Principles of Field Epidemiology

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Learning Objectives

- Define epidemiology and its' application to public health
- General knowledge of the history of epidemiology
- General knowledge of the basic steps involved in an outbreak investigation
- Understand common mathematical measures used by epidemiologists

Epidemiology Defined

Epidemiology is 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*

Concept Check #1

- Graph the number of cases of congenital syphilis by year for the country
  - *A. Distribution*
  - *B. Determinants*
  - *C. Application*
- Recommend that close contacts of a child recently reported with meningococcal meningitis receive Rifampin
  - *A. Distribution*
  - *B. Determinants*
  - *C. Application*
- Compare food histories between persons with *Staphylococcus f*ood poisoning and those without
  - *A. Distribution*
  - *B. Determinants*
  - *C. Application*

History of Epidemiology

- Circa 400 B.C.-Hippocrates
  - Proposed how behaviors might influence the development of disease
- 1662-John Graunt
  - Published the 1st study quantifying birth, death, and disease occurrence
- 1800-William Farr
  - Considered the father of modern vital statistics and surveillance
- 1854-John Snow
  - Published a study linking cholera outbreaks to local water sources
- 19th and 20th Century
  - Studies extended to include chronic disease, injury, and violence

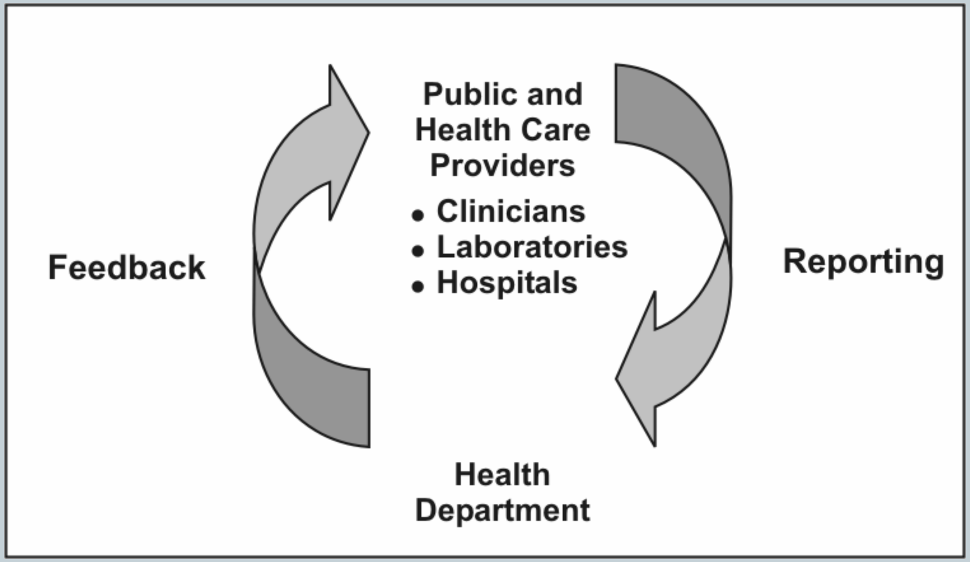
Primary Purposes of Epidemiology

- Assessing the community's health
- Identify new and emerging diseases
- Monitor and track existing diseases
- Evaluate the effectiveness of control measures

Core Epidemiological Functions

- Public health surveillance
- Field investigation
- Analytic studies
- Evaluation
- Linkages
- Policy development

