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Setting the Stage: The Burden of Injury and Strategies for Prevention

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Section A

Building the Case for Policies and Programs Aimed at Reducing the Burden of Injury

Leading Causes of Death in the U.S. (All Ages)

All ages

#1	Heart disease	699,597
#2	Cancer	553,694
#3	Stroke	163,426
#4	Injury	150,992

Leading Causes of Death in the U.S. (Ages 1–44)

Ages 1–44

#1	Injury	78,210
#2	Cancer	23,695
#3	Heart disease	17,982
#4	HIV	8,244

More young lives between the ages of 1 and 34 are lost to injury than to all other causes of death combined

Injury Deaths Represent . . .

- Injury deaths represent only the tip of the pyramid
  - 150,000 deaths
  - 1.6 million hospital discharges
  - 28 million emergency department visits
  - For every death there are 10 hospital discharges and 190 emergency department visits

Injuries Account For . . .

- Eight percent of all hospital discharges
- Thirty-seven percent of all emergency department visits
- Thirty-five percent of all EMS transports

Injury Prevention and Treatment

- Lecture #1: setting the stage
- Lecture #2: example of prevention policy—airbag regulation
- Lecture #3: example of treatment policy—funding of trauma centers

Objectives

- Convince you that injury is a major public health problem and that we can do something about it
- Discuss principal strategies for quantifying the burden of injury (illness)
- Illustrate the use of burden measures in assessing the impact of policy options

Definition of Injury

- Results from the acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation in amounts or at rates above or below the threshold of human tolerance
- Injuries are typically classified by *mechanism* and *intent*

Mechanism

- Refers to the external agent or particular activities that precipitate the injury
  - Motor vehicle crash
  - Firearm injury
  - Fall
  - Poisoning
  - Fire and burns
  - Drowning
  - Stab or cutting/piercing wound

