EPIDEMIOLOGY III.

Screening

Prevention

Prevention levels[6]	Doctor's side	
	Disease	
	absent	present
Patient's side / **Illness** — absent	**Primary prevention** (illness absent disease absent)	**Secondary prevention** (illness absent disease present)
Patient's side / **Illness** — present	**Quaternary prevention** (illness present disease absent)	**Tertiary prevention** (illness present disease present)

Prevention

- ***Primary prevention*** strategies intend to avoid the development of a disease
- ***Secondary prevention*** strategies attempt to diagnose and treat an existing disease in its early stages (no signs and symptomps) before it results in significant morbidity
- The aim of **terrtiary prevention** is to reduce the negative impact of established disease by restoring function and reducing disease-related complications
- ***Quaternary prevention*** describes the set of health activities that mitigate or avoid the consequences of unnecessary or excessive interventions in the health system

Secondary prevention (screening)

The World Health Organization (WHO) defines screening as the presumptive identification of unrecognised disease or defects by means of tests, examinations or other procedures that can be applied rapidly. Screening is intended for all people, in an identified target population, who do not have symptoms of the disease or condition being screened for.

The process can identify:
- • a pre-disease abnormality;
- • early disease; or
- • disease risk markers.

Population-based screening

A test is offered systematically to all individuals in the defined target group within a framework of agreed policy, protocols, quality management, monitoring and evaluation.

It is an organised integrated process where all activities along the screening pathway are planned, coordinated, monitored and evaluated through a quality improvement framework.

DEFINED TARGET POPULATION
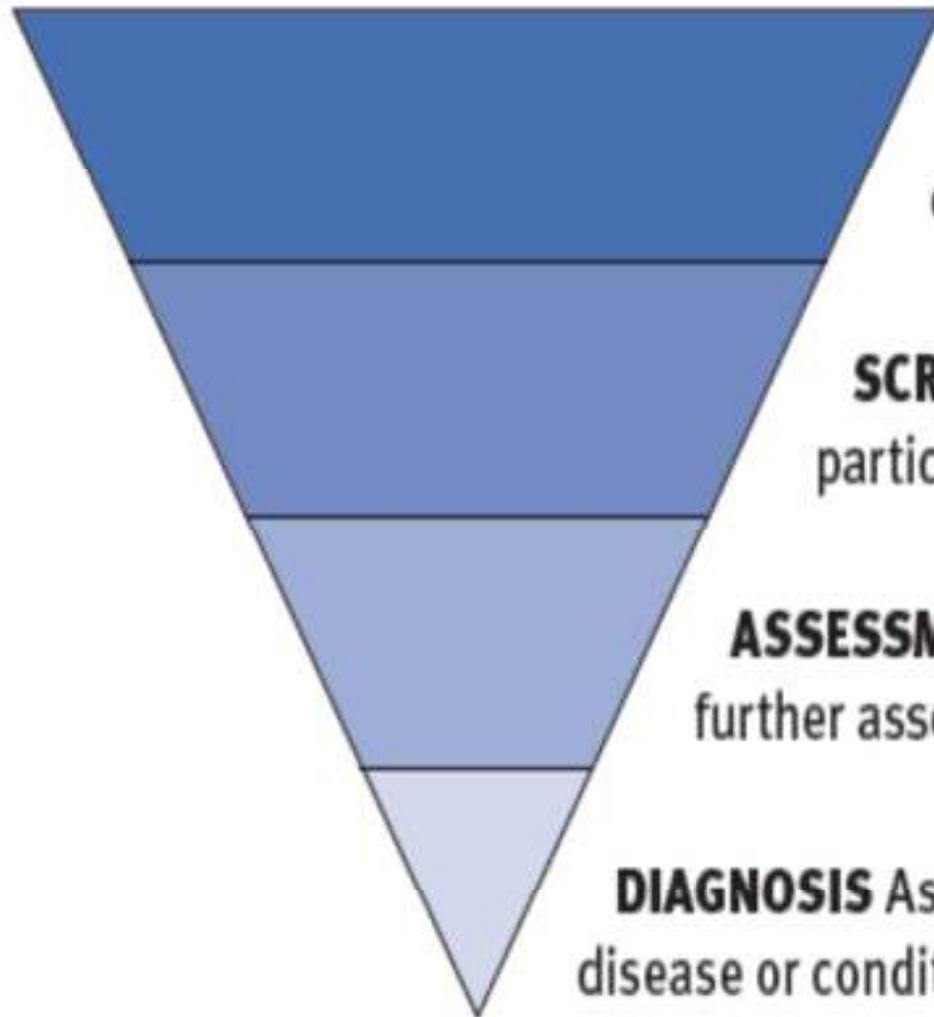
RECRUITMENT Targeted population encouraged to participate in screening

SCREENING Targeted population who participate in screening

ASSESSMENT Screened population who require further assessment

DIAGNOSIS Assessed participants diagnosed with the disease or condition

OUTCOME Reduced morbidity and mortality from the disease

Opportunistic case-finding

A test is offered to an individual without symptoms of the disease when they present to a health care practitioner for reasons unrelated to that disease.

