CDC Objective #1, Understand the Conceptual Framework of Injury Prevention, with location of relevant IHS materials noted in Blue.

Comments from Group:
- Content here subject to consideration for review or exclusion only.
- Perhaps warrants quick overview in intro. Should not be main objective.

Session I. Understand the Conceptual Framework of Injury Prevention

1. Injury Definition.
   
   Billings Injuries as a PH Problem.ppt. Slides 6-8 (Injuries aren’t accidents).

2. Injury classification.
   
   Billings Injuries as a PH Problem.ppt. Slide 5 (Unintentional/intentional).

3. The global burden of injuries.

4. The cost of injuries.
   
   Billings Injuries as a PH Problem.ppt. Slides 4, 20 (Cost to AI/AN communities), 15 (Types of costs) 18-19, 21 (National costs), 25-30 (Interventions that save money), 32 (Cost benefits of prevention to AI/AN communities);
   Injuries as a PH Problem Presentation.ppt. Slides 3, 15 (Cost to AI/AN communities, same as above), 11 (Types of costs, same as above), 14 (National costs, same as above), 16-21 (Cost benefits of prevention);
   Alcohol and Injuries Presentation.ppt. Slide 12 (Photo of injured AI);
   Billings Alcohol and Injuries.ppt. Slide 15 (Photo of injured AI);
   Data Collection Strategies.ppt. Slides 5 (Determining cost of injuries is one objective of surveillance), 11 (Limited info on costs of death), 12 (Hospitalization costs easier to describe), 14 (Distribution of resources to reduce cost of injuries).

5. Conceptual models for understanding and preventing injury: The public health approach to injury prevention;
   
   Billings Injuries as a PH Problem.ppt. Slides 5 (Preventing injuries based on our ability to use PH approach), 23-24 (About PH approach);
   Injuries as a PH Problem Presentation.ppt. Slide 22 (About PH approach, same as above);
   Billings Alcohol and Injuries.ppt. Slide 5 (About PH approach, same as above);
   Alcohol and Injuries Presentation.ppt. Slide 4 (About PH approach, same as above);
   Marketing.ppt. Slide 2 (About PH approach, same as above);

The Epidemiological Triad;

IP Intervention Theory Presentation.ppt. Slides 3-4, 11 (About);
Introduction to Data Presentation Billings Area 2011.ppt. Slides 7-9 (Brief mention).

The Haddon Matrix;

IP Intervention Theory Presentation. Slides 11-19 (About - see entire presentation for
The Ecological Model.

   - Data Collection Strategies.ppt. Slides 4-28 (10-Step plan for data collection).
   - Goals and Objectives Powerpoint Presentation Billings.ppt. Slide 14 (Ex Goal: Develop Injury Surveillance System);

7. Ethical considerations.
INJURY SURVEILLANCE TRAINING MANUAL

PARTICIPANT GUIDE

SESSION I

UNDERSTAND THE CONCEPTUAL FRAMEWORK OF INJURY PREVENTION

Source: National Center for Injury Prevention and Control

Developed with the support of the National Center for Injury Prevention and Control
Division of International Health, Epidemiology Program Office
Centers for Disease Control and Prevention
Atlanta, GA
SESSION I

UNDERSTAND THE CONCEPTUAL FRAMEWORK OF INJURY PREVENTION

Learning Objectives

- Understand concepts, definitions, and classification of injury.
- Know the differences between violence-related and unintentional injuries.
- Describe the global burden and cost of injuries.
- Know the conceptual models for understanding and preventing injury.
- Know the steps to develop an injury surveillance system.
- Review ethical considerations.

Introduction

This session reviews key concepts of injury prevention. You are encouraged to review these concepts before the training course. The definition of injury and its varied classifications are reviewed in the first part of the session; the magnitude of the injury problem worldwide is covered in the second part. Conceptual models for understanding and preventing injury (Epidemiological Triad, Haddon Matrix, and Ecological Model) are also covered. Afterwards, the steps to develop and maintain an injury surveillance system are discussed. Finally, ethical considerations are mentioned.

1. Injury Definition

An injury is caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts or at rates that exceed the threshold of human tolerance (Baker et al. referenced Gibson 1961 and Haddon 1963). In some cases (for example drowning and frostbite), injuries result from the sudden lack of essential agents such as oxygen or heat. About three-fourths of all injuries, including most vehicle crashes, falls, sports, and shootings, are caused by mechanical energy.

“Injury” Versus “Disease”

Some definitions of injury include a relationship between the time of exposure and appearance of an injury, usually classified as “short.” Some experts consider that the interval between exposure and the appearance of injury can be relatively long, such as in poisoning from carbon monoxide, alcohol abuse, or heavy metals. The distinction between injury and disease is a related issue. Consider the following examples:
In each of the preceding examples, we would say the first victim suffered from an “injury,” while the second suffered from a “disease.” Acuteness is certainly a factor: the shorter the time from exposure to a hazard to its physical effects, the more likely we are to call the resulting condition an “injury” rather than a “disease.”

Other experts have added to this discussion: “It is the acuteness of exposure that differentiates injury from disease. Thus, acute smoke inhalation is generally classified as an injury, whereas chronic damage from substances such as lead and cigarette smoke are excluded as injuries because toxic effects often occur slowly. This distinction is somewhat arbitrary and certainly not rigid, but it is conceptually useful for classification, research, and policy purposes.”

<table>
<thead>
<tr>
<th>Injury</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>A construction worker fractures his toe while using a jackhammer.</td>
<td>Another worker is diagnosed as having tendonitis of the elbow from the chronic vibrations of the jackhammer.</td>
</tr>
<tr>
<td>An operator at a nuclear power plant is burned severely when a fuel rod breaks open.</td>
<td>A fisherman develops thyroid cancer 20 years after fallout from an aboveground nuclear test that blanketed his boat with radiation.</td>
</tr>
<tr>
<td>A child is bitten by guard dog and requires 10 stitches to his leg.</td>
<td>A child dies of rabies after a bat bite.</td>
</tr>
</tbody>
</table>

**Interval from Appearance of Injury to Death**

The interval from the appearance of injury to death could be immediate, or as long as months or years. For instance, in the United States, a death can be linked to an injury at any time. It is classified as “injury sequelae” if one year or more has elapsed since the injury. In the Fatality Analysis Reporting System (FARS) of the U.S. National Highway Traffic Safety Administration, for vehicles traveling on public roads, all injuries resulting in the death of the victim within 30 days of the event are considered motor vehicle-related death. Another example is the Fatal Injury Surveillance System in Cali, Colombia, that classifies a death as injury-related regardless of the length of time between the injury and death. In some cases, this period could exceed one year. The situation in other countries may be different.

**“Injury” Versus “Accident”**

“Accident” is often used to mean an unintentional event that produces, or has the potential to produce, an injury. Sometimes, the word “accident” is used synonymously with “injury.” However, many experts in public health believe that widespread use of the term “accident” has not only caused semantic confusion, but has inhibited efforts to reduce injuries.
What Injuries Are Not

- Injuries are *not* accidents!
- They do not happen by chance.
- They are not random acts.

Accidents are events that are without apparent cause, or are unexpected.

Ask the audience: Was the rollerblader's injury an accident? Could we have predicted it would occur?
This is because many people think of an “accident” as being something unpredictable or “an act of God” (Holder et al. referenced Haddon 1968). In actuality, events that injure people are not random and have identifiable risk factors. These events involve interactions among people, vehicles, equipment, processes, and the physical and social environment. For these reasons, the word “accident” should be avoided.5

2. Injury Classification

Injuries can be classified by the intention of the act into two groups: unintentional injuries and violence-related injuries (also called intentional injuries). The first group includes injuries related to transportation and traffic incidents, or occurring at home, in the workplace, in public places, and in natural disasters. The second group includes injuries related with interpersonal, collective, terror-related, and self-inflicted violence.

Unintentional Injuries

Unintentional injury is defined as:

1. Physical damage to the body;
2. Damage resulting from excessive energy applied to the body (physical, radiant, etc.); or from exposure to external agents (e.g., poisons); or from the absence of essentials (warmth, oxygen);
3. The application, exposure, or deprivation not done deliberately to oneself or by another person.

Unintentional injuries occur by a number of mechanisms, including falls, road traffic, water hazards, fire and hot liquids, and poisonings.3 The energy that causes injury may be:

- Mechanical (an impact with a moving or stationary object such as surface, knife, or vehicle);
- Radiant (ultraviolet radiation);
- Thermal (air or water that is too hot or too cold);
- Electrical (lightning strike, electric shock);
- Chemical (a poison or mind-altering substance such as drugs or alcohol).6

Unintentional injuries account for about two thirds of all injury deaths in the United States. Almost half are attributable to motor vehicle-related incidents. In Table 1, the mechanism of injury is matched with the place of injury occurrence. Shaded boxes indicate locations where the injury occurs most often.
Injuries are considered to be either **unintentional** or else **intentional** in nature.

**Unintentional injuries** (like the falls, car crashes, drowning and burns) occur without the intent of anyone involved; and

**Intentional injuries** (including the varied types of violence) occur because of a person’s **deliberate** intent to harm another person

Our ability to prevent these types of injuries is based on our ability to effectively use the public health approach.
### Table 1. Unintentional Injuries

<table>
<thead>
<tr>
<th>Mechanism of Injury</th>
<th>Place of Occurrence</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Home</td>
<td>Sports/Leisure</td>
<td>Workplaces</td>
<td>School Facilities</td>
</tr>
<tr>
<td>Burns/Scalds</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>From electrical appliances, cooking mishaps, cooking stoves with open flame, radiators, home fires, fireworks</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Cuts/Lacerations</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Toys, sports, playgrounds, furniture, household gadgets, gadget blades, occupational hazards</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Drowning</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>At pools and beaches or from floods, falls into ponds and wells, water transport</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Impact Injury</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Falls from rooftops, windows or furniture; falls related to agriculture, construction, recreation, sports, or transportation (automobiles, cyclists, pedestrians, motorcyclists)</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Electric Shock</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>From household gadgets, toys, and substandard or hazardous wiring; improper use of and substandard electrical gadgets</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Poisoning</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>From medicines, household chemicals, cooking fuels, seeds</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Suffocation/Asphyxia</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>From infant and toddler furniture, clothes and toys, plastic bags, swallowing of seeds or toys</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Firearms</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Insect and Animal Bites</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>From dogs, snakes, scorpions, etc.</td>
<td></td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>


### Violence-Related Injuries (Intentional Injuries)

The World Health Organization (WHO) defines violence as:

> The intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment, or deprivation.7

The three categories differentiate among violence a person inflicts upon oneself (self-directed); interpersonal violence inflicted by another individual or by a small group of individuals; and violence inflicted by larger groups such as states, organized political groups, militia groups, and terrorist organizations.

Each broad category is subdivided into specific types of violence. Self-directed violence includes suicidal behavior and self-abuse. Interpersonal violence includes two subcategories: violence between family members and intimate partners, and community violence between individuals who are unrelated (usually in a place other than the home). Collective violence is subdivided into social, political, and economic violence. The social violence category includes, for example, crimes of hate committed by organized groups, terrorist acts, and mob violence. Political violence
includes war and related violent conflicts, state violence, and similar acts carried out by large groups. Economic violence includes attacks by large groups motivated by economic gain. Clearly, acts committed by large groups can have multiple motives.

A violent act can also be classified by its nature. The four categories are physical violence, sexual violence, psychological violence, and violence involving deprivation or neglect. These four types of violent acts occur in each of the broad categories described above—except self-directed violence. For example, violence against children can include physical, sexual and psychological abuse, or neglect.

In the *World Report on Violence and Health*, violence is divided into three categories according to the person who commits the violent act and into four categories according to the nature of the violence. The horizontal array shows who is affected, and the vertical array describes how they are affected (Table 2).

### Table 2. A Typology of Violence

<table>
<thead>
<tr>
<th>Nature of Violence</th>
<th>Self-Directed</th>
<th>Interpersonal</th>
<th>Collective</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Suicidal Behavior</td>
<td>Self-Abuse</td>
<td>Family/Partner</td>
</tr>
<tr>
<td>Physical</td>
<td></td>
<td></td>
<td>Child</td>
</tr>
<tr>
<td>Sexual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deprivation or Neglect</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


According to WHO, an estimated 1.6 million people worldwide died in 2000 as a result of self-inflicted, interpersonal, or collective violence. Nearly half of these deaths were suicides; one third were homicides; and one fifth were war related. International estimates on physical and sexual assaults are lacking, as systems for reporting and compiling these data are absent in many countries, or are still being developed. There are often cultural and social pressures to keep violence behind closed doors or to accept it as a natural facet of human relations. Even in areas where surveillance systems are in place, victims may be reluctant to report violent experiences.
3. The Global Burden of Injuries

Every day around the world, almost 16,000 people die from injuries, according to WHO. For every person that dies, several thousand more are injured, some of them with permanent sequelae. Motor vehicle-related injuries are the eleventh leading cause of mortality worldwide (Table 3).

Table 3. Leading Causes of Mortality Worldwide, Both Sexes — 2002

<table>
<thead>
<tr>
<th>Rank</th>
<th>Causes</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ischemic Heart Disease</td>
<td>12.6</td>
</tr>
<tr>
<td>2.</td>
<td>Cerebrovascular Disease</td>
<td>9.6</td>
</tr>
<tr>
<td>3.</td>
<td>Lower Respiratory Infections</td>
<td>6.6</td>
</tr>
<tr>
<td>4.</td>
<td>HIV/AIDS</td>
<td>4.9</td>
</tr>
<tr>
<td>5.</td>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>4.8</td>
</tr>
<tr>
<td>6.</td>
<td>Perinatal Conditions</td>
<td>4.3</td>
</tr>
<tr>
<td>7.</td>
<td>Diarrheal Diseases</td>
<td>3.1</td>
</tr>
<tr>
<td>8.</td>
<td>Tuberculosis</td>
<td>2.8</td>
</tr>
<tr>
<td>9.</td>
<td>Trachea, Bronchus, Lung Cancers</td>
<td>2.2</td>
</tr>
<tr>
<td>10.</td>
<td>Malaria</td>
<td>2.1</td>
</tr>
<tr>
<td>11.</td>
<td>Road Traffic Injuries</td>
<td>2.1</td>
</tr>
<tr>
<td>12.</td>
<td>Diabetes Mellitus</td>
<td>1.7</td>
</tr>
</tbody>
</table>


In 1998, road traffic injuries were the leading cause of unintentional injury deaths in the world. Suicides were the leading cause of violence-related injury deaths and the third leading cause of injury overall (Table 4).

Table 4. Injury-Related Mortality Worldwide — 1998

<table>
<thead>
<tr>
<th>Injury Deaths</th>
<th>Number of Deaths</th>
<th>Mortality Rate (per 100,000)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unintentional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Traffic Injuries</td>
<td>1,170,694</td>
<td>19.9</td>
<td>20.3</td>
</tr>
<tr>
<td>Drowning</td>
<td>495,463</td>
<td>8.4</td>
<td>8.5</td>
</tr>
<tr>
<td>Falls</td>
<td>315,633</td>
<td>5.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Burning</td>
<td>282,178</td>
<td>4.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Poisoning</td>
<td>251,881</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Other Unintentional Deaths</td>
<td>977,259</td>
<td>16.6</td>
<td>16.9</td>
</tr>
<tr>
<td>Violence-Related</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suicide</td>
<td>947,697</td>
<td>16.1</td>
<td>16.4</td>
</tr>
<tr>
<td>Homicide</td>
<td>735,972</td>
<td>12.5</td>
<td>12.7</td>
</tr>
<tr>
<td>War</td>
<td>588,050</td>
<td>10.0</td>
<td>10.2</td>
</tr>
<tr>
<td>Total</td>
<td>5,764,825</td>
<td>97.9</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Age and Sex of Victims

According to WHO, an estimated 520,000 homicides occurred in 2000, with an adjusted rate of 8.9 per 100,000 population. Nearly 80% of the homicides were males, with a rate of 13.6 per 100,000, three times higher than for females, for which the rate was 4.0 per 100,000. Males aged 15 to 29 years had the highest rates of homicide of all age groups (19.4 per 100,000)7 (Table 5).

