

# Use and Misuse of Alcoholic Beverages as Factor in Motor Vehicle Accidents

JULIAN A. WALLER, M.D., M.P.H.

A REVIEW of the recent literature on alcohol and traffic accidents is simultaneously encouraging and depressing. Several studies in the past 10 years, following the lone meaningful step by Holcomb in 1938 (1), have met reasonable research standards by using comparison samples and controlling for the amount of driving exposure. These studies have identified a highly significant relationship between the ingestion of alcohol and the occurrence of traffic accidents.

Unfortunately, such studies are the exception. Most of the current research on the subject—and there is much of it—is hampered by naive methodology. For example, official police statistics, often because of presumed or actual legal necessity, identify alcohol as a factor only when the person is obviously intoxicated; also, comparison samples are used only rarely.

A number of studies have elucidated the pharmacology of alcohol both generally and with specific reference to the task of operating

a motor vehicle. Alcohol, however, is not merely a drug but also a social phenomenon surrounded by centuries' old rules and taboos. Its use is a way of life for many and a way of death for some. Suspicion is beginning to arise that the identification and control of many components of the relationship between alcohol and accidents will not come through more knowledge of the pharmacological properties of alcohol or of the physiological dynamics of driving, but through identification of the sociology, psychology, and psychopathology of drinking.

I will review some of the pertinent areas of present knowledge about alcohol and traffic accidents and some of the areas of conjecture and current investigation, as well as some of the possible solutions and the problems inherent in achieving them.

## Alcohol as a Drug

Since the sociology and psychology of drinking are directly related to the pharmacological properties of alcohol, it seems appropriate first to discuss its chemical effects. Ethyl alcohol is a short-chain hydrocarbon which can be produced both naturally through fermentation and, artificially, through fermentation and other chemical processes. It is absorbed through the stomach and small intestine, and 90 percent of it is metabolized by the liver after distribution

---

*Dr. Waller is a medical officer in the bureau of chronic diseases, California State Department of Public Health, Berkeley. He was with the department's bureau of occupational health when he presented this paper at the Secretary of Health, Education, and Welfare's Conference on Alcohol and Accidental Injury, in Washington, D.C., September 17, 1965.*

through the bloodstream to all parts of the body. In the blood, alcohol levels reach a peak in about an hour; in the brain, they reach a maximum somewhat earlier. The unmetabolized portion of alcohol is excreted through the kidneys, lungs, and skin.

Clinically, the effects of alcohol which are pertinent to driving and to drunk-driving arrests can be divided into impairment and intoxication. Most studies indicate that at all levels alcohol acts as a depressant to the central nervous system, although the initial depression of the higher centers which control super-ego functions may give the impression that the person is stimulated. Effects which can be categorized as impairment and which occur at low levels of alcohol (30–100 mg. percent blood alcohol) include decreased visual and auditory acuity, slowing of thought processes, and an increased propensity toward errors in problem solving. (Alcohol levels are expressed as milligrams percent. A blood alcohol level of 30–100 mg. percent means 30–100 mg. of alcohol per 100 cc. of blood, that is 0.03–0.10 percent by weight of alcohol, or 0.3–1.0 pro mille.)

At somewhat higher levels (50–250 mg. percent), further depression of the central nervous system usually results in the obvious clinical signs which are associated with intoxication, namely, inappropriate behavior, staggering gait, slurred speech, bloodshot eyes, involuntary micturition, slovenly appearance, and dozing. At higher levels coma and death ensue.

Frequent and heavy drinking modifies the picture somewhat. The occasional or moderate drinker may become impaired at blood alcohol levels as low as 30 mg. percent and become intoxicated at 50 mg. percent or slightly higher. The heavy drinker often will not be impaired until 100 mg. percent is attained (at which point almost everyone is impaired), and he may not appear intoxicated until levels of 150 mg. percent, or even higher, are reached. In fact, occasional reports describe problem drinkers who are still capable of walking with alcohol levels of 400–500 mg. percent. In contrast, the light or moderate drinker usually has vomited much of his alcohol or has become semicomatose at levels above 150–200 mg. percent.

