Epidemiologic Principles

Causality

Confounding

Bias

GOALS

◆ Apply elements of causality to assessment of data
◆ Identify potential confounders in research designs and studies
◆ Recognize sources of bias in published research reports

Surgical Site Infection Rate

◆ All surgeons: 2.3%
◆ Dr. H: 4.5%

Why?

◆ Sees highest risk patients (confounding)
◆ Caused by factor associated with both Dr. H and infections (confounding)
◆ Collects better data (bias)
◆ Sample size is too small (statistical artifact)
◆ Chance

Wound Infection Rates

Did Dr. H “cause” more infections?

◆ Temporal sequence: surgery before infection
◆ Strength of association: High relative risk
◆ Consistency: present over several risk categories
◆ Statistical significance: Events unlikely to be chance

Associations Between Variables

◆ None
◆ Artifactual
  ● Chance
  ● Bias
◆ Indirect (confounding, extraneous)
Causal

Evaluating Causality

Koch’s Postulate: An organism (cause) is always found with the disease (effect): SPECIFICITY

Exception:
Many different “causes” can result in the same effect (eg. pneumonia is caused by different organisms)

Evaluating Causality

Koch’s Postulate: The organism (cause) is not isolated in other diseases: SPECIFICITY

Exception: The same “cause” can have many different effects (eg. Strep. may cause sore throat, impetigo, scarlet fever)

Evaluating Causality

Koch’s Postulate: The organism (cause) when isolated from a diseased person will induce the same disease (effect) in another person

Exception:
Some “causes” may not produce any effect (eg. Colonization with an organism with no disease)

ELEMENTS OF CAUSALITY

Temporal Relationship
‘Cause’ must precede ‘effect

Strength of Association

Risk of the outcome ‘effect’ among those exposed to the ‘cause’ must be greater than the risk among unexposed

Strength of Association Measured by Relative Risk

<table>
<thead>
<tr>
<th>Disease</th>
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<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Exposed</td>
<td>Yes</td>
<td>B</td>
<td>A+B</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>D</td>
<td>C+D</td>
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<td></td>
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<td></td>
<td>A+C</td>
<td>B+D</td>
<td>A+B+C+D</td>
</tr>
</tbody>
</table>
Calculating Relative Risk
\[ \frac{A}{A+B} \] vs. \[ \frac{C}{C+D} \]
Incidence in exposed vs. Incidence in unexposed

\[ \frac{A/(A+B)}{C/(C+D)} \]

Specificity of the Association
One ‘cause’ is specifically and only associated with one ‘effect’ (e.g. HIV and AIDS)

Plausability
Association between ‘cause’ and ‘effect’ makes biological or psychological sense

Consistency of Association
The same ‘cause’ is associated with the same ‘effect’ in a variety of circumstances

Example:
Smoking and Lung Cancer
◆ Temporal: Did smoking precede lung cancer?
◆ Strength: Large relative risk?
◆ Specificity: Lung cancer only occurs in smokers?
◆ Plausability: Biologic rationale?
◆ Consistency: Lung cancer in men/women smokers? Several brands? Various study designs?

Why Was It Easy to Determine Causal Association Between Smoking and Lung Cancer?
◆ Exposure is easily, accurately assessed
◆ ‘Cause’ (smoking) is common and present in otherwise similar people
◆ Large relative risk and clear dose response
◆ Lung cancer (‘effect’) comparatively uncommon in non-
smokers

Nurse Accused of Murder

Old Age and Confusion: Relevant Questions?
◆ Temporal Relationship?
◆ Strength of Association?
◆ Specificity?
◆ Plausability?
◆ Consistency?

Catheterization and UTI: Relevant Questions?
◆ Temporal Relationship
◆ Strength of Association
◆ Specificity
◆ Plausability
◆ Consistency

Three Factors That Interfere With Causal Inference
◆ Chance
◆ Confounding
◆ Bias

Did It Occur By Chance?
Statistical significance?
Adequate statistical power?
Replicated studies?
Statistical tests to control for multiple comparisons?

Confounding (Extraneous) Variable
Variable that has an irrelevant or unwanted effect on the relationship between the variables being studied, causing a distortion of the ‘true’ relationship

Confounding
Exposure                     Outcome

Confounder

Example
◆ Exposure (‘cause’) = type of needle (plastic or steel)
◆ Outcome (‘effect’) = phlebitis
◆ Confounder = time in place

Example
◆ Exposure (‘cause’) = hours of study
◆ Outcome (‘effect’) = class grades
◆ Potential confounders =
  ● Health
  ● Intelligence

Crude mortality rates in US are higher than in Nicaragua, despite the fact that death rates in Nicaragua in every age category are higher.

Why?

Relationship Between Cholesterol Level and CHD

To Look for Confounding….
◆ Is the factor related to exposure? Disease? (must be related to both)
◆ Stratify by the variable (e.g. age groups). Is the relative risk different?

Examples of Confounders?
Effect of breathing exercises on post-operative respiratory complications
Effect of training course for pediatric nurses on nurturing behaviors of nurses
Effect of type of nursing education on involvement in professional organization and politics

Is Drinking Alcohol Associated with Increased Risk of Lung Cancer?
Same Subjects, Stratified by Smoking

Conclusion
Smoking was associated with lung cancer AND
Smoking was associated with drinking
Smoking was associated with both the dependent (lung cancer) and independent variable (drinking) and is therefore a confounding variable

THEREFORE…it was the smoking, not the drinking associated with lung cancer

Age-Adjusted Esophageal Cancer Deaths by Race and Sex

Age-Specific Mortality by Birth Year, Esophageal Cancer

Avoiding Confounding
Use homogeneous subjects
Match subjects or stratify by potential confounder
Randomize
Statistical procedures such as analysis of covariance

BIAS
A prejudice or opinion formed before the fact. In research,
usually unintentional and unknown to researcher

**Selection Bias**
Study population differs in a way that is likely to affect study results

**Detection Bias**
Knowledge about a particular exposure or characteristic of the subjects increases the search for certain effects

**Investigator Bias**
A preconceived notion about the outcome of a study which can influence the investigator’s evaluation

**Non-Response Bias**
Responders vary from non-responders with regard to relevant variables

**Recall Bias**
Certain subjects recall past differentially better than other subjects

**Give a rival hypothesis….**
◆ Nursing students and test anxiety
◆ Remedial math course
◆ Adolescent girls and pelvic exam

**Minimize Bias**
◆ **SELECTION:** strict inclusion criteria
◆ **DETECTION:** identify ‘effect’ equally in all subjects
◆ **INVESTIGATOR:** ‘blinding’/‘masking’, inter-rater reliability, explicit and objective measurement

**Minimize Bias**
◆ **NON-RESPONSE:** randomize study groups or carefully select groups for comparability, make study participation easy, followup with non-responders to identify systematic differences
◆ **RECALL:** structured interview or survey, reinterview a sample
Want More?