Chapter 7

Prevention of Accidental Childhood Injuries

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Prevention of Accidental Childhood Injuries[1]

INTRODUCTION

Accidental injuries are the leading cause of death in children after the first few months of life.[2] In 1984, 7,850 children under age 15 died as a result of such injuries (713). The exact number of children who are treated in emergency rooms or hospitalized for accidental injuries is not known. However, accidental and other injuries clearly account for a substantial proportion of the medical care received by children in hospitals. Children under age 15 make nearly 10 million emergency room visits due to injuries each year, and about 1 in every 130 children each year is hospitalized for injury (538). At current rates, about 1 of every 9 children born today will be hospitalized for injury before the age of 15. Although these statistics do include child abuse and self-inflicted injuries, the vast majority of injuries sustained by children are accidental (38).

The prominence of injuries as a cause of death and disability in children is largely due to society's success in reducing the incidence of severe infectious diseases, not to an increase in injuries themselves, In fact, many interventions to prevent and treat accidental injuries have met with considerable success, and accidental deaths among children under age 15 have been declining. Whereas there were 11,736 accidental deaths among children under age 15 in 1975 (1 per 4,632 children) (534), there were 9,703 such deaths in 1980(1 per 5,286 children) (452); and only 7,850 such deaths in 1984 (1 per 6,606 children) (713).3

This chapter describes the magnitude of the problem of accidental childhood injuries, the major causes of accidental injuries, the groups of children such injuries affect, and an epidemiological model for examining the causes of these injuries and conceptualizing interventions. The bulk of the chapter considers the effectiveness of specific strategies in preventing accidental injuries. These strategies fall into three general categories:

1. persuasion/education,
2. regulation of behavior, and
3. automatic protection.

Finally, the chapter considers the costs of accident prevention and the role of the Federal Government in this area.

[1]This chapter is based in part on a background paper on unintentional injuries prepared for OTA by L.S. Robertson (538). OTA, however, takes full responsibility for the use of that information in this chapter and for the use of the phrase "accidental injuries" rather than "unintentional injuries."

[2]To describe accidental injuries, many people prefer the label "unintentional injuries" because they believe that the term "accidental" implies unavoidability, OTA has chosen to use the term "accidental injuries" for two reasons. One is that it is the term more commonly used by the general public. The other is that many researchers in the field of child abuse argue that the term "unintentional injuries" does not in fact exclude all injuries due to child abuse, because some child abuse is unintentional.

[3]A small part of the decrease during this period may be due to the fact that the overall child population was declining at the same time.

THE PROBLEM OF ACCIDENTAL INJURIES

As a group, injuries (accidental and other) are the leading cause of potential years of life lost before age *65 (685).* In infants under age 1, injuries are the second leading cause of death (after death due to conditions present at birth); and in all other children under age 15, they are the leading cause of death *(451).* In 1984, as shown in table *7-1,* most of the accidental fatalities in children under

age 15 resulted from vehicle-related accidents. Drowning and fires/burns were also prominent causes of death among children in this age group.

More is known about fatal accidental injuries than about accidents that do not result in death. The fatality statistics in table 7-I are compiled from death certificates and published by the National Center for Health Statistics (NCHS). As described in appendix K, there are five major national sources of accidental injury data, each with limitations:

1. death certificates,
2. hospital discharge abstracts,
3. hospital emergency room reports,
4. national health survey data, and
5. traffic accident data.

None of these sources provides reliable national estimates of hospitalization for injuries. Death certificates include information on the cause of death and thus can yield injury fatality statistics such as those in table 7-1. Similar national data on hospitalizations by cause of injury, however, are not available. Hospital discharge abstracts do provide information on what types of injuries patients admitted to the hospital have (e. g., fractures, burns), but these abstracts do not typically provide any information on injury causes (or even information on whether injuries are accidental or not). Emergency room data are collected consistently only for injuries associated with products under the surveillance of the Consumer Product Safety Commission (CPSC). And, similarly, neither health survey data nor traffic accident data are both specific and comprehensive.

Even though there are no national data on hospitalizations for childhood injuries, there are some State-specific data. Data from Massachusetts for the year 1980-81, for example, indicate an annual rate of hospital admissions due to injury of 7.7 per 1,000 children aged O to 19 and an emergency room treatment rate of 216 per 1,000 children (234). North Carolina has reported a similar injury hospitalization rate of 8 admissions per 1,000 children aged ***O*** to 19 in 1980 (554). These data suggest ratios of about 45 hospitalizations and 1,271 emergency room treatments for each death. Nationally, these figures imply that approximately 353,000 hospitalizations and nearly 10 million

Table 7.1 .—Number of Accidental Fatalities in Children Under Age 15, by *Age* Group and Type of Accident, 1984

Type of accident	Number of fatalities by age group					
	0-4 yr					
	< 1 yr	1-4 yr	Total, 0-4 yr	5-9 yr	10-14 yr	Total, 0-14 yr
Vehicle-related accidents:						
Motor vehicle accidents	161	977	1,138	1,016	1,247	3,401
Person killed:						
Motor vehicle occupant	115	349	464	289	420	1,173
Pedestrian	14	502	516	488	321	1,325
Pedal cycle occupant	0	17	17	109	218	344
Motorcycle occupant	0	4	4	22	98	124
Other/unspecified	32	105	137	108	190	435
Air, rail, and water craft accidents	1	31	32	31	75	138
Other vehicle accidents	0	*9*	*9*	*17*	*24*	***50***
Non-vehicle-related accidents:						
Fires and burns	139	641	780	325	183	1,288
Drowning	70	556	626	229	265	1,120
Choking [a]	153	118	271	17	28	316
Firearms and explosives	0	*39*	*39*	*69*	190	298
Falls	28	86	114	27	41	182
Poisoning	21	77	98	22	34	154
Medical accident	40	31	71	11	9	91
All other	225	249	474	151	187	812
Total fatalities	838	2,814	3,652	1,915	2,283	7,850

[a] Does not include smothering.

SOURCE National Center for Health Statistics, Public Health Service, U S Department of Health and Human Services, unpublished data on accidental fatalities among children, 1987

emergency treatments annually are due to childhood injuries. Approximately ***4,700*** children under age 17 experience bed-disabling injuries' each year (705).

Childhood accidents are very costly to society, even after the tremendous social and emotional costs of death and disability are excluded. NCHS estimated that in ***1980,*** injury and poisonings (accidental and nonaccidental) accounted for 13.3 percent of acute medical care costs for children under age 17, or nearly $2 billion ***(479).*** Accidental injuries probably account for most of this cost, which does not include long-term care costs or nonmedical costs.

A detailed study of accidental and other injuries among Massachusetts children aged ***O*** to ***19*** estimated that in 1982, the annual direct cost of injuries for their hospital and emergency care alone was ***$81.6*** million ***(39).*** This figure implies annual hospital and emergency care costs of ***$48*** per child (in 1982 dollars). Physician and nonhospital acute medical care costs were not included in the study. For the approximately ***67*** million children aged ***O*** to 19 in the United States in 1982, $48 per year would translate into over $3.2 billion per year (in 1982 dollars).

