Screening for Disease

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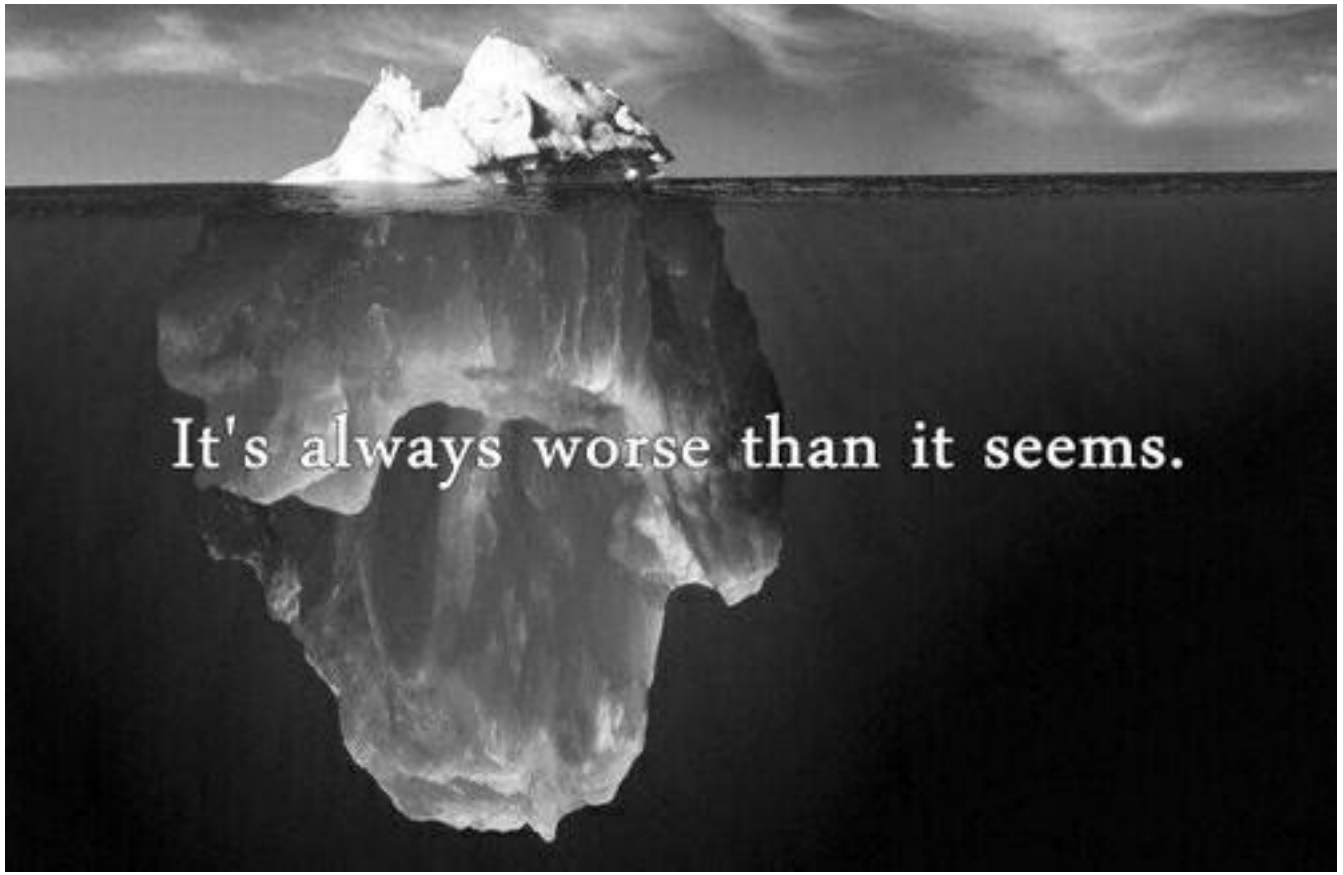
Objectives

