Screening

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

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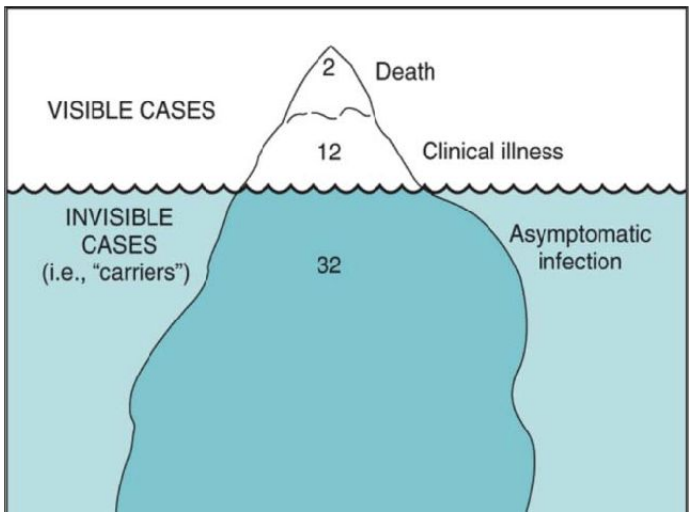
Iceberg Phenomenon of Disease [1]

- This concept helps in giving us a better idea of the progress of disease to its overt or apparent form.
- The **submerged portion** of the iceberg represents the hidden mass of the disease (carriers)
- The **floating tip** represents what physicians see in practice (symptomatic cases)
- This concept is **very challenging** in preventive medicine, because if we can't detect the disease we can't prevent it



Screening [2]

Definition

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

Examples

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

1. Epidemiologist and others who study disease find that the pattern of disease in hospitals is quite different from that in a community. That is, a far larger proportion of disease (e.g., diabetes, hypertension) is hidden from view in the community than is evident to physicians or to the general public. The analogy of an iceberg, only the tip of which is seen, is widely used to describe disease in the community.
2. They are based primarily on conserving the physician-time for diagnosis and treatment and having technicians to administer simple, inexpensive laboratory tests.

Lead Time

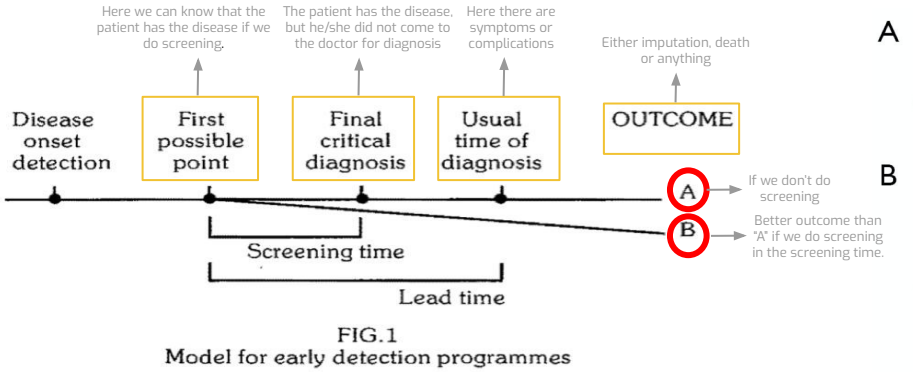
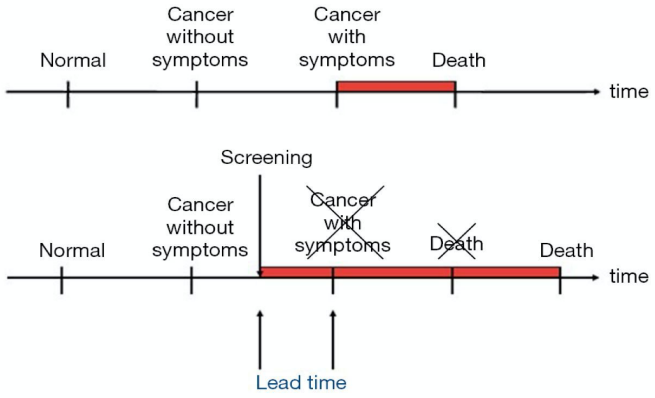


FIG.1
Model for early detection programmes



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

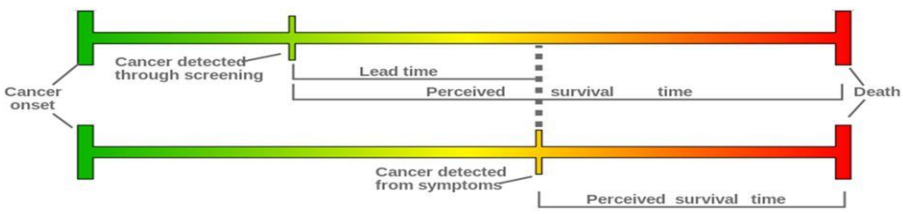
Is the benefit of the screening program.