Surveillance Cycle

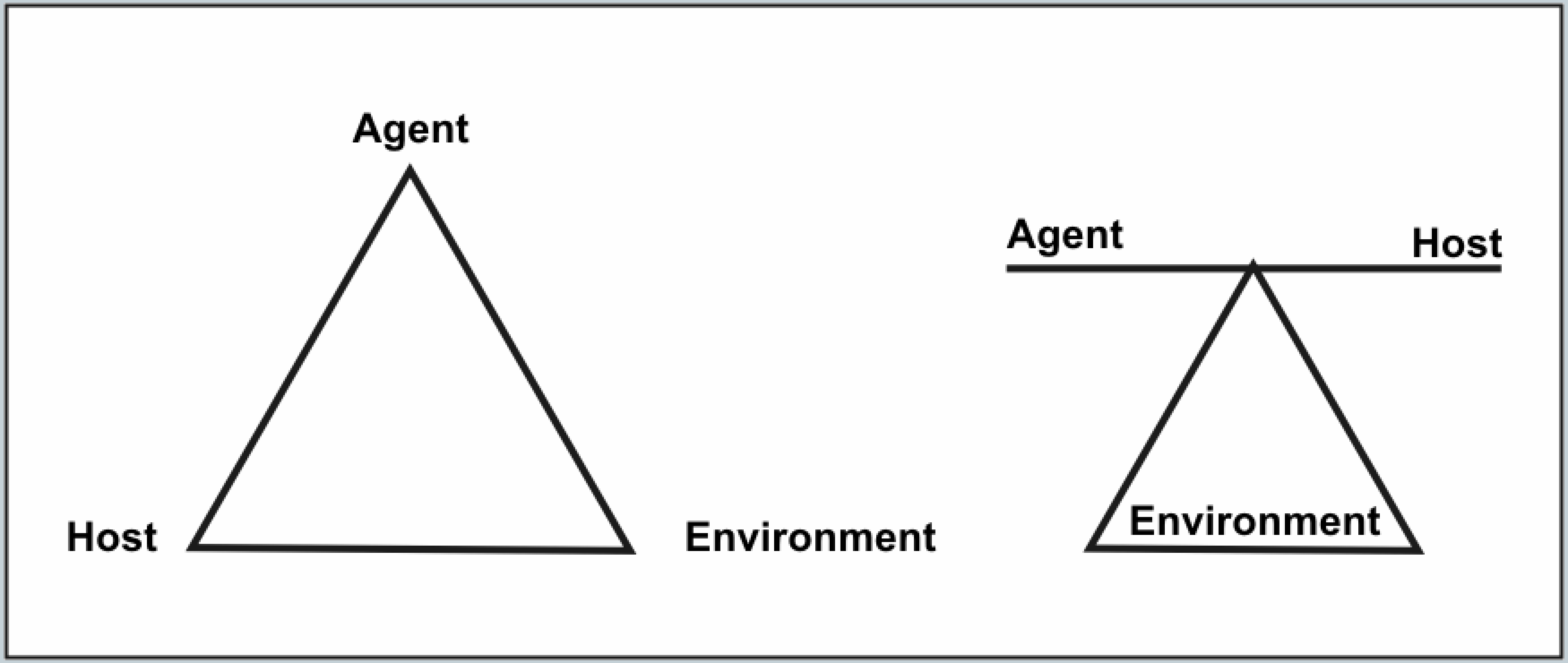


Concept Check #2

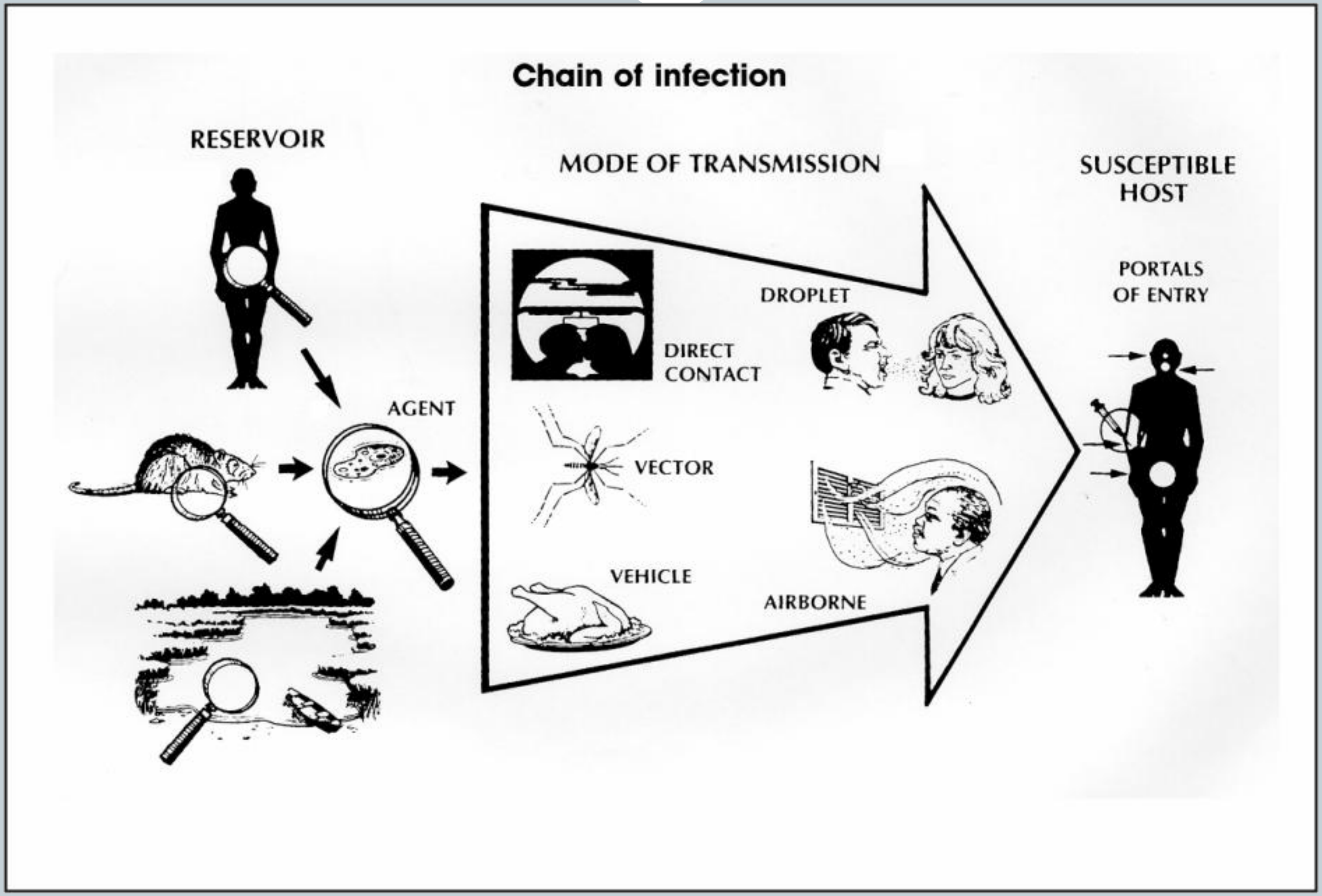
- Reviewing reports of test results for *Chlamydia trachomatis* from public health clinics
  - *A. Public health surveillance*
  - *B. Field investigation*
  - *C. Analytic studies*
  - *D. Evaluation*
  - *E. Linkages*
  - *F. Policy development*
- Conducting an analysis of patient flow at the public health clinic to determine waiting times for clinic patients
  - *A. Public health surveillance*
  - *B. Field investigation*
  - *C. Analytic studies*
  - *D. Evaluation*
  - *E. Linkages*
  - *F. Policy development*