WHO - Principles of Screening

1. The condition should be an important health problem.
2. There should be a treatment for the condition.
3. Facilities for diagnosis and treatment should be available.
4. There should be a latent stage of the disease.
5. There should be a test or examination for the condition.
6. The test should be acceptable to the population.
7. The natural history of the disease should be adequately understood.
8. There should be an agreed policy on whom to treat.
9. The total cost of finding a case should be economically balanced in relation to medical expenditure as a whole.
10. Case-finding should be a continuous process, not just a "once and for all" project.

Screening test characteristics

1. Highly sensitive and specific
2. Applicable and acceptable
3. Simple, accomplished easily and quickly
4. Harmless
5. Relatively inexpensive

Breast cancer screening results of the 2-county study in Sweden, 1977-1980

Screening test result	Confirmed breast cancer	No breast cancer	Total
Positive	413	3026	3439
Negative	67	65264	65331
Total	480	68290	68770

Interpreting results of screening

Screening result	Reference test result		
	Positive	Negative	Total
Positive	a	b	a+b
Negative	c	d	c+d
Total	a+c	b+d	a+b+c+d

a – True positive result, both screening and reference tests are positive

b – False positive result, screening result is positive, reference test is negative

c – False negative result, screening result is negative, reference test is positive

d – True negative result, both screening and reference tests are negative

Validity measures of sreening tests
sensitivity - specificity

TEST Result	Disease to be screened		Total
	Positive	Negative	
Pozitíve	a	b	a+b
Negatíve	c	d	c+d
Total	a+c	b+d	a+b+c+d

Sensitivity = a/(a+c) i.e. percentage (%) of true positives among patients indicated to be ill

Specificity = d/(b+d) i.e. percentage (%) of true negatives among patients indicated to be well

Predictive value of sreening tests

positive - negative

TEST Result	Disease to be screened		Total
	Positive	Negative	
Pozitive	a	b	a+b
Negative	c	d	c+d
Total	a+c	b+d	a+b+c+d

Positive predictive value = a/(a+b) i.e. percentage (%) of true positives among patients indicated to be positive

Negative predictive value = d/(c+d) i.e. percentage (%) of true negatives among patients indicated to be negative
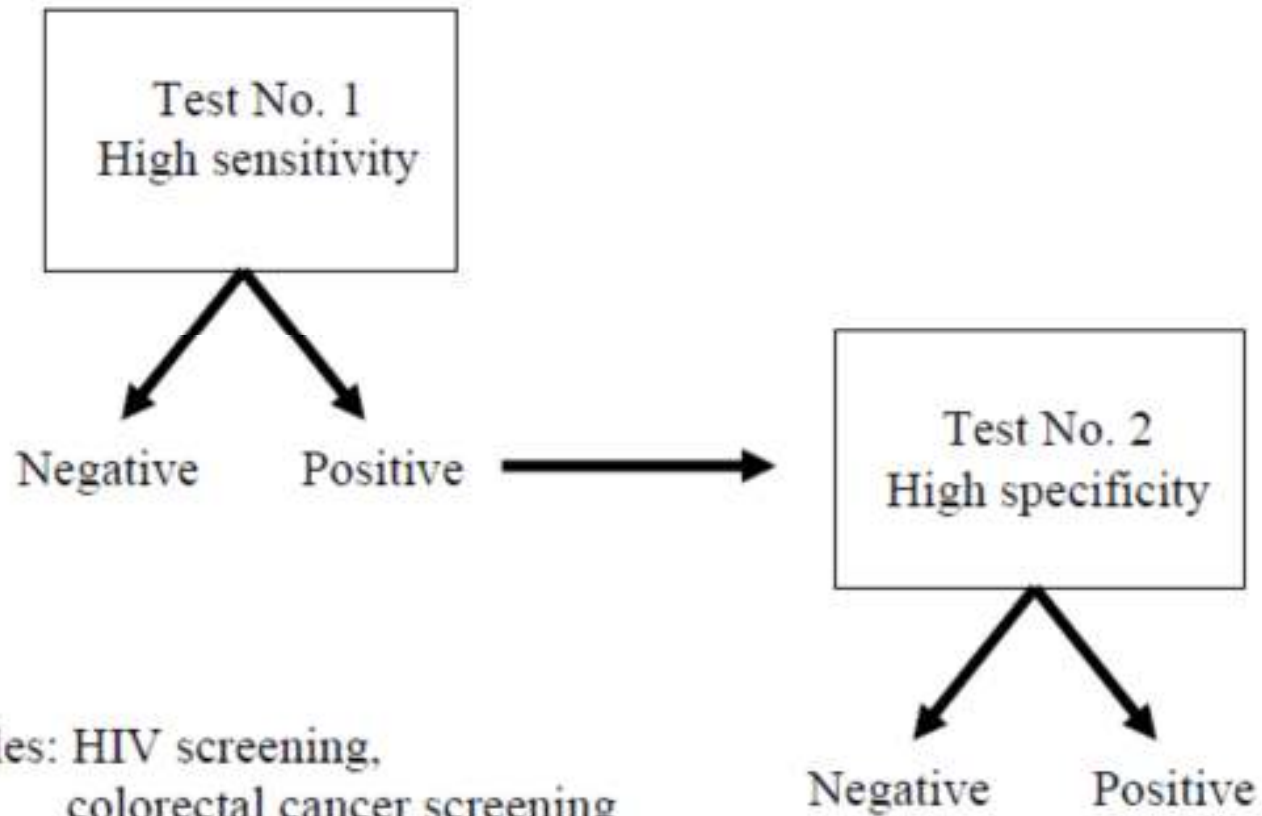
Validity measures of a screening test

