



AMERICAN COLLEGE OF SURGEONS
Committee on Trauma

Injury Prevention

Presented by the Subcommittee on Injury Prevention and Control

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Slide 1:

Title Injury Prevention

Slide 2: Introduction and Purpose

The purpose of this presentation is to increase the awareness by the health care community of the disease called "injury" and the concept of injury control.

The objectives are to:

- Characterize injury as a public health problem
- Detail the impact of injury on American society
- Identify control strategies and demonstrate how these can be applied to injury
- Highlight the key elements of effective, community-based prevention projects
- Address obstacles to prevention activities
- Identify resources for developing and conducting prevention programs
- Identify the role of the health care provider in prevention activities

Slide 3: Definition

Injury can be described as physical damage produced by the transfer of energy, such as kinetic, thermal, chemical, electrical, or radiant. It can also be due to the absence of oxygen or heat. The interval of time over which the energy transfer or the deprivation of physiologic essentials occurs is known as "exposure." The exposure may be acute or chronic.

Slide 4: Frequency
One of the most current information sources available on the health status of the nation is *Health, United States, 1998*.¹ The information in this slide text is taken from that source and other comparable sources.

Each year, 59 million Americans, (1 in every 4), sustain an injury. Not all injuries are fatal or serious enough to require inpatient care, but the total volume requires a tremendous allocation of health care resources. More than 36 million injury-related emergency department visits and 2.6 million hospital discharges occur annually. In 1995, there were more than 145,000 deaths due to injury.

Estimates place the lifetime cost of injury at more than \$250 billion. The majority of this sum is related to the indirect cost of productivity—loss from death and disability. The direct cost of medical services accounts for approximately 30 percent.

Slide 5: Mechanism and Outcomes
Injury can be blunt or penetrating, unintentional or intentional. Blunt injury represents the most frequent cause, but penetrating injury, particularly from handguns, is an increasing problem. Mechanisms of injury include motor vehicle crashes, firearms, falls (particularly in the elderly), fires, burns, drownings, and poisonings.

Some injuries, such as poisonings and drownings, are often not treated by trauma services or included in trauma registries. Trauma registries may not include all patients with injury, such as those treated and released from emergency departments or other outpatient care facilities. This omission presents problems for accurate data collection for injury surveillance.

Slide 5:
Mechanism and
Outcomes
(continued)

The majority of fatal injuries continue to be caused by unintentional blunt force trauma, and a significant proportion of those is a result of motor vehicle crashes. Intentional injury associated with penetrating wounds sustained as a result of homicide and suicide represents the next most frequent category and is a growing problem. Nationally, 80 percent of injuries are caused by blunt mechanisms and 20 percent by penetrating mechanisms.

In 1996, injury ranked fifth as a cause of death for all age groups, after cardiovascular disease and cancer. Injury, since 1980, remains the *leading* cause of death between 1 and 44 years of age.

Annually, motor vehicle-related injuries account for nearly 46,000 fatalities, over 500,000 hospitalizations, and injuries to 5 million persons who are not hospitalized. Injuries from motor vehicle crashes are the leading cause of death from age 5 through 27 years. Transportation and motor vehicle incident-related injuries are the leading cause of all injury deaths, as well as all occupational injury deaths.

Slide 6:
Disability and
Outcomes

Fatal injuries represent only a small portion of the total injury problem. For every death, there are 16 hospitalizations and nearly 400 outpatient encounters due to injury.

Injury is the leading cause of disability in the first 4 decades of life. Each year, approximately 90,000 people sustain injuries serious enough to produce long-term disability. Of these, 75,000 disabilities are related to traumatic brain injury. There are 6,000 spinal cord injuries, which result in quadriplegia or paraplegia.

Because the incidence of injury is greatest in the young, it is associated with a far greater rate of years of life lost (YLL) per death than is cancer or heart disease, which generally have their onset in the later years of life. The young also are our most productive members of society, just entering their work years, while elderly victims of

cancer and heart disease are, for the most part, in retirement.

