Test Measurements

Computer Skills for Medical Students
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Sick or Healthy

- Sick
- Has the Disease
- Abnormal
- Yes
- Positive

- Healthy
- Doesn’t Have the Disease
- Normal
- No
- Negative

Medical Screening

Application of a relatively simple, inexpensive test or procedure to a large number of apparently asymptomatic persons, in order to classify them as likely (high probability) or unlikely (low probability) to have the disease.

Screening tests vs Diagnostic tests

The primary purpose of **screening tests** is to detect early disease or risk factors for disease in large numbers of apparently healthy individuals.

The purpose of a **diagnostic test** is to establish the presence (or absence) of disease as a basis for treatment decisions in symptomatic or screen positive individuals.

Medical Screening and Diagnostic tests

	Screening tests	Diagnostic tests
Purpose	Done to those who are apparently healthy or asymptomatic	Done to those with suggestive signs or symptoms
Target population	Large numbers of asymptomatic, but potentially at risk individuals	Symptomatic individuals to establish diagnosis, or asymptomatic individuals with a positive screening test
Cost	Cheap, benefits should justify the costs since large numbers of people will need to be screened to identify a small number of potential cases	Higher costs associated with diagnostic test maybe justified to establish diagnosis.
Diagnosis results	Results are not conclusive	Results are conclusive and final

Medical Screening and Diagnostic tests

Screening tests	Diagnostic tests
Less accurate	More accurate
Less expensive	More expensive
Not a basis for treatment	Basis for treatment

Tests Validity

The validity of the test refers to the extent to which the test is capable of correctly diagnose the presence or absence of the disease.

Tests Validity

Validity is measured by :

- Accuracy .
- Sensitivity.
- Specificity.
- Negative Predictive Value.
- Positive Predictive Value.

True Positive (TP)

Number of cases where the patient tests positive on a disease when he/she actually has the disease.

Disease Present	Test Positive

Example :

If the patient "has an allergy " and the test is positive.

False Positive (FP)

Number of cases where the patient tests positive on a disease when he/she actually does not have the disease.

Disease Absent	Test Positive

Example :

If the patient "doesn't have an allergy " and the test is Positive.

True Negative (TN)

Number of cases where the patient tests negative on a disease when he/she actually does not have the disease.

Disease Absent	Test Negative

Example :

If the patient "doesn't have an allergy " and the test is Negative.

False Negative (FN)

Number of cases where the patient tests negative on a disease when he/she actually has the disease.

Disease Present	Test Negative

Example :

If the patient "has an allergy " and the test is Negative.

Ground Truth and Gold Standard

Gold Standard : refers to a diagnostic method with the best accuracy.

also it refers to the best performing test available .

For example :

MRI is the gold standard for brain tumor diagnosis, though it is not as good as a biopsy.

Ground Truth represents the reference values used as standard for comparison purposes.

Accuracy

The proportion of the success rate of a given test.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

Sensitivity

A measure of the test ability to identify correctly those who have the disease from all individuals with the disease.

$$Sensitivity = \frac{TP}{TP + FN}$$

Sensitivity

A test with 100% sensitivity correctly identifies all patients with the disease.

A test with 80% sensitivity detects 80% of patients with the disease (true positives) but 20% with the disease go undetected (false negatives).

A high sensitivity is clearly important where the test is used to identify a serious but treatable disease (e.g. cervical cancer).

Specificity

A measure of the test ability to identify correctly those who don't have the disease from all individuals free from the disease.

$$Specificity = \frac{TN}{TN + FP}$$

Specificity

A test with 100% specificity correctly identifies all normal patients.

A test with 80% specificity correctly reports 80% of normal patients as test negative (true negatives) but 20% normal patients are incorrectly identified as abnormal (false positives).

Positive Predictive Value (PPV)

It is the proportion of patients who actually have the disease with positive test results . By computing PPV we see how many of test positives are true positives .

$$PPV = \frac{TP}{TP + FP}$$

High value of PPV for a test indicates that when a test gives a positive outcome, it is more likely correct.

Low value of PPV for a test indicates that when a test gives a positive outcome, it is less likely correct.

Negative Predictive Value (NPV)

It is the proportion of patients who do not have the disease with negative test results. By computing NPV we see how many of test negatives are true negative.

$$NPV = \frac{TN}{TN + FN}$$

High value of NPV for a test indicates that when a test gives a negative outcome, it is more likely correct.

Low value of NPV for a test indicates that when a test gives a negative outcome, it is less likely correct.

Example 1 :

Gold Standard

Test	Influenza	No Influenza
Positive	TP = 80	FP= 5
Negative	FN = 20	TN = 95

Population Size is :________

The number of patients who are actually Sick is: _________

The number of patients who are diagnosed as sick is: ________

The number of patients who are actually Healthy is: ________

The number of patients who are diagnosed as healthy is:______

Example 1 :

Gold Standard

Test	Influenza	No Influenza
Positive	TP = 80	FP= 5
Negative	FN = 20	TN = 95

Population Size is :___200_____

The number of patients who are actually Sick is: ___100_____

The number of patients who are diagnosed as sick is: ___85____

The number of patients who are actually Healthy is: __100_____

The number of patients who are diagnosed as healthy is:__115____

Example 1 :

Test	Gold Standard: Influenza	Gold Standard: No Influenza
Positive	TP = 80	FP= 5
Negative	FN = 20	TN = 95

Sensitivity = 80/(80+20) = 0.8

Specificity = 95/(95+5) = 0.95

Accuracy = (80+95)/(200)= 0.875

NPV = 95/(95+20)= 0.826

PPV= 80/(80+5)= 0.4911

Example 2 :

	Disease	No Disease
Positive Test	90	200
Negative Test	10	800

Sensitivity = 90/ (90 + 10) = 0.9

Specificity = 800/ (200 + 800) = 0.8

Accuracy = 890/ 1100 = 0.809

PPV = 90/ (290) = 0.31

NPV = 800/ (10 + 800) = 0.987

Example 3 :

In an experiment to test a new blood test that detects a certain abnormality over a population of 5000. The test was able to correctly detect 2550 of the abnormal cases and 1900 of the normal ones. If you know that the population consists of 2600 abnormal cases while the rest are normal, compute:

1- True Positives, True Negatives, False Positives, and False Negatives.

2- Test Detection Accuracy, Sensitivity, Specificity, NPV, and PPV for this experiment.

Example 3 (Solution)

True Positives	2550
True Negatives	1900
False Positives	500
False Negatives	50
Population size	5000
Accuracy	0.89
Sensitivity	0.980769231
Specificity	0.791666667
Negative Predective Value	0.974358974
Positive Predictive Value	0.836065574