Injury and Disability Prevention and Alcohol-Related Crashes

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This chapter is built around four assumptions. First, contrary to the general impression of the public, and even of many working in the field of highway safety, about 80 percent of the people fatally injured in alcohol-related crashes are individuals who themselves had been drinking and are either drivers, impaired passengers of alcohol-impaired drivers, or impaired pedestrians (Waller 1985). About two-thirds of injuries in alcohol-related highway crashes also involve such individuals.

The image of the innocent victim who is run down by a drunken driver who escapes all injury himself has great emotional impact but only limited support from the real world. We have a responsibility to be fully aware that injury to the innocent is not the largest aspect of the problem.

Second, the tendency over the years has been to see issues involving alcohol and injury primarily as a safety problem, rather than a public health concern. As work over the past two decades has shown, reinforced by the recent National Academy of Sciences report *Injury in America*, injury is the primary cause of lost productive years of life in the United States, and alcohol abuse is an important contributor to that toll (National Research Council Committee on Trauma Research 1985).

A very substantial proportion – probably a majority – of persons who get into trouble with alcohol on the highway are not typical social drinkers, but rather problem drinkers or alcoholics. The safety issue is only part of a much larger public health problem.

In looking at the safety aspect, we must constantly be aware of this broader perspective. For example, an important effect of increasing the age for alcohol consumption to 21 was the reduction in the highway crash toll among teenagers. But, although at least some short-term data suggest otherwise (Vingilis and Smart 1981), it may be that the most important long-term result of such legislation will be to reduce a wide range of alcohol-related problems among teenagers and the onslaught of teenage and young adult alcoholics that we began to see when the drinking age was lowered to 18.

Third, during the late 1960s, Dr. William Haddon developed a matrix of highway crash analysis in which human, vehicular, and environmental factors interact during the precrash, crash, and postcrash phases to determine the occurrence, initial severity, and ultimate outcome of these events. He subsequently described generic interventions relevant to these phases in his brilliant paper, "On the Escape of Tigers" (Haddon 1970). In talking about injury prevention and amelioration, this chapter utilizes Haddon's basic approach, with an awareness of all three types of factors across all three phases of crash events.

Finally, this review is clearly not alone in discussing components of Haddon's nine cells. Therefore, this examination is quite selective, focusing on aspects that will not be considered by others or that will be considered in a different context.

Behavioral Issues in the Precrash Phase

How do we alter behavior to prevent the occurrence of crashes? All the other panels are concerned with one or another aspect of this area. This chapter focuses particularly on three aspects. One is the characteristics of the populations we are trying to reach.

As data expand, it is becoming increasingly clear that many people begin to be impaired at blood alcohol concentrations (BACs) below 0.05 gm/dl. But the data about who gets into trouble are equally clear. Over three-quarters of alcohol-related fatalities, and almost as high a proportion of alcohol-related injury crashes, involve drivers or pedestrians with BACs of 0.10 gm/dl or higher. Usually the BAC is much higher, averaging 0.16 gm/dl (NHTSA 1986).

My own work and that of others has focused on two groups of heavy drinkers, namely, teenage and young adult males, and problem drinkers and alcoholics. A new group causing increasing concern is teenage and young adult females who are drinking more and driving more, at least in part as aspects of their new independence (Fell 1987).

This discussion, however, focuses on a different issue, namely, the interdependence of lifestyle components. Studies show that those teenagers most likely to drive after drinking are also the ones most likely not to use seatbelts, to drive recklessly, to have less exercise, to prefer more fat in their diet, to have had premarital sexual experience, and to have done so without benefit of contraceptives (Jessor 1987; Maron et al. 1986). We know that heavy drinkers tend also to be heavy smokers, a fact not lost on the tobacco and alcohol beverage manufacturers, which often are divisions of single companies and thus are able to consolidate marketing strategies. A recent study by the Internal Revenue Service shows that individuals most likely to cheat seriously on their taxes are also more likely to be taking chances in other aspects of their lives, including speeding, drunken driving, adultery, and risky investments and sports (Goleman 1988).