The Epidemiological Triad

Epidemiological Triad



Chain of Infection



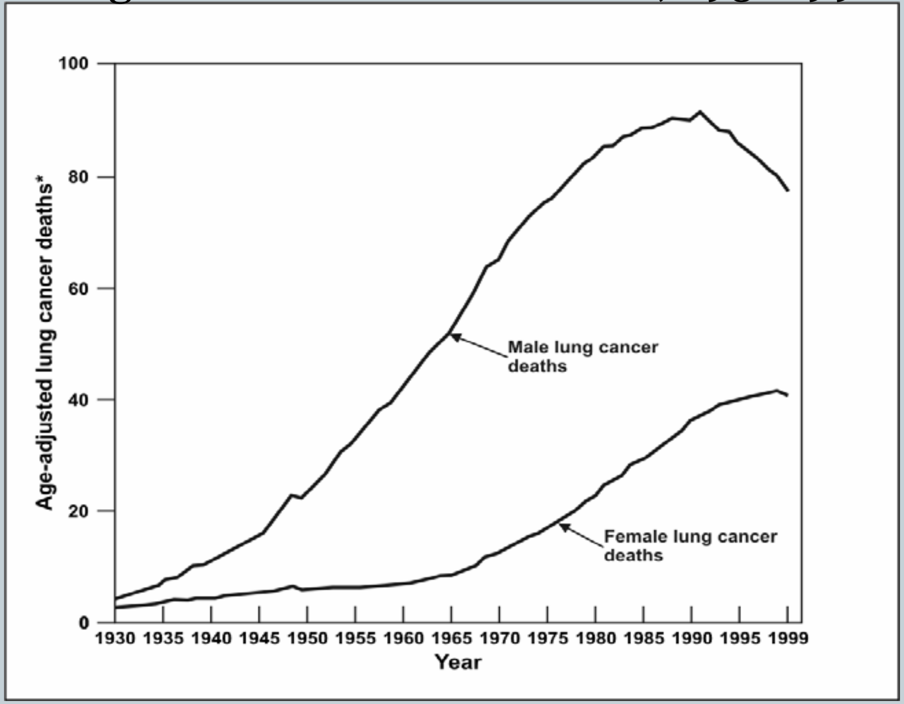
The Epidemiological Approach

- Counts
  - Health events in terms of person, place, and time
- Divides
  - The number of health events by the appropriate denominator to calculate rates
- Compares
  - Rates over time or for different groups of people

Descriptive Epidemiology

- The 5 W's
  - What= what health issue or concern
  - Who=person
  - Where=place
  - When=time
  - Why/How=causes, risk factors, modes of transmission

Lung Cancer Rates in the U.S., 1930-99



Analytic Epidemiology

- Experimental
  - Clinical trials
  - Community trials
- Observational
  - Cohort studies
  - Case-control studies
  - Cross-sectional studies

