Reducing Alcohol-Impaired Driving

Alcohol-impaired driving is a major public health problem in the United States. Traffic crashes involving alcohol killed more than 16,000 people in 1997 alone (National Highway Traffic Safety Administration [NHTSA] 1998b) and injure a million more each year (Blincoe 1996). Fatal traffic crashes, the leading cause of death for those aged 1 through 24, involve alcohol 4 times out of 10 (NHTSA 1998b; U.S. Department of Health and Human Services 1997).

The good news is that annual traffic deaths related to alcohol have dropped by more than one-third since the early 1980’s. The bad news is that the dramatic decline in fatalities seen in the early 1990’s has leveled off, while the number of people killed and injured each year remains staggeringly high. (More statistical information can be found later in this section and in the box below.)

Why Did the Fatality Rates Drop So Significantly?

Although many safety improvements have occurred since 1982—such as air bags, laws requiring the use of child restraints in all 50 States, and laws mandating the use of seat belts in 49 States—these improvements do not explain the major reduction in alcohol-related crashes. According to an analysis of the annual number of traffic fatalities that occur nationwide for every 100 million vehicle miles traveled, the traffic fatality rate dropped both for alcohol-related deaths and for other fatalities between 1982 and 1996 (NHTSA 1997b). Alcohol-
Chapter 7: Prevention Research

Research on the Effects of Laws and Programs: Methodological Considerations

When designing evaluations of efforts to reduce alcohol-impaired driving, researchers are challenged by constraints relating both to the nature of the law or program under study and to the research methods (De Jong and Hingson 1998). The optimal research design would be a true experimental design, with large numbers of communities or States randomly assigned either to a treatment group that is exposed to the intervention, or to a control group that is not. Clearly, however, random assignment of laws to States or communities is politically and financially unrealistic.

To follow are brief descriptions of alternative methods used to test the impact of community or State initiatives. (See also the discussion of “Methodological Concerns” in the section in this chapter on “Community-Based Prevention Approaches.”)

Quasi-Experimental Design

In studies with “quasi-experimental” designs, researchers compare outcomes for treatment communities or States with similar nontreatment (“control”) jurisdictions. Unlike the classic experimental design, the designation as a treatment or control community is not always random. Challenges for these studies include matching the intervention site with its control site on variables that might influence study outcomes, as well as teasing apart the effects of multiple laws or programs initiated within a relatively short time. These studies also need to account for shifts in legislation or law enforcement that might affect driving behaviors over the course of the study.

Time-Series Design

This research option involves the analysis of survey data or crash indicators over an extended period of time, both before and after the introduction of an intervention. When reliable and valid data are available over a lengthy time period, this design can be used to evaluate national, regional, or local campaigns. The design is most easily used when the occurrence of a single event can be precisely defined in time, thus enabling clear before-and-after comparisons.

In many cases, however, the only data available are broad indicators, such as statistics on alcohol-related traffic fatalities, or proxy measures, such as single-vehicle nighttime crashes, which are three times more likely than other crashes to involve alcohol. Using only this type of data can introduce imprecision in evaluating the effects of legislation or other programs, especially in short-term studies involving small jurisdictions (Heeren et al. 1985).

Crash Characteristic Comparisons

These methods were developed by analyzing the characteristics of crashes that involve alcohol in States that test blood alcohol levels in a high percentage of drivers in fatal crashes (Klein 1986). When available, alcohol test results are used for fatal crash analyses. When alcohol test results are not available, however, the characteristics of the crashes, in terms of how they compare to crashes involving alcohol, can be used to develop projections of alcohol involvement. The NHTSA has used this approach, called imputational methodology, to estimate annual alcohol involvement in fatal crashes at the national and State level. These estimates may be problematic when used for smaller subgroups, such as cities, specific age and gender groups, or at different times of the day or days of the week.

Using these methodological approaches, with cognizance of the strengths and limitations of each, researchers have been able to draw conclusions, as described in this section, about the effects of various legislative and programmatic interventions to reduce alcohol-impaired driving.

In addition, part of the alcohol-related traffic fatality decrease can be attributed to the passage of State-level legislation. This legislation includes “general deterrence laws” aimed at the population at large, such as raising the minimum legal drinking age to 21 or allowing police officers to immediately confiscate drivers licenses of drivers whose blood alcohol concentrations (BAC’s) exceed the legal limit. Other legislation includes “specific deterrence laws” aimed at persons already

related fatalities fell significantly more, however, down 56 percent versus only 11 percent for other traffic fatalities.

One likely contributor to the drop in alcohol-related crashes is the reduction in drinking since the early 1980’s. Nationwide, the annual per capita alcohol consumption has declined nearly 20 percent during this time period (Williams et al. 1996).
convicted of alcohol-impaired driving. These include lower legal BAC limits for convicted offenders, mandatory license suspension, mandatory treatment and rehabilitation, dedicated detention and probation, and actions against vehicles and tags. Research on the effectiveness of these and other deterrence laws is described later in this section.

Once laws are enacted, there is no guarantee that they will be observed. Active enforcement of, and education about, these laws at the community level has been critical to their success. As described later, publicity and police enforcement efforts such as well-publicized sobriety checkpoints can significantly enhance the benefits of State-level legal changes.

Reductions in alcohol-related crashes have also resulted from large-scale prevention programs at the community level. In recent years, researchers have begun exploring the potential of these comprehensive intervention programs, which combine the efforts of multiple departments of city governments with those of private citizens. A brief description of these programs is included in this section; for more information, see also the section “Community-Based Prevention Approaches” later in this chapter.

Other factors that have influenced the alcohol-related traffic fatality rates include policies such as alcohol taxation rates and State monopoly systems, which can influence alcohol availability, particularly to young drivers. Moreover, individual-level initiatives, such as personal interventions to prevent alcohol-impaired driving and designated driver strategies, also may reduce impaired driving. Each of these topics is described within.

Why Have the Rates Leveled Off in Recent Years?