### Table 5. Estimated Global Homicide and Suicide Rates by Age Group and Sex — 2000

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Homicide Rate*</th>
<th>Suicide Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td>0–4</td>
<td>5.8</td>
<td>4.8</td>
</tr>
<tr>
<td>5–14</td>
<td>2.1</td>
<td>2.0</td>
</tr>
<tr>
<td>15–29</td>
<td>19.4</td>
<td>4.4</td>
</tr>
<tr>
<td>30–44</td>
<td>18.7</td>
<td>4.3</td>
</tr>
<tr>
<td>45–59</td>
<td>14.8</td>
<td>4.5</td>
</tr>
<tr>
<td>60+</td>
<td>13.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Total **</td>
<td>13.6</td>
<td>4.0</td>
</tr>
</tbody>
</table>

* Rates per 100,000 population
** Age standardized


High- Versus Low-Income Countries

Analysis of mortality causes by region reveals important characteristics (Table 6). In high-income countries, self-inflicted injuries are the twelfth leading cause of injury mortality, and road traffic injuries are the fourteenth leading cause. In low-income countries, road traffic injuries are the tenth leading cause of death.8

### Table 6. Leading Causes of Mortality in High- and Low-Income Countries, Both Sexes — 2002

<table>
<thead>
<tr>
<th>High-Income Countries Rank Causes</th>
<th>Percentage of Total</th>
<th>Low-Income Countries Rank Causes</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ischemic heart disease</td>
<td>17.0</td>
<td>1. Ischaemic heart disease</td>
<td>11.8</td>
</tr>
<tr>
<td>2. Cerebrovascular disease</td>
<td>9.8</td>
<td>2. Cerebrovascular disease</td>
<td>9.6</td>
</tr>
<tr>
<td>3. Trachea/bronchus/lung cancers</td>
<td>5.8</td>
<td>3. Lower respiratory infections</td>
<td>7.0</td>
</tr>
<tr>
<td>4. Lower respiratory infections</td>
<td>4.4</td>
<td>4. HIV/AIDS</td>
<td>5.7</td>
</tr>
<tr>
<td>5. Chronic obstructive pulmonary disease</td>
<td>3.9</td>
<td>5. Chronic obstructive pulmonary disease</td>
<td>5.0</td>
</tr>
<tr>
<td>6. Colon/rectum cancers</td>
<td>3.3</td>
<td>6. Perinatal conditions</td>
<td>5.0</td>
</tr>
<tr>
<td>7. Alzheimer and other dementias</td>
<td>2.7</td>
<td>7. Diarrheal diseases</td>
<td>3.6</td>
</tr>
<tr>
<td>8. Diabetes mellitus</td>
<td>2.6</td>
<td>8. Tuberculosis</td>
<td>3.2</td>
</tr>
<tr>
<td>10. Stomach cancer</td>
<td>1.8</td>
<td>10. Road traffic injuries</td>
<td>2.2</td>
</tr>
<tr>
<td>11. Hypertensive heart disease</td>
<td>1.6</td>
<td>11. Trachea/bronchus/lung cancers</td>
<td>1.6</td>
</tr>
<tr>
<td>12. Self-inflicted injuries</td>
<td>1.6</td>
<td>12. Hypertensive heart disease</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Unintentional Injuries

The major types of unintentional injury have similar rates in most countries. However, the nature and extent of injury varies widely by geographic, cultural, urban/rural, and other factors. In Table 7, the major causes of severe injury in high-income countries are compared with those of low-income countries. Once the differences are understood, appropriate data can be gathered and effective preventive measures can be instituted.

Table 7. Major Causes of Severe Unintentional Injuries in High- and Low-Income Countries

<table>
<thead>
<tr>
<th>Low-Income Countries (causes not ranked)</th>
<th>High-Income Countries (causes not ranked)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fire and Burns</strong></td>
<td></td>
</tr>
<tr>
<td>Fires in slums and squatter housing</td>
<td>House fires in private dwellings, especially in slum housing and mobile homes</td>
</tr>
<tr>
<td>Scalds from boiling water</td>
<td>Scalds from hot tap water, cooking gas, boiling water</td>
</tr>
<tr>
<td>Ignition of clothing from cooking on open fires, with kerosene lamps, or on pressurized stoves</td>
<td>Ignition of clothing by cigarettes, outdoor fires, portable heaters</td>
</tr>
<tr>
<td>Children falling into open cooking fires</td>
<td>Occupational burns from molten metals, gasoline-powered appliances/vehicles</td>
</tr>
<tr>
<td><strong>Drowning</strong></td>
<td></td>
</tr>
<tr>
<td>Children falling into open wells</td>
<td>Children falling into home swimming pools</td>
</tr>
<tr>
<td>FLOODS</td>
<td>Leisure boat incidents</td>
</tr>
<tr>
<td>Public transport on waterways</td>
<td>Intoxicated persons near any body of water</td>
</tr>
<tr>
<td><strong>Falls</strong></td>
<td></td>
</tr>
<tr>
<td>Workers falling from high trees (e.g., palm or coconut trees)</td>
<td>Construction workers</td>
</tr>
<tr>
<td>Children falling from rooftops, farm animals, or low trees (e.g., fruit trees)</td>
<td>Children falling from apartment windows</td>
</tr>
<tr>
<td>Home construction and repair</td>
<td>Children or elderly falling down stairs</td>
</tr>
<tr>
<td></td>
<td>Incidents involving baby walker devices</td>
</tr>
<tr>
<td><strong>Motor Vehicle-Related</strong></td>
<td></td>
</tr>
<tr>
<td>Vulnerable road users (pedestrians, bicyclists, etc.) struck by motor vehicles</td>
<td>Occupants of private automobiles involved in single- and multiple-vehicle crashes</td>
</tr>
<tr>
<td>Motorcycle crashes</td>
<td>Motorcycle crashes</td>
</tr>
<tr>
<td>People falling off transport vehicles; crashes of public transport vehicles (buses and trains)</td>
<td>Pedestrians (especially children and elderly) struck by cars</td>
</tr>
<tr>
<td>Truck drivers killed in crashes</td>
<td>Farm tractor rollovers</td>
</tr>
<tr>
<td>Laborers falling from open truck beds</td>
<td>Young people falling from recreational all-terrain vehicles (ATVs)</td>
</tr>
</tbody>
</table>

Violence-Related Injuries (Intentional Injuries)

Most violence-related deaths occur in low- to middle-income countries. Less than 10% of all violence-related deaths occur in high-income countries.7 (See Figure 1.)

Figure 1. Proportion of Violence-Related Deaths

![Proportion of Violence-Related Deaths](image)


The Injury Pyramid

Mortality data are a powerful injury indicator, but deaths from injury comprise just a fraction of the impact of injuries on a population. For each death from injury, many more result in hospitalization, emergency department or general practitioner treatment, or treatment that does not involve formal medical care.

According to WHO, in the world’s high-income countries, for every person killed by injury, 30 people are hospitalized, and 300 are treated in emergency rooms; even more are treated in other health care facilities. This does not reflect the situation in developing countries, which have fewer resources for prevention, treatment, and rehabilitation of injuries. In all countries, people of low income are especially prone to injury and are less likely to survive or recover from disability.7

The injury pyramid shown in Figure 2 helps illustrate this fact. The pyramid top is composed of deaths, which are fewer in number, but more visible. Following deaths are severe injuries resulting in hospitalization and disability, usually classified by health sector, public or private. The third category is less-severe injuries, requiring emergency treatment. Next are injuries treated in basic health facilities. At the bottom of the pyramid are injuries which do not receive attention in a health institution. Estimates of these injuries can only be obtained through surveys or special research. For instance, a survey conducted in Nicaragua of 10,000 households showed that only 1 in 10 injured persons visited a local hospital for treatment.9
In addition to the severity of an injury, a host of cultural and economic factors determine the level of treatment an injury victim receives. As a result, injury pyramids cannot be compared across countries and are thus provided here for illustrative purposes only.

**Figure 2. The Injury Pyramid**
4. **The Cost of Injuries**

The reliability and validity of estimated costs of various injuries are greatly affected by the completeness and detail of epidemiologic surveillance. Accurate reporting of death rates, hospitalization, and disability from specific injuries by age and sex provides a foundation for estimating the economic impact. If rates for a wide range of injury events and outcomes are not available, it is difficult to calculate injury costs.\(^\text{10}\)

In 1992, direct and indirect annual costs due to gunshot wounds in the United States were estimated at $126 billion, with an additional $51 billion due to cutting or stab wounds.\(^\text{10}\) In New Brunswick, Canada, the mean total cost estimate per suicide was over $849,000.\(^\text{11}\) In Latin America, the Inter-American Development Bank sponsored studies of the impact of violence in six countries between 1996 and 1997. These studies found that the cost of violence, expressed as a percentage of the gross domestic product (GDP) was 1.9% of the GDP in Brazil, 5.0% in Colombia, 4.3% in Peru, and 0.3% in Venezuela.\(^\text{12}\)

Although direct costs such as hospital and physician charges, medications, and transportation are the most easily measured, acquiring data on such costs can be difficult. The list of direct costs is extensive and the information is not always in a usable form (Table 8).

**Table 8. Partial List of Direct Costs of Injuries**

<table>
<thead>
<tr>
<th><strong>Emergency Services:</strong></th>
<th>Ambulance, emergency room, personnel (Emergency Medical Technicians/Paramedics, Physicians, Nurses, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospital Inpatient Costs:</strong></td>
<td>Physicians, operating room, drugs</td>
</tr>
<tr>
<td><strong>Hospital Outpatient Services:</strong></td>
<td>Medications, appliances</td>
</tr>
<tr>
<td><strong>Office-Based Services:</strong></td>
<td>Physicians, Nurses</td>
</tr>
<tr>
<td><strong>Rehabilitation:</strong></td>
<td>Physical, occupational, speech and hearing therapy, prosthesis</td>
</tr>
<tr>
<td><strong>Long-Term Care:</strong></td>
<td>Custodial care, modification of home environment (e.g., wheelchair ramps)</td>
</tr>
<tr>
<td><strong>Home-Health Services:</strong></td>
<td>Nurses, Aides, Caregivers</td>
</tr>
<tr>
<td><strong>Administrative Costs:</strong></td>
<td>Insurance companies, government medical agencies, vehicle, barrier, and other property damage</td>
</tr>
<tr>
<td><strong>Legal Fees and Court Costs</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Law Enforcement and Judicial Costs</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Welfare and Human Services Costs:</strong></td>
<td>Social Workers, Medical Social Workers, support payments</td>
</tr>
<tr>
<td><strong>Funeral and Medical Examiner Costs</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Costs for Other Affected Persons:</strong></td>
<td>Witnesses time in court, family members</td>
</tr>
</tbody>
</table>

Why Injury Prevention?  **FIRST**, in injury prevention we seek to address injury death rates throughout Indian Country that are much higher than those of the overall U.S. population in some cases 2 to 3 times. There are many issues involved in this, including such factors as personal behavior, community law enforcement, and access to medical care, as well as geographic factors and lifestyles that contribute to injuries in many areas. You’ll be seeing more about these and other factors throughout this course.

**SECOND**, AI/ANs ages 1-44 are hugely affected by injury deaths and disabilities. Within this age range, injuries are the largest cause of death and disability. It’s only after reaching age 45 that deaths from other conditions like cancer and heart disease exceed injuries. **However**, it’s very important to remember that, when AI/ANs reach age 45, the injury problem doesn’t just go away. It remains a strong cause of death and disability among older populations, and in some communities it’s still the largest cause. We need to carefully identify the causes, locations and other factors of these injuries, in order to **accurately** identify prevention measures that **effectively** address these injury causes affecting different age groups.

Please **don’t misunderstand** the third point. We **ARE NOT** placing more importance on money over people. Quite the opposite – our priority is to have enough resources to treat **ALL** eligible patients for **ALL** medical conditions. But the treatment of injuries, especially **severe** injuries, is often **very** expensive, and is often needed by many injury victims **for the rest of their lives**. All the hospital stays, surgeries, medications, therapies and other treatments needed for severe injuries can become a major drain on health care budgets. And because IHS, like all other agencies, has a limited annual budget, all the funds used to treat severe injuries reduces the funds available for non-injury treatments. In many Tribal communities, there are often several “non-emergent” medical conditions that **cannot** be treated because of a lack of funds, since so much health care money is spent to treat local severe injuries.
AI/AN Injury Costs

- IHS Injury Treatment Costs
  - Inpatient
    » $1507/day (Medicaid reimbursement rate for 1 day at an IHS facility)
  - Contract Health
    » $11,305/inpatient case
    » $570/outpatient case

- One Alaska Corporation (TCC) spent $4.15 million for injury hospitalizations from ’94-’98

Sources - (1) Indian Health Focus-Injuries 1998-99 (2) Chandler B, Berger L: Financial Burden of Injury-Related Hospitalizations to an Alaska Native Health System

The cost of treating injuries among AI/AN populations continues to grow. For fiscal year 2002, the Medicaid reimbursement rate for 1 day at an IHS facility was $1507. Between FY 94-97, IHS spent over $128 million just on injury hospitalizations at contract care facilities. This came to about 18% of the entire IHS Contract Health Services budget for that period. At $11,305 per contract hospitalization as you see here, that works out to over 11,400 inpatient cases treated at contract facilities. During the same period, the cost of contract care for outpatient injuries totaled an additional $41 million, for the treatment of nearly 73,000 outpatient cases, again just at contract facilities. Now how many other beneficial treatments do you suppose IHS might have been able to provide to AI/AN if this huge amount of funds had not been spent on injury hospitalizations?

A fellowship project in 1999 sought to determine the total injury costs to the Tanana Chiefs Conference (TCC) for years 94 through 99. TCC is comprised of 14,000 Alaska natives scattered among 42 villages and the city of Fairbanks. TCC does not have a hospital instead they pay for medical expenses not covered by 3rd party health insurance. Approximately 60% of the TCC service population have medical insurance. The study found that even with the utilization of 3rd party sources, TCC still spent $4.15 million dollars for injury hospitalizations over a 5 year period. This is a considerable portion of the TCC healthcare budget..
What are the costs of injury?

- Physical Losses
- Financial
- Emotional
- Treatment

Ask the class… “What the costs of Injury” in terms of the following variables. Try to get participants to provide possible answers (provided in parentheses below) instead of giving them to them.

- Physical (Loss of mobility, Loss of independence)
- Financial (Personal – loss of salary, cost of funeral, single parent, Community – loss of community member (tribal councilperson), contract health costs)
- Emotional/Impact on Family (Loss of a parent, Loss of a child, Loss of a friend)
- Treatment (ER costs, Hospitalization, Rehab)
While it’s very true that we can help prevent needless suffering and deaths through injury prevention, we should also remember that there can be genuine monetary benefits to preventing injuries. First, though, we need to consider the economic burden of treating severe injuries.

In the Level I course, we briefly discussed the costs of injuries. In this course, we intend to expand our discussion of it.

It’s uniformly true that the costs of providing health care treatments only go in one direction, and that’s up, not down. ALSO, the hospital rates that you see do not include emergency treatment costs (including ambulance transport and Emergency Room treatments), nor do they include the costs of post-hospital treatments and therapies often needed for many severe injuries.

Injury costs throughout the US are now about $224 BILLION each year, including direct medical care and rehabilitation costs, as well as lost wages of the individuals, and productivity losses to the nation.

But WHO actually PAYS for these treatment costs?

- PRIVATE source (e.g., insurance) pay about 72% (or about $161 Billion) of the cost of injuries.

- PUBLIC sources (federal, state and local) pay about 28% (or about $63 Billion) of the cost of injuries.

The Federal government (which is part of the public share) pays out about $12.6 Billion annually in medical costs and $18.4 Billion in disability and death benefits.
We have been discussing the fact that injury hospitalizations are expensive. In fact, typically they are the most expensive type of hospitalization.

This data from the state of California shows the average comparative hospitalization costs per discharge type for a two year period. Injury is the most costly.

It's important to note that some injuries can lead to catastrophic costs. Serious head and spinal cord injuries can lead to millions of dollars in costs over a lifetime.
As a part of the TCC injury cost study, the average cost per case was calculated. Firearm related injuries were the most costly at $17,250 with off road injuries very close behind at $16,933 per case. (Off road injuries were those that involved snowmobiles and ATVs.) MVC injury related cases was third costing $11,538 per cases.
Now that we’ve discussed the burden of injury, let’s discuss some of the benefits of injury prevention. In preventing injuries, we can prevent needless suffering and deaths, and we should also remember that there can be genuine monetary benefits to preventing injuries, not just to the individual but to the community as well. There have been a few research and evaluation reports that have documented the cost savings of injury prevention in terms of dollars. Let’s look at a few……
Interventions that Save Money

- Primary seat belt laws/Child Car Seats
- Streetlights and guardrails
- Bike helmets

We know that there are many effective measures that help reduce both the number and severity of injuries. These are just a few of the many interventions that we can use to reduce injury deaths and disabilities.

Ask the class…… Are you aware of any of the listed interventions going on in their communities?.

Ask the class…… Are you aware of any additional injury prevention examples?
(Other examples could include:
  - reduced speeds
  - improved signage
  - new striping
  - road edge grooving on roads
  - sidewalks/bike paths separate from roads
  - police radar/video
  - carbon monoxide detectors
  - gun closets)
Interventions that $\textit{Save}$ Money

- DUI Laws
- Personal Floatation Devices
- Smoke detectors
- Gun locks

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- carbon monoxide detectors
- gun closets)
While injury prevention measures often don’t totally eliminate injuries, they are often effective in reducing the SEVERITY of the injury or injuries suffered. This in turn helps make for lower overall treatment costs. For example, every bike helmet utilized saves $395 dollars in treatment costs if an injury occurs. Every child seat properly utilized save $1360 and every smoke detector save $900.
Injury Prevention:  
Potential for Cost Savings

Victim Treatment costs resulting from each Motor Vehicle Crash:

- **NOT wearing** a seat belt: $2,395
- **Wearing** a seat belt: $470

Source - Phipps L: Cost Comparison of Medical Treatment for Restrained vs. Unrestrained Motor vehicle crash victims at a northeast Oklahoma IHS hospital (IHS Injury Prevention Fellowship)

A fellowship conducted by Lovetta Phipps looked at the treatment costs for Native Americans injured in motor vehicle crashes at a hospital in northeastern Oklahoma for a nine month period. Ms. Phipps compared costs for those wearing seat belts to those who were not. Her findings indicated that treatment costs were reduced by 80% when wearing seat belts in a crash as compared to not wearing them. ($2,395 as compared to $470.)

These estimates are very conservative as they were only for emergency room care and hospitalization for injured motor vehicle occupants at an IHS hospital. It did not include subsequent ambulatory and inpatient charges or charges for the 4 unrestrained patients who were treated in contract health care facilities.