This is precisely why it is so important to take a broader public health viewpoint. Specific behavioral interventions often show at least partial success. But such interventions all tend to bog down on the fact that they have minimal effect on those hard core segments of the population that are most overrepresented in whatever behavioral aspect they are trying to change.

The problem, simply stated, is that we are just beginning to learn which behaviors interact, and how, so as to create that entity we called lifestyle. We know relatively little about how lifestyles are either transmitted or altered between generations or within generations, and whether it is possible to alter selectively one aspect of lifestyle, even if it creates dissonance with other aspects. Frankly, we need such information if we are to do more than simply nibble around the edges of behavioral modification. Alcohol-related behavior is far too intimately and intricately tied to other life beliefs and behaviors to permit us to expect success with simplistic approaches to modifying behavior, especially as it relates only to the activity of driving.

The foregoing and subsequent comments may sound like a plea for more research, and on one level they are. But the ultimate goal is to achieve intervention programs that work. In addition to basic research, we need to try out interventions in such a way that they can be adequately evaluated to answer the following questions, among others (Waller 1980).

- Does the program alter behavior, morbidity, or mortality overall? Are any other activities or events going on in the community that may explain any changes observed? For example, the rise of activities by MADD, SADD, RID, and other groups concerned with alcohol and highway safety coincided with the end of the baby boom, and it appears that at least a part of the reduction in alcohol-related crashes can be attributed to the reduction in young males, rather than

to specific anti-alcohol activities. This is not a criticism of the activities per se, but rather of the method of determining effect.

- Is the program more or less successful with some segments of the population, or under some circumstances, than with others?
- What proportion of the total problem do those segments account for?
- What factors seem to explain the population or circumstance differences? Are the factors intrinsic to the population or circum- stances itself, to the way the intervention was carried out, or to both?
- Can the program be modified in a way more likely to reach the hard to reach, for example, by addressing more specifically those unique aspects of knowledge, attitudes, and practices that make them a more difficult target?
- Given the availability of other nonbehavioral options for injury control, is the cost-effectiveness of the program sufficient to warrant its continuation, or are other options preferable?

The methods for answering these questions must be built into the initial design of the intervention rather than being tacked on as an afterthought. This requires early involvement of someone with skills and knowledge in process and outcome components of program evaluation. It has been said that knowledge without action is futile; but action without knowledge is fatal. We need sound use of both.

The third concern is about alcohol-impaired pedestrians, who account for 7 percent of all alcohol-related highway fatalities (NHTSA 1986) but a substantially higher proportion of those in urban areas. Most attention in the efforts to reduce the alcohol-related highway toll has been paid to the impaired driver, as indeed it should. But we must not overlook the pedestrian. Efforts to educate people about alcohol-related risks should also mention the risks to this group of road users.

An excellent study by Blomberg et al. (1979) in New Orleans showed that, unfortunately, it is not possible to identify high-risk locations where impaired pedestrians are more likely to be found. Nonetheless, some efforts aimed at high-risk populations may be of use. Efforts to provide alcohol in controlled settings on campuses, for example, may reduce the likelihood that college students will travel as either drivers or pedestrians after becoming impaired off campus. But apparently no evaluation of such activities has taken place. Clearly, more needs to be done in both the research and program areas.

Vehicular Issues in the Precrash Phase

There is a tendency to assign *all* responsibility for a crash to the driver or the pedestrian if alcohol is present. But, as Patricia Waller cogently notes (Haight et al. 1976).

> The fact that the human error involved in accidents is frequently related to information failure (including recognition errors) strongly suggests that the demands of the driving situation are more than the driver can handle. There is considerable need to recognize that the human being varies in his performance and that on the whole it can be assumed that he probably does about as well as he can be expected to, given the circumstances. Accident investigations should be conducted in which the human element is taken as a given and the vehicle and environment are analyzed to determine the extent to which *they* need to be modified so that the human can function satisfactorily. Thus, simply because a vehicle is performing up to the manufacturer's standards does not mean that the vehicle performance is satisfactory. Perhaps the manufacturer's standards need to be modified and the vehicle performance enhanced. Simply because the roadway signing meets the criteria set down in a highway design handbook does not mean that the

