Road Traffic Injuries: A Public Health Problem

Dr. Amber Mehmood, MBBS, FCPS
Johns Hopkins International Injury Research Unit
Department of International Health
Johns Hopkins Bloomberg School of Public Health
jhsph.edu/IIRU
Objectives and Outline

- Define the injury
- Classification of injuries
- Global Burden of Injuries
- Outcomes of Injuries
  - Physical and economic
- Principles of Injury prevention with example
What do we mean by Injury?
Defining Injuries

• What Do We Mean by Injury?
  • “Body damage resulting from acute exposure to excessive amounts of thermal, mechanical (whether kinetic or potential), electrical, or chemical energy”
  • “Or from the absence of such essentials as heat or oxygen”
Epidemiology of Injuries

Microorganism

Vector

Environment

Host

Infectious disease model

Energy

Vector or Vehicle

Environment

Host

Injury model
Typology: Unintentional Injuries

- Burns
- Falls
- Road Traffic Injuries
- Drowning
- Poisoning
Describing Injuries

- **Etiology:**
  - Inappropriate energy transfer

- **Vehicles or vectors:**
  - Motor vehicles, bullets, animals...

- **Pathology:**
  - Fractures, dislocations, sprains, strains, concussions...

- **Treatment:**
  - Outpatient, hospitalization...

- **Prognosis:**
  - Recovery, sequelae, death...
Classification of Injuries

1. Themselves
   - Nature of injury (e.g., fracture, laceration, contusion)
   - Body region affected (e.g., head, chest, abdomen)
   - Severity (e.g., fatal, non-fatal)

2. Consequences
   - Death, hospitalization, emergency department visit . . .
3. Mechanism of Injury

- Mechanism
  - Penetrating—knife, bullet
  - Blunt—do not penetrate into the body
  - Burn—electrical, thermal, chemical
4. The Hazard that “Caused” Them

- “Cause” (e.g., motor-vehicle, falls, drowning)
- Type of activity (e.g., work, sport, recreational)
- Product involved (e.g., firearm, snowmobile)
- Location of activity (e.g., school, outdoors, home)
- Intent (e.g., intentional, unintentional)
Why are injuries relevant to Public Health?
### Leading Cause of Global Mortality - 2001

<table>
<thead>
<tr>
<th>Disease or injury</th>
<th>Deaths in thousands</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB</td>
<td>1,660</td>
</tr>
<tr>
<td>Road traffic accidents</td>
<td>1,259</td>
</tr>
<tr>
<td>Trachea bronchus and lung cancer</td>
<td>1,210</td>
</tr>
<tr>
<td>Malaria</td>
<td>1,080</td>
</tr>
<tr>
<td>Hypertensive heart disease</td>
<td>939</td>
</tr>
<tr>
<td>Self-inflicted injuries</td>
<td>814</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>808</td>
</tr>
</tbody>
</table>
Why Are Injuries Relevant to Public Health?

- Mortality (death)
- Morbidity (non-fatal injuries)
  - E.D. visits
  - Hospitalization
  - Outpatients visits
- Disability (short-term, mid-term, and long-term sequelae)
- Cost- economic, societal
- Let us review these 4 consequences...
Why Are Injuries Relevant to Public Health?

The Injury Pyramid

- Death
- (Acute) Hospitalization
- Emergency Dept Visit
- Injured But Not Treated

Disability

Why Are Injuries Relevant to Public Health?
Leading Causes of Global Mortality, 2011

The 10 leading causes of death in the world 2011

- Ischaemic heart disease: 7 million
- Stroke: 6.2 million
- Lower respiratory infections: 3.2 million
- COPD: 3 million
- Diarrhoeal diseases: 1.9 million
- HIV/AIDS: 1.6 million
- Trachea bronchus, lu.: 1.5 million
- Diabetes mellitus: 1.4 million
- Road injury: 1.3 million
- Prematurity: 1.2 million