- Define the term “screening”
- Explain the concept of screening and the lead time
- Explain the difference between “screening”, “case finding”, “periodic examination” and “diagnosis”
- State the uses of screening programs
- State the criteria of health problems amenable for screening
- Outline the differences between screening and diagnostic test
- Distinguish between “mass screening” and “high risk screening”
- State the criteria of an ideal screening test

Iceberg Phenomenon of Disease



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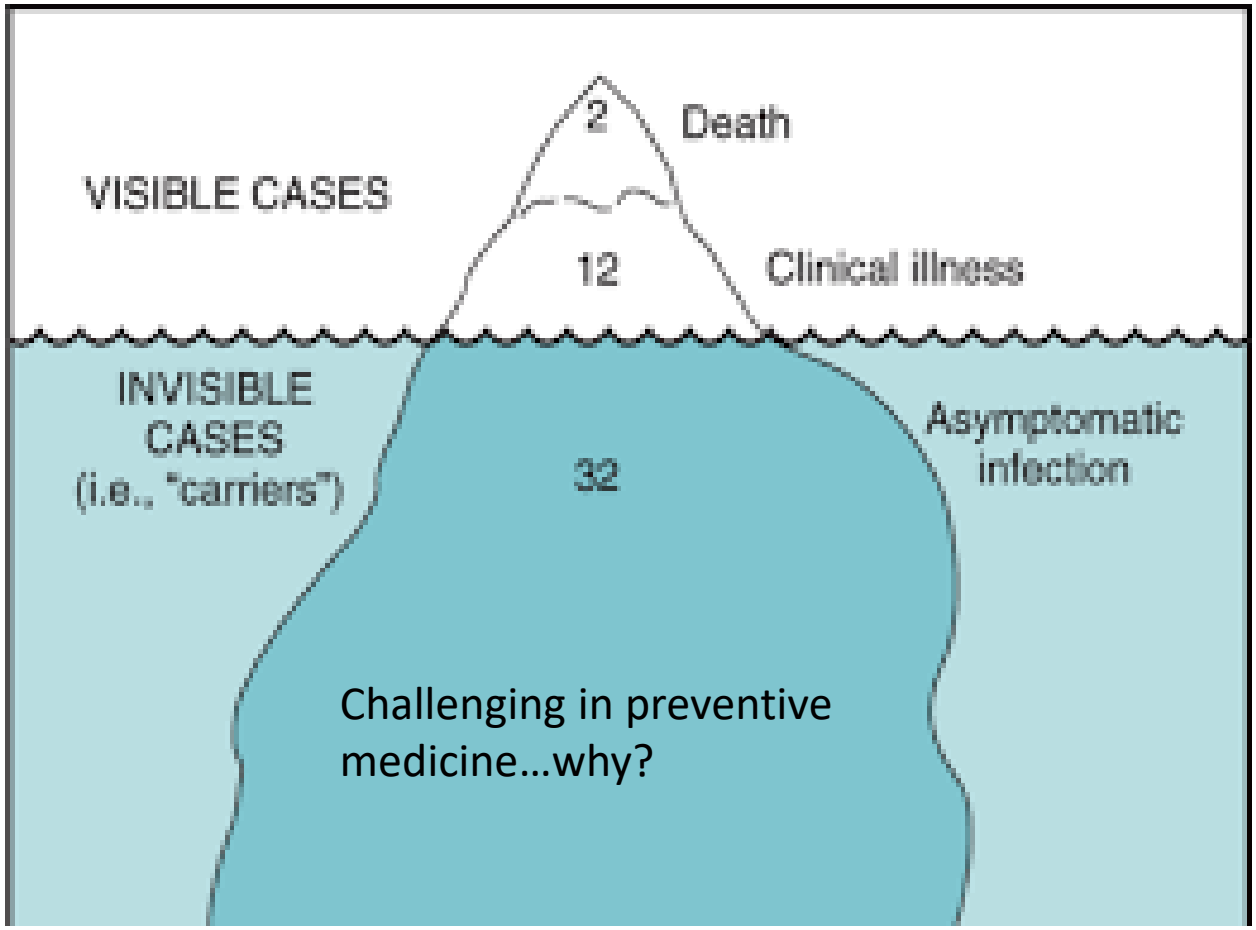


Screening

- "The search for **unrecognized** disease or defect by means of **rapidly** applied tests, examinations or other procedures in apparently **healthy** individuals."

