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Epidemiology I

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Do.
Make.
Heal.
Innovate.
Reinvent the Future.

Session Objectives

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1. Students will be able to define basic epidemiological terms as described in lecture following that lecture
2. Students will be able to evaluate which epidemiological study designs should be used in a given circumstance as described in lecture following that lecture
3. Students will be able to calculate basic epidemiological measures for a given circumstance as described in lecture following that lecture
4. Students will be able to defend their epidemiological calculations as described in lecture following that lecture
5. Students will be able to interpret basic epidemiological results as described in lecture following that lecture

Summary Slide

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- Epidemiology is the study of the patterns, causes, and effects of health and disease conditions in defined populations.
- There are several measures you must know that help define the epidemiology of any given disease.

Core Reference:

(Gordis, Epidemiology) 7th Edition

by Leon Gordis MD MPH DrPH

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Let's Start With a Seemingly Simple Question….

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"Five different people have told me today that their allergies are out of control. Is something going on with the air???"

Count

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- The simplest and most frequently performed quantitative measure in epidemiology.
- Refers to the number of cases of a disease or other health phenomenon being studied.
- Significant for rare diseases or symptom presentations (e.g., case of Ebola virus).

(Gordis, Epidemiology) 7th Edition by Leon Gordis MD MPH DrPH, Chapters 2 and 3

Rate

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- Definition: a ratio that consists of a numerator and a denominator and in which time forms part of the denominator.
- Contains the following elements:
  - disease frequency
  - unit size of population
  - time period during which an event occurs

(Gordis, Epidemiology) 7th Edition by Leon Gordis MD MPH DrPH, Chapters 2 and 3

Incidence Rate

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- Number of new cases of a disease that occur during a specified period of time in a population at risk for developing the disease.
- Can be multiplied by 1,000 so that we can express the incidence per 1,000 persons.
- Defining incidence rate is *NEW* cases of disease.
- The incidence rate is a measure of risk.
- Denominator of **incidence rate**: number of people who are at risk for developing the disease.
  - if we are calculating incidence of uterine cancer, the denominator must include only women, and they should not have had a hysterectomy

(Gordis, Epidemiology) 7th Edition by Leon Gordis MD MPH DrPH, Chapter 3

Incidence Rate Calculation

Incidence rate =

$$\frac{\text{Number of new cases over a time period}}{\text{Total population at risk during the same time period}} \times \text{multiplier (e.g., 100,000)}$$

Number of new cases = 1,085
Population at risk = 37,105

$$\text{Incidence rate} = \frac{1{,}085}{37{,}105} = 0.02924$$

= 292.4 cases per 10,000 women per year

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Prevalence rate

- Number of affected persons present in the population at a specific time divided by the number of persons in the population at that time
- That is, what proportion of the population is affected by the disease at that time?

(Gordis, Epidemiology) 7th Edition by Leon Gordis MD MPH DrPH, Chapters 3

Interpretation of Prevalence

Provides an indication of the extent of a health problem.

Example 1: Prevalence of diarrhea in a children's camp on July 13 was 33% (point prevalence)
Example 2: Prevalence of cancer in women during a specified time period (period prevalence)

Relationship Between Incidence and Prevalence

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Prevalence=

Incidence X Duration of Disease

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Which type of rate is a measure of risk of getting a disease?

The incidence rate – since this is what measures the rate of *new* cases. Prevalence rate measures existing cases

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Person years

- A useful way of expressing rates is by using person-years in the denominator- that is the number of years contributed by each individual.
- Problem in using person-years: each person-year is assumed to be equivalent to every other person-year

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Some difficulties:

One person at risk who is observed for one year = one person-year.

One person at risk observed for 5 years = 5 person-years.

But 5 people at risk, each of whom is observed for only 1 year, also = 5 person-years.

And 5 years from 1 person isn't actually the same as one year from 5 separate people

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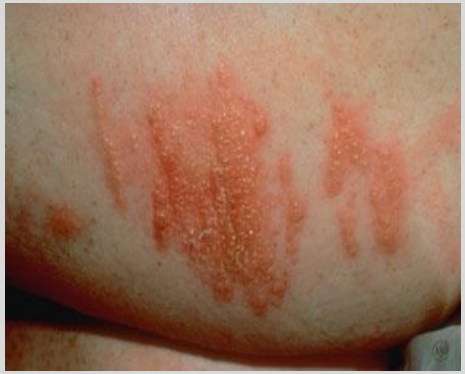
FICTIONAL CASE

You are a first-year emergency medicine resident in Los Angeles and your attending has asked you to help her investigate the behavior of a new illness and assist with public health solutions to this disease.



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This is what you already know:

The new illness causes high fevers, headaches, seizures, and in many cases, death. The illness is unique in that it also presents with a blistering, red, raised rash that often appears in streaks.

Most cases first present in the emergency room, as the disease progresses rapidly once the initial symptoms appear.

There is some suspicion that this illness originates from Senegal, as many of the individuals seen with the disease have visited the country.