Roughly 90 percent of the injuries in the Massachusetts study were accidental.5 Applying this percentage to the above NCHS and Massachusetts cost figures for all injuries suggests that national acute care medical costs for accidental injuries would be an estimated $1.8 to $2.88 billion (in 1982 dollars), These figures do not include all acute costs and are several years old. A better rough approximation of the present national acute medical costs of accidental injuries in children, therefore, is ***$2*** to ***$3.2*** billion each year. If long-term care costs were included, the estimated costs of accidental injuries would be substantially greater.

[4]A bed-disabling injury is defined as an injury resulting in at least one day during which a person must stay in bed.

[5]Rough preliminary estimates suggest that approximately 2 to 3 percent of emergency room visits for injury and 10 to 15 percent of hospitalizations were due to assaults and self-inflicted injuries (38). The extent of misrecording the cause of injury is unknown, but it seems reasonable to assume that 90 percent of all emergency room and hospital Inpatient costs incurred by injured children stemmed from accidental injuries.

Causes of Accidental Injuries in Children of Different Ages

As table 7-1 suggests, particular types of accidental deaths tend to cluster in specific age groups. Death from choking, for example, is most common in infancy. Deaths due to poisonings, falls, and drownings are most common in preschoolers (ages 1 to 4). Deaths from firearms and explosives are rare in very young children (under age 5), but are the third leading cause of accidental death in older children (ages ***10*** to 14). Motor-vehicle-related deaths are fairly constant across age groups under age 15, but the injured party varies considerably across groups. Most infants killed in motor vehicle collisions are occupants of the vehicle, whereas preschoolers killed in such collisions are likely to be pedestrians hit by an automobile, and older schoolchildren are often bicyclists.

The clustering of accident types in different age groups reflects the fact that rates of specific kinds of accidents depend substantially on a child's stage of growth and development ***(527).*** Infants and toddlers are particularly susceptible to household accidents associated with their increasing motor development and drive to explore the environment, In contrast, accidental injuries in teenagers over age 15 (a topic not addressed in this chapter) are often correlated with risk-taking behavior, such as participation in contact sports and unsafe driving practices. Boys have consistently higher rates of accidental injuries than girls ***(41,527),*** but researchers have generally resisted speculating on the reason for this difference.

Social and Economic Differences in Accident Rates

Social and economic differences in accident rates also exist. One study of infant morbidity found, for example, that infants with very young mothers had significantly higher accident rates than infants with older mothers ***(635).*** In general, persons with lower incomes have higher injury-related mortality rates than wealthier persons ***(527),*** perhaps in part because lower income people may lack the necessary education or resources to modify their home and neighborhood environ-

ments. One study found that fire-related deaths in urban children were particularly strongly correlated with income (757). Low incomes are also sometimes associated with isolated rural populations that may be exposed to greater than average hazards (farm machinery, poor roads, high-speed travel) and a lack of quick emergency response ***(527).*** A few particular types of accidents (e.g., deaths due to drowning in private swimming pools) are more likely to occur in wealthier populations than in lower income populations.

Injury Epidemiology and the Identification of Countermeasures

The epidemiology of injuries' has been approached in a manner similar to that used to characterize acute infectious diseases ***(527).*** In the case of an infectious disease (e. g., malaria), a disease-producing agent (e.g., a malarial parasite) is transmitted by a vehicle (e. g., a mosquito) to a person (or other host), who then becomes infected, Similarly, in the case of an injury, the agent of the injury is transmitted by some vehicle to a person, who then becomes injured. The "agent" of an injury is some form of energy, such as heat or mechanical energy. (Drowning or other forms of asphyxiation are caused by too little energy, rather than by too much.) The "vehicle" may be a cigarette (causing a fire), a car, the water in a swimming pool, a poisonous household cleaner, or gravity (the vehicle for a fall).

'Injury epidemiology attempts to describe the characteristics of injuries and the factors that contribute to them.

Injury epidemiology focuses on the full range of factors affecting the injury before, while, and after the injury happened that could have prevented it or reduced its severity. Once these specific factors have been identified, they may suggest interventions that can be employed before, during, or after an event. A matrix such as that shown in table ***7-2*** can be used to show potential targets for intervention (239).

In identifying interventions to reduce accidental childhood injuries, surveillance research—i.e., research into how specific injuries are clustered in time and space—is a potentially useful tool. In the case of child pedestrian injuries, for example, surveillance research could investigate where and when the injuries most frequently occurred; what the children were doing when they were injured; the characteristics and conditions of the automobiles involved; the actions and conditions of the drivers; and the medical response and treatment available after the injuries occurred. The results of such research might even suggest the areas most susceptible to intervention (e. g., a specific intersection near a school where placing a crossing guard could reduce injuries).

Countermeasures are usually based on considerably less information than that illustrated in this example. Lack of detailed surveillance data hinders both the identification of a cluster of accidental injuries and the evaluation of an intervention to decrease the number of such injuries ***(58).***

In a slightly different approach to identifying interventions, Haddon identified 10 general coun-

Table 7-2.—Preventing Motor. Vehicle/Child. Pedestrian Injuries: Potential Targets for Accident Intervention

	Targets for intervention		
Phases	Human factors	Vehicle factors[a]	Environmental factors
Before an accident	Hazardous activity, such as playing in traffic	Braking capacity of vehicles; condition of brakes	Parked vehicles and other obstructing objects
During an accident . .	Conditions of children that might increase trauma damage (e.g., hemophilia)	Sharp objects and edges on front of car; high bumpers	Hard road surfaces and other objects; street designs that increase exposure to vehicles
After an accident	First-aid abilities of bystanders	Property damage (irrelevant to injury)	Rapidity of response and adequacy of emergency medical system

[a]The term "vehicle factors" in this matrix refers to a vehicle in the sense of an agent of transmission rather than a mode of transportation See discussion in text

SOURCE Office of Technology Assessment, 1988, based on a background paper by L S Robertson, "Childhood Injuries Knowledge and Strategies for Prevent Ion," prepared for Office of Technology Assessment, U S Congress, Washington DC, February 1987

termeasures applicable to a variety of hazards, whether physical, chemical, or biological (238). Table 7-3 lists these general countermeasures and specific examples of countermeasures applicable to two types of accidental injuries. All 10 general countermeasures may not be applicable to every injury type, but a systematic review of each may suggest countermeasures that are potentially more effective or efficient than traditional measures. Various authors have used Haddon's conceptualization of countermeasures to suggest numerous options for a wide variety of injuries (136, 167,240,424,533,535,618).

Although a general conceptual analysis such as Haddon's is useful for identifying potential interventions, it cannot be used to estimate the relative necessity, effectiveness, cost, or feasibility of undertaking any particular option. In an area where most drownings occur in rivers or oceans, requiring fencing around private pools, for example, is likely to have little effect on drowning deaths. Similarly, if most children who drown know how to swim, increasing swimming education may be a relatively ineffective strategy. Furthermore, without adequate research on the effect of such training, there is no guarantee that the training will not increase the total amount of swimming and actually increase the number of deaths. It is in answering these questions that surveillance research and other research on the effectiveness of various options find their utility.