Some screening tests

Pregnancy	**Infancy**
Anaemia	LCB
Hypertension Toxemia	Congenital dislocation of hip
Rh status	Congenital heart disease
Syphilis (VDRL Test)	Spina bifida
Diabetes	Cerebral palsy
Cardiovascular disease	Hearing defects
Neural tube defects	Visual defects
Down's syndrome	Hypothyroidism
HIV	Developmental screening tests
	Haemoglobinopathies
Middle-aged men and women	Sickle cell anaemia
Hypertension	Undescended testis
Cancer	**Elderly**
Diabetes mellitus	Nutritional disorders
Serum cholesterol	Cancer
Obesity	Tuberculosis
	Chronic bronchitis
	Glaucoma
	Cataract

Concept of “Lead Time”

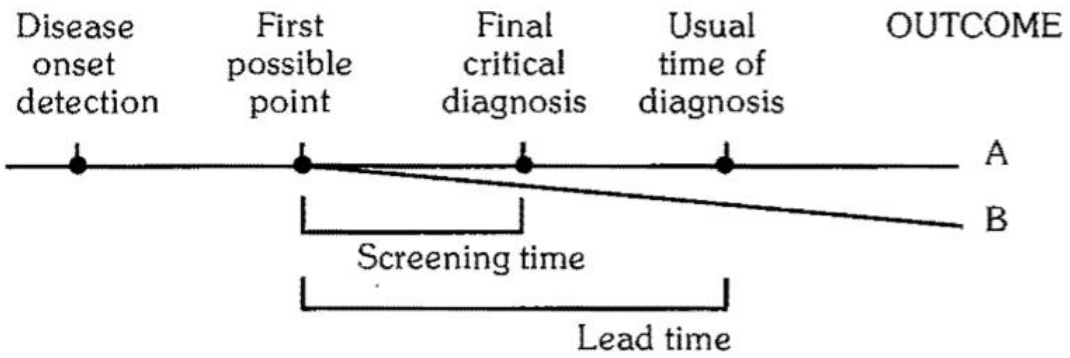
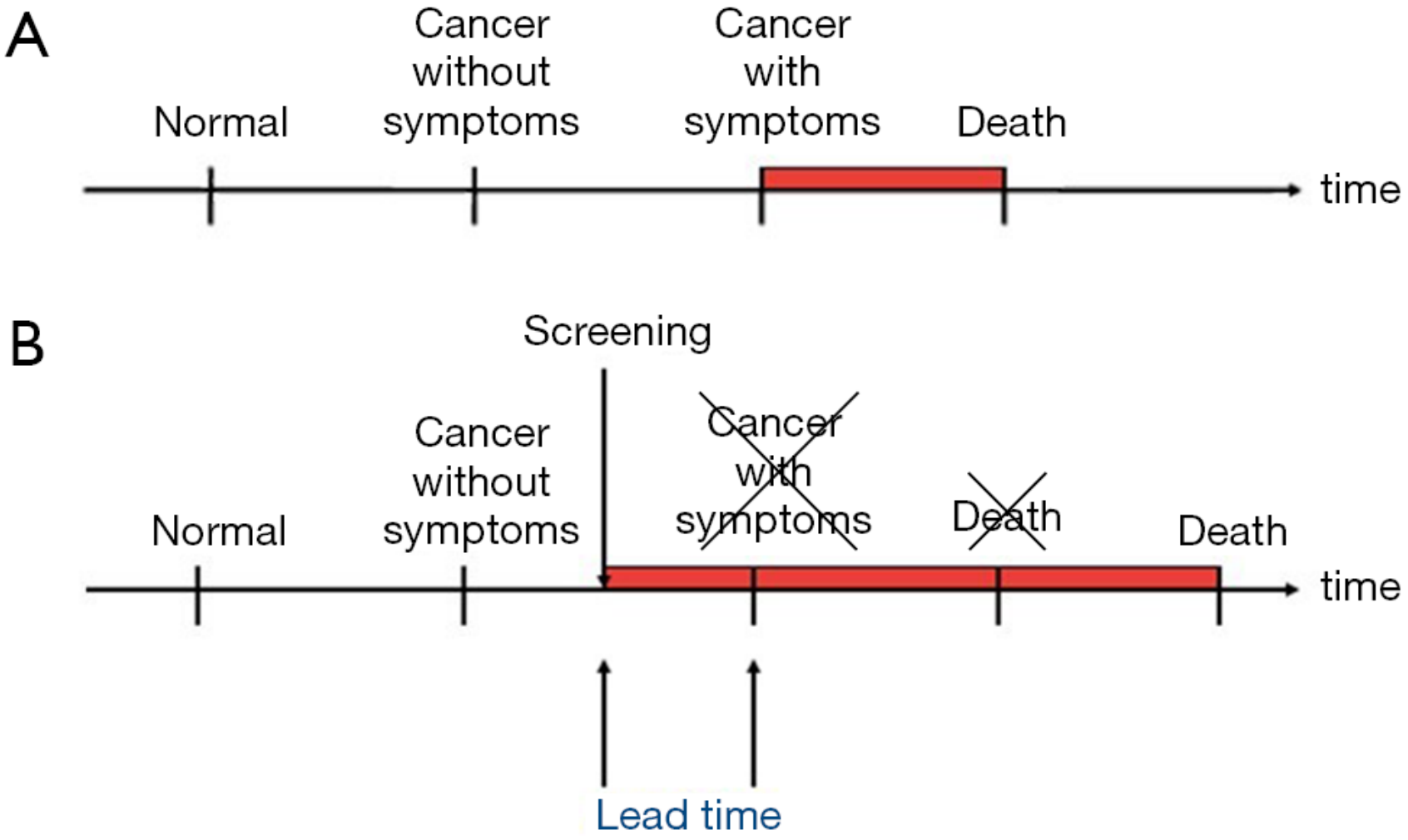