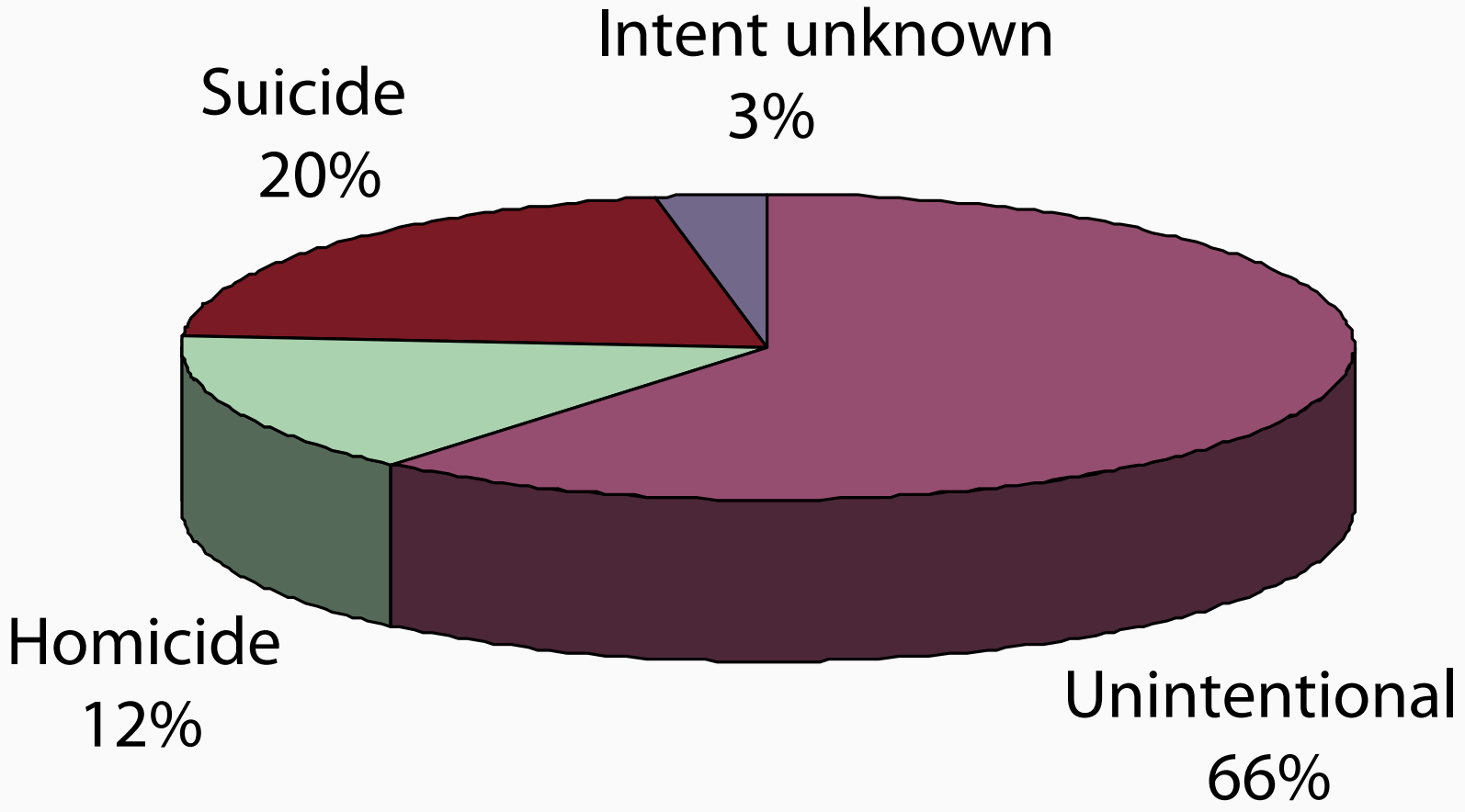
Mechanism: Nonfatal Injuries

	Deaths	Hosp'n	ED visits
MVC	29%	24%	16%
Firearms	19%	2%	<1%
Poisoning	14%	10%	1%
Falls	9%	39%	25%
Suffocation	8%	<1%	<1%
Cut/pierce	2%	5%	9%
Struck by/against	<1%	9%	22%

Intent

- Refers to the actor's purpose and awareness of the risk of injury
- Unintentional ("accidents")
- Intentional
  - Assaults and homicides
  - Self-inflicted injuries and suicides

Injury Deaths by Intent



Prevention Strategies

- **E**nforcement—and legislation
- **E**ngineering—to develop safer products and environments
- **E**ducation—modification of behavior

Enforcement: Legislation

- Bicycle and motorcycle helmet laws
- Drinking and driving laws
- Smoke detector laws
- Ownership and licensing restriction and safe storage of firearms
- Statewide trauma systems

Engineering: Products/Environment

- Motor vehicle and highway safety design
- Improved footwear to prevent falls
- Child-resistant packaging
- Knee braces in sports
- Personalized guns
- Health care technology

Education: Behavior Modification

- Designated driver programs
- Fire skills training
- Falls prevention among the elderly
- Mentoring and violence
- School-based programs to prevent suicide
- Bystander care and 911 access

Effective Prevention Strategies

- Involve and often rely on all three approaches
- Many of the most effective injury countermeasures are policy oriented
- But don't underestimate the role of education
  - General public and those at risk
  - Manufacturers
  - Policy makers who regulate exposure to hazards or mandate safety behaviors

Some Great Public Health Achievements

1. Vaccination
2. Motor vehicle safety
3. Safer workplaces
4. Control of infectious diseases
5. Decline in deaths due to coronary artery disease and stroke

Image source: CDC.

Today's Reality

- Still, too many people die or acquire a disability due to injury
- But we know how to prevent many of these injuries, yet programs and policies are not fully implemented—*Why not?*
- We also know how to treat many of these injuries, yet not everyone has access to optimal trauma care—*Why not?*

Part of the Answer

- We have not done a good enough job of ***assembling the evidence and projecting the outcomes***
- Decisions are often made without analytical consideration of what would be in the best interest of society
- Need good measures of ***efficiency***

Efficiency

- An important evaluative criterion for judging outcomes
- Defined as the relationship between the effectiveness of an intervention and the resources needed to implement it
- Two common approaches
  - Cost-benefit analysis (CBA)
  - Cost-effectiveness analysis (CEA)