Note to Instructors: Refer to/point out location of article by Lovetta Phipps in Student Manual or CD ROM

(IHS Primary Care Provider – March 1997 edition.)
Injury Prevention Cost Savings Projects in Indian Country

- Navajo Nation – occupant restraint usage
- Whiteriver, AZ – pedestrian crash reduction
- White Mountain Apache – livestock control
- Y-K Delta, AK – drowning prevention

A cost outcome (cost benefit and cost effectiveness) analyses of 4 transportation injury prevention efforts was undertaken by the Pacific Institute for Research and Evaluation. The article is included in your binder.

Pre and post intervention data were analyzed to estimate the projects' impact on injury reduction. The four transportation injury prevention efforts were the (1) the passage and implementation of a primary safety belt law; (2) the street light project designed to reduce pedestrian crashes in Whiteriver, Arizona; (3) a motor vehicle-livestock crash reduction project on the Fort Apache Reservation (Whiteriver, Arizona); and (4) a drowning prevention project in the Y-K Delta in Alaska.

This paper was the first to analyze the economic consequences of safety intervention in AI/AN jurisdictions. The analyses performed was a pretty technical process as it calculated both costs (project and operating) and savings (in terms of estimated reduction in medical and public program expenses, estimated decrease in lost productivity, and estimated quality adjusted life years saved.) All four projects yielded positive benefit cost ratios. In short, they saved money while saving lives and they suggest that many other injuries can be prevented cost effectively by similar interventions.

Note to Instructors: Provide the following background information to participants about each of the projects.

Navajo Nation Occupant Restraint - In 1988, the Navajo Nation passed a primary seat belt law. The law permitted officers to stop vehicles for seat belt use violations alone. The transition period between passage of the law and full enforcement saw an intensive public information campaign promoting the new law and the benefits of seat belt use.

Whiteriver Pedestrian Crash Reduction - A cluster of pedestrian fatalities was identified within a 1.1 mile stretch of roadway in downtown Whiteriver. 28 streetlights were installed. IHS funded a demonstration lighting project, AZ DOT widened the road. Recently, BIA funded reinstallation and upgrade of the lights.

White River Livestock - Data showed that 1/3 of all collisions were animal related in Whiteriver and the surrounding area. A law regarding the impoundment of livestock already existed, but allowed exemptions for tribal members. The Tribal Council amended the law and hired a livestock coordinator who picked up and impounded the livestock.

Y-K Delta Drowning – The Yukon Kuskokwim Health Corporation launched a drowning prevention project aimed at reducing drowning deaths in Y-K rivers. A float coat program was implemented which initially was unsuccessful. After changing the marketing strategy (message and incorporating consumer preferences such as color and style), the purchase of float coats increased dramatically.

Ask participants where they could see Cost Savings from each of these projects? (possible answers: fatalities, damage to vehicles, vehicle insurance, less severe injuries)

Note to Instructors: remind participants to read the article to obtain additional information that may be useful to their injury prevention efforts back at home.
Community benefits from injury prevention cost savings

- Elective medical services
  - more non-emergent treatments (surgeries, therapies, preventive services, other programs)

- Resources for additional community services
  - housing authorities
  - transportation programs

Many IHS / Tribal medical facilities have “waiting lists” of patients needing treatment for conditions that aren't life-threatening, but which can strongly impact their quality of life. Unfortunately, the funds for such treatments are all too often used up in treating severe injury cases. In addition, Tribal services are also strained by injuries, as housing authorities often must “rehab” homes to accommodate wheelchairs, and Tribal transportation services are often strained to accommodate local residents needing frequent trips for ongoing treatments and/or therapy for severe injuries.

It makes sense that, if we can reduce severe injuries in a community, then treatment funds are more available to serve the rest of the community for the non-emergent “quality of life” treatments that benefit the entire community. And Tribes can also make better use of their program funds to provide a greater range of services to benefit the ENTIRE community.

Remember, this can be a strong potential selling point for promoting injury prevention in your communities.
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(Other examples could include:
- reduced speeds
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- road edge grooving on roads
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- carbon monoxide detectors
- gun closets)
Safety equipment saves more than lives . . .

- Every bike helmet (for kids 4 – 15) saves $395 in treatment costs
- Every child seat saves $1,360
- Every smoke detector saves $900

References: National Public Services Research Institute / National SAFE KIDS Campaign

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IHS Day 1, Injuries as a PH Problem, Injuries as a PH Problem Presentation PPT, slide 20
Community benefits from injury prevention cost savings

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Remember, this can be a strong potential selling point for promoting injury prevention in your communities.
Describe the photos to highlight the point that risky alcohol use can lead to costly health problems.

Do you think he was wearing his seatbelt? Will he ever be the same again? We will spend money on his injuries, he may need to be transported to a Level 1 trauma center, injury rehabilitation, family situation, and long-term injury effects.

What does “risky alcohol use” mean?
Risky Behavior: high BAC levels mixing with risky behavior and risky environments. Examples: driving while intoxicated, sleeping outside in the winter, aggression
Step 1: Define Objectives

What will be done with the data?

What is the purpose?

How will injury be defined?

What is the case definition?

Key discussion points:

• Data collection requires substantial planning. Part of the planning involves determining your objectives for collecting the data.

• You should consider the purpose of surveillance and what might be done with the data.

• (OPEN FLOOR DISCUSSION & SUMMARIZE ON FLIP CHART; DISCUSSION SHOULD GENERATE A LIST WITH A SAMPLE OF THE FOLLOWING:)

  (pg 324-326 Christoffel/Gallagher)
  ✓ Understand injury problem well enough to design targeted programs
  ✓ Track progress & monitor trends in the magnitude & distribution of injury
  ✓ Identify new and emerging hazards in a timely fashion
  ✓ Describe injury patterns to justify need for a program
  ✓ Assess the global impact of a program
  ✓ Overview or snapshot of leading causes
  ✓ Determine magnitude/nature of perceived injury problems
  ✓ Better understand injuries at a particular location (hwy, home, school, workplace)
  ✓ Determine health care costs associated with injury
  ✓ Support policy and intervention efforts
  ✓ Marketing and disseminating data
  ✓ Linking data sources

• There’s much to consider in developing your INJURY DEFINITION and CASE DEFINITION…
Key Discussion Points:

• Deaths:
  • Readily accessible from death certificates, states, central data bases; inexpensive
  • Cause of death from injury consistently reported on death certificate
  • Rare events; ~1% of all injuries
  • Not good guide to ascertain overall injury problem or medical consequences (i.e., long term disability)
  • Influenced by small numbers, especially in small population/short time periods
Case Definition & Severity: Hospitalization

+ Better picture of the overall problem (w/deaths)
+ Describes disability & healthcare costs
- Access to data
- Data Quality & Reporting Inconsistency
- High demand on resources

Key Discussion Points:
• Hospitalizations:
  • When combined with mortality data, provides a much better picture of injury problem
  • Disability and healthcare costs can be better described
  • Access to data more difficult (privacy act, HIPAA, manual records)
  • Inconsistent or incomplete coding of injury causation; EXAMPLE: Ethnicity not a variable, coding, RPMS/RCIS not 100% utilized
  • Data collection, particularly manual review of records, consume significant human resources.
Key Discussion Points:

• **Outpatient/Physician Visits:**
  - May be good for specialized injuries (sports related, eye injuries)
  - Might be good supplemental information but in general not the place to start with injury surveillance
  - Difficult access. EXAMPLE: Behavioral Health data is highly protected by practitioners.

In summary re: severity and your case definition:

• Don’t try to do everything at once! Start small, with deaths and most severe injuries. Plan to expand and phase in other levels of severity as resources permit.
• You can work on prevention projects without knowing everything about every injury in your community.

• From Robertson’s *Injury Epidemiology, 1st ed.*, Pg. 29-30: The specification of injury severity is an essential element of the use of injury epidemiology for injury control. In any given year, virtually everyone experiences minor injuries, such as small scratches, bruises, and burns. Most of these heal with little to no treatment and do not interfere with one’s activities. The energy sources, vehicles and vectors, and other circumstances of injuries are often not the same for those that are relatively severe and those with trivial consequences. Since trivial injuries are so common, priority in the devotion of resources to control injuries based on total numbers in a given category can result in substantial misallocation of resources with respect to reducing the cost of injuries and the improvement of the quality of life of the severely injured or their families.
5. Conceptual Models for Understanding and Preventing Injury

**The Public Health Approach to Injury Prevention**

The public health model to prevention has been applied to a wide range of noninfectious and infectious public health problems, with a remarkable record of success. Although many scientific disciplines have advanced the understanding of injury, public health brings something that has been missing to this field: a multidisciplinary scientific approach that is explicitly directed toward identifying effective methods of prevention.

This model is based on the following principles:

a. Emphasis on primary prevention;
b. Multidisciplinary in nature;
c. Science-based;

The public health approach begins by defining the problem through surveillance systems, surveys, and other sources. The second step is to identify associated risks and causes through research. The third step is to develop and evaluate interventions. The last step is to widely implement interventions that show promise. Although Figure 3 illustrates a linear progression through these four steps, in reality, many of these steps are likely to occur simultaneously.

**Figure 3. Public Health Approach to Injury Prevention**

Source: National Center for Injury Prevention and Control
Injuries are considered to be either \textit{unintentional} or else \textit{intentional} in nature.

\textbf{Unintentional injuries} (like the falls, car crashes, drowning and burns) occur without the intent of anyone involved; and

\textbf{Intentional injuries} (including the varied types of violence) occur because of a person’s \textbf{deliberate} intent to harm another person

Our ability to prevent these types of injuries is based on our ability to effectively use the public health approach.
Who can remember the Public Health Approach?

What's the first step? (defining the specific injury problem)

Then where do we go? (identifying the specific factors involved in the problem)

Next? (identifying solutions to the problem)

And Finally? (implementing AND evaluating the preventive measures that reduce the problem;) It's very important to include the evaluation of the prevention measures, in order to verify the success or failure of the preventive measures in reducing the injury problem.)

And, if you remember from Level 1...

Traditional health care often focuses on the TREATMENT of the individual.

The public health focuses on the PREVENTION of disease and disability in the overall population.

Injury prevention serves both the community and the individual.
A Public Health Approach:

Starts with defining the problem and moves toward identifying risk and protective factors.

It also includes developing, implementing, and evaluating injury prevention interventions.

Public Health often takes a two pronged approach to health care; concern with the health of the public in general, as well as the health of individuals within the public.

In injury prevention we tend to focus on both.

Let’s all read this together (READ GRAPHIC). As you can see, the public health approach calls for us to do four things:

- identify the specific problem
- identify the various factors that contribute to the problem
- identify, develop, and evaluate potential preventive measures to reduce the problem (sometimes this involves a pilot project before full implementation in a community)
The Epidemiological Triad

William Haddon, the former director of the United States National Highway Traffic Safety Administration and the Insurance Institute for Highway Safety, played a leading role in bringing epidemiological principles to injury research and intervention programs. Haddon maintained that injuries could be easily examined from an epidemiological framework. In its classic sense, epidemiology considers the interaction of three factors in the development of disease: the host, the agent, and the environment, which is called the epidemiological triad (Figure 4).

Figure 4. Epidemiological Triad

The Haddon Matrix

Haddon applied the epidemiological triad primarily to unintentional injuries, and most often to injuries from motor vehicle crashes. As diagrammed in Figure 4, the host is the human being whose behavior is operation of the vehicle. Physical energy is the agent in injury events. For motor vehicle events, this translates into the physical energy involved with motor vehicles. The environment is the milieu in which the vehicle and the human interact—the type of road, the weather conditions involved, and so forth.14

Haddon extended the epidemiological triad even further to consider how these factors relate to the crash sequence. The crash sequence can be examined in terms of three elements: the circumstances surrounding the event prior to the crash; the circumstances of the crash; and those that follow the crash. The crash sequence interacts with human, environmental, and vehicular factors to define the frequency and severity of injury. Table 9 shows examples of the risk factors related to the likelihood of injury in motor vehicle crashes within the framework of the epidemiological triad and the Haddon Matrix.
We discussed these four PH Principles that are important in developing IP Interventions.

1. The relationship between HOST, AGENT, and ENVIRONMENT - otherwise known as the EPIDEMIOLOGY TRIANGLE - and how this relationship influences injury and the design of IP Initiatives.

2. Three levels of prevention - PRIMARY, SECONDARY, AND TERTIARY - and how these basics of PH are applied to IP.

3. In the most general of terms, an intervention is either a - PASSIVE or ACTIVE.

5. The importance of knowing what STRATEGIES are EFFECTIVE and what lessons have been learned from those that are not effective.

Let’s review each of these.
The injury model of the epidemiologic triangle is very similar to that of the traditional or infectious disease model. The HOST refers to the injured person, the ENVIRONMENT refers to the characteristics of the physical and social environment, and the AGENT is the energy that is transferred to the body at a rate sufficient to cause injury.

The parallel of the HOST and ENVIRONMENT between the traditional model and injury model has been relatively easy to understand. Simply put, there are characteristics and behaviors of a person that can help contribute to injury (like drunk driving) or that can help prevent injury (like wearing a seatbelt). Likewise there are characteristics in the physical environment (like smoke detectors in the home) and in the social environment (like laws and society’s unacceptance of drunk driving) that are important to injury prevention.

The use of the epi triangle to explain the AGENT of injury was a bit more difficult to describe until early injury prevention practitioners clarified that agent of injury was primarily the transfer of energy to the body at rates that cause damage (like the energy transferred when an unrestrained motor vehicle occupant’s head strikes the windshield during a crash); or in some cases (like drowning and hypothermia) the agent of injury is the result of the absence of such essentials as oxygen and heat.

Make sure to mention that the epi triangle is a useful way to think about injuries because it provides the IP Practitioner with three different opportunities for intervening.
In this session we will briefly review the Haddon Matrix and learn about another contribution of Dr. William Haddon: his 10 Countermeasures or Technical Strategies.

And we will introduce the Intervention Decision Matrix—another tool to aid in choosing which interventions may be right for a particular community.

Dr. Haddon felt that injuries were not just “accidents” caused by human error or behavior, but could be reduced or prevented by applying concepts we discussed in the Host, Agent, Environment—Epidemiologic Triangle, and the 3 Levels of Prevention.

Dr. Haddon is most famous for his “Haddon Matrix”—a way to look at planning for injury interventions by phases in time: Example Motor Vehicle Crash:

Pre-Injury Event phase--before the crash took place

Injury Event phase--during the crash

Post-Injury Event phase--after the crash

and then to assess the contributing factors from the perspective of:

Host or Human Factors;
Agent of Energy or Vehicle such as crashworthiness of a vehicle;
the Physical Environment such as Roadway design or safety features;
and the Social Environment, such as passage and enforcement of seat belt laws .

Agents of Injury: (Remember from Level 1, the epi triangle, with host, agent, and environment?)

Injuries, for the most part, result from short-term exposure to large concentrations of energy:
- Mechanical: crushing injury in wringer washer, energy transferred during M/V crash
- Thermal: heat injuries—fire, hot water scalding
- Chemical: battery acid spill, poisoning
- Electrical: lightening
- Radiation: sunburn, overexposure to x-ray
- Absence of oxygen: drowning, suffocation, smoke inhalation, carbon monoxide
- Absence of heat: hypothermia, frostbite
- Excess heat: heat stroke (hyperthermia)

Two Main Injury Categories: (An “agents of injury” isn’t a very specific way to categorize injuries for data collection and analysis)
- Unintentional: Drowning, Fall, Fire/Burn, MVC, Poisoning, Other
- Intentional: Suicide, Self-Harm, Assault (child abuse, elder abuse, domestic violence, etc)

Note to Instructor:
- Transition from two main categories of injury to ICD-9
- Consider statement similar to: “…In the medical field, injuries are classified with a standardized coding system call the International Classification of Disease…”
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Two Main Categories of Injury:

<table>
<thead>
<tr>
<th>Unintentional</th>
<th>Intentional</th>
</tr>
</thead>
<tbody>
<tr>
<td>✤ Drowning</td>
<td>✤ Suicide</td>
</tr>
<tr>
<td>✤ Fall</td>
<td>✤ Self-Harm</td>
</tr>
<tr>
<td>✤ Fire</td>
<td>✤ Assault</td>
</tr>
<tr>
<td>✤ Burn</td>
<td>✤ Child Abuse</td>
</tr>
<tr>
<td>✤ MVC</td>
<td>✤ Elder Abuse</td>
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- Host or Human Factors;
- Agent of Energy or Vehicle such as crashworthiness of a vehicle;
- the Physical Environment such as Roadway design or safety features;
- and the Social Environment, such as passage and enforcement of seat belt laws.

In 1962, Dr. Haddon developed a list of 10 general strategies or Countermeasures to use to interfere with the energy transfer/injury process. Many of our proven effective strategies are based upon at least one of these Haddon Countermeasures. (Ref: Injury Prevention Meeting the Challenge)

These 10 Countermeasures are another way to help to brainstorm ideas to prevent or reduce injuries. You are not required to use all 10 strategies trying to brainstorm intervention ideas. Practically speaking, the countermeasures are presented in a hierarchical way so that if you can’t develop an intervention for countermeasure #1, the you would go on to countermeasure #2 and brainstorm intervention ideas (and so on…). The countermeasures are organized so that they focus on those interventions with the broadest impact – policy development and environmental change – to more narrowly focused intervention types – engineering safer products – and finally to – repairing damage to the individual. Interventions that have the most wide spread effect and the most “bang for the buck” will typically fit into the first of the countermeasures.

One other note: the countermeasures focus on 2 of the 3 Es: environmental modification and engineering. These countermeasures prefer environmental modification and engineering over education and/or behavioral change.