FIG.1
Model for early detection programmes

- Lead time is the advantage gained by screening
- It is the period between diagnosis by early detection and diagnosis by other means.
- The benefit of the program must be seen in terms of its outcome
- **A** is the outcome of the disease
- **B** is the outcome to be expected when the disease is detected at the earliest possible moment.
- **B-A** is the benefit of the program

Concept of "Lead Time"



Lead Time bias

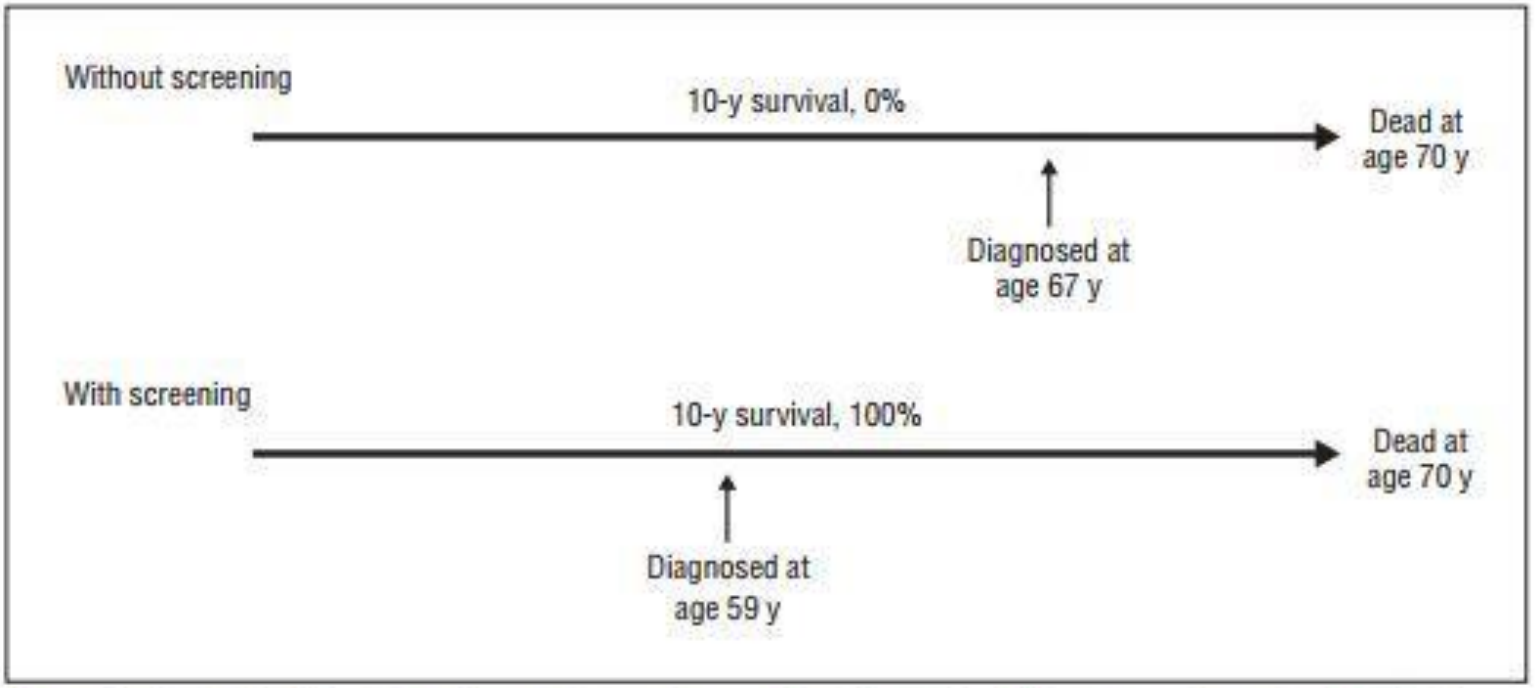


Figure 2. Lead-time bias. The diagram shows how earlier diagnosis will increase the survival statistic, even if death is not delayed.

Concepts related to screening

- Periodic examination
- Diagnosis
- Case finding

- ***Screening****:* is testing for infection or disease in populations or in individuals *who are* ***not seeking*** *health* care; for example, serological testing for AIDS virus in blood donors, neonatal screening, premarital screening for syphilis.

- ***Case-finding***

The use of clinical and/or laboratory tests to detect disease in individuals ***seeking*** *health care* for other reasons; for example, the use of VDRL test to detect syphilis in pregnant women. Other diseases include pulmonary tuberculosis in chest symptomatics, hypertension, cervical cancer, breast cancer, diabetes mellitus.

- ***Diagnostic tests***

Use of clinical and/or laboratory procedures to ***confirm*** or refute the existence of disease or true abnormality in patients **with signs and symptoms** presumed to be caused by the disease; for. example, VDRL testing of patients with lesions suggestive of secondary syphilis; endocervical culture for N. *gonorrhoea.*

TABLE 1

Screening and diagnostic tests contrasted