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Section B

Measuring the Economic Costs Associated with Injury

Measures of Efficiency

- Need good measures of ***efficiency*** to make sound policy decisions
- Two common approaches
  - Cost-benefit analysis (CBA)
  - Cost-effectiveness analysis (CEA)
- If the consequences of an intervention are identical, then the problem reduces to one of cost-minimization

Cost-Benefit Analysis

- Both the costs and benefits of the intervention are measured in monetary terms
- Results are typically expressed in net benefits
- Some CBA-type studies provide information only on monetary benefits or savings without calculating the cost per se
- An explicit monetary loss is assigned to premature death and disability

Cost-Effectiveness Analysis

- Provides information on the net cost of the intervention and its effectiveness, where effectiveness is ***not*** expressed in monetary terms
- Effectiveness can be defined in terms of lives saved, life years gained, or quality (disability) adjusted life years gained (or lost)

Measuring Benefits in Dollars

- Perspective of the analysis
- Approach for summing costs
- Framework for defining costs

Estimating Costs: Two Perspectives

- ***Societal perspective***
  - Incorporates all health effects regardless of who incurs costs and who obtains the benefits
  - Typically used when broadly allocating resources
- ***Targeted perspective***
  - In many cases may be more narrowly interested in costs incurred by a particular payer or employer

Summing Costs: Two Approaches

- ***Incidence-based***
  - Lifetime costs associated with new injuries occurring in defined time period
- ***Prevalence-based***
  - All costs associated with injury-related consequences suffered in defined time period

Estimating Costs: Two Frameworks

- ***Human capital***
- ***Contingent valuation or willingness to pay***

Human Capital Approach

- Accounts for resources lost because of an injury and assigns a monetary value to these losses
  - Direct costs—resources spent
  - Indirect costs—resources lost because they cannot be produced

Direct Costs

- Actual dollar expenditures for goods and services
- Health- (injury-) related costs
  - Acute hospital care, re-hospitalizations, rehabilitation, prescriptions, nursing home and attendant care, assistive devices, insurance administration
- Non-health– (non-injury–) related costs
  - Property losses

Indirect or Human Capital Costs

- Costs associated with lost or impaired ability to work due to morbidity or due to death
- Referred to as ***mortality*** and ***morbidity costs***
- Some also include non-injury-related costs, e.g., travel delays

Lifetime Cost of Injury and Impact on Health

MVC	31%
Falls	24%
Firearms	9%
Poison	5%
Drowning	3%
Fire	3%
Other	27%

Total Costs: Motor Vehicle Crashes

- $231 billion dollars (in 2000 dollars)
- 41,821 fatalities
- 5.3 million nonfatal injuries
- 28 million damaged vehicles
- $820 per person (2.3 percent of GDP)

Direct Costs

Direct Costs	**55%**
Medical care	15%
Insurance administration	7%
Workplace cost	2%
Legal costs	5%
Property damage	26%

Source: (2002). NHTSA.

Indirect Costs

Indirect Costs	**45%**
Lost productivity—mortality	14%
Lost productivity—morbidity	20%
Travel delay	11%

Source: (2002). NHTSA.

Estimated Source of Payment

- Society at large picks up nearly three-fourths of all crash costs incurred by individual MVC victims

Source of Payment	% Total	% Medical
Government	9%	24%
Insurer	51%	55%
Other	14%	6%
Self	26%	15%

Source: (2002). NHTSA.

Preventable Injury Costs

Type of Crash	Total Cost	% of Costs
Alcohol-involved crashes	$51 B	22%
Speed-related crashes	$40 B	17%
Safety belt non-use	$26 B	11%

Source: (2002). NHTSA.

Indirect Human Capital Costs

- Yield low values for children and the elderly
- Do not take into account pain, suffering, and reduced quality of life resulting from an injury
- Do not take into account the intangible (and tangible) costs to society from ***threat*** of injury

Willingness to Pay Method

- Life is valued according to the amount people are willing to pay (or actually do pay) for small changes in the probability of death or disability

Willingness to Pay: Two Approaches

- ***Revealed preferences***
  - Use of data on wage premiums, court awards, and consumption of goods that reduce injury risk
- ***Stated preferences***
  - Obtained by asking people directly about their willingness to pay for changes that reduce their risk

Cost of Gun Violence Using WTP

- The average household is willing to pay $239 more in taxes to reduce gunshot injuries by 30 percent; all households together are willing to pay $24.5 billion to reduce assault-related gunshot wounds (GSWs) by 30 percent

Cost in Taxes	% Voting in Favor of Program to Reduce Gunshot Injuries by 30%
$50	76%
$100	68%
$200	64%

Source: (2000). Cook and Ludvig.

