Introduction to Epidemiology

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Goals

- Define Epidemiology
- Discuss Concepts in Infectious Disease Epidemiology
- Introduce Biostatistical Concepts
- Introduce Study Designs

Defining Epidemiology

- Epidemiology is What Epidemiologists Do
- Epidemiology is Reasoned Argument
- Epidemiologists Count Things
- Epidemiologists are Clinicians to a Community

Defining Epidemiology

- Epidemiology is the study of the distribution and determinants of disease in human populations

History

- Nebuchadnezzar and Daniel
- James Lind – Scurvy
  - HMS Salisbury 1740 – 1744
- John Snow – Cholera
  - 19th Century London
  - Laid the foundation for modern epidemiology

The Epidemiology of Cholera

Water Company	Number of Houses	Deaths from Cholera	Deaths per 10,000 Houses
Southwark and Vauxhall	40,046	1263	315
Lambeth	26,107	98	37
Rest of London	256,423	1422	59

Austin Bradford Hill

- “The highest returns can be reaped by imagination in combination with a logical and critical mind, a spice of ingenuity coupled with an eye for the simple and humdrum, and a width of vision and pursuit of facts that is allied with an attention to detail that is almost nauseating”
- “Nature makes the experiments, and we watch and understand them if we can”

Concepts in Infectious Disease Epidemiology

- Glossary of Disease Transmission
- The Epidemiologic Triad
- Chain of Transmission

Glossary of Disease Transmission

- Epidemic
- Outbreak
- Cluster
- Endemic
- Pandemic

Epidemiologic Triad

- Agent
  - Nutritive, Chemical, Physical, Infectious
- Host (Person)
  - Inborn, Acquired, Behavioral
  - Susceptible, Immune, Infected
- Environment

Disease Transmission

- Time (Epidemic Curve)
- Chain of Transmission
  - Source
  - Portal of Exit
  - Mode
    - direct vs. indirect (airborne, vector, vehicle, droplet nuclei, fomites)
  - Portal of Entry

Introduction to Biostatistical Concepts

- Measures of Disease Frequency
- Measures of Effect
- Statistical Significance

Measures of Disease Frequency

- Ratios (Odds)
- Proportions (Risk)
- Rates
  - Incidence Rate
  - Cumulative Incidence
- Relative Rates
- Difference Between a Rate and a Risk

Measures of Effect

- The Four-Fold Table
- Relative Effects = Ratios
- Absolute Effects = Differences
- Attributable Proportion

Difference vs. Ratio

Mortality Rates per 100,000 person-years form lung cancer and coronary artery disease for smokers and non-smokers

	Smokers	Non-Smokers	Odds Ratio	Risk Difference
Lung Cancer	48.3	4.5	10.8	43.8
CAD	294.7	169.5	1.7	125.13

The Importance of Significance

- Chance and Probability
- P-values
- Confidence Intervals
- 1 is the loneliest number

Study Designs

- Overview
- Ecologic Studies
- Cross-sectional Studies
- Randomized Clinical Trials
- Case-Control Studies

Overview of Study Designs

- Ceteris Paribus
- Experiments and Quasi-Experiments
- Observational Studies
  - Descriptive Studies
    - Ecologic, Cross-sectional
  - Analytic Studies
    - Randomized Clinical Trials, Cohort, Case Control

Ecologic Studies

- The Ecologic Fallacy
- Durkheim
- Robinson
- Lung Cancer and Pollution

Cross-Sectional Studies

- Directionality
- Incidence-Prevalence Bias

	1-2 yrs	3-7 yrs	>7 yrs
% who have ever received AFDC	30%	40%	30%
% receiving AFDC at particular time	7%	28%	65%

Randomized Clinical Trial

- Selection of Study Population
  - Reference, experimental, actual
- Random Allocation
  - Placebo
- Blinding
  - Double, triple
- Weaknesses

Cohort Study

- Definition and Conduct
- Types
- Strengths
- Weaknesses
- Analysis
  - **RR = (A/A+B) / (C/C+D)**

Case-Control Studies

- Definition and Conduct
- Strengths
- Weaknesses
  - Temporality
  - Control Group
  - Recall Bias
- Analysis: The Odds Ratio

The Odds Ratio

- Prospective vs. Retrospective Approach
- Need for a New Measure of Effect
- Exposure Odds Ratio
- Disease Odds Ratio
- Rare Disease Assumption
- OR = ad/bc

Threats to Validity

- Confounding
  - Causally related to the disease
  - Associated with the exposure
  - Not a result of study design
- Bias
  - Systematic error
  - Design, conduct or analysis

Confounding

- Definition
- Examples
- OR = ad/bc = (90)(60) / (60)(90) = 2.25

Myocardial Infarction				
Coffee Drinking		Yes	No	
	Yes	90	60	150
	No	60	90	150
		150	150	300

Confounding

- Control
  - Design, Analysis

	Smokers			Non-Smokers
	MI	No MI	MI	No MI
Coffee	80	40	10	20
No Coffee	20	10	40	80
Totals	100	50	50	100
	OR = 1.0		OR = 1.0	

Bias

- Recall Bias
- Diagnosis Bias
- Hawthorne Effect
- Selection Biases

Selection Biases

- Detection (Surveillance) Bias
- Incidence Prevalence (Survivor) Bias
- Loss to Follow up (Non Response Bias)
- Health Worker Effect
- Volunteer Bias
- Berkson's Bias

Berkson's Bias

- Truth
  - No relationship between vag bleed and endometrial CA
  - OR = 1
- Bias
  - Probability of admission varies by diagnosis
  - OR = 4.3

Type of Cancer				
Vaginal Bleeding		Endometrial	Other	
	Yes	100	100	200
	No	900	900	1800
		1000	1000	2000

		Type of Cancer		
		Endometrial	Other	
Vaginal	Yes	73	85	158
Bleeding	No	90	450	540
		163	535	698

Standardization of Rates

Age-Specific Mortality Rates (per 1000): Sweden and Panama

Age	Sweden	Panama
0-29	1.1	5.3
30-59	3.6	5.2
>60	45.7	41.6

Next, we choose some standard age distribution, let's say:

Age	Weight
0-29	3, 145, 000
30-59	3, 057, 000
>60	1, 294,000

multiply the age-specific mortality rate by the standard population rates

Age	Sweden	Panama
0-29	1.1 x 3145000 = 3459.5	5.3 x 3145000 = 16668.5
30-59	3.6 x 3057000 = 11005.2	5.2 x 3057000 = 15896.4
>60	45.7 x 1294000 = 59135.8	41.6 x 1294000 = 53838.4

Divide by the total standard populations to get the standardized mortality rates:

Sweden = 73599.5 / 7, 496, 000 x 1000 = 9.8 per 1000

Panama = 86403.3 / 7, 496, 000 x 1000 = 11.5 per 1000