57. Counseling to Prevent Motor Vehicle Injuries

RECOMMENDATION

Counseling all patients, and the parents of young patients, to use occupant restraints (lap/shoulder safety belts and child safety seats), to wear helmets when riding motorcycles, and to refrain from driving while under the influence of alcohol or other drugs is recommended (see ***Clinical Intervention***). There is currently insufficient evidence to recommend for or against counseling patients to prevent pedestrian injuries. See Chapter 58 for recommendations on the prevention of bicycling injuries.

Burden of Suffering

In 1993, motor vehicle crash-related injuries were the eighth leading cause of death in the U.S.[1] Motor vehicle injuries are a leading cause of death in children and young adults,[2] and the leading cause of years of potential life lost before age 65.[3] A total of 40,115 Americans died in motor vehicle crashes in 1993 (15.6/100,000 population), and more than 3 million suffered nonfatal injuries (1,212/100,000).[4] Over 3,200 of those killed were children under age 16 years.[4] In the same year, 2,444 motorcycle occupants were killed.[4] The motorcycle occupant fatality rate is nearly 20 times higher than for passenger car occupants (25.1 vs. 1.3/100 million vehicle miles traveled).[4] More than 5,600 pedestrians were also killed in 1993 (2.2/100,000).[4] The annual number of motor vehicle fatalities has decreased since the late 1960s, despite an increase in annual number of vehicle miles traveled.[5] Motor vehicle crashes during 1990 resulted in an estimated total lifetime economic cost of $137.5 billion.[6] They account for about one-third of the total lifetime cost of injury in the U.S.[7]

Motor vehicle fatality rates are highest for young and elderly adults, while injury rates peak in young adulthood.[1,4] In 1992, motor vehicle crashes accounted for 30% of all deaths in persons aged 15–24.[1] The high mortality rate in older adults reflects a high case-fatality rate, probably due to increased likelihood of developing serious complications after motor vehicle injuries, as drivers 65 years of age and older have the lowest rate of crashes per 100,000 licensed drivers.[4,8,9] Motor vehicle fatality rates for males are more than twice that for females.[1,4] Although alcohol-related

traffic fatality rates have declined by more than one third since 1979,[10] alcohol use remains an important risk factor for motor vehicle injuries. An estimated 17,461 persons were killed in alcohol-related motor vehicle crashes in 1993, accounting for 44% of total traffic fatalities for the year.[4] About one third of drivers killed in crashes in 1993 were intoxicated by alcohol (typically defined in U.S. law as blood alcohol concentration [BAC] ≥ 0.10 g/dL).[4] The proportion of fatally injured drivers having BAC above 0.10 g/dL is highest for those aged 21–44.[4] In 1992, 1.6 million persons were arrested for driving under the influence of alcohol or drugs.[11] Alcohol-involved crashes have been estimated to account for 40% of comprehensive motor vehicle crash costs in the U.S.[12]

Efficacy of Risk Reduction

Driving while impaired by alcohol or drugs and failing to use occupant protection (e.g., safety belts, child safety seats, motorcycle helmets) are two of the most important risk factors for motor vehicle injury. (Screening for potential impairment due to medical conditions such as diabetes or epilepsy will not be addressed in this chapter.[13,14]) Case series have reported that up to half of fatally injured drivers have BAC of 0.10 g/dL or higher (although the proportion has declined in recent decades).[4,9,15] Controlled studies have shown that drivers involved or injured in crashes are more likely to have a BAC of at least 0.10 g/dL than are other drivers.[16–18] BAC at or below 0.05 g/dL are also associated with impaired driving skills performance and an increased risk of motor vehicle crash involvement and fatality, particularly for younger drivers.[19–22] In addition to its role as a risk factor for causing motor vehicle crashes, alcohol use may increase the risk of death or serious injury during a crash;[23,24] this association may be partially confounded by other high-risk behaviors associated with alcohol use, such as failing to use safety belts and motorcycle helmets.[25–27] Alcohol can also limit the ability of the victim to escape from the vehicle.[15,23] Alcohol-intoxicated survivors with severe brain injuries appear to have longer hospitalizations and more persistent neurologic impairment than those who were not intoxicated.[28] Evidence that reducing drinking and driving decreases the risk of motor vehicle injury comes from multiple time series studies demonstrating that raising the legal drinking age or lowering legal blood alcohol limits can significantly reduce alcohol-related fatal crashes.[29–33]

Many alcohol-related motor vehicle crashes may be attributable to problem drinkers. Persons dying in alcohol-related traffic crashes are significantly more likely to have alcohol-related arrest histories or autopsy findings suggestive of alcoholism.[4,34–36] In a cohort of Swedish men followed for 20 years, the relative risk of dying in a traffic crash among heavy drinkers was 2.3 times higher than for moderate drinkers and 8 times

higher than for nondrinkers.[37] One study has also suggested that alcoholic drivers, when compared to the general driving population, have more motor vehicle crashes per capita and per vehicle mile driven and more frequent convictions for impaired driving.[38] Screening for problem drinking followed by a brief counseling intervention has been proven to reduce alcohol consumption (see Chapter 52). Therefore, such screening is likely to be efficacious in reducing motor vehicle injuries and fatalities.

It has been estimated that drugs (such as marijuana, cocaine, and tranquilizers) may be present in 10–32% of drivers injured in traffic crashes,[39–43] although not all studies have been able to separate the effects of these drugs from those of alcohol and the presence of such drugs does not necessarily indicate impairment. In case series that tested drivers injured in traffic crashes for both substances, almost half who tested positive for illicit drugs had negative BAC.[41–43] One study evaluated 175 consecutive subjects stopped by police for reckless driving who were not felt to be alcohol-impaired based on a negative breath analysis, lack of odor of alcohol, or both.[44] Urine testing was performed on 150 (86%), of whom 88 (59%) tested positive for marijuana, cocaine, or both, while 5% tested positive for alcohol. Whether the illicit drugs caused reckless driving, or were simply associated with it in persons disposed to multiple high-risk behaviors, is not established. Simulated driving tests suggest impairment of certain abilities by marijuana and other drugs, similar to that produced by alcohol.[45–47] Thus, evidence indicates that impairment with drugs other than alcohol may also play an important role in traffic injuries and deaths, although the relationship is not as well defined as for alcohol.