1 **Lead time** [1] is the advantage gained by screening presented by alteration in the outcome.

2 It is defined as the period between diagnosis by early detection (screening) and diagnosis by other means [2].

3 The benefit of the program must be seen in terms of its outcome, so if there's no benefit in early detection the lead time is considered a bias and doesn't provide critical info.

Lead Time Bias [3]



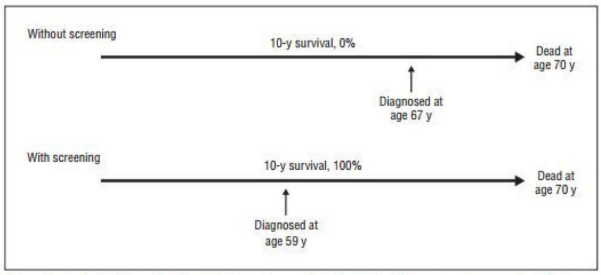


Figure 2. Lead-time bias. The diagram shows how earlier diagnosis will increase the survival statistic, even if death is not delayed.

1. Think of lead time as the time that could've been wasted before an actual diagnosis is made (after the symptoms appeared). Early detection can help treat many diseases and prevent their complications.
2. Detection programmes should, therefore, concentrate on those conditions where the time lag between the disease onset and its final critical point is sufficiently long to be suitable for population screening
3. Lead time bias is an increase in the perceived survival time (what you see) without affecting the outcome. For example, if there's an untreatable cancer and its survival time was 10 years, even if you diagnose the case early the outcome is the same.

Concepts Related to Screening

We need to differentiate between screening and other terms, which are:

- Periodic examination
- Diagnosis and diagnostic tests
- Case-finding

Screening tests [1]

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 and premarital screening for syphilis.

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. gonorrhoeae.

Screening vs Diagnostic tests [2]		
Difference	**Screening test**	**Diagnostic Test**
Target	Apparently healthy	People with indications or sick
Application	Applied to groups	Applied to single patients all diseases are considered
Evidence	Test results are arbitrary and final	Diagnosis is not final but modified in light of new evidence, diagnosis is the sum of all evidences
Criteria	Based on one criterion/cut-off point	Based on evaluation of sign(e.g diabetes), symptoms and laboratory findings
Accuracy	Less accurate	More accurate
Cost	Less expensive	More expensive
Treatment	Not a basis for treatment	Basis for a treatment
Initiative	From the investigator or care-providing agencies	From the patient with a complaint

1. A screening test is not intended to be a diagnostic test. It is only an initial examination. Those who are found to have positive test results are referred to a physician for further diagnostic work-up and treatment
2. However, the criteria in the table are not hard and fast. There are some tests which are used both for screening and diagnosis, e.g., test for anaemia and glucose tolerance test. Screening and diagnosis are not competing, and different criteria apply to each.

Concepts Related to Screening

Case finding [1]

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.

Periodic Health Examination

It 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 using a number of standard procedures such as counseling, examination, and lab tests..

Screening vs Periodic Health Examination [2]		
Difference	**Screening**	**Periodic Health Examination**
Application	Wide application	Individual application
Cost	Inexpensive	Consumes money
Time	Requires less time from the physician	Consumes physician time

Uses of Screening

1. **Case detection [2]:** people screened for their **own benefit**.
   For Example: Screening for breast cancer, deafness in children
2. **Control of disease [3]:** people are screened for the benefit of **others**
   For Example: TB to protect population
3. **Research purposes** such as measuring the prevalence and incidence.
4. **Educational opportunity**: creating public awareness and educating health professionals.

1. Case finding is a strategy for targeting individuals or groups who are suspected to be at high risk
2. This is also known as "prescriptive screening". It is defined as the presumptive identification of unrecognized disease, which does not arise from a patient's request, e.g., neonatal screening.
3. This is also known as "prospective screening". People are examined for the benefit of others, e.g., screening of immigrants from infectious diseases such as tuberculosis and syphilis to protect the home population; and screening for streptococcal infection to prevent rheumatic fever.

