Events, Exposure, and Risk Factors

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Lecture Topics

- Describing and quantifying injurious events
- Measuring exposure
- Identifying and quantifying risk factors
- Case study
Section A

Describing and Counting Events
Maria Segui-Gomez, MD, ScD
What Do We Mean by Events?

- Situations where energy is being released in either greater or smaller amounts than ordinary, in less than an ordinary amount of time, or both
- Circumstances that could lead to personal injuries (regardless of whether they actually occur)
  - For example, car or airplane crashes, fires, falls
Relevance of Events Data

- Necessary to understand circumstances leading to fatal or non-fatal injuries
  - Helps identify circumstances (or aspects of circumstances) that could be addressed by injury prevention programs
Relevance of Events Data

- Necessary to understand circumstances leading to fatal or non-fatal injuries
  - Key for secondary injury prevention planning
  - There is a lot that can be learned from events that do not lead to injuries despite the fact that they look like other events where injuries occurred
Events

- Used as numerators
  - There were 6,335,000 crashes in the U.S. in 1998

- Used as denominators
  - 0.6% of motor vehicle crashes lead to at least one death (41,471 deaths / 6,335,000 crashes)
Data Sources

Multiple:

- Police reports
  - Car crashes—normally there is a minimum amount of damage required before reporting
  - Home robberies
- Firemen records (e.g., fires)
- Nursing home records (e.g., falls among elderly)

Continued
Data Sources

- Personal surveys (e.g., recreational injuries)
- And all the same sources where the injuries are reported
Data Coding

- Events that lead to injuries
- We have listed the most frequent ones in mortality and morbidity sessions
- For example:
  - International Classification of Diseases (E codes in the 9th version), NOMESCO Classification of External Causes of Injuries, New Zealand, Australian codes, International Classification of External Causes of Injury (ICECI)
Data Coding

Events

- Other multiple data system-specific codes
Event Data Comparability

Beware of:

- Data source variability
- Case identification variability
  - Normally there is a minimum physical / economic damage used to define the event as reportable but that can vary
- Coding system variability
Section B

Measuring Exposure

Maria Segui-Gomez, MD, ScD
What Do We Mean by Exposure?

- Practically anything we do
- That is, situations where individuals interact with an environment that can eventually generate energy that could lead to an injury
  - For example, population, distance traveled, hours traveled, intersections crossed, takeoffs / landings undergone, hours training soccer, minutes spent using a saw, etc...
Relevance of Exposure Data

- Exposure is the denominator
- Needed for risk calculations
An Example

North America: 4.1
Europe: 9.5
Middle East: 11.4
Asia: 18.3
Eastern Europe: 20.6
Africa: 30.2

Another (fictional) Example

- Country A has fewer child passenger deaths per 100,000 population than country B
- Why?
- Possible explanations: Better child restraint use, fewer parents driving intoxicated, fewer children in cars, etc.
- How to look for explanations
Countries A vs. B

Fatalities

Acute care received, severity of injuries, frequency, type
Countries A vs. B

Fatalities
Acute care received, severity of injuries, frequency, type

Morbidity
Severity of crash, frequency, type
Countries A vs. B

Fatalities
Acute care received, severity of injuries, frequency, type

Morbidity
Severity of crash, frequency, type

Events
Frequency, type
Countries A vs. B

- **Fatalities**: Acute care received, severity of injuries, frequency, type
- **Morbidity**: Severity of crash, frequency, type
- **Events**: Frequency, type
- **Exposure**
How Does It All Come Together? An Example

Children

Occupants?

Crashes?

Injuries?

