Morbidity

Adnan Hyder, MD, PhD
Maria Segui-Gomez, MD, ScD
Bloomberg School of Public Health
Lecture Topics

- Morbidity data systems
- Morbidity coding systems
- Data poor environments
- Case study #2:
  - Lower extremity fractures
Section A

Morbidity Data Systems
Maria Segui-Gomez, MD, ScD
Morbidity

- Short-term morbidity requiring acute care:
  - Emergency care level
    - Outpatient setting
    - Hospital setting
  - Hospital admission

- Mid-term and long-term consequences
  - Requiring institutionalization (rehabilitation, nursing)
  - Limiting functionality
The Injury Pyramid

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

Disability
The Disability Model

Adapted by CTLT from: IOM (Power and Tarlov), 1991
Relevance of Injury Morbidity Data

- Acute consequences: Hospitalizations, ED visits
  - Counts; rates
- Mid-term and long-term consequences:
  - Counts; rates
- Effects on quality of life
  - \((\text{Age at injury—fixed age}^*) \times \text{quality of life}^{**} = \text{quality-adjusted life years (QALYs)}\)

*Fixed age: 65, 75, life expectancy at birth, life expectancy at time of event

**Quality-, disability-, health-adjustment and other variations
# Leading Causes of Global Burden of Disease (DALY), 2001

<table>
<thead>
<tr>
<th>Disease or Injury</th>
<th>Thousands (cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perinatal conditions</td>
<td>98,422</td>
</tr>
<tr>
<td>Lower respiratory infections</td>
<td>90,748</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>88,429</td>
</tr>
<tr>
<td>Unipolar depressive disorders</td>
<td>65,911</td>
</tr>
<tr>
<td>Diarrhoeal disorders</td>
<td>62,451</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>58,725</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>45,870</td>
</tr>
</tbody>
</table>

# Leading Causes of Global Burden of Disease (DALY), 2001

<table>
<thead>
<tr>
<th>Disease or Injury</th>
<th>Thousands (cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>42,280</td>
</tr>
<tr>
<td>Road Traffic Injuries</td>
<td>37,719</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>36,040</td>
</tr>
<tr>
<td>Maternal conditions</td>
<td>30,943</td>
</tr>
<tr>
<td>COPD</td>
<td>28,917</td>
</tr>
<tr>
<td>Musculoskeletal diseases</td>
<td>29,798</td>
</tr>
<tr>
<td>Congenital abnormalities</td>
<td>28,083</td>
</tr>
<tr>
<td>Violence</td>
<td>20,167</td>
</tr>
</tbody>
</table>

*Source: WHO Injuries and the World Health Report, 2002*
What Would We Like to Know about Non-fatal Injuries?

Similar to fatal injuries except:

- Victim characteristics: E.g., age, gender, ethnicity
- Injury characteristics: Where, what, severity (threat to life, intensity of resources needed to heal, threat to long term consequences, etc)
- Event characteristics: When, where, while doing what
Data Sources

- Hospital discharge
- Trauma registries
- Emergency departments
- Outpatient settings
- Health surveys
Data Sources

- Forensic records (for disability payments)
- Insurance companies
- Police reports (special events: Motor vehicle crashes, homicides, etc.)
- Others
Data Sources

- Special surveys
- Community-based surveillance
- Sport records
- School records
- Transportation entities, etc...
Data Sources

Population covered:
- Census: Total population
- Sample
  - Random Representative of population
  - Stratified
  - Convenience—Not representative

Periodicity:
- Frequently: Surveillance
- One time
In Particular

Hospital Discharge

- Information on individual and acute condition
- At times, info on co-morbid conditions and circumstances of injury
- Computerized data available
- Population catchment area ill-defined (aggregate data sometimes available)

Continued
In Particular

**Hospital Discharge**
- Information on individual and acute condition
- At times, info on co-morbid conditions and circumstances of injury
- Computerized data available
- Population catchment area ill-defined (aggregate data sometimes available)

**Trauma Registries**
- Emergency departments
- Same as hospital except availability in computerized format

Continued
In Particular

**Police Reports:**
- Underreporting of cases
- Misreporting of conditions and circumstances
- Computerized files rarely available
- Population catchment area ill-defined

**Health Surveys:**
- Scarce
- Limited info on injuries and circumstances
- Population based
Morbidity Data Availability and Comparability

