Injury Prevention and Control for Children and Youth

Third Edition

Author: Committee on Injury and Poison Prevention
American Academy of Pediatrics

Editor: Mark D. Widome, MD, MPH

American Academy of Pediatrics
PO Box 927, 141 Northwest Point Blvd
Elk Grove Village, IL 60009-0927
CHAPTER 1

The Science of Injury Prevention

The practice of clinical pediatrics is based on the traditional basic sciences that include physiology, pharmacology, genetics, and pathology, among others. As pediatrics has evolved, newer basic sciences have assumed greater importance. Today's clinician must also have a firm foundation in behavioral sciences, epidemiology, and developmental biology. Likewise, as the science and practice of injury prevention has emerged into the mainstream of pediatric practice -- both in the clinical setting and in community pediatrics -- it has been built on three pillars of scientific investigation and understanding: epidemiology, biomechanics, and behavioral science. Epidemiology provides an understanding of the nonrandom distribution of injury risk among populations of children so that targeted interventions can be designed. Biomechanics gives an understanding of human vulnerability and resilience to energy transfers, so those energy transfers can be limited to tolerable amounts. Behavioral science provides knowledge about effective and ineffective ways of changing risk by changing behaviors not only of children and adolescents, but also of parents, decision makers, and entire communities. This chapter introduces the reader to these areas of basic knowledge. Further readings are suggested for the interested clinician.

1.1 Injury Epidemiology

1.1.1 Introduction

Injuries are understandable, predictable, and preventable. They are not, as we used to think, "accidents," i.e., random, uncontrollable acts of fate or the result of a child being "accident prone." This is the central theme of injury epidemiology and has been the key to the development of injury prevention and control as a sophisticated science. Specific injuries share similar characteristics of person, place, and time. It is by under-
standing injuries that interventions can be developed and implemented to prevent or limit the extent of a given injury.

1.1.2 History

For the first half of this century the focus of injury prevention began with the premise that people who were injured were careless, stupid, or indifferent. Movements in the 1920s (traffic safety) and 1950s (home safety) focused on the implementation of educational measures and the eradication of careless behavior. However, a landmark paper in 1942 by Hugh DeHaven, a pilot and physiology researcher, pointed out the great importance of injury thresholds and biomechanics and that damage in an injury event was not inevitable. He concluded that, "Structural provisions to reduce impact and distribute pressures can enhance survival and modify injury within wide limits in aircraft and automobile accidents." In 1949, a seminal paper by Dr John Gordon introduced the concept of injury epidemiology. Dr Gordon patterned the epidemiologic behavior of injury on a paradigm used in understanding infectious diseases. Thus, injuries could be characterized by episodic and seasonal variation, long-term trends, and demographic distribution. In addition, the occurrence of an injury could be thought of as the interaction of a host, an agent (or vector), and the environment. James J. Gibson modified this understanding by introducing the concept of energy transfer as the direct cause of injury. Dr William Haddon, Jr further developed this concept and summarized it in his phase-factor-matrix.

The application of epidemiologic methods and other injury prevention strategies has met with substantial success in recent years. Motor vehicle injuries, as the most important cause of injury death for children and adolescents in the United States, have been the subject of a wide variety of injury prevention efforts. Efforts to reduce poisoning deaths among children have occurred at numerous levels. Reduction in the number of aspirin and iron tablets in one bottle to sublethal doses, the use of child-resistant packaging, the development of poison center networks and poison information lines, the use of syrup of ipecac in the home, and the development of effective protocols for the management of poisoning have all contributed to a remarkable reduction in these deaths among preschool children.

Successful injury prevention campaigns have also been initiated and realized by individual efforts at the local level. Community pediatricians using concepts and interventions based on application of sound principles of injury prevention and control have made significant differences in childhood injury morbidity. A Tennessee pediatrician, Robert S. Sanders, MD, using a variety of approaches and considerable persistence, was responsible for the passage of the first US child safety seat law in 1977. In 1978, Kenneth Feldman, MD, a Seattle pediatrician, became concerned about the scald burns he saw in his practice. Armed with a thermometer and the knowledge that serious burns will occur in less than 1 minute at water temperatures over 127°F (52.6°C), he visited households in his practice, where he measured the water temperature and routinely found temperatures of 150°F (65.6°C). With a combined strategy of community awareness, collaboration with the water company, and legislative action, all water heaters sold in Washington state eventually were set at a temperature of 125°F (51.7°C), thus greatly reducing the potential for scald injuries among children throughout the state as well as in his practice.

1.1.3 The Epidemiologic View of Injury

As William Haddon first outlined in his phase-factor matrix (Table 1.1, p 4), injuries can be studied in an organized fashion in much the same way as infectious diseases. Much like infectious disease, there is a "host" (the person with pneumonia or who has experienced blunt trauma), the "vector" (the bacterium or the vehicle), and the physical and socioeconomic environment (crowded living environment). However, unlike other diseases, the occurrence of an event leading to an injury (pre-event phase) can and should be distinguished from the actual injury-producing event (event phase). Finally, the ultimate morbidity and mortality from trauma are also affected by what happens after the injury occurs (postevent phase). Haddon's matrix allows one to consider an injury along all epidemiologic dimensions and at each phase in time. This generates further specific risk-factor hypotheses and determines points of intervention in the causal sequence.