Comparison of leading causes of death over the past decade, 2000 and 2011

Source: WHO Fact Sheet N°310 2013
<table>
<thead>
<tr>
<th>Rank</th>
<th>0-4 years</th>
<th>5-14 years</th>
<th>15-29 years</th>
<th>30-44 years</th>
<th>45-59 years</th>
<th>≥60 years</th>
<th>All Ages</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Perinatal conditions</td>
<td>Lower respiratory infections</td>
<td>HIV/AIDS</td>
<td>HIV/AIDS</td>
<td>Ischaemic heart disease</td>
<td>Ischaemic heart disease</td>
<td>Ischaemic heart disease</td>
</tr>
<tr>
<td>2</td>
<td>Lower respiratory infections</td>
<td>Road traffic injuries</td>
<td>Road traffic injuries</td>
<td>Tuberculosis</td>
<td>Cerebrovascular disease</td>
<td>Cerebrovascular disease</td>
<td>Cerebrovascular disease</td>
</tr>
<tr>
<td>3</td>
<td>Diarrhoeal diseases</td>
<td>HIV/AIDS</td>
<td>Maternal conditions</td>
<td>Road traffic injuries</td>
<td>HIV/AIDS</td>
<td>Chronic obstructive pulmonary disease</td>
<td>Lower respiratory infections</td>
</tr>
<tr>
<td>4</td>
<td>Childhood diseases</td>
<td>Drownings</td>
<td>Self-inflicted injuries</td>
<td>Maternal conditions</td>
<td>Tuberculosis</td>
<td>Lower respiratory infections</td>
<td>HIV/AIDS</td>
</tr>
<tr>
<td>5</td>
<td>Malaria</td>
<td>Childhood diseases</td>
<td>Tuberculosis</td>
<td>Ischaemic heart disease</td>
<td>Chronic obstructive pulmonary disease</td>
<td>Trachea, bronchus, lung cancers</td>
<td>Chronic obstructive pulmonary disease</td>
</tr>
<tr>
<td>6</td>
<td>Congenital anomalies</td>
<td>Fires</td>
<td>Violence</td>
<td>Self-inflicted injuries</td>
<td>Trachea, bronchus, lung cancers</td>
<td>Diabetes mellitus</td>
<td>Perinatal conditions</td>
</tr>
<tr>
<td>7</td>
<td>HIV/AIDS</td>
<td>Tuberculosis</td>
<td>Lower respiratory infections</td>
<td>Violence</td>
<td>Cirrhosis of the liver</td>
<td>Hypertensive heart disease</td>
<td>Diarrhoeal diseases</td>
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<tr>
<td>8</td>
<td>Protein-energy malnutrition</td>
<td>Protein-energy malnutrition</td>
<td>Drownings</td>
<td>Cerebrovascular disease</td>
<td>Road traffic injuries</td>
<td>Stomach cancer</td>
<td>Tuberculosis</td>
</tr>
<tr>
<td>9</td>
<td>Syphilis</td>
<td>Meningitis</td>
<td>Fires</td>
<td>Lower respiratory infections</td>
<td>Self-inflicted injuries</td>
<td>Tuberculosis</td>
<td>Trachea, bronchus, lung cancers</td>
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<tr>
<td>10</td>
<td>Meningitis</td>
<td>Leukaemia</td>
<td>War injuries</td>
<td>Cirrhosis of the liver</td>
<td>Stomach cancer</td>
<td>Colon and rectum cancers</td>
<td>Road traffic injuries</td>
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<tr>
<td>11</td>
<td>Drownings</td>
<td>Congenital anomalies</td>
<td>Ischaemic heart disease</td>
<td>Poisonings</td>
<td>Liver cancer</td>
<td>Nephritis and nephrosis</td>
<td>Childhood diseases</td>
</tr>
<tr>
<td>12</td>
<td>Road traffic injuries</td>
<td>Falls</td>
<td>Poisonings</td>
<td>Fires</td>
<td>Lower respiratory infections</td>
<td>Alzheimer and other dementias</td>
<td>Diabetes mellitus</td>
</tr>
<tr>
<td>13</td>
<td>Tuberculosis</td>
<td>Poisonings</td>
<td>Falls</td>
<td>War injuries</td>
<td>Diabetes mellitus</td>
<td>Cirrhosis of the liver</td>
<td>Malaria</td>
</tr>
<tr>
<td>14</td>
<td>Endocrine disorders</td>
<td>Violence</td>
<td>Leukaemia</td>
<td>Drownings</td>
<td>Breast cancer</td>
<td>Liver cancer</td>
