less alcohol involvement, but those who did have alcohol in all four age groups predominantly had concentrations of 100 mg% or higher. Among roadblock drivers, persons under age 20 and age 60 or older were much less likely to have alcohol than were individuals in the two middle age

Table 6-4

Distribution in Frequency and Percent of Sex by Blood Alcohol Concentration.

Sex by blood alcohol concentration	Fatal crash		Roadblock		Clear-record		DWI	
	N	%	N	%	N	%	N	%
< 20 mg%								
Male	38	77	766	79	40	73	--	--
Female	11	22	203	21	15	27	--	--
Total	49	99	969	100	55	100	--	--
≥ 100 mg%								
Male	42	95	20	83	--	--	40	97
Female	2	5	4	17	--	--	1	2
Total	44	100	24	100	--	--	41	99

Table 6-5

Distribution in Frequency and Percent of Blood Alcohol Conc^ ·ation bv Age.

Blood alcohol concentration by age	Fatal crash N	Fatal crash %	Roadblock N	Roadblock %	Clear-record N	Clear-record %	DWI N	DWI %
< 20 years								
< 20 mg%	9	56	115	91	10	100	0	0
20 - 99 mg%	3	19	10	8	0	0	0	0
≥ 100 mg%	4	25	2	1	0	0	4	10υ
Total	16	100	127	100	10	100	4	100
20 - 24 years								
< 20 mg%	8	31	152	84	3	100	0	0
20 - 99 mg%	2	8	24	13	0	0	0	0
≥ 100 mg%	16	61	4	2	0	0	6	100
Total	26	100	180	99	3	100	6	100
25 - 59 years								
< 20 mg%	22	43	606	85	36	97	0	0
20 - 99 mg%	7	14	92	13	1	3	0	0
≥ 100 mg%	22	43	18	3	0	0	24	100
Total	51	100	716	101	37	100	24	100
≥ 60 years								
< 20 mg%	10	77	96	94	6	100	0	0
20 - 99 mg%	1	8	6	6	0	0	0	0
≥ 100 mg%	2	15	0	0	0	0	7	100
Total	13	100	102	100	6	100	7	100

categories; but among all four age categories, the overwhelming majority of individuals with alcohol had concentrations under 100 mg%. Virtually all clear-record drivers, no matter what their ages, had no alcohol present when stopped. All DWI drivers had concentrations of 100 mg% or higher.

As noted earlier, drivers in the clear-record and roadblock groups had alcohol in their systems much less often than the fatality drivers, and, in turn, the fatality drivers had alcohol in their systems much less often and in much smaller concentrations than did the DWI drivers. This pattern holds across all four age categories.

Table 6-6 presents data from two samples of drivers who reached a blood alcohol concentration of 100 mg% or higher. These two samples consist of: (1) roadblock drivers, and (2) drivers who had gotten into alcohol-involved trouble on the highway either because they were convicted for driving while intoxicated or were fatally injured. The samples have been further subdivided into three age categories (under 25, 25-59, and 60 or older) and into three blood alcohol concentrations (100-149 mg%, 150-199 mg%, and 200 mg% or higher). Within the combined sample of fatalities and DWIs (as seen in Table 6-6), 70% of the young drivers, 50% of middle age drivers, and 22% of the oldest group of drivers with impairing amounts of alcohol had concentrations under 200 mg% ($p < .05$). Thus, these data confirm the hypothesis that young drivers with legally impairing amounts of alcohol who get into trouble on the highway in general do so at lower blood alcohol concentrations than do middle age or older drivers who get into such trouble.

Table 6-6

Distribution in Frequency and Percent of Blood Alcohol Concentration by Age among Legally Impaired Roadblock Drivers and Combined Fatal Crash or DWI Drivers.

Blood alcohol concentration by age	Roadblock		Fatal crash or DWI	
	N	%	N	%
< 25 years				
100 - 149 mg%	3	50	9	30
150 - 199 mg%	1	17	12	40
≥ 200 mg%	2	33	9	30
Total	6	100	30	100
25 - 59 years				
100 - 149 mg%	10	55	13	28
150 - 199 mg%	8	44	10	22
≥ 200 mg%	0	0	23	50
Total	18	99	46	100
≥ 60 years				
100 - 149 mg%	--	--	0	0
150 - 199 mg%	--	--	2	22
≥ 200 mg%	--	--	7	78
Total	--	--	9	100

6.2.1.3 Marital status. Because this particular variable is so markedly age-confounded, it is described only for persons age 25 or older. The distribution of marital status among roadblock subjects without alcohol was relatively similar to that among roadblock subjects with high alcohol concentrations (Table 6-7). Among the fatalities, however, those with alcohol were much more likely to be in an unmarried state than were those with no alcohol. Considering the small sample size among fatality and clear-record drivers with no alcohol, the distributions of marital status would appear to be relatively similar among fatality, roadblock, and clear-record drivers without alcohol. Among drivers with 100 mg% or higher, the DWI drivers and the fatalities were much more likely to be unmarried than were the roadblock drivers, with 11% of high-alcohol roadblock drivers, 27% of high-alcohol fatalities, and 49% of DWI drivers being in an unmarried state.

6.2.1.4 Occupational level. Because of age confounding, occupation was also analyzed only for individuals age 25 or older. Roadblock and fatality drivers without alcohol have lower reported occupational levels than do roadblock and fatality drivers with high alcohol concentrations (Table 6-8). The reason for this apparent deviation from the expected distribution is not known at present. Among drivers without alcohol, a significantly larger proportion (66%) of the clear-record drivers was listed in the highest category of occupational level, as compared with the road-block group (31%) and the fatality group (21%). Among drivers with high blood alcohol concentrations, the DWI group had substantially fewer ($p < .10$) individuals who were listed in the highest occupational classification when compared with the roadblock and fatality drivers.

Table 6-7

Distribution in Frequency and Percent of Marital Status by Blood Alcohol Concentration of Subjects Age 25 or Older.

Marital status by blood alcohol concentration	Fatal crash		Roadblock		Clear-record		DWI	
	N	%	N	%	N	%	N	%
< 20 mg%								
Single	1	5	77	11	2	5	--	--
Married	18	95	565	81	40	95	--	--
Wid., Div., Sep.	0	0	58	8	0	0	--	--
Total	19	100	700	100	42	100	--	--
≥ 100 mg%								
Single	4	22	2	11	--	--	7	23
Married	13	72	16	89	--	--	16	52
Wid., Div., Sep.	1	5	0	0	--	--	8	26
Total	18	99	18	100	--	--	31	101

Table 6-8

Distribution in Frequency and Percent of Occupational Level by Blood Alcohol Concentration of Subjects Age 25 or Older.

Occupational level by blood alcohol concentration	Fatal crash		Roadblock		Clear-record		DWI	
	N	%	N	%	N	%	N	%
< 20 mg%								
Upper	3	21	198	31	27	66	--	--
Middle	7	50	245	38	9	22	--	--
Lower	2	14	170	27	3	7	--	--
Other	2	14	28	4	2	5	--	--
Total	14	99	641	100	41	100	--	--
≥ 100 mg%								
Upper	8	50	7	41	--	--	3	10
Middle	4	25	5	29	--	--	11	35
Lower	3	19	3	18	--	--	12	39
Other	1	6	2	12	--	--	5	16
Total	16	100	17	100	--	--	31	100

6.2.1.5 Jobs within the previous five years. Similar proportions of fatality and roadblock drivers without alcohol had two or more jobs during the previous five years when compared with fatality and roadblock drivers with high alcohol concentrations (Table 6-9). Cutting across groups, similar distributions of individuals with two or more jobs were found among fatality, roadblock, and clear-record drivers who had no alcohol, and in turn, among fatality, roadblock and DWI drivers who had high alcohol concentrations.

6.2.2 PATTERNS OF ALCOHOL USE

The reported frequencies and quantities of beer and liquor consumption are shown in Tables 6-10 and 6-11. Regarding beer frequency, fewer fatality and roadblock drivers without alcohol are reported to drink beer at all (as opposed to such drivers with high alcohol concentrations). Among those who do drink beer, the fatality and roadblock drivers without alcohol are reported to drink beer much less frequently than the fatality and roadblock drivers with high alcohol concentrations. Thus, over twice as many fatalities with high alcohol concentrations are reported to drink beer daily (as opposed to fatalities without alcohol), and almost twice as many roadblock drivers with high alcohol concentrations report that they drink beer daily (as opposed to roadblock drivers without alcohol).

Comparing across groups, fatality, roadblock, and clear-record drivers without alcohol have similar distributions of frequency of beer consumption. Fatality, roadblock, and DWI drivers with high alcohol concentrations also have somewhat similar distributions of frequency of beer consumption, although the roadblock drivers report drinking beer daily less often than is reported for the fatality and DWI drivers. In fact, among those who drink beer, 80%

Table 6-9

Distribution in Frequency and Percent of Number of Jobs in Previous Five Years by Blood Alcohol Concentration of Subjects Age 25 or Older.

Number of jobs in previous five years by blood alcohol concentration	Fatal crash		Roadblock		Clear-record		DWI	
	N	%	N	%	N	%	N	%
< 20 mg%								
None	2	25	41	6	6	14	--	--
One	3	37	364	55	19	45	--	--
Two	1	13	150	23	11	26	--	--
Three or more	2	25	104	16	6	14	--	--
Total	8	100	659	100	42	99	--	--
≥ 100 mg%								
None	1	8	1	6	--	--	2	6
One	6	46	8	47	--	--	16	52
Two	3	23	7	41	--	--	6	19
Three or more	3	23	1	6	--	--	7	23
Total	13	100	17	100	--	--	31	100

Table 6-10

Distribution in Frequency and Percent According to Reported Usual Frequency and Quantity of Beer Consumption by Blood Alcohol Concentration.

Beer consumption by blood alcohol concentration	Fatal crash N	Fatal crash %	Roadblock N	Roadblock %	Clear-record N	Clear-record %	DWI N	DWI %
Beer frequency								
< 20 mg%								
Never	(5)	--	(303)	--	(19)	--	--	--
Monthly	3	43	141	27	12	33	--	--
Weekly	0	0	185	35	11	31	--	--
Daily	4	57	197	38	13	36	--	--
Total	7	100	523	100	36	100	--	--
≥ 100 mg%								
Never	(0)	--	(2)	--	--	--	(2)	--
Monthly	0	0	2	12	--	--	4	10
Weekly	3	20	7	41	--	--	9	23
Daily	12	80	8	47	--	--	26	67
Total	15	100	17	100	--	--	39	100
Beer quantity								
< 20 mg%								
Light	7	100	385	73	27	75	--	--
Medium	0	0	77	15	5	14	--	--
Heavy	0	0	66	13	4	11	--	--
Total	7	100	528	101	36	100	--	--
≥100 mg%								
Light	6	40	5	31	--	--	5	13
Medium	5	33	5	31	--	--	16	41
Heavy	4	27	6	37	--	--	18	46
Total	15	100	16	99	--	--	39	100

of fatalities and 67% of DWIs with high alcohol concentrations are reported to drink it daily.

Regarding beer quantity, similar patterns to those described above for beer frequency were obtained among those persons who reportedly consume this beverage. Fatality and roadblock drivers without alcohol consume much smaller quantities of beer on the average than do those with high alcohol concentrations. Among drivers without alcohol, similar patterns of consumption with respect to usual quantity are noted for fatality, roadblock, and clear-record drivers. For drivers with high alcohol concentrations, somewhat similar patterns of usual consumption are noted for fatality, roadblock, and DWI drivers, with the DWI drivers, however, having by far the smallest proportion (only 13%) reporting light amounts of consumption.