Let’s review them quickly before we do the “Gallery Walk” exercise.
Haddon Countermeasures
Motor Vehicles

1. Prevent the creation of the hazard
   – Don’t build a playground next to a highway

2. Reduce the amount of hazard
   – Lower temp of hot water heater

Note to Instructor: this and the next four slides are included here as an introduction to the 10 countermeasures. The purpose of including these is for the Participants to be introduced to the concepts and some examples. You might ask the Participants to hold their specific questions until the countermeasure exercise begins. They will have the opportunity to think about the countermeasures and practice with them in a few minutes.

Read slide
The Consumer Product Safety Commission often uses Countermeasure #1 very effectively in it’s mission, as it did when the Commission banned 3-Wheeled ATVs.

Go over each of the 10.
Haddon Countermeasures

3. Prevent the release of the hazard
   - Firearms stored in gun safes

4. Modify the rate of release of the hazard from its source
   - Seatbelts to control deceleration of occupants in a crash
Haddon Countermeasures

5. Separate the Hazard from that which is to be protected by time or space
   – *Nighttime driving restrictions for beginning teen drivers*

6. Separate the Hazard from that which is to be protected by a physical barrier
   – *Install 4-sided fencing around pools*

Read slide

Additional info for #5, in case you get a question about what is Separate by Time:
Graduated Licensing Laws and Nighttime driving restriction laws help to protect young teen drivers by restricting their driving during high risk times, such as late at night.

Another example is to prevent cooking related injuries to children, **cook at a time when children are not in the kitchen.**

Installation of sidewalks and pedestrian paths are another example of separation by space.
Haddon Countermeasures

7. Modify relevant basic qualities of the hazard
   - Fire safe cigarettes, use safer baseballs and breakaway bases

8. Make what is to be protected resistant to damage
   - Encourage calcium intake and exercise to reduce osteoporosis and strengthen bones for preventing fractures from falls

Read slide

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Haddon Countermeasures

9. Begin to counter damage done by the hazard
   – provide emergency medical care;

10. Stabilize, repair and rehabilitate the object of the damage
    – provide burn care; physical therapy

To summarize, many of the principles of injury prevention used today are based upon these concepts developed by Dr. Haddon 40 years ago.
Haddon Countermeasures
"Gallery Walk"

- Participants will be divided into small groups and given 15 minutes to visit their assigned stations (each station represents one countermeasure)
- Each group will be assigned 3-4 stations to visit
- At each station, groups should review the countermeasure and use their handout to record intervention ideas

Note to Instructor/Facilitator: this exercise is designed to make the presentation of the Haddon countermeasures more participatory as well as an opportunity for the Facilitator to model how the Participants could do this kind of brainstorming activity in their community (at a coalition meeting, etc.). Follow the instructions outlined below. It is a good idea to determine early how you plan to break up the students into small groups (i.e., the number of groups), as this will determine which and how many “stations” they will visit. The stations they should visit should be hand-written onto the copies of the Haddon Countermeasure Exercise Student Handout.

Instructions for Exercise:
- The Instructors will need to have one piece of flipchart paper for each of the 10 countermeasures – and lots of pens.
- Each piece of flipchart paper will need to include the name of the countermeasure, a definition of the countermeasure, and one or two examples.
- Divide the class into groups of 2-3 students each (depending upon size).
- Give each group a handout that provides a laundry list of countermeasures (this is a reference tool for the Participant). The handout should also indicate which group the Student belongs to and the stations that group will go to. Assigning stations will prevent all of the Participants from visiting the same stations – and bunching up.
- The number of stations that each group visits will vary depending on the size of the class. It is suggested that each group visit 3-4 stations for around 5 minutes each (15 minutes total).
- The Participants will visit their assigned stations and work as a group to discuss which of the interventions on their handout fit the countermeasure. They will record their intervention ideas on the appropriate flip chart paper.
- All Instructors should “mingle” and provide any assistance that is requested of the Participants.
- The Facilitator will keep track of time and will announce when each group should move on to their next station.
- At the end of the 15 minutes, the Participants can take their seats.
- The Facilitator will then walk from station to station reviewing the countermeasures and the Participant’s responses. This is a good opportunity to discuss the responses and perhaps pose questions to the class about why an intervention idea that has been recorded at a station might not fit into that specific countermeasure. If there is enough time, the Facilitator may also wish to ask the group for other examples that were not included on the handout.

Note to Instructors: There are a couple of countermeasures included on the list that could fit into more than one category. Be sure to identify these if/when they are discussed among participants. It would be a good idea to discuss how such countermeasures fit multiple categories.
So in summary, the Haddon Countermeasures and the Intervention Decision Matrix are additional tools to help to target what prevents the problem and aid in program implementation--the last 2 boxes of the PH Approach.
Exercise Instructions: Use this handout to record your group number and the stations that your group will be visiting during this exercise (above). Go to the first station that your group has been assigned, and use the list below to identify at least two injury prevention interventions that seem to fit that countermeasure. Repeat this process at each of the stations that your group visits.

Injury Prevention Interventions
Identify the Haddon Countermeasure that corresponds to each of these interventions:

- Reduce vehicle horsepower (2).
- Require physical conditioning before participation in sports (8).
- Improve EMS & police response times (9).
- Trigger locks on guns (7).
- Shorter cleats on sports shoes (4 and/or 7).
- Increase use of smoke detectors & carbon monoxide detectors (9).
- Quick release ski bindings (4).
- Stop manufacturing 3-wheel ATVs (1).
- Install air bags (6 and/or 4).
- Limit the number of prescription pills to a non-lethal amount (2).
- Improve motor vehicle braking capability, especially heavy trucks (3).
- Ban dangerous toys such as lawn darts (1).
- Install a fence around a dog yard (6).
- Rubber bullets (7).
- Require helmet use for motorcyclists, bicycles & horseback riders (6).
- Build cribs with slats too narrow to strangle a child (7).
- Fire retardant fabric (4).
- Stop manufacture & import of firearms (1).
- Lower height of playground equipment (2).
- Shelter for victims of domestic violence (5).
- Keep children out of the kitchen when cooking (5).
- Close pools & beaches when a lifeguard is not on duty (1).
- Empty swimming pools when not in use (3 and/or 7).
- Restrict driver’s licensing to older drivers (2).
- Install automatic sprinkler systems in homes or office (4).
- Place EMTs near areas with relatively high injury rate, i.e., rodeos (9).
- Increase the availability of roadside emergency telephones (9).
- Waiting period for firearm sale (5).
- Provide canes, walkers & handrails to the elderly in their environment (3).
- Handicap accommodation (10).
- Boat lights & highly visible swimwear (9).
- Develop a regional trauma system (10).
- Remove trees & poles from roadsides (5).
- Physical therapy (10).
- Build pedestrian & bike paths separate from roads (5).
- Physical & mental rehabilitation (10).
- Wear sunscreen (8).
- Stop manufacturing trampolines due to spinal cord injuries (1).
- Limit number of hunting days during season (2).
- Use child restraints & seatbelts in motor vehicles (4).
- Padded gym walls (7).
- Designing firearms that don’t discharge inadvertently (3 and/or 7).
- Exercise therapy to prevent osteoporosis (8).
- Communication systems for EMS (9).
- Don’t build a swimming pool at a daycare center (1).
- Eye protection (6).
- File down dog’s canine teeth (2).
Group #: _____  Assigned Countermeasure Stations: _______ _______ _______ _______

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- File down dog’s canine teeth.
- Boat lights & highly visible swimwear.
- Develop a regional trauma system (10).
PREVENTION

Introduction: Back to the Future—Revisiting Haddon’s Conceptualization of Injury Epidemiology and Prevention

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INTRODUCTION

Critiques of contemporary epidemiology have addressed the increasing gap between its scientific foundations and its contribution to the practice of public health (1–12). This debate has also addressed the value of using theory and conceptual models to guide both research and practice (1, 6–9, 11). Although seemingly unrecognized in this recent debate, Dr. William Haddon, Jr., widely considered the father of modern injury epidemiology, raised very similar issues some 35–40 years ago as he argued for both a more scientifically driven approach to injury control and also developed two complementary conceptual frameworks to guide epidemiologic research and prevention practice (13–18). This paper examines Haddon’s advances from both a theoretical and a practical perspective and demonstrates the applicability of his approach not only to injury problems but also to other public health issues.

THE CONTRIBUTIONS OF WILLIAM HADDON, JR.

William Haddon, Jr., made numerous contributions to the field of injury control through his research on a variety of injury topics and his leadership of the National Highway Traffic Safety Administration and later the Insurance Institute for Highway Safety. However, he is most well known for his conceptual work through which he developed two complementary conceptual frameworks for understanding how injuries occur and developing strategies for intervention. One conceptual framework has become known as the Haddon Matrix, while the other is his articulation of 10 countermeasure strategies for reducing injuries.

The Haddon Matrix

Haddon’s work clearly was informed by at least two predecessors, Drs. John E. Gordon and James J. Gibson. Gordon, in a 1949 paper in the American Journal of Public Health entitled “The Epidemiology of Accidents,” firmly placed injury control within the public health framework in which health problems are conceptualized to result from interactions among the host, agent, and environment (19). Gibson, a psychologist, in 1961 elaborated on this notion by classifying agents of injury in terms of various forms of energy including thermal, radiant, chemical, electrical, and mechanical (20). In addition to drawing on the agent-host-environment concepts in defining the columns of his matrix, Haddon relied on examples from public health efforts to address polio as he conceptualized countermeasures within phases of influence (14). For example, he described the first phase in combating polio as one of “preventing the etiologic agent from reaching the susceptible host”; the second phase as the “interaction of the etiologic agents and the susceptible structures”; and the third phase as “maximizing salvage, once damage has been done to the susceptible structures” (14, page 233). He expanded upon this by depicting the phases in the crash and injury process as precrash, crash, and postcrash to define the rows of his matrix.

Initially, in creating the matrix, Haddon crossed these concepts (the rows) with columns depicting such factors as driver, passengers, pedestrians, bicyclists, motorcyclists, vehicles, highways, and police (14). Later, Haddon (15, 17) refined the model to its current form, listing the columns as follows: human (or host); vehicles and equipment (vehicles for transmitting the agent); physical environment; and socio-economic environment. Still later, he revised the model to...
TABLE 1. The Haddon Matrix applied to the problem of injuries to children falling on playgrounds

<table>
<thead>
<tr>
<th>Event (during the fall and time of impact)</th>
<th>Host (children on the playground)</th>
<th>Agent/vehicle (specific playground equipment and devices)</th>
<th>Physical environment (overall playground design)</th>
<th>Social environment (community norms, policies, rules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-event (before the fall)</td>
<td>Teach children to follow safety rules on the playground (e.g., no crowding on the climbing equipment)</td>
<td>Construct equipment with tacky grips, sized to children’s hands, to reduce the risk of hands slipping</td>
<td>Build sliding boards into hillsides so children do not have to climb to heights</td>
<td>Foster social norms that encourage adults to help maintain orderly play on the playground</td>
</tr>
<tr>
<td>Event (during the fall and time of impact)</td>
<td>Teach children to fall in ways that reduce injury</td>
<td>Reduce the number of protrusions on equipment so falling children do not hit sharp components</td>
<td>Ensure the presence of resilient surfacing</td>
<td>Organize community-watch systems to monitor playground safety (e.g., maintaining surfacing)</td>
</tr>
<tr>
<td>Post-event (after the child is injured by the fall)</td>
<td>Teach children how to summon help when injuries occur (e.g., using emergency call boxes)</td>
<td>Avoid equipment in which children can fall into areas not easily reached by rescue personnel</td>
<td>Provide benches for supervisors that afford good visibility of all playground areas to facilitate noticing when children are injured</td>
<td>Ensure funding for adequate emergency personnel appropriately equipped to deal with pediatric emergencies</td>
</tr>
</tbody>
</table>

A third dimension, borrowing concepts from the policy analysis field. These concepts represent key values that might be considered when choosing intervention strategies (e.g., effectiveness, equity, freedom, cost, stigmatization). This third dimension is proposed as a way to help decision makers judge the relative merits of alternative intervention options. The examples supplied by Vernick et al. (22) in their paper in this volume of *Epidemiologic Reviews* provide a further reason to understand some of the factors driving judicial, jury, or business decisions.

Countermeasures

Another contribution of Haddon was that he organized 10 countermeasure strategies to address injury control. In his 1973 paper, he stated that one landmark in the advancement of scientific thinking was the development of classification schemes for understanding relations among phenomena (16). Table 2 lists the Haddon countermeasures as they apply to injuries from handguns and to cancer associated with smoking, demonstrating the utility of the model to both injury and noninjury problems. As with the matrix, this is an excellent brainstorming tool for developing ideas about a range of strategies for intervention.

The Haddon models, although developed to help understand the processes by which injuries occur and can be prevented, are extremely useful tools in public health and can help build the bridge between behavioral scientists and epidemiologists, as urged by Gielen and Sleet (23) in this volume. The models can be used either to understand any public health issue from the perspective of risk factor identification or to devise a diverse array of preventive strategies. In so doing, they provide both epidemiologists and interventionists a framework within which to examine problems systematically and to take action. Gielen and Sleet elaborate on this point, urging that interventions be based on both sound theory and systematic principles of practice, including efforts such as individual behavior, corporate decisions, and policy making aimed at influencing decisions in multiple sectors, and through other actions at the community level.
However, in another paper in this volume, Peek-Asa and Zwerling (24) caution that injury problems and their solutions are complex, requiring funding and methodologies adequate to enable satisfactory understanding and development of effective solutions.

**HADDON’S MODELS IN A THEORETICAL CONTEXT**

The social-ecologic framework created by Urie Bronfenbrenner (25) in the context of understanding human development is very compatible with a broader view of public health as adopted by Gordon (19), Gibson (20), and Haddon (13–18) in the context of injury and as articulated later by others, namely Susser (1), Susser and Susser (8, 9), and Kreiger (6, 7). Social-ecologic theory, as proposed by Bronfenbrenner, defines various levels of the social environment, depicting the nested roles of intrapersonal factors, interpersonal factors, institutional elements, and cultural elements. As previously argued by Runyan (26) and Margolis et al. (27), this social-ecologic framework enhances the standard public health model of agent-host-environment and is similar to what Susser and Susser (9) propose in describing the interactions among contributory factors to health as nested Chinese boxes.

With respect to understanding injury prevention, intrapersonal factors include both developmental and socioeconomic features of individuals (i.e., the host), for example, a young child’s curiosity and exploratory behaviors through touching, tasting, and crawling; an adolescent’s propensity to take risks and the varied responses to parent and peer influences; or the elderly person’s suicide risk due to a sense of hopelessness in the face of an incurable chronic disease or avoidance of walking in certain locations because of a fear of falling or assault. Likewise, biologic features of the host, such as the young child’s lack of balance and strength, high center of gravity, and small size, relate to some of the hazards encountered. For an elderly person, biologic characteristics such as bone brittleness; reduced visual acuity, reaction time, and balance; and thinner skin increase susceptibility to injury events such as traffic crashes, pedestrian injuries, falls, and burns.

Interpersonal factors are those that result from the interactions between two persons, for example, intimate partners, parent and child, employer and employee, or adolescents. In the injury sphere, this clearly relates to intentional injury as a result of behaviors associated with disciplinary practices or conflict resolution as well as, in the unintentional realm, certain kinds of activities such as contact sports or other recreational exposures more commonly engaged in by dyads.

Institutional elements are those that reflect the multiple organizations in which individuals function, for example,
schools, places of worship, and workplaces. How these organizations promote or control activities and environments—for example, the types of interscholastic sports at a school and the presence or required use of protective gear—can affect injury risks. Likewise, work sites contain many hazards and adopt many types of safety practices, whereas places of worship may either encourage or discourage certain safe or unsafe practices. In addition, prehospital trauma care and inpatient health care systems are institutions that affect injury outcomes. Several examples are included in the article by Peek-Asa and Zwerling (24) in this volume.

Cultural elements include broad social values and norms as well as the governmental policies that guide or mandate behaviors of individuals or organizations. Examples are values placed on individual freedom; social norms about drinking or corporal punishment; or laws, policies, and regulations about producing, selling, and storing firearms or providing alternate forms of transportation for the elderly who can no longer drive.

Any health problem can be viewed as resulting from and being alleviated by the interactions among these multiple factors that are constantly changing together. For example, the intrapersonal biologic characteristics of both elderly persons and toddlers increase the risk of falls. In each, balance may be unstable although the desire to walk is great. Developmentally, the toddler is also curious and may be eager to see inside an interesting-looking bucket, resulting in him tipping into the bucket and risking drowning. The features of the bucket and its contents that make it interesting and attractive to the child interact with his sense of curiosity.

By being developmentally oriented, Bronfenbrenner’s social ecology theory (25) naturally includes a historical dimension that considers the constantly changing relations among the variables over time. This notion of changing interactions in historical perspective is consistent with Susser’s eco-epidemiology approach (1, 28) as well as the concepts of interbehavioral psychology (29, 30).

Figure 1 depicts this new integration of Bronfenbrenner’s social-ecologic model with that of the classic public health model, depicted by Susser (28). This depiction is presented to demonstrate that Haddon’s concepts fit within a much broader social theoretical context.

CONCLUSION AND SYNTHESIS

Haddon (14) urged that injury research advance from what he termed “pre-scientific” thinking focused on accidents as random events or acts of God to applying scientific principles to understanding injury. A related argument in the contemporary debate about epidemiology posits that as epidemiology has evolved, it has adopted various conceptual models consistent with the scientific wisdom of the era, for example, the miasma theory, the germ theory, and what Susser (1) and Susser and Susser (9) describe as the “black box” theory of chronic illness. Susser suggests that the trend in epidemiology has been to develop research guided less by theory and more by the methodologies derived from varied scientific advances (e.g., molecular biology), implying that even the most novel and sophisticated methods in the presence of unclear thinking can impede scientific progress (1, 8, 9). Haddon et al. also warned of this possibility in their 1964 book, Accident Research: Methods and Approaches, pointing out that “the quality of research cannot be superior to that of its weakest element” (13, page 85). Although Savitz (12) argues for pragmatism over theory, Haddon’s contributions demonstrate the practical value of using theory and conceptual models to guide epidemiologic inquiry and prevention planning.