Among habituated drinkers, other effects of alcohol may be observed, including amnesia,

convulsions, hangover, delirium, chronic degeneration of the brain, and chronic gastritis. Much remains to be learned about the adaptation and functioning of the human organism during the several hours and days after the alcohol has been metabolized and excreted. The role of this postintoxication period in the occurrence of accidents is completely unknown.

### **Effect of Alcohol on Driving**

A number of projects have been completed, and others are in progress, to identify the effect of alcohol on the driving task (2–9). This determination is somewhat difficult because the task itself has only been grossly defined. The studies have fallen into two groups—testing persons before and after the use of alcohol on devices which simulate the driving task (4–7, 9) and testing persons in an actual vehicle which is driven over a predetermined course (2, 3, 5, 8).

Both types of studies, while permitting standardization and measurement, fall short of the real world in not presenting the many variations in traffic conditions and the unexpected events which may identify the real distinction between the normal and the impaired driver. Development of improved simulators by researchers at the University of California at Los Angeles and elsewhere may ultimately result in adequate, reproducible, and safe study facilities.

The two methods of study being used have validity, however, because they invariably have shown that impairment to the simplified driving task occurs at blood alcohol levels above 100 mg. percent. Since inability to accomplish more complicated tasks is one of the early effects of alcohol, it is reasonable to expect that significant impairment in performing a simplified driving task would mean even greater difficulty in performing the more complex activity.

### **Drinking Practices of Drivers**

Before considering the observed relationship between the use of alcohol and the occurrence of traffic accidents, we need to know just how many people are drinking and driving and at what levels of alcohol. Surveys of drinking practices (10) have shown that about three-quarters of

the adult population use alcohol and that about half of them do their drinking at home. Assuming that the person who drinks at home is less likely to drive after drinking, we can estimate that a minimum of one-third of the adult population may drink and drive on at least one occasion a year.

Recent studies in the San Francisco Bay area by Knupfer and associates, California State Department of Public Health (10), indicate that 28 percent of the men in the area and 13 percent of the women drink three or more times a week and usually take three to four drinks at a sitting, or drink less often but may take five drinks at a sitting. Twelve percent of the population admitted to 10 or more drinks on at least one occasion a year, while 7 percent admitted to 12 or more drinks on at least one occasion (personal communication from Knupfer). We may thus conclude that the vast majority of drinking drivers are likely to have a blood alcohol level of less than 50 mg. percent.

These figures can be compared with the blood alcohol levels that were observed among drivers not involved in accidents in several comparative studies of alcohol among accident-involved and nonaccident drivers. The correlation between alcohol use and traffic accidents, however, represents a bias which would slightly decrease the likelihood of finding alcohol in the nonaccident sample. These comparative studies showed that more than 80 percent of the nonaccident drivers had not been drinking, 6-7 percent of them had a blood alcohol level of 50 mg. percent or less, and 10-15 percent had a level of 100 mg. percent or less. Fewer than 1 percent had 150 mg. percent or more of alcohol in their blood (1, 11, 12).

### **Alcohol and Traffic Accidents**

In the real world of traffic accidents, it has been shown that alcohol-related accidents differ in several important ways from nonalcohol-related accidents. Accidents following drinking are more likely to occur at night and on weekends (2, 13, 14), to be more severe (13, 15, 16), and to involve only a single vehicle (14, 15).

Because of the difficulty of clinically identifying intoxication, official police statistics in States where blood alcohol determinations are not routine tend to underestimate the proportion of ac-

cidents in which use of alcohol is involved. For example, in the 1963 statistics of the California Highway Patrol (17) alcohol is identified in 20 percent of the injury-producing accidents. In contrast, in several studies from California and elsewhere (11, 12, 18-20) based on blood alcohol determinations, alcohol was shown to be present in from 25 to 75 percent of the accidents producing injuries and fatalities.

Three categories of comparative studies done during the past 10 years have completely dispelled any doubt that there is a relationship between alcohol ingestion and traffic accidents. Holcomb in 1938 (1), followed by Lucas and associates in 1955 (21), Vamosi in 1961 (11), McCarroll and Haddon in 1962 (12), and Borkenstein and associates in 1964 (13), showed that drivers involved in accidents are significantly more likely to have been drinking than are nonaccident drivers. In all these studies, a substantial proportion of the accident-involved drivers had blood alcohol levels above 150 mg. percent. In fact, McCarroll and Haddon found levels of 250 mg. percent or higher in 46 percent of the drivers who were considered responsible for their accidents. On the basis of these studies it has been estimated that a blood alcohol level of 100 mg. percent increases the risk of having an accident six- to tenfold, while a level of 150 mg. percent results in a 25- to 50-fold increase in the likelihood of an accident occurring (11).

