Injury Prevention

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Injury as a Public Health Problem

Injury Epidemiology

- 5-6 million people die each year from injuries worldwide.
- Globally, injury causes more deaths than HIV, TB, and malaria combined.
- 90% of these deaths occur in low- or middle-income countries (LMICs).
- In the US, injuries occur most frequently in men, the young, and communities of lower socio-economic status.
- Deaths due to injury are just small fraction of the overall impact of injury. Many people suffer disability or lost work due to injury. As injuries affect the young, the morbidity associated with injury can have significant societal impact.

Role of Injury Prevention

- Injuries are not "accidents." They are predictable and do not occur at random. Understanding who is affected by injury and the context of injury is the first step towards finding ways to prevent injuries and optimize trauma care.
- One-third to ½ of all trauma deaths still occur in the field before possibility of treatment. The main way to reduce this number is through injury prevention.
- Adequate injury prevention programs require a multidisciplinary approach, including clinicians, epidemiologists, urban planners, engineers, policy experts, and educators, among others.

History of Injury Prevention

- Historically seen as "accidents"—freak occurrences/bad luck, which are not preventable.
- Hugh DeHaven, 1916: Canadian Royal Flying Corps volunteer pilot who survived a plane crash (note: not a plane "accident"!). His gunner died, and DeHaven theorized that the internal environment of his part of the plane may have influenced his chances of survival, sparking the first developments of injury prevention.
- John E. Gordon: First to apply the standard epidemiological framework of host, agent, and environment to injuries. This development opened up the possibility of studying injuries as events that involve multifactorial components, some of which are modifiable.
- William Haddon: Director of the first National Highway Traffic Safety Administration. He expanded Gordon's "host—agent—environment" framework to include a temporal component, generating Haddon's Matrix (more below).

Injury Prevention Principles

- **Primary Prevention** (pre-event): designed to prevent the injury event from happening (e.g., separation of traffic mix—creating physical barriers between bike and car lanes).
- **Secondary Prevention** (event): designed to minimize the impact/severity of the injury event (i.e., airbags, seatbelts, or vehicle crashworthiness).
- **Tertiary Prevention** (post-event): focused on preventing the consequences of injury (e.g., rehabilitation to prevent disability).
- Any injury mechanism can be applied to **Haddon's Matrix** to identify potential prevention targets (figure 1).

- The development of Haddon's Matrix led Haddon to create a standard list of **10 injury prevention strategies** to help conceptualize injury prevention opportunities (figure 2).

- The **"Three E's" Framework** for injury prevention strategies includes:
    - Environment/engineering modifications
    - Enforcement/legislation
    - Education and behavior change
  - Most injury prevention strategies have one or more of these characteristics; successful ones often have all three.
- **Active** versus **Passive** interventions: Active interventions are interventions that require some action by the individual (seat belt use); passive ones do not require any action on the part of the individual (airbags). Generally, passive interventions tend to be more easily adopted, which should be considered when designing an injury prevention strategy.

Examples of Injury Prevention Programs

Domestic: Youth Violence Prevention

- Violent injury disproportionately affects young men of color. In studying risk factors for future violent injury, previous violent injury was found to be one of the strongest predictors. In a trauma center, the people at highest risk of dying of a future violent injury are probably some of the patients currently on the trauma service. This provides a unique opportunity to design a hospital-based intervention to prevent future injury in the highest risk population.
- San Francisco Wraparound was started with these public health principles in mind. Violently injured patients between the ages of 10 to 30 are screened by culturally competent case managers. Patients that screen as being high risk are offered Wraparound services; if they accept, these patients become Wraparound clients. Case managers work with clients to seek out and mitigate the root causes of violence, including substance abuse, poverty, mental illness or post traumatic stress, antisocial peers/parents, involvement in criminal acts, and poor education. Interventions include education support, job readiness training, mental health services, peer support groups to build positive coping mechanisms, intensive peer mentoring, housing, and employment opportunities. Over the 12 years of Wraparound's existence, the re-injury rate among the violently injured population in San Francisco has decreased 50% (8% reinjury rate to 4% reinjury rate). It has also been demonstrated to be cost-effective, further supporting it as a sustainable public health intervention.