Although developed in the context of injury control, Haddon’s models are applicable to any health problem and nicely demonstrate the value of using a conceptual approach to address practical problems through research and intervention. As such, his contributions to injury epidemiology were ahead of their time, because contemporary epidemiologists continue to debate the relative merits of using theory to inform research and practice as well as attempt to adopt a cogent theoretical approach to epidemiology. Even though Haddon does not appear to have explicitly developed his
models with a specific theory in mind, they are consistent with the established social-ecologic theory of Bronfenbrenner (25), as described above. This theory is very similar to the eco-epidemiology theory proposed by Susser (1) and the eco-social theory put forth by Kreiger (6, 7), as well as aspects of interbehavioral psychology developed in the 1920s by Kantor (29, 30).

Furthermore, Haddon most likely would have agreed with Kreiger’s assertion 30 years later that “theory, absent action, is an empty promise” (7, page 674), contending that theories should not only inspire the questions asked in research but also provide insight into how to translate research findings into practical strategies to improve health. However, he probably would also have agreed with Kurt Lewin’s assertion that “there is nothing so practical as a good theory” (31, page 169), arguing for the utility of theory to help guide thinking and practice. Haddon’s work is exemplary of this principle, providing injury epidemiologists and interventionists a compass to guide both their research and their practice. Perhaps reflecting on Haddon’s work will help epidemiologists find utility in a more theoretical approach.

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Achievements in Public Health, 1900-1999 Motor-Vehicle Safety: A 20th Century Public Health Achievement

The reduction of the rate of death attributable to motor-vehicle crashes in the United States represents the successful public health response to a great technologic advance of the 20th century--the motorization of America. Six times as many people drive today as in 1925, and the number of motor vehicles in the country has increased 11-fold since then to approximately 215 million (1). The number of miles traveled in motor vehicles is 10 times higher than in the mid-1920s. Despite this steep increase in motor-vehicle travel, the annual death rate has declined from 18 per 100 million vehicle miles traveled (VMT) in 1925 to 1.7 per 100 million VMT in 1997--a 90% decrease (Figure 1) (1).

Systematic motor-vehicle safety efforts began during the 1960s. In 1960, unintentional injuries caused 93,803 deaths (1); 41% were associated with motor-vehicle crashes. In 1966, after 5 years of continuously increasing motor-vehicle-related fatality rates, the Highway Safety Act created the National Highway Safety Bureau (NHSB), which later became the National Highway Traffic Safety Administration (NHTSA). The systematic approach to motor-vehicle-related injury prevention began with NHSB's first director, Dr. William Haddon (2). Haddon, a public health physician, recognized that standard public health methods and epidemiology could be applied to preventing motor-vehicle-related and other injuries. He defined interactions between host (human), agent (motor vehicle), and environmental (highway) factors before, during, and after crashes resulting in injuries. Tackling problems identified with each factor during each phase of the crash, NHSB initiated a campaign to prevent motor-vehicle-related injuries.

In 1966, passage of the Highway Safety Act and the National Traffic and Motor Vehicle Safety Act authorized the federal government to set and regulate standards for motor vehicles and highways, a mechanism necessary for effective prevention (2,3). Many changes in both vehicle and highway design followed this mandate.
Vehicles (agent of injury) were built with new safety features, including head rests, energy-absorbing steering wheels, shatter-resistant windshields, and safety belts (3,4). Roads (environment) were improved by better delineation of curves (edge and center line stripes and reflectors), use of breakaway sign and utility poles, improved illumination, addition of barriers separating oncoming traffic lanes, and guardrails (4,5). The results were rapid. By 1970, motor-vehicle-related death rates were decreasing by both the public health measure (deaths per 100,000 population) and the traffic safety indicator (deaths per VMT) (Figure 2) (1).

Changes in driver and passenger (host) behavior also have reduced motor-vehicle crashes and injuries. Enactment and enforcement of traffic safety laws, reinforced by public education, have led to safer behavior choices. Examples include enforcement of laws against driving while intoxicated (DWI) and underage drinking, and enforcement of safety-belt, child-safety seat, and motorcycle helmet use laws (5,6).

Government and community recognition of the need for motor-vehicle safety prompted initiation of programs by federal and state governments, academic institutions, community-based organizations, and industry. NHTSA and the Federal Highway Administration within the U.S. Department of Transportation have provided national leadership for traffic and highway safety efforts since the 1960s (2). The National Center for Injury Prevention and Control, established at CDC in 1992, has contributed public health direction (7,8). State and local governments have enacted and enforced laws that affect motor-vehicle and highway safety, driver licensing and testing, vehicle inspections, and traffic regulations (2). Preventing motor-vehicle-related injuries has required collaboration among many professional disciplines (e.g., biomechanics has been essential to vehicle design and highway safety features). Citizen and community-based advocacy groups have played important prevention roles in areas such as drinking and driving and child-occupant protection (6). Consistent with the public/private partnerships that characterize motor-vehicle safety efforts, NHTSA sponsors "Buckle Up America" week (this year during May 24-31), which focuses on the need to always properly secure children in child-safety seats (additional information is available by telephone, [202] 366-5399, or on the World-Wide Web at http://www.nhtsa.dot.gov).

**SPECIFIC PUBLIC HEALTH CONCERNS**

**High-Risk Populations**

**Alcohol-impaired drivers.** Annual motor-vehicle crash-related fatalities involving alcohol has decreased 39% since 1982, to approximately 16,000; these deaths account for 38.6% of all traffic deaths (9,10). Factors that may have contributed to this decline include increased public awareness of the dangers of drinking and driving; new and tougher state laws; stricter law enforcement; an increase in the minimum legal drinking age; prevention programs that offer alternatives such as...
safe rides (e.g., taxicabs and public transportation), designated drivers, and responsible alcohol-serving practices; and a decrease in per capita alcohol consumption (5,6).

**Young drivers and passengers.** Since 1975, motor-vehicle-related fatality rates have decreased 27% for young motor-vehicle occupants (ages 16-20 years). However, in 1997 the death rate was 28.3 per 100,000 population--more than twice that of the U.S. population (13.3 per 100,000 population) (9). Teenaged drivers are more likely than older drivers to speed, run red lights, make illegal turns, ride with an intoxicated driver, and drive after drinking alcohol or using drugs (11). Strategies that have contributed to improved motor-vehicle safety among young drivers include laws restricting purchase of alcohol among underaged youths (6) and some aspects of graduated licensing systems (e.g., nighttime driving restrictions) (12).

**Pedestrians.** From 1975 to 1997, pedestrian fatality rates decreased 41%, from 4 per 100,000 population in 1975 to 2.3 in 1997 but still account for 13% of motor-vehicle-related deaths (9). Factors that may have reduced pedestrian fatalities include more and better sidewalks, pedestrian paths, playgrounds away from streets, one-way traffic flow, and restricted on-street parking (6).

**Occupant-Protection Systems**

**Safety belts.** In response to legislation, highly visible law enforcement, and public education, rates of safety belt use nationwide have increased from approximately 11% in 1981 to 68% in 1997 (8). Safety belt use began to increase following enactment of the first state mandatory-use laws in 1984 (6). All states except New Hampshire now have safety-belt use laws. Primary laws (which allow police to stop vehicles simply because occupants are not wearing safety belts) are more effective than secondary laws (which require that a vehicle be stopped for some other traffic violation) (6,13). The prevalence of safety belt use after enactment of primary laws increases 1.5-4.3 times, and motor-vehicle-related fatality rates decrease 13%-46% (13).

**Child-safety and booster seats.** All states have passed child passenger protection laws, but these vary widely in age and size requirements and the penalties imposed for noncompliance. Child-restraint use in 1996 was 85% for children aged less than 1 year and 60% for children aged 1-4 years (14). Since 1975, deaths among children aged less than 5 years have decreased 30% to 3.1 per 100,000 population, but rates for age groups 5-15 years have declined by only 11%-13% (9). Child seats are misused by as many as 80% of users (15-17). In addition, parents fail to recognize the need for booster seats for children who are too large for child seats but not large enough to be safely restrained in an adult lap-shoulder belt (18).

**21ST CENTURY CHALLENGES**
Despite the great success in reducing motor-vehicle-related death rates, motor-vehicle crashes remain the leading cause of injury-related deaths in the United States, accounting for 31% of all such deaths in 1996 (CDC, unpublished data, 1999). Furthermore, motor-vehicle-related injuries led all causes for deaths among persons aged 1-24 years. In 1997, motor-vehicle crashes resulted in 41,967 deaths (16 per 100,000 population), 3.4 million nonfatal injuries (1270 per 100,000 population) (9), and 23.9 million vehicles in crashes; cost estimates are $200 billion (1).

The challenge for the 21st century is to sustain and improve motor-vehicle safety. Future success will require augmentation of the public health approach to 1) expand surveillance to better monitor nonfatal injuries, detect new problems, and set priorities; 2) direct research to emerging and priority problems; 3) implement the most effective programs and policies; and 4) strengthen interagency, multidisciplinary partnerships. Key public health activities will be to

- continue efforts shown to reduce alcohol-impaired driving and related fatalities and injuries.
- promote strategies such as graduated licensing that discourage teenage drinking and other risky driving behaviors such as speeding and encourage safety belt use.
- enhance pedestrian safety, especially for children and the elderly, through engineering solutions that reduce exposure to traffic and permit crossing streets safely and by encouraging safer pedestrian behaviors, such as crossing streets at intersections, and increasing visibility to drivers and driver awareness of pedestrians.
- accommodate the mobility needs of persons aged greater than 65 years—a population that will almost double to 65 million by 2030—through a combination of alternative modes of transportation (e.g., walking and better public transportation) and development of strategies to reduce driving hazards (6,19).
- encourage the 30% of the population who do not wear safety belts to use them routinely.
- encourage proper use of age-appropriate child-safety seats and booster seats, especially for older children who have outgrown their child seats but are too small for adult lap-shoulder belts.
- conduct biomechanics research to better understand the causes of nonfatal disabling injuries, in particular brain and spinal cord injuries, as a foundation for prevention strategies.
- develop a comprehensive public health surveillance system at the federal, state, and local levels that track fatal and nonfatal motor-vehicle-related injuries and other injuries and diseases (i.e., outpatient and emergency department visits, hospitalizations, disabilities, and deaths) as a basis for setting prevention and research priorities.
Reported by: Div of Unintentional Injury Prevention, National Center for Injury Prevention and Control, CDC.

References


**Figure 1**

**FIGURE 1. Motor-vehicle--related deaths per million vehicle miles traveled (VMT) and annual VMT, by year — United States, 1925–1997**
Figure 2

**FIGURE 2.** Motor-vehicle–related death rates per 100,000 population and per 100 million vehicle miles traveled (VMT), by year — United States, 1966–1997

[Graph showing motor-vehicle–related death rates from 1966 to 1997 with a decrease in deaths per 100,000 population and per 100 million VMT over time.]
ENERGY DAMAGE AND THE TEN COUNTERMEASURE STRATEGIES

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An important landmark is reached in the evolution of a scientific field when classification of its subject matter is based on the relevant, fundamental processes involved rather than on descriptions of the appearances of the phenomena of interest. In illustration, a fundamental turning point was reached when the debilitation and progressive susceptibility to browning of shipboard scurvy could for the first time be classified as the process resulting from a deficiency of consumption of something variously present in fruits and vegetables (much later identified as ascorbic acid, Vitamin C). In fact, such transition from classifications consisting essentially only of a description of appearances to those based on fundamental processes is basic to scientific progress generally; hence, examples abound from the full gamut of scientific concerns.

Additional illustrations, among the many, include the classificatory and conceptual transitions that followed recognition:

a. That rocks could be grouped on the basis of the processes involved in their formation—as sedimentary, igneous, metamorphic.

b. That the variations among the Galapagos finches studied by Darwin were the result of differential ecologic processes.

c. That earthquakes were one aspect of tectonic processes.

d. That the epidemic disease of the young which could for decades be described only as “infantile paralysis” was a rare variant of a commonplace process initiated by infection with one of several similar and previously unknown viruses.

e. That plague was a process in which a specific pathogen, Pasteurella pestis, rats, fleas, and people interacted.

EXTRARATIONAL EXPLANATIONS IN THE ABSENCE OF PROCESS KNOWLEDGE

Before such conceptual and hence classificatory advance, lacking an understanding of processes, and therefore of the possibility of human intervention or avoidance, phenomena of concern to people have commonly been attributed to extrarational factors. “Luck,” “chance,” “accident,” “fate,” and similar terms are the hallmarks of such ignorance, and perhaps of a human necessity for explaining it away (8). The distinction between the way in which people tend to deal with the understood as opposed to the merely known-about is illustrated nicely by the renowned anthropologist Malinowski. He found that Trobriand natives viewed the hazards outside the reef, which they did not understand, in ways more supernatual than they viewed those inside the reef, which they did understand. As he wrote, “It is most significant that in the lagoon fishing, where man can rely completely upon his knowledge and skill, magic does not exist, while in the open-sea fishing, full of danger and uncertainty, there is extensive magical ritual to secure safety and good results” (16).

DIVINE PUNISHMENT AS AN EXPLANATION IN THE ABSENCE OF PROCESS UNDERSTANDING

The Book of Job epitomizes another commonplace aspect of human response to undesirable happenings not yet understood—and therefore not yet categorized—in process terms. The events are explained as divine retribution for shortcomings. The suffering of oneself, someone else, or some group occurs because it is divine and well-deserved punishment. Therefore, unless
the sin can be expiated by appropriate change in behavior, it may be “too bad,” but there is nothing else to be done to ameliorate the personally or societally undesirable happening unless it is an increase in efforts at human reform.

EXPANDED CLASSIFICATORY SETS, AND DIFFERENT SETS

The transition to understanding of underlying, relevant processes commonly results in more than just a relabeling of past groupings (8). Usually the phenomena previously recognized have been “the tip of the iceberg,” and the recognition of underlying process adds much more. Thus, in the case of what was originally termed “infantile paralysis,” it was found that the infectious process routinely involved hundreds of individuals subclinically for each person ill enough to be diagnosed. Moreover, parallel illustrations are legion, not only from medicine but also widely from other sciences.

For example, understanding the actual nature of earthquakes is to classify them conceptually as one aspect of a far broader range of tectonic processes; and understanding the origins of a butterfly or a clam is to identify it in terms of its life cycle, a process classification. Understanding the process involved in eclipse is to classify them as one aspect of celestial mechanics.

Another frequent result of transition to process-based understanding is regrouping of phenomena not merely in expanded sets, but in new sets that do not bear a one-to-one correlation with the old. Figure 1 illustrates this. As process (or, to use a related [medical] term, etiologic) understanding advanced, the set of phenomena formerly referred to as “wasting” was, in effect, parcelled out to such process-defined sets as tuberculosis, amebiasis, protein deficiency, and a host of others (8).

More relevant here is to view the process in reverse; that is, from the standpoint of the etiologic or process sets in picking up pieces of many pre-existing descriptive sets, as illustrated in Figure 2 (8).

Thus syphilis, the etiologic set based on the infectious agent, Treponema pallidum, picked up parts of previous descriptive sets, such as pariesis, amebiasis, monile lesions, rashes, certain gastric lesions, certain abnormalities of the growing ends of bone, and many others, but not all of those in any one of the earlier descriptive sets.

Again, an important point is that there is usually not in such transitions a one-to-one relationship between the earlier, descriptive ways of looking at the phenomena and those process-based which are substituted for them (8).

The foregoing is brief background for that which follows, an introduction to the classification of certain widespread, important phenomena defined and grouped in terms of a small number of closely parallel processes. Most of the included phenomena are not yet regarded in process terms by the implicit and explicit classi-
fications still applied to them by most professionals and laymen. Yet there is widespread, implicit, and at least qualitative recognition of the processes themselves, because cultures, past and present, abound in actions directed at changing the outcome of these processes through intervention at specific points in their sequences.

ENERGY DAMAGE PROCESSES

The phenomena of concern are those involved when energy is transferred in such ways and amounts, and at such rapid rates, that inanimate or animate structures are damaged (1, 6-8, 10, 14). (Much of the remainder of this paper closely follows Reference 10.) The harmful interactions with people and property of hurricanes, earthquakes, projectiles, moving vehicles, ionizing radiation, lightning, configurations, and the cuts and bruises of daily life illustrate this class.

10 STRATEGIES FOR REDUCING THESE LOSSES

Several strategies, in one mix or another, are available for reducing the human and economic losses that make this class of phenomena of social concern. In their logical sequence, they are as follows:

The first strategy is to prevent the marshaling of the form of energy in the first place: preventing the generation of thermal, kinetic, or electrical energy, or ionizing radiation; the manufacture of gunpowder; the concentration of uranium-235; the build-up of hurricanes, tornadoes, or teetock stresses; the accumulation of snow where avalanches are possible; the elevating of skiers; the raising of babies above the floor, as to cribs and chairs from which they may fall; the starting and movement of vehicles; and so on, in the richness and variety of ecologic circumstances.

The second strategy is to reduce the amount of energy marshalled: reducing the amounts and concentrations of high school chemistry reagents, the size of bombs or firecrackers, the height of divers above swimming pools, or the speed of vehicles.