In 1961, Haddon and associates (22) compared blood alcohol levels of pedestrians fatally injured in traffic accidents with levels of nonaccident-involved pedestrians and found that alcohol also played a major role in the occurrence of pedestrian accidents. Schmidt and co-workers in 1962 (23) and Waller in 1964 (24, 25) compared the accident experience of people with alcoholism and of people not known to be problem drinkers. Again, an increased accident risk was found among the alcoholic group. The alcoholic population in both studies had about twice as many accidents per mile of driving as did the comparison group. The study of Schmidt and associates showed that the entire excess of accident experience could be attributed to accidents while the drivers were under the influence of alcohol. Further analysis of our own sample shows strikingly similar results.

## Drivers in Alcohol-Related Accidents

Identification of a relationship between drinking and traffic accidents does not necessarily present clues useful to the development of control measures. Use of the slogan "If you drink, don't drive" has not resulted in general in an appreciable decrease in alcohol-related accidents and cannot be expected to do so if drinking drivers represent a population that is not approachable through the usual educational techniques. These techniques are predicated on the assumption that most drinking drivers likely to be involved in accidents are social drinkers. Review of recent statistics about the proportion of drinking drivers with very high alcohol levels casts substantial doubt, however, upon the assumption that most of these accident-involved drivers are social drinkers.

Before going any further it might be well to fish in thoroughly muddy waters by defining social drinking and problem drinking. Social drinking might be considered normative because it represents the moderate alcoholic intake of the majority of the drinking population, it is not engaged in for pathological reasons, and it does not appreciably affect the health or social functioning of the person. In contrast, problem drinking and alcoholism involve heavy intake and often greater frequency of imbibing. Moreover, the problem drinker follows a pathologically motivated pattern and has reached a level where his health or social functioning, or both, are adversely affected.

Using these rather vague criteria, Selzer and associates (26) identified problem drinking in a majority of the drinking drivers who had been involved in accidents or apprehended for drunk driving.

Handel (27), using the more specific criterion of prior offenses while under the influence of alcohol, found that 38 percent of a group of drunk drivers had a record of such offenses, while only 4 percent of alcohol-free drivers had such records. Bjerver and associates (28) found similar patterns in Sweden. At the California State Department of Public Health, under a Federal Bureau of Public Roads grant, we are currently reviewing community records for evidence of prior difficulty with alcohol among people with drunk-driving convictions and among several comparison groups. It is

already apparent that major differences exist in prior histories of alcohol-related offenses. Schmidt and associates (20) reported a three-fold increase in treatment for alcoholism among drunk drivers over expected admissions in the general population. Haddon (29), in an excellent review article, has summarized the probable role of alcoholism in alcohol-related traffic accidents.

If most alcohol-related traffic accidents relate to alcoholism rather than to social drinking, it should be possible to find a higher proportion of livers with fatty infiltration or cirrhosis among people killed in traffic accidents while intoxicated than among those killed without alcohol. To test this hypothesis, Dr. Henry Turkel and I reviewed observations about the liver at autopsy and the blood alcohol levels for all drivers and pedestrians killed in San Francisco over a 2-year period.

We found alcohol in 37 percent of the persons age 25 years or older who were killed in traffic accidents; 72 percent of them had blood alcohol levels of 150 mg. percent, or higher. Fatty or cirrhotic livers were observed in almost two-thirds of those who died within 6 hours of the accident and who had alcohol levels of 150 mg. percent, or higher. In contrast, only 15 percent of the alcohol-free victims had similar liver disease. Even if we assume that all of the cirrhosis among the alcohol-free persons and a similar proportion among those who had been drinking was caused by medical conditions other than alcoholism, we still are left with the observation of alcoholic cirrhosis in about half of the persons with blood alcohol levels of 150 mg. percent, or higher. We can now say with a fair degree of certainty that alcoholism as a disease is the major correlate to drinking among accident-involved drivers and pedestrians.