Table 7-3.—General Countermeasures to Hazards: Examples of Their Application to Two Specific Hazards

	Examples of countermeasures to address specific hazards	
General countermeasure	Example 1: Preventing drowning and submersion injury	Example 2: Preventing medication Poisoning in small children
1. Prevent creation (or accumulation) of hazard	Prohibit private, unsupervised swimming pools	Reduce use of drugs: get rid of old medications
2. Reduce amount of hazard	Reduce the number or permitted depth of private, unsupervised pools	Prescribe or package less medication per bottle
3. Prevent the release of the existing hazard	Teach all children to swim	Discourage medications in homes with small children
4. Modify the release of the hazard	Place sensors in dams and levees to signal appropriate release of water	Use coating on tablets to delay absorption; allow time for treatment
5. Separate hazard in time and space from those to be protected	Place playgrounds at a distance from streams, lakes, or pools	Keep medications in high or locked cabinet
6. Place physical barrier between hazard and those to be protected	Fence swimming pools; fence playgrounds near streams, lakes, or pools	Use child-resistant packaging
7. Modify relevant basic qualities of the hazard	Not applicable—water is not modifiable in any acceptable way	Make tablets too large for children to swallow; make liquids very u n palatable
8. Make that which is to be protected more resistant to the hazard	Encourage children to exercise to increase lung capacity	Educate children regarding dangers of medications
9. Begin to counter the damage already done by the hazard	Place underwater lights in pools; train lifeguards and parents in resuscitation	Educate the public regarding use of keeping ipecac and activated charcoal in every home
10. Stabilize, repair, and rehabilitate the object of the damage	Improve treatment and rehabilitation services to near-drowning victims	Train emergency personnel in poison identification and treatment techniques

SOURCES Modified from W Haddon, Jr , "On The Escape of Tigers An Ecologic Note, Technology Review 7244, 1970, L S Robertson Childhood Injuries Knowledge and Strategies for Prevention, " paper prepared for Off Ice of Technology Assessment, U S Congress, Washington DC, February 1987 and P Steele and D A Spyker "Poisonings" *Ped Clin* N Am 32(1) 77-86 1985

EFFECTIVENESS OF PREVENTION STRATEGIES

There are three broad ***strategies*** for preventing accidental injuries in children:

1. ***Persuasion/education:*** persuading people to increase their self-protection (e. g., through education or reminders to use seatbelts).
2. *Regulation of behavior:* requiring people to increase their self-protection (e. g., by passing laws requiring the use of seatbelts).
3. *Automatic protection:* providing automatic protection from injury through product or environmental design (e.g., by designing automobiles so that a person is automatically seatbelted when in the vehicle) (451,531).

In terms of the matrix in table ***7-2,*** all of these strategies focus on the period either before or during an accident, rather than after an accident,[7] In general, the first two strategies target human factors for intervention and are usually implemented at the State or local level. The strategy of automatic protection, on the other hand, generally targets "vehicle" (i. e., transmission agent) factors or large-scale environmental factors and can often be implemented nationally. [8]

The following discussion examines the effectiveness of these three general strategies in the context of specific *interventions* to prevent selected kinds of childhood injuries. An intervention, as used here, is a way of increasing the use of a preventive technology (e.g., a media campaign to increase smoke detector use, or the establishment of an agency to regulate potentially injurious products). Assessing the comparative effectiveness of alternative strategies depends on the effectiveness of the particular interventions, Such assessment is complicated by the fact that the interventions themselves vary in effectiveness, and by the fact that different strategies (e.g., education and regulation) may be combined in one intervention (e.g., a program that both teaches people how to install smoke detectors and requires their installation).

The critical outcomes of an intervention are the number of accidental injuries prevented and changes in the severity of such injuries. But many evaluations of accident prevention programs are not designed to capture these outcomes (or cannot attribute the outcome to the intervention). The necessary data may not be obtainable or may be prohibitively expensive; or, the target population for the intervention may be so small that effects on injuries cannot be detected or attributed to the intervention with any statistical significance (58). Consequently, many studies report intermediate outcomes (e.g., the installation of a safety device).

The problem of attributing critical outcomes to the intervention employed is particularly acute for educational interventions. Figure 7-1 illustrates the effect of a public education program for preventing burns if two-thirds of the population at each step in the education process went on to the next step. Not all of those in the target population are exposed to the educational messages, and not all of those who are exposed actually comprehend the messages. Even smaller numbers of people change their behavior. The ultimate effect of the program in reducing injuries would be expected to be very small; it might be undetectable even if the study were designed to measure it.

Persuasion/Education

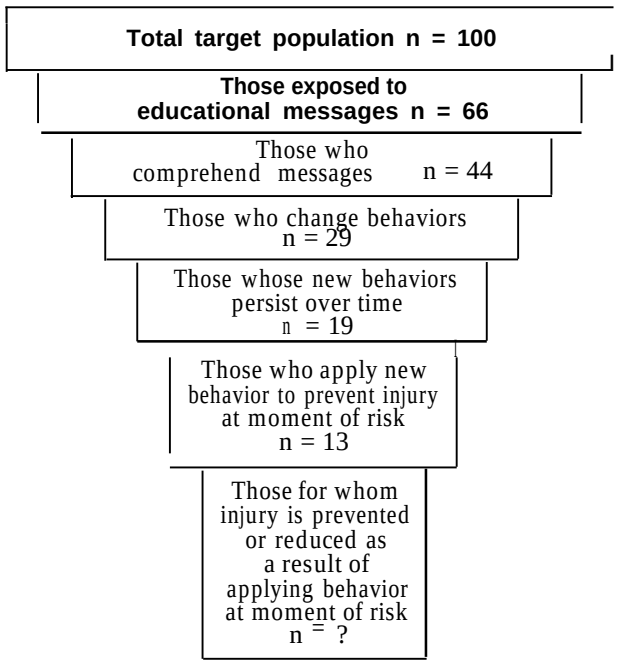
Persuasion as a strategy to prevent childhood accidents is the historical cornerstone of injury prevention, but its success varies and is widely debated. Although educational programs can be relatively inexpensive and do not typically encounter the political resistance that regulatory programs often do, they tend to have only modest effects at best. One major educational program for older teens—driver education in public schools —has actually increased the incidence of accidental injury (539).[9] This experience suggests that sim-

[7] Postevent environmental factors that can reduce the severity of injury (e. g., rapid trained emergency response) are not included in the preventive strategies discussed here.

[8] Classification of interventions into three general preventive strategies is a useful way to think about interventions, but, of course, a particular intervention may borrow from two or even all three strategies. For example, a landlord could be required by law to change a tenant's environment,

[9] In Connecticut, when a driver education program was dropped from nine school districts following the elimination of State funding for the program, licensure and crashes of 16- and 17-year-olds in those nine districts, unlike districts that maintained the program

Figure 7-1.— Attenuation of the Effect of a Public Education Program



SOURCE Adapted from E McLoughlin, C.J. Vince, A M Lee, et al , Project Burn Prevent Ion Outcome and Implications, " American Journal of **Public** Health 72(3) 241-247, 1982

ilar educational programs for younger children (e.g., swimming lessons) may not reduce injuries if education results in increased exposure to a hazard.

The effectiveness of persuasion as a strategy often depends on the frequency of the behavior that one is attempting to change. In general, the more frequent the behavior that people must change in order to protect themselves or their children and the greater the effort required to change it, the less effective will be programs to persuade them to do so (41,531).