Injury

Hospitalization

Deaths

Disability
Data Sources

- When population: Census
- For all other exposure units: Multiple data sources, specific to injury problem and location
- In general:
  - Personal surveys
  - Observational studies
  - Estimates from goods bought (and average usage)
Data Coding

- Fragmented
- Among the most commonly used are vehicle miles (kilometers) traveled, derived from either:
  - Personal diaries / surveys
  - National estimates of fuel used and average fuel consumption per mile
Data Coding

- Units tend to be big since injuries follow a Poisson distribution (that is, their frequency is rare)

Poisson Distribution with Mean $= 2$

Graph by JHSPH CTLT
Exposure Data Comparability

- Beware of:
  - Data source variability
  - Case inclusion criteria
  - Coding system variability
Section C

Identifying and Quantifying Risk Factors
Adnan Hyder, MD, PhD
Risk Factors for Injuries

**Not Modifiable:**
- Gender
- Age
- Time

**Modifiable:**
- Site
- Behavior
- Environment
- Equipment
Population Based Cohort Study of Injuries: Gender Differences

Madras City

- Incidence
- Overall: 127 / 1000 persons
- Males: 137 / 1000 persons
- Females: 118 / 1000 persons

Source: Sathiyasekaran, B.W.C.; Injury 1997; 27: 695–698
Relative Risk of Injuries Occurring to Males Compared to Females

By Place of Occurrence

Source: Sathiyasekaran, B.W.C.; Injury 1997; 27: 695–698
Sao Paulo Brazil—*Age* of Traffic Accident Victims 1995

![Bar graph showing age distribution of traffic accident victims in Sao Paulo, Brazil in 1995.](image)

Saudi Arabia—*Age of Traffic Accident Victims 1993*

Deaths from Bicycle Injuries by Age: 1979-1990, Israel

% Distribution According to Age of Patient Admitted in Burn Care Center in Teheran

Sites of 107 Near Drownings, 1976–1987, South Africa

- Swimming pool: 46%
- Bucket: 18%
- Sea: 9%
- Dam: 7%
- Bath: 7%
- Unknown: 8%
- Other: 5%

Risky Behavior of Bus Commuters in Karachi, Pakistan

**Disembarking Passengers**
- 33% did not wait for bus to stop
- 54% stepped off into the center of the road
- 84% did not look out for traffic

**Embarking passengers**
- 38% got on moving bus
- 83% waited for buses on the street

Risky Behavior of *Bus Drivers* in Karachi, Pakistan

- At the bus stop, 30% of the bus drivers did not stop completely
- 46% stopped away from the stop
- 79% stopped in the center of the road

Young Drivers *Life Style* and Road Traffic Accident Risk in Athens

- Logistic regression analysis showed:
  - Young drivers whose dominant life style trait is alcohol consumption or driving without destination have a higher risk of road traffic accident.

Young Drivers *Life Style* and Road Traffic Accident Risk in Athens

- Logistic regression analysis showed:
  - Those whose dominant lifestyle is “culture” face low risk of RTA
  - Young drivers who were “religious” also seem to have low accident risk

Causes of Road Accidents in Saudi Arabia

For the Decades 1970s, 1980s, 1990s

Risky Behavior and Injuries

Drowning

- Study in Barbados found that 37% of visitors who were victims of a near drowning experience had evidence of alcohol intoxication.

Risky Behavior and Injuries

Poisoning

- In India, more than 200 people died in New Delhi after drinking alcohol mixed with methanol during the Hindu festival of Deepawali.

Frequency of Frostbites According to Height (Environment) in the Karakoram Mountains, Pakistan

Rural and Urban Environment

China

- Rates of suicide and drowning are much higher in rural areas
- Death rates for the elderly (from falls) are much higher in urban areas

Source: WHO, 1998
Rural and Urban Environment

Papua New Guinea

- Rates of suicide among women and of drowning among men are significantly higher in remote rural villages than in periurban villages

Source: Barrs, 1991
Equipment Factors

Burns

- From May 1995 to December 1996, 40% of patients admitted to the burn unit of Ain Shams University (Cairo, Egypt), sustained injuries from kerosene stoves.