It is too soon to know why the fatality rates have leveled off since the dramatic drops of the late 1980’s and early 1990’s. One contributing factor may be a drop in police enforcement, as drunk driving arrests nationwide have decreased 23 percent since 1983 (Hingson 1996a). In addition, questions have been raised as to whether public pressure to reduce drunk driving has dropped in recent years. (These topics are discussed in more detail later in this section.) In the meantime, continued research is needed to monitor and analyze the trends and to expand the range of approaches for reducing alcohol-related traffic fatalities.

Recent Trends in Alcohol-Related Traffic Fatalities

The remarkable progress in decreasing alcohol-related traffic fatalities has been documented by National Roadside Surveys conducted in 1973, 1986, and 1996, in which drivers were stopped between 10:00 p.m. and 3:00 a.m. on Friday and Saturday nights, when most drinking occurs (Voas et al. 1997c). The researchers used similar sites and sampling procedures in each survey.

The surveys revealed the following changes in drinking and driving statistics from 1973 through 1996:

- **Changes in Drinking and Driving in General:** A 53-percent drop in the proportion of drivers with positive BAC’s (from 36 percent in 1973 to 17 percent in 1996). The decline was greatest for drivers with lower BAC’s, in the range of 0.005 to 0.049 percent.

- **Changes by Age Group:** A 92-percent drop in the proportion of drivers under age 21 with 0.10-percent BAC (from 4.1 to 0.3 percent of drivers in this age group). By 1988, it was illegal to sell alcohol to individuals under 21 years of age, which may account in part for this decline, the largest in any age group. The smallest reduction by age group was still substantial—a 33-percent drop in the proportion of drivers aged 21 through 25 with 0.10-percent BAC (from 5.7 to 3.8 percent).

- **Changes by Gender:** A 50-percent drop in the proportion of female drivers at 0.10-percent BAC (from 3.0 to 1.5 percent of female drivers) and a 36-percent drop in the proportion of male drivers at 0.10-percent BAC (from 5.5 to 3.5 percent of male drivers).
Changes by Race/Ethnicity: A 55-percent drop in the proportion of white drivers with positive BAC’s (from 5.1 to 2.3 percent of white drivers) and a 40-percent drop in the proportion of black drivers with positive BAC’s (from 6.0 to 3.6 percent of black drivers). At the same time, the proportion of Hispanic drivers with positive BAC’s more than doubled (from 3.3 to 7.5 percent of Hispanic drivers). This is a worrisome finding, since the proportion of surveyed drivers who were Hispanics increased sevenfold during the study period (from 1.4 to 10.3 percent).

In addition, as mentioned previously, data from fatal crashes, first collected nationally in 1982, confirm the overall declines in alcohol-impaired driving. Between 1982 and 1997, alcohol-related traffic fatalities dropped 36 percent, from 25,165 to 16,189 fatalities (NHTSA 1997a, 1998b) (figure 1). The greatest reductions were among youth aged 15 through 20, whose alcohol-related traffic deaths dropped 59 percent, from 5,380 to 2,209 per year (NHTSA 1997a, 1998a) (figure 2).

Legislative Efforts To Reduce Alcohol-Impaired Driving

Legislative efforts to reduce alcohol-impaired driving have emphasized laws that deter violations by applying swift, certain, and severe penalties when warranted. The punishment’s severity is considered less of a deterrent than is its quick and unavoidable administration (Ross 1992).

Most of this legislative activity has been stimulated at the State level, although Federal initiatives did promote the passage of laws forbidding drinking, and driving after drinking, for those under age 21. The passage of Federal and State-level legislation has been spurred by grassroots citizen activist groups, such as Mothers Against Drunk Driving and Remove Intoxicated Drivers, and the political coalitions they have formed with medical, public health, community, and business groups.

As mentioned previously, laws to deter drunk driving fall into two categories: laws aimed at the general public, and laws aimed specifically at those already convicted of “driving under the influence” (DUI). (Note: As used throughout this section, DUI also refers to driving while intoxicated [DWI], a term used in some States.) Although convicted DUI offenders have a higher than average likelihood of further arrests and crashes, most drivers in fatal crashes involving alcohol have never been previously convicted. In 1997, for example, 89 percent of fatally injured drivers with a BAC of 0.10 percent or
Reducing Alcohol-Impaired Driving

Figure 2: Trends in alcohol-related and non-alcohol-related traffic fatalities, persons aged 15 through 20, United States, 1982–1997

<table>
<thead>
<tr>
<th>Year</th>
<th>Alcohol-related (↓ 59%)</th>
<th>Non-alcohol-related (↑ 30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>82</td>
<td>5,380</td>
<td>3,120</td>
</tr>
<tr>
<td>83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>84</td>
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<td></td>
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<td>85</td>
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<td>91</td>
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<td></td>
</tr>
<tr>
<td>92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>4,049</td>
<td></td>
</tr>
<tr>
<td>94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>97</td>
<td>1,049</td>
<td></td>
</tr>
</tbody>
</table>


Higher did not have a DUI conviction during the 3 years prior to the crash (NHTSA 1998b). In addition, among those arrested for DUI, two-thirds have never been arrested before (NHTSA 1995). Thus, laws and programs need to deter both first-time offenses and repeat offenses.

Many studies have been undertaken to evaluate the effectiveness of both general and specific deterrence laws. Highlights from recent research are described next.

General Deterrence Laws

Minimum Legal Drinking Age. In 1984, when the National Minimum Drinking Age Act was passed, half of the States had a legal drinking age of 21. By 1988, all States had a minimum legal drinking age of 21. Of the 29 studies performed since the early 1980’s that evaluated the effects of increases in the minimum legal drinking age, 20 showed significant decreases in traffic crashes and crash fatalities (Toomey et al. 1996). Only three clearly found no change in traffic crashes involving youth; the remaining six studies had equivocal results.

According to NHTSA, States that adopted a minimum legal drinking age of 21 in the early 1980’s experienced a 10- to 15-percent drop in alcohol-related traffic deaths among youth, compared with States that adopted the law later (Blincoe 1996). Overall, NHTSA estimates that imposing a minimum legal drinking age of 21 has prevented more than 17,300 traffic deaths since 1976, or approximately 700 to 1,000 deaths each year for the past decade (NHTSA 1998b) (figure 3).