Epidemiologic studies that investigate risk factors commonly concentrate on pre-event host factors, such as age or sex. However, injury prevention depends more on examining modifiable risk factors: pre-event factors such as separation of bicyclists from traffic, event factors such as
head protection offered by helmets, and postevent factors such as availability of emergency medical services and trauma center care. The field of injury control, then, attempts to reduce mortality and morbidity from trauma through primary prevention of the injury event, secondary prevention through better acute care, and tertiary prevention through improved and more accessible long-term rehabilitation.

**Exposure measurement**

A key element of any epidemiologic study design is the proper measurement of risk. Risk of a given injury is, in turn, related to exposure to a given environment, product, or activity. The risk of childhood drowning is clearly related to exposure to water. However, it is also related to the type of exposure (swimming vs wading), the length of the exposure, the duration of exposure per episode, and the number of episodes per year. The apparent increased risk of some types of injuries, i.e., injuries to children in child care, may disappear when the number of hours of exposure are taken into account. If possible, calculation of rates of injuries should take these exposure measurements into consideration. For instance, motor vehicle fatalities are reported as both number of deaths per 100,000 population and as number of deaths per 100 million miles driven. Unfortunately, calculation of rates based on hours of exposure is difficult for most activities because of the lack of availability of such data.

**Risk factor analysis**

Risk factors are identified in order to apply epidemiologic methods to the study of injury. These risk factors become crucial to the planning of interventions directed at those persons at increased risk of a given injury. The questions “Who? What? Where? and How?” must be answered. The science of injury prevention and control seeks to determine modifiable risk factors through analytic epidemiologic studies. Study designs are chosen to minimize the probability of confounding factors biasing the estimate of risk.

The case-control and the cohort studies are two mainstays of analytic epidemiology that have been applied successfully in injury prevention research. The case-control design is ideal for the study of relatively rare problems, such as head injuries from bicycle crashes or suicides from home ownership of guns. It allows the researcher to measure the strength and direction of association between an injury and multiple risk or protective factors. Often, existing records and data sources are used, making these studies more economically feasible than cohort studies. Case-control studies do not require long-term follow-up. It was just such a study design that demonstrated the risk of serious head injury increases dramatically if a bicycle helmet is not worn. Challenges in the conduct of valid case-control studies include the proper selection of control subjects and accurate measure of the exposure of interest.

Cohort studies can be conducted either prospectively or retrospectively and are often more difficult and more expensive to conduct. Individuals are selected for the study based on the presence or absence of a particular potential risk factor. The subsequent occurrence of a specific injury is measured. Cohort designs can better show causality because the time sequence of exposure to risk factors and the injury event can be better determined. The major drawback of this design is that it may take a long time to gather a significant number of cases because specific injuries of a given mechanism are relatively rare events. By using both case-control
Injury prevention and control for children and youth

and cohort methods, one can identify high-risk individuals, high-risk activities, or high-risk products (or combinations) to target interventions.

### 1.1.4 Data Sources

Readily available and accurate injury data are the foundation of the study of injury. Without them we have no valid way to quantify the problem, no basis with which to make informed decisions about prevention, and great difficulty in evaluating control measures. These data are also essential for educating the public and policy makers about the magnitude of injuries and the usefulness of prevention and control efforts. Population-based injury statistics are the ideal, although often difficult to come by (except for mortality statistics).

Although needs for accurate and adequate data are great, a number of data sources are available to the injury researcher or those interested in a descriptive or analytic evaluation of a local injury problem. In general, mortality data are much more readily obtained and more complete than are morbidity data. Mortality statistics are available from both national (National Center for Health Statistics at the Centers for Disease Control and Prevention) and state vital statistics offices.

Unfortunately, deaths due to injury are the “tip of the iceberg” and thus do not give a complete picture of the injury problem. Nonfatal injury data are much more difficult to obtain and may be less accurate. Most states have hospitalization discharges abstracted in a central database and coded by a diagnosis code (ICD-9 N Codes). Unfortunately, relatively few states code injury admissions by mechanism of injury using the available ICD-9 external cause of injury codes, or E-codes. Other local sources of injury data include the county or city medical examiner’s office for injury fatalities, state or local trauma registries, and EMS databases, among others. All databases have limitations that must be understood and taken into account in the interpretation of the data (Table 1.2, p 7).