Motor-Vehicle-Related Injuries

Before laws were passed requiring the use of child restraints in automobiles, several programs sought to increase voluntary use of this preventive technology. Two studies showed some success. One, a controlled study of pediatric practices, found a modest short-term increase in the use of child restraints among families whose pediatricians prescribed the restraints and demonstrated their proper use ***(523).*** In a second study, mothers of newborns who were randomly selected to receive a free child restraint used the restraints more than both mothers who were given only educational materials and those given neither information nor free restraints (522), The improvement was modest, about a 7- to 8-percent increase in use compared to the control group.

Attempts to reduce child pedestrian injuries have generally focused on teaching children appropriate pedestrian behavior (or to avoid crossing streets altogether) ***(235).*** Although some studies of these interventions indicate that children acquire pedestrian skills easily (774), others are more cautious. One such study used model cars and roads to teach children pedestrian skills. After training, less than half the children remembered to look for turning cars, and a substantial number of children (half the 6-year-olds and ***25*** percent of 9-year-olds) did not remember to stay in the crosswalk. On the positive side, an education program in three cities resulted in a ***20-*** to 30-percent reduction in child pedestrian injuries involving children darting into the street (509). This program used film and television spots to teach children to stop and look for moving vehicles.

Fire-Related Injuries

The wide variation in outcomes that can result from different persuasive strategies is well demonstrated by programs to prevent fire-related injuries (although presumably other factors entered into the outcomes as well). In one experimental program, pediatricians counseled families regarding the importance of smoke detectors. The counseled group increased the proportion of correctly installed detectors by 41 percent, while the uncounseled control group did not change behavior (429). In Missouri, a community awareness program using media, school, and group presentations succeeded in decreasing burn deaths by an apparent 43 percent (although probably not all of the decrease was due to the education program)

through local funding, declined precipitously (532). A Canadian study found that motor vehicle crash rates of teenage drivers were much more strongly correlated with age than with driver education and experience. Newly licensed 18-year-olds had roughly the same crash rates as 18-year-olds with 2 years of driving experience. both groups of 18-year-olds had much lower crash rates than newly licensed 16-year-olds (535).

(197). A community awareness program in two Massachusetts communities, on the other hand, increased self-reported knowledge of preventive actions but had no detectable effect on the number of burns (416).

A Baltimore, Maryland, program to increase smoke detector use gave free detectors to people who requested them. In a study of 231 people randomly selected from among the 3,720 recipients, investigators found that 92 percent of their detectors were actually installed, and 88 percent were operating correctly 4 to 9 months later (217). Furthermore, the recipients were highly concentrated in areas of the city with the greatest fire-injury rates.

Other Home Injuries

Many injuries, particularly to very young children, occur at home. But "safety-proofing" homes has proved difficult to do (134). The fact that an educator may be trying to change many behaviors and environmental factors simultaneously (e. g., storage of hazardous products; use of window locks; lowering of water heater settings) may contribute to reduced impact of the message and a lower probability of compliance (134).

In one program aimed at reducing home injuries associated with 10 categories of household items, a prepaid health plan furnished parents with information regarding appropriate use and storage of these hazardous items at the time of a pediatric health care visit (135). In a followup telephone call, parents claimed to have made many of the items inaccessible to children. An on-site inspection of homes, however, showed no difference in access to hazardous items compared to access in a control group of families who had received no information.

In contrast, a Massachusetts home inspection program that used family counseling at the time of a sanitary code inspection to educate parents, with the inspectors actually installing some safety devices themselves, showed significant improvements in reduction of household hazards in the inspected homes when compared with homes in a control group (191).

Pediatricians are a common source of safety education for parents, although most pediatricians actually spend little time in injury prevention counseling (521). An American Academy of Pediatrics program known as TIPP (The Injury Prevention Program) encourages pediatricians to educate parents about accident prevention by providing the physician with a schedule for introducing injury topics to families and with materials on these topics suitable for general distribution.

When pediatric counseling is extensive, it can sometimes have an effect. In a group of families where parents were given written materials regarding falls, were counseled by a pediatrician, and were exposed to reminders at each visit, falls occurred in 10 percent of infants during the subsequent year compared to 17 percent in a comparison group that did not receive the messages ***(355).*** In another study, families who were counseled by pediatricians regarding six categories of household hazards had significantly fewer hazards apparent at followup than families in a control group (51).

Poison information centers are a longstanding and effective intervention to prevent serious injury (100,178). Their primary purpose is to reduce the severity of poisoning injury by providing information and assistance to parents after a suspected poisoning. Educating parents regarding the use of these centers has been shown to decrease inappropriate use of hospital emergency rooms (loo).

Regulation of Behavior

If changes in behavior are effective in preventing injuries, but education is only partially successful in changing behavior, then *requiring* behavioral change may be more effective. Many accident problems, however, are not well suited to a regulatory strategy (e.g., proper storage of household poisons). And since the essence of the regulatory approach is that people's voluntary choices may be contrary to the ideals of public health, regulation of behavior raises issues regarding the relative importance of individual freedom v. public health and public dollars. Still, regulating behavior has been very effective in increasing the use of several technologies, most notably child restraints in automobiles and smoke detectors.

The effect of laws and administrative rules, like the effect of persuasion, depends to some degree

on the frequency of the required behavior. Also important are the public observability of the behavior, the degree to which the behavior is sanctioned by the community, and the ability to enforce the law.

Motor-Vehicle-Related Injuries

The gradual implementation of individual State laws requiring infant safety restraints in automobiles has provided an opportunity to compare behavior in those States, before and after the laws were implemented, with behavior in States without such laws. Tennessee was the first State to pass such a law (in 1977); it required all children under the age of 4 in parent-owned automobiles to be restrained in an infant or child seat unless they were traveling in an adult's lap. (This exception to the law was later removed.) In the first 3 years after Tennessee's law was implemented, restraint use by children under the age of 4 increased from 8 to 28 percent (753). Fatalities to children in this age group declined by about ***50*** percent between ***1978*** and 1983, in parallel with increased enforcement of the law (130). The decrease in fatalities was greater than expected given the observed increase in use of restraints, so factors other than the use of restraints were probably at work as well.

By 1984, all 50 States had enacted laws requiring the use of safety restraints for children in automobiles (29). Several States have, like Tennessee, reported impressive increases in the use of child restraints and decreases in child mortality following implementation of the laws (231,577, 753).[10] No national estimate of injury reduction due to the cumulative effect of child safety restraint laws is available. Undoubtedly, however, these laws contributed to the 36-percent decline in motor vehicle occupant deaths among children under age ***5*** between 1980 and 1984 (234,713).

Whether as a result of laws or increased consumer awareness, observed use of child safety restraints in automobiles in the United States has increased substantially over the past few years. The National Highway Traffic Safety Administration (NHTSA) reports that use of restraints among children under age 5 more than tripled between 1981 and 1986—from 22.8 percent in 1981 to 75.8 percent in 1986, based on a 19-city observational survey. Furthermore, the percentage of young children who were correctly restrained increased from 17 to 67 percent of all observed children during this period. Engineering improvements that have made child safety restraints easier to use may have contributed to the increase in correctly used restraints (29).