<td>Hypertensive heart disease</td>
</tr>
<tr>
<td>15</td>
<td>Fires</td>
<td>Leishmaniasis</td>
<td>Rheumatic heart disease</td>
<td>Liver Cancer</td>
<td>Hypertensive heart disease</td>
<td>Oesophagus cancer</td>
<td>Self-inflicted injuries</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cause</th>
<th>2010 Rank</th>
<th>DALYs (95% UI) in thousands</th>
<th>1990 Rank</th>
<th>DALYs (95% UI) in thousands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemic heart disease</td>
<td>1</td>
<td>129,795 (119,218–137,398)</td>
<td>4</td>
<td>100,455 (96,669–108,702)</td>
</tr>
<tr>
<td>Lower respiratory tract infections</td>
<td>2</td>
<td>115,227 (102,255–126,972)</td>
<td>1</td>
<td>206,461 (183,354–222,979)</td>
</tr>
<tr>
<td>Stroke</td>
<td>3</td>
<td>102,239 (90,472–108,003)</td>
<td>5</td>
<td>86,012 (81,033–94,802)</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>4</td>
<td>89,524 (77,595–99,193)</td>
<td>2</td>
<td>183,543 (168,791–197,655)</td>
</tr>
<tr>
<td>HIV–AIDS</td>
<td>5</td>
<td>81,549 (74,698–88,371)</td>
<td>33</td>
<td>18,118 (14,996–22,269)</td>
</tr>
<tr>
<td>Malaria</td>
<td>6</td>
<td>82,689 (63,465–109,846)</td>
<td>7</td>
<td>69,141 (54,547–85,589)</td>
</tr>
<tr>
<td>Low back pain</td>
<td>7</td>
<td>80,667 (56,066–108,723)</td>
<td>12</td>
<td>56,384 (38,773–76,233)</td>
</tr>
<tr>
<td>Preterm birth complications</td>
<td>8</td>
<td>76,980 (66,210–88,132)</td>
<td>3</td>
<td>105,965 (88,144–120,894)</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>9</td>
<td>76,779 (66,000–89,147)</td>
<td>6</td>
<td>78,298 (70,407–86,849)</td>
</tr>
<tr>
<td><strong>Road-traffic injury</strong></td>
<td>10</td>
<td>75,487 (61,555–94,777)</td>
<td>11</td>
<td>56,651 (49,633–68,046)</td>
</tr>
<tr>
<td>Major depressive disorder</td>
<td>11</td>
<td>63,239 (47,894–80,784)</td>
<td>15</td>
<td>46,177 (34,524–58,436)</td>
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<tr>
<td>Neonatal encephalopathy*</td>
<td>12</td>
<td>50,163 (40,351–59,810)</td>
<td>10</td>
<td>60,604 (50,209–74,826)</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>13</td>
<td>49,399 (40,027–56,009)</td>
<td>8</td>
<td>61,256 (55,465–71,083)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>14</td>
<td>46,857 (40,212–55,252)</td>
<td>21</td>
<td>27,719 (23,668–32,925)</td>
</tr>
<tr>
<td>Sepsis and other infectious disorders in newborns</td>
<td>16</td>
<td>44,236 (27,349–72,418)</td>
<td>17</td>
<td>46,029 (25,147–70,357)</td>
</tr>
<tr>
<td>Congenital anomalies</td>
<td>17</td>
<td>38,890 (31,891–45,739)</td>
<td>13</td>
<td>54,245 (45,491–69,057)</td>
</tr>
<tr>
<td><strong>Self-harm</strong></td>
<td>18</td>
<td>36,655 (26,894–44,652)</td>
<td>19</td>
<td>29,605 (23,039–37,333)</td>
</tr>
<tr>
<td>Protein-energy malnutrition</td>
<td>20</td>
<td>34,874 (27,957–41,662)</td>
<td>9</td>
<td>60,542 (50,378–71,639)</td>
</tr>
<tr>
<td>Cancer of the trachea, bronchus, or lung</td>
<td>22</td>
<td>32,405 (24,401–38,327)</td>
<td>24</td>
<td>23,850 (18,839–29,837)</td>
</tr>
<tr>
<td>Other musculoskeletal disorders</td>
<td>23</td>
<td>30,877 (25,858–34,650)</td>
<td>29</td>
<td>20,596 (17,025–23,262)</td>
</tr>
<tr>
<td>Cirrhosis of the liver</td>
<td>24</td>
<td>31,026 (25,951–34,629)</td>
<td>23</td>
<td>24,325 (20,653–27,184)</td>
</tr>
<tr>
<td>Meningitis</td>
<td>25</td>
<td>29,407 (25,578–33,442)</td>
<td>18</td>
<td>37,822 (33,817–44,962)</td>
</tr>
</tbody>
</table>