Slide 7:
Injury Does Not Equal
Accident

The real problem as it relates to injury prevention and control rests in the word “accident.” According to *Webster’s*, an accident is “an unexpected occurrence which happens by chance.” It is an event that is not amenable to planning or prediction. Injury, however, is a definable, correctable event, with specific, identifiable risks for occurrence.

Perhaps a better definition for “accident” is that it results because of a risk that is poorly managed.

Accidents or, rather, injuries, don’t just happen. They are caused by lack of knowledge and/or carelessness—a lack of proper training and realization that a risk exists.

Injury truly is a disease entity and must be approached as such. When viewed in this light, injury is preventable, diagnosable, treatable, survivable, and ultimately, controllable.

Like other diseases, there are patterns we can identify. These relate to age, gender, race, association with alcohol and other drugs, geographic factors, socioeconomic factors, and offending agents.

- ! Injury is a disease of males, which has 2 peaks in death rates: between the ages of 15 and 35 and then again for those aged greater than 65. The greatest incidence is in the 15–40 age group.
- ! Very young children make up the largest portion of deaths attributable to fires and burns, drowning, and unfortunately, homicides related to child abuse.
- ! Homicide is the leading cause of deaths in children under the age of 1.
- ! Overall, in young adults, nearly half of all injury deaths are caused by motor vehicle-related incidents.
- ! A growing concern is related to firearms and violence. Firearm-related injuries have a disproportionate incidence in young, adolescent African-Americans and are the leading cause of their deaths.

! In the elderly, falls account for the largest proportion of injury-related fatalities.

Slide 7:
Injury Does Not Equal
Accident
(continued)

Identification of many of the patterns and factors associated with the incidence of injury is not difficult or complex. Working in an emergency department or trauma center for a short period of time will demonstrate the fact that alcohol and other drugs play a major role in injury occurrence and contribute to over 50 percent of injury-related deaths.

Research shows that nearly 50 percent of patients admitted to the trauma service had recently consumed alcohol, and of these, 36 percent were legally intoxicated. Of intoxicated trauma patients, 75 percent were noted to have behavioral evidence of chronic alcohol use, and between 25 percent and 35 percent had biochemical evidence of chronic alcohol use.

Analysis of injury death rates by place of residence reveals that, while the incidence of unintentional injury in rural areas is less than that in urban locations, the death rate is appreciably higher. Conversely, for homicide, the death rate is far less in rural areas.

When injury death rates are analyzed in relation to income status, we find that for unintentional injury and homicide, there is an inverse correlation. Those in the lower income categories have higher death rates. While income may be a proxy for other factors which may be equally responsible for this finding, such as level of education or ability to produce health insurance, the association between income and injury death rates cannot be denied.

Slide 8:
The Epidemiologic
Triangle—One Model
of Injury Assessment

“Prevention is the vaccine for the disease of injury.”

The analysis of injury patterns in groups of people helps to determine the causal factors for injury occurrence. This analysis, in turn, allows for the development of programs of prevention and control targeted at the high-risk groups that appear at risk for injury. One model used for many years in research on the causation of disease is referred to as the “Epidemiologic Triangle.” This triangle consists of 3 components: host, agent, and

environment. A key assumption of this model is that each component must be studied in order to determine proper strategies for prevention.

Slide 8:
The Epidemiologic
Triangle—One Model
of Injury Assessment
(continued)

The HOST is the person at risk for injury. The AGENT is the entity, which causes the disease. In injury, the agent is always ENERGY. There are different mechanisms of injury by which energy is transmitted. The ENVIRONMENT is the context in which the interaction between host and agent occurs. This can refer to either the local environment that influences injury occurrence or the social, political, economic environment that predisposes to particular types of injury events.

Slide 9:
General Principles

Prevention strategies have more recently been categorized using the concept of the 4 “E’s,” those being related to: Education, Enforcement (in addition to Enactment), Engineering, and Economic incentives and penalties.

Education strategies for injury prevention are effective in a number of ways and at varying levels. Programs can be targeted at the high-risk groups identified in populations. Examples include bicycle and helmet safety programs for children, alcohol and crash awareness programs for high school students, and violence prevention and conflict resolution programs for inner city, urban populations. The variety is endless, but the program must be relevant and meaningful to the population at risk as identified in the planning process.