The third strategy is to prevent the release of the energy: preventing the discharge of nuclear devices, armed crossbows, gunpowder, or electricity; the descent of skiers; the fall of elevators; the jumping of would-be suicides; the undermining of cliffs; or the escape of tigers. An Old Testament writer illustrated this strategy in the context both of the architecture of his area and of the moral imperatives of this entire field: "When you build a new house, you shall make a parapet for your roof, that you may not bring the guilt of blood upon your house, if any one fall from it" (3). This biblical position, incidentally, is fundamentally at variance with that of those who, by conditioned reflex, regard harmful interactions between man and his environment as problems requiring reforming imperfect man rather than suitably modifying his environment.

The fourth strategy is to modify the rate of spatial distribution of release of the energy from its source: slowing the burning rate of explosives, reducing the slopes of ski trails for beginners, and choosing the re-entry speed and trajectory of space capsules. The third strategy is the limiting case of such release reduction, but is identified separately because in the real world it commonly involves substantially different circumstances and tactics.

The fifth strategy is to separate, in space or time, the energy being released from the susceptible structure, whether living or inanimate: the evacuation of the Bikini islanders and test personnel, the use of sidewalks and the phasing of pedestrian and vehicular traffic, the elimination of vehicles and their pathways from community areas commonly used by children and adults, the use of lightning rods, and the placing of electric power lines out of reach. This strategy, in a sense also concerned with rate-of-release modification, has as its hallmark the elimination of intersections of energy and susceptible structure—a common and important approach.

The very important sixth strategy uses not separation in time and space but separation by interposition of a material "barrier": the use of electrical and thermal insulation, shoes, safety glasses, shin guards, helmets, shields, armor plate, torpedo nets, antiballistic missiles, lead aprons, buzz-saw guards, and boxing gloves. Note that some "barriers," such as crash padding and ionizing radiation shields, attenuate or lessen but do not totally block the energy from reaching the structure to be protected. This strategy, although also a variety of rate-of-release modification, is also separately identified because the tactics involved comprise a large, and usually clearly discrete, category.
The seventh strategy, into which the sixth blends, is also very important—to modify appropriately the contact surface, subsurface, or basic structure, as in eliminating, rounding, and softening corners, edges, and points with which people can, and therefore sooner or later do, come in contact. This strategy is widely overlooked in architecture, with many minor and serious injuries the result. It is, however, increasingly reflected in automobile design, and in such everyday measures as making lollipop sticks of cardboard and making some toys less harmful for children in impact. Despite the still only spotty application of such principles, the two basic requisites, large radius of curvature and softness, have been known since at least about 400 B.C., when the author of the treatise on head injury attributed to Hippocrates wrote: "Of those who are wounded in the parts about the bone, or in the bone itself, by a fall, he who falls from a very high place upon a very hard and blunt object is in most danger of sustaining a fracture and contusion of the bone; and of having it depressed from its natural position; whereas he that falls upon more level ground, and upon a softer object, is likely to suffer less injury in the bone, or it may not be injured at all..." (15).

The eighth strategy in reducing losses in people and property is to strengthen the structure, living or nonliving, that might otherwise be damaged by the energy transfer. Common tactics, often excessively underapplied, include tougher codes for earthquake, fire, and hurricane resistance, and for ship and motor vehicle impact resistance. The training of athletes and soldiers has a similar purpose, among others, as does the treatment of hemophiliacs to reduce the results of subsequent mechanical insults. A successful therapeutic approach to reduce the osteoporosis of many postmenopausal women would also illustrate this strategy, as would a drug to increase resistance to ionizing radiation in civilian or military experience. (Vaccines, such as those for polio, yellow fever, and smallpox, are analogous strategies in the closely parallel set to reduce losses from infectious agents.)

The ninth strategy in loss reduction applies to the damage not prevented by measures under the other preceding—to move rapidly in detection and evaluation of damage that has occurred or is occurring, and to counter its continuation and extension. The generation of a signal that response is required; the signal's transfer, receipt, and evaluation; the decision and follow-through, are all elements here—whether the issue be an urban fire or wounds on the battlefield or highway. Sprinkler and other suppressor responses, firedoors, MAYDAY and SOS calls, fire alarms, emergency medical care, emergency transport, and related tactics all illustrate this countermeasure strategy. (Such tactics have close parallels in many earlier stages of the sequence discussed here, as, for example, storm and tsunami warnings.)

The tenth strategy encompasses all the measures between the emergency period following the damaging energy exchange and the final stabilization of the process after appropriate intermediate and long-term reparative and rehabilitative measures. These may involve return to the pre-event status or stabilization in structurally or functionally altered states.

SEPARATION OF LOSS REDUCTION AND CAUSATION

There are, of course, many real-world variations on the main theme. These include those unique to each particular form of energy and those determined by the geometry and other characteristics of the energy's path and the point or area and characteristics of the structure on which it impinges—whether a BB hits the forehead or the center of the cornea.

One point, however, is of overriding importance: subject to qualifications as noted subsequently, there is no logical reason why the rank order (or priority) of loss-reduction countermeasures generally considered must parallel the sequence, or rank order, of causes contributing to the result of damaged people or property. One can eliminate losses in broken teacups by packaging them properly (the sixth strategy), even though they be placed in motion in the hands of the postal service, vibrated, dropped, piled on, or otherwise abused. Similarly, a vehicle crash, per se, need necessitate no injury, nor a hurricane housing damage.

Failure to understand this point in the context of measures to reduce highway losses underlies the common statement: "If it's the driver, why talk about the vehicle?" This confuses the rank or sequence of causes, on the one hand, with
that of a loss-reduction countermeasure—in this case "crash packaging)—on the other.

There are, nonetheless, practical limits in physics, biology, and strategy potentials. One final limit is operative at the boundary between the objectives of the eighth and ninth strategies. Once appreciable injury to man or to other living structure occurs, complete elimination of undesirable end results is often impossible, though appreciable reduction is commonly achievable. (This is often also true for inanimate structures, for example, teacups.) When lethal damage has occurred, the subsequent strategies, except as far as the strictly secondary salvage of parts is concerned, have no application.

There is another fundamental constraint. Generally speaking, the larger the amount of energy involved in relation to the resistance to damage of the structures at risk, the earlier in the countermeasure sequence must the strategy lie. In the ultimate case, that of a potential energy release of proportions that could not be countered to any satisfactory extent by any known means, the prevention of marshalling or of release, or both, becomes the only approach available. Furthermore, in such an ultimate case, if there is a finite probability of release, prevention of marshalling (and dismantling of stockpiles of energy already marshalled) becomes the only, and essential, strategy to assure that the undesirable end result cannot occur.

FOR EACH STRATEGY AN ANALOGOUS OPPOSITE

Although the concern here is the reduction of damage produced by energy transfer, it is noteworthy that to each strategy there is an opposite focused on increasing damage. The latter are most commonly seen in collective and individual violence—as in war, homicide, and arson. Various of them are also seen in manufacturing, mining, machining, hunting, and some medical and other activities in which structural damage, often of a very specific nature, is sought. (A medical illustration would be the destruction of the anterior pituitary with a beam of ionizing radiation as a measure to eliminate pathologic hyperactivity.) For example, a maker of motor vehicles or of aircraft landing-gear struts—a product predictably subject to energy insults—could make his product more delicate, both to increase labor and sales of parts and materials, and to shorten its average useful life by decreasing the age at which commonplace amounts of damage increasingly exceed in cost the depreciating value of the product in use. The manufacturer might also design for difficulty of repair by using complex exterior sheet metal surfaces, making components difficult to get at, and other means.

The type of categorization outlined here is similar to those useful for dealing systematically with other environmental problems and their ecology. In brief illustration, various species of toxic and environment-damaging atoms (such as lead), molecules (e.g. DDT and heroin), and mixtures (garbage and some air pollutants, among others) are marshalled, go through series of physical states and situations, interact with structures and systems of various characteristics, and produce damage in sequences leading to the final, stable results.

Similar differences can be made concerning the ecology of some of the viral, unicellular, and metazoon organisms that attack animate and inanimate structures; their hosts; and the types of stages of damage they produce. Actual and potential birth control and related strategies and tactics can be somewhat similarly categorized. Thus, in brief, beginning on the male line: preventing the marshalling of viable sperm (by castration or certain pharmacological agents); reducing the amount of sperm produced; preventing the release of semen (or of one of its necessary components, e.g., by vasectomy); modifying the rate of spatial distribution of release of semen (as in hypoplasia, a usually developmental or traumatic condition in which the urethra opens on the underside of the penis, sometimes near its base); separating semen release in space or time from the susceptible ovum (e.g., continence, limiting intercourse to presumably nonfertile periods, coitus interruptus, and preventing a fertile ovum from being present when sperm arrive); separation by interposition of a material barrier (e.g., condoms, spermicidal creams, foams, jellies); increasing resistance of the ovum to penetration; making the ovum infertile, even if penetrated; prevention of implantation of the fertilized egg; abortion; and infanticide.

Sufficient differences among systems often exist, however—for example, the ecology of the agents of many anthropod-borne diseases is
quite complex, and the life cycles of organisms such as schistosomes require two or more different host species in sequence—to preclude at this time many generalizations useful across the breadth of all environmental hazards and their damaging interactions with other organisms and structures.

A SYSTEMATIC ANALYSIS OF OPTIONS

It has not generally been customary for individuals and organizations that influence, or are influenced by, damage due to harmful transfers of energy to analyze systematically their options for loss reduction, the mix of strategies and tactics they might employ, and their cost. Yet it is entirely feasible and not especially difficult to do so, although specific supporting data are still often lacking. In fact, unless such systematic analysis is done routinely and well, it is generally impossible to maximize the pay-offs both of loss-reduction planning and of resource allocation.

Such analysis is also needed to consider properly the problems inherent in the use of given strategies in specific situations. Different strategies to accomplish the same end commonly have different requirements; in kinds and numbers of people, in the disciplines involved, in material resources, in capital investments, and in public and professional education, among others. In the case of some damage-reduction problems, particular strategies may require political and legislative action more than others. And, where the potential or actual hazard exists across national boundaries, correspondingly international action is commonly essential.

The types of concepts outlined in this note are basic to dealing with important aspects of the quality of life, and all of the professions concerned with the environment and with the public health need to understand and apply the principles involved—and not in the haphazard, spotty, and poorly conceptualized fashion now virtually universal. It is the purpose of this brief note to introduce the pathway along which this can be achieved.

REFERENCES

APPENDIX A

This appendix gives additional examples of tactics classified by the strategy categories into which they fall. The strategies, identified sequentially I-X, are:

I. To prevent the initial marshalling of the form of energy.
II. To reduce the amount of energy marshalled.
III. To prevent the release of energy.
IV. To modify the rate of spatial distribution of release of energy from its source.
V. To separate in space or time the energy being released from the susceptible structure.
VI. To separate the energy being released from the susceptible structure by interposition of a material barrier.
VII. To modify the contact surface, subsurface, or basic structure which can be impacted.
VIII. To strengthen the living or nonliving structure which might be damaged by the energy transfer.
IX. To move rapidly in detection and evaluation of damage and to counter its continuation and extension.
X. All those measures which fall between the emergency period following the damaging energy exchange and the final stabilization of the process (including intermediate and long-term reparative and rehabilitative measures).

Dismantling nuclear bombs and preventing production ........................................ I
Limiting nuclear bomb size and manufacture .................................................. II
Total nuclear use-hand treaty ............................................................................. III
Plastic surgery ................................................................................................. X
Making polo goal posts to yield on impact ....................................................... VII
Old tires on sides of tugs ................................................................................... VI
Railroad under- and overpasses ....................................................................... V
Parachutes ......................................................................................................... IV
Fire alarms ....................................................................................................... IX
Seeding an established hurricane ...................................................................... IV
Built-in automobile crash padding ................................................................... VII
Fallout shelters ................................................................................................. VI
Sanding icy sidewalks ...................................................................................... III
Aircraft carrier arresting gear ........................................................................... IV
Keeping people out of dry woods .................................................................... III
Fire doors ......................................................................................................... VI
Boiler safety valves .......................................................................................... IV
Opening volcanoes to achieve controlled release ............................................. IV
Lubricating San Andreas Fault to cause a succession of small slippages
(see “The Modification of the Planet Earth by Man,” by Gordon
J. F. MacDonald, Technology Review, October/November, 1969) ..................... IV
Aircraft landing and takeoff priorities .............................................................. V
Skin grafts for burns .......................................................................................... X
Diver’s decompression routine ........................................................................ IV
Hanging padding in horse stalls ....................................................................... VI
Wrapping padding on goalpost supports ........................................................ VI
Window washers’ belts ..................................................................................... III
Fire-retardant clothing ...................................................................................... IV
Sunburn lotion that blocks U.V. ....................................................................... VI
Chaining tigers .................................................................................................. III
Not moving flowerpots over onto windowsills .................................................. III
Stopping hemorrhage ..................................................................................... IX
Banning explosives in tunnels or under "air rights" buildings ............................................... V
Skiers' "pre-season conditioning" ................................................................................................ VII
Mouth-to-mouth resuscitation ....................................................................................................... IX
Teaching Braille to a blind soldier ................................................................................................ X
Use of retaining walls to prevent California mud slides ............................................................... III
Storm cellars in tornado areas ....................................................................................................... V and VI
Underground disposal of radioactive wastes .................................................................................. V and VI
Smuggling auto bumpers in sheet metal ........................................................................................ Opposite of V
Causing earthquakes by damaging streams (see MacDonald, noted above) .......................... Opposite of I
Spacesuits ...................................................................................................................................... A variety of VI
Smoking in bed .............................................................................................................................. Opposite of III
Pointing a spear; edging a sword .................................................................................................. Opposite of VII
Skin tanning in relation to subsequent sun exposure ................................................................. A naturally occurring illustration of VIII
Release bindings on skis ............................................................................................................. A variety of III, preventing further energy release
Earmuffs .......................................................................................................................................... A variety of VI
Reducing amount of explosive in each shipment ........................................................................ II
Playing with matches in pine woods ............................................................................................. Opposite of III
Welders' goggles and helmets ...................................................................................................... VI
Fire fighters' suits .......................................................................................................................... VI
Fire escapes ..................................................................................................................................... V
Lengthening fuses on explosives ................................................................................................... V (to allow the lighter to avoid injury)
Roadside ("breakaway") poles that yield gently when hit ........................................................ VII
Lowering crib heights to reduce brain and other injuries when infants fall out ..................... II
Preventing the conception of tigers to prevent subsequent human injury ................................ I
Developing less expensive fender repair methods ....................................................................... X
Stopping a would-be suicide from jumping ................................................................................ III
Reduce the calibre and number of firearms in private hands ....................................................... II
Eliminate utility poles from roadsides ........................................................................................ IV
The electrical fuse ........................................................................................................................ A variety of III; it could be argued that the disconnection is usually achieved by V or VI (barrier, air), but whatever the physical means, the primary strategy is to prevent (further) release of energy

APPENDIX B

This appendix gives four case studies, applying the fundamental approach to provide systematic, basic options analysis of four important public problems. The tactics and overall statements are not intended as definitive. They are illustrative only, and not necessarily practical. Furthermore, these will not treat questions of priorities for optimum strategy-influence on the end results, a subject touched on elsewhere (8, 11). The first three of these examples are from Reference 12. As in Appendix A, the strategy options are labeled I–X in logical, consecutive order.

Case Study A: Reducing the Losses Associated with Femoral Fractures among the

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Elderly. This mechanical energy-damage problem has customarily been conceived as a problem primarily of preventing falls and of treatment once injured. Systematic analysis gives a richer range of options, an analysis more likely to identify ways for greater loss reduction.

I. Do not raise patients above their surroundings. Do not allow the high-risk elderly to stand. What does not go up cannot come down. Note that the “potential energy,” the release of which in falling produces damage, is a characteristic of the falling person or other body, and that from the standpoint of injury to that same body cannot be regarded as being transferred to it at the moment of impact. The same point holds for the “kinetic energy” released when a person, for example, is injured walking or running into a wall.

II. If patients and other high-risk elderly must be raised, raise them less far, or for shorter intervals. Keep beds lower. Use wheel chairs instead of walking, and housing into and in which steps, stairs, and inclines are eliminated.

III. Keep them from falling. Use measures that retard deterioration of, or improve sensorimotor and musculo-skeletal status and performance. Eliminate occasions and means for tripping. Improve coefficients of friction of underfoot surfaces and of shoes. Make sure shoe heels are broad and not worn unevenly. Repair heels. Provide handgrips, canes and walkers, bedrails, and, as necessary, restraints.

IV. Provide walkers, wall handgrips, or other means for reducing rate of fall, for example, when tripped. (The author is not certain of good sample tactics for IV.)

V and VI. Since the falling person carries her own energy, separation is, in this context, in a sense, theoretically impossible.

VII. Cover impactable floor and other surfaces with energy-managing barriers—“crash-padding.” This technique, used in vehicles and elsewhere, is a largely ignored tactic for reducing femoral damage. In hospitals and other environments and for the elderly it has considerable potential, since impact forces decrease directly with increase in stopping distance (1, 7, 11). Eliminate, soften, or round sharp points, protruding corners, and edges. Soften bathroom and other microenvironmental hardware and structures.

VIII. Increase relevant musculo-skeletal strength. Develop measures that reverse or lessen postmenopausal and other osteoporosis and of soft tissue weakening. Ideally, these should be “passive” rather than “active,” (13) that is, as with pasteurization, chlorination, fluoridation, vaccination, food enrichment, and vehicular air bags and other crashpackaging tactics, as little as possible or no active cooperation should be required on the part of the individuals to be protected (13). If effective in reducing osteoporosis, addition of an essential mineral to deficient water supplies would illustrate this tactic and principle (5). The same point concerning passive approaches being preferable holds generally whenever possible for all strategies.