signing is adequate. The criteria often used call for signs that can be readily viewed by drivers with 20/30 vision. Furthermore, the standards must be met only by the signs when they are new. Most highway signs remain in place for years, and many legally licensed drivers cannot meet a vision criterion of 20/30. Under such circumstances, when the driver fails to read the sign in time to make a decision, is it a driver failure? Most human factors experts would not agree, yet *accident causation studies persist in perpetuating the myth that drivers are somehow supposed to be able to compensate under any conditions for the shortcomings (legalized failures?) of the vehicles and driving environment.* (p. 48-49)

Ample evidence exists that vehicle design or other characteristics contribute to the occurrence of highway crashes.

- Perhaps the most obvious example involves the motorcycle, which combines special problems with stability and handling, reduced conspicuousness so that other drivers are less able to avoid it and, once in a crash, reduced survivability for the occupants. Recent work from California and New York indicates that special training and licensing requirements for motorcycle drivers are inadequate to compensate for these problems (Insurance Institute for Highway Safety). In 1986, fully 54 percent of motorcycle fatalities had been drinking (NHTSA 1986), but whether the unique features of the motorcycle exacerbate the effects of the alcohol impairment is not known. In other words, if a driver has a crash at a given BAC it is not known to what extent the vehicle handling characteristics versus the driver's handling capabilities contribute to the crash.
- One modification of motorcycle design that has aided crash avoidance has been linking the ignition switch to lights so that motorcycles always operate with their lights on during the daytime, thus increasing their visibility. The addition of reflectors to bicycles also improves the nighttime visibility of these vehicles, thus giving a car driver impaired by alcohol additional time to react.
- Issues of vehicle handling characteristics also are relevant to the crashes of certain utility vehicles that have a propensity to roll over in crashes (Reinfurt et al. 1982). When faced with the rollover data, persons representing the automotive industry on a related lawsuit countered that the overrepresentation of rollovers did not reflect the vehicle characteristics per se, but rather the sorts of people who drive these vehicles, for example, the fact that such vehicles are often driven by the young.[1] As seen in figure 1, the propensity to rollover *is* associated with age. Both the young driver and the "older" driver are at higher risk of rollover in crashes for two of the three models examined. If the issue were solely driver characteristics, one would expect to see overrepresentation only of young drivers, but not of those who have reached the "senile" years of 35 or older!
- But it is also known that the automotive industry—as does any industry—tries to target its buying audience by selective placement and design of advertisements to highlight vehicle characteristics that are likely to attract certain buyers. It is unlikely that many 45-year-old business executives drove around during the 1960s and 1970s in VW bugs, or currently use pickup trucks as their transportation of choice. It is equally unlikely that many 19-year-old laborers or college students are in the market for a Mercedes or Volvo or Lincoln Continental, and advertisements for these vehicles that appear to be aimed at these audiences are seldom, if ever, seen.
- How does all this relate to alcohol? A study from the General Motors research staff shows a strong correlation between "Youth Sport," "High Sport," "Sixties

[1] Comments about the Reinfurt et al. paper by Kent Joscelyn and others during post-presentation question and answer period at AAAM meeting, 1982.