Use of occupant restraints has been shown to reduce the risk of motor vehicle injury and death. The efficacy of safety belts has been demonstrated in a variety of study designs that include laboratory experiments (using human volunteers, cadavers, and anthropomorphic crash dummies), postcrash comparisons of injuries sustained by restrained and unrestrained occupants, and postcrash judgments by crash analysts regarding the probable effects of restraints had they been used.[48–53] It has been estimated on the basis of such evidence that the proper use of lap and shoulder belts can decrease the risk of moderate to serious injury to front seat occupants by up to 55%[49,53,54] and can reduce crash mortality by 40–50%.[53,54] When brought to the hospital, crash victims who were wearing safety belts at the time of the crash have less severe injuries, are less likely to require admission, and have lower hospital charges.[50,52] Multiple time series studies evaluating mandatory seat belt laws have reported significant reductions in motor vehicle-related injuries, hospital admissions, and fatalities after implementation of such laws.[55–59]

Child safety seats are also effective. It has been reported that unrestrained children are over 10 times as likely to die in a motor vehicle crash

as are restrained children,[60,61] although these data come from studies with important design limitations. More recent studies suggest that child safety seats can reduce serious injury by up to 67% and mortality by as much as 71%.[62–64] A 20–25% decline in head and extremity injuries for children under age 4 has been reported in States after enactment of mandatory child restraint legislation.[65] Child restraints may also reduce noncrash injuries (e.g., those due to sudden stops) to child passengers by preventing both falls within the vehicle and ejections.[66] The efficacy of child safety seats may be reduced by improper use; such misuse has been reported in up to two thirds of children.[67] The safety of child safety seats used in combination with air bags is unknown. Laboratory crash test data indicate a potential for injury to an infant placed in a rear-facing car seat in the front seat of a vehicle equipped with a passenger-side air bag.[68]

Beginning with the model year 1998, all new passenger cars in the U.S. will be required to have driver- and passenger-side air bags.[69] A review by the National Highway Traffic Safety Administration estimated that air bags increase the effectiveness of lap/shoulder belts by about 5–10%.[70] Recent modeling[71] and observational[72] studies estimate that air bags prevent 18–19% of all automobile driver fatalities and 13% of right front passenger fatalities, over and above the fatality reduction due to seat belt use. The estimated reduction in driver fatalities was about 21% for unbelted drivers and 9% for belted drivers.[72] Air bags are designed to be a supplemental restraint system, and they do not deploy in low-speed, rear, side, or rollover crashes. Most reported adverse effects of air bag deployment are minor (e.g., erythema, abrasions, and contusions), although more serious injuries such as facial fractures have also been reported.[73,74]

By wearing safety helmets, persons who operate or ride on motorcycles can reduce their risk of injury or death from head trauma in the event of a crash. Head injury rates are reduced by about 40–75% among motorcyclists who wear safety helmets.[75–77] Multiple time series studies have reported that rates of fatal and nonfatal injuries have declined significantly in states that have passed mandatory helmet laws.[9,78–81] In one large study, a motorcycle helmet use law was associated with a 37.5% reduction in fatalities (from 523 in 1991 to 327 in 1992), a 26.5% reduction in motorcycle fatality rates (from 70.1 to 51.5/100,000 per year), and similar reductions in admitted and emergency department-treated riders with motorcycle crash injuries.[82] Observed helmet use during the first year of the law was over 99%, compared to 46% helmet usage before the law.[83] States that have repealed mandatory motorcycle helmet laws have experienced significant increases in motorcycle fatalities.[75,84]

The epidemiology of pedestrian injury varies by age group. Child pedestrian injuries most often occur close to home and the majority of events involve children darting out into traffic at mid-block.[85,86] Risk fac-

tors for child pedestrian injury are being male and age 5–9 years,[4] presumably due to both increased exposure and developmentally related limitations in pedestrian skills.[85,87] In a population-based New Zealand study, child pedestrian injury hospitalization rates were 1.7/1 million road crossings and 72/100,000 population at age 5 years, declining to about 0.6 and 40, respectively, by age 9 years with little change thereafter.[88] One of the most important risk factors for adult pedestrian injury is alcohol intoxication. In 1993, 36% of fatally injured pedestrians over 14 years of age had BAC of at least 0.10 g/dL.[88a] Elderly persons have the highest pedestrian death rate, despite studies showing that they may exhibit the most cautious street-crossing behavior.[89,90] Reduced mobility[91] and sensory deficits associated with aging may contribute to their increased risk. As with motor vehicle crash injuries, however, the high death rate in elderly persons to a large extent reflects a high case-fatality rate.

There is no evidence to date that changes in any of the risk factors for the different age groups reduces pedestrian injury. Studies have shown that parents of young children may overestimate the pedestrian skills of their children, implying that teaching parents about developmental limitations on pedestrian skills might decrease injuries.[92,93] Observational studies suggest that pedestrian visibility affects the risk of motor vehicle-pedestrian crashes.[94,95] Several small experiments have reported that wearing reflective or brightly colored clothing increases pedestrian visibility and motorists' yielding to pedestrians,[96–98] but these studies have important design limitations. Whether wearing such clothing would reduce the risk of pedestrian injury has not been studied.

