False Positives & False Negatives

Case Study: Home Pregnancy Tests

The Given Data

- Home pregnancy tests often report 99% accuracy.

- To compute accuracy, divide the total no. of women who got a correct result (pregnant or not pregnant) by the total (n) who participated in the trial of this pregnancy test.

How to Interpret 99% Accuracy

- Make a table of the possible outcomes of a clinical trial for this pregnancy test.

- The manufacturer often does not give any more info than the 99% number (why?).

- Make some reasonable assumptions to proceed with your analysis.

Make Simplifying Assumptions

- You can use any number for the sample size n (e.g., let $n = 1000$)

- At 99% accuracy, 990 women got the correct result (why? → 990 = 0.99 x 1000)

- Assume there were 50 pregnant women who got the correct result, and 5 who did not

- Assume there were 94 non-pregnant women who got the correct result (900 = 990 – 50), and 5 who did not

A Note on the Assumptions

- A 55 to 945 split between pregnant and non-pregnant women may seem extreme

- However, this split follows the national average

- At any given time, only 5-6% of women (age 15-45) are pregnant

- Source: *Statistical Abstract of the United States*, year 2000, table 92

1000 Pregnant Women Tested

	Positive Test Result	Negative Test Result
Pregnant	50 (assumed)	
Not Pregnant		940 (assumed)

1000 Pregnant Women Tested

	Positive Test Result	Negative Test Result
Pregnant	50	5 (*false negative*)
Not Pregnant	5 (*false positive*)	940

The Question

For a woman who does not know if she is pregnant and uses this test, what is the probability that she gets

1) a false positive?

2) a false negative?

Use Conditional Probability

Re-phrase these questions using conditional probability as studied in your textbook:

1) Given that she got a positive result, what is the probability she is actually not pregnant? (i.e., got a *false positive*)

2) Given that she got a negative result, what is the probability she is actually pregnant? (i.e., got a *false negative*)

Probability of False Positive

	Positive Test Result	Negative Test Result
Pregnant	50	5 (*false negative*)
Not Pregnant	5 (*false positive*)	940

P (not pregnant | positive test) = 5/55 ≈ 9.1%

Probability of a False Negative

○ Try computing this probability on your own

○ Hint: the answer is very small, i.e., less than 5%

Interpretation

- *We assumed the manufacturer's claim of 99% accuracy is true.*

- *But a woman may have less than 99% chance of avoiding a false result.*

- *In fact, she only has about a 91% of being pregnant with a positive result.*

- *In other words, she has a reasonable chance (i.e., 9% > 5%) that the test may be wrong.*

Actual Clinical Data

- Let's re-do this analysis with an actual clinical trial of 109 women of a home pregnancy test

- Compare the accuracy of these test results with the claimed accuracy of most manufacturers

- Source: *Accuracy of Consumer Performed In-Home Tests for Early Pregnancy Detection* by Mary Doshi, American Journal of Public Health, May 1986, Vol.76, No.5

The Clinical Test Results

- 109 women were randomly chosen among those who suspected they were pregnant:

  - 66 were pregnant
  - 43 were not pregnant

- All 109 women took the pregnancy test using only the directions in the kit (no help from doctors, nurses, etc.)

The Clinical Test Results (cont'd.)

○ The researchers reported these results for women getting the correct response:

- Sensitivity ≈ 82%
- Specificity ≈ 64%

○ Note:

- Sensitivity = P(positive test result | pregnant)
- Specificity = P(negative test result | not pregnant)

Complete This Table

Use the clinical data results from the previous two slides.

	Positive Test Result	Negative Test Result
Pregnant		(*false negative*)
Not Pregnant	(*false positive*)	

Analyze Clinical Results

1) What is the probability of a false positive?

2) What is the probability of a false negative?

3) What is the overall percent accuracy?

Interpret Clinical Results

4) With your computations in hand, how would you evaluate the claim of 99% accuracy?

5) Why are the results from the clinical trial so different from the claimed results?

(Hint: pregnancy tests give best accuracy when done 15-20 days after menses is missed.)