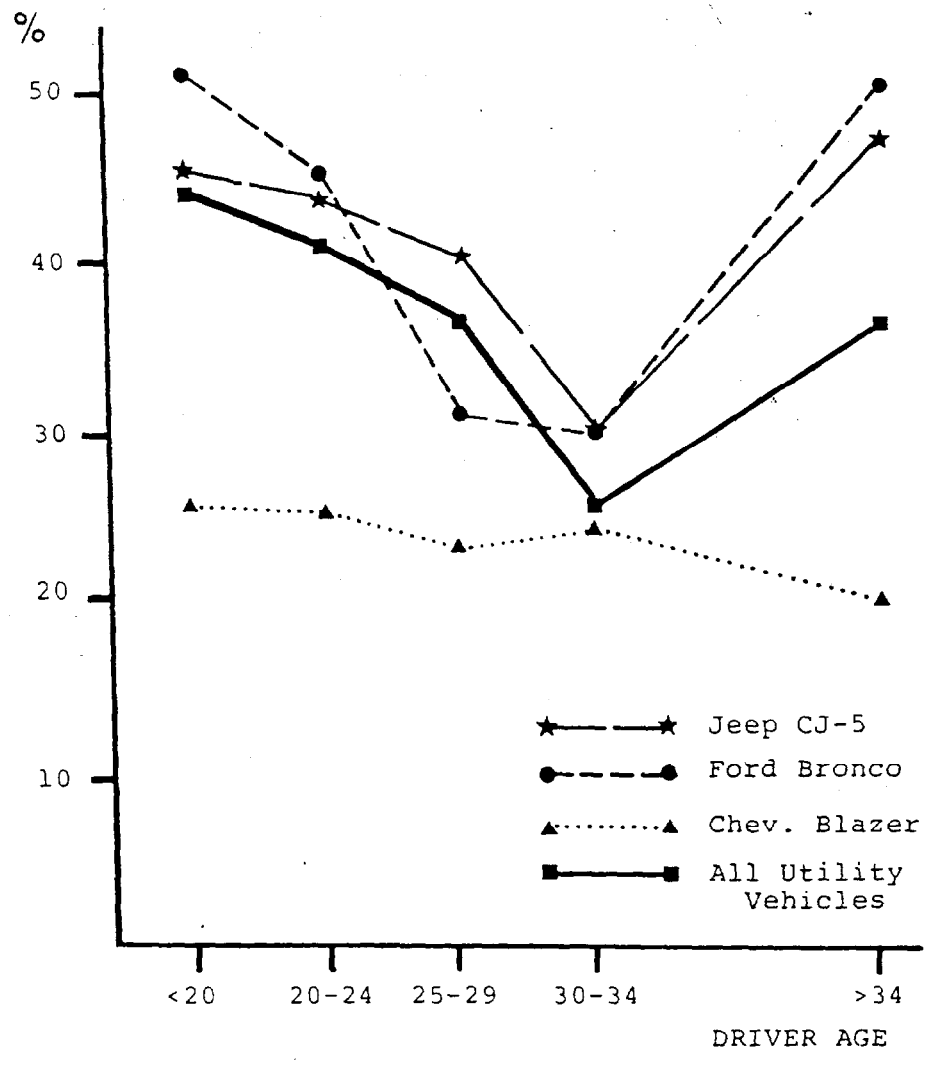

Figure 1. Utility vehicle rollover percentages by driver age for single vehicle crashes.

Generation," and "Wild West/Cool Bravado" vehicles and likelihood of involvement or death in an alcohol-related crash, and either negative or no association for "Sedate, Self-restrained" or "Domestic Economy" vehicles (Angell and Von Buseck 1985). The authors of this research were not able to divulge which vehicles fit into such categories. The question, of course, is to what extent do handling characteristics of the vehicles involved make driving easier, more difficult, or have no effect for drivers with alcohol in their systems?

- Issues related to braking provide an additional vehicular example. Recent improvements of braking systems in more expensive vehicle models through the use of computers are aimed at a longstanding problem of brakes that lock up and permit the vehicle to skid. In considering the anticipation or early identification of a skid situation, Olsen (1978) has noted that suspension systems in many U.S. vehicles are sufficiently "soft" so the driver may realize he is beginning to skid when there is barely time, or it is already too late, to make an appropriate response.

- Given the fact that alcohol alters perception, judgment, and slows response

time, "soft" suspension and standard brake systems can only add to the demands of the driving task for a person who is already impaired. The recent installation of elevated rear brake lights is an important improvement to quickly alert drivers to potential danger and should especially benefit those with modest impairment by alcohol.

