Screening for Diseases

Dr. Nadhim Ghazal

- Screening: is the examination of members of the population to discover those who are likely to have the disease and those who are unlikely to have it. Or it is the application of relatively simple, inexpensive tests to large number of people in order to classify them (either likely or unlikely to have the disease).

- It is not a definitive diagnostic test but a secondary preventive measure. It aims to decrease the morbidity and mortality from the screened disease, e.g. patient with AIDS are screened to protect the community from the infection. Sometimes rescreening is needed to discover new cases.

- **NOT all disease are screened, so the disease needs certain characteristic to be suitable for screening. These characteristics are :**

1. The disease should be important for the patient (i.e. severe, virulent, fatal) and for the community (i.e. community health problem e.g. AIDS and cancer).

2. The disease should have clear natural history with a clear detectable pre- clinical stage e.g. CA cervix begins as CA in situ and shows no signs or symptoms. So it is detected by screening (PAP-smear) and treated while CA pancreas has a very short pre-clinical stage, so it is not suitable for screening.

3. The disease should be treatable, except for AIDS which is a community health problem screened not for treatment but for community protection.

4. The disease should be common and if it is not, we can make it common e.g. CA breast is not common for screening (not too many cases), So we can make it common by screening women more than 45 years of age or women with a positive family history of CA breast i.e. we screen the risk groups.

- **Characteristics of Screening Test:**
1. They should be **safe**, because the majority of the screened people may be healthy and we should not harm them.
2. They should be **acceptable** e.g. for CA breast use mammography, not fine needle aspiration.
3. They should have **low cost** during and after screening.
4. They should be **reliable (repeatable)** i.e. we get similar results when we repeat the test. Sometimes variability may happen due to technique (instrumentation), examiner (method), or biological factors.
5. They should be **valid**, i.e. the results should be around the normal value.

- **Validity:** is the ability of detecting people who are likely or unlikely to have the disease. Or is the ability of the test to distinguish the diseased from healthy people.

- It is measured by sensitivity and specificity so valid screening tests should have high sensitivity and high specificity. If the test is 100% sensitive and 100% specific (i.e. 100% valid), it will not be a screening test . this situation is impossible.

- **Example:** a group of athletes was screened for their systolic blood pressure. The test was done by 4 different sphygmomanometers; we got the following results:
- Instrument 1 : 120 + 5 mm Hg
- Instrument 2 : 140 + 5 mm Hg
- Instrument 3 : 120 + 20 mm Hg
- Instrument 4 : 140 + 20 mm Hg

- **Question: give your evaluation to these results concerning the validity and reliability of instrumentation?**
- **Answer:**
- **Instrument1**: the findings are very close to each other and they surround the normal value, so it is reliable and valid instrument.
- **Instrument2**: the findings are close to each other, but they surround an abnormal value, so it is reliable but not valid instrument.
- **Instrument3**: the findings are not close to each other, but they surround the normal value, so it is valid but not reliable instrument .
- **Instrument4**: the findings are not close to each other and they do not surround the normal value, so it is not reliable not valid instrument.

  In screening; we should use an instrument with the characteristics of instrument 1 in the previous example, i.e.: it should be reliable and valid.

- **After screening, we get 4 main categories summarized into two ways:**

- 1-

Population (by screening)

diseased — healthy

+ True + (TP) − False − (FN) + False + (FP) − True − (TN)
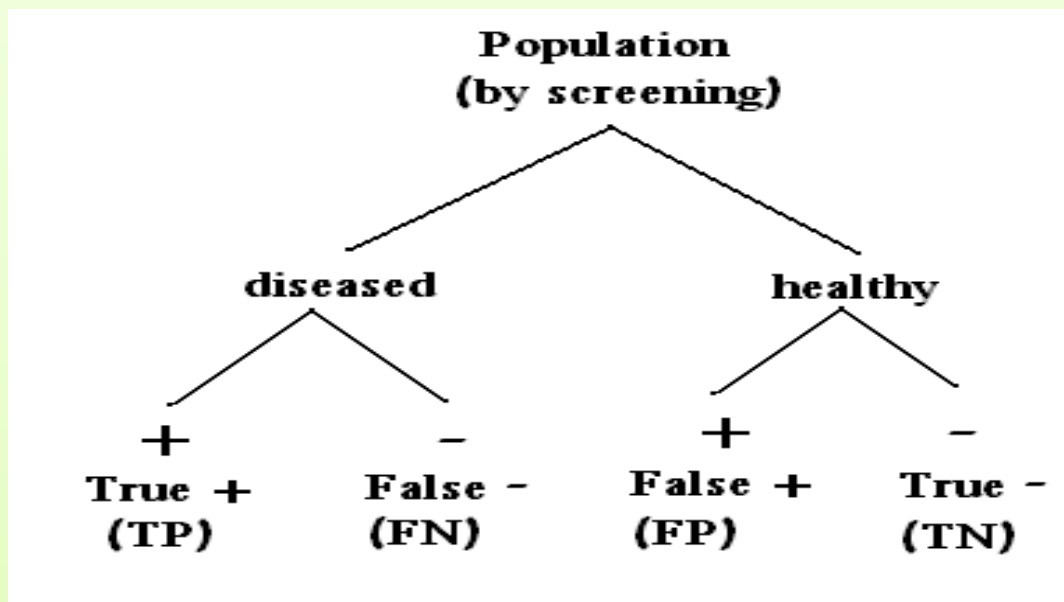
- **2- By 2 X 2 (4 cell table):**