Concept Check #3

- Subjects were children enrolled in a health maintenance organization. At 2 months, each child was randomly given one of two types of a new vaccine against rotavirus infection. Parents were called by a nurse two weeks later and asked whether the children had experienced any of a list of side-effects.
  - *A. Experimental*
  - *B. Observational cohort*
  - *C. Observational case-control*
  - *D. Observational cross-sectional*
  - *E. Not an analytical or epidemiologic study*

Descriptive v. Analytical Epidemiology

Descriptive Epidemiology	Analytic Epidemiology
Search for clues	Clues available
Formulate hypotheses	Test hypotheses
No comparison group	Comparison group
Answers: How much, who, what, when, where	Answers: How, why

Prevalence

- The number of affected persons present in the population divided by the number of people in the population

$$\text{Prevalence} = \frac{\#\text{ of cases}}{\#\text{ of people in the population}}$$

Prevalence

- Useful for assessing the burden of disease within a population
- Valuable for planning
- **Not** useful for determining what caused disease

Prevalence Example

In 1999, a US state reported an estimated 253,040 residents over 20 years of age with diabetes. The US Census Bureau estimated that the 1999 population over 20 in that state was 5,008,863.

$$\text{Prevalence} = \frac{253{,}040}{5{,}008{,}863} = 0.051$$

- In 1999, the prevalence of diabetes was 5.1%
  - Can also be expressed as 51 cases per 1,000 residents over 20 years of age

Incidence

- The number of new cases of a disease that occur during a specified period of time divided by the number of persons at risk of developing the disease during that period of time

$$\text{Incidence} = \frac{\text{\# of new cases of disease over a specific period of time}}{\text{\# of persons at risk of disease over that specific period of time}}$$

Incidence

- High incidence represents diseases with high occurrence; low incidence represents diseases with low occurrence
- Can be used to help determine the causes of disease
- Can be used to determine the likelihood of developing disease

Incidence Example

A study in 2002 examined depression among persons with dementia. The study recruited 201 adults with dementia admitted to a long-term care facility. Of the 201, 91 had a prior diagnosis of depression. Over the first year, 7 adults developed depression.

$$\text{Incidence} = \frac{7}{110} = 0.064$$

- The one year incidence of depression among adults with dementia is 6.4%
  - Can also be expressed as 64 cases per 1,000 persons with dementia