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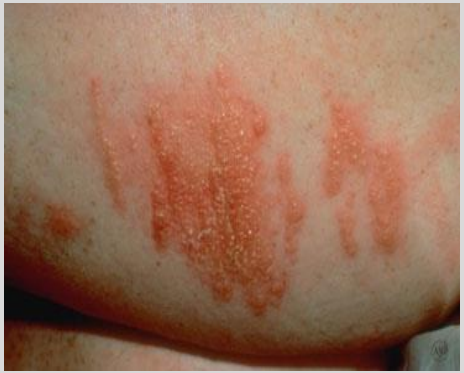

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You start to gather information

You learn that there are no estimates available for the incidence rate of the disease, but the disease specific mortality rate in the population due to this disease is thought to be 2 per 1000 people. The disease is considered severe and lethal, and reportedly people die shortly after diagnosis.

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Can you estimate the incidence rate?

Can you estimate the incidence rate?

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- Mortality rates serve as measures of disease severity
- Helps us to determine whether the treatment for a disease has become more effective over time.
- Mortality rates may serve as surrogates for incidence rates when the disease being studied is a severe and lethal one.

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CASE-FATALITY RATE

- Number of people who die of a disease divided by the number of people who have the disease.
- Given a person has disease, what is the likelihood that he or she will die of the disease?
- Time is expressed implicitly

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Can you estimate the incidence rate?

2/1000

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Upon investigating further, you realize that the mortality rate people are quoting may not be entirely accurate. While there has been an attempt to calculate an actual incidence rate, it has been complicated by an inability to keep track of all of the people in the LA population-some people moved or were lost to follow-up.

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Is there an alternate way of calculating incidence rate when the number of people who were at risk for the disease were not all followed for the same period of time?

Person-years

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What if a cure is quickly developed for this disease, aka the disease no longer exists in the person. Now what would happen to prevalence?

What if a treatment is quickly developed for this disease, aka the disease no longer deadly. Now what would happen to prevalence?

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What if a cure is quickly developed for this disease, aka the disease no longer exists in the person. Now what would happen to prevalence?

Prevalence decreases

What if a treatment is quickly developed for this disease, aka the disease no longer deadly. Now what would happen to prevalence?

Prevalence increases

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What can lower prevalence?

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Either death or cure

These two outcomes represent a major difference to a patient, but with regard to prevalence, cure and death have the same effect: they reduce the number of diseased persons in the population and thus lower prevalence.

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Does an increase in prevalence mean the problem is getting worse?

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No! For example …..

When insulin first became available, the prevalence of diabetes increased. The disease was not cured, but was only controlled. Many patients with diabetes who formerly would have died now survived; therefore, the prevalence increased.

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Upon studying what you can about this disease, you learn that this disease has always been present in small amounts in Senegal. There appears to be no increase in disease rates at this time.

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Endemic, Epidemic, Pandemic

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- **Endemic**
  - Habitual presence of a disease within a given geographical area.
  - Usual occurrence of a group of illnesses within such an area.
- **Epidemic**
  - Occurrence in a community or region of group of illnesses of a similar nature clearly in excess of normal expectancy and derived from a common or propagated source.
- **Pandemic**- worldwide epidemic

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In the USA, given that there was no presence of the disease until recently, the disease rate is considered grossly in excess of what is considered normal.

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You also learn that the disease has now shown up in excess rates in Japan, parts of South America, France and England and people are rapidly dying from the disease.

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Someone points out to you that you cannot compare mortality rates between two countries as they have completely different demographics.

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Crude Rates

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- A simple calculation performed with no consideration of additional factors.
- Use crude rates with caution when comparing disease frequencies between populations.
- Observed differences in crude rates may be the result of systematic factors (e.g., gender or age distributions) within the population rather than true variation in rates.

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Specific Rates

Specific rates refer to a particular subgroup of the population defined in terms of race, age, gender, or single cause of death or illness.

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Adjustment for Demographic Factors

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- Standard population is used mathematically adjust rates
- Purpose is to eliminate the effects of any differences in age or other factors between two or more populations
- When numbers of deaths for each demographic-specific stratum are not available, indirect methods can be used.
- Eliminates any possibility that observed differences could be a result of differences in the population.

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Let's Shift Now to Thinking About Disease Prevention

Disease Prevention

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- Primary Prevention- Preventing the initial development of the disease
- Secondary Prevention- Early detection of an existing disease to reduce severity and complications
- Tertiary Prevention- Reducing the impact of a disease.

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What kind of prevention is vaccination?

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What kind of prevention is vaccination?

Primary Prevention

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If you were considering introducing a vaccine for this disease for those traveling to Senegal, what are the different things you would have to consider about the biology of the disease?

What would you have to consider about the behaviors of people who would be offered the vaccine?

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The Biology of the Disease

- Have you isolated the pathogen?
- Is it a bacteria, virus, fungus or another agent?
- If it is a virus, is it DNA or RNA based?
- Do you know the genetic sequence?
- Does it have a high mutation rate?

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Herd Immunity

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- May not be important to vaccinate 100% of people
- A group of people can become resistant to an attack by a disease in which a large proportion of the members are immune- even those individuals who were not vaccinated will be immune. This is because transmission as a whole is reduced!!!