### 1.1.5 Interventions

Once causal factors are identified, appropriate preventive interventions should be devised. They should aim at preventing the injury from occurring in the first place, diminishing the damage caused by the injury event once it occurs, or limiting the long-term sequelae of the injury. As

| Table 1.2. Local and State Sources for Injury Morbidity and Mortality Data |
|-------------------|-----------------|-----------------|
| **Level**         | **Type of Data** | **Limitations**  |
| Vital statistics  | State County    | Deaths — demographics on person, cause of death, location (death certificates) |
|                   | County Local    | Detailed data about injuries ending in death |
| Medical examiner data | State Local | All hospitalizations |
|                   | (Uniform Hospital Discharge Data Sets) Local | May not contain E-coding, considerable lag time with state data |
| Trauma registries data | State Local | Hospitalizations due to trauma |
| EMS and prehospital reporting systems | State | All cases transported by EMS |
| Criminal justice agencies | Local State | Assaults, homicides known to police |
| Physicians of ces, HMOs | Local | All injuries presenting to offices |

shown in Table 1.1, a researcher could devise a number of strategies for all three phases: bike paths to separate riders from traffic, helmets on riders to limit injury should a crash occur, and further development of EMS systems and trauma centers.

Traditionally, interventions or countermeasures are considered either passive or active, depending on requirements for behavior change on the part of the host. Active interventions rely on actions taken by the host individual (the child or someone acting on behalf of the child, eg, the parent). For example, poisoning can be prevented by storing
medications away from children's reach. Passive interventions, on the other hand, do not rely on the effort of the host to be successful. An effective passive strategy has been the packaging of medications in non-lethal amounts.

Many interventions cannot be classified as strictly active or passive but are somewhere between the two or use both active and passive strategies. For example, a helmet will help protect from head injury if someone falls off a bicycle, but the helmet must be properly worn in the first place. The likelihood that an intervention will be successful at preventing injury is inversely related to the amount of individual effort required.

Interventions — targeting

The first step in planning an injury control or prevention countermeasure is to define a target group or population in which to implement the intervention. Targeting is important because the intervention can be designed with a particular population in mind and population-specific goals can be set. A target group may be chosen because the injury occurs relatively frequently in that group (eg, age group), the intervention is most likely to be successful in the group, or a combination of the two. The Seattle Bicycle Helmet Campaign was targeted to school-age children because bicycle-related head injuries are common in this population and the behavior of 5- to 9-year-olds was perceived to be more open to change (as opposed to teenagers, for instance).11

Interventions — implementing

After the countermeasure is chosen and a target group is identified, the countermeasure must be implemented. This may involve several activities and may be carried out at a variety of levels: among patients in a given practice, among students at a given school, or in an entire community. Implementing an injury prevention effort is often a collaborative affair — the joint effort of health care educators, public relations specialists, community leaders, and other concerned groups.

Interventions — evaluating

One of the most important uses of epidemiology in injury research is the evaluation of interventions. The traditional evaluation of disease prevention programs has been based on examining subsequent reductions in disease and deaths. Injuries, however, are relatively rare, and reduc-

The Science of Injury Prevention

tion in the number of deaths or hospitalizations for a specific injury, particularly in a local study, may not be statistically feasible. Emergency departments remain a potential source of data, but many emergency departments do not routinely code injury data by mechanism. Ongoing emergency department-based surveillance systems, such as those that exist in children's hospitals in Canada and many hospitals in Australia, are clearly helpful.

At the other end of the outcome spectrum are surveys that measure changes in knowledge and attitudes. Although often used to measure the effectiveness of injury prevention programs, the evidence argues against them as valid measures in injury research since they correlate poorly with changes in behaviors. Likewise, self-reporting of behaviors can be misleading. Comparison of self-report data on safety belt use and observed use shows that safety belt use is substantially over-reported.12,13

One method that avoids those limitations and has proven useful in the evaluation of injury prevention programs is the use of proxies, or changes in behavior that lead directly to prevention. A proxy evaluation was used to measure the effectiveness of community bicycle helmet programs in Seattle, Wash. Bicycle helmet use among school-age children increased from 5% to 16% after 1 year of intervention. The control community, Portland, Ore, showed no such increase. Determining the effectiveness of a particular intervention is critical to use limited resources most effectively.14

1.1.6 Conclusion

Epidemiology is the cornerstone science upon which the field of injury prevention and control is built. It provides the direction for intervention efforts by helping to choose important injury problems and high-risk groups and to create strategies to decrease the most serious injuries. Epidemiology also plays a key role in evaluating interventions and directing scarce resources to programs that have the greatest impact. The greatest advances in injury control over the last decade have come from applying the science of epidemiology to our efforts and moving from programs that "seem to make sense" to those that are evidence-based. While large case-control studies and manipulation of computer databases are beyond the reach of many practicing pediatricians, the
ability to understand the patterns of injury in a community is available to us all.

The pediatrician is referred to several basic texts on the epidemiology of injury.\textsuperscript{1,2,8,9} A national directory of injury prevention professionals is available from the National Center for Education in Maternal and Child Health, 38th and R Streets, NW, Washington, DC 20057 (202-625-8400).\textsuperscript{17}

1.2 Biomechanics

Effective injury control involves strategies for avoiding injury-producing events and minimizing the injuries that may result if these events should occur. While epidemiologists have identified risk factors for the child and the environment, bioengineers study injury events to design safety technologies that will reduce the risk of injury and the severity of injury. The key to understanding the use of specific safety devices is in understanding the biomechanical principles that led to their design.