Effectiveness of Counseling

Although the rate of alcohol-related driver fatalities has decreased in recent years, as many as 1.6 million persons continue to be arrested annually for driving under the influence of alcohol or other drugs;[11] this substantially underestimates the total number of persons who drive while impaired, since only a small proportion are arrested.[98a] Similarly, while the use of occupant protection systems and motorcycle helmets has increased substantially in recent years,[69,99–101] at least half of all Americans, and presumably many patients seen by clinicians, either do not use occupant restraints or do not use them correctly when driving or riding in a motor vehicle. Thus, it is likely that many patients could potentially benefit from clinician counseling to modify their behaviors as drivers and passengers in motor vehicles. Since motor vehicle crashes represent a leading cause of death and nonfatal injury in the U.S., even modest successes through clinical interventions could have major public health value.

In actual practice, however, little is known about how effectively clini-

cians can alter any of these behaviors. Although there is some evidence that persons involved in motor vehicle crashes while intoxicated demonstrate lower recidivism with alcohol treatment interventions[102] and that community-based educational interventions to reduce alcohol-impaired driving may be effective,[103] there is generally little information from clinical studies on the ability of clinicians to influence patients to refrain from driving while impaired by alcohol or other drugs. There is good evidence, however, that brief clinician counseling can reduce alcohol consumption in problem drinkers (see Chapter 52), which may, in turn, result in reduced drinking and driving.

There have been few studies examining the effectiveness of clinician counseling to increase safety belt use. Most of the available studies have evaluated counseling parents to increase seat belt use by their children.[104] One controlled trial found increased self-reported safety belt use with pediatrician counseling compared to mailed information; the interval to outcome assessment was not specified.[105] A second trial found that pediatrician counseling resulted in an immediate increase in observed safety belt use, but there was no difference in self-reported usage rates between the study group and controls at 1-year follow-up.[106] In the same study, however, observed seat belt use was highly correlated with the physician's own estimate of the proportion of visits during which he counseled parents about seat belts.[106] A nonrandomized controlled trial involving adult patients evaluated the effect of improved physician delivery of clinical preventive services after an intervention that included physician training, physician use of prevention protocols, and reimbursement for counseling.[107] The proportion of patients reporting that they "began always using seat belts" was significantly higher in the intervention group at 1-year follow-up. In a questionnaire survey, patients claimed to have increased their use of safety belts as a result of a brief statement by their physician during a routine office visit,[108] but the study lacked controls and may have been biased by the patients selected. Other measures that have been proven successful in motivating persons to use safety belts, such as community educational programs and intensive psychological strategies,[109] may not be generalizable to the clinical practice setting.

Stronger evidence that clinician counseling can be effective comes from randomized and other controlled trials in which parents of newborns and infants were encouraged to use infant safety seats before this practice became widely mandated by law. These trials often used other types of interventions in addition to clinician counseling, including written materials, videos, or free or loaner car seats. Results from such trials indicate that significant immediate or short-term (up to 3 months) improvements in car seat use are possible.[110–118] One randomized controlled trial involving parents of children ages 1–17 years found no effect of clinician counseling and

additional interventions on the use of occupant protection,[119] but most of the children were already using restraints prior to the intervention.

The long-term efficacy of clinician counseling is less clear. One randomized controlled trial in a military population showed increased reported car seat use at 9–12 months and increased car seat sales for 10 months after the intervention,[112] but in several other trials that included clinician counseling, significant immediate or short-term increases in car seat use were not maintained at longer follow-up.[113,116–118] A time series study in which nurses conducted educational sessions in the prenatal period, postpartum period, and at 2-month intervals after discharge found that proper use of child safety seats had improved compared with rates in the previous year, suggesting that periodic reinforcement is necessary to maintain high use rates.[120]

Direct evidence that physician counseling combined with community education programs can reduce motor vehicle-related injuries to young children comes from a nonrandomized controlled trial.[121] This trial reported a 54% decrease in motor vehicle-related injuries among children aged 0–5 living in the intervention communities compared to children in the control communities, despite no difference in self-reported overall restraint use. In a separate analysis in which persons in both communities were combined, reported car seat use was 12% higher in households exposed to "participatory" prevention programs (i.e., received specific counseling, materials, or other interventions), compared to those not exposed. Persons in the intervention communities were significantly more likely to have such "participatory" exposure than were those in control communities (55% vs. 34%). The authors were unable to distinguish between the effects of the various interventions; a similar proportion of subjects reported exposure to pediatrician counseling (21%) and to community education programs (17%).

Studies of the effectiveness of school-based programs to teach pedestrian skills to children have shown some improvement in their attitudes and skills,[122–124] and one researcher has reported reductions in child pedestrian crash involvement through safety education films and other materials.[125,126] There is no evidence to indicate whether or not such interventions are generalizable to the clinical setting.

Recommendations of Other Groups

Mandatory safety belt laws were in effect in 43 states, the District of Columbia, and Puerto Rico in 1993.[4] Child safety seat use is required by law in all 50 states, the District of Columbia, and Puerto Rico.[4] Recommendations specifically urging clinicians to counsel patients to use occupant restraints (child safety seats or fitted lap/shoulder belts, as appropriate for age) have

been issued by a number of groups. These include the American Medical Association,[127,128] the American College of Physicians,[129,130] the American Academy of Family Physicians (AAFP),[131] the American Academy of Pediatrics (AAP),[132] the Bright Futures project,[133] the American College of Obstetricians and Gynecologists,[134] the Canadian Task Force on the Periodic Health Examination,[135] the Public Health Service,[135a] and the National Highway Traffic Safety Administration.[136] The AAP has instituted special parent-oriented educational programs ("Every Ride, Safe Ride") in which pediatricians encourage the use of child occupant protection beginning with the ride home from the hospital and continuing throughout childhood.[137] The AAP, Centers for Disease Control and Prevention, and the Society of Automotive Engineers recommend against the use of rear-facing child restraints in the front seat of cars with passenger-side air bags.[68]