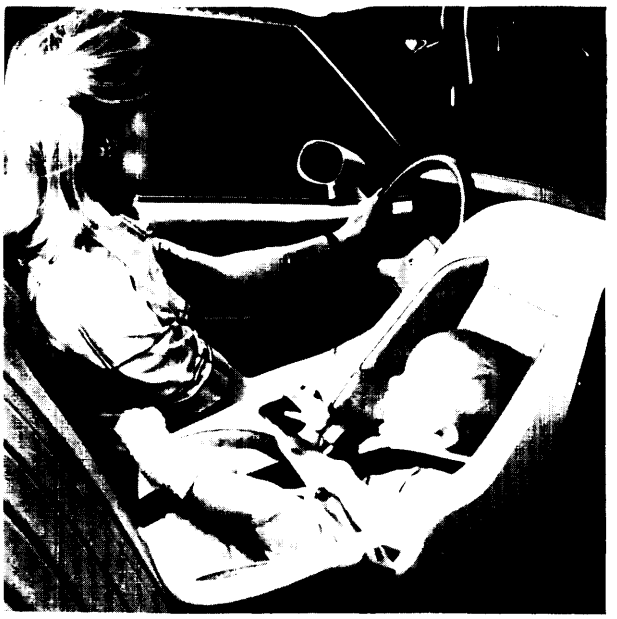


Photo credit: American Association for Automotive Medicine

Infant seats have contributed to substantial reductions in motor-vehicle-related injuries to children,

Still, there is considerable room for improving child safety restraint laws. As shown in table 7-4, many States require safety restraints in automobiles only for very young children. Altogether, 38 States have no restraint requirements for children over age 5 (and many States do not require restraints for children over 3 or 4) (719). Most other States have general seatbelt laws that require persons other than very young children to be restrained; a few States do not require seatbelts for adults but do require older children to wear them (719). Laws covering only certain ages and exempting certain vehicles may fail to prevent a substantial number of avoidable deaths. One analysis of motor vehicle occupant fatalities in very

[10] Again, some of the decrease in mortality may be due to factors other than restraint laws (3).

Table 7-4.–Comparison of Child Safety Restraint Laws in 50 States and the District of Columbia, June 1987

State	Year effective	Age required to be restrained	Age required to be in safety seat	Existence of general belt law covering older children?	Selected comments
Alabama	1982	Under 3	Under 3	No	—
Alaska	1985	Under 6	Under 4	No	—
Arizona	1983	Through 4	Through 4	No	a,b,d
Arkansas	1983	Under 5	Under 3	No	—
California	1983	Under 4	Under 4	Yes	a,b
Colorado	1984	Under 4	Under 4	Yes	b
Connecticut	1982	Under 4	Under 4	Yes	—
Delaware	1982	Under 4	Under 4	No	a
District of Columbia	1983	Under 6	Under 3	Yes	—
Florida	1983	Under 6	Under 4	Yes	d
Georgia	1984	Under 4	Under 3	No	—
Hawaii	1983	Under 4	Under 3	Yes	—
Idaho	1985	Under 4	Under 4	Yes	a,b
Illinois	1983	Under 6	Under 4	Yes	a,d
Indiana	1984	Under 5	Under 3	Yes	—
lowa	1985	Under 6	Under 3	Yes	d
Kansas	1982	Under 4	Under 4	Yes	a,c,d
Kentucky	1982	Under 40”	Under 40”	No	a,b
Louisiana	1984	Under 5	Under 5	Yes	—
Maine,	1983	Under 12	Under 4	No	a,d
Maryland	1984	Under 5	Under 3	Yes	—
Massachusetts	1982	Under 12	Under 5	No	d
Michigan	1982	Through 4	Through 4	Yes	—
Minnesota	1983	Under 4	Under 4	Yes	d
Mississippi	1983	Under 2	Under 2	No	—
Missouri	1984	Under 4	Under 4	Yes	—
Montana	1984	Under 4	Under 2	Yes	a,b,d
Nebraska	1983	Under 4	Under 1	No	—
Nevada	1983	Under 5	Under 5	Yes	—
New Hampshire	1983	Under 5	Under 5	No	d
New Jersey	1983	Under 5	Under 5	Yes	—
New Mexico	1983	Under 11	Under 5	Yes	d
New York	1982	Under 10	Under 4	Yes	d
North Carolina	1982	Under 6	Under 3	Yes	d
North Dakota	1984	Through 5	Under 3	No	d
Ohio	1983	Under 4	Under 4	Yes	b
Oklahoma	1983	Under 5	Under 4	Yes	d
Oregon	1984	Under 16	Under 1	Yes	d
Pennsylvania	1984	Under 4	Under 4	No	
Rhode Island	1980	Through 12	Through 3	No	d
South Carolina	1983	Under 4	Under 4	No	—
South Dakota	1984	Under 5	Under 2	No	d
Tennessee	1978	Under 4	Under 4	Yes	d
Texas	1984	Under 4	Under 2	Yes	—
Utah	1984	Under 5	Under 2	Yes	a
Vermont	1984	Under 5	Under 5	No	d
Virginia.	1983	Under 4	Under 3	Yes	d
Washington	1984	Under 5	Under 1	Yes	
West Virginia	1981	Under 9	Under 3	No	d:
Wisconsin	1982	Under 4	Under 2	No	d
Wyoming	1985	Under 3	Under 3	No	b

KEY TO COMMENTS
a—Law applies only to parents and legal guardians.
b—Restraint required for child of specified age or less than 40 pounds.
c—Kansas law applies only to children riding in the front seat
d—State has upgraded its original child restraint law This table reflects those revisions

SOURCE US Department of Transportation National Traffic and Highway Safety Administration, unpublished data on child restraint laws. Washington, DC, June 1987 and July 1, 1987

young children (ages O to 5) concluded that in some States, up to 43 percent of deaths occurred in children who would not have been covered under restraint laws as of 1984 (636).

The evidence regarding the role of enforcement in improving the effectiveness of restraint use is somewhat conflicting. A few studies of specific enforcement efforts have found that such efforts had little additional effect (535). However, one study of seatbelt use found that Texas had the highest rate of compliance in the Nation, a rate which Texas authorities attributed to vigorous enforcement efforts (518).

Fire-Related Injuries

The presence of a properly installed and functioning smoke detector is associated with large reductions in the number of deaths from residential fires (415). A national survey found that the proportion of households with smoke detectors increased from ***22*** percent in 1977, to 46 percent in 1980, to 67 percent in 1982 (722). In specific cases, legislation requiring the installation of smoke detectors in private residences has been associated with decreased deaths. In Montgomery County, Maryland, where smoke detectors are required by law in all residences, the number of working detectors is greater (and the number of residences without detectors smaller) than in nearby (and demographically similar) Fairfax County, Virginia, which does not have such a law. Furthermore, after the law was enacted, fire deaths declined more rapidly in Montgomery County than in Fairfax County (415).

Other Injuries

Regulation has proved successful in preventing drownings associated with children entering unsupervised swimming pools. The annual pool-associated fatality rate in Honolulu, Hawaii, where fences and childproof gates around pools are required, is approximately one-third that of Brisbane, Australia, which has a similar climate and pool-to-household ratio but no fencing requirement (480).

Bicycle helmets have been proposed as a potential new target for regulation. In 1984, 344 young children died from collisions between motor vehicles and pedal cycles (bicycles and tricycles) (see table 7-1). In addition, an estimated ***582,000*** emergency room visits by children *were* attributable to bicycle-related injuries in 1985 (667). Approximately 14 percent of motor-vehicle/bicycle collisions result in head injuries to the cyclist (190). These figures imply that the use of bicycle helmets might substantially reduce severe injury resulting from bicycle falls and collisions, although valid studies of the relationship between helmet use and bicycle-related injuries do not exist. Helmet use is uncommon among children. An Arizona study found that less than 2 percent of Tucson children commuting to school by bicycle wear helmets (745). To OTA's knowledge, the use of bicycle helmets *is* not required in any State *or* municipality in the United States.