- Side and rear view vision systems have been faulted in many vehicles, especially trucks, and in 1972 an estimated 900,000 crashes per year were attributed to inadequate vision on trucks, with 500,000 of those believed to result from poor but correctable mirror design (Reiss et al. 1972). Alcohol severely affects vision, including narrowing of visual fields. Inadequacies of vehicle vision systems, therefore, are likely to be even more of a problem for the alcohol-impaired driver than for the average driver.
- Trucks present their own set of difficulties. In 1986, almost 5,100 medium or heavy trucks (over 10,000 lbs) were involved in crashes, in which 4,881 persons died. Only 16 percent of the fatalities were truck occupants (NHTSA 1986). Crash rates for trucks exceed those of other vehicles on all types of roads, including freeways, and when trucks account for 25 percent of traffic volume on an expressway system, a 3-percent increase in truck traffic produces a 23-percent increase in crash frequency per mile (U.S. Bureau of Public Roads 1963). Overwhelmingly, such crashes are more serious because the energy loadings are greater.
- Other drivers find it particularly difficult to maneuver in the presence of large trucks, not only because they are behemoths, but because they often are traveling faster or slower than the traffic flow, may be poorly visible at night, create aerodynamic turbulence and, in bad weather, may obscure the vision of other drivers by splashing their windshields. Each of these characteristics adds to the alcohol impairments of the driver. Therefore, the very presence of more trucks on the roads quite likely exacerbates the problem of alcohol-related crashes. Add to this the safety effects of deregulation and of increases in truck size and double trailers that have been approved at the Federal level and it is clear why we have a serious problem.

Roadway Issues in the Preinjury Phase

The earlier quote by Patricia Waller is relevant to issues of highway design and construction as well as to vehicles. It is not enough to know that individuals crashed because they were impaired by alcohol. The question also is, if they were so impaired, why did they crash where they did and not at an earlier location along their path? The answer often is that only at this location did the driving task become too demanding.

Much is already known about the types of roadway characteristics that increase demands on the driver and are associated with more crashes. In addition, some recent work has pinpointed the interrelation between some of these factors and alcohol impairment. Here are a few examples.

- Several studies done for the Insurance Institute for Highway Safety pinpointed roadway characteristics that are overrepresented in single vehicle crashes. One study in Georgia showed that such crashes are most likely to occur at or near curves of greater than 6 degrees, especially if associated with grades of 2 percent or more (Wright and Robertson 1976). These data, however, are not specific to drivers using alcohol, and it is reasonable to assume - but currently not known - that a person with a BAC of 0.10 gm/dl might be at greater risk at somewhat less demanding locations, e.g., curves of 4 degrees or greater with or without an associated grade.
- Presumably, the higher the BAC the less demanding the roadway that will prove

excessive. However, since the Georgia study examined single vehicle crashes, which commonly involve alcohol, it may also be that unimpaired individuals tend not to crash until the road is much more demanding and, in fact, the combination of a 6-degree curve and 2-percent grade is a good measure of the point at which the demand becomes too great for the typical driver impaired by alcohol. This can only be determined, however, by a BAC-specific analysis of crash environment.

- Increasing the speed with which a traffic light changes from green to red is associated with an increase in intersection crashes, whereas slowing the change cycle reduces the crash rate (Zador et al. 1985). A change of 20 percent, from 10-percent slower than that recommended in traffic management manuals to 10-percent faster, is associated with a fourfold difference in crash rate. Again, impaired drivers are uniquely likely to be affected by such changes because they have slower reaction times, especially for situations that involve making choices.
- A report from the National Transportation Safety Board (1980) identified the State of Utah as having two to three times as many crashes per day of wet weather as do the surrounding States. It does not seem reasonable to assume that Utah has more careless or alcohol-impaired drivers than these other States. In fact, given its large Mormon population, one would anticipate less alcohol use. The difference appears to be attributable to the Utah roads, which are built with a dense aggregate so that water doesn't drain off readily and vehicles can hydroplane easily.