In 1993, twenty-five states, the District of Columbia, and Puerto Rico had universal motorcycle helmet laws; an additional 22 states required only that persons under a specified age (usually 18) wear a helmet.[138] The AAFP,[131] the AMA,[128,139] and Bright Futures[133] recommend that physicians counsel their patients who are motorcyclists to use approved helmets. The Canadian Task Force found insufficient evidence to recommend for or against counseling patients to wear motorcycle helmets.[135]

In 36 states and the District of Columbia, driving a motor vehicle with a BAC of 0.10 g/dL is a criminal offense; in 10 states, the limit is 0.08 g/dL.[4] In addition, all states prohibit the purchase of alcohol by persons under the age of 21.[140] The AAP,[141] the AAFP,[131] the AMA,[128] Bright Futures,[133] and the Centers for Disease Control and Prevention[142] recommend counseling patients to abstain from intoxicants when driving. The AAP also advises parents and children to discuss the use of alcohol at teen parties, and suggest alternatives to driving while intoxicated or riding in a vehicle operated by an intoxicated driver.[141] The Canadian Task Force found insufficient evidence to recommend for or against counseling patients to avoid drinking and driving.[135]

Bright Futures and the AAP recommend teaching pedestrian safety to children.[132,133]

Discussion

There is good evidence that persons who use occupant protection devices or avoid driving while alcohol or drug impaired are at significantly decreased risk of injury or death from motor vehicle crashes. The evidence is less extensive that counseling by clinicians to adopt these practices is effective in changing the behavior of motorists or passengers. Since motor vehicle injury represents one of the leading causes of death in the U.S. and years of potential life lost, however, interventions of even modest effec-

tiveness are likely to have enormous public health benefit. Most of the available evidence supports a relatively short-term effect of clinician counseling on the use of occupant restraints, indicating the need for periodic reinforcement of this message.

There is little published evidence evaluating whether changing pedestrian behavior leads to reductions in motor vehicle-related injuries or whether clinician counseling can influence pedestrian behavior. Further study is also needed on environmental controls (e.g., barriers that prevent pedestrians from crossing in the middle of dangerous roadways) that have the potential to reduce pedestrian injuries.

CLINICAL INTERVENTION

Clinicians should regularly urge their patients to use lap/shoulder belts for themselves and their passengers, and for their children who have outgrown safety seats, whenever driving or riding in an automobile, including automobiles equipped with air bags ("A" recommendation for wearing seat belts; "B" recommendation for counseling). Operators of vehicles carrying infants and toddlers should be urged to install and regularly use federally approved child safety seats in accordance with the manufacturer's instructions and the child's size ("A" recommendation for child safety seat use; "B" recommendation for counseling parents). Passengers should not ride in the cargo beds of pickup trucks. Passengers also should not ride in the cargo areas of station wagons or vans except when those areas are fitted with passenger seats and passengers are properly restrained in them with seat belts or child safety seats as appropriate for age. Clinicians may wish to inform their patients of the effectiveness of air bags as a supplement to lap/shoulder belt use in reducing motor vehicle crash-related morbidity and mortality. Rear-facing infant seats should not be placed in the front seat of a car equipped with a passenger-side air bag. Although forward-facing infant seats can be used in this situation, clinicians may wish to inform parents that the safest seating position in the car is the middle of the rear seat. Those who operate or ride on motorcycles should be counseled to wear approved safety helmets; this recommendation is based on the proven efficacy of risk reduction from wearing helmets ("A" recommendation), although the effectiveness of clinician counseling to increase helmet use has not yet been evaluated ("C" recommendation). Recommendations for bicyclists appear in Chapter 58.

All patients should be counseled regarding the dangers of operating a motor vehicle while under the influence of alcohol or other drugs, as well as the risks of riding in a vehicle operated by someone who is under the influence of these substances. This recommendation is based on the proven efficacy of risk reduction ("A" recommendation) and the effectiveness of

counseling problem drinkers to reduce alcohol consumption ("B" recommendation) (see Chapter 52); the effectiveness of counseling patients to avoid drinking and driving has not been evaluated ("C" recommendation). Adolescents and young adults in particular should be encouraged to avoid using alcohol or other drugs when driving is anticipated and to discuss with their families transportation alternatives for social activities where alcohol and other drugs are used (also see Chapters 52 and 53). The optimal frequency for counseling patients about motor vehicle injury has not been determined and is left to clinical discretion. Counseling is most important for those at increased risk of motor vehicle injury, such as adolescents and young adults, persons who use alcohol or other drugs, and patients with medical conditions that may impair motor vehicle safety.

There is currently insufficient evidence to recommend for or against counseling patients or their parents in order to reduce pedestrian injuries ("C" recommendation). Recommendations for such counseling for elderly patients and for the parents of school-age and younger children may be made on other grounds, including high burden of suffering, low cost, and lack of adverse effects. One measure that may reduce pedestrian injury risk is wearing brightly colored or reflective clothing to increase visibility to motorists. Educating parents to recognize the developmental limitations on the pedestrian skills of young children and provide appropriate supervision in situations that place children at risk for pedestrian injuries may also be effective in reducing pedestrian injury risk. Although there is insufficient evidence to recommend for or against counseling regarding problem drinking and alcohol use specifically to prevent pedestrian injury ("C" recommendation), such counseling can be recommended on other grounds (see Chapter 52).

The draft update of this chapter was prepared for the U.S. Preventive Services Task Force by Natalie Smith, MD, MPH, and Carolyn DiGuiseppi, MD, MPH.