	Disease	
	D +	H -
Test +	TP	FP
Test -	FN	TN

- **Notes:**
- In the 4 cell table do not change the rows by columns. (test) by (disease).
- If the false results (FN and FP) were high, the test is bad and vice versa. If they were equal to zero, the test is definitive (Diagnostic), it will not be screening.

  Note: see the definition of screening in the 1st page

- **TP:** the patient is screened to have the disease when he is really having it.

  TN: the patient is screened healthy when he is really healthy.

  FP: the patient is screened to have the disease when he is free of it.

  FN: the patient is screened healthy when he has the disease.

- FN screening dose not cost us, because the patient will think himself healthy and will not search any medical help. But the final result will be bad, because he will search the medical help after signs and symptoms appearance, i.e deterioration at the case.

- FP does cost us, because we will do more and more tests on people who are healthy and we will get no benefit from that.

Evaluation of Screening Tests or Parameters of Screening Tests

- To evaluate a screening test, 6 parameters are used, depending on the 2 X 2 table.

	Disease	
	D +	H -
Test +	TP	FP
Test -	FN	TN

1- Sensitivity TP%:

- It's the ability of the test to identify all those having the disease.

$$Sn = \frac{TP}{\text{diseased people}\ (TP + FN)} \times 100$$

2- FN%:

- It's the percentage of diseased people who were negative in the test, i.e. the percentage of missed cases.

$$FN\ \% = \frac{FN}{diseased\ people\ (TP\ +\ FN)}\ X\ 100$$

- Criteria of successful screening test?

[safe, acceptable, reliable (repeatable), low cost, valid]

A good screening test should have **high Sn**, **low FN** & **(low FN%).**

If the **Sn** decreased and the **FN** increased the **FN%** will be increased as well.
I.e. high number of diseased people who are undetected and undiagnosed which have got false feeling of being healthy.

So $Sn + FN\% = 100\%$

e.g. 90% **Sn** means that 90% of diseased people screened by the test will get **TP** result and the remaining 10% get **FN** result.

3- Specificity (TN%):

- It is the ability of the test to identify correctly all those not having the disease(healthy people).

$$Sp = \frac{TN}{\text{Not diseased people} \atop (FP + TN)} \; X \; 100$$

4- FP%:

- It's the percentage of the non diseased people who were positive in the test.

$$FP \% = \frac{FP}{\text{Not diseased people} \atop (FP + TN)} \times 100$$

- A good screening test should have **high SP**, **low FP** & **(low FP%).**

- If **Sp** is low, **FP** is high, **FP%** will be high and lead to increase in the number of those people detected incorrectly to have the disease, which will lead to unnecessary phobia from the disease and high cost by need for more number of diagnostic tests.

- So

$$Sn + FN\% = 100\%$$

- e.g. 90% *SP* means that 90% of the non diseased people screened by the test get **TN** result and the remaining 10% get **FP** result.

- **Positive Predictive Value(*Pr+*):**

- Also called the diagnostic power of the test. It's the probability that a person with positive test really have the disease, or it is the percentage of diseased people in the test +ve group.

$$Pr+ = \frac{TP}{\underset{(TP\ +\ FP)}{All\ positives}} \times 100$$

- **Negative Predictive Value (*Pr-*):**
- It's the probability that a person with negative test does not have the disease or it is the percentage of healthy people in the test –ve group.

$$Pr- = \frac{TN}{\substack{\text{All negatives} \\ (TN + FN)}} \; X \; 100$$

- Notes: look at the 2 X 2 table

a) If we have:

Sn & $FN\%$: use the left column.

Sp & $Fp\%$: use the right column.

$Pr+$: use the upper row.

$Pr-$: use the lower row.

b) Concerning Sp and Sn:

If ≥ 90 % …………… High

70% - 90% ……….. Moderate

< 70% ………………. Low

END