In the years since these laws were enacted, the proportion of high school seniors who reported drinking in the previous month has declined substantially, from 72 percent in 1980 to 51 percent in 1999, according to the annual Monitoring the Future Study (Johnston et al. 1999). The proportion who consumed five or more drinks on at least one occasion in the previous 2 weeks declined from 41 to 31 percent (figure 4). Minimum legal drinking age laws not only have reduced drinking among people under 21, but they also have reduced drinking among people aged 21 through 25 who grew up in States with a minimum legal drinking age of 21 (O’M alley and Wagenaar 1991).

Although U.S. laws prohibit the sale to, or possession of alcohol by, individuals younger than 21, this age group can still obtain alcohol from many sources. Buyers who appear to be younger than
21 can successfully purchase alcohol from licensed establishments without showing age identification in 50 percent or more of their attempts (Forster et al. 1994, 1995; Preusser and Williams 1992). An analysis of attempts by youth who appeared underage to purchase alcohol at 100 outlets in 28 Minnesota communities revealed that liquor stores were more likely than bars to sell to minors (Wolfson et al. 1996). Bars without managers present at all times were more likely to sell to minors, as were those where staff received no formal server training.

In addition, although many youth purchase alcohol themselves, most indicate that they generally obtain alcohol through social contact with persons over age 21 (Wagenaar et al. 1996). Laws prohibiting the sale and provision of alcohol...
Reducing Alcohol-Impaired Driving

Heightened enforcement of drinking age laws can, however, reduce youth access to alcohol. One study demonstrated dramatic reductions in alcohol sales to minors following an enforcement campaign involving three sting operations in which underage males attempted to purchase alcohol (Preusser et al. 1994). Over the course of a year, sales to minors dropped from 59 to 26 percent, during which time store owners were informed about the results of the initial sting, impending stings, and potential penalties for selling to minors.

Other measures that might further enhance compliance with the age 21 law include: (1) use of distinctive and tamper-proof licenses for drivers under age 21, (2) “use and lose” laws that impose driver’s license penalties on minors who purchase or are found in possession of alcohol, (3) keg registration or other limits on large container sales, and (4) increased penalties for illegal service to minors, including laws that entitle injured parties to sue for damages. Research is needed to establish whether these proposals would significantly reduce alcohol consumption and driving after drinking (De Jong and Hingson 1998).

Zero Tolerance Laws. When most States raised the legal drinking age to 21, they did not simultaneously make it illegal for persons under age 21 to drive after drinking. In the fall of 1995, the U.S. Congress amended the National Minimum Drinking Age Act by mandating withholding of Federal highway funds from States that did not adopt laws that make it illegal for those under 21 to drive after drinking any alcohol. At that time, only half the States had these “Zero Tolerance” laws, which set legal BAC limits of zero to 0.02 percent. As of April 1998, 50 States and the District of Columbia had passed Zero Tolerance legislation.

The impact of these laws has been significant. One recent study compared the first 12 States that lowered the legal BAC’s for drivers under 21 with 12 nearby States that did not. The study found that the States adopting Zero Tolerance laws experienced a 20-percent decline in the proportion of crashes that are most likely to involve alcohol (single-vehicle, nighttime fatal crashes) among drivers under 21, compared with the States that did not lower BAC’s. States that adopted BAC limits of 0.04 or 0.06 percent had no significant declines (Hingson et al. 1994).

Some States, however, have found it difficult to achieve broad awareness of the Zero Tolerance law. Studies in California and Massachusetts found that 45 to 50 percent of young drivers were unaware of the law (Martin and Andreasson 1996).

Administrative License Revocation. Forty States have administrative license revocation (ALR) laws that allow a police officer or other official to confiscate immediately the license of a driver whose BAC exceeds the legal limit. ALR laws permit punishment to occur at the time of infraction and, because the court system is bypassed, the punishment is more swift and certain. One nationwide study found that ALR was associated with a 5-percent decline in fatal crashes and a 9-percent decline in single-vehicle, nighttime fatal crashes (Zador et al. 1989).

A more recent national study examined the effect of ALR laws by analyzing, within the States that adopted these laws, the difference in fatal crash rates before and after the legislation was enacted. To exclude the effects of other Statewide changes that could influence crash rates, such as safety belt laws and highway improvements, the researchers tracked changes in the rates of fatal crashes that did not involve drinking drivers as well as those that did. They found that regardless of changes in overall fatal crash rates, States that adopt ALR laws witnessed annual declines of 13 percent in
the proportion of fatal crashes involving drivers
with BAC’s of 0.10 percent or higher (Voas and
Tippetts 1999).

These laws have faced some challenges for
allegedly imposing “double jeopardy” on a
driver who subsequently is convicted of DUI
and receives additional penalties, but no State
supreme court has upheld such a challenge.
Questions have also been raised as to whether
ALR laws create economic hardship for offenders
whose licenses are suspended. Recently, however,
a survey of 579 first-time offenders and 233
multiple offenders in four States with varying
ALR laws found that ALR does not have a major
impact on a DUI offender’s job or income
(Knoebel and Ross 1997).

Reducing Legal Limits for Blood Alcohol
Concentration. Every State except Massachu-
setts and South Carolina has adopted laws that make
it a criminal offense to drive with a BAC above
the State’s legal limit, which in most States is
0.10 percent. The laws include a provision that
the driver’s BAC in and of itself, or “per se,” is
enough to demonstrate impairment, so prosecu-
tors do not have to introduce other evidence and
thus can make convictions more easily.

Seventeen States have lowered the legal BAC
limit from 0.10 to 0.08 percent. Massachusetts
has set the BAC for its ALR law at 0.08 percent.
A number of studies have found that after States
adopt a 0.08-percent law, they experience signifi-
cant decreases in alcohol-related fatal crashes
(Hingson et al. 1996a; Johnson and Walz 1994;
NHTSA 1991). Often, however, the States
implemented ALR laws after the 0.08-percent
laws, which made it difficult to separate the
effects of each law (NHTSA 1991; Rogers 1995).

