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ALCOHOL AND HIGHWAY SAFETY: BEHAVIORAL AND MEDICAL ASPECTS

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Summary Report

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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 respondents. 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 post-mortem 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 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 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 satellite 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 con-

centration 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 violations, 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 counter-measures 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 attendant 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.