Availability:
- Fragmented
- Aggregated across inconsistent levels

Variability:
- Definition of injury
- Outcome being measured: Anatomic injury, physiologic injury, threat to life, disability
- Classification system
- Accuracy of diagnoses
- Completeness rates
When Comparing Morbidity Data

- Check for definition of injury
- Validity of data sources
- Age- and gender- (severity) adjust
- Other adjustments (e.g., exposure?)
- Statistical significance
Section B, Part I

Morbidity Coding Systems
Adnan Hyder, MD, PhD
Maria Segui-Gomez, MD, ScD
Selected Morbidity Codes

- Coding the injuries
  - International Classification of Diseases

- Coding their severity
  - KABCOU
  - Abbreviated Injury Severity Score (AIS), Injury Severity Score (ISS)
  - Revised Injury Trauma Score (RTS), Trauma Revised Injury Severity Score (TRISS)
Selected Morbidity Codes

- Coding how they happened: ICD, ICECI, NOMESCO
- Coding their mid- and long-term consequences: DALYs, QALYs, HALYs, HeaLYs, ICI DH, ADLS
- See mortality session and web appendix to this session: Morbidity Codes
Coding System

- In general coding system should be:
  - Exhaustive and exclusive
  - Simple to use and reliable
  - Flexible yet consistent
International Classification of Diseases (ICD-CM)

- World Health Organization but country specific
- Period revisions, currently 9th version (10th version under development)
- Coding follows strict rules outlined in documentation
  - Great level of detail
  - Requires training
- Codes injury information and cause of injury (chapters XVII and supplement E, respectively on ICD9-CM)
ICD-9-CM Examples

Diagnostic (800-999):
- Closed fracture of the base of the skull with cerebral laceration and contusion and less than one hour loss of consciousness: 801.11
- Major laceration of liver: 864.4

External Causes (E800-E999):
- Driver in motor vehicle traffic accident involving collision with another vehicle: E813.0
- Burn caused by ignition of clothing in private dwelling: E893.0
International Classification of External Causes of Injury (ICECI)

- Long version / short version
- Short version: Designed for ED settings
- Collects information on:
  - Where injury happened
  - Activity when injury happened
  - Intent of injury (if intentional, by whom)
  - Detailed mechanisms of injury
  - Safety equipment used
  - Narrative
Police Reports

KABCOU:
- Killed, incapacitating injury, non-incapacitating injury, possible injury, no injury, unknown if injured

Others:
- Death, hospital admission, medical attention, other, none

Poor validity when hospital records are checked (misclassification issues)
**Threat to Life Measures**

**Abbreviated Injury Severity (AIS):**
- Anatomical severity descriptor plus locates injury body region, type, and specific anatomic structure involved, level of injury
- E.g., 751030.2 shoulder dislocation
- Offsprings: ISS, NISS, RTS

**And, Trauma and Injury Severity Score (TRISS):**
- Adds physiological parameters to AIS scores in three most severe body regions
- TRISS = f{AIS, Glasgow coma scale, systolic blood pressure, respiratory rate}
- Can compute probabilities of survival
Selected Consequences

International Classification of Functioning and Disability (ICIDH):

- Codes information on the impact at the:
  - Body level, individual level, and societal level
  - And also the impact of environmental factors
- Does not indicate source of disability

Health outcomes:

- Functional independence measure (FIM)
- Activity Daily Living (ADL), IADL
- Short Form-36 (SF-36)

Health outcomes that are preference-based (Quality-of-life compatible or QALYs):

- Quality of well-being
- HALYs
- DALYs
Section B, Part II

Morbidity Coding Systems
Adnan Hyder, MD, PhD
Maria Segui-Gomez, MD, ScD
<table>
<thead>
<tr>
<th>Group</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Communicable diseases, maternal, perinatal and nutritional disorders</td>
</tr>
<tr>
<td>Group 2</td>
<td>Non-communicable diseases</td>
</tr>
<tr>
<td>Group 3</td>
<td>Intentional and unintentional injuries</td>
</tr>
</tbody>
</table>

*Source: Murray, C.J. 1997*
Summary Measures of Population Health-1

- Combine mortality and disability impact of diseases on population
- Measures impact in terms of time-lost from premature mortality and disability
- Time expressed as loss of healthy life (in state of perfect health)
Summary Measures of Population Health-2

- Disability adjusted life years: DALY
- Healthy life-years: HeaLY
- Years lived with disabilities: YLD
- Disability adjusted life expectancy: DALE
- Quality adjusted life years: QALY
# Global Burden of Disease Study