- **Sensitivity**: The proportion of actually positive subjects the screening test detects

$$\text{Sensitivity} = \frac{a}{a+c} * 100$$

- **Specificity**: The proportion of actually negative subjects the screening test identifies as negative

$$\text{Specificity} = \frac{d}{b+d} * 100$$

Relevance of screening tests to screened subjects

- **_Positive predictive value_**: proportion of positive screening test results that are actually positive

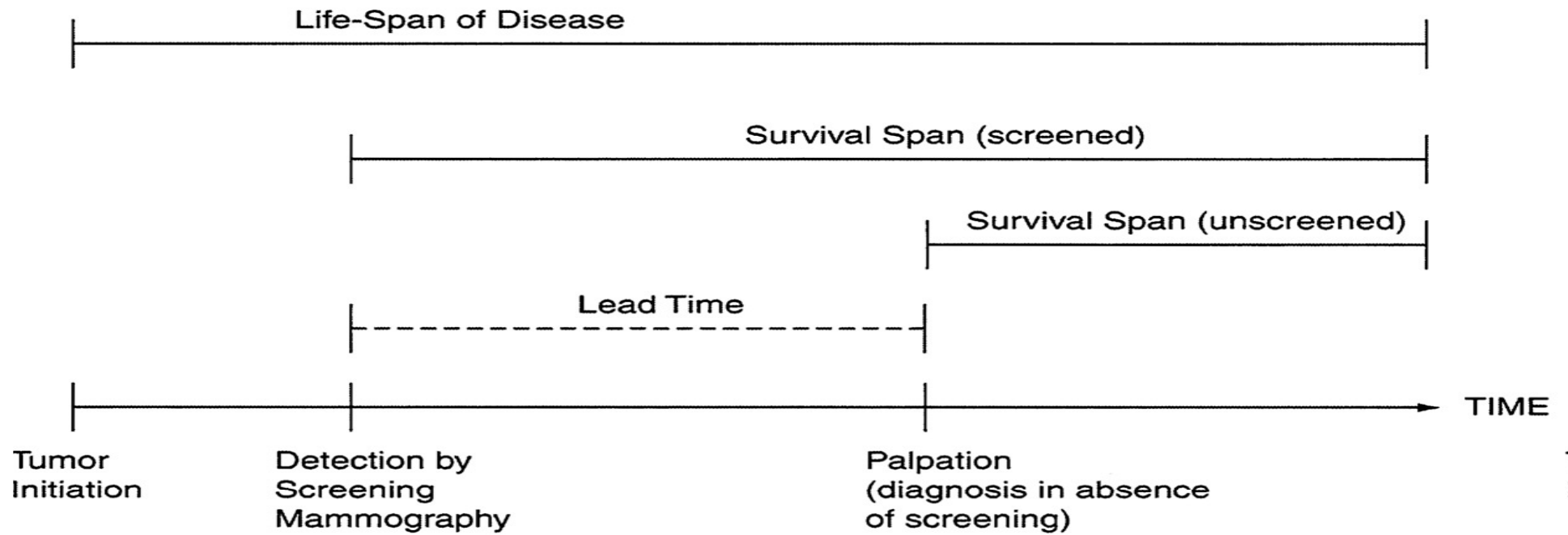$$\text{Positive predictive value} : \frac{a}{a+b} *100$$