A different pattern is observed with respect to frequency and quantity of liquor reported consumed (Table 6-11). Fatality drivers without alcohol are less often reported as daily consumers of liquor than are fatality drivers with high alcohol concentrations. On the other hand, the roadblock drivers without alcohol and with high alcohol concentrations report similar frequencies of liquor consumption. Examined across groups with no alcohol, roadblock and clear-record drivers have similar patterns with respect to frequency of liquor consumption; however, none of the fatalities without alcohol was reported to drink daily. Fatality, roadblock, and DWI drivers with high alcohol concentrations had similar patterns of liquor consumption frequency, with approximately 25% in each group reporting daily consumption.

The quantity of liquor reportedly consumed per sitting was similar

Table 6-11

Distribution in Frequency and Percent According to Reported Usual Frequency and Quantity of Liquor Consumption by Blood Alcohol Concentration.

Liquor consumption by blood alcohol concentration	Fatal crash N	Fatal crash %	Roadblock N	Roadblock %	Clear-record N	Clear-record %	DWI N	DWI %
Liquor frequency								
< 20 mg%								
Never	(4)	--	(347)	--	(15)	--	--	--
Monthly	5	63	200	49	26	65	--	--
Weekly	3	37	102	25	8	20	--	--
Daily	0	0	104	26	6	15	--	--
Total	8	100	406	100	40	100	--	--
≥100 mg%								
Never	(4)	--	(7)	--	--	--	(10)	--
Monthly	5	45	3	33	--	--	16	52
Weekly	3	27	4	44	--	--	8	26
Daily	3	27	2	22	--	--	7	23
Total	11	99	9	99	--	--	31	101
Liquor quantity								
< 20 mg%								
Light	8	100	274	68	28	70	--	--
Medium	0	0	101	25	10	25	--	--
Heavy	0	0	27	7	2	5	--	--
Total	8	100	402	100	40	100	--	--
≥100 mg%								
Light	4	36	5	63	--	--	7	23
Medium	5	45	2	25	--	--	10	33
Heavy	2	18	1	13	--	--	13	43
Total	11	99	8	101	--	--	30	99

for roadblock drivers with no alcohol and those with high alcohol concentrations, but fatalities with high alcohol concentrations were reported to drink medium or heavy amounts of liquor much more often than those with no alcohol present. Examined across groups, the roadblock and clear-record drivers without alcohol had patterns similar to each other, but differed from fatalities without alcohol, all of whom were reported to be light liquor drinkers.

In the high alcohol range, there were marked differences among those who consume liquor. Specifically, 43% of DWI drivers who drink liquor, but only about 15% of liquor-drinking fatality and roadblock drivers are categorized as heavy drinkers. However, among these high alcohol subjects, 63% of fatalities, 38% of roadblock, and 76% of DWI drivers are found in the combined categories of medium and heavy liquor consumption.

The Quantity-Frequency Index for preferred beverage appears in Table 6-12, excluding individuals who reportedly never drink. Fatality and roadblock drivers without alcohol are reported to have medium or heavy QFIs much less often than are such drivers with high alcohol concentrations. Not one of the 8 fatality drivers without alcohol for whom QFIs could be calculated was classified as a medium or heavy drinker, in comparison with 26% of both clear-record and roadblock drivers. Among the drivers with high alcohol concentrations, 66% of the fatality, 42% of the roadblock, and an astonishing 87% of the DWI drivers met the criteria for classification as medium or heavy drinkers on the QFI. In fact, 56% of the DWIs were reported just in the heavy drinking QFI category alone.

Table 6-12

Distribution in Frequency and Percent According to Reported Usual Quantity-Frequency Index for Preferred Beverage by Blood Alcohol Concentration.

Quantity-Frequency Index by blood alcohol concentration	Fatal crash		Roadblock		Clear-record		DWI	
	N	%	N	%	N	%	N	%
< 20 mg%								
Light	4	50	327	43	18	39	--	--
Light-medium	4	50	246	32	16	35	--	--
Medium	0	0	112	15	8	17	--	--
Heavy	0	0	81	11	4	9	--	--
Total	8	100	766	101	46	100	--	--
≥100 mg%								
Light	2	13	6	23	--	--	1	3
Light-medium	3	20	9	35	--	--	4	10
Medium	5	33	4	15	--	--	12	31
Heavy	5	33	7	27	--	--	22	56
Total	15	99	26	100	--	--	39	100

6.2.3 DRINKING AND DRIVING PATTERNS

In response to the question about frequency of driving after consumption of alcohol, 32% of the roadblock drivers who did not have alcohol present, but only 8% of those with high alcohol concentrations reported that they never combine these two activities (Table 6-13). Conversely, 28% of the roadblock drivers without alcohol, but 42% of those with high alcohol concentrations, report that they combined these two activities at least half the time they drink. Across groups, roadblock and clear-record drivers without alcohol had virtually identical patterns with respect to frequency of drinking and driving in combination, and, in turn, roadblock and DWI drivers with high alcohol concentrations had virtually identical patterns with each other.

6.2.4 DRIVING PATTERNS

6.2.4.1 Crashes. The self-reported crashes during the previous five years appear in Table 6-14. Roadblock drivers without alcohol and with high alcohol concentrations report similar histories of crashes. Examined across groups, clear-record drivers by definition had clear records in comparison with all roadblock drivers (the exception being an individual who had a clear record at the time of the roadblock, but who had been involved in a crash during the intervening time between the road-block and a subsequent, more intensive interview). DWI drivers with high alcohol concentrations are no more likely to report no crashes and only slightly more likely to report two or more crashes during the preceding five years than are roadblock drivers with high alcohol concentrations.

6.2.4.2 License suspensions. Record check data for suspensions during lifetime are shown in Table 6-15. For fatalities, no substantial

Table 6-13

Distribution in Frequency and Percent of Drinking and Driving Patterns by Blood Alcohol Concentration.

Drinking and driving patterns by blood alcohol concentration	Roadblock		Clear-record		DWI	
	N	%	N	%	N	%
< 20 mg%						
Never drive after drinking	248	32	14	33	--	--
Less than 1/2 the time	305	40	20	47	--	--
1/2 the time or more	212	28	9	21	--	--
Total	765	100	43	101	--	--
≥100 mg%						
Never drive after drinking	2	8	--	--	3	8
Less than 1/2 the time	12	50	--	--	20	53
1/2 the time or more	10	42	--	--	15	39
Total	24	100	--	--	38	100

Table 6-14

Distribution in Frequency and Percent of Crashes in Previous Five Years According to Self-report by Blood Alcohol Concentration.

Crashes in previous five years by blood alcohol concentration	Roadblock		Clear-record		DWI	
	N	%	N	%	N	%
< 20 mg%						
None	629	67	54	98	--	--
One	232	25	1	2	--	--
Two or more	84	9	0	0	--	--
Total	945	101	55	100	--	--
≥100 mg%						
None	15	63	--	--	25	61
One	6	25	--	--	7	17
Two or more	3	13	--	--	9	22
Total	24	101	--	--	41	100

Table 6-15

Distribution in Frequency and Percent of License Suspensions
According to Official Record Check by Blood Alcohol Concentration.

License suspensions by blood alcohol concentration	Fatal crash		Roadblock		Clear-record		DWI	
	N	%	N	%	N	%	N	%
< 20 mg%								
None	32	76	642	87	51	93	--	--
One	4	9	63	9	4	7	--	--
Two or more	6	14	35	5	0	0	--	--
Total	42	99	740	101	55	100	--	--
≥100 mg%								
None	27	67	12	80	--	--	17	41
One	8	20	0	0	--	--	7	17
Two or more	5	13	3	20	--	--	17	41
Total	40	100	15	100	--	--	41	99

difference in previous suspensions appeared between those individuals who had no alcohol and those with high alcohol concentrations. However, greater proportions of roadblock drivers with high alcohol concentrations were found to have had suspensions and to have had two or more suspensions than among those with no alcohol present. Examined across groups with no alcohol present, clear-record drivers were least likely to have had previous license suspensions, roadblock drivers next, and fatality drivers most likely to have suspensions and to have had two or more suspensions. Thus, one in every four fatalities without alcohol present had at least one previous license suspension on his record.

Among drivers with high alcohol concentrations, 33% of fatalities, 20% of roadblock, and 58% of DWI drivers had at least one previous suspension; and indeed 41% of the DWI drivers had two or more previous suspensions during their lifetimes, the sort of record that could hardly be attributed to random factors. Some of the possible reasons for this extraordinary pattern are discussed in Section 6.3.

6.2.4.3. Citations. In a comparison of the record check of citations for moving traffic violations in the previous five years, roadblock drivers without alcohol were slightly less likely to have citations and to have two or more citations on their record than were those who had high alcohol concentrations (Table 6-16). Among fatalities, however, relatively similar patterns appear with respect to citations between those who had no alcohol and those who died with very high alcohol concentrations. Fatalities who died with no alcohol more often had citations and had two or more citations than did roadblock drivers without alcohol (perhaps a reflection of the fact that fatalities were more heavily weighted with young, new drivers and relatively more of such drivers tend to have

Table 6-16

Distribution in Frequency and Percent of Citations Received During Previous Five Years According to Official Record Check by Blood Alcohol Concentration.

Citations in previous five years by blood alcohol concentration	Fatal crash		Roadblock		Clear-record		DWI	
	N	%	N	%	N	%	N	%
< 20 mg%								
None	31	74	616	83	55	100	--	--
One	5	12	98	13	0	0	--	--
Two or more	6	14	30	4	0	0	--	--
Total	42	100	744	100	55	100	--	--
≥100 mg%								
None	30	73	10	67	--	--	13	32
One	8	19	2	13	--	--	14	34
Two or more	3	7	3	20	--	--	14	34
Total	41	99	15	100	--	--	41	100

citations). By definition, both fatality and roadblock drivers without alcohol had citations more often than did the clear-record drivers.

Fatality and roadblock drivers with high alcohol concentrations had rather similar patterns with respect to previous citations, but fully 68% of DWI drivers had previous citations during the five years preceding the current DWI conviction for which they were sampled, and 34% of them had two or more such citations during this period. Again, such a record could hardly be attributed merely to chance.

6.3 COMPARISONS OF DRIVERS AGE 25 OR OLDER WITH HIGH ALCOHOL CONCENTRATIONS

In comparing the various groups, it is important to know not only to what extent drivers who have gotten into trouble on the highway differ with respect to the use of alcohol and other characteristics from those who have not gotten into trouble. We also wish to know to what extent all drivers with impairing amounts of alcohol are similar, regardless of whether or not they have gotten into trouble. The underlying question is whether roadblock drivers with alcohol represent the population from whom DWI and fatally injured drivers with alcohol will probably come, or whether differences exist despite similarity of blood alcohol concentrations. Are some groups of drivers with high alcohol concentrations unlikely to get into trouble, others only to have DWI arrests, and still others to be involved in fatal alcohol-related crashes?

In order to answer these questions, the groups must be similar not only with respect to blood alcohol concentrations (as in Section 6.2), but also with respect to age and sex because, as we have shown: (1) the driver fatalities tend to be much younger than the DWI or roadblock drivers, and (2) the roadblock group has more females than either of the other two groups. Therefore, the comparisons that follow are limited solely to fatality, roadblock, and DWI drivers who had blood alcohol concentrations of 100 mg% or higher <u>and</u> who were age 25 or older. (Drivers in this age range comprised the majority of all three groups with high alcohol concentrations.) Since the proportions of women in all three groups are very small (3% to 11%), female subjects have not been excluded from the analysis because of small total sample size of all three groups.