  While this situation has been documented for Utah, it is not known how often such differences in roadway construction contribute in extremely subtle ways to the occurrence of crashes, or to those involving alcohol. Police investigations simply take the roadway construction as an immutable fact and, if drivers skid, they assume it must have been something they did wrong, rather than considering the possibility that something may also have been wrong with the way the road was built.
- Two cases provide information about the effect of roadway characteristics on drivers at different BACs. One study indicated that drivers at BACs of 0.05 gm/dl, and, to a lesser extent at 0.10 gm/dl, are less likely to wander off the sides of roads or across the center line if the painted stripes are 6 or 8 inches wide instead of the usual four inches (Nedas et al. 1982). Test areas of roadway with wider side and center stripes had significantly fewer crashes than did standard roads.
- Other work shows that putting reflectors on signs or on pedestrians permits drivers with moderate BACs to recognize these features from a further distance (Hazlett and Allen 1969). Since the inadequacies of road sign placement, size, readability, and information presented have been well documented, such greater visibility and consequently longer time for the impaired driver to react can only be helpful (Tamburri 1969). Studies of wrong-way driving by alcohol-impaired drivers about 20 years ago identified problems of poor signage and inadequate separation of some on- and off-ramps on freeways and resulted in important and successful corrective actions (Alcohol and Highway Safety 1968).

The Missing Link in Alcohol-Related Crash Avoidance Research

Excellent information has existed for at least the past two decades about the relative risk of crashing that a driver faces at given BACs (Jones and Joscelyn 1978; Haight et al. 1976). Information is also available about the crash contribution, and sometimes even the relative crash risk, of certain vehicular or roadway characteristics. What is not known is how the three sets of data interact. To date, no study has specifically examined the

interaction of alcohol, roadway, and vehicular characteristics in crashes without making the methodologic error of assuming that the roadway and vehicular aspects were functioning optimally if they were working as designed and constructed. The fact that they may have been designed or constructed so as to increase crash risk has been considered irrelevant by prior researchers.

Again quoting Patricia Waller on this issue (Haight et al. 1976),

> It is a serious error to consider the vehicle and environment as noncontributory simply because they meet the currently established standards. Most drivers also meet the currently established standards. After all, driver licensing programs exist precisely to see that this is the case. Critics may quickly point out that our licensing standards are not adequate, but cannot the same criticism be made with equal validity of the standards concerning vehicles and roadways? Why are these standards somehow sacrosanct while the standards used to license drivers are so readily the object of criticism? If the driver in a crash holds a valid license, then the argument can be made that he, too, has met existing standards and can be held no more culpable than the inadequate signing that is nonetheless legal. (p. 31)

Such unnecessary additions to the demands on the driver or the pedestrian, of course, create a problem not only for the person impaired by alcohol, but also for the elderly, those just learning to drive, persons unfamiliar with the specific road, and all the rest of us at times when traffic is particularly heavy, weather is bad, or when, for whatever reason, we happen to be functioning at less than our personal optimum capacity. If the goal is truly the prevention of crashes, rather than simply the excoriation of those who consume alcohol, we will look to all possible options in crash prevention, especially if they have the wider benefits described above.

Human Issues During the Crash Phase

A common axiom says, "Drunks don't get hurt when they fall because they are so relaxed." Unfortunately, this assumption not only is inaccurate; it is the exact opposite of what occurs. Both laboratory and epidemiologic evidence has been growing rapidly documenting that, especially at lower levels of kinetic impact, persons who have consumed alcohol are more likely to be injured, to have severe injury, to die, and to die before definitive treatment can be brought to bear (Waller 1985). The reason is that alcohol adversely affects both the internal function of individual cells and the functioning of organ systems to make it easier for them to become injured and more difficult for them to respond properly to injuries that do occur. Clearly, this myth of invulnerability for alcohol-impaired persons needs to be dispelled.

Vehicular Issues During the Crash Phase

The past two decades have seen considerable attention to, and correction of, vehicular components that increase crash severity. Examples include laws requiring seatbelt use and the move toward wider availability of airbags, collapsible steering columns designed to absorb damaging kinetic energy before it reaches the driver's chest, development of high-penetration windshields, dashboard construction that is less hazardous on impact, removal of pedestrian-spearing hood ornaments and tail fins, and attempts to alter the front design of vehicles to reduce pedestrian damage on impact.

Some major hiatuses still exist, however. Attempts to reduce the effects of side impacts on vehicle occupants are as yet unsuccessful. Most States have not reinstated laws requiring use of helmets by motorcyclists, despite the documented savings of life, limb, and money that accompanied initial passage of such laws and the loss of such savings where these laws were repealed.