Source: Mabrouk, A.; Burns 26 (2000) 474-477
Equipment Factors

Burns

- In developing countries, hot tap water is a main cause of severe burns in children
- 63% of all burn cases among children aged less than 15 years in Casablanca, Morocco were scalds from water


Continued
Equipment Factors

MVA

- On the main highway, between Delhi and Bombay, India, it was found that 25% of all fast moving vehicles did not have a proper brake system

Seasonality of Drowning Deaths of Children Aged 1–4 in Matlab, 1983–95

Annual *Seasonal Average* % of Road Traffic Accidents
*For Period 1989-1993 in Saudi Arabia*

Injuries and Socioeconomic Development

- Injuries used to be commonly viewed as the "disease of development"
- Kopits E and Copper M (2003) showed a sharp increase in fatalities per head of population with increasing GDP per capita up to a peak of $6100- $8600, after which the fatalities began to decline

Injuries and Socioeconomic Development

- Their study also showed that fatalities per vehicle decline sharply with income per capita in excess of $1180.
- Overall, the results display how economic development relates to increased motorization and increased exposure to risk.

Section D

Case Study on Exposure, Events, and Risk Factors
Adnan Hyder, MD, PhD
Occupational Injuries

- Account for nearly one-fifth of the total global burden of injuries
- Estimates of the burden of occupational injury are often imprecise because of under reporting and classification problems
Occupational Injuries in Brazil

- The cohort was comprised of 21,752 male workers at a steel plant in Minas Gerais, Brazil who were employed between 1 January 1977 and 31 August 1990

Continued
Occupational Injuries in Brazil

♦ The study monitored injuries to these workers in two categories

♦ Workplace injuries that occurred inside the plant during the work shift (see risk factors in tables I to III)

♦ Injuries that occurred during travel to and from work (see risk factors in tables IV-VI)
Tables I–III

Risk Factors for Injuries in the Workplace
# Table I—Age Group

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Injuries (n)</th>
<th>Person Years</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>891</td>
<td>7084</td>
<td>12.6</td>
<td>1.00</td>
</tr>
<tr>
<td>20–24</td>
<td>3240</td>
<td>35003</td>
<td>9.3</td>
<td>0.76 (0.70–0.83)</td>
</tr>
<tr>
<td>25–29</td>
<td>2799</td>
<td>44958</td>
<td>6.2</td>
<td>0.61 (0.56–0.66)</td>
</tr>
<tr>
<td>30–34</td>
<td>1780</td>
<td>42197</td>
<td>4.2</td>
<td>0.51 (0.46–0.55)</td>
</tr>
<tr>
<td>35–39</td>
<td>1043</td>
<td>30358</td>
<td>3.4</td>
<td>0.42 (0.38–0.47)</td>
</tr>
<tr>
<td>40–44</td>
<td>628</td>
<td>18438</td>
<td>3.4</td>
<td>0.40 (0.36–0.45)</td>
</tr>
<tr>
<td>≥45</td>
<td>510</td>
<td>16183</td>
<td>3.2</td>
<td>0.35 (0.3–0.40)</td>
</tr>
</tbody>
</table>
### Table II—Duration of Employment (DOE)

<table>
<thead>
<tr>
<th>DOE (y)</th>
<th>Injuries (n)</th>
<th>Person Years</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>1547</td>
<td>11281</td>
<td>13.7</td>
<td>1.00</td>
</tr>
<tr>
<td>1–1.9</td>
<td>1400</td>
<td>11947</td>
<td>11.7</td>
<td>0.89 (0.82–0.95)</td>
</tr>
<tr>
<td>2–4.9</td>
<td>3278</td>
<td>37394</td>
<td>8.8</td>
<td>0.72 (0.67–0.76)</td>
</tr>
<tr>
<td>5–9.9</td>
<td>2346</td>
<td>52528</td>
<td>4.5</td>
<td>0.47 (0.44–0.51)</td>
</tr>
<tr>
<td>10–14.9</td>
<td>1293</td>
<td>42853</td>
<td>3.0</td>
<td>0.39 (0.36–0.42)</td>
</tr>
<tr>
<td>≥15</td>
<td>1027</td>
<td>38218</td>
<td>2.7</td>
<td>0.30 (0.27–0.33)</td>
</tr>
</tbody>
</table>
### Table III — Calendar Year