<u>With only a few exceptions, the data suggest that there are major similarities between DWIs and driver fatalities who had alcohol. We must conclude that to a substantial degree, these two groups of high alcohol drivers are probably drawn from a single population</u>. These similarities and the few areas of differences are described below.

The mean blood alcohol concentrations of the roadblock drivers in these analyses were relatively so much lower than those of the other two groups, however, that we are unable to state whether the observed differences between the roadblock group and the others was because the extremely heavy drinkers were absent, or because the roadblock drivers represent a different population for other reasons as well. We believe the former explanation is more likely. Since half of the DWIs were arrested after crash involvement, we therefore suspect that extremely high blood alcohol concentrations are so clearly associated with hazard that they are only rarely found even in very large samples of roadblock drivers who are just stopped incidentally and not because they have gotten into trouble on the highway.

6.3.1 BLOOD ALCOHOL CONCENTRATIONS

Table 6-17 shows the blood alcohol concentrations of the three groups. Although every member of these three groups has a blood alcohol concentration of 100 mg% or higher, it is clear that the average blood alcohol concentration for the DWIs is higher than for the other two groups, and that in turn, the fatalities had a much higher blood alcohol concentration that the roadblock drivers (mean blood alcohol concentrations: fatality, 202 mg%; roadblock, 141 mg%; DWI, 215 mg%). As noted by several researchers, the extraordinarily high blood alcohol concentrations of the DWIs may be a reflection of the fact that police officers (and physicians as well) commonly cannot identify impairment by alcohol without the aid of chemical tests unless the blood alcohol concentrations are at least 150 mg%.

6.3.2 BIOGRAPHICAL VARIABLES

6.3.2.1 Marital status. As seen in Table 6-18, the fatalities and DWIs both tend to be single, widowed, divorced, or separated much more often than the roadblock drivers with high alcohol concentrations ($p < .05$). Again, it is not known whether the differences between the roadblock subjects and the other subjects in these analyses are attributable to the differences in mean blood alcohol concentration, or to other factors.

6.3.2.2 Occupational level. An important difference between the DWI drivers and the other two groups can be seen in Table 6-18 in which subjects are classified according to occupational level. Substantially more DWI drivers are in the lower occupational classification and sub-

Table 6-17

Distribution in Frequency and Percent of Blood Alcohol Concentration among Legally Impaired Drivers (100 mg% or greater) Age 25 or Older.

Blood alcohol concentration (mg%)	Fatal crash		Roadblock		DWI	
	N	%	N	%	N	%
100 - 149	8	33	10	55	5	16
150 - 199	5	21	8	44	7	23
200 - 249	6	25	0	0	9	29
≥ 250	5	21	0	0	10	32
Total	24	100	18	99	31	100
Mean (mg%)	202		141		215	

Table 6-18

Distribution in Frequency and Percent of Marital Status, Occupational Level, and Number of Employers in Previous Five Years among Legally Impaired Drivers (100 mg% or greater) Age 25 or Older.

Biographical item	Fatal crash		Roadblock		DWI	
	N	%	N	%	N	%
Marital status						
Single	4	22	2	11	7	23
Married	13	72	16	88	16	52
Wid.,Sep.,Div.	1	6	0	0	8	26
Total	18	100	18	99	31	101
Occupational level						
Upper	8	50	7	41	3	10
Middle	4	25	5	29	11	35
Lower	3	19	3	18	12	39
Other	1	6	2	12	5	16
Total	16	100	17	100	31	100
Number of jobs						
None	6	46	8	47	16	52
One	3	23	7	41	6	19
Two	3	23	1	6	7	23
Three or more	1	8	1	6	2	6
Total	13	100	17	100	31	100

stantially fewer are in the upper occupational classification when compared to the other two groups ($p < .10$). It has been noted elsewhere by Waller (1971) that drivers with high blood alcohol concentrations who are in older cars are much more likely to be reported as having been drinking than are drivers with similar blood alcohol concentrations who are driving new cars. The fact that more DWIs are in the lower occupational status may be reflected by the age and type of vehicles they are driving and thus may be a factor in the readiness of the police to arrest them for this type of alcohol offense.

The possibility must also be considered that lower class drivers with high alcohol concentrations actually behave quite differently than do middle or upper class drivers with similar blood alcohol concentrations.

6.3.2.3 Jobs in previous five years. In comparison to the roadblock drivers, both the fatality and DWI drivers appear to have had greater job mobility within the past five years (Table 6-18). One quarter of both these groups have had three or more jobs within the past five years as compared to 6% of the roadblock group. The differences are not statistically significant, however ($p < .10$).

6.3.3 PATTERNS OF ALCOHOL USE

The frequency and quantity of beer and liquor consumption are shown in Table 6-19 and the Quantity-Frequency Index (QFI) for preferred beverage is shown in Table 6-20. Again, these DWIs and the fatalities are similar with respect to quantity of beer usually consumed. Beer drinking is both frequent and heavy among all three groups, especially among the DWIs and fatalities. (Differences among the three groups are not statistically significant.)

Table 6-19

Distribution in Frequency and Percent of Reported Usual Frequency and Quantity of Beer and Liquor Consumptions among Legally Impaired Drivers (100 mg% or greater) Age 25 or Older.

onsumption	Beer						Liquor					
	Fatal crash		Roadblock		DWI		Fatal crash		Roadblock		DWI	
	N	%	N	%	N	%	N	%	N	%	N	%
requency												
Never	(0)	--	(1)	--	(1)	--	(1)	--	(3)	--	(7)	--
Monthly	0	0	1	7	4	13	2	25	2	29	11	46
Weekly	2	22	6	43	6	20	3	37	4	57	6	25
Daily	7	78	7	50	20	67	3	37	1	14	7	29
Total	9	100	14	100	30	100	8	99	7	100	24	100
antity												
Light	3	33	4	29	5	17	3	37	5	71	7	30
Medium	4	44	5	36	14	47	4	50	1	14	8	35
Heavy	2	22	5	36	11	37	1	13	1	14	8	35
Total	9	99	14	101	30	101	8	100	7	99	23	100

Concerning liquor consumption, the fatalities used liquor frequently, but apparently only in medium amount (we cannot rule out the possibility that surviving relatives reported quantity of alcohol consumption in somewhat more favorable terms than was actually the case); the roadblock drivers report they use liquor neither frequently nor heavily; whereas the DWIs use liquor both frequently and heavily. Again, however, the differences among the three groups are not statistically significant. As noted before, relative to liquor consumption, the reported abuse of beer is a significant variable with respect to highway safety and deserves much more attention in future countermeasure programs and research.

The QFI based on preferred beverage (Table 6-20) indicates that medium and heavy drinking (at least on a weekly basis) is reported for 77% of the fatality, 51% of the roadblock, and 80% of the DWI groups; whereas, just heavy drinking, at least on a weekly basis, is reported for 33% of the fatality, 28% of the roadblock, and 42% of the DWI groups. These data confirm the impression that drivers with high blood alcohol concentrations at any given moment are most often repeating a drinking pattern which they have followed many times in the past and are not merely average social drinkers who happened only on this one occasion to "have had a few too many."

6.3.4 DRINKING AND DRIVING PATTERNS

With respect to driving after drinking, only about 5% of the DWI and roadblock drivers state that they never combine these two activities, whereas about 40% of these presumably impaired roadblock and DWI drivers state that they drive after at least half of the occasions on which they have been drinking (Table 6-21).

Table 6-20

Distribution in Frequency and Percent of Reported Usual Quantity-Frequency Index, Frequency, and Quantity of Preferred Beverage Consumption among Legally Impaired Drivers (100 mg% or greater) Age 25 or Older.

Preferred beverage consumption	Fatal crash		Roadblock		DWI	
	N	%	N	%	N	%
Quantity-frequency						
Light	1	11	3	17	1	3
Light-medium	1	11	6	33	4	13
Medium	4	44	4	22	12	40
Heavy	3	33	5	28	13	43
Total	9	99	18	100	30	99
Frequency						
Monthly	0	0	3	17	2	7
Weekly	2	22	6	33	12	40
Daily	7	78	9	50	16	53
Total	9	100	18	100	30	100
Quantity						
Light	2	22	7	39	3	10
Medium	4	44	6	33	14	47
Heavy	3	33	5	28	13	43
Total	9	99	18	100	30	100

Table 6-21

Distribution in Frequency and Percent of Drinking and Driving Patterns among Legally Impaired Drivers (100 mg% or greater) Age 25 or Older.

Drinking and driving patterns	Roadblock		DWI	
	N	%	N	%
Never drive after drinking	1	6	1	3
Less than 1/2 the time	10	56	16	55
1/2 the time or more	7	39	12	41
Total	18	101	29	99

6.3.5 DRIVING PATTERNS

6.3.5.1 Crashes. It is only possible to describe the self-reported crashes during the previous five years because of the Motor Vehicle Department's practice of "purging" records of crashes which occurred more than three years ago. Table 6-22 shows the self-reported crashes for the roadblock and DWI drivers. The differences between the two groups appear to be slight ($p < .10$), in comparison to the self-reported differences in suspensions and citations between the two groups. It is, of course, not possible to know to what extent either group was under-reporting crashes during the previous five years. However, taking the self-reported data about crashes at face value, it is reasonable to ask whether DWI drivers differ from roadblock drivers in citations and suspensions, but not in crashes because of differences in visibility and life style which were mentioned in the discussion of differences in occupational classification.

6.3.5.2 License suspensions. The DWIs were significantly more likely to have had previous suspensions (on the basis of record check) than either of the other two groups ($p < .001$). Although the DWIs appeared likely to report the fact that they had been suspended ($p < .05$), they also tended to under-report the number of times they had been suspended (Table 6-23).

6.3.5.3 Citations. Table 6-24 shows the distributions of citations for serious moving violations during the previous five years as self-reported by DWI and roadblock subjects and as obtained from the Motor Vehicle Department's record check for all three groups. It is especially relevant that record checks could be conducted only on relatively few impaired roadblock drivers since most of these roadblock drivers with high alcohol concentrations were not willing to volunteer their names at the

Table 6-22

Distribution in Frequency and Percent of Crashes in Previous Five Years According to Self-report among Legally Impaired Drivers (100 mg% or greater) Age 25 or Older.

Crashes in previous five years	Fatal crash		Roadblock		DWI	
	N	%	N	%	N	%
None	--	--	13	72	20	65
One	--	--	3	17	5	16
Two or more	--	--	2	11	6	19
Total	--	--	18	100	31	100

Table 6-23

Distribution in Frequency and Percent of License Suspensions According to Official Record Check and Self-report among Legally Impaired Drivers (100 mg% or greater) Age 25 or Older.

License suspensions	Fatal crash		Roadblock		DWI	
	N	%	N	%	N	%
Record check						
None	18	78	11	79	11	35
One	1	4	0	0	5	16
Two or more	4	17	3	21	15	48
Total	23	99	14	100	31	99
Self-report						
None	--	--	14	78	12	39
One	--	--	4	22	8	26
Two or more	--	--	0	0	11	35
Total	--	--	18	100	31	100

Table 6-24

Distribution in Frequency and Percent of Citations Received During Previous Five Years According to Official Record Check and Self-report among Legally Impaired Drivers (100 mg% or greater) Age 25 or Older.