	Screening test	Diagnostic test
1	Done on apparently healthy	Done on those with indications or sick.
2	Applied to groups	Applied to single patients, all diseases are considered.
3	Test results are arbitrary and final	Diagnosis is not final but modified in light of new evidence, diagnosis is the sum of all evidence.
4	Based on one criterion or cut-off point	Based on evaluation of a number of symptoms, signs (e.g., diabetes) and laboratory findings.
5	Less accurate	More accurate.
6	Less expensive	More expensive.
7	Not a basis for treatment	Used as a basis for treatment.
8	The initiative comes from the investigator or agency providing care.	The initiative comes from a patient with a complaint.

Periodic health examination

Periodic health examination is a common and important part of office practice. Its purpose is the detection of asymptomatic illness and the prevention of disease before irreversible pathological changes occur.

- Applied individually
- Consumes physicians' time
- Consumes money

Screening vs. Periodic health examination

- Capable of wide application
- Inexpensive
- Requires less time from the physician

Uses of screening

- **Case detection** (people screened for their own benefit) eg.: breast cancer, deafness in children,…
- **Control of disease** (people are screened for the benefit of others) eg.: TB to protect population
- **Research purposes** (prevalence, incidence)
- **Educational opportunity** (public awareness, education to health professionals)

Uses of Screening

Case detection:

- Is the presumption identification of unrecognized disease, which does not arise from a patient request.
- Neonatal screening
- The people are screened primarily for their own benefit.