Unfortunately, with both helmet and seatbelt laws, among those least likely to obey the law are persons under the influence of alcohol (e.g., Jessor 1987; Maron et al. 1986). Research has shown that excessive nonuse of seatbelts is to be found as often among persons entering bars as among those leaving and, therefore, greater nonuse is not an acute effect of the alcohol per se but rather appears to reflect underlying lifestyle issues (Preusser et al. 1986). Despite this relatively greater tendency toward nonuse, however, persons using alcohol more often wear helmets and seatbelts where the law rquires them than where use is voluntary, indicating that this high-risk group may be harder to reach, but not impossible to reach.

Another major hiatus is the failure to improve truck design or construction to reduce crash severity. It has been known for years, for example, that sides and rear ends of trucks can be constructed to prevent underride by automobiles during crashes and, consequently, to avoid decapitation of automobile occupants. But the trucking industry, to date, has successfully avoided regulations that would require this small addition to truck weight (Minahan and O'Day 1977). The industry may have gained, but public safety has lost. In similar fashion, energy-absorbing features universally found in automobiles are often not required by NHTSA in pickup trucks or various recreational vehicles, which are probably the vehicles preferred by high-risk young, heavy-drinking males.

Roadway Issues During the Crash Phase

The past two decades have seen both substantial progress and continuing problems in roadway safety. Energy-absorbing construction of guardrails, bridges, and underpasses, and of light- and sign-posts has become far more common, especially on primary roads built for higher speeds. These changes reflect the decades-old data indicating that such design and construction reduce crash severity. Little of this, however, has been applied to secondary roads, and in many places trees, rock outcroppings, and telephone poles remain – or in some cases continue to be planted or placed – dangerously close to the roadway, even for roads that have posted speed limits of 50 mph or higher.

One continuing problem is that even the best energy-absorbing devices that were designed for one generation of vehicles may be inappropriate for subsequent generations of vehicles that might follow during the expected lifetime of these devices. For example, devices built to deal effectively with crashes of the large and mid-size cars that preceded the 1973 oil embargo are no longer adequate for the large population of compact and subcompact automobiles, especially as these share the roadways with more and larger trucks.

Again, the Missing Link

Alcohol increases injury severity, especially at lower rates of energy exchange. All the vehicular and roadway research and designs for alteration of energy transfer to date have been based on a presumption of normal tissue response. It is not known to what extent, if at all, assumptions need to be altered in considering the reduction of injury for alcohol-impaired persons or, as well, for the elderly, rather than just for unimpaired young individuals.

Issues During the Postcrash Phase

Only two issues during the postcrash phase are considered, namely, the acute management of injured persons who have consumed alcohol, and the application of rehabilitation concepts. Treatment of underlying alcoholism postinjury is also an extremely important issue, but it is being considered by another panel.

Before turning to alcohol-specific issues of acute management, a brief comment should be made about the general status of trauma care systems in the United States.

Over the past two and a half decades, substantial improvements have occurred in the trauma care system. Modified hearses and police cars to transport the injured have been replaced by modular, well-equipped ambulances. The 80-hour or beyond emergency medical technician (EMT) training has replaced the 8-hour standard Red Cross course. Ambulance-to-hospital radio communication has become commonplace. Emergency department nurses and many physicians are being trained in advanced life support, and the whole specialty of emergency medicine has developed.

What is still missing is the widespread regionalization of such improvements, especially as they involve cooperation between ambulance services, between ambulances and hospitals and, most assuredly, between hospitals themselves. A tremendous economic power struggle is taking place in many States concerned with designating specific hospitals as trauma centers because they are better equipped and better staffed, while neighboring hospitals perceive them as likely to "steal" lucrative cases. Until we see a system of regionalization of trauma care in every State of the Nation, instead of the current spotty distribution of such systems, we will not be able to say that this Nation's acute care system is beginning to be adequate.

We turn now to alcohol-specific issues in acute care. As long ago as 1928, Bogen documented the need to determine whether a person had consumed alcohol in order to provide effective emergency care. It is becoming increasingly apparent that the competent physician must determine if the individual is likely, not only to be acutely under the influence of alcohol, but also to be an alcoholic.