New research has shown, however, that 0.08-
percent laws do have independent effects, but
the lower limits work best when enacted in
combination with ALR. In a recent analysis,
researchers examined data on fatal crashes for
six States that adopted 0.08-percent laws in 1993
and 1994 and six nearby States with higher BAC
limits (Hingson et al. in press). Over the study
period, the States with lower limits experienced
a 26-percent drop in the proportion of drivers
in fatal crashes with BAC’s of 0.10 percent or
higher, which was significantly greater than the
20-percent decline observed in the comparison
States. The 26-percent reduction was also
significantly greater than the declines observed
in all other States that did not have 0.08-percent
laws during the same period.

In this study, four of the States with 0.08-percent
laws also had ALR laws, but the ALR laws had
been in place prior to most, if not all, of the
analysis period. Hence, the ALR laws could not
have explained the decreases in alcohol-related
fatal crashes. The researchers concluded that
independent effects of the 0.08-percent law
occurred in these States, although they noted
that stronger effects had been shown in other
studies of States that adopted 0.08-percent and
ALR laws at the same time or nearly the same
time (Hingson et al. 1996a; Rogers 1995).

Another new investigation, a national study
conducted over a 16-year period, found that
upon enacting 0.08-percent laws, States can
expect, on average, an annual 8-percent decline
in the proportion of drivers involved in fatal
.crashes who have positive BAC’s (Voas and
Tippetts 1999). The reduction attributed to
the 0.08-percent laws was observed for drivers at
all BAC’s and it was distinct from the effects of
other DUI laws, safety belt laws, and potentially
confounding trends in alcohol consumption and
demographic, economic, and seasonal factors. In
addition, an 11-State study examined the effects
of 0.08-percent legislation in each State before
and after the laws were enacted (Apsler et al.
1999). The researchers found that the 0.08-
percent laws, alone and in conjunction with ALR
laws, were associated with significant declines in
alcohol-related fatalities in seven States, as well as
with significant declines attributed solely to the
0.08-percent laws in five of those States.

Currently 10 States have adopted neither 0.08-
percent laws nor ALR laws. Meanwhile, many
other nations have set much lower legal blood
alcohol limits than the United States. The limit
in Canada, Austria, Switzerland, and the United
Kingdom is 0.08 percent. In Australia, the legal
limit ranges from 0.05 to 0.08 percent. The Netherlands, Finland, France, and Germany have 0.05-percent legal limits. Sweden's limit is 0.02 percent, and Japan's is 0.005 percent.

The feasibility of reducing legal limits depends heavily upon public support. In the United States, a recent survey shows that many people do not think that drinking five drinks in 2 hours guarantees unsafe driving (Jones and Boyle 1996). On average, with this level of drinking on an empty stomach, a 165-lb man would reach a BAC of 0.08 percent, which increases the risk of having a fatal crash by about 11 times (see the box “The ABC’s of BAC’s”). In this national survey of more than 4,000 drivers, however, 75 percent believed that at least half of all drivers would be dangerous if they drove after five drinks in 2 hours, but only 28 percent thought all drivers would be unsafe (Jones and Boyle 1996).

Specific Laws To Deter Repeat Offenders

Once convicted of alcohol-impaired driving, a DUI offender is more likely than other drivers to be arrested again for driving while intoxicated and to be involved in alcohol-related crashes (NHTSA 1996a). Repeat offenders account for approximately one-third of drivers arrested or convicted for DUI each year and for one-sixth of drivers with positive blood alcohol levels who are killed in traffic crashes (NHTSA 1995; Voas et al. 1997c). Specific deterrence laws seek to reduce this recidivism through such measures as actions against vehicles and tags, lower legal blood alcohol levels for convicted DUI offenders, treatment programs, jail sentences, victim impact panels, probation, detention dedicated to DUI offenders, and a combination of these actions. To follow are highlights of recent research in these areas.

Actions Against Vehicles and Tags. Although license actions have been shown to reduce recidivism, many people with suspended licenses continue to drive. Unlicensed drivers can be apprehended only when police have probable cause to stop their vehicle. Washington and Oregon have enacted legislation that allows police to seize the vehicle registration of drivers caught driving after suspension, leaving the motorist with a temporary, 60-day registration. A sticker on the vehicle tag gives the police probable cause to stop the vehicle and ask to see the driver's license. This law has been effective in Oregon but not in Washington, where it was enforced less often (Voas et al. 1997a).

In another recent study, researchers examined the effects of a 1993 Ohio law that permits immobilization of vehicles belonging to people caught driving while their licenses were suspended for a DUI offense (Voas et al. 1997b). The immobilization period was 30 days for a first offense, 60 days for a second offense, and 180 days for a third offense. Third- and fourth-time offenders were also subject to vehicle forfeiture. In a 2-year follow-up study, the researchers noted reductions in incidents of driving with a suspended license and of repeat DUI offenses among those whose vehicles were immobilized or impounded. This held true both before and after the offenders reclaimed their vehicles. The research team also evaluated a somewhat different application of the same law in a different part of Ohio and obtained similar results (Voas et al. 1998).

Another approach uses ignition interlock devices to prevent vehicle operation when a measurement of the driver's breath alcohol level exceeds a designated limit. This technique temporarily reduces recidivism, which may rise once the device is removed. In Maryland, 1,380 multiple-DUI offenders with suspended or revoked drivers licenses were randomly assigned to either a treatment program or an experimental interlock program when their licenses were reinstated (Beck et al. 1997). One year later, the alcohol-related traffic violation rate was significantly lower for participants in the interlock program.

Lower Legal Blood Alcohol Concentration Limits for Convicted DUI Offenders. Although persons convicted of DUI have increased chances of further DUI arrests or crashes, almost all States allow the same legal BAC for these drivers as for those never convicted of DUI. One exception is Maine. In 1988, the State set the legal limit at
Chapter 7: Prevention Research

The proportion of alcohol to blood in the body is expressed as the blood alcohol concentration (BAC), which is determined by a person's drinking rate as well as the body's absorption, distribution, and metabolism of the alcohol. To follow is a brief introduction to BAC's and their consequences for driving.

Absorption and Distribution
When alcohol is consumed, it passes from the stomach and intestines into the bloodstream. As it circulates in the bloodstream, alcohol distributes itself evenly throughout all the water in the body's tissues and fluids. Thus, the alcohol level can be measured not only by testing the blood, but also by testing the urine, saliva, or water vapor in the breath.