Citations in previous five years	Fatal crash		Roadblock		DWI	
	N	%	N	%	N	%
Record check						
None	19	83	10	71	10	32
One	3	13	2	14	11	35
Two or more	1	4	2	14	10	32
Total	23	100	14	99	31	99
Self-report						
None	--	--	15	83	19	61
One	--	--	1	6	7	23
Two or more	--	--	2	11	5	16
Total	--	--	18	100	31	100

end of the interview.

The data reveal, first, that the DWIs differ significantly from both the fatality and the roadblock drivers in the proportions with record-check citations, and with three or more record-check citations during the previous five years ($p < .01$). Second, it is very clear that many of the DWIs described themselves much more favorably to the interviewer with respect to lack of citations during the previous five years than was revealed by their driving records. However, this discrepancy between personal statement and historical reality was not observed with the roadblock group.

6.4 COMPARISONS ON OTHER BIOGRAPHICAL, ATTITUDINAL, AND PERSONALITY VARIABLES

This section consists of four separate subsections which contain data that are not readily analyzed at the three levels of treatment used in the three preceeding sections of this chapter. More specifically, this section contains: (1) analyses of the selected biographical, drinking and driving, and driving variables as cross-tabulated by the Quantity-Frequency Index of alcohol consumption; (2) a multivariate discriminant analysis using twelve of the most promising variables with the clear-record and DWI drivers; (3) analyses of the seven scales from the Driver Attitude Survey; and (4) analyses of the three scales from the Eysenck Personality Inventory.

6.4.1 QUANTITY-FREQUENCY INDEX

Because of its apparent importance, the Quantity-Frequency Index (QFI) was cross-tabulated with some of the other selected variables in addition to those already described. Included in this subsection are the more salient results of the cross-tabulations on the biographical variables, as well as on drinking and driving patterns, and driving history variables.

6.4.1.1 Sex. Regarding QFI and sex, the general finding is that the proportion of males to females increases as the quantity and frequency of alcohol consumption increase. Thus, of drivers interviewed at roadblocks, 75% with a light QFI were male and 25% were female; 84% with a light-medium QFI were male and 16% were female, and 87% with a medium QFI were male and 13% were female; whereas 97% with a heavy QFI were male and only 3% were female. (For reference purposes, it should be noted that 80% of the total roadblock sample was male and 20% female.) In other terms, 14% of all male drivers interviewed at roadblocks were abstainers versus 24% of all females; 30% of males had a light QFI versus 41% of females; 29% of males had a light-medium QFI versus 24% of females; and 16% of males had a medium QFI versus 10% of females; whereas 13% of males had a heavy QFI versus only 1.5% of females. It is especially interesting to note that the one lone female convicted for DWI provided alcohol consumption data which qualified her as having a daily-heavy QFI.

6.4.1.2 Age. Regarding QFI and age, some of the older stereotypes were not confirmed; for example, that the very young drivers are not heavy drinkers. Among drivers under 20 years of age (and who, as of the date of the roadblock, could not legally purchase alcoholic beverages in Vermont), none of the very young driver fatalities were reported by next-of-kin to be in either the medium or heavy QFI categories (perhaps understandably); 80% in the hospitalization-crash sample had either a medium or a heavy QFI (with 50% having a heavy QFI); 30% in the roadblock sample had either a medium or a heavy QFI (with 18% having a heavy QFI); 18% in the clear-record sample had either a medium or heavy QFI (with 18% having a heavy QFI); 75% of the DWI sample had a medium or heavy QFI, but all of these actually had a heavy QFI; and 63% of the non-DWI citation sample had a medium or heavy QFI (with 21% having a heavy QFI).

As noted earlier, however, almost half of the deceased drivers under 20 years of age had a blood alcohol concentration of 50 mg% or greater and a quarter of them had 100 mg% or greater, thus indicating a certain amount of slippage between the next-of-kin reports and the teenagers' actual drinking behavior. In other terms, drivers under 20 who had a heavy QFI constituted the following proportions of each group: fatal crash, 0%; hospitalization crash, 83%; roadblock, 20%; clear-record, 50%; DWI, 10%; and non-DWI, 30%. If drivers with a heavy QFI who were between 20 and 24 years are added to those under 20, the following proportions are obtained: fatal crash, 33%; hospitalization crash, 83%; roadblock, 50%; clear-record, 75%; DWI, 34%; and non-DWI, 80%. Especially interesting is the finding that, of those drivers in the hospitalization-crash sample who had a medium or heavy QFI, a shocking 73% were under 20 years of age. Thus, a surprisingly large proportion of the very young (i.e., teenage) drivers state that they are heavy and frequent drinkers, information which cannot be written off simply as braggadocio in view of the limited but convincing data from the distributions of blood alcohol concentration.

The quantity of alcohol typically consumed apparently decreases with increasing age. For example, the proportion of roadblock drivers within each age category who reported a heavy QFI were: under 20, 20%; 20-24, 30%; 25-29, 22%; 30-39, 15%; 40-49, 9%; 50-59, 4%; and 60 or older, 1%. This trend was apparent in all other groups, even among the DWI drivers.

6.4.1.3 Marital status. Regarding QFI and marital status, the major finding is that the proportion of married drivers decreases significantly as reported alcohol consumption increases ($p < .01$). Specifically, the proportion of married respondents to single respondents among roadblock drivers (the largest and most representative group) was as follows: 71% married versus 26% single among abstainers; 71% versus 26% for light QFI; 77% versus 21% for light-medium QFI, 62% versus 38% for medium; and 48% versus 51% for heavy QFI. A generally similar trend was found in each of the other groups.

6.4.1.4 Occupational level. Regarding QFI and occupational level, no significant differences were observed. That is, the distributions of occupational level (upper, middle, lower, and other) were essentially the same within each of the QFI categories as they were within each total group (see Table 5-4).

6.4.1.5 Jobs in previous five years. There was a tendency for drivers who had heavy QFIs to have changed jobs more frequently in the last five years than would be expected by the distribution within each total group. That is, the proportion of drivers with heavy QFIs who had two or more jobs during the past five years increased within each group (ranging from a 10% to a 40% increase), and the proportion with three or more jobs also increased within each group (ranging from a 9% to a 45% increase). However, in terms of comparison with the total sample (and using number of jobs as the independent variable), the largest and statistically most reliable increase was found among those roadblock drivers with three or more jobs during the past five years, namely, proportionally twice as many in this category had a heavy QFI (45%) relative to the proportion in the total roadblock sample (21%). Thus, there is some evidence that a driver with a heavy QFI is more likely to have had a greater number of job changes in recent years.

6.4.1.6 Drinking and driving patterns. The most important results of cross-tabulating QFI and the driving-after-drinking variables were found among the drivers in the two citation groups. Approximately half of DWI and non-DWI citation drivers who were coded as heavy drinkers of their preferred beverages were also coded as driving after drinking half the time or more. Thus, DWI and non-DWI citation drivers who had heavy QFIs drive after drinking much more frequently than those with light or medium QFIs, whereas just the opposite relations obtained in the other three groups. Conversely, among individuals who reported driving after drinking half the time or more, the DWI and non-DWI citation drivers were heavier and more frequent drinkers than those in the other samples. That is, among individuals who reportedly drive after drinking half the time or more, 68% of DWI and 32% of non-DWI citation drivers had a heavy QFI, whereas the proportions of roadblock and clear-record drivers with heavy QFIs in this upper category were 18% and 9% respectively.

The results of these cross-tabulations permit the following generalizations:

1. The higher the frequency of driving after drinking, the heavier and more frequent the reported usual alcohol consumption, and vice versa.
2. The lighter and less frequent the reported usual alcohol consumption, the lower the frequency of driving after drinking, and vice versa.

6.4.1.7 Driving patterns. No clear-cut patterns of differences beyond those in the basic distributions (already described in previous sections) were obtained from cross-tabulations of crashes or license suspensions by QFI. However, when citations were cross-tabulated by QFI, substantial deviations from the basic distributions within each group were found, especially in the roadblock sample. Specifically, roadblock drivers with higher QFIs tended to have more citations in the previous five years than roadblock drivers with lower QFIs. Thus, it would seem that the number of previous citations is worth further examination as a basis for identifying drivers who may have an elevated likelihood of receiving a DWI or non-DWI citation.

In summary, the analyses of the alcohol consumption data indicate that these variables are in fact useful in differentiating across the spectrum of drivers. Further encouragement for the utility of these variables is provided by the relation of the reported alcohol consumption data to the actual consumption data and to the driving variables.

6.4.2 DISCRIMINANT ANALYSIS

The pilot work on this potentially very useful technique has just been completed and has involved 104 subjects classified into two groups: (1) clear-record drivers (N=56), and (2) DWI drivers (N=48). Twelve variables were tested for significance in discriminating between these two groups, namely: (1) sex, (2) age, (3) number of lifetime citations, (4) number of citations in past five years, (5) license suspensions, (6) occupation (grouped into 13 classifications), (7) number of jobs in past five years, (8) marital status, (9) frequency of beer consumption, (10) quantity of beer consumption, (11) frequency of liquor consumption, and (12) quantity of liquor consumption.

The four variables which were significant in discriminating between these two groups at p <.025 were, in order of importance: (1) number of lifetime citations, (2) occupation, (3) frequency of beer consumption, and (4) quantity of liquor consumption. Quantity of beer consumption was the next variable in this series, but was only significant at p = .10. It was determined that, on the basis of a discriminant function using the first four variables, 95% of the clear-record drivers could be correctly classified and 87% of the DWIs could be correctly classified. Thus, preliminary indications were obtained that it is in fact possible to determine classification hits and misses (at least for these two extremely divergent samples) on the basis of a weighted function which incorporates components from an individual's driving record, from his socio-economic status, and from his reported patterns of alcohol use.

6.4.3 DRIVER ATTITUDE SURVEY (DAS)

Each respondent in the five treatment groups (i.e., all but the deceased drivers) completed a 126-item Driver Attitude Survey (Schuster & Guilford, 1964). A score was obtained for each subject on each of the seven scales described above (see Method) using the scoring keys provided with the DAS. The scores on each scale were arranged in two different ways for analysis: (a) by subject in a specific treatment group, and (b) all subjects pooled regardless of treatment group. The first arrangement provided the basis for analyzing the differences among and between treatment groups, using analysis of variance and the *t* test. The second arrangement permitted successive dichotomization across all combinations of contiguous response-code categories, using biserial and point-biserial correlations, to determine the most efficient (i.e., most significant) cutting point on a given scale independent of membership in the original treatment group (i.e., independent of the original selection criteria for being admitted into a given sample). However, only the results from the first arrangement are presented here because those from the second are beyond the scope of this report.

Due to the relatively small samples, the DAS data from all subjects were included in all preliminary analyses. That is, no subject was eliminated from consideration because he had a score higher than the recommended cutting point on any of the three validation scales (D, F, X). Subsequent analyses are scheduled for this finer sifting of the data.

The group means and standard deviations on each of the seven DAS scales are presented in Table 6-25, along with a percent of the maximum score on a given scale which the group mean comprises.

The results of one-way analysis of variance conducted to evaluate differences among the five treatment groups on the seven DAS scales are presented in Table 6-26. Significant differences among the groups were found on the deviance scale ($p < .01$) and on the violation-attitude scale ($p < .05$). However, subsequent Newman-Keuls tests indicated that the differences on these two scales should not be considered significant in terms of acceptable error rates.

Despite the lack of stable significant differences among groups, the mean differences between groups were evaluated for this exploratory phase

Table 6-25

Group Means, Standard Deviations, and Percentages of Maximum Score for Driver Attitude Survey (DAS) and Eysenck Personality Inventory (EPI) Scales among Five Study Groups.