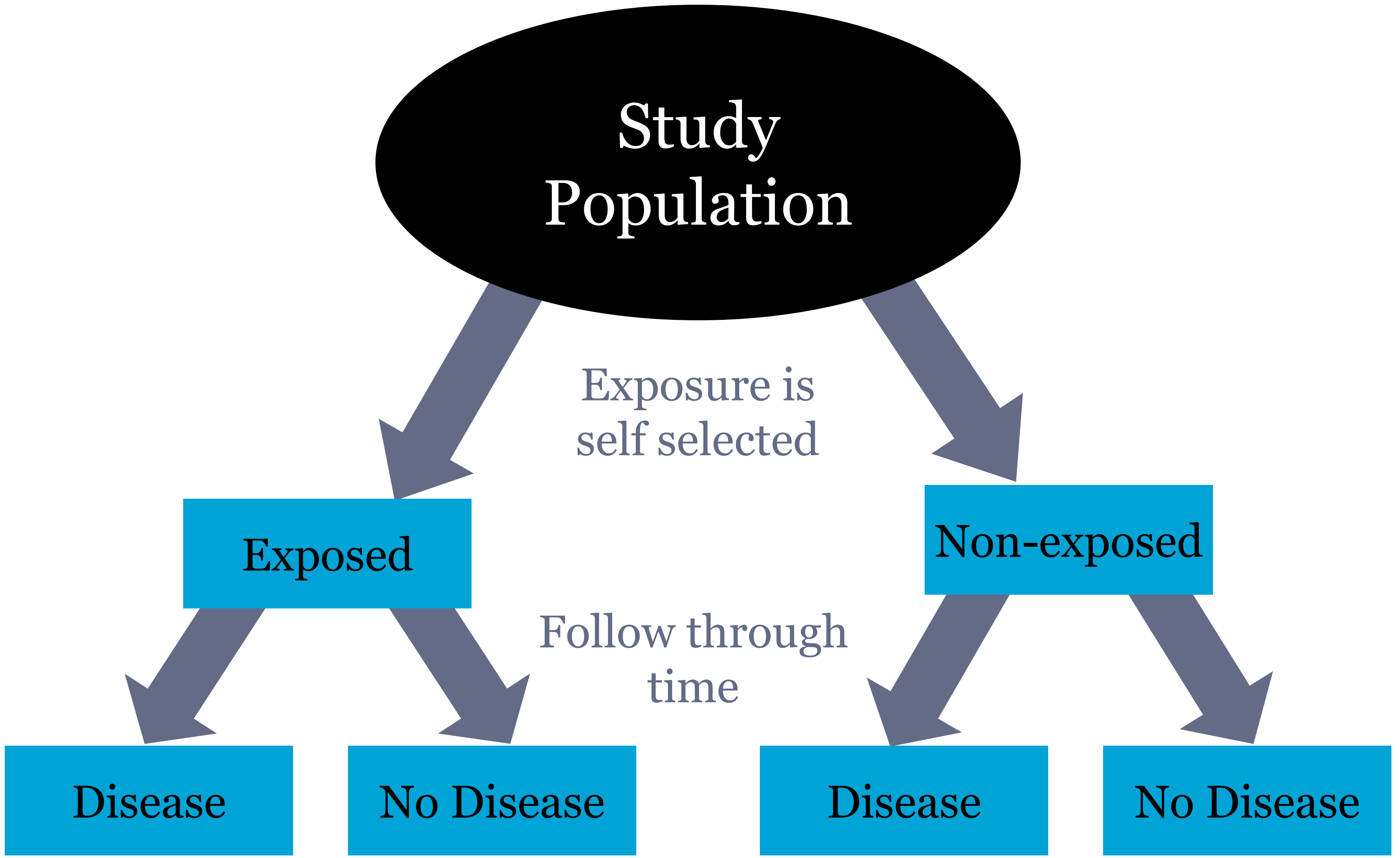
Concept Check #4

- Prevalence can be a useful measure for assisting with determining risk factors associated with a disease?
  - True
  - False

Cohort Studies

- Definition of a cohort
  - In epidemiology, “Any designated group of individuals who are followed or traced over a period of time.”
- Cohort studies
  - A cohort study analyzes an exposure / disease relationship within the entire cohort
- Cohort study types
  - Prospective
    - The Framingham Study
  - Retrospective
    - Usually used in outbreak investigations

Cohort Studies



Cohort Studies

- Preferred study design when:
  - Members of cohort are easily identifiable
  - Members of a cohort are easily accessible
  - Exposure is rare
  - There may be multiple diseases involved

Cohort Studies: Prospective v. Retrospective

	Exposure	Outcome
Prospective	Assessed at beginning of study	Followed into the future for outcome
Retrospective	Assessed at some point in the past	Outcome has already occurred

Cohort Study Example

- Recent Norovirus outbreaks on cruise ships
- Attempt to interview all passengers
- Collect food history information

Cohort Study Examples

- Shigellosis among swimmers in a Georgia park
  - Used park registry to identify park visitors

Iwamoto M, Hlady G, Jeter M et al. Shigellosis among Swimmers in a Freshwater Lake-Georgia, 2003. Presented at the 53rd Annual Epidemic Intelligence Service Conference. Atlanta, GA. April, 2004.

