Screening for Disease

Ch.4

Dr. Afnan Younis, MBBS, MPH, SBCM

Assistant Professor, Community Medicine

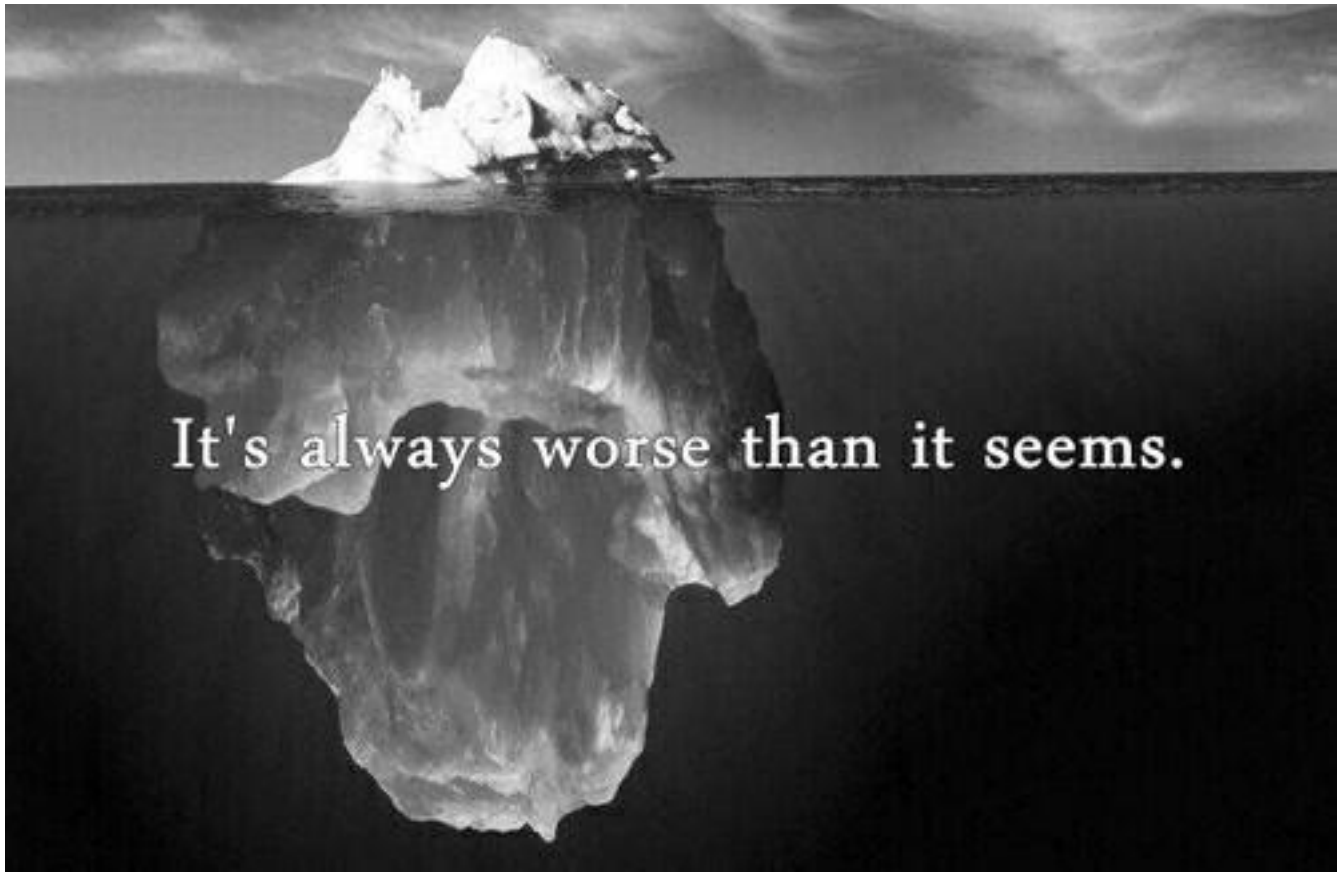
ayounis@ksu.edu.sa

Afnan.younis@gmail.com

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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