Scale	Crash			Citation						Clear-record					
	Hospital			DWI			Non-DWI			Clear-F			Clear-H		
	Mean	SD	% max	Mean	SD	% max	Mean	SD	% max	Mean	SD	% max	Mean	SD	% max
DAS															
D	1.58	2.35	8	3.35	4.69	17	2.84	2.33	14	1.70	1.42	9	1.25	1.37	6
F	11.03	2.99	55	10.42	3.28	52	10.17	3.69	51	10.79	3.62	54	11.97	3.32	60
X	5.00	1.75	36	5.87	8.00	42	4.48	1.50	32	5.28	1.77	38	4.76	2.10	34
V	7.67	2.56	21	8.69	4.26	24	8.63	1.87	24	6.79	2.42	19	7.83	2.64	22
A	10.98	3.54	23	11.13	6.76	23	11.42	3.48	24	9.52	3.69	20	8.96	3.52	37
AL	3.36	2.10	34	5.11	6.84	51	4.53	1.91	45	3.34	1.85	33	3.70	3.91	19
P	5.54	2.20	21	7.07	9.45	27	6.31	2.52	24	4.85	2.01	19	4.83	1.91	19
EPI															
E	14.25	2.69	59	13.76	4.27	57	14.94	2.50	62	13.71	4.42	57	14.79	3.43	62
N	9.10	4.04	38	9.59	5.62	40	10.12	4.67	42	8.55	4.93	36	8.59	4.15	36
L	2.03	1.48	23	2.59	2.01	29	1.88	1.90	21	1.76	2.28	20	1.50	1.66	17

Table 6-26

Summary of Analysis of Variance on Seven Scales from the Driver Attitude Survey (DAS) and Five Scales from the Eysenck Personality Inventory (EPI) for Five Study Groups.

Source	MS	F
DAS		
D	8.95	3.75**
F	11.73	1.43
X	19.85	0.63
V	9.20	2.49*
A	22.02	1.89
AL	17.55	1.48
P	27.07	1.36
EPI		
E	13.08	0.93
N	23.43	0.70
L	3.65	1.93

of analysis by conducting two-tailed *t* tests. The DWI group had significantly higher scores than clear-record drivers on the deviance and the violation-attitude scales. The non-DWI citation drivers had significantly higher scores than clear-record drivers on the deviance, violation-attitude, accident-attitude, alcohol-attitude, and personal relations scales. The hospitalization crash group had significantly higher scores than clear-record drivers on the accident-attitude scale.

Regarding within-group differences, it should be noted that the degree to which the scores on a particular DAS scale were related to scores on each of the other six scales was determined by means of Spearman rank correlation coefficients (rho). Although the results are useful in evaluating aspects of the DAS, no unequivocal patterns of rho's were obtained which were germane to the scope of this report. However, the appropriate cluster and item analyses are being conducted in an attempt to determine relevant within-group differences and associations.

6.4.4 PERSONALITY VARIABLES

The information concerning personality variables is derived from performance on the extroversion and neuroticism scales of the 57-item Eysenck Personality Inventory (EPI). As with the DAS, the scores on each scale, plus the lie scale, were arranged in two different ways for analysis, but only the results from the first, concerning differences between treatment groups, are presented here (see DAS above).

The group means and standard deviations on each of the three EPI scales are presented in Table 6-25, along with the percent of the maximum score on a given scale which the group mean comprises. A summary of the analysis of variance results is presented in Table 6-26 for the three EPI scales. No significant differences were found among the five treatment groups. Furthermore, the only significant difference between groups was found on the lie scale, with the DWIs having higher lie scores than the hospitalization crash drivers ($t = 2.51$, $p < .02$).

As with the DAS, no clear-cut patterns of Spearman rank correlation coefficients emerged from analysis of the scores on the three EPI scales. However, numerous significant correlations between scales on the DAS and EPI were obtained, but further analysis is warranted before these associations can be meaningfully interpreted.

In conclusion, no significant or unequivocal differences between groups were obtained on either the extroversion-introversion or the neuroticism-stability scales of the Eysenck Personality Inventory. The high amount of variance found on the attitudinal and personality scales accounts in part for the paucity of significant differences between groups. More sensitive individualized analyses are therefore warranted and are being conducted. Thus, these preliminary results are interpreted as providing additional support for the working assumption that it is indeed possible and feasible to construct a weighted combination of demographic, drinking, driving, attitudinal, and personality variables which will enable future identification of a large proportion of high-risk problem-drinking drivers.

Chapter 7

INFLUENCES OF ALCOHOL UPON DRIVING-RELATED BEHAVIOR

The following research consists of an interrelated series of induced-intoxication experiments designed to establish a workable methodology for investigating the influences of alcohol on certain key perceptual-cognitive functions which are assumed to be especially crucial for successful automobile driving. Three types of induced-intoxication experiments were conducted, namely: (1) small-group studies in which subjects drank together in a simulated cocktail-party atmosphere, but were tested separately (Sections 7.1, 7.2, 7.4, 7.5, and 7.6); (2) laboratory experiments in which subjects both drank and were tested individually (Sections 7.3, 7.7, and 7.8); and (3) a closed-course pilot study using an instrumented car to investigate the influences of alcohol upon actual driving behavior. However, the latter study is simply mentioned here since it was part of another contract and is accordingly reported elsewhere (U.S. DOT Contract FH-11-7469).

Initially, a repeated measurement, treatment-by-subjects design was used for the immediate purpose of assigning certain behavioral and attitudinal changes to selected blood alcohol concentrations obtained in a controlled social drinking situation. These results will eventually be related to actual driving behavior under the influence of alcohol. Thus, the goals of the series of experiments reported here consisted of: (1) developing reliable procedures for controlling alcohol dosage and ingestion rates in order to obtain predetermined blood alcohol concentrations,

(2) comparing the reliability of several methods of determining the obtained concentrations, and (3) selecting and testing psychological tasks which meet the following criteria: (a) are related to the perceptual-cognitive aspects of driving, (b) are readily, but differentially subject to the influences of alcohol, and (c) will ultimately differentiate high-risk and low-risk drivers.

The results of this research indicate that the first two criteria can be met by three types of performance tasks (divided and selective attention, information transmission, and risk taking) which are briefly reported below in separate experiments (Sections 7.2, 7.3, 7.4, 7.5, 7.7, and 7.8).

7.1 COMPARISON OF FOUR METHODS FOR DETERMINING BLOOD AND BREATH ALCOHOL CONCENTRATIONS

An accurate and reliable method of determining blood alcohol concentration is a necessary procedural requirement for rigorous experimentation on the behavioral influences of alcohol. Furthermore, it is deemed highly desirable to use a determination method that is immediately sensitive to current capillary blood alcohol concentrations, since it seems logical that the concentration of dissolved solutes (including ethanol) in surface capillary blood closely approximates the concentration of similar solutes in the blood of those capillary circuits in the brain, spinal cord, and peripheral nerves (as well as those other viscera) in which the action of ethanol assumes pharmacologic, pathologic, and behavioral significance. In addition, it is important for procedural convenience that the method can be used without extensive training or medico-technical assistance. Accordingly, the Borkenstein Breathalyzer has been chosen as our principle method of assessing blood alcohol concentrations.

However, our dependence upon an indirect method of estimating blood alcohol concentration from a breath sample (as opposed to those methods which involve direct blood sampling) has prompted concern about the reliability of the Breathalyzer. Consequently, an induced-intoxication study was conducted to compare the reliability of the Breathalyzer with three other common methods of determining blood alcohol concentrations: one other breath testing device (the Mobat Sobermeter, SM 2) and two blood sampling techniques--capillary blood samples (obtained using the "Unopette" collection system) and venous blood samples. Both types of blood sample were analyzed using an alcohol dehydrogenase method.

7.1.1 METHOD

A counterbalanced, repeated measurements design was employed in which each subject's blood alcohol concentration was assessed with each of the four determination methods. The set of four determinations was obtained four times, once each at four consecutive 30-minute intervals following the ingestion of one dose of alcohol equivalent to 1.21 ml of 95% ethanol per kg of body weight. The data (in the form of milligrams of alcohol per 100 milliliters of blood fluid, or mg%) were combined across the 16 subjects and the four time intervals for part of the analysis. Thus, the standard deviations obtained with respect to the four determination methods reflect not only method error, but between-subject and between-time-of-sample variability as well. Therefore, the differences between the four obtained standard deviations, rather than their absolute values, provide the most useful information about the relative reliability of the four methods.

7.1.2 RESULTS

Shown in Table 7-1 are the means and standard deviations of the estimates of blood alcohol concentration obtained at four consecutive 30-minute intervals using the four blood and breath determination methods. Regarding Table 7-1, it should be noted that the four methods are ordered according to increasing degree of variability: Breathalyzer, venous blood, Sobermeter, and capillary blood; the last being the most variable of all. In addition, it can be seen that the mean values of the obtained blood alcohol concentrations fall in this same sequence. Therefore, the magnitude of the mean blood alcohol concentration was positively associated with the magnitude of the variability.

Table 7-1

Means and Standard Deviations of Estimated Blood Alcohol Concentration Obtained at Four Consecutive 30-minute Intervals using Four Determination Methods

Sample intervals (minutes)	Breathalyzer		Venous		Sobermeter		Capillary	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1 (30)	87.87	14.33	98.68	16.28	114.31	18.62	131.33	33.90
2 (60)	77.68	11.88	97.93	16.96	116.56	22.19	120.31	31.65
3 (90)	74.68	13.17	89.18	14.72	103.81	27.06	118.13	31.70
4 (120)	67.06	13.98	85.68	14.19	105.00	17.80	115.57	30.46
Column means	76.82	13.33	92.80	15.53	109.99	21.42	121.33	31.92

A Friedman one-way analysis of variance was performed upon both means and standard deviations of the sampling-interval data, and indicated that the over-all differences were statistically significant ($X_r^2 = 64$, $p < .001$).

The column means were then analyzed with t-tests, the results of which indicated that the Breathalyzer method was significantly different from both the capillary method ($t = 3.94$, $p < .01$) and the Sobermeter method ($t = 3.81$, $p < .01$).

Furthermore, on the basis of correlation coefficients computed between all possible pairs of the four methods, the highest positive relationship was found between the Breathalyzer and the venous blood methods, i.e., between the two methods which were also found to be the most reliable.

7.1.3 CONCLUSIONS

Although a relatively conservative indicator of blood alcohol concentration, the Borkenstein Breathalyzer was the most reliable of the four methods tested. Thus, the Breathalyzer has been used for all subsequent alcohol determinations.

7.2 SELECTIVE AUDITORY ATTENTION

This study was concerned with the influences of alcohol upon dichotic identification of numbers. It was one of four studies conducted concurrently using the same group of subjects in a controlled, social drinking situation.

7.2.1 METHOD

7.2.1.1 Subjects. Eighteen paid, male volunteers served as subjects. All were academically average undergraduates and were 21 or more years of age. One subject completed only one session and none of his data was analyzed.

