Clinical Epidemiology

Rowland Chang, M.D., M.P.H.

Objectives

- Define epidemiology
- List at least five types of clinical inquiry that epidemiologic studies can address
- Summarize the epidemiologic method
- List the threats to truth in epidemiologic studies

What is epidemiology?

- Science which is about the distribution of disease (or consequence of disease) in populations
- Set of methods used to reduce uncertainty about information

What is clinical epidemiology?

- The science of making predictions about individual patients by counting clinical events in similar patients, using strong scientific methods for studies of groups of patients to ensure that the predictions are accurate
- Used as an aid to clinical decision making

Epidemiologic methods

- Methods of observation that will lead to valid conclusions by avoiding being misled by systematic error (bias) and chance

Why learn about clinical epidemiology? - 1

- Traditional basic sciences (pathophysiology, pharmacology, etc.) do not incorporate the uncertainties of medicine
- Traditional clinical approaches do not formally consider the context of disease (or health) in a population

Why learn about clinical epidemiology? - 2

- Traditional clinical approaches do not encourage assigning patients into “crude” categories of risk which allows for the detection of association between risk factors and outcomes in populations
- The associations found in populations may be relevant to individual patients

How is clinical epidemiology used?

- Test hypotheses generated by the basic sciences (etiology, diagnosis, treatment) in research studies
- Assess research reports in the literature
- Assess clinical and population data

Key premise: Life is uncertain

- Uncertainty is best expressed as a probability
- Probability for an individual patient is best estimated by referring to past experience with groups of similar patients (not the last patient)
- All observations are subject to systematic and random error

Types of questions addressed by clinical epidemiology

- Abnormality
- Diagnosis
- Frequency
- Risk
- Prognosis
- Treatment
- Prevention
- Cause
- Cost

Outcomes of clinical epidemiologic studies

- Death
- Disease
- Discomfort
- Disability
- Dissatisfaction

Methods of clinical epidemiology

1. Formulate question (hypothesis)
2. Choose study design
3. Choose study population base and sample from that base
4. Collect and analyze data
5. Interpret results

1. Formulate Question (Hypothesis)

- Elements of a good question (hypothesis)
  - Target population
  - Target exposure (risk factor, protective factor, treatment) and its control
  - Specified outcome
  - Example: In adults is hypertension associated with an increased risk of coronary artery disease?
- Criteria for a good question
  - New information?
  - Feasible to answer?
  - Public health importance?

2. Choose Study Design

A. Experimental (e.g. RCT)

B. Observational

1) Cohort (incidence) study
2) Case-control study
3) Cross-sectional (survey, prevalence) study

A. Experimental Study

- Also called randomized, controlled trial (RCT)
- Randomly assign "exposure" (usually an intervention) to study population
- Measure "outcome" during some follow-up period
- Best method to eliminate selection bias (required for pharmacologic treatment by FDA)
- However
  - Some exposures cannot be randomly allocated
  - Selection criteria may limit generalizability
  - High cost

B. Observational: 1) Cohort study

- Classify individuals in study population into "exposure" categories
- Measure "outcome" during some follow-up period
- Can be retrospective or prospective
- Feasible for common outcomes, less costly than RCTs
- However
  - Subject to selection bias
  - Among observational study designs most costly
  - Not feasible for rare outcomes

B. Observational: 2) Case-control study

- Choose a sample of individuals with the "outcome" of interest (cases) and a sample of individuals without the "outcome" (controls)
- Assess "exposure" status of study population sometimes in the past
- Retrospective except for nested case-control studies, i.e. when case and control subjects are drawn from a cohort study
- Advantages: less costly, appropriate for rare outcomes
- Disadvantages: more subject to bias

B. Observational: 3) Cross-sectional study

- Also called a prevalence study
- Assess "exposure" and "outcome" of study population at the same time
- Advantage: least expensive of observational studies
- Disadvantage: no temporal relationship between "exposure" and "outcome"

3. Choose Study Population Base and Sample from that Base

- Struggle between access and generalizability
- Population Base choices include
  - Active patients (clinic/hospital)
  - Community residents (geographic)
  - Combination
- Sampling choices include
  - Random sampling
  - Stratified random sampling
  - Convenience sampling
- Depends on study design

4. Analysis of epidemiologic studies

- Sensitivity and specificity in studies of diagnostic tests
- Relative risk and odds ratios in studies of association between risk factors and outcomes

Example – I (Sensitivity/Specificity)

	CAD	No CAD	Total
ETT+	160	50	210
ETT-	40	150	190
Total	200	200	400

Sensitivity: 160/200 = .80; Specificity: 150/200 = .75

Example – II (Relative Risk)

	CAD	No CAD	Total
High BP	100	900	1000
No High BP	50	950	1000
Total			2000

RR = (100/1000)/(50/1000) = 2

Example – III (Odds Ratio)

	CAD	No CAD	Total
High BP	50	25	
No High BP	50	75	
Total	100	100	

OR = (50*75)/(25*50) = 3

5. Interpret Results

- Threats to the validity of epidemiologic studies
  - Bias (a process at any stage of inference tending to produce results that depart systematically from the true values)
  - Chance

Bias in clinical observations

- Selection bias
  - Occurs when selection and/or follow-up procedures lead to study group differences in determinants of outcome other than the one under study
- Measurement bias
  - Occurs when measurements are imprecise and/or the methods of measurement are dissimilar among study groups
- Confounding bias
  - Occurs when two factors are associated ("travel together") and the effect of one is confused with or distorted by the effect of another)
  - Due to selection or by chance

Selection bias and confounding control

- Restriction (exclude the young)
- Matching (for every 50 year old with BP+, find a 50 year old with BP-
- Stratification at enrollment (set sample size for each decade of age)
- Statistical adjustment (stratification of data, standardization, multivariate adjustment)

Measurement (Information) bias control

- Use "objective" and precise measures when possible
- Blinding of assessors of outcome to risk status of subject and vice versa
- Assess extent of measurement (information) bias by comparing responses to external information (e.g. pharmacy records, or health utilization data bases)

Chance (random error)

- Arises from sampling and measurement
- Assessed by statistical methods

Validity

- Internal validity
  - The degree to which the results of a study are correct for the sample of patients being studied
- External validity
  - The degree to which the results of an observation hold true in other settings

Objectives

- Define epidemiology
- List at least five types of clinical inquiry that epidemiologic studies can address
- Summarize the epidemiologic method
- List the threats to truth in epidemiologic studies

References

- Fletcher RH, Fletcher SW, Wagner: Clinical Epidemiology: The Essentials. 4th edition. Williams & Wilkins, Baltimore MD, 2005.
- Rothman KJ. Epidemiology, an introduction. Oxford University Press, 2002