International: Road Traffic Injury Prevention

- As low and middle income countries industrialize, road traffic injuries are quickly becoming a leading cause of death and disability. Roads in these countries are characterized by poor traffic regulation enforcement and extreme traffic mix, in which pedestrians, two-wheeled vehicles, cars, trucks, and sometimes animal-drawn vehicles all share the same road. These factors lead to high rates of road traffic crashes and injury. In Ghana, road traffic crashes were analyzed; high vehicle speeds were found to be the most common underlying factor, accounting for over 50% of all road traffic crashes from 1998-2000. Speed bumps and rumble strips were created along the road corridor with the highest frequency of road traffic crashes. After this intervention, crash events were found to be reduced by 35%, while fatalities were reduced by 55%. Speed bumps in sub-Saharan Africa have also been modeled and found to be cost-effective at US $6.17 per DALY* averted.

*Disability Adjusted Life Years (= years of life lost + years of life lived with weighted disability) discounted at 3%.

Suggested Reading

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Figures:

Figure 1: Application of Haddon's Matrix to motor vehicle crashes. *The example used in figure 1 is for motor vehicle crashes. How would you use Haddon's Matrix to identify injury prevention targets for falls? Firearm injuries? Drowning? Other injury mechanisms?*

	Human Factors	Agent Factors	Environmental Factors*
Pre-Event (before the crash happens)	Impairment/inebriation, speed, seatbelt use, traffic safety enforcement	Vehicle maintenance (brakes, steering), speed	Road design, intersection design, separation of traffic mix, light timing, speed limits
Event (during the crash)	Size and frailty of victim, protective equipment in place	airbags, vehicle crash safety	Guard rails/medians, embankments, surrounding fixed objects
Post-Event (after the crash)	Health, age of crash victim	Vehicle's fire safety, electronic notification systems/GPS locator	EMS, trauma system readiness, distance to trauma center, access to longer term care (rehab)

*May include social/political/cultural factors, which can be included as a separate fourth factor category in some versions of Haddon's Matrix.

Figure 2: Haddon's 10 injury prevention strategies.

Phase	Strategy
Pre-Event	
	1. Prevent the creation of the hazard; prevent the development of the energy that would lead to a harmful transfer. 2. Reduce the amount of the hazard. 3. Prevent the release of the hazard that already exists.
Event	
	4. Modify the rate or spatial distribution of the release of the hazard from its source. 5. Separate in time or space the hazard being released from the people to be protected 6. Separate the hazard from the people to be protected by a mechanical barrier 7. Modify the basic structure or quality of the hazard to reduce the energy load per unit area 8. Make what is to be protected (both living and nonliving) more resistant to damage from the hazard
Post-Event	
	9. Detect and counter the damage already done by the environmental hazard. 10. Stabilize, repair, and rehabilitate the damaged object.

Questions

1. Injury and injury prevention are important public health issues

a. because the millions of deaths worldwide due to injury are a fraction of the overall impact of injury with morbidity associated with injury having a significant societal impact.
b. although HIV, TB, and cholera pose a much greater overall problem
c. and this is largely related on the unpredictability of injuries
d. however, trauma deaths can be largbely prevented by improved post injury care

2. It is generally recognized that injury preventions programs

a. can be most effective if developed and staffed largely by acute care surgeons
b. are most effective if aimed at highly developed nations due to the concentration of population and risk of injury
c. can be built by applying the standard epidemiological framework of host, agent, and environment to injuries
d. are only applicable to a minority of injury causes since most injuries are random accidents

3. The principles of injury prevention

a. commonly refer to the framework of the "Three Es" which include Expertise, Economic growth, and Energy.
b. include active interventions such as seatbelt use and passive interventions such as addition of airbags to automobiles
c. Use Haddon's Matrix to identify geographic areas in which injuries are most likely to occur
d. by definition must be aimed at issues that occure before the injury event

4. Implementation of airbag and seatbelt requirements as well as improving the crash worthiness of vehicles

a. will likely make further afforts at vehicle injury prevention unnecessary
b. are good examples of post event factors that can be manuipulated as needed
c. can be combined with improvement of injury rehabilitation methods to represent all of the cells in Haddon's Matrix.
d. Are examples of secondary prevention