These results, however, do not mean that drinking among the nonalcoholic population cannot also present a hazard. Among drivers under the age of 25 years who were killed in traffic accidents, the proportion with comparatively low alcohol levels is impressive. Possibly, such drivers, because they are simultaneously learning the skills of driving and experimenting with the use of alcohol, are more likely to encounter trouble than are the somewhat older social drinkers who have learned the

limitations of their driving ability and of their drinking prowess. Studies by Goldwell and associates (8) and Newman and associates (5) support this hypothesis. They found that people who scored highest on driving tests before drinking experienced relatively less deterioration of driving skill after drinking than did those who originally had poor scores.

### Possible Control Measures

It is now apparent that a significant relationship exists between ingestion of alcohol and the occurrence of traffic accidents. We have also shown that a major portion of the accidents are attributable to driving drinkers rather than to drinking drivers. While this information permits a more meaningful approach to the development of control measures, it also greatly increases the complexity of such controls. Simple campaigns advising people to avoid driving after drinking are not likely to be effective among people with compulsive drinking behavior. The treatment of alcoholism has, at best, been only partially successful.

The problem is not one which any one group can solve, be it the police, the courts, or the medical profession. We need much closer cooperation to identify problem drinking as early as possible and to provide the intensive treatment and motivation which is now too rarely available. The following are possible components of a comprehensive control program.

1. *It is imperative that implied consent legislation be enacted to identify the impaired driver who does not appear to be inebriated.* Because of the tolerance to alcohol that the heavy drinker develops, he may not display the usual signs of intoxication until long after he has become impaired.

2. *Records of prior arrests and convictions should be obtained to guide the judge in sentencing all convicted drunk drivers with blood alcohol levels of 150 mg. percent, or higher.* If the defendant has a prior record of difficulty with alcohol—such as arrests for public intoxication, assault while intoxicated, and the like—he should tentatively be identified as having a long-standing drinking problem rather than be considered a social drinker. To promote this program successfully, judges will have to be-

come better informed on the role alcoholism plays in traffic accidents.

Let us briefly examine the casefinding potential of such a plan. Based on the Jellinek estimation formula, California in 1960 to 1962 had 850,000 people with alcoholism (30). Probably 150,000 of these were on skid row or did not drive for other reasons. About 100,000 arrests for “drunk driving” and “drunk in and about the vehicle” are made per year in the State. If 50 percent of the persons involved in these arrests could be identified as problem drinkers—and I believe this is possible—we could find 7 percent of the total prevalence of drivers with alcoholism in any one year. Since alcoholism is a condition of long duration and approximately three-quarters of the drunk-driving arrests are first offenses, it should be possible in a 10-year period to identify more than half of the existing drivers with alcoholism. I do not know of any other program with such great potential for finding previously unidentified alcoholism within the community.

3. *The driver in whom a drinking problem has been identified should be referred to the motor vehicle authorities for evaluation and regulation in the same manner as any other person with a chronic medical condition which may adversely affect his driving.* Almost all States currently have authority to revoke the license of a person with such a medical condition pending improvement of the condition.

The existing patterns of invoking heavy fines on the driver with a drinking problem or of suspending his license for a limited term is no more likely to prevent further drinking and driving than is such punishment likely to prevent further heart attacks in a person who has had a prior heart attack behind the wheel. If, however, the person has not been shown to have a drinking problem, such fines or suspensions may be appropriate. Revocation of the license will not, of course, be 100 percent effective. Coppin and Van Oldenbeek (31) recently reported that at least 46 percent of the California drivers who had had a license revoked continued to drive despite the revocation. To develop more successful control programs, we need much more research to identify which people are most likely to disregard a revocation order. License revocation, however, is the best procedure we have at

present. It does effectively remove half of the drivers with revocations from the road.

4. *When the person with a drinking problem is referred to the motor vehicle authorities, he should simultaneously be directed toward treatment facilities.* It has been shown that treatment under compulsion can be as effective as treatment sought voluntarily (32). In fact, most people with alcoholism seek help only because they are under duress to do so by employers, family, or others.

5. *An intensive and realistic program must be developed to make adequate facilities for treatment of alcoholism more generally available.* Currently, such facilities are few and far between and are swamped by requests for help from people whose difficulties have already been identified. The screening and referral program that I suggest would be totally impractical without a major increase in community resources.