Value of Human Life

- ***Willingness to pay***
  - Estimates range from $2 to $7 million
- ***Human capital***
  - $997,000 per death from motor vehicle crash

Both Measures Put a Dollar Value on Human Life

- Can be used in cost-benefit analyses where both costs and benefits of the intervention are expressed in monetary terms
- But are you comfortable in doing this?
- Are the numbers compelling to decision makers?

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Section C

Measuring Effectiveness of an Intervention

Cost-Effectiveness Analysis

- Provides information on the net cost of the intervention and its effectiveness (where effectiveness is ***not*** expressed in monetary terms)
- Effectiveness can be defined in terms of lives saved, life years gained, or quality (disability) adjusted life years gained (or lost)

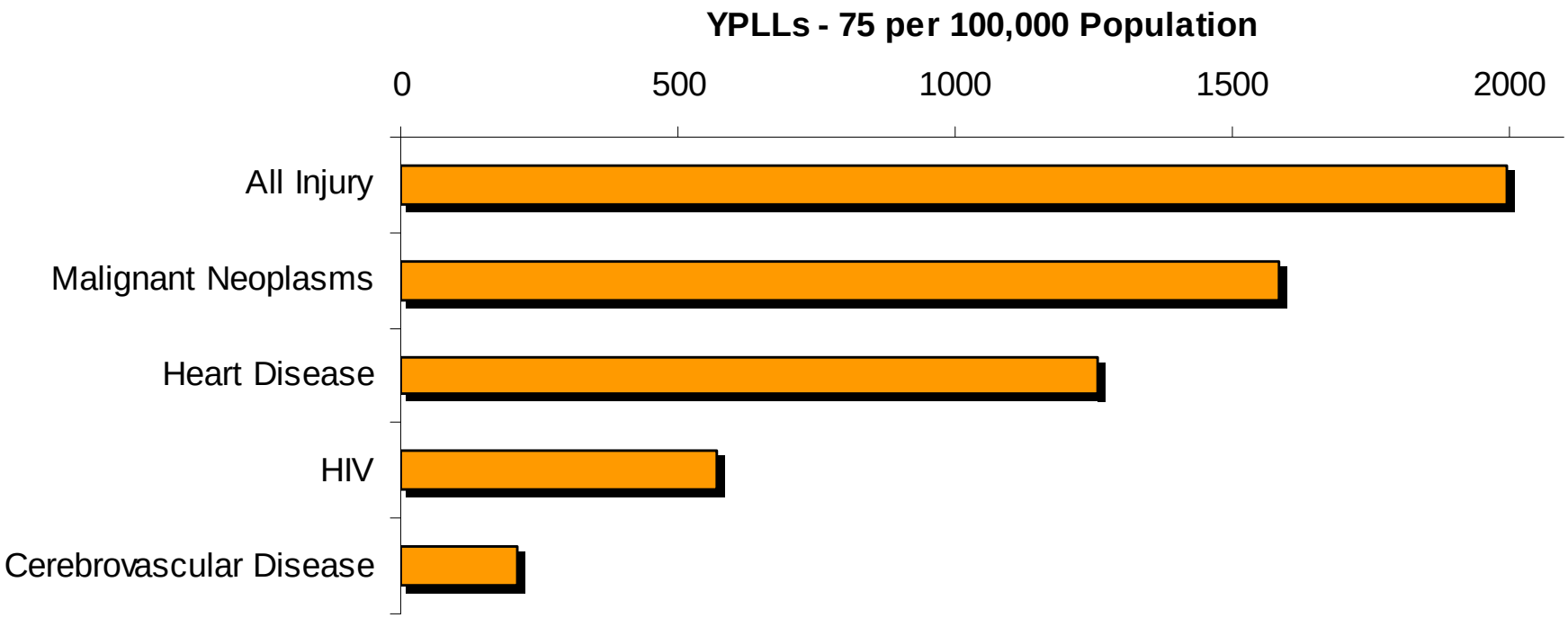
Effectiveness Measures

- Lives saved
  - Two-thirds of all injury deaths occur among children and young adults less than 45 years of age
- Years of Potential Life Lost