In cases of traffic fatalities involving alcohol, blood testing must, of course, be used to estimate alcohol levels; otherwise, law enforcement agencies primarily use breath testing. Breath-test results are often converted to equivalent blood alcohol measurements, however, because early drunk driving laws set limits based on blood tests (National Highway Traffic Safety Administration [NHTSA] 1990).

In the United States, blood alcohol measurements are based on the amount of alcohol, by weight, in a set volume of blood. For example, a BAC of 0.10 percent—a level at which it is illegal to drive in the United States—is equivalent to 0.10 grams of alcohol per 100 milliliters of blood. This translates, by weight, to a proportion of just under 1 gram of alcohol for every 1,000 grams of blood in the body (Jones et al. 1998).

Breakdown in the Body
Within a few seconds after ingestion, alcohol reaches the liver, which begins to break it down, or metabolize it. Any BAC measurement therefore reflects not only a person's drinking rate but also his or her rate of metabolism.

Alcohol is metabolized much more slowly than it is absorbed, so the concentration of alcohol builds when additional drinks are consumed before prior drinks are metabolized.

How any one person absorbs and metabolizes alcohol varies depending on factors such as, age, gender, whether or not food is eaten with the alcoholic beverage, and the proportion of body mass that is fatty tissue.

Although individual rates can vary widely, on average, a 165-lb man who has four drinks in an hour on an empty stomach, or a 135-lb woman who has three drinks under similar conditions, would reach a BAC of 0.08 percent (NHTSA 1992). This is the legal limit for driving in 17 States; other States have a 0.10-percent BAC limit (See pp. 382–383 for further discussion on legal BAC limits).

Consequence: Crash Risk
Drinking even a little alcohol can change an individual's ability to respond to the demands of driving. For example, a driver's ability to divide attention between two or more sources of visual information can be impaired by BAC's of 0.02 percent or lower (Howat et al. 1991; Moskowitz 1985; Starmer 1989). Starting at BAC's of 0.05 percent or higher, consistent impairment occurs in eye movements, glare resistance, visual perception, reaction time, certain types of steering tasks, information processing, and other aspects of psychomotor performance (Finnigan et al. 1992; Hindmarch et al. 1992; Howat et al. 1991; Starmer 1989).

Research has documented that the risk of a motor vehicle crash increases as BAC increases (Howat et al. 1991; Starmer 1989; Zador 1991) and that the more demanding the driving task, the greater the impairment caused by low doses of alcohol (Starmer 1989). Increases in blood alcohol levels cause the risk of fatal crashes to rise dramatically (table 1). For drivers under 21 years of age, the fatal crash risk increases to an even greater degree as BAC rises (Zador 1991). Alcohol consumption enhances the dangers unique to young drivers, who have less driving experience and tend to take more risks.

Table 1: Compared With Drivers Who Have Not Consumed Alcohol—

<table>
<thead>
<tr>
<th>Blood Alcohol Concentration (BAC) in This Range</th>
<th>Then Your Chances of Being Killed in a Single-Vehicle Crash Increase by</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02–0.04 percent</td>
<td>1.4 times</td>
</tr>
<tr>
<td>0.05–0.09 percent</td>
<td>11 times</td>
</tr>
<tr>
<td>0.10–0.14 percent</td>
<td>48 times</td>
</tr>
<tr>
<td>0.15 percent and above</td>
<td>380 times</td>
</tr>
</tbody>
</table>

Source: Data are from Zador 1991.
0.05 percent for drivers previously convicted for DUI, lower than the 0.08-percent limit for other drivers. Convicted drivers have their licenses reinstated on the provision that if they are caught driving with BAC's above 0.05 percent, their licenses will be immediately suspended.

A new study shows that the law significantly reduced fatal crashes involving drivers previously convicted of DUI (Hingson et al. 1998). During the 6 years after the law was enacted, the proportion of fatal crashes involving drivers previously convicted of DUI dropped by 25 percent, while it rose in the rest of New England. In addition, the proportion of crashes involving fatally injured drivers with prior DUI convictions and illegal alcohol levels declined by nearly a third. Most of the later decline was due to a reduction in alcohol-related fatalities of previously convicted drivers with BAC's of 0.15 percent or higher at the time of the fatal crash. Because of the benefits shown by this law, Maine adopted a Zero Tolerance Law for Convicted DUI Offenders in 1995.

**Treatment.** Treatment to rehabilitate DUI offenders reduces the incidence of repeat offenses by up to 9 percent compared with standard sanctions such as jail or fines, according to an analysis of research on this topic (Wells-Parker et al. 1995). Treatment strategies that combine punishment, education, and therapy with follow-up monitoring and aftercare appear to be more effective than any single approach for first-time as well as repeat offenders, according to the analysis. For example, combining treatment with a licensing action—such as suspension, revocation, or a daytime-only driving permit—was more effective than either tactic alone. In addition, weekend intervention programs that evaluate alcohol and other drug abuse and that create individualized treatment plans produced lower recidivism rates than jail, suspended sentences, or fines.

**Jail Sentences.** Although jail sentences may have some short-term deterrent effects, mandatory jail sentences tend to negatively affect court operations and the correctional process by increasing the demand for jury trials and plea bargains and by crowding jails (NHTSA 1996a). Within the past decade, Norway and Sweden abandoned mandatory jail sentences for people driving above the legal BAC limit. In both countries, traffic deaths decreased after the reforms, which raises questions about the general deterrent effects of jail sentences (Ross and Klette 1995).

**Victim Impact Panels.** A Victim Impact Panel (VIP) is a group of three or four speakers who were seriously injured or who had a loved one killed in a DUI crash. The panelists present their stories to DUI offenders with the goal of reducing DUI recidivism. In one study, the rates of repeated DUI incidents among 2,000 offenders who attended VIP's were compared with an equal number of DUI offenders who were not ordered to attend the sessions. The study included drivers matched by age and gender in two States; in Oregon those who attended a VIP had a lower rate of recidivism than those who did not, but in California no differences between the two groups were observed (Shinar and Compton 1995).