REFERENCES

1. National Center for Health Statistics. Annual summary of births, marriages, divorces, and deaths: United States, 1993. Monthly vital statistics report; vol 42, no 13 (suppl). Hyattsville, MD: Public Health Service, 1994.
2. National Highway Traffic Safety Administration. Traffic safety facts 1993. Washington, DC: Department of Transportation, 1994. (Publication DOT HS 808 169.)
3. Desenclos JA, Hahn RA. Years of potential life lost before age 65, by race, Hispanic origin, and sex—United States, 1986–1988. MMWR 1992;41(SS-6):13–23.
4. National Highway Traffic Safety Administration. Traffic safety facts 1992: a compilation of motor vehicle crash data from the Fatal Accident Reporting System and the General Estimates System. Washington, DC: Department of Transportation, 1994. (Publication DOT HS 808 022.)
5. Centers for Disease Control and Prevention. Deaths resulting from firearm- and motor-vehicle-related injuries—United States, 1968–1991. MMWR 1994;43:37–42.
6. Centers for Disease Control and Prevention. Economic impact of motor-vehicle crashes—United States, 1990. MMWR 1993;42:443–448.

7. Max W, Rice DP, MacKenzie EJ. The lifetime cost of injury. Inquiry 1990;27:332–343.
8. Barr RA. Recent changes in driving among older adults. Hum Factors 1991;33:597–600.
9. Baker SP, O'Neill B, Ginsburg MJ, et al. The injury fact book. New York: Oxford University Press, 1992.
10. Zobeck TS, Grant BF, Stinson FS, et al. Alcohol involvement in fatal traffic crashes in the United States: 1979–90. Addiction 1994;89:227–231.
11. Federal Bureau of Investigation. Uniform crime reports for the United States, 1992. Washington, DC: Government Printing Office, 1993:216–217. (Publication no. 342-498/94321.)
12. Miller TR, Blincoe JL. Incidence and cost of alcohol-involved crashes in the United States. Accid Anal Prev 1994;26:583–591.
13. Doege TC, Engelberg AL, eds. Medical conditions affecting drivers. Chicago: American Medical Association, 1986.
14. Fisher RS, Parsonage M, Beaussart M, et al. Epilepsy and driving: an international perspective. Epilepsia 1994;35: 675–684.
15. Waller JA. Injury control: a guide to causes and prevention of trauma. Lexington, MA: DC Heath, 1985.
16. McCarroll JR, Haddon W Jr. A controlled study of fatal automobile accidents in New York City. J Chronic Dis 1962;15:811–826.
17. Hurst PM. Epidemiological aspects of alcohol in driver crashes and citations. J Safety Res 1973;5:130–148.
18. National Highway Traffic Safety Administration. Alcohol and traffic safety: a review of the state of knowledge, 1978. Washington, DC: Department of Transportation, 1979. (Publication DOT HS 805 172.)
19. Howat P, Sleet D, Smith I. Alcohol and driving: is the 0.05% blood alcohol concentration limit justified? Drug Alcohol Rev 1991;10:151–166.
20. National Highway Traffic Safety Administration. Consensus report on impaired driving. Washington, DC: U.S. Department of Transportation, 1989. (Publication DOT HS-807-390.)
21. Zador PL. Alcohol-related relative risk of fatal driver injuries in relation to driver age and sex. J Stud Alcohol 1991;52:302–310.
22. Mayhew DR, Donelson AC, Beirness DJ, et al. Youth, alcohol and relative risk of crash involvement. Accid Anal Prev 1986;18:273–287.
23. AMA Council on Scientific Affairs. Alcohol and the driver. JAMA 1986;255:522–527.
24. Waller PF, Stewart JR, Hansen AR, et al. The potentiating effects of alcohol on driver injury. JAMA 1986;256: 1461–1466.
25. Andersen JA, McLellan BA, Pagliarello G, et al. The relative influence of alcohol and seatbelt usage on severity of injury from motor vehicle crashes. J Trauma 1990;30:415–417.
26. Nelson D, Sklar D, Skipper B, et al. Motorcycle fatalities in New Mexico: the association of helmet nonuse with alcohol intoxication. Ann Emerg Med 1992;21:279–283.
27. Foss RD, Beirness DJ, Sprattler K. Seat belt use among drinking drivers in Minnesota. Am J Public Health 1994;84:1732–1737.
28. Kraus JF, Morgenstern H, Fife D, et al. Blood alcohol tests, prevalence of involvement, and outcomes following brain injury. Am J Public Health 1989;79:294–299.
29. Hingson R, Heeren T, Winter M. Lower legal blood alcohol limits for young drivers. Public Health Rep 1994;109: 738–744.
30. O'Malley P, Wagenaar A. Effects of minimum drinking age laws on alcohol use, related behaviors and traffic crash involvement among American youth, 1976–1987. J Stud Alcohol 1991;52:478–491.
31. Jones NE, Pieper CF, Robertson LS. The effect of legal drinking age on fatal injuries of adolescents and young adults. Am J Public Health 1992;82:112–115.
32. Williams A, Zador P, Harris S, et al. The effect of raising the legal minimum drinking age on involvement in fatal crashes. J Leg Stud 1983;XII:169–179.
33. Smith DI. Effect on traffic safety of introducing a 0.05% blood alcohol level in Queensland, Australia. Med Sci Law 1988;28:165–170.
34. Waller JA, Turkel HW. Alcoholism and traffic deaths. N Engl J Med 1966;275:532–536.
35. Fine EW, Scoles P. Secondary prevention of alcoholism using a population of offenders arrested for driving while intoxicated. Ann NY Acad Sci 1976;273:637–645.
36. Brewer RD, Morris PD, Cole TB, et al. The risk of dying in alcohol-related automobile crashes among habitual drunk drivers. N Engl J Med 1994;331:513–517.
37. Andreasson S, Romelsjo A, Allebeck P. Alcohol, social factors and mortality among young men. Br J Addict 1991; 86:877–887.

