

## Tutorial 3: Screening

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# Components of Validity

**TABLE 3-A**

Screening test result by diagnosis

Screening test results	Diagnosis		Total
	Diseased	Not diseased	
Positive	a (True-positive)	b (False-positive)	a + b
Negative	c (False-negative)	d (True-negative)	c + d
Total	a + c	b + d	a + b + c + d

## Sensitivity

$$(a) \text{ Sensitivity} = a / (a + c) \times 100$$



The ability of the test to identify correctly all those who have the disease, that is “**true-positive**”.



90% sensitivity means that 90% of the diseased people screened by the test will give a “**true-positive**” result and the remaining 10% a “false-negative” result.

## Specificity

$$(b) \text{ Specificity} = d / (b + d) \times 100$$



The ability of a test to identify correctly those who do not have the disease, that is “**true-negatives**”



90% specificity means 90% of non-diseased persons will give “**true-negative**” result, 10% of non-diseased people screened by the test will be wrongly classified as “diseased” when they are not “false-positive”.

Diagnosis of brain tumours by EEG

EEG results	Brain tumour	
	Present	Absent
Positive	36	54,000
Negative	4	306,000
	40	360,000

$$\text{Sensitivity} = 36 / 40 \times 100 = 90 \text{ per cent}$$

$$\text{Specificity} = 306,000 / 360,000 \times 100 = 85 \text{ per cent}$$

Diagnosis of brain tumours by computer assisted axial tomography

CAT results	Brain tumour	
	Present	Absent
Positive	39	18,000
Negative	1	342,000
	40	360,000

$$\text{Sensitivity} = 39 / 40 \times 100 = 97.5 \text{ per cent}$$

$$\text{Specificity} = 342,000 / 360,000 \times 100 = 95 \text{ per cent}$$

# Cont'

## Predictive accuracy

- Reflects the diagnostic power of a test.
- Depends upon sensitivity, specificity and disease prevalence
- The probability that a patient with a positive test result has, in fact, the disease in question.
- The more prevalent is a disease in a given population, the more accurate will be the predictive value of a positive screening test.

$$(c) \text{ Predictive value of a positive test} = a/(a + b) \times 100$$

$$(d) \text{ Predictive value of a negative test} = d/(c + d) \times 100$$

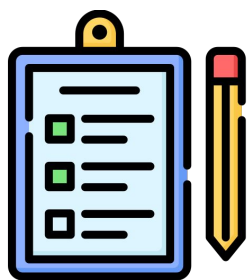
$$(e) \text{ Percentage of false-negatives} = c/(a + c) \times 100$$

$$(f) \text{ Percentage of false-positive} = b/(b + d) \times 100$$

Predictive value of a positive gram-stained cervical smear test  
(with constant sensitivity of 50% and specificity of 90%) at three levels of prevalence

	Prevalence 5%			Prevalence 15%			Prevalence 25%		
	Culture		Total	Culture		Total	Culture		Total
	+	-		+	-		+	-	
Smear	+ 25	95	120	+ 75	85	160	Smear + 125	75	200
	- 25	855	880	- 75	765	840	- 125	675	800
Total	50	950	1000	Total 150	850	1000	Total 250	750	1000
Positive predictive value	$\frac{25}{120} \times \frac{100}{1} = 21\%$			Positive predictive value $\frac{75}{160} \times \frac{100}{1} = 47\%$			Positive predictive value $\frac{125}{200} \times \frac{100}{1} = 63\%$		

# Questions and answers



## Exercise 1:

In a survey, 100 persons were positive to the reference test for disease A and 900 were negative. The screening test identified 200 persons to be positive. Of these 80 were positive to the reference test.

		Diagnostic test		
		Disease	Non Disease	Total
Screening test	+ve	80	120	200
	-ve	20	780	800
	Total	100	900	1000



(a) Sensitivity =  $a / (a + c) \times 100$

=  $80 / 100 \times 100 = 80\%$



(b) Specificity =  $d / (b + d) \times 100$

=  $780 / 900 \times 100 = 86.7\%$



(c) Predictive value of a positive test =  $a / (a + b) \times 100$

=  $80 / 200 \times 100 = 40\%$  **who tested +ve actually they have the disease**



(d) Predictive value of a negative test =  $d / (c + d) \times 100$

=  $780 / 800 \times 100 = 97.5\%$  **who tested -ve actually don't have the disease**



(e) Percentage of false-negatives =  $c / (a + c) \times 100$

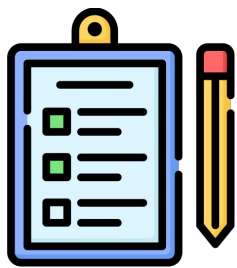
=  $20 / 100 \times 100 = 20\%$



(f) Percentage of false-positive =  $b / (b + d) \times 100$

=  $120 / 900 \times 100 = 13.3\%$

# Questions and answers



## Exercise 2:

A new non invasive test has been developed to diagnose breast cancer. Of 1000 patients; 50% were diagnosed positive. Of those who tested positive, a Biopsy test yielded 475 with positive results. Of those who tested negative; 50 patients were actually Cancer breast positive when tested against the Biopsy.

		Diagnostic test		
		+ve breast cancer	-ve breast cancer	Total
Screening test	+ve	475	25	500
	-ve	50	450	500
	Total	525	475	1000

## Answers for ex.2:



(a) Sensitivity =  $a / (a + c) \times 100$

= 90.5%

→ Among those who are diseased, 90% will be positive with the new test



(b) Specificity =  $d / (b + d) \times 100$

= 94.7%

→ Among those who doesn't have the disease, 94.7% will show true negative



(c) Predictive value of a positive test =  $a / (a + b) \times 100$

= 95%

→ Among those who tested positive, 95% are actually have the disease



(d) Predictive value of a negative test =  $d / (c + d) \times 100$

= 90%

→ Among those who tested negative, 90% will not have the disease



(e) Percentage of false-negatives =  $c / (a + c) \times 100$

= 9.5%



(f) Percentage of false-positive =  $b / (b + d) \times 100$

= 5.2%

# Questions and answers



**Exercise 3** (in the slide it was repeated so this is ex4):

Match the following sentences with the appropriate term:

- I. The ability of a test to correctly identify those who have a disease (**sensitivity**)
- II. The proportion of those without the disease correctly identified as negative by screening test (**Specificity**)
- III. Ability of the test to detect true negative cases (**Specificity**)
- IV. Probability of disease in patients with positive test result (**PP+ve**)
- V. Probability of not having the disease in a subject with negative test result (**PP-ve**)



**Exercise 4:**

300 known diabetics (positive on the glucose tolerance test) and 250 normal volunteers (negative on the glucose tolerance test) are given finger prick tests, the results are:

		Glucose tolerance test		
		+	-	Total
Finger Prick	+	282	20	302
	-	18	230	248
	Total	300	250	550

Sensitivity of the test is:

- a) 20%
- b) 90%
- c) 94% ✓
- d) 98%

Specificity of the test is

- a) 90%
- b) 92% ✓
- c) 94%
- d) 98%

The capacity of a test or procedure to screen as “**negative**” those NOT having a specific disease is:

- a) sensitivity
- b) specificity ✓
- c) positive predictive value
- d) negative predictive value