1.2.1 Injury and Energy

All prevention strategies work by minimizing the burden of various harmful agents on the body. Just as viruses and bacteria are among the agents of infectious disease, energy is the agent of injury. And, in the same way that infectious diseases are prevented by minimizing the burden of pathogenic viruses and bacteria on the body, injury is prevented by minimizing harmful forms of energy. Injury results when a body is exposed to energy that surpasses the body's ability to absorb or dissipate that energy without structural or functional damage.

Energy may be mechanical, thermal, chemical, electrical, or ionizing radiation. When the human body is exposed to significant quantities of energy of any form, the body must somehow manage this excess energy or be damaged. For example, when the body is exposed to excess thermal energy or heat, blood vessels dilate to manage the excess energy. If the temperature is beyond the thermoregulatory capacities of the body, a burn or heat stroke may result.

Mechanical energy is of special importance in any general discussion of pediatric injury prevention. It is the energy of motion and the agent that can break bones and cause head injuries in falls, automobile crashes, and gunshot wounds. This form of energy is responsible for the majority of injury hospitalizations and fatalities. Mechanical trauma can occur without impact (eg, whiplash after rapid flexion-extension of the neck or avulsion fracture after twisting an ankle), but most of the severe mechanical traumas occur following impact. At low levels of excess mechanical energy, bodies manage the energy locally by bending and stretching; at higher levels, bones will break, often preserving the more vital internal organs.

1.2.2 Energy and Safety Technologies

The goal of many safety technologies is to aid the body in managing excess mechanical energy. An energy-absorbing surface beneath playground equipment can prevent serious injuries from falls. Seat belts can allow a child to survive what would otherwise be a fatal motor vehicle crash. A polystyrene-lined helmet can prevent brain damage in a fall from a bicycle.

These examples illustrate some of the most important principles in the management of energy by safety technologies. Safety technologies serve to reduce the severity of injury by minimizing the energy delivered to the child and by altering the manner in which energy is delivered. The severity of injury is related to the amount of energy the body must manage, the direction of impact, the mechanical properties of the tissue impacted, the suddenness of the impact, and the localization of the impact.

The relationship between magnitude of energy delivered and degree of injury is the most obvious. Magnitude of energy varies directly with the distance of a free fall and varies with the square of the velocity of impact. A child falling 6 ft onto a playground surface will suffer more severe injuries than a child falling 3 ft. The energy delivered is twice the magnitude because the distance of the fall is twice the distance. However, a car crashing into a tree at 30 miles per hour will not deliver twice the energy to occupants of one crashing at 15 miles per hour; it will deliver four times the energy, because energy varies as the square of speed. From the above, it can be concluded that limiting the height of playground equipment and enforcing speed limits are important injury prevention strategies based on biomechanical principles. It can also be concluded that limiting speed plays an especially important role in limiting energy transfers.\textsuperscript{12}
Another important determinant of injury severity is the direction of impact. The body is not symmetrical. Impacts to the left side of the body will result in different injuries from impacts to the right side, the front, or the back. In particular, lateral impacts to the head are more closely associated with diffuse axonal injury and coma than impacts in other directions. This biomechanical principle of injury may partly explain the continued high prevalence of morbidity and mortality associated with side-impact motor vehicle collisions. To minimize the energy delivered to the body with lateral collisions, a side-impact air bag for automobiles has been developed.

*Mechanical properties of biological tissues* vary considerably with respect to medical condition and age. In particular, infants have relatively large head-to-body mass ratios and weak neck musculature. As a result, infants would be subject to severe whiplash injuries in frontal motor vehicle collisions. Because the majority of severe motor vehicle collisions are frontal, engineers have designed infant safety seats that face backward.

The suddenness of impact is another determinant of injury severity. Biological tissues have a property known as viscoelasticity: the faster they are struck, the more easily they are injured. Many safety technologies work to reduce the suddenness of impact to ease the blow. In other words, they are designed to deliver the energy over a long enough period of time that the tissues can manage it. Helmet liners crush on impact and seat belts stretch. These technologies all serve to increase the time (a larger fraction of a second) over which energy of an impact is delivered to the body.

The degree of localization of the impact is related to the amount of surface area exposed to the impact. For a given force, the larger the area over which an impact is distributed, the less severe the injury. (This is often measured in pounds per square inch.) As an extreme example, sitting on a sharp tack will result in injury while sitting on a chair will not. In both situations the force is the same but the area over which the force is distributed is different. When used properly, seat belts distribute an impact over the bones of the pelvis and thorax, thereby spreading the load and minimizing injuries. If seat belts are not worn, a properly shaped dashboard will cause less injury than one with edges and protrusions, though both may deliver the same total energy in a crash.

Some of the principles of biomechanical reasoning can be appreciated in the following examples: vehicle crashes and bicycle head injuries.

**What happens to an unrestrained passenger during a motor vehicle collision?**

During an impact, the vehicle decelerates suddenly and comes to a complete stop over a distance related to the amount the vehicle is crushed. For a 30-mph frontal impact with a rigid barrier, this deceleration to a stop occurs over about 2 ft.