It is difficult to separate the effectiveness of regulation alone from the effectiveness of the accompanying education and enforcement. A conscious combination of the three applied to a specific problem, however, can be extremely effective. Box 7-A describes the successful application in New York of a combined strategy to reduce fatal injuries from falls out of windows.

Automatic Protection

Providing automatic protection avoids the need for individuals to alter their behavior; it requires only a one-time change that does not depend on altering behavior. An airbag installed in an automobile, for example, does not require the individual to "buckle-up" every time he or she gets in the automobile. Automatic protection can be brought about not only by regulating products but also by eliminating hazards in the environment (e. g., dangerous intersections). The design of automobiles, children's products, and medication packages are areas where automatic protection has been widely and successfully implemented to reduce injuries.

For automatic protection to be successful, the manufacturers and producers of potential hazards must be aware of and use technical strategies to reduce the hazardous characteristics of the products. In some cases, a private entity or the government itself can reduce a hazard through environmental changes, such as by providing better

Box 7-A.—Example of a Successful Strategy
To Prevent Fatal Childhood injuries From Falls

An effort by the New York City Health Department illustrates the effect that can be obtained by combining good surveillance research, a simple and effective preventive technology, and an intervention that combines persuasive and regulatory strategies. An investigation of 201 fatal falls, conducted between 1965 and 1969, revealed that 61 percent of fatal falls in children under age 15 and 85 percent of those in children under age 5 were falls out of windows. Furthermore, 96 percent of the fatal falls occurred in three of the five boroughs of the city (Bronx, Brooklyn, and Manhattan).

The most feasible technical approach to addressing this problem was identified as the installation of barriers over windows. A campaign was launched in high-risk neighborhoods to persuade parents or landlords to install such barriers **(607).** Eventually, the Health Department issued regulations requiring landlords to install the barriers whenever they were asked to by tenants. The number of children's deaths due to fatal falls from windows declined dramatically as a result —from 30 to 60 per year in the mid-1960s to 4 in 1980 (55).

After a while, as families moved and children were born in new families, the number of fatal falls from windows increased. In July 1986, the city changed the regulation. It now requires landlords to install barriers in windows in buildings where there are children under age 11, regardless of whether a parent has requested the barrier.

street lighting or installing a traffic signal. Reduction of hazards associated with private products can sometimes be accomplished without regulation if consumers are discriminating enough to choose items that are safer (and sometimes if they are willing to pay more as well). Where such voluntary changes are insufficient, government regulation may be employed to force all manufacturers to meet some standard of safety. Uniform regulation can ensure that producers who want to make their products safer are not placed at a competitive disadvantage when safety features increase production costs, and that consumers need not (or cannot) trade off safety and cost .

Motor-Vehicle-Related Injuries

Attempts to reduce automobile injuries have included both product and environmental changes. The Motor Vehicle Safety Act of 1966 (Public Law 89-563) required automakers to include certain safety features in 1968 and subsequent model cars.[11] Automobile safety regulations are administered by NHTSA.

Estimates of the effects of these standards, based on comparison of fatalities associated with vehicles to which the standards did or did not apply, indicate approximately 15,000 fewer deaths per year (in all age groups) in the early 1980s than would have occurred without the standards (536). Some of the continued reductions in automobile-associated deaths observed in the 1980s can probably be attributed to the continued attrition of old vehicles that did not meet the standards. The effect of the standards on death rates of children alone has not been estimated.

Automatic restraints (airbags or automatic seatbelts) are a current area of controversy among industry, consumer groups, and government. Such restraints are now provided in a few car models and are currently scheduled to become mandatory by 1990 unless at least two-thirds of the U.S. population resides in States with mandatory seatbelt use by that time.

Other possibilities for improvement also remain. For example, many vehicles still have protrusions such as knobs and tapered dashboards that can cause injury to the faces, heads, and chests of individuals during crashes or sudden braking (752). One study found that 12 percent of children's injuries in motor vehicles occurred in noncrash braking or swerving (4).

Street and highway improvement can also significantly affect vehicle-associated deaths in all age groups—adults as well as children. For example, deaths due to crashes at railroad crossings de-

[11] The safety features included shoulder belts, energy-absorbing steering assemblies, interior padding, seat integrity, and side running lights, among others. Subsequent standards were imposed for hoodlatch, brake fluids, and head restraints (1969); child seating systems and power-operated windows (1971); retread tires and flammability of interior materials (1972); side door and roof strength (1973); one-piece lap and shoulder belts (1974); rear-end fuel system integrity and windshield zone intrusion (1976); and, most recently, eye-level brake lights (1986).

clined by 52 percent between 1974 and 1984, at least in part as a result of railroad crossing improvements brought about by the Highway Safety Act of 1973 (133). Vehicle-associated deaths can be further reduced by such measures as improved road-striping and installation of energy-absorbing materials at selective roadside sites where crashes are likely to occur ***(357,766,767).*** Better street design in areas of high-density housing holds potential for reducing the number of child pedestrian deaths (235,528). Federal grants to the States for road construction and site modification to reduce crash incidence and severity are administered by the Federal Highway Administration.

Changes in right-turn-on-red laws and speed reduction are two examples of legal interventions that have been suggested to decrease motor-vehicle-related injuries. A study of motor vehicle accidents after the implementation of right-turn-on-red laws found that the number of child pedestrian injuries was 30-percent higher after the laws were in place, and that most of the increase took place in urban areas ***(778).***

Speed reduction, through enforced speed limits or limited top speed capacity in automobiles, has been widely cited as a way to decrease fatalities (444,535). Recent legislation (Public Law 100-17) permits States to raise speed limits on rural highways to 65 mph. There is evidence that rural areas had higher automobile fatality rates than other areas even before this legislation (43). Future studies can evaluate whether higher legal speed limits in these areas further increase fatality rates.

Injuries From Toys and Other Consumer Products

Toys and other products intended for use by children are subject to voluntary product safety design (by manufacturers) and to consumer product regulation administered by CPSC. That Commission was created in 1972 (Public Law 92-573) and has the authority to promulgate mandatory safety standards for any consumer product that poses an "unreasonable risk" of injury or illness. (The Commission does not have jurisdiction over foods, drugs, tobacco products, firearms, boats, aircraft, or motor vehicles.) In extreme cases, CPSC can ban products from the market (15 U.S. C. 2052).

The statutes that are administered by CPSC contain wording directing particular attention to products used by children, making this organization the Federal agency most directly involved in regulating children's products. Bicycles, for example, were one of the first major products for which CPSC developed standards (241). The Commission tested 277 toys and children's products with suspected hazards during fiscal year 1985; 58 percent of the tested products failed to comply with CPSC standards.