38. Schmidt W, Smart RG, Popham RE. The role of alcoholism in motor vehicle accidents. Traffic Safety Res 1962;6: 21–27.
39. Williams AF, Peat MA, Crouch DJ, et al. Drugs in fatally injured young male drivers. Public Health Rep 1985;100: 19–25.
40. National Highway Traffic Safety Administration. Use of controlled substances and highway safety: a report to Congress. Washington, DC: Department of Transportation, 1988. (Publication DOT HS 807 261.)
41. Marzuk PM, Tardiff K, Leon AC. Prevalence of recent cocaine use among motor vehicle fatalities in New York City. JAMA 1990;263:250–256.
42. Kirby JM, Maull KI, Fain W. Comparability of alcohol and drug use in injured drivers. South Med J 1992;85: 800–802.
43. Soderstrom CA, Trifillis AL, Shankar BS, et al. Marijuana and alcohol use among 1023 trauma patients: a prospective study. Arch Surg 1988;123:733–737.
44. Brookoff D, Cook CS, Williams C, et al. Testing reckless drivers for cocaine and marijuana. N Engl J Med 1994;331: 518–522.
45. Rafaelson OJ, Bech P, Christiansen J, et al. Cannabis and alcohol: effects on simulated car driving. Science 1973;179:920–923.
46. Moskowitz H, Hulbert S, McGlothin WH. Marijuana: effects on simulated driving performance. Accid Anal Prev 1976;8:45–50.
47. Smily A, Moskowitz HM, Ziedman K, et al. Effects of drugs on driving: driving simulator tests of secobarbital, diazepam, marijuana, and alcohol. Washington, DC: Department of Health and Human Services, 1985. (Publication no. (ADM) 85-1386.)
48. Newman RJ. A prospective evaluation of the protective effect of car seatbelts. J Trauma 1986;26: 561–564.
49. Campbell BJ. Safety belt injury reduction related to crash severity and front seated position. J Trauma 1987;27: 733–739.
50. Orsay EM, Turnbull TL, Dunne M, et al. Prospective study of the effect of safety belts on morbidity and health care costs in motor-vehicle accidents. JAMA 1988;260:3598–3603.
51. McGee DL, Rhodes P. Estimating trends in the effectiveness of seat belts in saving lives, 1975–1985. Stat Med 1989;8:379–385.
52. Marine WM, Kerwin EM, Moore EE, et al. Mandatory seatbelts: epidemiologic, financial, and medical rationale from the Colorado matched pairs study. J Trauma 1994;36:96–100.
53. Cooper PJ. Estimating overinvolvement of seat belt nonwearers in crashes and the effect of lap/shoulder restraint use on different crash severity consequences. Accid Anal Prev 1994;26:263–275.
54. Department of Transportation. Final regulatory impact assessment on amendments to Federal Motor Vehicle Safety Standard 208, Front Seat Occupant Protection. Washington, DC: Department of Transportation, 1984. (Publication DOT HS 806 572.)
55. Reinfurt DW, Campbell BJ, Stewart JR, et al. Evaluating the North Carolina safety belt wearing law. Accid Anal Prev 1990;22:197–210.
56. States JD, Annechiarico RP, Good RG, et al. A time comparison study of the New York State safety belt use law utilizing hospital admission and police accident report information. Accid Anal Prev 1990;22:509–521.
57. Wagenaar AC, Margolis LH. Effects of a mandatory safety belt law on hospital admissions. Accid Anal Prev 1990; 22:235–261.
58. Campbell BJ, Stewart JR, Reinfurt DW. Change in injuries associated with safety belt laws. Accid Anal Prev 1991; 23:87–93.
59. Lestina DC, Williams AF, Lund AK, et al. Motor vehicle crash injury patterns and the Virginia seat belt law. JAMA 1991;265:1409–1413.
60. Decker MD, Dewey MJ, Hutcheson RH, et al. The use and efficacy of child restraint devices: the Tennessee experience, 1982 and 1983. JAMA 1984;252:2571–2575.
61. Scherz R. Fatal motor vehicle accidents of child passengers from birth through 4 years of age in Washington State. Pediatrics 1981;68:572–575.
62. Kahane C. An evaluation of child passenger safety: the effectiveness and benefits of safety seats. Washington, DC: Department of Transportation, 1986. (Publication DOT HS 806 890.)
63. Centers for Disease Control. Child passenger restraint use and motor-vehicle-related fatalities among children—United States, 1982–1990. MMWR 1991;40:600–602.