**Probation.** According to a 1996 review of sentencing options, probation may slightly reduce recidivism among drivers at low risk for being repeat offenders (NHTSA 1996a). However, probation alone does not reduce recidivism among those at high risk for another DUI citation. In one study, the effects of intensive, supervised probation involving both treatment and in-home confinement with electronic monitoring resulted in significant decreases in recidivism relative to comparison groups (Jones and Lacey 1996).

**Dedicated Detention.** Detention facilities maintained specifically for DUI offenders can offer both incarceration and supervised rehabilitation services. One program of this type, in Prince Georges County, Maryland, reduced recidivism among both first-time and repeat offenders (Harding et al. 1989).
Enforcement of Impaired-Driving Laws

The extent to which drunk driving laws are enforced can influence their impact on impaired driving. Drunk driving arrests increased dramatically between 1978 and 1983, from 1.3 to 1.9 million, but have dropped since then, to 1.5 million in 1996 (NHTSA 1998b). The general public may sense this drop in enforcement, as suggested by a 1995 national survey of 4,000 drivers. The survey respondents believed that people who drink and drive are more likely to be in a crash than to be stopped by the police (Jones and Boyle 1996).

Several studies have demonstrated that sobriety checkpoints serve not only to enforce laws, but also to deter drunk driving. In a California study, the use of sobriety checkpoints reduced alcohol-related crashes regardless of the number of officers present or the number of locations used (Stuster and Blowers 1995). In Tennessee, an extensive statewide sobriety checkpoint program was implemented from April 1994 through March 1995. More than 150,000 drivers were stopped at 900 checkpoints widely publicized on television, on radio, and in newspapers. The program yielded a 22-percent reduction in alcohol-related fatal crashes, compared with five adjacent States during the same time period (Lacey et al. 1997). Publicity appears to have been a crucial element in the effort.

Declining arrest rates may reflect the reduction in the number of intoxicated drivers on the road. Even so, plenty remain to be caught, as only one driver is arrested for every 300 to 1,000 drunk driving trips (Voas and Lacey 1988). It is also possible that arrests have dropped because public pressure has declined. An important area for future research is whether the public views the alcohol-impaired driving problem as less urgent than it did in the early 1980’s and how to sustain public concern about this major health problem.

In summary, many different legal approaches have been used in an attempt to reduce the incidence of DUI, with varying degrees of success. The NHTSA (1996a) sentencing guide identifies several other sentencing approaches that researchers have not yet systematically evaluated, including financial sanctions, publication of offenders’ names in newspapers, victim restitution programs, and court-ordered visits to emergency rooms.

Comprehensive Community Programs

Citing the long-term success of community-based approaches in confronting other public health problems, the Institute of Medicine of the National Academy of Sciences has recommended comprehensive, multistrategy community interventions to reduce alcohol-related problems (Institute of Medicine 1989). One program is described below; a more comprehensive discussion of recent community programs can be found in the section “Community-Based Prevention Approaches” later in this chapter.

In Massachusetts, the Saving Lives Program began in March of 1988 in six cities that had a combined population of 318,000 (Hingson et al. 1996b). The communities not only attempted to reduce alcohol-impaired driving, but also targeted other risky driving behaviors in which alcohol-impaired drivers are more likely to engage, such as speeding, running red lights, not yielding to pedestrians in crosswalks, and not wearing seat belts.

In each of the six cities, a full-time coordinator from the mayor’s or city manager’s office organized a task force of concerned private citizens, organizations, and officials representing various city departments, such as education, health, police, and recreation. Active membership in these task forces ranged from 20 to more than 100 individuals, and included an average of 50 organizations. For funding, each community received about $1 per resident annually from the program.

To reduce drunk driving and speeding, the communities introduced media campaigns, business information programs, speeding and drunk driving awareness days, speed watch telephone hot lines, police training, high school peer-led education, Students Against Drunk Driving chapters, college prevention programs,
alcohol-free prom nights, beer keg registration, and increased liquor outlet surveillance. To increase pedestrian safety and seat belt use, the communities conducted media campaigns and sobriety checkpoints, posted crosswalk signs warning motorists of fines for failure to yield to pedestrians, added crosswalk guards, and offered education programs for preschool children and training for hospital and prenatal clinic staff.

Fatal crashes in these six cities decreased 25 percent compared with the rest of the state, dropping from 178 in the 5 years before the program to 120 during the 5 program years. Fatal crashes involving alcohol declined by 42 percent, from 69 to 36, and fatally injured drivers with positive BAC’s dropped 47 percent, from 49 to 24. Visible injuries per 100 crashes declined 5 percent, from 21 to 17. The program also cut in half both the proportion of vehicles observed speeding and the proportion of teenagers who reported driving after drinking.

The results from this and other programs indicate that comprehensive community initiatives that combine the forces of multiple city departments and private citizens can reduce driving after drinking, related driving risks, and traffic deaths and injuries. A major question is whether these changes can be sustained without support from initial funding sources.

Alcohol Control Policies

In addition to laws that seek to deter drinking and driving, a number of laws and policies have attempted to reduce alcohol-related driving deaths by controlling the availability of alcohol as a means of discouraging drinking, particularly among persons under 21. Among the actions described below are raising taxes on alcoholic beverages, mandating training of alcoholic beverage servers, restricting sales through government-run monopolies, and limiting the number and location of alcohol outlets.

Taxes

Studies have consistently found that increases in beer taxes are linked with lower rates of alcohol-related traffic fatalities (Chaloupka 1993; Cook 1981; Saffer and Grossman 1987a,b). One recent study found, for example, that for every 1-percent increase in the price of beer, traffic fatality rates would be expected to drop by nearly the same proportion, or 0.9 percent (Ruhm 1996). The study found that higher beer taxes are linked most strongly with lower rates of traffic fatalities that occur at night or among those aged 18 through 20.

Another recent study questioned the reliability of the estimated relationship between taxes and traffic fatality rates (Dee 1999). The results showed that the effect on daytime fatalities, although smaller than the effect on nighttime fatalities by about one-fourth, was still statistically significant and of substantial magnitude. The researcher found this result implausible, because alcohol is far more likely to be involved in nighttime fatalities than daytime fatalities.