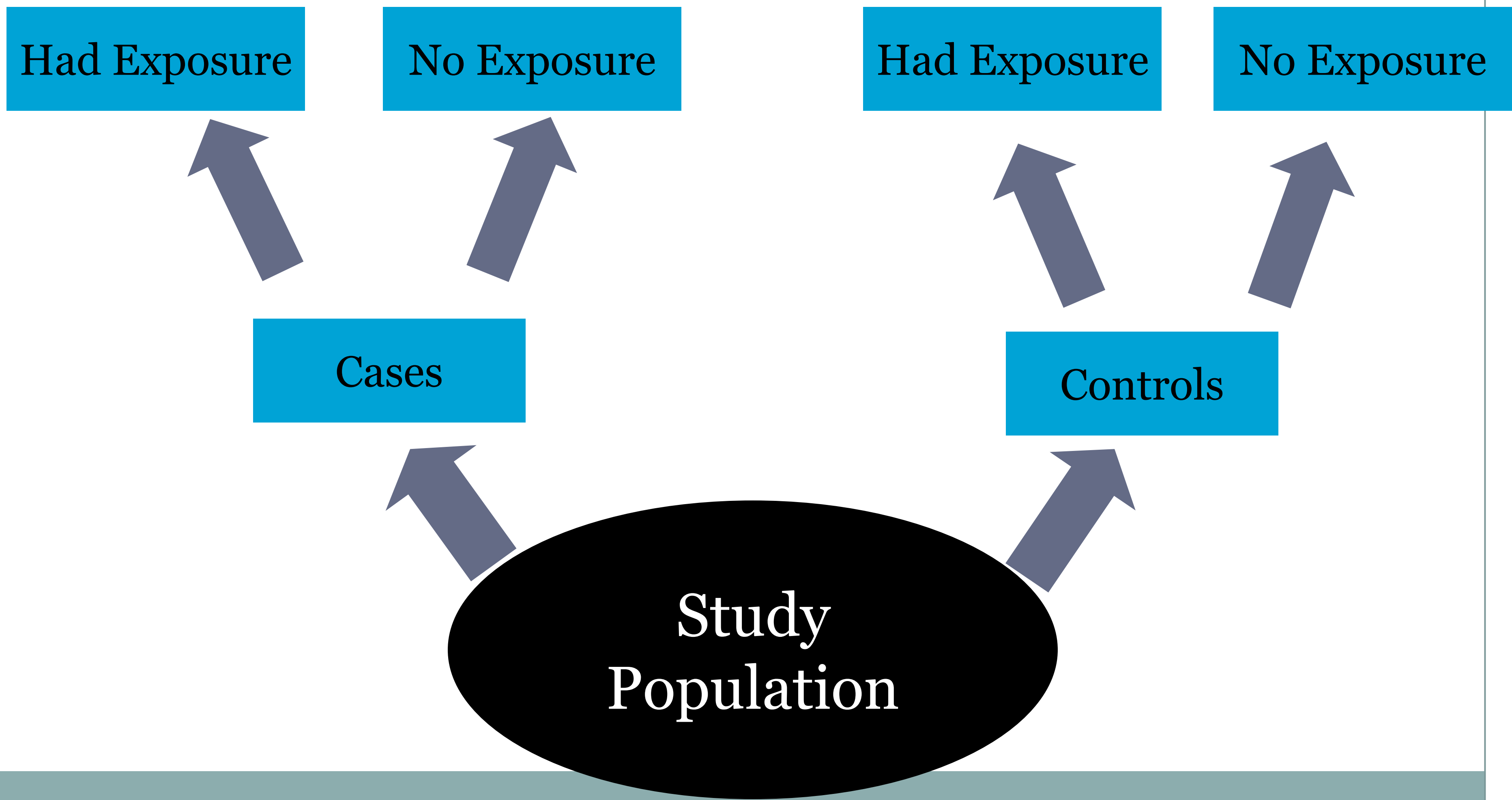
- Whirlpools and Methicillin-Resistant *Staphylococcus aureus*
  - Occurred on a college football team

Begier EM, Barrett FK, Mshar PA et al. Body Shaving, Whirlpools, and Football: An Out break of Methicillin-Resistant Staphylococcus aureus Cutaneous Infections in a College Football Team-Connecticut, 2003. Presented at the 53rd Annual Epidemic Intelligence Service Conference. Atlanta, GA. April, 2004.

Case-Control Study

- Sometimes, identifying a cohort is difficult
  - Members of cohort can’t be identified / contacted
- Case-control study is an alternative

Case-Control Studies



Case-Control Study

Steps in a Case-Control Study:

1. Identify the source population
   1. Represents the population that the cases came from; is similar to the cohort in a cohort study
2. Establish a case definition and select cases
   1. A standard set of criteria for deciding disease status clinical criteria, time, place, and person
3. Select controls
   1. Represent source population
   2. Collect same exposure information as for cases

Cohort v. Case-Control

	Cohort Study	Case-Control Study
Preferred Study Design When . . .	Members are easily identifiable Members are easily accessible Exposure is rare There may be multiple diseases involved	Identifying entire cohort would be too costly or time consuming Accessing entire cohort would be too costly or time consuming Illness is rare
Study Group	Exposed persons	Persons with illness (cases)
Comparison Group	Unexposed persons	Persons without the illness (controls)

Study Design Comparisons

Study Design	Advantages	Disadvantages
Cohort	1. Least prone to selection bias 2. Can reasonably conclude that cause preceded disease 3. Can study several diseases at once 4. Can examine rare exposures 5. Retrospective can be low-cost	1. Prospective can be expensive, time-consuming 2. Prospective can lead to loss to follow up 3. Exposed may be followed more closely than unexposed, yielding invalid conclusions about causality
Case-Control	1. Less expensive and quicker than cohort 2. Can examine the effect of multiple exposures 3. Require a smaller sample population	1. Inefficient for studying rare exposures 2. Susceptible to selection bias 3. Cannot directly estimate the risk of disease 4. Cannot study several diseases at once

Basic Outbreak Investigation Steps

1. Prepare for field work
2. Verify the diagnosis and confirm the outbreak
3. Define a case and conduct case finding
4. Tabulate and orient data: time, place, person
5. Take immediate control measures
6. Formulate and test hypotheses
7. Plan and execute additional studies
8. Implement and evaluate control measures
9. Communicate findings