6. *Informing the general driving population, and especially the young driver, about the hazards of drinking and driving should be continued.*

7. *Driver training programs to improve basic driving skills, improved road design, development of safer vehicles—all efforts along these lines should continue unabated.* They may do much to mitigate the handicap of driving while under the influence of alcohol.

8. *Greater support of well-conceived research is needed to fill many of the existing gaps in our knowledge about the potential effects of the postintoxication period, about the interrelationships among the driver, the vehicle, and the roadway, about the sociological, psychiatric, and physiological processes associated with drinking, and about the identification and treatment of people with drinking problems.* Inherent in this proposal is a decrease in jurisdictional disputes among various Federal, State, and local agencies and organizations and greater cooperation among various professions in designing and executing research. The number of multidisciplinary research efforts in the field of accident control can almost be counted on the fingers of both hands.

9. *Finally, any program worth trying is worth evaluating.* It is appalling to learn of results which are hidden or discarded because they are embarrassing to some agency. It is to the ever-

lasting credit of the California Transportation Agency that its staff have been willing to admit that revocation is not a panacea and that other regulatory measures leave room for improvement. As a result of this candid approach, the agency has been able to develop some new and exciting programs for driver improvement. Without such honest evaluation an adequate program becomes almost a chance phenomenon.

### Summary

A highly significant correlation has been shown to exist between the ingestion of alcohol by either drivers or pedestrians and the occurrence of traffic accidents. Studies of a person's ability to perform a simulated driving task after drinking have consistently indicated that impairment occurs at blood alcohol levels between 50 and 100 mg. percent. These studies are the basis of current standards by which drivers with blood alcohol levels above 100 mg. percent are considered to be impaired and for the assumption that social drinking is responsible for most alcohol-related traffic accidents. More recent studies, however, of blood alcohol levels actually associated with traffic accidents and of the personal characteristics of drinking drivers and pedestrians involved in such accidents have identified alcoholism in the majority. Among fatally injured young drivers, in whom low blood alcohol levels are frequently observed, many of the fatalities may be related to social experimentation with the use of alcohol rather than to pathological drinking.

Measures to control the accidents caused by alcohol should include implied consent legislation, earlier identification and referral to treatment of drivers with a drinking problem, teaching young drivers the hazards of alcohol, improvement of driver training and of vehicle and roadway design, and closer cooperation among Federal, State, and local agencies and the various disciplines in the identification of problems and the initiation and evaluation of control programs.

### REFERENCES

- (1) Holcomb, R. L.: Alcohol in relation to traffic accidents. *JAMA* 111: 1076-1085 (1938).
- (2) Bjerver, K., and Goldberg, L.: Effect of alcohol ingestion on driving ability. *Quart J Stud Alcohol* 11: 1-30 (1950).