The implementation of "childproof" caps on certain drugs and household chemicals is a major success story in product regulation's effect on child safety. Child poisoning deaths from aspirin declined 80 percent between 1965 (the year that manufacturers voluntarily adopted container caps that were difficult for children to remove) and 1975 (137). The Poison Prevention Packaging Act of 1970 (Public Law 91-601) resulted in further packaging standards, implemented by CPSC between 1972 and 1980. Reported ingestions of the regulated products by children under age 5, measured from the year that a given product was regulated to 1983, declined from between 40 and 90 percent, depending on the product (668). Nonetheless, over 60,000 unintentional] ingestions of prescription medications by children under age 5 were reported to poison control centers in 1985 (694). Household solvents, corrosives, and caustics continue to result in a child hospitalization rate of about 5 to 12 per 100,000 children each year for each category of product (645), or an estimated 3,000 to 7,500 children per product type.[12]

CPSC has been the subject of considerable recent controversy. During the 1980s, the Commission has emphasized voluntary rather than mandatory industry standards for unsafe products (622). It has been criticized not only for a lack of mandatory standards for what are perceived as substantial problems (538) but also for its use of cost-benefit calculations when considering product regulation (406) and for its alleged lax enforcement of existing standards (596).

[12]The Consumer Product Safety Commission (CPSC) is not the only Federal regulatory agency involved in the regulation of poisonous products. The Food and Drug Administration, for example, has promoted poison educational materials and has required warning labels on both prescription and over-the-counter drugs,

Recent products with which CPSC has been involved include proposed regulation of all-terrain vehicles and hot water heaters. In the former case, CPSC's own database has documented a dramatic rise in injuries, and the Commission is still debating the appropriate regulatory policy (407). In the case of hot water heaters, addressed by CPSC at the time of a public petition, the Commission has chosen to rely on voluntary compliance of manufacturers to set temperature settings at levels sufficiently low to prevent scald burns (506). Two products associated with substantial numbers of injuries—cigarettes (causing fires) and firearms—are not within the jurisdiction of CPSC (538).

THE COSTS OF ACCIDENT PREVENTION

There is very little published information on the costs of accident prevention programs to government agencies (e. g., a State health department) or to producers and consumers. What little cost information exists is largely in the area of Federal regulatory interventions, and it is very controversial.

One study of the effects of Federal regulation on automobile costs, for example, concluded that the cumulative costs of all safety regulations (after accounting for "learning curve" efficiencies) had added approximately $491 to the cost of manufacturing an automobile (120). According to the researchers, approximately two-thirds of regulatory costs were eventually passed on to consumers (120). This study is considered by some critics to overestimate the costs of automobile regulation, because the source of the study's manufacturing cost data was manufacturers, who have incentives to make the costs of regulation appear high (537).[13]

In contrast to the automatic protection strategy that is the context of Federal regulation by NHTSA and CPSC, behavior-modifying strategies—education and regulation of behavior—tend to be implemented on the State or local level. Many of the costs of educational programs are often borne by State or local health departments. The great advantage of educational interventions is that they are rarely subject to political opposition. On the other hand, costs to individual families—monetary or nonmonetary-often limit the effectiveness of educational interventions. The evidence on these interventions presented above tends to suggest that educational programs are more successful when the costs to the family are low or minimized through the provision to families of free safety devices.

Interventions that regulate behavioral change have many of the same costs and characteristics as educational interventions, partly because they still require the acquisition of a device or alteration of habitual behavior. They also usually involve education on some level, if only because the political process often includes attempts to persuade the public (as well as legislators) regarding the desirability (or undesirability) of the law. Passing a law tends to be more expensive if the law is controversial, and the factors that would make a requirement controversial can be the same barriers that might make an education-only intervention ineffective. For example, making bicycle helmets mandatory would probably be controversial, because it would require consumers to purchase helmets; to remember to use them each time they ride bicycles; to monitor helmet use in their children; and to give up the freedom of choice not to wear a helmet. Persuading people to wear helmets voluntarily might be difficult for all of the same reasons except the last.

Enforcement imposes an additional cost on regulatory interventions, but it may well be worth the expense because enforcement seems (at least sometimes) to be an important component of the increased effectiveness of regulation compared to education. Some of the costs of enforcement can be recovered through fines, but imposing a fine merely transfers the cost from the enforcement agency to the fine payer.

[13] "Historically, for example, manufacturers have suggested that adding airbags to automobiles would increase consumer costs from $290 to $1,150 (738). Their own costs were estimated at S135 to $280 (1982 dollars). Some of the variation in estimates is due to estimates of the volume that would be produced. The large ranges and apparently high anticipated markups for these and other passive restraint systems, however, have suggested to some researchers that costs may be inflated in order to discourage regulation (462).

Sometimes the costs of adherence to regulations can be very great to consumers, For example, the use of infant seat restraints could be required on commercial aircraft just as it is in automobiles, but the costs of such an intervention might be more than simply the inconvenience and the cost of the restraint. Infants are often permitted by commercial airlines to travel free if they ride on the lap of an adult. An intervention that required parents to use restraints for their infants, therefore, would also require them to purchase an additional ticket (unless the airline had a policy requiring ticket purchase only if the flight were full). Parents might perceive such a requirement as entailing a much greater cost than benefit, particularly if the marginal increase in safety is low.

In summary, most interventions to reduce accidental injuries in children involve some costs—some monetary, some nonmonetary —borne either by governments or directly by people. The nonmonetary costs of compliance with regulations, for example, may lead consumers not to fully comply unless enforcement is rigorous and sanctions are high. Although some nonmonetary costs of compliance can be reduced through education that alters dangerous habitual behavior, successful education programs can also be costly. A full accounting of the costs of specific accident prevention interventions to all parties (not just the program costs) would enhance the development of more cost-effective interventions.

FEDERAL AGENCIES INVOLVED IN PREVENTION EFFORTS

After a quiescent period, the Federal Government has shown renewed interest in injury prevention during the past few years. In addition to the ongoing efforts of NHTSA and CPSC in motor vehicle and consumer product regulation, there is now significant effort in several agencies toward developing better surveillance systems, promoting research into accident causes and prevention, and assisting States in the implementation of accident prevention programs. Some of the activities of NHTSA, the Centers for Disease Control (CDC), and other Federal agencies in these areas are summarized in box 7-B.

For the most part, the different Federal agencies involved in funding specific programs and projects have different foci. NHTSA has been particularly involved in child restraint projects. CDC, with a recent increase in funding, is providing grants for a wide variety of demonstration and research projects and for three research centers; these grants include prevention of injuries in all age groups. CDC has also taken the lead in coordinating surveillance efforts. The Division of Maternal and Child Health of the Public Health Service funds demonstration projects on injuries in children and provides program implementation assistance. The National Institute for Child Health and Human Development is focusing on background research into accidental injury.

Most injury demonstration programs are oriented, at least initially, at preventing accidental injuries through behavior modification and are implemented at the State or local level. The local approach is a logical one for many types of accidents. The local environment may contribute to accidents (e. g., high-density housing and child pedestrian accidents), and prevention programs may need to be tailored to local social characteristics.

Box 7-B.—Federal Injury Prevention Assistance

The Federal Government's primary involvement in the prevention of accidental childhood injuries occurs through the regulation of motor vehicles by the National Highway Traffic Safety Administration (NHTSA) and the regulation of certain consumer products by the Consumer Product Safety Commission (CPSC). In the past few years, however, as a result of increased interest and increased funding, there has been a substantial increase in Federal agencies' support of State and local accidental injury prevention activities. Some of the injury prevention assistance activities by NHSTA and other Federal agencies are outlined below.