64. Johnston C, Rivara FP, Soderberg R. Children in car crashes: analysis of data for injury and use of restraints. Pediatrics 1994;93:960–965.
65. Margolis LH, Wagenaar AC, Liu W, et al. The effects of mandatory child restraint law on injuries requiring hospitalization. Am J Dis Child 1988;142:1099–1103.
66. Agran PF, Dunkle DE, Winn DG. Motor vehicle childhood injuries caused by noncrash falls or ejections. JAMA 1985;253:2530–2533.
67. Margolis LH, Wagenaar AC, Molnar LJ. Use and misuse of automobile child restraint devices. Am J Dis Child 1992;146:361–366.
68. American Academy of Pediatrics, Society of Automotive Engineers and Centers for Disease Control and Prevention. Warning on interaction between air bags and rear-facing child restraints. MMWR 1993;42:280–282.
69. National Highway Traffic Safety Administration. Traffic safety facts 1993: occupant protection. Washington, DC: U.S. Department of Transportation, 1994.
70. Federal motor vehicle safety standard occupant crash protection: final rule. Fed Reg 1984;49:28962–29010.
71. Evans L. Restraint effectiveness, occupant ejection from cars, and fatality reductions. Accid Anal Prev 1990;22:167–175.
72. Zador PL, Ciccone MA. Automobile driver fatalities in frontal impacts: air bags compared to manual belts. Am J Public Health 1993;83:661–666.
73. Smith GR, Gulash EC, Baker RG. Human volunteer and anthropomorphic dummy tests of driver air cushion system. Clin Plast Surg 1975;2:35-45.
74. Huelke DF, Moore JL. Field investigations of the performance of air bag deployments in frontal collisions. Accid Anal Prev 1993;25:717–730.
75. National Highway Traffic Safety Administration. A report to the Congress on the effect of motorcycle helmet use repeal—a case report for helmet use. Washington, DC: Department of Transportation, 1980.
76. Offner PJ, Rivara FP, Maier RV. The impact of motorcycle helmet use. J Trauma 1992;32:636–641.
77. Rutledge R, Stutts J. The association of helmet use with the outcome of motorcycle crash injury when controlling for crash/injury severity. Accid Anal Prev 1993;25:347–353.
78. McSwain NE, Belles A. Motorcycle helmets—medical costs and the law. J Trauma 1990;30:1189–1197.
79. Sosin DM, Sacks JJ, Holmgreen P. Head injury-associated deaths from motorcycle crashes. JAMA 1990;264: 2395–2399.
80. Sosin DM, Sacks JJ. Motorcycle helmet-use laws and head injury prevention. JAMA 1992;267:1649–1651.
81. Fleming NS, Becker ER. The impact of the Texas 1989 motorcycle helmet law on total and head-related fatalities, severe injuries, and overall injuries. Med Care 1992;30:832–845.
82. Kraus JF, Peek C, McArthur DL, et al. The effect of the 1992 California motorcycle helmet use law on motorcycle crash fatalities and injuries. JAMA 1994;272:1506–1511.
83. Kraus JF, Peek C, Williams A. Compliance with the 1992 California motorcycle helmet use law. Am J Public Health 1995;85:96–99.
84. Chenier TC, Evans L. Motorcyclist fatalities and the repeal of mandatory helmet wearing laws. Accid Anal Prev 1987;19:133–139.
85. Malek M, Guyer B, Lescohier I. The epidemiology and prevention of child pedestrian injury. Accid Anal Prev 1990;22:301–313.
86. Pitt R, Guyer B, Hsieh C, et al. The severity of pedestrian injuries in children: an analysis of the pedestrian injury causation study. Accid Anal Prev 1990;22:549–559.
87. Rivara FP. Child pedestrian injuries in the United States. Am J Dis Child 1990;144:692–696.
88. Roberts IG, Keall MD, Frith WJ. Pedestrian exposure and the risk of child pedestrian injury. J Paediatr Child Health 1994;30:220–223.
88a. National Highway Traffic Safety Administration and Centers for Disease Control and Prevention. Motor vehicle-related deaths involving intoxicated pedestrians—United States, 1982–1992. MMWR 1994;43:249–253.
89. Harrell WA. Perception of risk and curb standing at street corners by older pedestrians. Percept Motor Skill 1990;70:1363–1366.
90. Harrell WA. Precautionary street crossing by elderly pedestrians. Int J Aging Hum Dev 1991;32: 65–80.
91. Hoxie RE, Rubenstein LZ. Are older pedestrians allowed enough time to cross intersections safely? J Am Geriatr Soc 1994;42:241–244.

92. Rivara FP, Bergman AB, Drake C. Parental attitudes and practices toward children as pedestrians. Pediatrics 1989;84:1017–1021.
93. Dunne RG, Asher KN, Rivara FP. Behavior and parental expectations of child pedestrians. Pediatrics 1992;89:486–490.
94. Hazlett RD, Allen MJ. The ability to see a pedestrian at night: the effects of clothing, retroreflectorization and driver intoxication. Am J Optom Arch Am Acad Optom 1968;45:246–257.
95. Ferguson SA, Preusser DF, Lund AK, et al. Daylight saving time and motor vehicle crashes: the reduction in pedestrian and vehicle occupant fatalities. Am J Public Health 1995;85:92–96.
96. Shinar D. Actual versus estimated nighttime pedestrian visibility. Ergonomics 1984;27:863–871.
97. Shinar D. The effects of expectancy, clothing reflection and detection criterion on nighttime pedestrian visibility. Hum Factors 1985;27:327–333.
98. Harrell WA. Effects of pedestrians' visibility and signs on motorists' yielding. Percept Motor Skills 1994;78:355–362.
98a. Smith PF, Remington PL. The epidemiology of drinking and driving: results from the behavioral risk factor surveillance system, 1986. Health Educ Q 1989;16:345–358.
99. National Highway Traffic Safety Administration. Nineteen-city safety belt and child safety seat use observational survey. Washington, DC: Department of Transportation, February 1989.
100. Centers for Disease Control. Child passenger restraint use and motor-vehicle-related fatalities among children—United States, 1982–1990. MMWR 1991;40:600–602.
101. National Highway Traffic Safety Administration. Traffic safety facts 1992—motorcycles. Washington, DC: Department of Transportation, 1993.
102. Colquitt M, Fielding LP, Cronan JF. Drunk drivers and medical and social injury. N Engl J Med 1987;317: 1262–1266.
103. Worden JK, Flynn BS, Merrill DG, et al. Preventing alcohol-impaired driving through community self-regulation training. Am J Public Health 1989;79:287–290.
104. Bass JL, Christoffel KK, Widome M, et al. Childhood injury prevention counseling in primary care settings: a critical review of the literature. Pediatrics 1993;92:544–550.
105. Bass JL, Wilson TR. The pediatrician's influence in private practice measured by a controlled seat belt study. Pediatrics 1964;33:700–704.
106. Macknin ML, Gustafson C, Gassman J, et al. Office education by pediatricians to increase seat belt use. Am J Dis Child 1987;141:1305–1307.
107. Logsdon DN, Lazaro CM, Meier RV. The feasibility of behavioral risk reduction in primary medical care. Am J Prev Med 1989;5:249–256.
108. Kelly RB. Effect of a brief physician intervention on seat belt use. J Fam Pract 1987;24:630–632.
109. Weinstein ND, Grubb PD, Vautier JS. Increasing automobile seat belt use: an intervention emphasizing risk susceptibility. J Appl Psychol 1986;71:285–290.
110. Allen DB, Bergman AB. Social learning approaches to health education: utilization of infant auto restraint devices. Pediatrics 1976;58:323–328.
111. Kanthor HA. Car safety for infants: effectiveness of prenatal counseling. Pediatrics 1976;58:320–322.
112. Scherz RG. Restraint systems for the prevention of injury to children in automobile accidents. Am J Public Health 1976;66:451–455.
113. Reisinger KS, Williams AF, Wells JK, et al. Effect of pediatricians' counseling on infant restraint use. Pediatrics 1981;67:201–206.
114. Kelly B, Sein C, McCarthy PL. Safety education in a pediatric primary care setting. Pediatrics 1987; 79:818–824.
115. Greenberg LW, Coleman AB. A prenatal and postpartum safety education program: influence on parental use of infant car restraints. J Dev Behav Pediatr 1982;3:32–34.
116. Christophersen ER, Sullivan MA. Increasing the protection of newborn infants in cars. Pediatrics 1982;70:21–25.
117. Robitaille Y, Legault J, Abbey H, et al. Evaluation of an infant car seat program in a low-income community. Am J Dis Child 1990;144:74–78.
118. Reisinger KS, Williams AF. Evaluation of programs to increase the protection of infants in cars. Pediatrics 1978;62:280–287.
119. Miller JR, Pless IB. Child automobile restraints: evaluation of health education. Pediatrics 1977;59:907–911.