Educational efforts are relatively easy to begin for those inexperienced with injury prevention methods.

Enforcement and enactment strategies identify opportunities for injury prevention that can be legislated for the protection of all citizens. Examples include seat belt or car seat laws, stoplights at dangerous intersections or railroad crossing gates. Statewide efforts to promote trauma system legislation also come under this category. Although more time consuming, the impact is more significant and sustained than education alone.

Slide 9:
General Principles
(continued)

Engineering is an effective way to reduce the impact of energy transmission across the host by design. Better head protection from better-designed helmets and better occupant restraints in vehicles decrease the impact that energy has and limits the effect of the injury event.

When purchase costs act as a barrier, and to reinforce injury prevention legislation when voluntary participation is necessary to achieve compliance, economic incentives and penalties can serve to provide access to prevention devices, such as child restraint seats.

Slide 10:
The Haddon Matrix

To further expand the range of potential injury control interventions, one can attempt to modify the host agent or environment utilizing 1 or more of the 4 “E’s” in the pre-event, event, or post-event phases of the injury. This slide depicts the Haddon Matrix which was introduced by Dr. William Haddon, Jr., in 1970. It is one of the most widely used mechanisms for generating a range of injury prevention strategies. In this example of the Haddon Matrix, motor vehicle crashes are analyzed by the “Host,” “Agent,” and “Environment” factors in 3 phases: pre-event, event, and post-event.

The Haddon Matrix and Injury Prevention

	Pre-event	Event	Post-event
Host			
Mechanism			
Environment			

Slide 11: A Public Health Approach

The value of using the Haddon Matrix to analyze injury risks is that it naturally leads to discussion about how best to control injury. This is a frequently omitted process in many injury prevention programs. Five key components are identified. First, based on surveillance, *“What is the problem?”* This information is often available from the trauma registry, but may also be derived from the coroner’s office or police reports. Second, *“What is the cause?”* Use the Haddon Matrix format to perform a cause analysis. This should involve as many individuals as possible, not merely trauma center personnel. Third, *“What interventions might work to prevent or control the problem?”* The Haddon Matrix analysis will suggest opportunities for control based upon the 4 E’s previously discussed. Fourth, *“How do you best implement the proposed solution(s)?”* The same broad coalition brought together to identify the problem and analyze the causes should develop the action plan. Without broad-based community support, little long-term effect will result. Fifth, *“Did it work?”* Outcome measurement and the assessment of effect are also frequently neglected components of injury prevention programs. Without these, however, there is no way to document the effectiveness of the prevention program.

Slide 12: Control

Injury prevention and injury control are *not* synonymous terms. There are 3 categories of injury PREVENTION, all of which, taken as a whole, comprise injury CONTROL:

- ! *Primary prevention* seeks to totally eliminate the injury incident from occurring.
- ! *Secondary prevention* minimizes the severity of injuries that occur during incidents that cannot be primarily prevented.

- ! *Tertiary prevention* involves efforts following the incident that will optimize the outcome from injury, regardless of injury severity.

Slide 13: Injury countermeasures and prevention strategies ARE effective! A good example was the decline of highway fatalities after the phasing in of federal motor vehicle and state highway safety standards and the further reduction brought about by the institution of a national 55-mph speed limit in 1973. This was the result of combined technologic, educational, and legislative strategies.

Strategies

The effects of enforcement and enactment are demonstrated in this observational study showing that when the posted speed limit is 65 mph, the percentage of cars noted to exceed 70 mph ranged from 19 percent to 32 percent. However, in states where the posted speed limit was 55 mph, the percentage of cars exceeding 70 mph was less, ranging from 8 percent to 14 percent.

The institution of motorcycle helmet legislation also appears to be effective in controlling motorcycle crash fatalities. In comparing fatalities in states with helmet use laws with those in states that had no such laws during the study period, a reduction in the fatal crash involvement per 10,000 motorcycles was witnessed for states with helmet laws.

As the active enforcement of the Child Passenger Protection Act in Tennessee began in 1980, the number of citations issued rose, while the number of pediatric traffic deaths correspondingly declined.

With the institution of a law requiring window protection in New York city public housing, the number of window fall fatalities in children was reduced by half over the period of 1 year and continued to decline 2 years after the law took effect.