*Estimated DALYs by Disease Group*

<table>
<thead>
<tr>
<th>Causes</th>
<th>Group</th>
<th>1990 DALYs %</th>
<th>2020 DALYs %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Communicable diseases, maternal, perinatal and nutritional disorders</td>
<td>43.9</td>
<td>20.1</td>
</tr>
<tr>
<td>Group 2</td>
<td>Non-communicable diseases</td>
<td>40.9</td>
<td>59.7</td>
</tr>
<tr>
<td>Group 3</td>
<td>Intentional and unintentional injuries</td>
<td>15.2</td>
<td>20.1</td>
</tr>
</tbody>
</table>

*Source: Murray, C.J., 1997*
DALYs by Cause Globally, 2000

- Others 61%
- Injuries 12%
- Cancer 5%
- Cardiovascular 10%
- Neuropsychiatric conditions 12%
Injury DALYs by specific cause
Globally, 2000

- Road traffic injuries: 22%
- Other: 23%
- Poisoning: 5%
- Falls: 11%
- Fires: 6%
- Drowning: 7%
- Self-inflicted violence: 11%
- Interpersonal violence: 9%
- War: 6%

Source: WHO Injuries 2002
Loss of Healthy Life-Years in Ghana, by Disease (1981)

Healthy Life-Years
Lost in Pakistan, 1990

# Leading Causes of Years Lived with Disability (YLDs), World 1990

<table>
<thead>
<tr>
<th>Disease or Injury</th>
<th>Thousands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unipolar major depression</td>
<td>50810</td>
</tr>
<tr>
<td>Anemias</td>
<td>21987</td>
</tr>
<tr>
<td>Falls</td>
<td>21949</td>
</tr>
<tr>
<td>Alcohol use</td>
<td>15770</td>
</tr>
<tr>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>14692</td>
</tr>
</tbody>
</table>

*Source: WHO Injuries and the World Health Report 1999*
Percentage Distribution of YLDs by Causes 1990

Source: Murray, C.J., 1996
Healthy Life Expectancy Rankings

Based on the World Health Organization’s Disability Adjusted Life Expectancy (DALE)

- Disability Adjusted Life Expectancy (DALE) summarizes the expected number of years to be lived in what might be termed the equivalent of "full health"

- To calculate DALE, the years of ill-health are weighted according to severity and subtracted from the expected overall life expectancy to give the equivalent years of healthy life
## DALE

<table>
<thead>
<tr>
<th>Rank</th>
<th>WHO Member State</th>
<th>Overall</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Japan</td>
<td>74.5</td>
<td>71.9</td>
<td>77.2</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>73.2</td>
<td>70.8</td>
<td>75.5</td>
</tr>
<tr>
<td>3</td>
<td>France</td>
<td>73.1</td>
<td>69.3</td>
<td>76.9</td>
</tr>
<tr>
<td>4</td>
<td>Sweden</td>
<td>73.0</td>
<td>71.2</td>
<td>74.9</td>
</tr>
<tr>
<td>5</td>
<td>Spain</td>
<td>72.8</td>
<td>69.8</td>
<td>75.7</td>
</tr>
</tbody>
</table>
QALY Losses Due to Unintentional Injuries
For Children Ages (0 to 19) the United States, 1996

% of QALY Loss Due to Unintentional Injuries to Children Ages (0 to 19) the United States, 1996

- Hospital-admitted Injuries: 36%
- Other Injuries: 48%
- Fatal Injuries: 16%

Section D

Morbidity Case Study
(Injuries in Nigeria and Qatar)
Maria Segui-Gomez, MD, ScD
Some Facts about the Country

- Some 900,000 square km.
- 125 M pop (250 ethnic groups)
- GDP per capita U.S. $1,380
- Independent (from Britain) since 1960
- “Medical establishments owned by federal, state, and local governments and private groups
- Shortage of medical facilities and physicians in rural areas”

Source: US Library of Congress, online catalog
Objective is to assess pattern, severity, and outcome of childhood injuries from motor vehicle crashes

Medical records ("case studies") from 1992–1995 reviewed

Demographics, injury circumstances, injuries, injury severity (GCS, AIS, ISS), procedures ("injury management"), and outcomes (survival) collected

GCS

- Glasgow Coma Score (Teasdale, 1976)
- Ordinal scale that ranges between 3 (worst) to 15 (best). Composite of:
  - Verbal response (5 possible points ranging from 1 [none] to 5 [perfect])
  - Eye response (same scoring as above but range 1–4)
  - Motor response (same scoring as above but range 1–6)
GCS