As the collision develops, the vehicle begins to stop but the unrestrained passenger continues to move at the original speed of the vehicle. Because the knees contact the instrument panel early in the crash phase, before the vehicle has come to a complete stop, the knees benefit from the deceleration, or impact ride-down, of the vehicle. Before impact, the head is approximately 2 ft from the windshield and will hit after the vehicle has come to a complete stop. Therefore, the head of an unrestrained occupant will be exposed to a sudden, short-duration stop and will not benefit from ride-down.

Unrestrained infants are at particular risk during motor vehicle crashes, especially if a passenger holds the infant in his or her lap. During the collision, the infant will not only experience a violent impact when thrown against the vehicle interior, but will also be crushed by the passenger. In effect, the infant will serve to cushion the blow of the passenger holding him. Older unrestrained children may be thrown against the interior of the vehicle or ejected through windows.

Prevention technologies are created to increase the time and the surface area over which the energy of the crash is delivered to the body. The crushing of the front of the automobile absorbs some of the energy in addition to distributing the remaining energy over time. Restraint systems such as seat belts or child-restraint systems provide some additional ride-down time when they stretch. Additionally, they deliver forces over additional area given the width of the webbing. Most importantly, they deliver the energy load to parts of the body that can tolerate it better (e.g., the pelvis) rather than parts that can poorly tolerate it (e.g., the head).

As discussed in chapter 9, restraints must be used properly to achieve maximum benefit and to prevent injuries induced by the restraint sys-
tem itself. The mechanical properties of tissues impacted are considerations in the recommendation that infants not face forward in the automobile. Large head, weak neck muscles, and small pelvis all make it imperative that the infant be rear-facing and allow the crash forces to be distributed along the long axis of the infant’s body, thus avoiding spinal flexion injuries or abdominal injuries.

Prevention of bicycle-related head injuries

In a bicycle crash, the head is often the first body part to hit an object or the ground. The mechanical energy involved in the impact is transmitted directly to the skull and then to the brain and dural blood vessels. Helmets are designed to decrease energy transmitted to the head during impact.

During a crash, the head crushes the foam liner in the helmet. As the foam liner is crushed, it absorbs sufficient force to slow the head to a relatively gentle stop. This protects the head from the potentially lethal levels of energy it would otherwise sustain. In other words, helmets are designed to protect the head by absorbing and dissipating the energy of impact. Helmets are designed to spread a concentrated load over a larger portion of the head, protect against penetration, and remain on the wearer’s head during an impact.

Until recently, all helmets protected against a single impact. Once the foam was crushed, the helmet was no longer protective for future impacts and needed to be replaced. However, a new generation of multi-impact helmets is emerging. These helmets are made of new foams that crush during impact, but then recover after crushing. The foam is able to crush multiple times, making these helmets ideal for sports involving multiple falls such as rollerblading.20

Helmets must be worn properly to give their greatest protective effect. Four key points should be considered when purchasing and fitting a helmet — the four S’s: Sticker, Size, Straight, and Straps. A sticker indicating conformity with a recognized voluntary performance standard should be affixed to the inside of the helmet. (A sticker from The Snell Memorial Foundation on the inside of the helmet assures the buyer that the helmet has passed the most rigorous premarket and postmarket testing currently [1996] available for helmets.) The helmet should be sized to fit the child comfortably when placed on the head horizontally straight across the midforehead. Foam pads should be added to ensure a tight fit. Finally, the retention straps should be adjusted according to the manufacturer’s instructions so that the helmet will not come off during an impact. Like safety seats, helmets are complicated to use and are often used incorrectly.

1.2.3 Conclusion

Safety technologies are designed to minimize the energy delivered to the child during impact and to deliver this energy to the child in a manner that will result in the least severe injuries. The pediatrician can serve as an information resource for injury prevention strategies in the same way that he or she educates about disease. The frustration that accompanies using complicated safety devices can be lessened by counseling from a pediatrician who has an understanding of the biomechanical principles employed in the design of these technologies.

1.3 Behavioral Sciences and Pediatric Injury Control

Of all the major mandates in health care today, injury control is perhaps the one to which behavioral scientists have the most to contribute. The complexity of the task provides a compelling rationale for professionals with a wide range of backgrounds to contribute to injury control efforts. Within the behavioral sciences alone, many productive professionals have died or had their productivity diminished or compromised by injuries. In the landmark 1985 document, Injury in America, several major approaches were identified to prevent injuries.21 These include:

1. Persuading persons at risk of injury to alter their behavior to increase their self-protection — for example, to use seat belts or install smoke detectors.
2. Requiring individual behavior change by law or administrative rule — for example, by passing laws that require the use of seat belts or the installation of smoke detectors in all new buildings.
3. Providing automatic protection by product and environmental engineering — for example, installation of built-in sprinkler systems that automatically extinguish fires.

Each of these fundamental approaches to injury control can benefit from the behavioral sciences. Not only can behavioral scientists provide
guidance in the design of strategies to modify personal behaviors, they can also suggest how to best influence demand for and acceptance of public policy to reduce injury (legislation and regulation). Even passive (engineer)ing strategies can greatly benefit from the behavioral sciences since all technologies require human motivation and acceptance in their design and implementation. Tragically, thousands of lives were needlessly lost on our nation's highways in the several decades that passed between the development of air bag technology and its final acceptance into automobile design.