Acutely alcohol-impaired patients are more likely to have cardiac arrhythmia that may be life-threatening either at the crash site or shortly after arrival in the emergency department. They may have greater respiratory distress both because of the acute effects of alcohol and because they are likely to be smokers. Alcohol may cause severe hypotension. The presence of alcohol may, on the one hand, cause serious masking of symptoms of intra-abdominal injuries because of clouded sensorium and, on the other hand, result in overdiagnosis of the severity of head injury because alcohol-related altered consciousness is confused with trauma-related effects.

If patients are alcoholics, their wounds are more likely to become infected, because alcohol depresses immune response. But, at the same time, sudden fever may not be a sign of infection, but rather of impending delirium tremens, which carries a 25-percent mortality rate.

Many physicians have been concerned about their legal liability if they do a blood alcohol determination without specific patient approval. It is becoming increasingly obvious, however, for all of the above reasons, that the physician who does not obtain a BAC for clinical management is courting a suit for malpractice if problems occur that might have been foreseeable had the BAC been known.

Lastly, attention must be turned to the subject of rehabilitation. The whole field of rehabilitation medicine developed as a result of the progressively higher survival rates of severely injured soldiers that was achieved during World War II and the Korean Conflict. The years since have seen tremendous advances in basic research in this field as well as in the design and development of new techniques, skills, equipment, and prostheses and the formation of rehabilitation teams.

Unfortunately, as was pointed out in the National Research Council (1985) report, *Injury in America*, much of what is known is not being applied. Patients may not be referred to a physiatrist, or the referral may be sufficiently delayed so that disability is unnecessarily prolonged or may even have become permanent. Complete rehabilitation centers are few and far between, and many physicians do not know how to access them. This is especially true for the services needed for severe head injury, which is a more common outcome in the presence of alcohol. The plea of this chapter, therefore, is not so much for new research, but rather for the wider application of what is already known.

Summary

Alcohol contributes not only to the occurrence of crashes but also to the initial severity of injuries, problems in treatment, and ultimate outcome. The exact relationship of alcohol use and abuse and other lifestyle issues is just beginning to be examined, and the dearth of knowledge remains an important obstacle to achieving behavioral change for drivers and pedestrians who drink.

Characteristics of the vehicle and the road environment also contribute to crash occurrence and crash severity. Because little research, either qualitative or quantitative, has examined the interaction of vehicular and road environment characteristics in crashes at various blood alcohol concentrations, the exact relationship remains conjecture, and potential improvements in injury and disability prevention may be missed. Specifically, the following are recommended:

- Research needs to be carried out and the results used to intervene in the interaction between alcohol use practices and other aspects of lifestyle.
- Persons knowledgable in evaluation concepts and methods must be utilized early in the design of intervention programs, and evaluation should be an integral part of all such programs.
- Research should be undertaken into the interaction between different BACs, vehicle handling characteristics, and aspects of road design, construction, and maintenance to determine which vehicular and roadway aspects exacerbate the effects of impairment caused by BACs below 0.10 gm/dl, and to set vehicle and road standards that will take this knowledge into consideration. Similar research is needed to determine quantitatively the relation between BAC and vehicle and roadway features relevant to injury severity, and to apply such knowledge for injury reduction standards.
- Motorcycle helmet laws need to be reinstated in those States where they were rescinded.
- Federal crash and injury prevention standards currently applicable to automobiles should be extended to pickup trucks and recreational vehicles. Rear and side guards on trucks should be mandated to prevent other vehicles from underriding medium and large trucks in two-vehicle crashes.
- All necessary steps must be undertaken, including legislation if necessary, to ensure that regionalization of adequate trauma systems is achieved throughout the Nation.
- Physicians must be educated through hospital quality assurance programs and other means about the need to determine BAC and to screen for alcoholism as part of the proper management of the trauma patient. Similar educational methods should be used to get physicians to seek prompt and appropriate assistance for the rehabilitative aspects of trauma care.

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