<table>
<thead>
<tr>
<th>Years</th>
<th>Injuries (n)</th>
<th>Person Years</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977–80</td>
<td>5636</td>
<td>49174</td>
<td>11.5</td>
<td>1.00</td>
</tr>
<tr>
<td>1981–84</td>
<td>2538</td>
<td>51965</td>
<td>4.9</td>
<td>0.53 (0.50–0.56)</td>
</tr>
<tr>
<td>1985–88</td>
<td>1671</td>
<td>50526</td>
<td>3.3</td>
<td>0.40 (0.38–0.43)</td>
</tr>
<tr>
<td>1989–92</td>
<td>1046</td>
<td>42557</td>
<td>2.5</td>
<td>0.33 (0.30–0.35)</td>
</tr>
</tbody>
</table>
Table IV–VI

Risk Factors for Injuries During Travel to and from Work
## Table IV—Age Group

<table>
<thead>
<tr>
<th>Injuries (n)</th>
<th>Person Years</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>305</td>
<td>7084</td>
<td>4.3</td>
</tr>
<tr>
<td>20–24</td>
<td>1206</td>
<td>35003</td>
<td>3.5</td>
</tr>
<tr>
<td>25–29</td>
<td>1046</td>
<td>44958</td>
<td>2.3</td>
</tr>
<tr>
<td>30–34</td>
<td>686</td>
<td>42197</td>
<td>1.6</td>
</tr>
<tr>
<td>35–39</td>
<td>395</td>
<td>30358</td>
<td>1.3</td>
</tr>
<tr>
<td>40–44</td>
<td>223</td>
<td>18438</td>
<td>1.2</td>
</tr>
<tr>
<td>45</td>
<td>220</td>
<td>16183</td>
<td>1.4</td>
</tr>
</tbody>
</table>
## Table V—Duration of Employment

<table>
<thead>
<tr>
<th>DOE (y)</th>
<th>Injuries (n)</th>
<th>Person Years</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>463</td>
<td>11281</td>
<td>4.1</td>
<td>1.00</td>
</tr>
<tr>
<td>1Š1.9</td>
<td>474</td>
<td>11947</td>
<td>4.0</td>
<td>1.00 (0.88Š1.14)</td>
</tr>
<tr>
<td>2Š4.9</td>
<td>1203</td>
<td>37394</td>
<td>3.2</td>
<td>0.89 (0.80Š0.99)</td>
</tr>
<tr>
<td>5Š9.9</td>
<td>964</td>
<td>52528</td>
<td>1.8</td>
<td>0.62 (0.55Š0.70)</td>
</tr>
<tr>
<td>10Š14.9</td>
<td>522</td>
<td>42853</td>
<td>1.2</td>
<td>0.48 (0.42Š0.56)</td>
</tr>
<tr>
<td>15</td>
<td>455</td>
<td>38218</td>
<td>1.2</td>
<td>0.43 (0.38Š0.50)</td>
</tr>
</tbody>
</table>
## Table VI — Calendar Period

<table>
<thead>
<tr>
<th>Calendar Period</th>
<th>Injuries (n)</th>
<th>Person Years</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977-80</td>
<td>1948</td>
<td>49174</td>
<td>4.0</td>
<td>1.00</td>
</tr>
<tr>
<td>1981-84</td>
<td>947</td>
<td>51965</td>
<td>1.8</td>
<td>0.54 (0.49-0.59)</td>
</tr>
<tr>
<td>1985-88</td>
<td>775</td>
<td>50526</td>
<td>1.5</td>
<td>0.51 (0.46-0.56)</td>
</tr>
<tr>
<td>1989-92</td>
<td>411</td>
<td>42557</td>
<td>1.0</td>
<td>0.35 (0.31-0.39)</td>
</tr>
</tbody>
</table>
Rate of Injury

- Rate of injury relative to the number of previous injuries experienced for workers recruited January 1, 1977 or later (n=10,963)
# Table VI I — Injury in the Workplace