7.2.1.2 Procedure. The three testing sessions occurred on consecutive days (Thursday afternoon and evening; Friday 4:30 - 10:00 pm; and Saturday 9:00 - 12:00 am). Since all tasks were individual in nature, extensive scheduling of subjects was required at all three sessions, but especially at the "party." Accordingly, during the "party," a staggered sequence of the five test stations was maintained with the aid of volunteer female "assistants." Thus, each subject was assigned a female partner who paced his drinking at 15-minute intervals, drank non-alcoholic punch herself, and escorted him on the four highly programmed, 80-minute cycles of tests. To maximize the simulation of a normal cocktail party, hors d'oeuvres were continuously available on an ad lib basis (subjects had been requested not to eat or drink after lunch on the day of the "party"), appropriate recorded music was played, and all rooms on the first floor of a large, old, one-family house were used either for testing or socializing.

7.2.1.3 Alcohol. Every 15 minutes, each subject received and consumed a pre-determined amount of vodka punch based on his body weight such that his blood alcohol concentration would steadily increase 30 mg% every 80-minute cycle to a final concentration of about 100 mg%. A 10 cc venous blood sample was taken every 80 minutes at the "party" and once at the post-test (this and the following "party" experiments were conducted prior to the above methodological study). Laboratory analysis (using an alcohol dehydrogenase method) revealed a progressive increase in blood alcohol concentrations across the 4 sample-cycles at the party, with the mean blood alcohol concentration at the fourth sample being 113 mg% (see Table 7-2).

7.2.1.4 Auditory task. In order to study auditory information processing under conditions which met the first 2 criteria stated above, a perceptual conflict was created by presenting numerical stimuli dichotically. The competing inputs consisted of 10 pairs of different 2-digit or 3-digit numbers which had been carefully tape-recorded on 2 channels at 2-second intervals. Each pair was then presented simultaneously, but separately, to each ear by means of earphones. The subject was instructed to write down the numbers he heard and, if possible, to maintain the proper laterality. The tape was played through twice at each sitting.

7.2.2 RESULTS

Shown in Table 7-2 are the means and standard deviations of omission errors on the dichotic listening task: (1) at the pre-test session on the first day; (2) at the "party," sampled at the four consecutive 80-minute intervals during controlled drinking; and (3) at the post-test session on the morning of the third day, approximately 11 hours following completion of the final drink at the "party." Mean blood alcohol concentrations are also presented in Table 7-2.

Table 7-2

Means of Blood Alcohol Concentrations and Means and Standard Deviations of Omission Errors on the Dichotic Listening Task Obtained at Four Consecutive 80-minute Intervals during Alcohol Consumption and at Pre-test and Post-test No-alcohol Sessions

Statistic	Pre-test (day 1)	"Party" (day 2)				Post-test (day 3)
	No alc.	Alc. 1	Alc. 2	Alc. 3	Alc. 4	No alc.
Mean	25.1	13.9	11.8	11.1	17.2	8.2
SD	18.06	10.58	9.85	10.2	10.72	7.48
Mean BAC (mg%)	---	23	54	87	113	8

More errors of omission were made at the pre-test than at the post-test or at the "party" in Alcohol Sample 1, Alc. 2, or Alc. 3; and more were made at the time of highest blood alcohol concentration in Alc. 4 than in Alc. 2, Alc. 3, or at the post-test (see Table 7-2). These differences are statistically significant.

7.2.3 CONCLUSIONS

Thus, in a task involving filtering and selective attention to discrepant channels of auditory input, it was found that performance in such an information conflict situation improved with practice, but ability to attend to the relevant auditory channel deteriorated at the peak blood alcohol concentrations investigated (113 mg%). That is, the learning curve was interrupted by alcohol, especially at the highest blood alcohol concentrations.

7.3 SELECTIVE VISUAL ATTENTION

A study concerning the influences of alcohol upon ability to filter and select visual information has also been started to determine whether the effects of alcohol on the auditory attention task can be generalized to conditions involving the visual sense modality. Initially, we have studied the influences of alcohol on the Stroop effect.

7.3.1 METHOD

In the Stroop test, subjects are asked to name the hues of a series of color chips under two conditions: (1) an incorrect color name (e.g., "RED") is superimposed on a chip of some other hue (e.g., blue), as opposed to (2) in which no such interference is present. When performance in these two situations is compared, it is usually found that response latency is longer and errors more frequent when the interference words are present. This performance difference is called the Stroop effect.

In contrast to the procedures used in the four "party" studies, individual subjects in the present experiment drank in isolation and were tested on the basis of a counter-balanced design.

7.3.2 RESULTS

Shown in Table 7-3 are the means and standard deviations of errors made and of time taken between start and finish of the Stroop test by five subjects in a no-alcohol condition and with blood alcohol concentrations of approximately 100 mg%.

Table 7-3

Means and Standard Deviations of Errors and Elapsed Time on the Stroop Test with and without Alcohol

Statistic	No alcohol		Alcohol (100 mg%)	
	Errors	Elapsed time	Errors	Elapsed time
Mean	3.05	90.60	4.95	101.50
SD	3.20	31.57	3.00	29.50

As shown in Table 7-3, our initial work with alcohol and performance on the Stroop test indicated that alcohol is associated: (1) with increases in the length of time required to do the task, and (2) with apparent, but unsystematic increases in errors. So far, no data have been obtained suggesting that alcohol has differential effects with respect to the two Stroop conditions, i.e., that it changes the magnitude of the Stroop effect.

7.3.3 CONCLUSIONS

Within the context with which we are working, no evidence has been obtained to indicate that alcohol influences the ability to filter visually dependent information. Nevertheless, as found with auditory information processing, legally impairing blood alcohol concentrations were associated with a general decrease in the subject's performance efficiency in a serial information-transformation task.

7.4 DIVIDED ATTENTION

This study was concerned with the influences of alcohol upon the performance of two concurrent tasks and was developed to simulate the time-sharing and information-reduction-and-transformation aspects of automobile driving.

7.4.1 METHOD

Each of ten subjects participating as volunteers in the "party" (see Section 7.2.1) was required to monitor a display for one of four possible light signals (each of which was associated with one of two response levers) while attending to a fixed-pace mental-arithmetic task (problems presented every five seconds). At the end of monitoring periods of varying lengths of time (equal to or less than one minute), a visual signal was presented, to which the subject responded by pulling the appropriate lever. The subject was required to perform the task five times on the "party" day (once prior to drinking any alcohol and once at each of the four consecutive 80-minute intervals during the drinking period) and once again at the post-test session eleven hours after the completion of drinking.

7.4.2 RESULTS

Mean blood alcohol concentrations are presented in Table 7-2. Mean lever-response latencies decreased from .67 seconds on the pre-test to .64 on both Alcohol 1 and Alcohol 2 trials, whereas the mean reaction times increased to .70 and .76 on Alcohol 3 and Alcohol 4 trials respectively. The lowest mean reaction time was obtained on the post-test. Analyses of variance indicated that the difference between pre- and post-test scores is significant ($F = 14.07$; $df = 1,45$; $p < .001$), and that the difference between the first two alcohol trials (Alc. 1 and Alc. 2) and the second two alcohol trials (Alc. 3 and Alc. 4) is also significant ($F = 27.04$; $df = 1,45$; $p < .001$).

No significant alcohol effects were found either on number of correct lever responses or on number of correct mental-arithmetic solutions.

7.4.3 CONCLUSIONS

These results suggest that the effects of legally impairing amounts of alcohol are less on accuracy than they are on the temporal reaction aspects of performance. This finding is important when one considers that incorrect responses in psychomotor performance such as driving are frequently the result of information overload, and that information overload is directly related to decreases in available processing time.
In other words, alcohol may facilitate onset of information overload by increasing information processing time.

7.5 RISK TAKING

The influences of blood alcohol concentration upon risk-taking behavior in a gaming situation were investigated by comparing the responses of 17 subjects during control and experimental trials. It was hypothesized that degree of risk-taking changes as a function of increasing blood alcohol concentration. It was also hypothesized that response latency is affected by blood alcohol concentration.

7.5.1 METHOD

Relevant methodological information concerning subjects, procedure, and alcohol are presented above in Section 7.2.1.

The game, which consisted of 20 rounds, required the subject to respond by choosing either RED or GREEN for each round. The "opponent" also made such a choice (according to random 50% schedules of RED and GREEN), and the payoff was made accoriding to the combination of both players' choices. Two different, but visible payoff matrices were utilized to decrease the learning effect due to repeated sessions necessitated by the "party" format within which the study was conducted. Matrix 1 awarded the subject 4 points to the opponent's 2 points if both chose GREEN, but vice versa if the opponent chose RED. On the other hand, if both chose RED, the subject received 0 points to the opponent's 10, but vice versa if the opponent chose GREEN. Matrix II, which modified the payoff by reversing the efforts of the opponent's choice, was introduced after the second session. The subject was informed that if he obtained more points than his opponent after 20 rounds, he would receive \$0.50. (The subjects were given \$0.25 if they tied, but were not informed of this arrangement in advance so that tying strategies would not be encouraged.) For both payoff matrices, degree of risk-taking was defined as the number of RED responses (i.e., an attempt at the largest gain at the risk of an equally large loss) per game of 20 rounds. The time between the onset of a red light (which signaled the beginning of each round) and the subject's choice provided a measure of response latency.

7.5.2 RESULTS AND CONCLUSIONS

It was found that the greatest number of REDS (i.e., the riskier concentrations. However, no significant relation was obtained between blood alcohol concentration and response latencies at the highest blood alcohol concentrations, although subjects generally tended to use less time in deciding to take the riskier choice (RED).

Thus, it was shown that blood alcohol concentration is directly associated with increases in risk-taking. Cohen (1960) found such a relationship among bus drivers who were required to estimate their chances of success in driving their familiar vehicle through narrow gaps.

7.6 PERSONALITY AND AFFECT

The 17 "party" subjects (see Section 7.2) each completed an Eysenck Personality Inventory (EPI) and a Zuckerman Multiple Affect Adjective Check List (MAACL) prior to alcohol ingestion. Following the onset of drinking, the MAACL was readministered four times at 80-minute intervals throughout the drinking period during which the 17 subjects' blood alcohol concentrations were raised to a mean of 113 mg%.

For purposes of data analysis and interpretation, subjects were categorized with respect to the EPI dimensions as high or low anxious and as high or low neurotic, with the group means of these two dimensions used as the dividing points. When MAACL scores were examined with reference to the resultant categories, the following relationships emerged: (1) alcohol tended to be associated with reductions in MAACL anxiety and depression scores for subjects in the EPI high anxiety category; (2) alcohol tended to be associated with a reduction in MAACL hostility scores for those in the EPI high neurotic category; and (3) in all three cases, no-alcohol vs. alcohol differences in affect scores were greatest during the first half of the drinking period, i.e., when blood alcohol concentrations were at relatively low values (50-75 mg%), but were still increasing. No other consistent trends were found for these two instruments.

A survey of attitudes toward alcohol which was given prior to drinking, as well as on the morning following the experiment, revealed a pre-to-post increase in the subjects' attitudes against drinking alcoholic beverages.

7.7 INFLUENCES OF ALCOHOL AND TIME-SHARING UPON EXTRAFOVEAL SENSITIVITY

The purpose of this laboratory experiment was to determine the effects of medium blood alcohol concentrations, the difficulty of a sub-task which required foveal vision, and the distance (in degrees of visual angle) of a peripheral light flash from the point of fixation upon reaction time to the peripheral flashes.

7.7.1 METHOD

The reaction times of nine subjects were determined at three blood alcohol concentrations (0, 50, and 100 mg%), and under three levels of sub-task difficulty. Key-press responses were made at the onset of single white-light flashes located at five selected points (4°, 24°, 44°, 64°, or 84°) from the point of fixation on a horizontal perimeter.