Line List

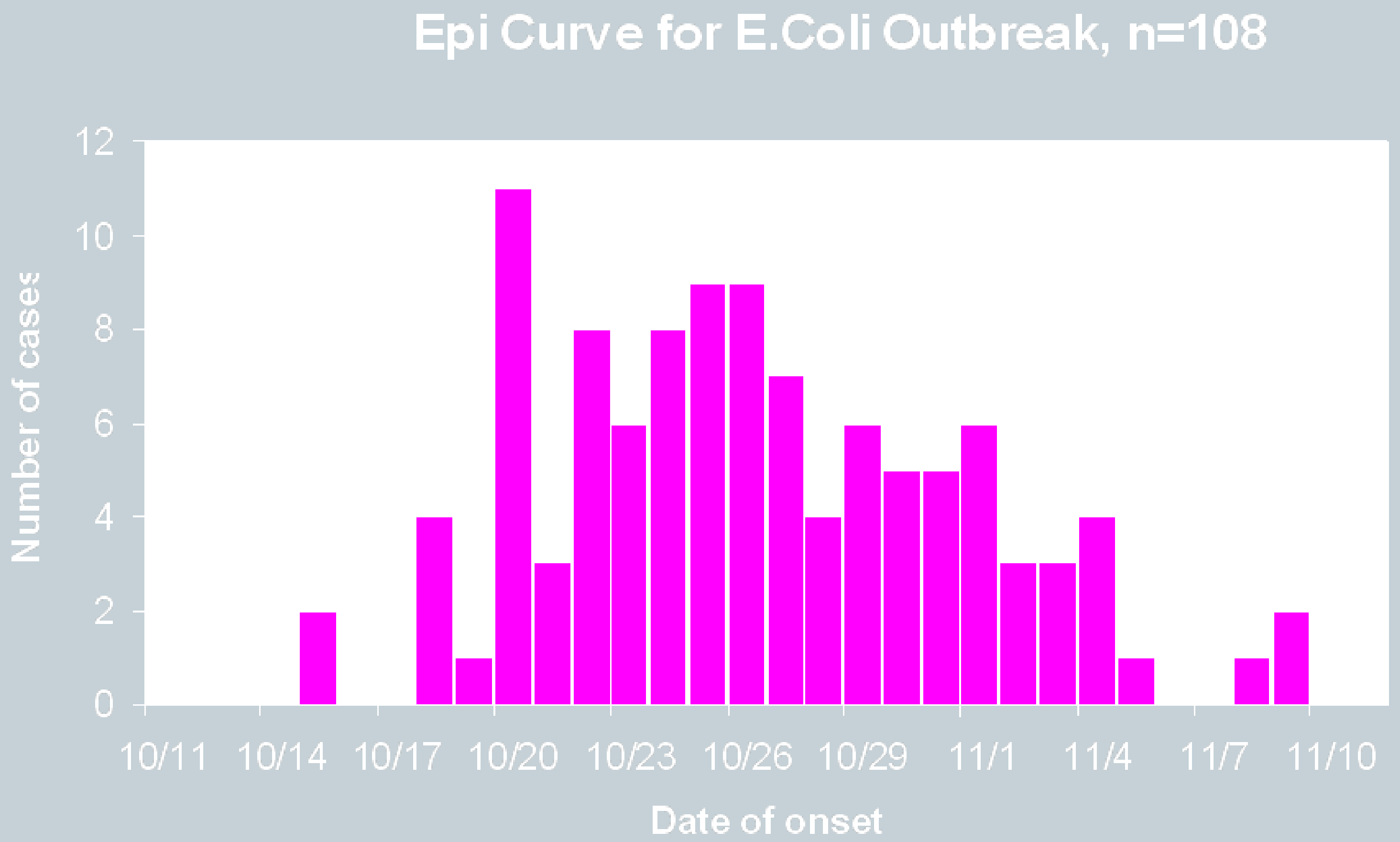
GASTROENTERITIS LINE LIST FORM

Facility Name Askance County Hospital

Contact Person J. Spence, RN Phone 555-2667

										Treatment		Lab Testing Lab Name (if testing done)						
Case initials	Sex	County	Symptom onset date	Fever Y/N/U	Vomiting Y/N/U	Diarrhea Y/N/U	Abdominal Cramps Y/N/U	Duration	Physician Seen Y/N/U	Antibiotic Y/N/U	Antidiarrheal Medication Y/N/U	Specimen Type	Collect Date	Type of test	Result	chicken	lettuce	mac. salad
BF	M	Wash.	9/10	Y	Y	Y	Y	3d	Y	N	Y	stool	9/12	cult.	+ salm.	Y	Y	N
GF	M	Askance	9/11	Y	Y	Y	N	4d	Y	Y	Y	stool	9/14	cult.	+ salm.	Y	Y	Y
TE	F	Wash.	9/10	N	Y	Y	Y	2d	N	N	N	---	--	---	---	y	y	N
LL	M	Askance	9/10	N	N	Y	N	2d	N	N	Y	--	--	--	--	Y	N	Y
MJ	F	Askance	9/10	Y	Y	Y	N	3d	y	N	Y	stool	9/13	cult.	+ salm.	y	N	N
CC	M	Askance	9/11	Y	Y	Y	Y	4d	Y	N	Y	stool	9/13	cult.	+ salm.	Y	Y	Y
PZ	F	Askance	9/10	Y	Y	Y	Y	3d	Y	N	Y	--	--	--	--	Y	Y	N
MZ	F	Troy	9/10	Y	Y	Y	N	5d	Y	Y	Y	blood	9/11	cult.	+ salm.	Y	Y	Y
SK	M	Wash.	9/9	y	y	y	Y	3d	y	N	Y	stool	9/1	cult.	+ salm.	y	N	Y

Epidemic Curve



Attack Rates

AR

$$\frac{\text{\# of cases of a disease}}{\text{\# of people at risk (for a limited period of time)}}$$

Food-specific AR

$$\frac{\text{\# people who ate a food and became ill}}{\text{\# of people who ate that food}}$$

Food Specific Attack Rates

	Consumed Item			Did Not Consume Item		
Item	Ill	Total	AR(%)	Ill	Total	AR(%)
Chicken	12	46	26	17	29	59
Cake	26	43	61	20	32	63
Water	10	24	42	33	51	65
Green Salad	42	54	78	3	21	14
Asparagus	4	6	67	42	69	61

Measures of Association

- Assess the strength of an association between an exposure and the outcome of interest

- Two widely used measures:
  - Risk ratio (a.k.a. relative risk, RR)
    - Used with cohort studies
  - Odds ratio (a.k.a. OR)
    - Used with case-control studies

2x2 Tables

- Used to summarize counts of disease and exposure in order to do calculations of association

	Outcome		