X. Intermediate medical care, long-term reparative and rehabilitative care.

It should be noted that the reduction of mechanical energy-damage to the brains of infants produced by falls from cribs can be similarly analyzed, and that the tactics are similar, and in some cases identical (9).

Case Study B: Reducing Thermal Energy Damage to Children and Others. As a practical matter, analyses of the thermal-damage problem must include consideration of circumstances that can produce heat quickly. This is the case especially in relation to strategy options I-IV.

I. Do not keep gasoline, old newspapers, and other flammables in the house. Do not make dwelling units flammable. Do not allow bedding, nightclothes, sweaters, saris, and appropriate other garments to be flammable. Eliminate space and floor heaters (2, 14, 17).

II. Reduce the amount of such items. Reduce brewing temperatures for coffee and tea.

III. Stop smoking in bed, in storage areas, in explosives plants. Keep coffee cups and other hot items out of reach of infants and small children. Improve their stability and handles (? eliminate handles). Keep matches, cigarettes, and people out of dry woods.

IV. Fire-retardant paints. Cups that spill at a different rate or in a different direction.

V. Don’t brew or use coffee and tea when small children are or will be near. Use blowtorches and other hot items at a distance from people to be protected. Don’t use night clothes.

VI. Interpose thermal insulation. Firedoors.
VII. Make the hot object of material that has both low heat content and inability to transfer heat at hazardous rate: for example, the glass doors of some household ovens (most are not yet adequately designed in this respect), and the double-walled (with air between) design of some Japanese teacups.

VIII. Make people more resistant to heat in a way somewhat analogous to sun-tanning, for example, by use of salt-tablets.

IX. Organize equivalent of poison control centers. Organize for quick response in bringing emergency medical care and the burned together. Make sure, require, and enforce that ambulance and other emergency personnel are very well able to deal with burns.

X. Grafting and other cosmetic surgery. Psychotherapy. Retraining.

Case Study C: Reducing Drownings. Drownings are the result not of energy damage per se, but in essence of interference with energy exchange. As such, they are a prime illustration of a closely related class of ecologic phenomena (6, 7), and can be approached just as easily with this basic options analysis.

Other members of this group include carbon monoxide and cyanide poisoning, and the various forms of strangulation and nonaqueous suffocation. Frostbite and the varieties of cardiac and vascular malfunction causing interference with the energy exchange provided by the circulating blood provide additional illustrations (7).

Identifying options for reducing losses of this type succumbs to essentially the same approach, the difference being that the environmental hazard central to the analysis is not one of the forms of energy, but rather the cause of such interference with energy exchange—water, by definition, in the case of drowning:

I. Prevent the synthesis or aggregation of water. Do not collect it. Prevent rainfall, do not build swimming pools.

II. Reduce the amount marshalled. Produce or bring together cups—no pool-fulls. Reduce precipitation.

III. Prevent its release to site of concern. Do not open the dam, tap, or hydrant.

IV. Modify the rate of aggregation or spatial distribution of the water aggregated. Control rate of release from source, use sluice gates. Seep through ground rather than flow through irrigation ditches. Make shallow.

V. Separate the water and the target population. Route streams away from play areas. Clam at low tide; cross estuaries when the water has receded; cross while not in flood, e.g., the legendary crossing of the Red Sea (4).

VI. Interpose material barrier. Dykes, sea walls, fences around swimming pools. Well and culvert covers. Use flotation gear, face mask and snorkel, diving suit, submarine, or diving bell.

VII. Modify the water. Spray, vaporize, or freeze.

VIII. Make the people less susceptible to drowning. Teach swimming, including breath-holding. Increase vital capacity. Develop gills.

IX. Emergency response. Teach lifesaving, including retrieval from water, resuscitation. Airsea rescue operations. Equip boats and litoral with life preservers, boats, ropes and ladders (for ice breakthroughs).

X. Intermediate and long-term reparative and rehabilitative measures. In the case of drowning, this strategy usually has little to offer.

Case Study D: Reducing Mob Damage Losses to the White House or other Private or Public Building. Mobs, other than through coercion, example, and interference with normal social intercourse, most commonly produce damage through the application of energy in excess of the thresholds of target animate and inanimate structures. All crowds have muscle power, and hence can potentially damage by transfer of mechanical energy, as with rocks, fists, and breaking down doors and other barriers. Some mobs also have other forms of energy with which to damage. These include explosives—whether as bombs or in firearms—and incendiary devices. Though from a quantitative standpoint often dissimilar both in range and in their potential targets, the same general, qualitative analysis applies equally to them as to all cases within the general class.

Using the same strategy-option nomenclature given above, the following illustrate the options for reducing possible damage to the White House. This is an example of a commonplace contemporary and historic problem also illustrated by masts, castle walls, Renaissance palace architec-
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ture, the Kremlin, and the apparent policy in Roman Britain of encamping troops at a distance from headquarters to lessen the likelihood of damage from their rioting.

I. Prevent crowd formation.

II. Keep crowds small. Limit the number of persons allowed in Lafayette Park (across the street from the White House). Proposals under recent Presidents to level a nearby block for a public and parade assembly area fundamentally violate this principle.

III. Prevent crowd from becoming unruly. That is, permit only "peaceful assembly."

IV. Modify rate and spatial distribution of the mob's energy release, as with water hoses, tear gas, arrests.

V. Only allow demonstrations at more distant lot— the Washington Monument grounds, or in West Potomac Park. Phase for less convenient days and times, or those when there is less to damage.

VI. Barriers. Fences, doors, moats, hedges, walls, and ornamental pools. Park buses interposed in lines bumper-to-bumper.

VII. Prevent carrying or availability of devices used to localize mechanical force: brass knuckles, chains, knives, loose benches.

VIII. Strengthen structure. Force-resistant exteriors and glazing, locks, reinforced framing, fireproofing.

IX. Emergency response. Signal generation and transfer, evaluation, decision, command, dispatch of response from nearby, and control.

X. Clean-up and stabilization.

Finally, several miscellaneous points seem especially noteworthy in this context:

The various poisoning problems, including lead poisoning and drug addiction, are also readily susceptible to such basic, and very similar, options (and causal) analyses.

Since basic analysis in the energy damage problem field and its use must be based primarily on physics, as must many aspects of more quantitative work, some subtlety of understanding of physics is very helpful. For example, the "Tigers" (1) categories are not merely boxes in a classification scheme; the first eight reflect fundamental aspects of the physical world.

Moreover, the phenomena so represented are rapidly occurring, typically transient subsets of the ecology of energy flows, distributions, and changes. It is important that the relationships between these derivatives of the larger sets be understood in relation to them.
Table 9. Factors Related to the Likelihood of Crash Injury: The Haddon Matrix

<table>
<thead>
<tr>
<th>Phases</th>
<th>Human</th>
<th>Vehicle</th>
<th>Physical and Social Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Crash</td>
<td>Alcohol intoxication; Fatigue; Experience and judgment; Driver vision; Amount of travel</td>
<td>Brakes, tires; Center of gravity; Jackknife tendency; Ease of control; Load weight; Speed capability</td>
<td>Laws related to alcohol and driving; Visibility of hazards; Road curvature and gradient; Surface coefficient of friction; Divided highways, one-way streets, intersections, access control; Signalization; Speed limits</td>
</tr>
<tr>
<td>Crash</td>
<td>Seat belt use; Age; Sex</td>
<td>Speed at impact; Vehicle size; Automatic restraints; Hardness and sharpness of contact surfaces; Load containment</td>
<td>Recovery areas; Guardrails; Characteristic of fixed objects; Median barriers; Roadside embankments</td>
</tr>
<tr>
<td>Post-Crash</td>
<td>Age; Physical condition; Disabilities</td>
<td>Fuel system integrity</td>
<td>Emergency communication and transport systems; Distance to and quality of medical services; Rehabilitation programs</td>
</tr>
</tbody>
</table>


The Haddon Matrix changed how injuries are viewed and provided a framework for the development of injury control interventions. Haddon demonstrated that an appropriate understanding of the factors affecting injuries in each cell of the matrix could lead to more effective interventions. By identifying which factors are important and their location in the crash sequence, it will be possible to understand where interventions may be most appropriate.14

Haddon identified the pre-injury phase as the period when primary prevention approaches, such as divided highways and speed limit enforcement, could be implemented. The injury phase focuses on secondary prevention such as the deployment of airbags or the installment of breakaway signposts. The post-injury phase emphasizes tertiary prevention such as effective emergency medical services and trauma rehabilitation. Haddon applied this matrix to several other unintentional injuries and to those from motor vehicle crashes. Barss et al. compared the application of these epidemiological methods to diseases and to injuries, with attention to the host, agent, and environment,3 as shown in Table 10. This table also shows that equipment factors and activity at the time of the incident are essential considerations.
Table 10. Comparative Epidemiology of Disease and Injury: Malaria Versus Brain Damage to Motorcyclist

<table>
<thead>
<tr>
<th>Variable</th>
<th>Disease</th>
<th>Health Condition</th>
<th>Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathology</td>
<td>Malaria</td>
<td>Health Condition</td>
<td>Brain damage</td>
</tr>
<tr>
<td>Incident</td>
<td>Mosquito bite</td>
<td></td>
<td>Crash into tree</td>
</tr>
<tr>
<td>Agent</td>
<td>Plasmodium parasite</td>
<td></td>
<td>Kinetic energy</td>
</tr>
<tr>
<td>Vector/Vehicle</td>
<td>Anopheles mosquito</td>
<td></td>
<td>Motorcycle</td>
</tr>
<tr>
<td>Activity</td>
<td>Sleeping</td>
<td></td>
<td>Motorcycle travel</td>
</tr>
<tr>
<td>Personal/Host Factors</td>
<td>Low immunity — young child</td>
<td></td>
<td>Alcohol intoxication; youth; male sex; inexperience; fatigue</td>
</tr>
<tr>
<td>Equipment Factors</td>
<td>Mosquito net; insect screening</td>
<td></td>
<td>Motorcycle helmet; guardrail</td>
</tr>
<tr>
<td>Environment Factors</td>
<td>Unscreened home near swamps; rain</td>
<td></td>
<td>Unprotected curve near tree; unsafe surface and incline; rain</td>
</tr>
<tr>
<td>Time/Visibility Factors</td>
<td>Night/Darkness</td>
<td></td>
<td>Night/Darkness</td>
</tr>
</tbody>
</table>


The Ecological Model

In the same way that the Haddon Matrix has been valuable for addressing prevention of unintentional injuries, there is also a model for understanding the prevention of violence. The Ecological Model examines the complex interplay of individual, relational, social, cultural, and environmental factors that increase or decrease the risk for violence. This model was first introduced in the 1970s and was initially applied to child abuse. Subsequently it was applied to youth violence and, most recently, researchers have used it to understand intimate partner violence and abuse of the elderly (Figure 5).

Figure 5. Ecological Model for Understanding Violence

The ecological model posits that (1) health and well-being are affected by a dynamic interaction among biology, behavior, and the environment, and that (2) this interaction changes over the life course.

**Individual Factors:** Characteristics of the individual that increase the likelihood of being a victim or a perpetrator of violence, such as:

- Impulsivity;
- Low educational attainment;
- Substance abuse (alcohol, drugs);
- Prior history of aggression and abuse.

**Relationship Factors:** Proximal social relationship (i.e., with peers or within family environments) that increase the risk for violent victimization and perpetration. Examples of relationship factors include:

- Harsh parenting practice;
- Association with peers involved in delinquent activities;
- Poor parental supervision.

**Community Factors:** Characteristics of context in which social relationships are embedded that are associated with being victims or perpetrators of violence, such as:

- Residential mobility;
- High-population density;
- Drug trafficking;
- High levels of unemployment;
- Social isolation;
- Few institutional supports.

**Societal Factors:** Factors that create an acceptable climate for violence, reduce the inhibitions against violence, and create and sustain gaps among different segments of society or tensions among different groups or countries. Examples of such factors include:

- Cultural norms that support violence as an acceptable way to resolve conflicts;
- Attitudes that regard suicide as a matter of individual choice instead of a preventable act of violence;
- Norms that give priority to parental rights over child welfare;
- Norms that entrench male dominance over women and children;
- Norms that support the use of excessive force by police against citizens;
6. **Development of an Injury Surveillance System**

Injuries have been shown to account for a significant health burden on populations, regardless of gender, age, income, or geographic region. The historical neglect of injuries as accidents or random events is fading with the growing understanding that injuries are a preventable health threat that affect us all. The role of the epidemiologist is fundamental in this evolution. By conscientiously providing the public and policy makers with a steady stream of effectively gathered and correctly analyzed and interpreted surveillance data, epidemiologists can significantly contribute to effectively addressing this previously overlooked health issue.

Currently, surveillance for injury is similar to that for infectious or chronic diseases. However, some circumstances are unique to injury, such as the role of institutions outside the health sector, including police departments, district attorneys, forensic medicine, coroners and medical examiners, and transportation offices. Ethical considerations also come into play more often in violence-related injury, especially when the injury results from crime (e.g., homicide).

**Injury surveillance** is defined as:

“…the ongoing systematic collection, analysis, and interpretation of injury data, for use in planning, implementation and evaluation of prevention activities. Injury prevention programs use surveillance data to assess the need for new policies or programs and to evaluate the effectiveness of those that already exist.”

The steps for developing and maintaining an injury surveillance system follow. Notice that the process is considered **cyclical**; when you evaluate the system you will probably revisit the steps you completed earlier to make adjustments and to continually improve the quality of the system. For example, circumstances change, and the coalition members or operations team may need to be adjusted, or you may find you need to change your indicators. In addition, it is very likely that some of these steps occur simultaneously or in a different order. The first step is to know the conceptual framework of injury prevention, which is basic to developing the subsequent steps. The second step is to describe the size of the injury problem and the data sources. In the third step, some considerations about the coalition necessary to support the injury surveillance and prevention activities are described. The fourth and fifth steps specify the technical skills necessary to develop the surveillance system. Discussions of the methodology and analysis plans are also covered in
Key discussion points:

• Surveillance is one model for data collection.

• These 10 steps, although focused on surveillance, are applicable to a number of injury prevention data collection endeavors – such as: observational surveys, home risk assessments, focus groups, community surveys/assessments.

• Today’s discussion on data collection with be framed around these 10 steps.
Step 1: Define Objectives

What will be done with the data?

What is the purpose?

How will injury be defined?

What is the case definition?

Key discussion points:

• Data collection requires substantial planning. Part of the planning involves determining your objectives for collecting the data.

• You should consider the purpose of surveillance and what might be done with the data.

• (OPEN FLOOR DISCUSSION & SUMMARIZE ON FLIP CHART; DISCUSSION SHOULD GENERATE A LIST WITH A SAMPLE OF THE FOLLOWING:)

  (pg 324-326 Christoffel/Gallagher)
  ✓ Understand injury problem well enough to design targeted programs
  ✓ Track progress & monitor trends in the magnitude & distribution of injury
  ✓ Identify new and emerging hazards in a timely fashion
  ✓ Describe injury patterns to justify need for a program
  ✓ Assess the global impact of a program
  ✓ Overview or snapshot of leading causes
  ✓ Determine magnitude/nature of perceived injury problems
  ✓ Better understand injuries at a particular location (hwy, home, school, workplace)
  ✓ Determine health care costs associated with injury
  ✓ Support policy and intervention efforts
  ✓ Marketing and disseminating data
  ✓ Linking data sources

• There’s much to consider in developing your INJURY DEFINITION and CASE DEFINITION...
An important part of determining the purpose of your data collection system is to develop a study or research question. Having a study question will help you stay on track and guide you in the design of your data collection system.

A key characteristic of a study question is that it be as specific as possible to a given issue. Often you will begin with a general topic of interest and then narrow your focus to a specific, researchable question. Discuss two examples.
Having narrowed your focus of study, you are better able to arrive at a study question.

State a specific question that you are going to answer through the systematic collection of data in your community. Your data collection efforts will be designed to answer this question.
Characteristics of a Good Study Question

- Specific, clear, and to the point.
- Measurable.
- Provide the information you want.
- As simple as possible.
- Of commonly understood terms.
- Avoid subjective terms (good, bad).

Key Discussion Points:

- Must be specific, clear, and to the point.
- Must be measurable.
- Must be adequate to provide the information you want.
- Should be as simple as possible.
- Be composed of commonly understood terms. You need to make sure everyone is clear on definitions, even common terms. EXAMPLE: Maintain an active coalition...what is active?
- Avoid "loaded" and subjective terms (e.g., should, ought, good, bad, dirty) EXAMPLE: Porch steps in poor condition v. not meeting minimum construction standards.

To further arrive at defining the objectives of your data collection system, you need to develop a good injury case definition.
How will injury be defined?  
What is the case definition?