Control of disease:

- People are examined for the benefit of others
- Screening of immigrants from infectious diseases like Ebola, TB and syphilis to protect the home population
- Screening for HIV, STD etc…
- Leads to early diagnosis to permit more effective treatment and reduce the spread of infectious disease and mortality.

Research purposes:

- To know the history of many chronic diseases like cancer, HTN etc,
- Screening may aid in obtaining more basic knowledge about the natural history of such diseases
- Initial screening provides a prevalence estimate and subsequent screening provides and incidence figure

Educational opportunities:

- Acquisition of information of public health relevance
- Providing opportunities for creating public awareness

Mass screening vs high risk screening

- ***Mass screening***

Mass screening simply means the screening of a whole population or a sub-group, as for example, all adults. It is offered to all, irrespective of the particular risk individual may run of contracting the disease in question

- It is not useful for preventive measures.

High-risk or selective screening

- Screening will be most productive if applied selectively to high-risk groups, the groups defined on the basis of epidemiological research (e.g., diabetes, hypertension, breast cancer in patients with positive family history)
- Screening for risk factors

Criteria for Screening (disease)

- Important health problem.
- Recognizable latent or early symptomatic stage.
- The natural history of the condition should be understood.
- There is a test that can detect the disease
- Facilities should be available for confirmation of the diagnosis.

- Has an effective treatment.
- There should be an agreed-on policy concerning whom to treat as patients
- Good evidence that early detection and treatment reduces morbidity and mortality.
- Expected benefits (e.g., the number of lives saved) of early detection exceed the risks and costs.

Criteria for Screening (test)

- **Acceptability**: acceptable to people at whom it is aimed. Painful, discomforting or embarrassing examinations are not likely to be acceptable to the population in mass campaigns

- **Repeatability**: the test must give consistent results when repeated more than ones on the same individual under the same conditions.

- **Validity**: refers to what extent the test accurately measures which it purports to measure.
- Glycosuria vs GTT

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

Components of Validity

- Sensitivity = a/ (a+c) x 100
- Specificity = d/ (b+d) x100
- Predictive value of a positive test=a/(a+b)x100
- Predictive value of a negative test=d/(c+d)x100
- Rate of false-negative=c/(a+c)x100
- Rate of false-positive=b/(b+d)x100

Sensitivity

- 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

- 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.

Predictive accuracy

- Reflects the diagnostic power of a test.
- Depends upon sensitivity, specify 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.

Example

Diagnosis of brain tumours by EEG

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

Sensitivity = 36/40 × 100 = 90 per cent

Specificity = 306,000/360,000 × 100 = 85 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

Sensitivity = 39/40 × 100 = 97.5 per cent

Specificity = 342,000/360,000 × 100 = 95 per cent

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%

	Culture +	Culture −	Total
Smear +	25	95	120
Smear −	25	855	880
Total	50	950	1000

Positive predictive value $\frac{25}{120} \times \frac{100}{1} = 21\%$

Prevalence 15%

	Culture +	Culture −	Total
Smear +	75	85	160
Smear −	75	765	840
Total	150	850	1000

Positive predictive value $\frac{75}{160} \times \frac{100}{1} = 47\%$

Prevalence 25%

	Culture +	Culture −	Total
Smear +	125	75	200
Smear −	125	675	800
Total	250	750	1000

Positive predictive value $\frac{125}{200} \times \frac{100}{1} = 63\%$

Summary

- Screening for common health issues is integral part of improving population health
- Screening predicts who will develop a specific disease and detects disease among those in early stages
- Screening tests need to be studied for validity (sensitivity and specificity)
- We often have a trade-off between sensitivity and specificity
- Predictive value of screening test is maximized in populations with high prevalence of health indicator of interest
- Value of screening program will depend on cost-effectiveness, minimal invasiveness, availability of effective treatment

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