- (3) Heise, H. A. : Alcohol and automobile accidents. *JAMA* 103 : 739-741 (1934).
- (4) Newman, H. W., and Fletcher, E. : The effect of alcohol on driving skill. *JAMA* 115 : 1600-1602 (1940).
- (5) Newman, H. W., Fletcher, E., and Abramson, M. : Alcohol and driving. *Quart J Stud Alcohol* 3 : 15-30 (1942).
- (6) Vernon, H. M. : Alcohol and motor accidents. *Brit J Inebriety* 34 : 153-165 (1937).
- (7) Loomis, T. A., and West, I. C. : The influence of alcohol on automobile driving ability. *Quart J Stud Alcohol* 19 : 30-46 (1958).
- (8) Coldwell, B. B., et al. : Effect of ingestion of distilled spirits on automobile driving skill. *Quart J Stud Alcohol* 19 : 590-616 (1958).
- (9) Drew, G. C., Colquhoun, W. P., and Long, H. A. : Effect of small doses of alcohol on a skill resembling driving. Medical Research Council Memorandum No. 38. Her Majesty's Stationery Office, London, 1959.
- (10) Knupfer, G., Fink, R., Clark, W. B., and Goffman, A. S. : Factors related to amount of drinking in an urban community. California Drinking Practices Study. Report No. 6. Division of Alcoholic Rehabilitation, California State Department of Public Health, Berkeley, April 1963.
- (11) Vamosi, M. : Experiences with non-alcoholic road traffic in Czechoslovakia. Proceedings, 3d International Conference on Alcohol and Road Traffic. BMA House, London, 1963, pp. 79-82.
- (12) McCarroll, J. R., and Haddon, W., Jr. : A controlled study of fatal automobile accidents in New York City. *J Chronic Dis* 15 : 811-826 (1962).
- (13) Borkenstein, R. F., et al. : The role of the drinking driver in traffic accidents. Department of Police Administration, Indiana University, Purdue, 1964.
- (14) Collister, R. M. : The incidence of alcohol in road traffic accidents. Proceedings, 3d International Conference on Alcohol and Road Traffic. BMA House, London, 1963, pp. 31-35.
- (15) Breitnecker, L. H. : The effects of the Austrian legislation concerning drunken driving. Proceedings, 3d International Conference on Alcohol and Road Traffic. BMA House, London, 1963, pp. 336-338.
- (16) Mach, N., *quoted in* J. D. J. Havard : Recent developments in the alcohol and road traffic situation. *Brit J Addiction* 59 : 55-64 (1963).
- (17) Traffic Accident Statistics—1963. Department of California Highway Patrol, Sacramento.
- (18) West, I., Ryan, J., Nielsen, G., and Gilmore, A. : Alcohol held big factor in California's July 4 crashes. *Traffic Safety* 65 : 10-12, 34, 35 (1965).
- (19) New Jersey alcohol determination program in fatal traffic accident cases. New Jersey Department of Law and Public Safety, Trenton, 1964.
- (20) Campbell, H. E. : The role of alcohol in fatal traffic accidents and measures needed to solve the problem. *Mich Med* 63 : 699-703 (1964).
- (21) Lucas, G. H. W., et al. : Quantitative studies of the relationship between alcohol levels and motor vehicle accidents. Proceedings, 2d International Conference on Alcohol and Road Traffic. Garden City Press Cooperative, Toronto, Canada, 1955, pp. 139-142.
- (22) Haddon, W. J., Valien, P., McCarroll, J. R., and Umberger, C. J. : A controlled investigation of the characteristics of adult pedestrians fatally injured by motor vehicles in Manhattan. *J Chronic Dis* 14 : 655-678 (1961).
- (23) Schmidt, W., Smart, R. G., and Popham, R. E. : The role of alcoholism in motor vehicle accidents. *Traffic Safety Res Rev* 6 : 21-27 (1962).
- (24) Waller, J. A. : Alcohol and traffic accidents: Can the Gordian knot be broken? *Traffic Safety Res Rev* 10 : 14-21, March 1966.
- (25) Waller, J. A. : Chronic medical conditions and traffic safety: a review of the California experience. *New Eng J Med* 273 : 1413-1420 (1965).
- (26) Selzer, M. L., Payne, C. E., Gifford, J. D., and Kelly, W. L. : Alcoholism, mental illness and the "drunk driver." *Amer J Psychiat* 120 : 326-331 (1963).
- (27) Handel, K. : Die persönlichkeit alkoholbeeinflusster verkehrsteilnehmer. Proceedings, 3d International Conference on Alcohol and Road Traffic. BMA House, London, 1963, pp. 61-65.
- (28) Bjerver, K. B., Goldberg, L., and Linda, P. : Blood alcohol levels in hospitalized victims of traffic accidents. Proceedings, 2d International Conference on Alcohol and Road Traffic. Garden City Press Cooperative, Toronto, 1953, pp. 92-102.
- (29) Haddon, W., Jr : Alcohol and highway accidents. Proceedings, 3d International Conference on Alcohol and Road Traffic. BMA House, London, 1963, pp. 3-13.
- (30) California's alcoholism problems and resources. Division of Alcoholic Rehabilitation, California State Department of Public Health, Berkeley, September 1964.
- (31) Coppin, R. S., and Van Oldenbeek, G. : Driving under suspension and revocation. California Department of Motor Vehicles, Sacramento, 1965.
- (32) Chafetz, M. E. : Is compulsory treatment of the alcoholic effective? Selected papers, 15th annual meeting, North American Association of Alcoholism Programs, Portland, Oreg., 1964. North American Association of Alcoholism Programs, Washington, D.C., pp. 65-73.