- **_Negative predictive value_**: proportion of negative screening test results that are actually negative

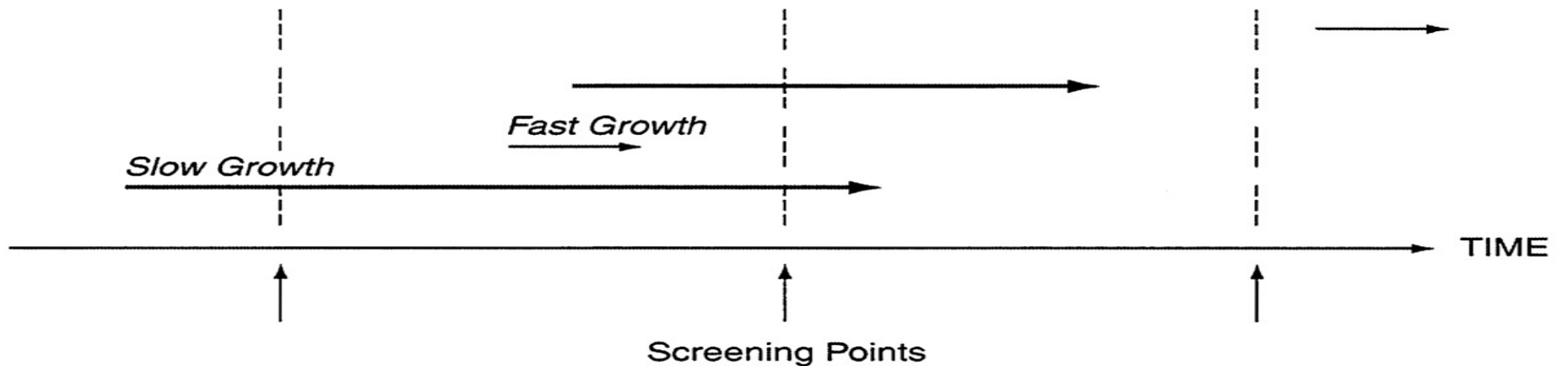$$\text{Negative predictive value} : \frac{d}{c+d} *100$$

Disadvantages of screening

- Screening involves cost and use of medical resources on a majority of people who do not need treatment.

- Adverse effects of screening procedure (e.g. discomfort, radiation exposure, chemical exposure).

- Stress and anxiety caused by a false pozitive screening result.

- Unnecessary investigation and treatment of false positive results.

- Stress and anxiety caused by prolonging knowledge of an illness without any improvement in outcome.

- A false sense of security caused by false negatives, which may delay final diagnosis.

A Lead Time Bias

Life-Span of Disease

Survival Span (screened)

Survival Span (unscreened)

Lead Time

TIME

Tumor
Initiation

Detection by
Screening
Mammography

Palpation
(diagnosis in absence
of screening)

B Length Bias

Fast Growth

Slow Growth

TIME

Screening Points

Lead time bias

- If the disease is diagnosed earlier with screening, the survival time since diagnosis is longer with screening, but life span may have not been prolonged
- Looking survival time since diagnosis, screening will show an increase what might be attributed success to a screening test that does nothing but advance diagnosis
- Comparing statistics of mortality due to a disease in a screened and unscreened population gives more meaningful information.

Selection bias

- If people with a higher risk of a disease are more likely to be screened (e.g. women with a family history of breast), then a screening test will look worse than it really is: negative outcomes among the screened population will be higher than for a random sample.

- If a test is more available to young and healthy people then fewer people in the screening population will have negative outcomes than for a random sample, and the test will seem to make a positive difference.

Effect of disease's prevalence Calculation

Predictive value in case of 1% and 10% prevalence levels

- Sensitivity
- Specifty
- PPV_1
- PPV_{10}
- NPV_1
- NPV_{10}

Screening test result	Prevalence 1%		Prevalence 10%	
	Diseased	Not diseased	Diseased	Not diseased
Positive	95	990	950	900
Negative	5	8910	50	8100
Total	100	9900	1000	9000