A complete practice session, which was identical for all subjects, was conducted on the first of four consecutive days of testing. On the three subsequent experimental days, each subject performed at each of the three alcohol conditions, with only one alcohol treatment being experienced by a subject on a single day. Each subject received four target presentations from each of five peripheral locations in each of three sessions given on a single day. During each of these three sessions, the subject performed the peripheral detection task while simultaneously engaged in one of three foveal sub-task conditions (which varied in level of difficulty) with only one sub-task difficulty level being experienced by a subject in a given session. The subject indicated detection and laterality (left or right side) of the peripheral signals by release of one or the other of two hand-held switches. Subjects were told that performance on the foveal sub-task was of primary importance and received a monetary reward for each trial during which the fixation task was done perfectly.

7.7.2 RESULTS

Shown in Table 7-4 are the means and standard deviations of reaction time (in milliseconds) to extrafoveal stimulation at the three blood alcohol concentrations and at the three levels of sub-task difficulty that were investigated.

Table 7-4

Means and Standard Deviations of Reaction Time (in milliseconds) to Extrafoveal Stimulation at Three Blood Alcohol Concentrations and at Three Levels of Sub-task Difficulty

	Blood alcohol concentration		
Statistic	0 mg%	50 mg%	100 mg%
Mean	303.46	313.27	320.40
SD	83.10	85.12	70.80

	Sub-task difficulty level		
	Simple	Medium	Difficult
Mean	295.98	313.78	327.37
SD	58.14	81.93	93.40

It can be seen in Table 7-4 that reaction times to extrafoveal stimulation lengthened with increases in blood alcohol concentration and with increases in sub-task difficulty. In addition, it was found that reaction time to extrafoveal stimulation was long in response to targets located 24° and 84° of visual angle from the fixation point, but relatively short in response to targets located 4° and 44° of visual angle from the fixation point. No main-effect interactions were obtained. The above trends were statistically significant beyond the .05 level.

7.7.3 CONCLUSIONS

A direct relation was found between medium blood alcohol concentrations (i.e., below legal impairment) and choice reaction time to extrafoveal stimulation when a memory task was performed which was concurrent, high priority and dependent upon the detection of foveal light blinks. Furthermore, although alcohol was associated with reductions in performance on the reaction-time task, blood alcohol concentration did not influence foveal-task performance to a statistically significant degree, despite the fact that performance on tasks heavily dependent upon memory have been shown to be susceptible to alcohol effects (Carpenter, Moore, Snyder, & Lysansky, 1961). Thus, although drinking subjects were able to maintain a certain level of performance on the foveal task, they could not do so without sacrificing performance on the peripheral task. Whether performances on the latter could be maintained at the possible expense of fixation-task performance by a reversal of the task priorities is an open question which awaits further research.

The present study has also demonstrated that the difficulty of a high priority task which is dependent upon foveal vision is directly related to reaction time to extrafoveal stimulation. This relation is consistent with the notion that the attentional capacity of the human observer is limited. Therefore, under certain conditions, performance on one task can only be improved (or even maintained) at the expense of decreases in the performance of other tasks which must be done simultaneously.

7.8 INFLUENCES OF ALCOHOL AND CONGENERS UPON SUGGESTIBILITY[1]

This second laboratory experiment was concerned with the influences of beverage alcohols with different congener levels and of experimental set upon the autokinetic effect. The stimulus for this line of research was the notion that alcohol increases the lability of the perceived world (particularly in a sensory deprived environment such as that which may occur during freeway driving and lead to highway hypnosis) and thereby renders these perceptions unduly susceptible to personal desires and/or peer-group suggestions.

7.8.1 METHOD

Sixteen subjects were tested in an environment which was conducive to obtaining the autokinetic effect (i.e., the apparent movement of a small stationary spot of light viewed in darkness) and to administering the Barber Suggestibility Scale. Eight subjects received instructions strongly suggesting that they would see autokinetic movement; the remaining 8 subjects received weak suggestion. All 16 subjects received the Barber Suggestibility Scale under the same specified conditions. Personality measures and biographical information (including drinking patterns and driving history)

[1]This investigation was supported in part by Public Health Research Grant MH 17583-01, National Institute of Mental Health.

were obtained at a preliminary session.

A repeated-measures, modified Latin-Square design was used with four alcohol-order sequences and four alcohol conditions, consisting of two no-alcohol and two alcohol treatments. The two no-alcohol treatments consisted of: (1) a 100% orange-juice drink which the subject was explicitly told contained no alcohol, and (2) a placebo drink of orange juice with 5 ml of bourbon floated on the surface and served in a glass which was sprayed lightly with bourbon. The two alcohol treatments differed selectively in volume and in congener content, but were equal in target blood alcohol concentration (75 mg%). The no-congener alcohol treatment consisted of 1.11 ml of ethanol per kg of body weight mixed with orange juice and with 5 ml of bourbon gloated on the surface just before serving. The congener alcohol treatment consisted of 2.22 ml of 100-proof bourbon per kg of body weight mixed with orange juice. The volume of beverage was constant within subject, and, with the exception of 100% orange-juice condition, subjects were not informed of the contents of the three different drinks, each of which actually was, or at least simulated, a bourbon-and-orange drink in terms of initial olfactory and gustatory cues.

Each subject received one of the four alcohol conditions on each of four consecutive days of testing. After consuming the particular experimental beverage in four equal doses, 15 minutes apart, the subjects were dark-adapted for 20 minutes. The autokinetic part of the experiment was then conducted and consisted of ten trials, for each of which the following measures were obtained: reported autokinetic movement, estimated linear extent, estimated direction of movement, and latency. The Barber Suggestibility Scale was administered after completion of these 10 autokinetic trials.

7.8.2 RESULTS

Mean blood alcohol concentrations (for both ethanol and bourbon treatments), measured at successive points during the experimental session, were: (1) 78 mg% 10 minutes after the end of the one-hour drinking period, (2) 63 mg% at the beginning of the autokinetic presentations, and (3) 54 mg% at the beginning of the Barber Suggestibility Scale determinations.

In the autokinetic part of the experiment, mean blood alcohol concentration was found to be associated with interaction effects between instructional set and alcohol treatments in two autokinetic measures. Specifically, the strong instructional set group reported greater incidence of autokinetic movement and of estimated linear extent in the 100% orange-juice treatment than did the weak set group; the reverse obtained in the high congener alcohol treatment ($p < .01$). In the primary suggestibility part of the experiment, mean blood alcohol concentration was found to be directly associated with increased scores on the Barber Suggestibility Scale ($p < .05$). Personality measures showed low correlations with the suggestibility measures obtained. Barber Suggestibility Scale scores and autokinetic responses were not significantly correlated with each other.

7.8.3 CONCLUSIONS

While most of the findings from this study (only some of which are summarized above) are relevant for other laboratory experiments, those results with implications for driving should be noted.

In general, further evidence has been obtained that alcohol is associated with alterations in visual perception, which should contribute to further understanding the contribution of alcohol to decreased ability to perceive, process, and respond appropriately to subtle, but crucial nuances of changed environmental features, especially under reduced-cue conditions (e.g., night driving).

It would also seem that the driver with a medium blood alcohol concentration might well be unduly susceptible to misleading or inappropriate suggestion from human sources (such as peer-group norms, passengers, prestige suggestion, etc.), in addition to inadvertent perceptual distortion stemming from environmental ambiguity.

Finally, there is reason to believe that alcohol may facilitate the onset of "highway hypnosis," other conditions equal and independent of any consideration of the possible contributions of narcolepsy in a limited proportion of the driving population. Further investigations under appropriate conditions of prolonged driving would seem warranted.

7.9 SUMMARY

Three types of induced-intoxication experiments were conducted, namely: (1) small-group studies in which subjects drank together in a simulated cocktail-party atmosphere, but were tested separately; (2) laboratory experiments in which subjects both drank and were tested individually; and (3) a closed-course pilot study using an instrumented car to investigate the influences of alcohol upon actual driving behavior. However, the latter study was not reported here since it was part of another contract and is accordingly reported elsewhere (U.S. DOT Contract FH-11-7469).

7.9.1 SMALL-GROUP STUDIES

Using a before-after paradigm, a series of concurrent individual experiments was conducted in satelite fashion relative to the small-group drinking situation. These investigations were concerned with influences of alcohol upon: (1) selective attention, within both auditory and visual sense modalities; (2) divided attention, in which a mental-arithmetic and an information-reduction task were done simultaneously; and (3) risk taking in a gaming situation. It was found that medium doses of alcohol were associated with: (1) performance deterioration on both auditory and visual selective-attention tasks; (2) decreases in the rate of transmitting visual information; and (3) increases in risky gaming behavior.

The influences of alcohol upon mood were also examined; and it was found that with respect to personality variables, alcohol affects mood differentially.

Another investigation was conducted to compare the reliability of four different methods (two breath and two blood) of estimating blood alcohol concentration. The Borkenstein Breathalyzer was found to be more reliable and more conservative than the other three determination methods (venous blood, digital capillary blood, and Mobat Sobermeter SM2).

7.9.2 LABORATORY EXPERIMENTS

Using a counterbalanced repeated-measures design, the first experiment was conducted to examine the influences of alcohol and foveal subtask difficulty upon extrafoveal sensitivity of the dark-adapted eye to photic stimulation. The reaction times of nine subjects were tested at three blood alcohol concentrations (0, 50, and 100 mg%) and under three levels of fixation-task difficulty in response to photopic targets at five selected points along the horizontal meridian of the extrafoveal portion of the nasal hemiretina. During test sessions, the peripheral signal-detection task was performed concurrently with the fixation task, which varied in difficulty, such that only one task-difficulty level was experienced in a given session. Detection and localization of a peripheral signal was indicated by release of a hand-held switch. Blood alcohol concentration was found to be directly associated with increases in reaction time. Reaction time also increased as a direct function of fixation-task difficulty. No main-effect interactions were obtained, i.e., no evidence was found for an alcohol-facilitated "tunnel-vision" effect. The implications for driving and for driving after drinking were discussed in terms of peripheral detection and divided attention.

The second laboratory experiment was concerned with the influences of alcohol upon primary suggestibility and conforming, using a counter-balanced repeated-measures design which incorporated two alcohol (ethanol, and bourbon) and two no-alcohol (placebo, and an explicitly identified no-alcohol drink) conditions. The target blood alcohol concentration was 75 mg% and the obtained mean was 78 mg%. In the autokinetic task, dark-adapted subjects were placed in a blacked-out room for brief periods to observe a pin-point of light and to estimate its movement. Half the subjects had received a strong instructional set to report movement, whereas the other half had received a weak instructional set. It was found that relative to the subjects with weak instructional set, those with strong set reported greater incidence of autokinetic movement and greater estimated linear extent in the identified no-alcohol condition; whereas the opposite relations obtained with high congener alcohol condition (bourbon).

All subjects received the Barber Suggestibility Scale after completion of the autokinetic task. Increased scores on the Barber

Suggestibility Scale were found to be associated with the alcohol conditions.

The findings from this laboratory study have possible implications for driving after drinking in terms of "highway hypnosis," suggestibility, and conformity, as well as for attentional mechanisms.

7.9.3 CONCLUSIONS

The following general conclusions concerning the influence of alcohol upon perceptual-cognitive and motor behavior can be drawn from the induced-intoxication studies. Doses of alcohol which result in presumptive legal impairment may be associated with: (1) reductions in performance on both auditory and visual attention tasks which require the monitoring of multi-channel inputs; (2) decreases in responsiveness to stimulation of the retinal periphery; (3) alterations of visual perception in ambiguous situations; (4) increases in the likelihood of risky behavior in gaming or chance-taking situations; (5) differential mood and performance effects with respect to personality; and (6) reductions in driving accuracy and changes in automobile control-use patterns.