Results of one study suggested that raising alcoholic beverage prices may have little effect on consumption by the most heavily drinking persons (Manning et al. 1995). The findings showed that the most heavily drinking individuals (the top 5 percent of drinkers in terms of consumption) were significantly less likely than more moderate drinkers to alter their consumption in response to price changes. Although the study showed no significant effects of price changes on consumption among the most heavily drinking persons, it found significant responsiveness to prices among drinkers up through the 90th percentile of consumption levels, with the greatest responsiveness found among drinkers at the 50th percentile.

Estimates of lives saved help to give a concrete picture of the effects of higher alcohol taxes. In estimating the potential effects of the 1991 national alcohol tax increase, one research team started by analyzing motor vehicle fatalities in the 48 contiguous States from 1982 to 1988 (Chaloupka 1993). The investigators estimated that had the tax of 33c per six-pack been in effect throughout that period, 1,744 fewer people would have died each year, of whom 671 would have been 18- to 20-year-olds.
Moreover, if the beer tax had been set higher, at 81¢ per six-pack from 1982 to 1988 (based on a tax of 25¢ per ounce of pure alcohol), the researchers estimated that 7,142 fewer people of all ages would have been killed in traffic crashes each year. Of this number, 2,187 would have been youths and young adults. These estimates suggest that raising the tax on alcohol could have saved the lives of considerably more 18- to 20-year-olds than can be attributed to setting the minimum legal drinking age to 21. (See also the discussion in the section “Effects of Changes in Alcohol Prices and Taxes” in the chapter on economic and health services perspectives.)

Server Training, Sanctions, and Liability

When legally impaired drivers take to the road, they are more likely to have just left a bar or restaurant than any other single departure point (McKnight 1993). Between one-third and one-half of intoxicated drivers consumed their last alcoholic beverage at these locations, as reported by drivers in roadside surveys (Palmer 1988; Foss et al. 1990). Breath tests given to patrons leaving bars indicate that about one-third have BAC’s above the legal limit (Stockwell et al. 1992; Werch et al. 1988). These findings point to a need for server training programs to help waiters, waitresses, and bartenders to avoid serving alcohol to people who are already intoxicated, as well as manager training to focus additionally on service policies.

During the 1980’s, when server training programs proliferated, some communities and States made training a condition of licensing. Evaluations of these programs produced mixed results, but some studies show that such training can modify serving practices to help reduce the rate and amount of alcohol consumed by patrons. After training, servers usually are more likely to intervene with intoxicated customers (Geller et al. 1987; McKnight 1987) and in some instances, patrons have lower BAC’s (Hennessy and Saltz 1990; Saltz 1987).

As a result of a server training law passed in Oregon in 1985, some 36,000 servers and 6,000 owner-managers completed a State-approved training course by the end of 1988. All beverage service license holders in the State had completed training by 1991, and 13,000 new servers receive training each year. In the first 6 months of the law, single-vehicle, nighttime crashes likely to involve alcohol decreased by 4 percent (Holder and Wagenaar 1994). This crash rate dropped by a total of 11 percent after the first year, 18 percent after the second year, and 23 percent at the end of the third year. Unfortunately, the researchers did not have direct evidence of changes in alcohol server behavior, although 68 percent of those who completed the course self-reported changes in their behavior (Holder and Wagenaar 1994). Therefore, it is difficult to assess whether all of this substantial 23-percent reduction can be directly attributed to this specific legislation.

All States have either criminal or civil sanctions against serving patrons who are obviously intoxicated; active enforcement of these laws can enhance the effects of server training laws. As one example, after introduction of an enforcement effort in Washtenaw County, Michigan, investigators found that refusals of alcohol service to “pseudo-patrons” (people hired by the researchers to simulate intoxication) rose from 18 to 54 percent (McKnight and Streff 1994). In addition, the percentage of people arrested for drunk driving who had come from bars declined by 25 percent.

All but seven States recognize some form of server liability. These regulations permit individuals to sue for damages incurred as a result of service to a minor or intoxicated patron. In an analysis of the effects of a variety of public policies on mortality rates by State and year, researchers found that server liability laws significantly reduced traffic mortality rates, while mandatory minimum jail sentences and fines did not (Sloan et al. 1994).

State Monopoly Versus Privatized Sales Outlets

Eighteen States have some form of monopoly control over the sale of alcoholic beverages, which influences both the availability and price of alcohol. Compared with States that issue licenses to private retail sellers, in monopoly
Reducing Alcohol-Impaired Driving

states spirits are less available, beer is more available, and alcoholic beverages cost more (Gruenewald et al. 1993).

Relatively little research has examined the effect of State-regulated alcohol sales on alcohol use or related problems. One study documented that a State policy change regarding sales was associated with a significant increase in alcohol-related crashes and single-vehicle, nighttime crashes (Blose and Holder 1987; Holder and Blose 1987). Both types of crashes rose 16 to 24 percent after North Carolina allowed the sale of spirits by the drink in bars and restaurants instead of requiring spirits to be purchased by the bottle at markets and other off-site establishments.

The conversion of Iowa and West Virginia from monopoly to license States resulted in increased sales of alcoholic beverages in both States (Holder and Wagenaar 1990; Wagenaar and Holder 1991). Unfortunately, these analyses did not examine the effect of increased sales on alcohol-related traffic crashes.

Outlet Density

More than a decade ago, researchers established the connection between the density of outlets in an area and fatal traffic crashes (Dull and Giacopassi 1988). The investigators examined alcohol control regulation and outlet density in 95 counties of Tennessee. After controlling for population size, urbanization, and race, they found that both higher outlet density and the absence of restrictions on alcohol sales were associated with increased motor vehicle mortality.

More recently, another research team reported that regions with greater outlet density and higher ratios of outlets to people had higher alcohol sales (Gruenewald and Ponicki 1995). In this study, a 10-percent increase in outlet density resulted in a 4-percent increase in sales of spirits and a 3-percent increase in sales of wine. This team also analyzed crash data from 38 States over 12 years and found that the rates of single-vehicle, nighttime fatal crashes were more strongly related to sales of beer than to sales of spirits and wine. In addition, they explored the question of whether reducing outlet density might lead to increases in fatal crashes as a result of people driving further to obtain alcohol. The researchers found that reductions in the availability of alcohol did not appear to increase the fatal crash rate.