This section will emphasize the application of the behavioral sciences to the first fundamental approach: persuasion. To that end, a review of the areas of health education and behavior management are of particular pertinence to the work of pediatricians.

1.3.1 Active and Passive Strategies

All injury control strategies can be placed on an active-passive continuum depending on how dependent each strategy is on modifying human behavior. Automobile air bags that automatically inflate in a crash are considered passive. The traditional seat belt that an individual uses every time he or she enters an automobile is considered active. There is a broad consensus in the injury control literature that active approaches are more difficult to implement and less effective than passive approaches.22

While passive ("nonbehavioral") strategies to injury control are preferred, such strategies are not possible in many instances. For example, parents can turn down their hot water heater temperature to protect their children from scald burns, but there is no practical way to remove all potential sources of drowning in a home (toilets, buckets, and bathtubs). In those instances where a totally passive strategy is not feasible, a combination of active and passive strategies is desirable.

Despite the preference for injury control solutions that depend minimally on behavior, there is little chance that injury control can be realized without the contributions of both active and passive strategies. Effective injury control will always depend, in part, on an understanding of what motivates safe and unsafe behaviors and how those behaviors might be reinforced or modified.

1.3.2 Health Education

Most of the early efforts at injury control involved some form of health education. Health care providers often informed patients of the potential benefits and dangers of particular behaviors that their patient engaged in and would, typically, make alternative recommendations.

It is unfortunate that so much early (and current) effort in health education has been conducted without adequate evaluation. Often, even intensive safety education efforts, when subject to scrutiny, have been shown to have little or no benefit.23,24 It is therefore imperative that health education interventions be subject to the same objective scrutiny demanded for other kinds of injury control interventions.

Both Reisinger and Dershowitz tried brief (less than 2 minutes in duration) educational "pep-talks" for restraint-seat usage and smoke detector installation, respectively.25,26 Both studies reported minor improvements in parents' implementation of injury control measures. Later studies have shown that when health care providers took more time and effort to give the health education messages, more promising results emerged. Christopherson and his colleagues reported high rates of compliance with infant automobile restraint-seat use when a multidimensional educational program was used.27 Their program included the passage of state legislation, a hospital loaner program for provision of the restraint seats, nurses and physicians who encouraged and educated new parents about the need to use restraint seats, and a community-wide educational program about the advantages of restraint-seat use. The parents in the study correctly used restraint seats more than 85% of the time at hospital discharge and at 3-month, 6-month, and 12-month follow-up observations. It is unclear, however, how important a role the educational component played.

In an extension of this study, Treiber reported that similar health education approaches were effective in encouraging parents to use automobile-restraint devices for young children correctly.28 Treiber demonstrated parents had the highest compliance rates when they were informed about both the dangers of automobile travel and the advantages inherent in using child-restraint devices. Discussions of only the dangers of automobile travel or of only the advantages of restraint-seat use produced lower rates than the two strategies combined.
In another study, Thomas and her colleagues demonstrated the potential effectiveness of an alternative health education format—called group well-child care—in encouraging parents to lower the temperature of hot water heaters in their homes.\textsuperscript{29}

Future health education research should concentrate on identifying those components of multidimensional programs that may be critical to their effectiveness.

### 1.3.3 Behavioral Approaches

While health education efforts frequently have been used to encourage individuals to implement changes that will reduce the risk of injury that they face each day, a variety of behavior modification approaches also have been used in recent studies of injury control.

Behavioral researchers frequently have viewed problematic behavior as falling into one of two categories:

- Behaviors that need to be learned initially or increased in frequency, such as using seat belts and conscientiously monitoring children
- Behaviors that need to be eliminated or reduced in frequency, such as playing in the street, playing with matches, exceeding highway speed limits, and driving while intoxicated

Many standard behavioral interventions, including the use of tangible rewards and incentives, have been widely used in past research. Several researchers have applied these or similar interventions to injury control research.

Roberts and Turner used behavioral techniques to encourage parents and children to use automobile safety belts or child-restraint devices by rewarding parents for correct use.\textsuperscript{30} The parents were given lottery tokens redeemable for prizes if their children were appropriately secured with an automobile seat belt when they arrived at the child’s day care center. When the parents began receiving rewards based upon their seat belt use, there was an increase in their own use of seat belts. After the rewards were removed, seat belt use gradually declined.

Sowers-Hoag et al. used behavioral strategies, assertiveness training, and social and contrived reinforcers to successfully establish and maintain automobile safety belt use in young children.\textsuperscript{31} Geller and his colleagues also showed the effectiveness of rewards on increasing the use of child safety devices.\textsuperscript{32} These studies demonstrate that behavior modification strategies can be applied to injury prevention.