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Upon questioning several emergency rooms in the LA area, as well as several primary care clinics, you learn that there have been some individuals who appeared to become ill shortly after visiting Senegal, while others become sick several months after living in Senegal.

Why might this be?

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Incubation Period

- Interval from receipt of infection to onset of clinical illness
- How long should a person be in isolation after exposure to disease?

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Screening

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- Definition: Presumptive identification of an unrecognized disease or defect by the application of tests, examinations, or other procedures. Screening classifies asymptomatic people as likely or unlikely to have a disease or defect. It is usually not diagnostic.
- Purpose: To delay the onset of symptomatic or clinical disease, or to improve survival.

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Screening

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- Seems simple but is complex. There are hidden costs and risks. Screening can create morbidity and anxiety. Must be aware of biases.
- For screening to be successful you need a:
  - Suitable disease
  - Suitable test
  - Suitable screening program

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Screening

- First you classify people as “diseased” or “healthy” using a diagnostic test. Remember- a screening test is generally NOT diagnostic
- You then administer the screening test and classify people as “screen positive” or “screen negative.”

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		Gold Standard- Diagnostic Test		
		Present	Absent	Total
Screening Test Result	Positive	A True Positive (TP)	B False Positive (FP)	a + b
	Negative	C False Negative (FN)	D True Negative (TN)	c + d
	Total	a + c	b + d	

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Measures of the Validity of Screening Tests

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- *Sensitivity*--the ability of the test to identify correctly all screened individuals who actually have the disease. TP/(TP+FN) or (a/a+c).

- *Specificity*--the ability of the test to identify only non-diseased individuals who actually do not have the disease. TN/(TN+FP) or (d/b+d).

		Gold Standard-Diagnostic Test		
		Present	Absent	Total
Screening Test Result	Positive	A True Positive (TP)	B False Positive (FP)	a + b
	Negative	C False Negative (FN)	D True Negative (TN)	c + d
	Total	a + c	b + d	

Predictive Value

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- *Predictive value (+)*--the proportion of individuals screened positive by the test who actually have the disease. TP/(TP+FP) or (a/a+b).

- *Predictive value (-)*--the proportion of individuals screened negative by the test who *do not* have the disease. TN/(TN+FN) or (d/c+d).

		Gold Standard-Diagnostic Test		
		Present	Absent	Total
Screening Test Result	Positive	A True Positive (TP)	B False Positive (FP)	a + b
	Negative	C False Negative (FN)	D True Negative (TN)	c + d
	Total	a + c	b + d	

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Reliability

The ability of a measuring instrument to give consistent results on repeated trials.

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A screening test that is reliable is not necessarily also valid.

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You develop a screening test with 80% sensitivity. What does this mean?

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You develop a screening test with 80% sensitivity. What does this mean?

80% sensitivity means that of all of the people with a disease, you are correctly identifying 80% of them using your screening test.

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The screening test you have developed has 90% specificity. What does this mean?

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The screening test you have developed has 90% specificity. What does this mean?

90% specificity means that of all of the healthy people without a disease, you are correctly identifying 90% as being healthy using your screening test.

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Back to our case… The next time you see a patient in clinic with this disease, you mention that you have a screening test that may be useful for the other family members who recently traveled to Senegal, and the test is both sensitive and specific, but your patient and their family tell you they really don't understand what you are talking about. They want to know if they test positive on the screening test, what the probability will be that they actually have the disease.

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Back to our case… The next time you see a patient in clinic with this disease, you mention that you have a screening test that may be useful for the other family members who recently traveled to Senegal, and the test is both sensitive and specific, but your patient and their family tell you they really don't understand what you are talking about. They want to know if they test positive on the screening test, what the probability will be that they actually have the disease.

YOU CAN TELL THEM ABOUT POSITIVE PREDICTIVE VALUE!

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SURVIVAL

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- A common question is- "What is the probability that, having survived the first year after beginning treatment, the patient will survive the second year?"
- "Given that a person has survived to the end of the second year, what is the probability that he or she will survive to the end of the third year?”
- Now we can answer the question, "If a person is enrolled in the study, what is the probability that he or she will survive 5 years after beginning treatment?" The probability of surviving for 5 years is the product of each of the probabilities of surviving each year
- These calculations can be presented graphically in a survival curve
- There are multiple methods to make these curves. One of the most common is the Kaplan Meier curve.

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Lead-time Bias

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-When exactly where the groups you are comparing first diagnosed? Did they have different protocols for their diagnoses?

-People who were diagnosed earlier with a disease due to screening don't necessarily have better survival than those who weren't screened. Those who were screened may have just gotten their official documented diagnosis earlier, making it look like they had longer survival.

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Length Bias

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-Screening could selectively identify cases of the disease which have a better prognosis.

-Specifically, severe disease may result in early death (shorter disease length) and these individuals may never even make it to screening, whereas those with milder disease will be around long enough (longer length) to actually have screening.

-This may make it look like screening lead to survival, but in actuality, milder disease was what led to better survival.

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This concludes this epidemiology session. Please make certain you understand all of the listed objectives.

Lecture and Lab Feedback Form:

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