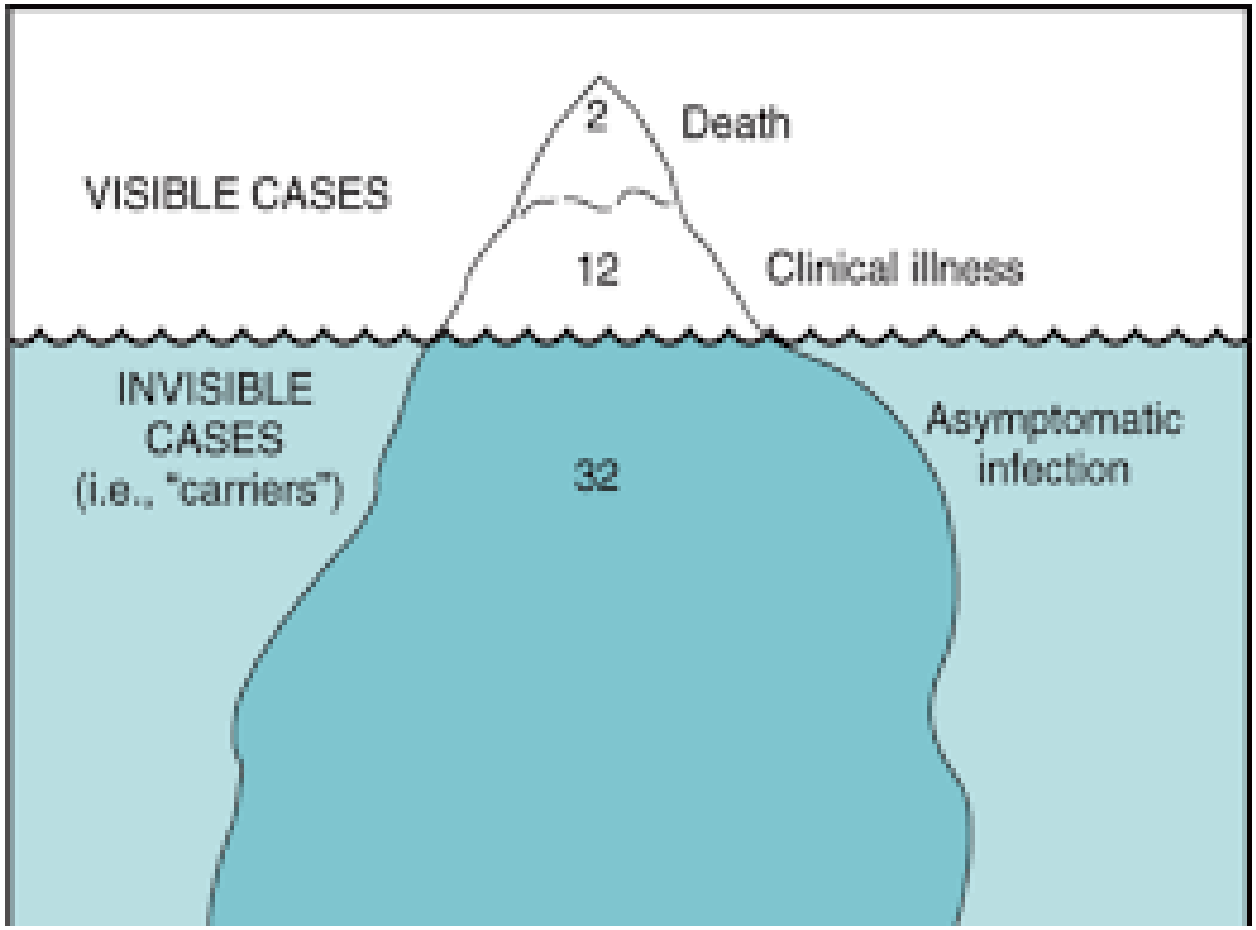


Screening

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

Concept of “Lead Time”

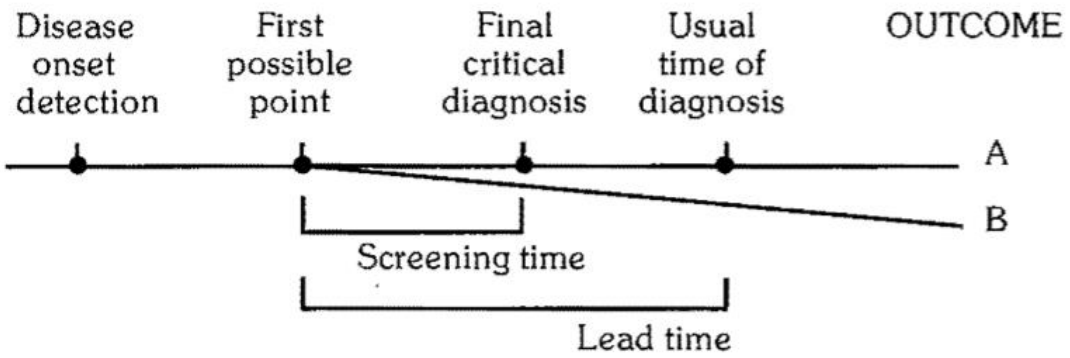


FIG.1
Model for early detection programmes

- 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”