Mathews and colleagues reported on a program for teaching mothers to use standard child behavior management techniques to reduce the number of dangerous behaviors in their young children.\textsuperscript{33} They showed that the use of techniques originally developed to reduce other undesirable behaviors in young children was also effective in reducing dangerous behavior. In this study, teenage mothers were taught through modeling and demonstration how to reward their infants with brief physical contact for age-appropriate behaviors. They were also taught to dissuade dangerous behaviors by placing their child in a playpen for a brief timeout. The infants in the study engaged in potentially dangerous behaviors approximately 55\% of the time prior to training. After the mothers were trained in the use of these behavioral techniques, the children’s potentially dangerous behaviors occurred less than 10\% of the time. These results were maintained at a 6-month follow-up.

In the future, researchers should continue to study and refine promising techniques of behavioral modification to injury prevention problems. In the study by Mathews et al.\textsuperscript{33} the mothers were trained using in-home demonstrations by behavior therapists. Future research can examine whether the same procedures might work if used in an office setting. Future studies must also examine whether behavior changes can be sustained over extended periods of time.

In 1985, Gallagher et al. reported encouraging results from a program that utilized a three-part injury prevention strategy.\textsuperscript{34} The three strategies were regulatory (identification and abatement of violations of existing housing codes), educational (counseling on potential safety hazards in the home), and technological (installation and/or distribution of inexpensive safety devices at no cost to the family). Gallagher et al. showed that the homes in the intervention group had fewer household hazards—including fewer hazardous items and lower hot water heater temperatures. Future investigators should evaluate similar comprehensive programs that incorporate behavioral and nonbehavioral strategies.
1.3.4 Conclusion

The behavioral sciences play a complementary role to epidemiology and biomechanics in the development of focused injury control strategies. Pediatricians have traditionally relied on their behavioral science backgrounds to educate parents and patients to ensure compliance with recommendations. The application of behavioral sciences to injury control has the potential to extend the pediatrician's effectiveness in the office and in community-based endeavors.

References

2. DeHaven H. Mechanical analysis of survival in falls from heights of fifty to one hundred and fifty feet. War Med. 1942;2:586–596
An Office-Based Approach to Injury Counseling

The pediatrician has a key role in educating parents and children about injury prevention strategies. As the professional who regularly sees parents of young children, and as the professional who establishes and maintains a continuing relationship based on concern for the child's health, growth, and development, the pediatrician is key in influencing parental behavior to reduce risk of injury.

An effective office-based injury prevention program for children is developmentally focused and cogent, emphasizes the most important injuries, and actively engages the parent in a dialogue regarding injury prevention. Such a program engenders a sense of responsibility and urgency to adopt and follow safe practices. Any such program must take into account the parent's own viewpoint on injury prevention. In addition, an effective program is adaptable to office practice and works efficiently with other health supervision activities.

2.1 TIPP

Although a wide variety of materials are available for injury prevention and many pediatricians have developed their own system of injury prevention counseling, the American Academy of Pediatrics (AAP) TIPP (The Injury Prevention Program) is the most comprehensive system that is readily available for practicing pediatricians. TIPP consists of three major elements:

- A policy statement on injury prevention by the American Academy of Pediatrics Committee on Injury and Poison Prevention
- Childhood Safety Counseling Schedules
- Safety information sheets and safety surveys for use in providing anticipatory guidance to parents
2.1.1 Policy Statement

The Academy's first policy statement on injury prevention was published in 1982. The most recent version of the statement (October 1994) reflects the Academy's attempts to address the most significant issues of the 1990s (see Appendix C). The policy focuses on common injuries with known effective intervention strategies, such as child safety seats and smoke detectors, and addresses those issues of greatest significance to parents of children by age group. The policy has made injury prevention counseling a standard of care in pediatrics and provides an important benchmark defining comprehensive pediatric practice.

2.1.2 The Childhood Counseling Schedules

TIPP injury counseling schedules have been designed to correspond intentionally to the AAP Periodicity Schedule for children. An Early Childhood Safety Counseling Schedule and a Middle Childhood Safety Counseling Schedule are included in the program. Both schedules explain when to introduce concepts related to injury prevention, when they should be reinforced, and what materials are available to accomplish the goal.

2.1.3 Materials

Materials in TIPP include age-specific and topic-specific Safety Sheets (see Appendix E). Also included are the Framingham Safety Surveys, a series of developmentally oriented questionnaires that highlight specific risk areas for individual parents. TIPP sheets help focus the pediatrician's counseling at each visit on selected important injuries, ensuring compliance with the TIPP counseling schedules. The Safety Surveys highlight the education issues concerning injury that are most germane to the parent being counseled.

The Safety Surveys are a series of developmentally appropriate two-part forms on which only at-risk answers appear on the duplicate copy. The reading levels (fifth and sixth grade) of the surveys have made them adaptable to a wide range of clinical settings, and studies have shown them to be both well accepted and effective. TIPP sheets, Framingham Safety Surveys, and counseling schedules are color coded to allow for ease of use. In addition, TIPP includes a Guide to Safety Counseling in Office Practice that explains all the details of TIPP, as well as specific counseling guidelines for every question on each of the Framingham Safety Surveys.²

2.2 Additional Strategies

In addition to TIPP, other strategies are available to strengthen injury prevention counseling. The physician's office should be a model of safety in the waiting room, reception areas, and examining rooms. Posters promoting and demonstrating safety are available from many sources. In particular, announcements of hazardous products from the Consumer Product Safety Commission can be prominently displayed in the office. Use of such strategies creates an atmosphere in which parents can readily learn to appreciate the importance that the physician places on injury control.