National Highway Traffic Safety Administration (U.S. Department of Transportation) .—In 1985, NHTSA distributed $15.8 million in grant money to States for use in child safety restraint programs (538). NHTSA grant money is also used to fund more general activities, such as alcohol countermeasures, emergency medical services, bus driver programs, and pedestrian safety programs,

A **1985** National Academy of Sciences report, *Injury in America* **(451),** heightened congressional interest in the prevention of injuries, and in 1986, Congress appropriated $10 million to NHTSA to carry out the recommendations of that report. One of these recommendations was that the Centers for Disease Control (CDC) coordinate Federal injury prevention efforts. Consequently, NHTSA transferred nearly all of this special appropriation to CDC. The language surrounding the appropriation specified that at least half of the money was to be targeted to motor-vehicle-related injury, so NHTSA has worked together with CDC in decisions regarding that funding **(29).**

Centers for Disease Control (Public Health Service) .-During the 1970s and early 1980s, CDC awarded small contracts to States and other entities to develop injury control strategies for persons in all age groups. (CDC awarded a total of approximately $765,000 during this period (538),) In 1985, CDC increased the number of staff committed to accidental injury prevention projects from **3** to 14 people (566). In early 1986, CDC received the nearly $10 million in injury prevention funds from NHTSA described above, and the agency consolidated staff from the intentional and unintentional injury divisions. With the $7.8 million of this money allocated to extramural research, CDC has funded 5 injury research centers and 32 individual research project grants (566).

Division of Maternal and Child Health (Public **Health** Service) .–The Division of Maternal and Child Health funds demonstration projects on various topics, one of which is accidental injury prevention. Until 1986, this agency was the most significant source of Federal funding for projects to prevent non-motor-vehicle-related injuries in children. In fiscal year **1986,** the Division of Maternal and Child Health spent just over $1.5 million of approximately $71.7 million in total grant funding on prevention of accidental injuries in children (about 8.5 percent of grant funds) (268). Grant topics during fiscal year 1986 included statewide injury prevention programs in Massachusetts, North Carolina, and Wisconsin, and a six-State New England cooperative injury prevention network (697). In fiscal year 1987, the Division of Maternal and Child Health is providing a small amount of additional funding to support the implementation of ongoing injury prevention programs in eight States **(268).**

In addition to providing grants, the Division of Maternal and Child Health has produced a guide for States on implementing accidental injury prevention programs. The Division is also joining with NHTSA and CDC in funding a National Commission on Injury Prevention whose mission is to aid States in designing injury prevention programs.

National institute for Child Health and Human Development (NICHD) (National Institutes of Health). —NICHD has only recently begun to devote substantial resources to injury research. The Institute held a workshop on accidental injury research needs in September 1986, and it has since funded two projects on injury research methods at a cost of **$450,000 (564).**

NICHD is now in the process of funding injury research, with the intention of focusing on basic mechanisms of injury, NICHD is also providing some funding to support enhanced injury data collection during the upcoming 1988 Child Health Supplement to the National Health Interview Survey (564).

CONCLUSIONS

Although both numbers and rates of childhood deaths due to injuries have declined, injuries remain the leading cause of death and hospitalization for children over the age of 1. The vast majority of injuries in children are accidental. This fact suggests that there is merit in giving prevention of accidental childhood injuries a high priority in the maintenance of children's health.

The United States has clearly made some progress toward reducing accidental injury fatalities in children—and presumably nonfatal childhood injuries as well. Between 1975 and 1984, the country achieved a 33-percent reduction in accidental fatalities among children under age 15. The decline in deaths from motor-vehicle-related injury is a particularly important part of this achievement, accounting for one-third of the reduction—approximately 1,400 lives saved in 1984 alone (534,713).

Despite this progress, we are still remarkably ignorant about many important facets of injury prevention and program implementation. For instance, very little is known about the costs of alternative preventive interventions (the most startling fact about these costs is that they are almost never discussed). Similarly, although there is good evidence for the effectiveness of specific interventions, there has been little study of the underlying reasons why one educational intervention is effective and another is not; of the marginal benefits of additional preventive technologies or interventions; and of the relative costs and effectiveness of alternative strategies.

This lack of information results in decisionmaking that may be more guess than calculation. How much does it cost to give out free smoke detectors? How much does an educational program to encourage their use cost? What about the costs of requiring their installation and enforcing the regulation with inspections? Which is more effective? Would requiring sprinklers be more effective than requiring smoke detectors? At what cost? What are the marginal costs and benefits to requiring sprinklers in addition to smoke detectors? How much education is needed to make either technology fully effective?

Automatic protection is probably the most effective preventive injury strategy in most instances, because it requires no behavioral change on the part of the consumer. Automatic protection often allows the end users to make a one-time purchase (e.g., an automobile equipped with airbags) but to receive a certain amount of constant protection. The per-unit costs will tend to decline if all products include the protection, and production efficiencies result. Many motor vehicle-related injuries can be prevented by measures amenable to Federal and State regulation, and indeed, such injuries have declined dramatically in parallel with regulatory efforts, Product regulation has likewise been an effective preventive measure. In some cases, however, improved automatic protection may have increasing marginal costs for each increment of added protection.

Strategies that require people to change their behavior, occasionally or habitually, have been generally considered less effective than automatic protection. Regulation of behavior, which can be enforced, is considered by most researchers to be a more effective method of increasing safety-enhancing behavior than merely educating people regarding dangers and appropriate behaviors. Neither education nor regulation is a one-time cost; both require ongoing investments (into re-education, enforcement, or both).

Still, it is difficult to discount education as an important strategy to combat accidental injuries. The literature suggests that the educator, the audience, and the existence of additional incentives are all variables that can affect the success of educational efforts to prevent injury. The disappointing results of many persuasive programs are not failures to communicate: many such programs do increase knowledge regarding dangers. Rather, these programs are relatively ineffective because they often encourage changes in frequent or habitual behavior (behavior considered inconvenient by the parent or child). Education may be an important component of regulatory strategies, both in encouraging the legislative process and as a necessary background to acceptance and proper use of required technologies (177).

Rivara has suggested that 12 currently known or available preventive interventions could, if universally applied, reduce childhood deaths due to injuries by 29 percent (528):

- infant seat restraints in automobiles,
- air bags for front seat motor vehicle occupants,
- helmets for motorcyclists,
- helmets for bicyclists,
- expansion and enforcement of the Poison Prevention Packaging Act,
- barriers around swimming pools,
- self-extinguishing cigarettes,
- smoke detectors,
- elimination of handguns,
- knowledge of the Heimlich maneuver,
- adherence to CPSC regulations, and
- window bars in windows above the first floor.

Other observers have promoted more widespread or mandatory application of such interventions as:

- hot water heater temperatures of no more than 120 degrees Fahrenheit,
- stringent limits on the sales and use of all-terrain vehicles
- "no-right-turn-on-red" laws,
- prohibitions on radar detectors,
- maximum speed limits to car performance, and other extensions of automobile or consumer product safety (538).

Rivara's estimates of effectiveness rates are limited by the existence of only a few sound evaluations of these interventions, The estimates thus tend to be optimistic. Also, some of these interventions involve additional costs to society or substantial loss of personal choice, issues that need to be taken into account when considering accident prevention policies. Nonetheless, this list of currently available interventions illustrates that progress in accident prevention need not wait.