Murray et al: NEJM Aug 2013
Mortality Rates by Regions

- Injury rates higher in developing countries
  - 94 injury-related-deaths per 100,000 in developing countries
  - 49 injury-related-deaths per 100,000 in the developed world
  - 92% road traffic deaths occur in low-middle income countries, which have only 53% of world’s registered vehicles

Source: WHO, Global Status Report on Road safety, 2013
In 2012, 31,743,028 non-fatal injuries were recorded in United States
  • Age adjusted rate of 10,231/100,000 population
  • An estimated 31.7 million people treated in Emergency Department for injury each year
  • 2.8 million people hospitalized with injury each year
  • Every year, one in three persons suffers a non-fatal injury
  • One in every eight hospital beds is occupied by an injured patient
  • Violence and injuries cost more than $406 billion in medical care and lost productivity each year
## 10 Leading Causes of Death by Age Group, United States – 2010

<table>
<thead>
<tr>
<th>Rank</th>
<th>Age Groups</th>
<th>1-4</th>
<th>5-9</th>
<th>10-14</th>
<th>15-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Short Gestation</td>
<td>4,148</td>
<td>Congenital Anomalies</td>
<td>507</td>
<td>Malignant Neoplasms</td>
<td>439</td>
<td>Malignant Neoplasms</td>
<td>477</td>
<td>Homicide</td>
<td>4,678</td>
<td>Suicide</td>
</tr>
<tr>
<td>3</td>
<td>SIDS</td>
<td>2,063</td>
<td>Homicide</td>
<td>385</td>
<td>Congenital Anomalies</td>
<td>163</td>
<td>Suicide</td>
<td>267</td>
<td>Suicide</td>
<td>4,600</td>
<td>Homicide</td>
</tr>
<tr>
<td>4</td>
<td>Maternal Pregnancy Comp.</td>
<td>1,561</td>
<td>Malignant Neoplasms</td>
<td>346</td>
<td>Homicide</td>
<td>111</td>
<td>Homicide</td>
<td>150</td>
<td>Malignant Neoplasms</td>
<td>1,604</td>
<td>Malignant Neoplasms</td>
</tr>
<tr>
<td>5</td>
<td>Unintentional Injury</td>
<td>1,110</td>
<td>Heart Disease</td>
<td>159</td>
<td>Heart Disease</td>
<td>68</td>
<td>Congenital Anomalies</td>
<td>135</td>
<td>Heart Disease</td>
<td>1,028</td>
<td>Heart Disease</td>
</tr>
<tr>
<td>6</td>
<td>Placenta Cord. Membranes</td>
<td>1,030</td>
<td>Influenza &amp; Pneumonia</td>
<td>91</td>
<td>Chronic Low Respiratory Disease</td>
<td>60</td>
<td>Heart Disease</td>
<td>117</td>
<td>Congenital Anomalies</td>
<td>412</td>
<td>HIV</td>
</tr>
<tr>
<td>7</td>
<td>Bacterial Sepsis</td>
<td>583</td>
<td>Septicemia</td>
<td>62</td>
<td>Cerebrovascular</td>
<td>47</td>
<td>Chronic Low Respiratory Disease</td>
<td>73</td>
<td>Cerebrovascular</td>
<td>190</td>
<td>Diabetes Mellitus</td>
</tr>
<tr>
<td>8</td>
<td>Respiratory Distress</td>
<td>514</td>
<td>Benign Neoplasms</td>
<td>59</td>
<td>Benign Neoplasms</td>
<td>37</td>
<td>Benign Neoplasms</td>
<td>45</td>
<td>Influenza &amp; Pneumonia</td>
<td>181</td>
<td>Cerebrovascular</td>
</tr>
<tr>
<td>9</td>
<td>Circulatory System Disease</td>
<td>507</td>
<td>Perinatal Period</td>
<td>52</td>
<td>Influenza &amp; Pneumonia</td>
<td>37</td>
<td>Cerebrovascular</td>
<td>43</td>
<td>Diabetes Mellitus</td>
<td>165</td>
<td>Liver Disease</td>
</tr>
<tr>
<td>10</td>
<td>Necrotizing Enterocolitis</td>
<td>472</td>
<td>Chronic Low Respiratory Disease</td>
<td>51</td>
<td>Septicemia</td>
<td>32</td>
<td>Septicemia</td>
<td>35</td>
<td>Complicated Pregnancy</td>
<td>163</td>
<td>Congenital Anomalies</td>
</tr>
</tbody>
</table>