Years of Potential Life Lost (YPLL)

- If a person dies of a MVC at age 45 but was expected to live to age 75, then one can conclude that the MVC was associated with a loss of 30 potential life years

Years of Potential Life Lost by Cause



Capturing Nonfatal Consequences

- Number of injuries averted
- Number of severe injuries averted
- Years of quality adjusted life saved

Adjusted Life Years

- Summarizes impact of premature death ***and*** reduced quality of life into a single metric
- Different terms used
  - Quality adjusted life years (QALY)
  - Disability adjusted life years (DALY)
  - Years of healthy life (YHL)

Example

- If a person dies of a MVC at age 45 but is expected to live to age 75, then one can conclude that the MVC was associated with a loss of 30 potential life years (YPLL)
- If the same person survives but his quality of life is reduced by 50 percent (for the remainder of his life), then his future years of life are weighted by a factor of 0.5 and we conclude that the crash is associated with 15 potential well years or quality adjusted life years (QALY)

How to Measure Quality of Life

- Preference- (utility-) based measures
  - Quality of well being scale (QWB)
  - EuroQol (EQ-5D)
  - Health utility index (HUI)
  - SF-6D (derived from SF-36)
  - Functional capacity Index (FCI)

Cost-Effectiveness of Airbags

- CEA—ratio of net costs divided by net effectiveness for airbags versus a comparator, e.g., safety belts
- Net costs are gross capital costs plus operating costs minus savings in health-related costs
- Net effectiveness measured in terms of QALYs
- Result—net cost per QALY saved

Net Costs of Airbags

Actual equipment

\+ Replacement costs when airbag is deployed

Maintenance costs

– Medical costs saved due to reduction in injuries (based on NHTSA estimates)

Net Effectiveness

- Quality of life post-injury was adjusted using the functional capacity index (FCI) associated with injuries of varying severity

Injury Severity	FCI Quality Weight
Mild	0.71
Moderate	0.67
Severe	0.51
Very severe	0.06
Fatal	0.00

Cost-Effectiveness Using QALYs

- CE ratio—incremental cost divided by incremental QALY

Intervention	Comparator	$ per QALY
Driver airbag	Seat belt	$24,000
Dual airbags	Driver airbags	$61,000

Source: (2002). Graham et al.

Cost-Effectiveness Using QALYs

Intervention	Comparator	$ per QALY
Frontal airbags	Manual lap/shoulder belt	$24,000
Helmet law	No law	<0
55-mph speed limit	65-mph limit	$78,000
Pap smears—4 yrs	No screening	$15,200
Annual mammography	Annual clinical breast exam	$227,000

How Good Are Our Projections?

Intervention	Comparator	$ per QALY
Driver airbag	Seat belt	$24,000
Dual airbags	Driver airbags	$61,000
Projections Based on What We Knew in 1984		
Driver airbag	Seat belt	$10,000
Dual airbags	Driver airbags	$11,000

Source: (2002). Graham et al.

Contributors to the Error

- Airbag effectiveness overestimated
  - Failure to appreciate risks and benefits for children and small-statured adults
- Baseline fatality/injury rates overestimated
  - Failure to predict progress in highway safety and effectiveness of trauma systems
- Rates of safety belt use underestimated
  - Miscalculation of feasibility of mandatory seat belt laws and growth in seatbelt use

Lessons Learned

- An evaluation is as good as its inputs
- Good estimates of cost are possible
- Carefully consider pre-regulation estimates of benefits—risks induced by regulation must also be considered
- Should consider degree of uncertainty in estimates of risks and benefits

Role of Efficiency Criterion

- How do CBA and CEA play out in the real world?
  - ***Prevention policy***
    - Airbag regulation
  - ***Trauma systems policy***
    - Funding of trauma centers