120. Berger LR, Saunders S, Armitage K, et al. Promoting the use of car safety devices for infants: an intensive health education approach. Pediatrics 1984;74:16–19.
121. Guyer B, Gallagher SS, Chang BH, et al. Prevention of childhood injuries: evaluation of the Statewide Childhood Injury Prevention Program (SCIPP). Am J Public Health 1989;79:1521–1527.
122. Rivara FP, Booth CL, Bergman AB, et al. Prevention of pedestrian injuries to children: effectiveness of a school training program. Pediatrics 1991;88:770–775.
123. Renaus L, Suissa S. Evaluation of the efficacy of simulation games in traffic safety education of kindergarten children. Am J Public Health 1989;79:307–309.
124. Yeaton WH, Bailey JS. Teaching pedestrian safety skills to young children: an analysis and one-year followup. J Appl Behav Anal 1978;11:315–329.
125. Preusser DF, Blomberg RD. Reducing child pedestrian accidents through public education. J Safety Res 1984;15: 47–56.
126. Preusser DF, Lund AK. And Keep on Looking: a film to reduce pedestrian crashes among 9 to 12 year olds. J Safety Res 1988;19:177–185.
127. American Medical Association. Resolution no. 62 (A-84): seat belts and survival in auto accidents. Chicago: American Medical Association, 1984.
128. American Medical Association. Guidelines for adolescent preventive services (GAPS). Chicago: American Medical Association, 1994.
129. American College of Physicians. Health promotion/disease prevention: seat belt use. Philadelphia: American College of Physicians, 1984.
130. Hayward RS, Steinberg EP, Ford DE, et al. Prevention care guidelines: 1991. Ann Intern Med 1991;114:758–783.
131. American Academy of Family Physicians. Age charts for periodic health examination. Kansas City, MO: American Academy of Family Physicians, 1994. (Reprint no. 510.)
132. Committee on Injury and Poison Prevention, American Academy of Pediatrics. Office-based counseling on injury prevention. Pediatrics 1994;94:566–567.
133. Green M, ed. Bright Futures: national guidelines for health supervision of infants, children, and adolescents. Arlington, VA: National Center for Education in Maternal and Child Health, 1994.
134. American College of Obstetricians and Gynecologists. Automobile passenger restraints for children and pregnant women. Technical Bulletin no. 151. Washington, DC: American College of Obstetricians and Gynecologists, 1991.
135. Canadian Task Force on the Periodic Health Examination. Canadian guide to clinical preventive health care. Ottawa: Canada Communication Group, 1994:514–524.
135a. U.S. Department of Health and Human Services. Healthy People 2000: national health promotion and disease prevention objectives. Washington, DC: Public Health Service, 1991. (DHHS Publication no. (PHS) 91-50212.)
136. Steed D. The case for safety belt use. JAMA 1988;260:3651.
137. Committee on Accident and Poison Prevention, American Academy of Pediatrics. Safe transportation of newborns discharged from the hospital. Pediatrics 1990;86:486–487.
138. National Highway Traffic Safety Administration. Facts about motorcycle crashes and safety helmet use. Washington, DC: Department of Transportation, 1994. (Publication no. NTS-23.)
139. Council on Scientific Affairs, American Medical Association. Helmets and preventing motorcycle- and bicycle-related injuries. JAMA 1994;272:1535–1538.
140. National Highway Traffic Safety Administration. Alcohol involvement in fatal traffic crashes—1992. Washington, DC: Department of Transportation, 1994. (Publication DOT HS 808 094.)
141. Committee on Adolescence. Alcohol use and abuse: a pediatric concern. Pediatrics 1987;79:450–453.
142. Brewer RD, Sleet DA. Alcohol and injuries: time for action. Arch Fam Med 1995;4:499–500.