- Only relevant if neurological damage exists
- Maybe not applicable if patient sedated and/or intubated
- Problems:
  - When to measure it?
  - Reliability?
AIS

- Abbreviated Injury Severity Score (AAAM, 1976)
- Several revisions since then (most recent 1998)
- Extensively used by crash investigators, epidemiologist, policy makers (slightly less used by clinicians)
- Requires training

- Anatomical Injury Descriptor of individual injuries (injury coding system) with one additional field on severity (e.g., 751030.2)
- (Other numbers reflect body region, area injured)
- This last digit (e.g., 2) is the severity score
- Severity is an ordinal scale between one (least) and six (almost unsurvivable)
ISS

- Injury Severity Score (Baker, 1974)
- Integrates multiple injuries in one subject
- Computed from AIS as the sum of the squares of the three highest AIS in the (up to) three most severely-injured body regions
- ISS = (maxAIS br_a)^2 + (maxAIS br_b)^2 + (maxAIS br_c)^2

Br = Body Region (i.e., head or neck, face, chest, abdominal or pelvic contents, extremities or pelvic girdle, and external)

- Ordinal scale that ranges between 1–75 and has “gaps” in between
- More recently, new ISS (Osler, 1997) proposed to use three highest AIS, regardless of body region
Results

- 324 children
- Head injuries most frequent (25.3%)
- Fractures, next in frequency (22.2%), particularly low extre.
- ISS 1–54 (majority less than 25 and no mortality),
- Some 6% (25+), some died
- Highest severity among MV occupants
- 43% admitted to hospital
- Length of stay shorter among fatal cases
- LOS ranged between 1–450 days
Discussion

- “The findings [...] confirm that whilst the incidence and severity of injuries due to RTA in Nigerian children may not be as high as in industrialized countries, the consequences are no less severe”

- Why would “[t]he ISS differ between the studies in developed and underdeveloped countries”?
Caution Points

- Be aware of differences between scale versions (for example, AIS 1985 had little consideration for pediatric injuries)
- ISS may be underestimated in fatality cases if no autopsy is performed
- If multiple injuries are present, AIS may be insufficient (consider new ISS instead of ISS if multiple injuries in same body region are frequent)
Some Facts about the Country

- Some 11,000 square km.
- 0.7 M
- GDP per capita U.S. $17,100
- Independent (from Britain) since 1971

“Comprehensive [health] system of well-equipped public clinics and hospitals staffed by mainly foreign personnel. Most care provided free to all residents. Several private clinics located in Doha”

Source: US Library of Congress, online catalog
The Paper at Hand

- Objective is to measure incidence and severity of abdominal trauma due to motor vehicle crashes in Qatar
- Medical records (case studies) from the only acute general hospital from 1991–1995 reviewed
- Demographics, physiological, injury circumstances, injuries, injury severity (AIS, ISS, RTS), length of SICU stay, and outcome (survival) collected

RTS

- Revised Trauma Score (Champion, 1989)
- Composite of anatomic and physiologic parameters
- Predicts probability of survival
  - \( P = \frac{1}{1 + e^{-A}} \)

Where \( A \) is derived from GCS, systolic blood pressure, and respiratory rate categories (denoted \( c \)) synthesized using a mathematical model

\[ A = w_0 + w_1 \text{GCS}_c + w_2 \text{SBP}_c + w_3 \text{RR}_c \]
Results

- Of 667 patients in SICU, 84 had abdominal injuries
- AIS (1990 version)
- ISS:

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-8</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>9-15</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>16-24</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>25-40</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>41-49</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>50-74</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>75</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>76</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>21</td>
</tr>
</tbody>
</table>
Results

- Descriptive by anatomic structure/organ (e.g., spleen)
- Death could be attributed to abdominal injury in only 9 cases

RTS:

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1-2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2.1-3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.1-4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4.1-5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>5.1-6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>6.1-7</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>7.1-7.8</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
<td>15</td>
</tr>
</tbody>
</table>
Discussion

- “. . . only in nine patients, death could be attributed to abdominal trauma alone”
- “Other abdominal injuries did not contribute to mortality”
- Why did “the RTS and ISS contribute very little to our attempt to stage the severity of the injuries and correlate it to survival”? 
Caution Points

- What about multiple injuries?
- Understanding the tables at the end
  - They present the AIS distribution of the liver and splenic injuries, the bottom half of each table contains the data dictionary