Introduction to Epidemiology

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Outline

- Define
- History
- Basis of epidemiology
- Objectives of epidemiology
- Causal inference
Epidemiology

- The study of the distribution and determinants of health-related states or events in specified populations and the application of this study to the control of health problems
Epidemiology

The study of how disease is distributed in a population and of the factors that influence or determine that distribution.
History of epidemiology

John Snow, 1854

- Cholera outbreak in London
- Snow had previously hypothesized cholera was transmitted via water.
- Two water companies in London
- One pulled water down stream from sewage, one from up stream
- Deaths occurred around water pumps from the downstream company
Basis of epidemiology

Disease, illness and ill-health are not randomly distributed in a population.
Determinants of disease

- Host
- Agent
- Environment
Agent

- A necessary ingredient in the production of disease
- May be infectious (virus, bacteria) or noninfectious (chemical, radiation)
- May be a single agent or a complex of agents
Host

- The biological and behavioral qualities of an individual
- Factors can influence the exposure to disease causing agents and the occurrence of disease after exposure
Host

- Age
- Sex
- Race/ethnicity
- Occupation
- Immune status
- Alcohol / drug use
- Sexual activity
Environment

- External factors that affect the likelihood of disease occurrence
- Examples: weather, population density, geography
Objectives of epidemiology

1. Identify the causes of disease and the factors that increase a person’s risk of disease
2. Describe the extent of disease found in a community
3. Describe the natural history and characteristics of a disease
4. Evaluate preventive/therapeutic measures
5. Guide policy decisions
1. Identify causes of disease

- Classic application of infectious disease epidemiology
- Outbreak or cluster investigations
- Medical detective
Examples of outbreak investigations

- Pneumonia associated with convention attendants discovered Legionnaires Disease
- SARS cases in Toronto traced back to exposures in Hong Kong
- Deaths due to E.coli from eating at fast food restaurants
Local outbreak examples

- A case of Hemolytic Uremic Syndrome caused by E Coli from a church retreat
- Outbreak of shigella after a 21st birthday party caused by one of the guests
2. Describe the extent of disease

- Descriptive epidemiology
- Person – populations/communities affected
- Place – geographical locations
- Time – seasonal patterns, trends over time
AIDS case rates by race/ethnicity*

*Austin EMA
2. Describe the extent of disease

- **Epidemic** – any disease that occurs at a greater than expected frequency.
- **Endemic** – any disease that does not fluctuate over time in a defined place.
3. Natural history & characteristics

- the natural development of a disease over time
- modes of transmission
- distribution
- prognosis
Smallpox in the US, 1900-1950

From “Smallpox & Its Eradication”
Smallpox: eradication

- 1949 – last US case
- 1967 – eradicated from Western Hemisphere, except for Brazil
- 1967 – global eradication program began
- 1977 – last indigenous case in Somalia
- 1980 – WHO certifies global eradication
Smallpox: reservoir

- Humans are the only natural host
- No chronic carrier status
Smallpox: temporal pattern

- Seasonality similar to measles and chickenpox
- Incidence was highest in winter and spring
- Virus is more viable at low temperatures and humidity
Smallpox: transmission

- Most transmission occurs from direct face-to-face contact, usually ≤ 6 feet with infected persons
- Direct contact with infected materials or scabs
- Highly infectious
Smallpox: outcomes

- High fatality rate: 20 – 40% of ill individuals die
- Pockmarks: scarring left on body and face
- Blindness: result of co-infection
- Encephalitis
### Case fatality rates by age

<table>
<thead>
<tr>
<th>Country (area)</th>
<th>0-4</th>
<th>All ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>47%</td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td>26.8%</td>
<td>18.5%</td>
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<tr>
<td>India (Tamil Nadu)</td>
<td>43%</td>
<td>26%</td>
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<tr>
<td>Burma</td>
<td>23%</td>
<td>17%</td>
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<tr>
<td>Afghanistan</td>
<td>19%</td>
<td>16%</td>
</tr>
<tr>
<td>India (Punjab)</td>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td>Indonesia (Jakarta)</td>
<td>18%</td>
<td>13%</td>
</tr>
<tr>
<td>Indonesia (West Java)</td>
<td>11%</td>
<td>8%</td>
</tr>
<tr>
<td>West Africa</td>
<td>14%</td>
<td>13%</td>
</tr>
<tr>
<td>Tango</td>
<td>10%</td>
<td>8%</td>
</tr>
</tbody>
</table>

From “Smallpox and Its Eradication”
4. Evaluation

- Determine the effectiveness of health programs and services in improving the health of the community
## Evaluation of Health Study

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Intervention</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Measure BMI</td>
<td>Aerobics</td>
<td>Measure BMI</td>
</tr>
<tr>
<td>B</td>
<td>Measure BMI</td>
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</tr>
</tbody>
</table>
Poliomyelitis–US, 1950-2001*

*2001 provisional data

CDC
5. Policy

- Warnings on cigarettes
- Targeted community interventions
- Smallpox preparedness program
- Polio eradication program
Applications of epidemiology

- Clinical
- Genetic
- Social
- Infectious Disease
- Chronic Disease
- Pharmacoepidemiology
- HIV/AIDS
- Maternal & child
Causal Inference

- Does an exposure or factor cause disease?
- More than is a factor statistically associated with disease.
**Association**

- Exposure
- Disease or Outcome
  - Statistical association

**Causal Association**

- Exposure
- Disease or Outcome
  - Statistical association
Criteria for causal association

- Temporal relationship
- Strength of relationship
- Dose-response relationship
- Biologic plausibility
- Consistency of results
Causal inference

- Temporal association
  - Does the exposure precede the disease?
Causal inference

- Strength of relationship
  - The stronger the association, the more likely it is that the exposure-disease relationship is causal
  - Strong associations are not as likely as weak association to be due to different types of study bias
Causal inference

- Dose-response relationship
  - Is the association stronger with increased intensity or duration of exposure?
Dose-response relationship

From: Hammond & Horn, JAMA 166:194-1308; 1958
Causal inference

- Biologic plausibility
  - Results consistent with current knowledge of biology?
  - Are there any known or suspected biological mechanisms that help explain the exposure-disease association?
Causal inference

- Consistency of results
  - Do other studies with different populations and methods report the same results?
More information

For more information on epidemiology

Epidemiology Supercourse
http://www.pitt.edu/~super1/
Contact information

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