As the number of households with smoke detectors has increased over the years, fire deaths per million have been shown to have a corresponding decrease.

Slide 14:
Host Factors

The human element (or host factors) cannot be ignored when considering prevention interventions. Prevention strategies can be active or passive. There is a hierarchy of effect among the various prevention strategies (the 4 E's) that is generally inversely proportional to the amount of active involvement required: Technology-related strategies are among the most effective, with legislative strategies somewhat less effective, and educational strategies least effective and taking the longest time to show effect.

Air bags, for example, provide the greatest likelihood of protection because they require the minimal amount of effort. Air bags deploy automatically in a crash whether you want them to or not. Manual seat belts, on the other hand, require a maximal amount of effort on the part of the host to utilize them. Therefore, they provide the least likelihood of protection, despite the uncontested proof that seat belts save lives. An intermediate likelihood of protection is associated with automatic seat belts, which correspondingly require an intermediate amount of effort on the part of the vehicle occupant.

Active strategies, on the other hand, involve more participation on the part of the individual at risk in order to achieve the desired effect. Helmet safety programs, for example, require an educational component that must be continually reinforced to be effective.

Slide 15:
A Successful Program

This slide illustrates a prevention strategy that embodies all the components necessary for a successful prevention program. The bicycle helmet program

highlighted here was conceived and implemented by the Harborview Injury Prevention and Research Center in Seattle, Washington.

Based on data from the Northwest Regional Trauma Center at Harborview Medical Center, it was found that 86 percent of 173 fatally injured bicyclists sustained their most severe injuries to the head and neck region. The current literature suggested that a significant number of head injuries could be prevented or lessened in severity through the use of bicycle helmets.

Slide 15:
A Successful Program
(continued)

To encourage the use of bicycle helmets, the “Head Smart” campaign was developed and implemented throughout the greater Seattle area. The campaign was spearheaded by the Injury Center, but integrally involved a community coalition of schools, businesses, and the media. A public information and education initiative, using various media, alerted the community as to why they should be “Head Smart,” where to be “Head Smart,” and where to get “Head Smart.”

Discount coupons for the purchase of bicycle helmets were distributed at various sites throughout the community through the sponsorship of a helmet manufacturer and a number of local retailers.

A key component of the project was the evaluation piece. This piece compared an observational study of unadjusted helmet use rates between Seattle and Portland, a socioeconomic-geographically similar city. These rates were compared at baseline, prior to institution of the “Head Smart” program, and at intervals of up to 1 year after institution of the campaign. While usage rates increased in both cities over the study period, the observed helmet use rate plateaued at 1 year in Portland, while it continued to rise in the Seattle area.

Bicycle helmet use has continued to rise to an observed rate approaching 70 percent.

Correspondingly, the mortality rate for Seattle bicyclists was noted to decline during the period of the campaign.

Success of the campaign can also be inferred from data showing a decrease in the percentage of patients admitted with serious injuries to the head, represented by an AIS score of 4 or 5, and a parallel increase in those with minor to moderate injuries in the head region represented by an AIS score of 1 to 3. It would appear that increased helmet usage was associated with converting many of what were previously categorized as severe head injuries into minor or moderate injuries.

Slide 15:
A Successful Program
(continued)

This evaluation of the “Head Smart” campaign and analysis of pre- and post-campaign data allowed credible substantiation of efficacy and provided a sound foundation upon which to request further funding for expansion of the program to other areas of the state. Lack of program evaluation can therefore be a problem and is often due to inadequate funding, lack of expertise, failure to realize the importance of the evaluation component, or, perhaps, fear of the results. Demonstration of positive and tangible results directly attributable to a prevention program is often a difficult task, but can, and should, be attempted. Failure to demonstrate efficacy is also an important finding. With information from a properly conducted evaluation, one can determine why a program was ineffective, improve it, or abandon it in favor of one which may prove to be more successful.

Slide 16:
Community-based
Programs

Successful community-based injury prevention programs depend upon a community-wide sense of ownership and empowerment to accomplish tasks. Successful community-based programs also revolve around the formation of new partnerships between a diverse group of constituents who have a vested interest in injury control, including representatives of public safety, law enforcement, and fire and EMS agencies; local government; schools; businesses; community groups; health care providers; and public health agencies.