Chapter 8

RECOMMENDATIONS

8.1 RECOMMENDATIONS RELEVANT TO HIGHWAY SAFETY ACTION PROGRAMS CONCERNING ALCOHOL

8.1.1 This study has convincingly reconfirmed the marked over-representation of problem drinkers and other very heavy users of alcohol, both among those responsible for serious and fatal highway crashes or among those convicted of driving-while-intoxicated or other serious moving violations. The present emphasis of the Department of Transportation upon identification and control of this category of drinker should be continued.

8.1.2 The marked over-representation of beer drinkers, and especially of heavy beer drinkers, both among the fatalities and those arrested for driving-while-intoxicated is another important observation of this study. Therefore, the following are recommended:

.1 More research and administrative concern should be focused on the effects of beer and on those who use beer frequently and heavily.

.2 Specific public educational programs should be developed to counteract the image sought by the malt beverage industry that beer is clearly a less intoxicating - and less harmful - beverage than hard liquor and that it therefore lies somewhere on the continuum between soda pop and liquor. In particular, we would recommend that films and TV spots developed by or for the Department of Transportation attempt to show scenes in which drinking of malt beverages leads to difficulty at least as often as they show scenes in which drinking of hard liquor leads to difficulty.

.3 Furthermore, in view of this evidence, we question the advisability of the continued permission by the Federal Communications Commission for the advertising of beer on radio and television at the same time that it prohibits the advertising of distilled spirits by these media. Clearly, there is no justification for the continuance of this double standard.

The licensing of several different categories of establishments for the retail distribution of alcoholic beverages appears to be another example of this double standard.

8.1.3 Although problem drinkers were markedly over-represented in this study among those who got into trouble on the highway, we cannot over-emphasize the fact that, especially among those who were fatally injured with alcohol present, there was a substantial proportion of young social drinkers. Therefore, we recommend that due emphasis should be given to this fact by the Department of Transportation in its countermeasure program.

8.1.4 Because both problem drinkers and social drinkers are involved in crashes and violations attributable to alcohol, we urge further work to: (a) develop satisfactory administrative definitions of social drinking, problem drinking, and alcoholism which are capable of being used effectively by persons concerned with the problem at all levels, and (b) develop indicators or social signatures (or both) which are capable of distinguishing individuals who meet the definitions described above for the purpose of applying selective countermeasures tailored to the specific needs of the individual and to the method most likely to bring about a lessening of his subsequent risk of crashes involving alcohol. In particular, we would recommend that those who develop these indicators pay special attention to developments and studies identifying behaviors which are implicative both of present problem drinking and of future risk. Further, we recommend more highly focused research (using such techniques as cluster analysis and multiple discriminant analysis) on detailing the psychological-biographical characteristics which differentiate the various groupings of social drinkers and problem drinkers.

8.1.5 It has been said that the best single predictor of future behavior is past behavior; and the present study provides further support for this statement. Therefore, we urge that serious crashes and violations, and arrests for driving-while-intoxicated should not be considered merely as isolated instances of behavior simply to be punished and forgotten, but rather as both diagnostic and prognostic indicators requiring further individual evaluation, follow-up, and help. In particular, we are impressed by the relatively large number of young drivers who have already displayed patterns of excessive crashes and citations. We would urge that particular attention be given to this category of young drivers because they are probably in the early development of their problems and thus have the greatest number of potentially dangerous driving years ahead.

We must caution, however, that while presence of a "problem record" is highly suggestive of future problem behavior, absence of such a record is not necessarily indicative of absence of either past or future problem behavior. There is ample and convincing evidence that driving records have built-in biases and inequities so that at this point in time they represent only an imperfect screening device for certain categories of drivers.

8.1.6 As this study has demonstrated, drivers with alcohol are no more likely, and perhaps less likely, to be wearing seatbelts (or to have passengers wearing seatbelts) than are drivers who do not have alcohol present. Since these drivers and their passengers not only are at greater risk of crashing because of the alcohol they have consumed, but also at greatest risk of injury if they do crash, we urge continued development and early implementation of systems for passive restraint of vehicle occupants.

8.1.7 In this project, we found it extraordinarily difficult to track down and interview individuals who had had arrests for driving-while-intoxicated. In part, this difficulty occurred because such individuals appeared to move frequently with advance warning and without visible trace. As programs are developed to rehabilitate individuals with drinking problems who have been identified because of arrests for driving-while-intoxicated, we strongly urge that mechanisms be established to maintain exceedingly close surveillance on these persons. In some cases, it might be necessary during the early stages of rehabilitation to have the individual spend his nights in jail and his days at work or whatever his usual activity is (so called work-release program).

8.1.8 This study documented both the frequency with which teenagers are drinking (and drinking heavily before they are legally of age to do so in the state of Vermont) and the frequency with which they are getting into trouble on the highway with alcohol (and commonly with blood alcohol concentrations that are below those of drivers age 20 and older). In light of these observations, we would recommend:

.1 That caution be observed in attempts to establish laws prohibiting drinking by teenagers in one geographic area if neighboring geographic areas have lower legal drinking ages, since this arrangement is only likely to encourage some individuals to drive to neighboring areas, consume alcoholic beverages, and drive back in an impaired condition.

.2 *That prohibition of the purchase or possession of alcohol by a* specific age group should be a prohibition on all forms of alcohol rather than one which excludes beer and wine, as is currently the practice in some states. As was noted above, there is no rational base for distinguishing beer as a less harmful beverage than liquor with respect to highway safety.

.3 That the presumptive limit for impairment by alcohol for teenage drivers should be lower than that for drivers age 20 or older, and preferably no higher than 50 mg% (0.05% by weight).

8.1.9 One appalling conclusion of this study was that almost one-fourth of the highway fatalities died of injuries either definitely or possibly survivable. The ommissions and commissions that lead to these unnecessary deaths were distributed throughout the health care system, both during the pre-hospital phase and once the patient arrived at the hospital. For the sake of the patient, we recommend: (a) that blood alcohol concentrations be routinely performed on all individuals with serious enough injuries to require hospitalization, (b) that blood alcohol concentrations and complete post-mortem examination be performed on all individuals who are fatally injured in highway crashes in order to help assess the adequacy of emergency and other aspects of care, and (c) that continued attention be given to implementing and enlarging upon the emergency medical care standard of the National Highway Traffic Safety Administration.

8.2 RECOMMENDATIONS RELEVANT TO RESEARCH ON ALCOHOL AND HIGHWAY SAFETY

One problem in comparing studies that have made use of roadblocks is that they have been dissimilar in selection criteria. We urge the Department of Transportation to establish operational criteria for carrying out roadblocks. These should not be departed from unless there are very cogent reasons for doing so, for example, specifically characterizing individuals who frequent road-houses. Under such circumstances, however, it must clearly be stated that the roadblock is applicable only to such special groups.

8.3 SUGGESTIONS FOR FUTURE INDUCED-INTOXICATION RESEARCH ON DRIVING-RELATED BEHAVIOR

As with most experiments, the induced-intoxication studies have succeeded in stimulating more questions than they have answered. Some of the most compelling of these questions are suggested below as potentially profitable areas for future research.

8.3.1 We have found that alcohol decreases performance in an auditory divided-attention task when the subject is required to ignore one input channel systematically while simultaneously shadowing another. In real life, one is rarely required to monitor the input of one channel to the complete exclusion of others; rather, it is more usual to have to respond selectively to relevant information presented through different channels, while simultaneously ignoring task-irrelevant information which is also being presented. Therefore, it would seem very worthwhile to investigate the influences of alcohol upon divided-attention tasks which involve channels defined in terms of meaning, as well as anatomical location.

8.3.2 Alcohol has been shown to decrease choice reaction time to peripheral stimulation in a visual time-sharing task. However, the design used in our investigation did not permit an independent assessment of the differential effects of alcohol upon choice reaction time and upon brightness sensitivity. Alcohol has been shown to affect the former, but no systematic investigations of its effect upon the latter have been published. Follow-up studies should be conducted to investigate this rather basic issue.

8.3.3 It was found that alcohol increased response latency, but did not affect accuracy of response in simultaneous mental-arithmetic and information-reduction tasks. Thus, it would be expected that a decrease in the time interval between mental-arithmetic problems and signal presentations would make task performance more susceptible to the influences of alcohol. This proposed relationship has important implications for the influence of alcohol on human functioning in emergency and other rapid-sequence situations, and should therefore be investigated experimentally in order to define the relevant parameters.

8.3.4 It was determined in the alcohol and suggestibility study that, under certain conditions, alcohol facilitates the reporting of movement where none actually occurs. Based upon this result, we have hypothesized that alcohol reduces the stability of the perceived environment, particularly in ambiguous viewing situations. In order to extend the obtained results beyond the autokinetic effect and obtain further support for this rather sweeping hypothesis, the influence of alcohol should be studied in other perceptually ambiguous contexts, e.g., with the rod-and-frame apparatus. Furthermore, the relevance of field-dependent and field-independent personality constructs for this hypothesis could also be examined. The results of research in this area of behavior could well have important implications for the phenomenon referred to as "highway hypnosis."

8.3.5 Several experiments have shown that alcohol has different effects upon individuals with different personality characteristics, but the basis for the occurrence of these differential effects is not known. There is, however, some evidence that alcohol affects the autonomic nervous system of various physiological "types" differently, and that people with different personalities have different physiological responses to stress.

Consequently, a sequence of studies should be designed and conducted to investigate the physiological correlates of personality dimensions that have been shown to be susceptible to the influences of alcohol. Concurrently, the influences of alcohol upon these same physiological correlates should also be examined.

8.3.5 Because of the obvious dangers in experimenting with drinking subjects on public roads in actual traffic, behavioral research in this area is effectively limited to: (1) closed driving courses, (2) driving simulators, or (3) laboratory experiments on assumedly relevant, but isolated components of the driving task. None of the published studies has investigated the same behavioral variables across all three of these conditions. The vast majority of this experimental literature is comprised of studies which fall in the third category, and these laboratory experiments on the effects of alcohol range from simulated driving tasks to simple sensory or psychophysical tasks. The second category of alcohol study, using the driving simulator, is next most frequent; however the relevance and the predictive validity of these simulator findings for actual driving behavior has yet to be conclusively demonstrated. In fact, a striking lack of correspondence between simulator "driving" and actual performance on the road has recently been reported.

Least frequent, but most pertinent are drinking-and-driving studies conducted with real cars on a closed driving course. Given the potential hazards and liabilities of drinking experiments conducted on public roads, the significance and strength of this type of research arises from the achieved compromise between the actual highway driving situation with its attendent traffic-associated dangers, and the secure, artificial, and cue-deprived environment of the driving simulator. That is, a real automobile (which is highly instrumented) should be used instead of a highly instrumented but contrived simulator; and a closed, but demanding course should be substituted for the public highway. Thus, the results of this type of study should prove more useful and valid for understanding everyday drinking-and-driving behavior.

APPENDIX A

As noted in Chapter 2 (Section 2.3), a more complete discussion of roadblock procedures and methodological considerations is already available elsewhere, namely:

> Perrine, M. W. Methodological considerations in conducting and evaluating roadside research surveys. U. S. Department of Transportation, NHTSA Technical Report, 1971 (Feb.), DOT HS-800 471, 138 p.

For the information and convenience of the potentially interested reader, the table of contents from that publication is reproduced here.

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