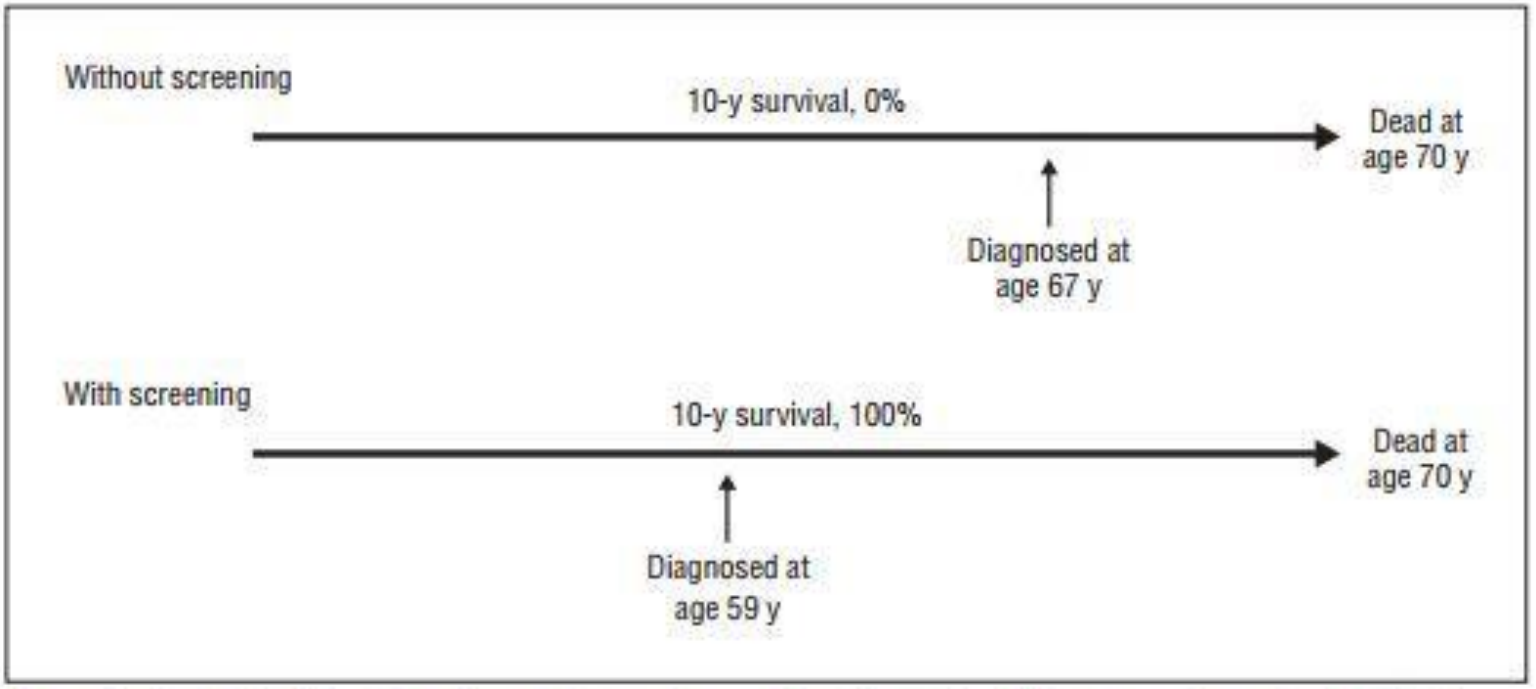
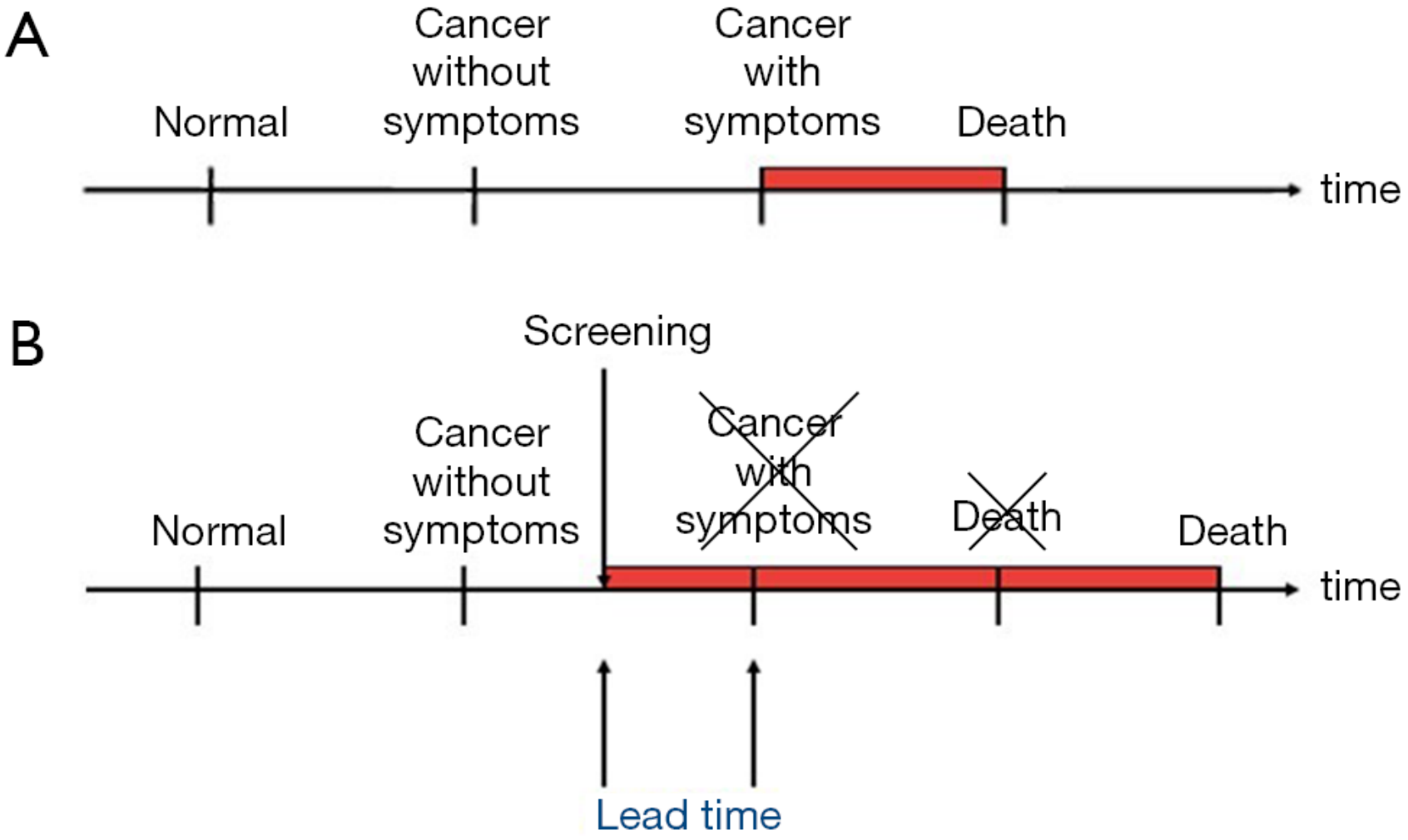


Figure 2. Lead-time bias. The diagram shows how earlier diagnosis will increase the survival statistic, even if death is not delayed.


A
Normal
Cancer without symptoms
Cancer with symptoms
Death
time
B
Screening
Normal
Cancer without symptoms
Cancer with symptoms
Death
Death
time
Lead time

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.

Physical examination

- Applied individually
- Consumes physicians' time
- Consumes money

Uses of screening

- **Case detection** (people screened for their own benefit) eg.: breast cancer, PKU, 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 (e.g., tuberculosis).

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
- Percentage of false-negative=c/(a+c)x100
- Percentage 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-positive” 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
	−	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
	−	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
	−	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

PREVENTIVE AND SOCIAL MEDICINE-
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