The process involves building an injury control coalition among the relevant stakeholders, using community data to identify injury problems of priority and their causes, developing and testing solutions and interventions based on coalition consensus, implementing these interventions, and evaluating the intervention process, as well as outcome, using evaluation variables generated by the coalition.

Slide 17:
Health Care Provider's
Role

There are many opportunities for health care workers in the area of injury prevention. These include helping to define the injury problem by providing, collecting, or analyzing injury data; assisting in the design of interventions; selecting and participating in a plan of action; and participating in the evaluation of the program or intervention.

There are a number of reasons why we should be involved in injury prevention efforts. Injury affects us on a daily basis, either professionally, personally, or as a tax-paying member of the community. We are continually facing the aftereffects of injury. We can be a powerful force in the community that can help bring about change. We can make a difference individually, or as part of a larger public or professional community effort.

This role in prevention efforts can revolve around primary, secondary, or tertiary prevention strategies. It can involve the advancement of education of the public, as well as the health care community, both in the magnitude and epidemiology of the injury problem, as well as specific risk-avoidance behaviors. Legislative education and facilitation of the enactment and enforcement of pertinent injury prevention and public safety legislation, or health care policy, may be involved. Advancement of technology related to the prevention and/or treatment of injury and its sequelae may also be involved.

This role in secondary and tertiary prevention efforts may be as simple and perfunctory as accurate and complete documentation of injuries or safety device use for cataloging into trauma registry and other injury information databases. It can even be the mere act of participating in trauma systems and the clinical care of trauma patients.

Slide 18:
Obstacles to
Participation

Despite the broad spectrum and relative ease of participation in prevention efforts, common obstacles to involvement with injury prevention by health care providers include uncertainty regarding effectiveness and value, role, time commitment, and costs associated with participation.

Slide 19:
Resources

There are many local, state, regional, and national resources available on injury prevention activities. Many of these are available through the Internet. Local resources include hospitals and trauma centers, community civic organizations, businesses, law enforcement/fire/EMS agencies, and health departments.

At the state level, the department of transportation, the governor's highway safety representative, the state health department, and the state EMS office often have programs and materials available for local use.

On the regional level, the National Highway Traffic Safety Administration (NHTSA) has a number of regional offices across the country, and the Centers for Disease Control and Prevention funds injury prevention and research centers throughout the nation.

Three particularly useful documents include:

! *Injury Prevention: You Can Do It. A Community Guide to Injury Prevention*

This is produced and available through the Harborview Injury Prevention and Research Center.

! *The PIER (Public Information and Education Resource) Manual*

This is produced and available through the National Highway Traffic Safety Administration (NHTSA). While it is primarily intended for prehospital EMS providers, it is appropriate for use by any health care provider interested in this important aspect of injury prevention.

! *The Prevention of Youth Violence. A Framework for Community Action*

This is produced and available through the Department of Health and Human Services and the Centers for Disease Control and Prevention.

! *The SAFE Document*

This recent release from NHTSA is primarily aimed at the EMS provider, but it is easily adaptable and used by surgeons, nurses, and other interested health care providers.

Slide 20:
Effective Programs

Injury control must be community based and encompass a multidisciplinary approach. Public information and education are key components of any injury control program to garner grassroots support, as well as to influence legislative and health care policy initiatives. Technology and tertiary prevention measures continue to be the most developed and effective methods of injury control. Behavioral and cultural modifications brought about through educational strategies and primary injury prevention programs are slower to take effect, but equally important and necessary to optimize injury control.

Health care providers play an important role in prevention activities. Problem identification can occur in hospitals' emergency departments and trauma centers. Additional information may be available from the coroner and police reports. Data collection concerning the magnitude and severity of injury involves trauma registrars and others with access to care data. Health care providers should be involved in the intervention design process and selection of the action plan. Measurement of effect is an essential component of prevention efforts.

Reference

1. National Center for Health Statistics: *Health, United States, 1998*. Hyattsville, MD, Public Health Service, 1998.