**Data Source:** National Vital Statistics System, National Center for Health Statistics, CDC.  
**Produced by:** Office of Statistics and Programming, National Center for Injury Prevention and Control, CDC using WISQARS™.
Global Burden of RTIs

- Road Traffic Injuries (RTIs) take approximately 1.24 million lives per year
  - 3,397 deaths/day
  - 2.36 deaths/minute
- Half of all road traffic deaths are among pedestrians, cyclists and motorcyclists
- Age group 15-44 years comprise of 59% of these deaths
- 20-50 million people are seriously injured each year.
  - 15 or more serious injuries/second
  - over 900 serious injuries/minute

Source: Global Status Report on Road Safety 2013.
Road traffic deaths per 100,000 population, by WHO region

<table>
<thead>
<tr>
<th>Region</th>
<th>Road traffic deaths per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Region</td>
<td>24.1</td>
</tr>
<tr>
<td>Eastern Mediterranean Region</td>
<td>21.3</td>
</tr>
<tr>
<td>Western Pacific Region</td>
<td>18.5</td>
</tr>
<tr>
<td>South-East Asia Region</td>
<td>18.5</td>
</tr>
<tr>
<td>Region of the Americas</td>
<td>16.1</td>
</tr>
<tr>
<td>European Region</td>
<td>10.3</td>
</tr>
</tbody>
</table>
## US Incidence and Costs of Injury
(Finkelstein, et al 2006)

<table>
<thead>
<tr>
<th></th>
<th>Medical Costs</th>
<th>Productivity Losses</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fatal</strong></td>
<td>$1 Billion</td>
<td>$142 Billion</td>
<td>$143 Billion</td>
</tr>
<tr>
<td><strong>Hospitalized</strong></td>
<td>$34 Billion</td>
<td>$49 Billion</td>
<td>$92 Billion</td>
</tr>
<tr>
<td><strong>Non-hospitalized</strong></td>
<td>$45 Billion</td>
<td>$125 Billion</td>
<td>$171 Billion</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$80 Billion</td>
<td>$326 Billion</td>
<td>$406 Billion</td>
</tr>
</tbody>
</table>

*Cost Estimates Based on 2000 data*
• In 2002 the estimated costs of **motor vehicle crashes** in the US was $230.6 billion
• For 2005, Motor vehicle–related fatal and nonfatal injury costs exceeded $99 billion
  • Costs associated with motor vehicle occupant fatal and nonfatal injuries was $70 billion
  • $58 billion was attributable to fatalities
  • Costs associated with nonfatal hospitalized injuries totaled $28 billion
  • $14 billion was associated with injured persons that were treated in the ED and released

-U.S. Department of Transportation, 2002
-Naumann et al, 2010
...So, what do we do about it?
Lessons Learned