Exposure	Yes	No	Total
Yes	*a*	*b*	*a* + *b*
No	*c*	*d*	*c* + *d*
Total	*a* + *c*	*b* + *d*	*a* + *b* + *c* + *d*

2x2 Tables

a = number who are exposed and have the outcome
b = number who are exposed and do not have the outcome
c = number who are not exposed and have the outcome
d = number who are not exposed and do not have the outcome

	Outcome		
Exposure	Yes	No	Total
Yes	*a*	*b*	*a* + *b*
No	*c*	*d*	*c* + *d*
Total	*a* + *c*	*b* + *d*	*a* + *b* + *c* + *d*

2x2 Tables

$a + b$ = total number who are exposed
$c + d$ = total number who are not exposed
$a + c$ = total number who have the outcome
$b + d$ = total number who do not have the outcome
$a + b + c + d$ = total study population

	Outcome		
Exposure	Yes	No	Total
Yes	a	b	$a + b$
No	c	d	$c + d$
Total	$a + c$	$b + d$	$a + b + c + d$

Risk Ratio

	Ill	Not Ill	Total
Exposed	A	B	A+B
Unexposed	C	D	C+D
Risk Ratio	$\frac{[A/(A+B)]}{[C/(C+D)]}$		

Interpreting a Risk Ratio

- RR=1.0 = no association between exposure and disease
- RR>1.0 = positive association
- RR<1.0 = negative association / protective effect

Risk Ratio Example

	Ill	Well	Total
Ate alfalfa sprouts	43	11	54
Did not eat alfalfa sprouts	3	18	21
Total	46	29	75

RR = (43 / 54) / (3 / 21) = **5.6**

Odds Ratio

	Cases	Controls
Exposed	A	B
Unexposed	C	D
Odds Ratio	(A/C)/(B/D)=(A*D)/(B*C)	

Interpreting an Odds Ratio

The odds ratio is interpreted in the same way as a risk ratio:

- OR=1.0 = no association between exposure and disease
- OR>1.0 = positive association
- OR<1.0 = negative association

Odds Ratio Example

	Case	Control	Total
Ate at restaurant X	60	25	85
Did not eat at restaurant X	18	55	73
Total	78	80	158

OR = (60 / 18) / (25 / 55) = **7.3**

Summary

- Outbreaks occur frequently
- Outbreaks are almost always unexpected events
  - Systematic investigation is crucial
  - Preparation is key

Questions??

Contact Information:

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