<table>
<thead>
<tr>
<th>n</th>
<th>Injuries (n)</th>
<th>Person Years</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3074</td>
<td>57406</td>
<td>5.4</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>1168</td>
<td>16431</td>
<td>7.1</td>
<td>1.89 (1.76–2.03)</td>
</tr>
<tr>
<td>2</td>
<td>443</td>
<td>5617</td>
<td>7.9</td>
<td>2.63 (2.36–2.93)</td>
</tr>
<tr>
<td>3</td>
<td>191</td>
<td>1764</td>
<td>10.8</td>
<td>4.03 (3.44–4.72)</td>
</tr>
<tr>
<td>4</td>
<td>82</td>
<td>761</td>
<td>10.8</td>
<td>4.13 (3.27–5.22)</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>330</td>
<td>10.6</td>
<td>4.27 (3.09–5.89)</td>
</tr>
<tr>
<td>6</td>
<td>39</td>
<td>212</td>
<td>18.4</td>
<td>8.13 (5.92–11.19)</td>
</tr>
</tbody>
</table>
Table VIII—Injury During Travel to Work

<table>
<thead>
<tr>
<th>n</th>
<th>Injuries (n)</th>
<th>Person Years</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1457</td>
<td>71567</td>
<td>2.0</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>274</td>
<td>9127</td>
<td>3.0</td>
<td>2.15 (1.81–2.56)</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>1543</td>
<td>2.6</td>
<td>2.37 (1.58–3.56)</td>
</tr>
<tr>
<td>&gt;3</td>
<td>11</td>
<td>285</td>
<td>3.9</td>
<td>3.24 (1.59–6.59)</td>
</tr>
</tbody>
</table>
## Table IX—Job Category

<table>
<thead>
<tr>
<th>Workplace</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio</th>
<th>Travel to work Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professionals</td>
<td>1.0</td>
<td>1.00</td>
<td>0.7</td>
<td>1.00</td>
</tr>
<tr>
<td>Technicians</td>
<td>2.3</td>
<td>2.34</td>
<td>1.5</td>
<td>1.26</td>
</tr>
<tr>
<td>Support Workers</td>
<td>2.9</td>
<td>2.70</td>
<td>2.8</td>
<td>3.86</td>
</tr>
<tr>
<td>Group Leaders</td>
<td>4.2</td>
<td>3.99</td>
<td>1.6</td>
<td>2.14</td>
</tr>
<tr>
<td>Laborers</td>
<td>7.5</td>
<td>7.35</td>
<td>2.2</td>
<td>3.13</td>
</tr>
</tbody>
</table>
Table X—Place of Work

<table>
<thead>
<tr>
<th>Workplace</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio</th>
<th>Travel to Work</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Support Services</td>
<td>2.7</td>
<td>1.00</td>
<td>2.2</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Research &amp; Production</td>
<td>4.5</td>
<td>1.67</td>
<td>2.5</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>Energy Supply</td>
<td>4.4</td>
<td>1.63</td>
<td>2.0</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>6.5</td>
<td>2.41</td>
<td>1.9</td>
<td>0.88</td>
<td></td>
</tr>
</tbody>
</table>
## Table X—Place of Work

<table>
<thead>
<tr>
<th>Workplace</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio</th>
<th>Travel to Work</th>
<th>Rate / 100 Person Years</th>
<th>Adjusted Rate Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranes / Rail &amp; Trucks</td>
<td>5.9</td>
<td>2.36</td>
<td></td>
<td>1.7</td>
<td>0.83</td>
</tr>
<tr>
<td>Steel Mill &amp; Foundry</td>
<td>11.2</td>
<td>4.07</td>
<td></td>
<td>2.4</td>
<td>1.05</td>
</tr>
<tr>
<td>Plate Mill</td>
<td>5.9</td>
<td>2.25</td>
<td></td>
<td>2.2</td>
<td>1.05</td>
</tr>
<tr>
<td>Coke Oven &amp; Blast Furnace</td>
<td>6.5</td>
<td>2.49</td>
<td></td>
<td>1.8</td>
<td>0.85</td>
</tr>
</tbody>
</table>
Main Results

- Injury rates are highest for workers less than 20 years of age and the rates progressively decline with increasing age.
- Recently employed workers met with more injuries than those who had been employed for longer periods.
Main Results

- Decreasing trend in injury rate with calendar year
- Significant increase in both workplace and travel injuries was found to be related to the number of injuries of that type previously experienced (table VII and VIII)
- Laborers and group leaders were at highest risk for workplace injuries (table IX)
Main Results

- Highest rate of injury was among those working in foundry
- The smallest number of injuries among those in general support services (table X)