- Person  
- Place  
- Time  
- Type of Injury  
- Intent  
- Severity

Injury Surveillance: A 10-Step Plan

Key Discussion Points:

- Injury definition and case definition are inter-related.
- Your focus should be on developing a clear statement of the following: (slide list)
- Elaborate with examples, such as:
  - **Person**: Race, Tribe, Age, Gender
  - **Place**: State, Reservation, Roadway
  - **Time**: Year, Day/Night-time, Day of Week, Specific Dates like 4th of July Weekend
  - **Intent**: Unintentional/Intentional
  - **Severity**: This is probably one of the bigger decisions you'll make...Discuss on next slide
Key Discussion Points:

• Injury Pyramid (or Iceberg) is most common model of injury severity, represented by the degree of medical intervention and forces of energy at work.
Key Discussion Points:

• Deaths:
  • Readily accessible from death certificates, states, central data bases; inexpensive
  • Cause of death from injury consistently reported on death certificate
  • Rare events; ~1% of all injuries
  • Not good guide to ascertain overall injury problem or medical consequences (i.e.,
    long term disability)
  • Influenced by small numbers, especially in small population/short time periods
Key Discussion Points:
• Hospitalizations:
  • When combined with mortality data, provides a much better picture of injury problem
  • Disability and healthcare costs can be better described
  • Access to data more difficult (privacy act, HIPAA, manual records)
  • Inconsistent or incomplete coding of injury causation; EXAMPLE: Ethnicity not a variable, coding, RPMS/RCIS not 100% utilized
  • Data collection, particularly manual review of records, consume significant human resources.
Key Discussion Points:

- **ED Visits:**
  - When combined with death and hospitalization data, helps provide “big picture”
  - Small populations with limited injury mortality & hospitalization may benefit by casting the net wider to include ED visits.
  - ED visit data can be useful for specialized studies and injury. EXAMPLE: child burns @ San Carlos
  - Large number of cases may be difficult to manage; too time consuming given limited time/resources; can be overwhelming task
  - Access to data may be difficult (manual records)
  - Inconsistent or incomplete identification of injury causation
Key Discussion Points:

• Outpatient/Physician Visits:
  • May be good for specialized injuries (sports related, eye injuries)
  • Might be good supplemental information but in general not the place to start with injury surveillance
  • Difficult access. EXAMPLE: Behavioral Health data is highly protected by practitioners.

In summary re: severity and your case definition:

• Don’t try to do everything at once! Start small, with deaths and most severe injuries. Plan to expand and phase in other levels of severity as resources permit.
• You can work on prevention projects without knowing everything about every injury in your community.

• From Robertson’s *Injury Epidemiology, 1st ed.* Pg. 29-30: The specification of injury severity is an essential element of the use of injury epidemiology for injury control. In any given year, virtually everyone experiences minor injuries, such as small scratches, bruises, and burns. Most of these heal with little to no treatment and do not interfere with one’s activities. The energy sources, vehicles and vectors, and other circumstances of injuries are often not the same for those that are relatively severe and those with trivial consequences. Since trivial injuries are so common, priority in the devotion of resources to control injuries based on total numbers in a given category can result in substantial misallocation of resources with respect to reducing the cost of injuries and the improvement of the quality of life of the severely injured or their families.
Injury Case Definition:

- Clearly stated, understood
- Comparable to definitions used elsewhere
- Considers
  - specific types/causes of injury
  - severity
  - intentionality
  - age groupings
  - all cases v. sample of cases

Example for 2\textsuperscript{nd} bullet re: comparability: Elder definition nationally is 65+
Examples: Injury Case Definition

- **Severe Injury**: Injury occurring during 2000-2005 resulting in LOC, big bone fracture, amputation, ≥ 1 day of hospitalization, or fatality for which treatment or payment by the Tribal clinic was provided.

- **Assault Injury**: Injury occurring on the Reservation during 1996-1998 resulting in ≥ 1 day of hospitalization or fatality that was purposely inflicted by another person (E960-969).

- **MVC Case**: Crash on one of the 4 major Reservation roads during 1990-1997 that involved Tribal or state police department investigation.

Possible examples:
- Surveillance systems
- Fellowship studies
- Other studies
Example Objectives

- Develop a protocol for collecting basic level data (IHS RPMS and State Inpatient Hospitalization Data) by April 1, 2010.
- Provide a comprehensive injury report to Tribes by the end of fiscal year 2010.
Data collection efforts can be difficult and complex. Forming a data committee (or some form of partnership) is important in your surveillance endeavors.

Partnerships are important to all of our work in IP, including data collection.

Establish partnership with organizations that collect data and with community entities interested in receiving injury data. Some questions to consider in identifying data committee members (see slide bullets).

Provide listing of potential data committee members from Gallagher pg. 330, Exhibit 12-1.

Example of formal data committee: EXAMPLE: IHS data sharing with state.
KEY POINTS:

- Several entities have IP data; many of whom collect data in which injury prevention was is not the original intent
- As a result, there may be some limitations; but there’s almost always a limitation with a data collection system…Accept it!
- Take advantage of existing data sources; it will save you a significant amount of time and resources.
- Among the entities that have data that may contribute to your IP data collection endeavors:
  - PH entities
  - Health Care Delivery
  - Law Enforcement
  - Other Public Safety Entities (fire, EMS)

- These entities may have data at the national, state, or local level.

- National: provides big picture of trends in US; some state specific; generally not sufficient for community program development
- State/Local: more likely to reflect local injury problems; quality/completeness issues; not always computerized; timeliness/lag time; Race not always specified, like AZ ED data base. Surrogates for race? Perhaps zip code of residence or location of treatment facility.

15 minute buzz group
- What existing data sources have you utilized?
- Strengths/Weakness

- Provide Data Sources Matrix
KEY POINTS:

• No approach to data collection is perfect; each has own strengths, limitations, costs, levels of quality and reliability

• Always keep in mind your data objectives when considering these strengths and weaknesses

• Important considerations include (discuss slide bullets)
Step 5:
Conduct Preliminary Data Analysis

- To understand data source completeness and adequacy
- Start with analysis of broader categories
- Services of epidemiologists

KEY POINTS:
• Finer nuances of a data source completeness and adequacy rarely are evident until you actually try to carry out data analysis.
• Thus, preliminary data analysis is an important step.
• Start with analysis of broad categories (i.e. interpersonal violence) then go more in depth as possible (domestic violence among women)
• Epidemiologist can be useful in this step. Seek them out from such places as state health department, epi centers, academic institutions, graduate students
KEY POINTS:

• Once you’ve attempted to gather and analyze data from existing sources, you should be ready to determine the feasibility of achieving your data collection objectives.

• Addressing these questions will help you prepare a data collection plan that includes collection, analysis, and dissemination of the data needed.
Step 7: Linkages with Other Data Sources

Advantages:
- Supplemental data
- Comprehensive description
- Highlights completeness from each source
- Improve data quality

Challenges:
- Personal identifiers needed/Confidentiality
- Interagency “Politics”
- Different storage media
- Data Quality

KEY POINTS:
- It is unlikely for a single data source to contain all the information desired for your IP program.
- With an understanding of their strengths and weaknesses, consider linking data from more than one source.
- Linkage can have two meanings (1) combining data from different sources, such as supplementing police crash data with state crash data; or (2) an electronic linkage between data sets (i.e., CODES)
- Discuss advantages/challenges
- Discuss examples:
  - CODES (see reference handout)
Step 8: Perform Validation Studies

- How complete?
- How accurate?
- Meeting objectives? Met with less information?
- Operating efficiently?
- Improvements?
KEY POINTS:

• Describe each term
• Give real world examples
• As previously mentioned, data collection activities almost always have limitations. That’s OK. You need to understand what they are and disclose them when you present your data

BIAS: In general, this term refers to processes of data collection that impact how representative the data are. You should minimize the amount of bias in your methods but acknowledge that there will likely be some degree of bias and acknowledge it as a limitation of your data collection system. Consider the following:

• Are subgroups of the population systematically excluded? Over-represented?
• Have all persons involved in data collection been trained?
• Is there a data collection protocol?
• Does your data collection effort include interviewing people? If so, such factors as reliable memory, embarrassment, and communication barriers are of concern.
• What is the degree of under-reporting by some entities?
• Have activities in the community (intervention, media, staff changes, changes in access to health care, policy/law changes) taken place to influence the data?

SENSITIVITY: In general, refers to circumstances in which your data collection efforts are missing cases that occur. Often refers to FALSE NEGATIVES. Example: cases triaged directly from the scene and bypassing your healthcare facility.

Implications of issues with sensitivity: Too many missed cases (False Negatives) results in inaccuracies in gauging the magnitude of the problem and, in evaluation, dilutes the effect of your counter measures.

SPECIFICITY: In general, refers to circumstances in which your data collection efforts are including cases that do not meet your case definition (FALSE POSITIVES) Example: Fractures due to degenerative bone disease or diabetic amputations.

Implications of issues with specificity: Too many non-injury cases mistaken as meeting your case definition (False Positives) results in inaccuracies in gauging the magnitude of the problem and may result in directing higher than necessary resources to a countermeasure.
Step 9:
Develop a Dissemination Plan

- Share with your stakeholders!
- Choose right format for intended audience.
- Data committee can help.
- Some Considerations
  - Summary vs. detailed
  - Narrative, graphs
  - Frequency of production & distribution
  - Electronic, paper

KEY POINTS:
(See Gallagher pg 359-361)
• Put the data in the hands of the right people.
• Different formats are required for different stakeholders. Data and information are not synonymous!
• Stakeholders include:
  • Providers of the data
  • Target audiences in the community
  • Policy makers in your organization, the tribe, and other influential organizations
• Effective dissemination of data can lead to:
  • Support for continued data collection
  • Prioritization of injury interventions
  • Implementation of interventions
  • Visibility for the problem of injury and for your program

Provide some examples of: Studies, Briefing Documents, News or newsletter articles, white-papers, poster presentations

Provide copy of Exhibit 12-4: Framing the Data (pg 361)
Step 10: Tie Data into Action & Funding

- Data are never the end product.
- Translate the data into action.
- How?

KEY POINTS:

- No particular “recipe” to translate data to action.
- Discuss with class their experience where data has translated to action or funding. Some examples:
  - Improved data systems
  - Policy changes
  - Funding through grants
  - Interventions (e.g., highway safety improvements)
Example

- How data collection is evolving in Montana/Wyoming
- What is the etiology of injury hospitalizations and fatalities for MT/WY American Indians?
- Data Sources: IHS RPMS and Arizona Hospital Discharge Data
- Case Definition: E-Code and Injuries (> 1 day of hospitalization or fatal)
- Result: A Passive Severe Injury Surveillance System
G: Develop Injury Surveillance System
(Data Collection Plan)

Objective 1: Develop a protocol for injury surveillance by the end of 2009.

Objective 2: OEH will collect injury data for years 2005-2008 at five tribal clinics by October 2009

Objective 3: Report findings to key stakeholders and Tribal Council by the end of 2009.

Read the goal. DATA COLLECTION PLAN Goal & Objectives
Read the FIRST objective – Ask the group: “Is this objective SMART?” Specific-protocol for injury surveillance, Measurable-completed protocol, Action-who will develop?, Reasonable-timeline and staff to develop protocol?, Time-end of 2009, by Dec. 31, 2009?

Read the SECOND objective – Ask the group: “Is this objective SMART?”, Specific-collect injury data at clinics, Measurable-completed 2005-08 data, Action-OEH will collect injury data, Reasonable-4 years of data collection by Oct 09, Time-October 2009.

Read the THIRD objective – Ask the group: “Is this objective SMART?”, Specific-report findings to key stakeholders, Measurable-end of 2009, Action-Who will report findings?, Reasonable-reporting findings, Time: end of 2009.

IF you leave objectives open-ended as to who will do it, no one will do it! Assign objectives.
these sessions. The sixth step focuses on translating surveillance data into prevention activities. The last step involves defining an evaluation plan and monitoring activities. These steps draw upon other important documents and reports such as the *Injury Surveillance Guidelines*.5, 18

**Steps to Develop and Maintain an Injury Surveillance System**

1. **Understand the conceptual framework of injury prevention**
   - Definition and typology of unintentional and violence-related injuries

2. **Assess injury data sources and describe the injury problem**
   - Identifying strengths and weakness of injury data sources and size of the problem

3. **Build a coalition to support the injury surveillance system and prevention activities**
   - Identify the partners to include in a coalition to support the injury surveillance system

4. **Determine the appropriate Methodology for the surveillance system**
   - Determine events, data elements, type of surveillance, and data collection instruments

5. **Define and develop an analysis plan for the surveillance data**
   - Calculate indicators, demographic, and environmental characteristics

6. **Use injury surveillance data to inform injury prevention**
   - Use data to identify preventable injuries, high-risk groups, and most appropriate interventions

7. **Define an evaluation plan for the surveillance system and monitor prevention activities**
   - Apply the criteria to evaluate the surveillance system and monitor the strategies

7. **Ethical Considerations**

Effective public health activities, including public health surveillance, depend on a trusting relationship between public health practitioners and the society they need to help.19 Epidemiologists should consider any known or potential risks that individuals or populations may encounter as a result of their participation in surveillance activities. Consideration should be given not only to physical risks, but also to psychological, economic, legal, and social risks. Surveillance practitioners should be sensitive to the possible stigmatization of groups as a result of categorization in surveillance data.20
Two final planning considerations may affect your study.

Most of us likely have some basic knowledge of the Privacy Act, one of the precursors of HIPAA. The Privacy Act of 1974 basically addresses how government agencies handle and maintain records about individuals, and includes provisions for employee responsibilities and individual rights. The Privacy Act does not automatically apply to all government records - some situations are excluded.

The Institutional Review Board - or IRB - is an entity whose function is to review and approve/disapprove research activities that use medical facilities, data, staff, or, for IHS, funding. IHS and some Tribes have an IRB. An IRB will closely examine the informed consent process, which is the negotiation or agreement between the researcher and the potential volunteer(s), and the negotiation between the researcher and the Tribal community to verify that the research is safe, of benefit, and respectful to the participants. Admittedly, not all IHS Areas have a strong IRB process.

The point today is not to go into great detail about the Privacy Act and IRBs, but instead to mention them as possible planning considerations. There are resources available to assist you in determining if the Privacy Act or an IRB review applies to your study. Such resources may include: local Privacy Act coordinators (often Medical Records staff), the Area IHS Privacy Act coordinators, and web sites, as shown, that address the specific topics.
HIPAA of 1996

- HIPPA privacy rule provides first national standards for protecting the privacy of health information.
- Provides protection for the privacy of certain individually identifiable health data (PHI).
- Regulates how certain entities (Covered Entities) use and disclose PHI.


Does anyone know what the acronym stands for? The Health Insurance Portability and Accountability Act.

HIPAA requires HHS to address the security and privacy of health information, especially individually identifiable health information in all forms.

The HIPAA Privacy Rule federally regulates the definition of administrative steps, policies, and procedures that safeguard individuals' personal, private health information (protected health information or PHI).

The Privacy Rule guarantees patients access to their medical records, gives them more control over how their PHI is used and disclosed, and provides means for action if their medical privacy is compromised. It is designed to protect PHI maintained by covered entities. These covered entities may provide PHI to persons or organizations who are contracted to perform various functions (e.g. legal or accounting services), but the contacted "business associates" may not use or disclose PHI in any way not permitted of the primary covered entity.

What information is protected?
The rule defines “protected health information” as health information that
1. identifies an individual and
2. is maintained or exchanged electronically or in hard copy.

If the information has any components that could be used to identify a person, it is protected. The protections apply to individually identifiable information in any form, electronic or hardcopy.

What types of information are considered personal identifiers?
- Name, SS#, address

In Alaska, the population is small enough in some regions that if you name a type of injury event and a year, that might be sufficient to identify the individual.
“Privacy rule expressly permits disclosures without individual authorization to public health authorities authorized by law to collect or receive the information for the purpose of preventing or controlling disease, injury, or disability, including by not limited to public health surveillance, investigation, and intervention”.

Covered Entities encompass certain types of health care providers, hospitals, health plans, health insurers and health care clearinghouses.

Public Health Authorities include: read slide.

Can anyone identify this facility? Is it a Covered Entity? A Public Health Authority?
Data Collection Planning
Confidentiality Resources

- CDC, MMWR, May 2, 2003 / 52(S-1);1-12.
- Oversight and enforcement responsibilities with HHS Office for Civil Rights:
  www.hhs.gov/ocr/hipaa
- IHS HIPAA Homepage:
  www.ihs.gov/AdminMngrResources/HIPAA/index.cfm
- CITI Course in The Protection of Human Research Subjects:
  www.citiprogram.org

Read slide
Protecting Confidentiality and Privacy

Privacy refers to the right of individuals to refuse to provide information about themselves. Confidentiality refers to the obligation of parties receiving such information to restrict access to it as stipulated by the individual in question. Except under unusual circumstances (e.g., when there is a need for follow-up counseling or treatment, or when release of information is mandated by a court of law), information obtained about participants in a surveillance project should be kept confidential. Protection of confidentiality is not only required by the ethical principle of respecting people (autonomy), but also because the disclosure of certain information to third parties or subsequent use of the data for a purpose other than that which motivated its initial collection may cause harm to an individual, such as discrimination in employment, housing, or health insurance coverage.

A successful reporting system will have clear policies that protect the privacy and confidentiality of information. Policies and procedures also need to protect sensitive or personally-identifying information from being disclosed. For instance, law enforcement agencies may be reluctant to divulge information that could even remotely compromise pending investigations. Law enforcement may be particularly sensitive about “legal” homicides or deaths that occur in the course of duty. The privacy rights of living suspects and alleged perpetrators associated with violent deaths include the right to be free from defamation. The duty of law enforcement agencies to thoroughly investigate homicides and to apprehend perpetrators requires agencies to protect information from disclosure in many open or pending cases. Protection of information on juveniles is even stronger: state statutes almost universally protect such information, based on the philosophy that juveniles should receive rehabilitation and services as opposed to punishment.

8. Summary

Now that you have completed this session, you should be able to:

- Understand concepts, definitions, and classification of injury;
- Know the differences between violence-related and unintentional injuries;
- Describe the global burden and cost of injuries;
- Know the conceptual models for understanding and preventing injury;
- Know the steps to develop an injury surveillance system;
- Review ethical considerations.

Session II addresses the next step, assessing injury data sources and describing the injury problem.
REFERENCES