Individual Actions

Designated Drivers

The use of designated drivers has been widely promoted in the United States since 1988, when Jay Winsten at the Harvard School of Public Health initiated a national campaign with the television industry. For 6 years, more than 160 prime-time U.S. television networks, with audiences of 45 million people, showed subplots, scenes, and dialogue in their regular programs as well as 30- and 60-minute episodes supporting the designated driver campaign. The major networks, ABC, NBC, and CBS, also aired public service messages promoting the designated driver concept (Winsten 1994).

Two Roper Organization surveys (1991) showed strong recognition and acceptance of the concept: 93 percent of Americans thought the use of designated drivers was an excellent or good idea, and 46 percent of drinkers reported being a designated driver in 1991 versus only 35 percent in 1987. However, recent national surveys (Voas et al. 1997) revealed a drop from 42 percent in 1993 to 39 percent in 1995 in the percentage of drivers 16 through 64 years of age who said they had been a designated driver. Whether this change reflects reductions in drinking is not clear.

In 1996, the National Roadside Survey stopped drivers at 211 locations in 24 cities or counties on weekend nights, when drinking is most likely to occur. Of the 6,480 drivers stopped, nearly all of whom were breath tested, 24.7 percent reported being designated drivers (Fell et al. 1997). This is a sharp increase from 5 percent who were self-reported designated drivers in a similar survey in 1986 (Lund and Wolfe 1991).

In the 1996 study, most of the designated drivers (82 percent) had BAC's between zero and 0.02 percent. In all, about a third of
designated drivers consumed some alcohol before driving, but most (95 percent) remained at BAC's below the legal limit of 0.08 percent. Also of note in this study, a far greater proportion of non-designated drivers left bars with BAC's of greater than 0.10 percent, compared with designated drivers (8.0 percent of non-designated drivers vs. 1.5 percent of designated drivers).

Whether or not the impaired, non-designated drivers in this study had passengers in their vehicles was not reported. It is quite possible that passengers in vehicles driven by a "designated driver" who has a BAC of 0.08 percent are generally unaware that the driver has consumed that much alcohol. It may be particularly difficult for passengers who themselves have been drinking heavily to discern whether the designated driver has been drinking excessively too.

One recent study of 109 injured pairs of drivers and passengers at a trauma center revealed that more than 4 in 10 drivers and passengers had positive BAC's (Soderstrom et al. 1996). In nearly two-thirds of cases when alcohol had been consumed by the driver, a passenger, or both, the person with the higher BAC was driving.

Thus, many more people now use designated drivers, and most designated drivers in roadside surveys do not exceed the legal BAC limit. However, designated drivers who do exceed the legal limit, like any driver who does so, are at greater risk of crashing. Rather than protecting their passengers, these designated drivers endanger them.

Personal Interventions To Reduce Alcohol-Impaired Driving

Few studies have examined the effectiveness of personal interventions to dissuade impaired people from driving. One recent study of young men who drink heavily, however, found that personal interventions, particularly by wives or girlfriends, can have a high degree of success (Kennedy et al. 1997).

The research team surveyed a random sample of 730 men aged 21 through 35 from areas of the country where a disproportional number of fatal alcohol-involved crashes had occurred. More than half of these men reported having been the target of an intervention to prevent them from drinking and driving. Of the respondents, 41 percent had consumed 10 or more drinks, and another 40 percent had consumed 6 to 10 drinks. Those who intervened were usually friends (51 percent) or wives or girlfriends (36 percent). Most of the respondents (85 percent) reported that the most recent intervention prevented them from driving after drinking. Those who consumed 10 or more drinks were most likely not to drive, and wives or girlfriends were most successful in preventing drinking and driving.

A smaller college survey in California revealed that 73 percent of interventions prevented impaired driving among that population. Assertive interventions were more likely than passive ones to achieve success. Generally, the older and more sober the person who was intervening, the greater the likelihood of success (Newcomb et al. 1997). Systematic programs to increase personal intervention behavior have not been tested, and they warrant consideration.

Safety Belt Laws

People who drive after heavy drinking and passengers who ride with heavily drinking drivers are less likely to wear safety belts, according to studies conducted by observations (Foss et al. 1994) and telephone interviews (Hingson et al. 1996b). Both of these studies found that legally intoxicated drivers are about one-third less likely to wear seat belts than are other drivers.

The use of safety belts reduces the risk of crash fatality and serious injury requiring hospitalization by 45 to 50 percent (Voas et al. 1997c). However, laws enforcing the use of safety belts have not had that much additional impact, as they reduce injuries and fatalities by only 5 to 10 percent (Campbell and Campbell 1988). One important reason for these smaller than anticipated effects is...
that the people most likely to be involved in traffic crashes, such as young males who drive after drinking, have been significantly less responsive to safety belt use laws (Dee 1998). Efforts to combine safety belt laws and drunken driving law enforcement should be considered, particularly in “primary” safety belt law States where police can stop motorists simply because they are not wearing safety belts. Such strategies may hold promise both in reducing driving after drinking and increasing safety belt use.

In Closing

While the overall reduction in alcohol-related traffic deaths since 1982 is a remarkable achievement, progress has slowed in recent years. The current level of 16,000 deaths and more than 1 million injuries in alcohol-related traffic accidents each year demonstrates the need for continuing attention to this major public health problem. Further reductions could be achieved if all States adopted ALR, Zero Tolerance laws for youth, 0.08-percent “criminal per se” laws for adults, and mandatory treatment, if needed, for convicted offenders. These laws would have the greatest benefits if they were actively publicized and enforced at the community level through checkpoints and comprehensive community programs that involve multiple city government departments, organizations, and private citizens.

In the early 1980’s, the formation of citizen groups like Mothers Against Drunk Driving reflected a sense among the public that private citizens could participate in identifying more effective solutions to the problem of drinking and driving. Indeed, many important legislative reforms at the State level were enacted. Stimulating public concern and developing new ways to engage private citizens to work with local government departments will be key challenges for the next decade.

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Chapter 7: Prevention Research


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