- Injuries are predictable
  - Epidemiology, risk factors

- Accidents vs. injuries
  - “Accidents happen” vs. injuries are not accidents

- Injuries are preventable
Strategies for Injury Prevention

- Strategies for injury prevention
  - Primary, secondary, and tertiary prevention
  - Individual, vector, environment-level interventions

- Systems approach to injury prevention
What Can We Do? Prevention

- **Primary** prevention or “prevention”
  - Avoid something that might happen
  - Prevent, reduce, or modify hazards or events that cause injury
What Can We Do? Prevention

- **Secondary** prevention or *acute care*
  - Minimize the damage if it happens
  - Counter the damage already done by the hazard
  - Stabilize and repair the damage
What Can We Do? Prevention

- **Tertiary** prevention or prevention of long term disability and *rehabilitation*
  - Reduce the sequelae once it has happened
  - Restore the functioning of injured patients to pre-injury levels
United Nations Decade of Action for road safety: 2011-2020

The five pillars that guide national road safety plans and activities over the Decade of Action

National activities

- **Pillar 1**: Road safety management
- **Pillar 2**: Safer roads and mobility
- **Pillar 3**: Safer vehicles
- **Pillar 4**: Safer road users
- **Pillar 5**: Post-crash response
Multi-Sectoral Engagement for Production of Safety

- Police Enforcement
- Policy Legislation
- Urban Transport Planning
- Product Manufacturers
- Consumer Protection
- Health
- Engineering Vehicle & Road design
- Safety

[Image of a diagram showing the interconnections between different sectors involved in safety production.]
Examples of preventive interventions

- **Speed**
  - Set/enforce limits
  - Road design
  - Cameras

- **Drinking & Driving**
  - Set/enforce limits
  - Random breath testing
  - Swift and tough penalties

- **Motorcycle Helmets**
  - Set/enforce laws
  - Helmet standards
  - Penalties for non-use

- **Seatbelts/Child restraints**
  - Set/enforce laws
  - Audible reminders in cars
  - Loan programs?

- **Visibility**
  - Daytime running lights
  - Reflectors
  - Bright helmets
  - Street lighting

Source: Global Status Report on Road Safety, 2009
 Improvement of post-crash response

<table>
<thead>
<tr>
<th></th>
<th>Host</th>
<th>Agent</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-event</strong></td>
<td>Alcohol Use, Education, Enforcing Laws, Risk-taking behavior, Medications, Cognitive function,</td>
<td>Technology of safety measures – Brake systems, air bags, tether systems, tire quality, Load weight, Ergonomic controls, Center of gravity, Speed capability</td>
<td>Visibility of hazards, Road condition, Weather, Speed limits, Intersections, Coefficient friction, Signalization Drunk driving laws</td>
</tr>
<tr>
<td></td>
<td><strong>Event</strong></td>
<td>Speed of impact, Direction of impact, Vehicle size, Automatic restraints, Airbag, Whiplash lessening seats and head rests,</td>
<td>Speed limits of traffic, Recovery areas, Guard rails, Characteristics of fixed objects, Median barriers, Roadside embankments</td>
</tr>
<tr>
<td></td>
<td>Age, Sex, Bone Density, Stature</td>
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<td><strong>Post-event</strong></td>
<td>Non collapsible vehicles, Accessibility to evacuate, Alert systems,</td>
<td>911 access, EMS response, Location &amp; quality of ED, Access to definitive care, Access to rehabilitation care</td>
</tr>
<tr>
<td></td>
<td>Age, Sex, Medications, Preexisting medical and physical conditions, Social situation</td>
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</table>
Violence and injuries are a major public health problem, which requires multi-sectoral interventions.

Most common victims are young adults.

Effective preventive strategies can reduce death and disability.

Timely and appropriate care plays an important role in treatment and rehabilitation of injured.

Documenting the magnitude and severity of non-fatal injuries can help improving the quality of care and the outcomes.
Acknowledgment

Abdul Bachani,
Associate Director of Capacity Building and Training,
JH- IIRU
Thank You

Email: amehmoo2@jhu.edu