Sensitivity and Specificity

After completing this unit, students should be able to:

- Define sensitivity and specificity.
- Use information on sensitivity, specificity, and prevalence to calculate the probability of having a condition given a positive test for it.
Before Class

• Read the March 26, 2020 article "A ‘negative’ coronavirus test result doesn’t always mean you aren’t infected” from the Washington post. https://www.washingtonpost.com/science/2020/03/26/negative-coronavirus-test-result-doesnt-always-mean-you-arent-infected/

• Answer the questions
  1. Match the terms to their definitions.
     A. A test result that says you have the disease, even though you don’t.
     B. A test result that says you do not have the disease, even though you do.
     C. A test result that says you have the disease, when you do have the disease.
     D. A test result that says you do not have the disease, when you do not have it.
       (i) True positive
       (ii) True negative
       (iii) False positive
       (iv) False negative
  2. The article states that “A critical-care blog, EMCrit, estimated that the genetic tests [for covid-19] are about 75 percent sensitive.” What does this mean?
(a) That means that for someone who has the virus, there’s a 75 percent chance they test positive and 25 percent chance they test negative.

(b) That means that for someone who has the virus, there’s a 25 percent chance they test positive and 75 percent chance they test negative.

(c) That means that for someone who does NOT have the virus, there’s a 75 percent chance they test positive and 25 percent chance they test negative.

(d) That means that for someone who does NOT have the virus, there’s a 25 percent chance they test positive and 75 percent chance they test negative.
Definitions

Suppose a diagnostic test is performed on 550 people, with the following results.

<table>
<thead>
<tr>
<th></th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
</tr>
<tr>
<td>Disease Status: Positive</td>
<td>120</td>
</tr>
<tr>
<td>Disease Status: Negative</td>
<td>40</td>
</tr>
</tbody>
</table>

Which box represents
- true positives?
- false positives?
- true negatives?
- false negatives?

What is the sensitivity of the test?

What is the specificity of the test?
HIV testing

The standard test for the HIV virus is the enzyme-linked immunosorbent assay (ELISA), also known as the EIA (enzyme immunoassay), that tests for the presence of HIV antibodies in the blood. According the U.S. Preventative Services Task Force’s 2005 report, “A large study of HIV testing in 752 U.S. laboratories reported a sensitivity of 99.7% and specificity of 98.5% for enzyme immunoassay.”

If a person tests positive on the ELISA test, a confirmatory test, called the Western blot test, is carried out. If this is positive, the person is assumed to have the HIV virus.

We will focus on the ELISA test.

• A sensitivity of 99.7% means that for every 1000 people tested who...

• The specificity of 98.5% means that for every 1000 people tested who ...

• The Center for Disease Control estimates that 1.1 million people in the US are infected with HIV (as of 2016).
Assume that a large group of people in the US are tested using the ELISA test. If a person tests positive, what is the chance that this person has the HIV virus?

First, make a guess on PollEv.

A. 20%
B. 40%
C. 60%
D. 80%
E. 95%

Now, diagram out what would happen in a large group of, say, 100,000 people in the US.
The Washington Post article in the before class assignment gave two estimates for specificity for covid-19 tests: 85% to 75%. Let’s use the 85% figure.

Suppose a person with known exposure to covid-19 takes the test? Let’s pretend that the probability of infection given known exposure is 50%. If this person tests positive, what is the chance they have the disease? What if they test negative?
Homework

1. In class, based on the ELISA test’s sensitivity of 99.7% and specificity of 98.5%, and the prevalence of HIV of 1.1 million out of 327.2 million, we found that the probability of having HIV if you test positive is only about 18%. How does your answer change if you are testing a group of people at high risk, such as incarcerated adults? About 1.5% of incarcerated adults are estimated to be infected with HIV. Reference: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3682655/

2. Suppose we assume that 5% of people are drug-users. A test is 95% accurate, by which we mean that it is 95% sensitive and 95% specific.

(a) A randomly chosen person tests positive. What is the chance that the person is a drug user?

(b) A randomly chosen person tests negative. What is the chance that the person is a drug user?