2.3 Effectiveness of Physician Counseling

Although the AAP has recommended injury prevention counseling for more than a decade, the question of the validity of counseling has been raised in the literature over the years. At least three questions need to be addressed:

- Is there a need for the counseling?
- Is the counseling process effective?
- Can the results be documented?

2.3.1 Educational Needs

The need for injury prevention counseling is perhaps the easiest of these three questions to address. Several studies have demonstrated that parents do have varied and significant educational needs about injury prevention.

A 1980 study in Framingham, Mass, demonstrated the educational needs of parents regarding a wide range of injury prevention activities. This study included parents from suburban and clinic practices.³ Extraordinary deficiencies were identified in parental awareness and reported practice of basic injury prevention techniques for parents of
children of all age groups and among all social and ethnic groups studied. Knowledge deficiencies were noted in the areas of fire and burn prevention, poison prevention, and vehicular safety. Similar deficiencies were noted in a statewide survey that included nearly 1500 Massachusetts parents from urban, suburban, and rural communities. In addition, a study of clinic patients in Tennessee documented the educational needs of parents regarding the developmental aspects of injury prevention.

Although the three studies previously described date from the early 1980s and most closely reflect educational programs available to parents through the mid- to late 1970s, a more recent study using a nationwide telephone survey demonstrated that parents had significant educational needs concerning pedestrian and bicycle injuries, burns, and drowning. An interesting aspect of this study was that parents thought they would be most likely to obtain information on child safety from the physician's office and physicians were cited as the parents' first choice for information on injury control and child safety.

2.3.2 Effectiveness of the Counseling Process

An effective injury prevention counseling program must:

- Be easy to administer
- Be readily comprehensible to parents
- Make efficient use of the physician's time
- Address relevant issues that concern parents

A recent study performed by the AAP Department of Research showed that different groups of parents each adopt injury prevention strategies that reflect their own concepts of good parenting. Urban parents tend to believe that their children are safer indoors and are more concerned about hazards outside the home. They also think that keeping an eye on their children is most important for good parenting and that safety equipment is unnecessary provided supervision is available. Suburban parents, in contrast, tend to believe that good parents use safety equipment and supplies. Appreciation of such patterns of parental attitudes enables effective counseling to motivate compliance and overcome resistance to counseling suggestions.

2.3.3 Outcomes of Counseling

When the effectiveness of injury prevention counseling is reviewed, three types of outcomes can be examined: educational change, behavioral change, and change in the occurrence of injury. A recent review of the literature on the effectiveness of pediatric counseling has shown that of 20 studies reviewed, 18 demonstrated positive effects. The results and types of effects both for motor vehicle–related and non–motor vehicle–related injuries are summarized in Tables 2.1 and 2.2, p 28. This review included 11 randomized controlled reports. In view of these results, it is evident that physician counseling to prevent injury is an important component of pediatric primary care.

As a final point, the economic impact of injury prevention counseling may also be significant. A recently published analysis based on the AAP literature review estimated if the parents of all 19 million children from birth to 4 years of age received the TIPP counseling, approximately $230 million would be saved annually in medical spending due to injury and that injury costs overall would decline by $3.4 billion. Each dollar spent on TIPP was estimated to return nearly $13 in economic value.

Considering both the efficacy studies and the economic analysis based on those studies, ample evidence exists that pediatric injury preven-

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Design</td>
</tr>
<tr>
<td>Controlled/randomized</td>
</tr>
<tr>
<td>Controlled/not randomized</td>
</tr>
<tr>
<td>Multiple time series</td>
</tr>
</tbody>
</table>

*From Bass et al.6
### TABLE 2.2

<table>
<thead>
<tr>
<th>Study Design</th>
<th>Educational Measures</th>
<th>Behavioral Measures</th>
<th>Injury Occurrence Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled/ randomized</td>
<td>Increased recognition of household injuries</td>
<td>Increased home safety</td>
<td>Increased use of outlet covers</td>
</tr>
<tr>
<td></td>
<td>Decreased reported hot water temperature at tap</td>
<td>Decreased hot water temperature at tap</td>
<td>Decreased falls</td>
</tr>
<tr>
<td>Controlled/ not randomized</td>
<td>Increased reported ipecac possession</td>
<td>Increased home safety</td>
<td>Decreased injury rates and relative risk for injury</td>
</tr>
<tr>
<td>Multiple time series</td>
<td>Increased knowledge of ipecac use</td>
<td>Increased installation of smoke detectors</td>
<td>Decreased home accidents</td>
</tr>
<tr>
<td>Descriptive</td>
<td>Increased knowledge of poisoning prevention strategies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*From Bass et al.*

Injury counseling is an important effort of significant benefit to children and families.

### References


### AN OFFICE-BASED APPROACH TO INJURY COUNSELING