Uses of Screening

Case detection:

- Is the presumption identification of unrecognized disease, which does not arise from a patient request.
- For example, in 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.
- Another example is the screening for HIV and other STDs
- It also 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

Educational opportunities:

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

Types of Screening [1]

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)
- **Not useful for preventive measures [2]**

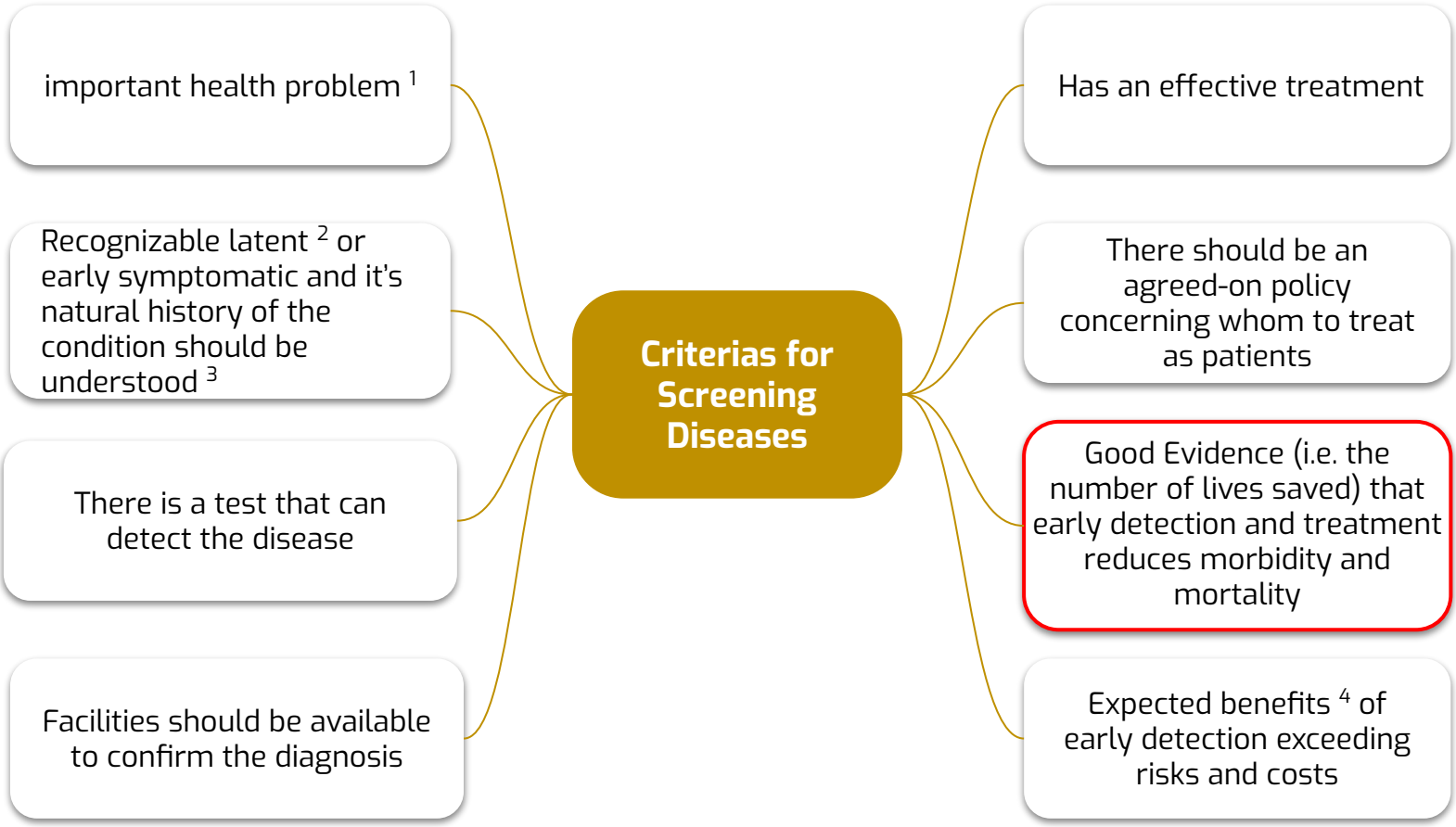
VS

High risk / Selective screening

- Screening will be most productive if applied selectively to high-risk groups, the groups defined on the basis of epidemiological research
- For example: screening for diabetes, hypertension, breast cancer in patients with positive family history
- **Screening for risk factors.**

1. There's a third type of screening called multiphasic screening which is defined as defined as the application of two or more screening tests in combination to a large number of people at one time than to carry out separate screening tests for single diseases. The procedure may also include a health questionnaire, clinical examination and a range of measurements and investigations (e.g., chemical and haematological tests on blood and urine specimens, lung function assessment, audiometry and measurement of visual acuity)
2. Unless it is backed up by suitable treatment that will reduce the duration of illness or alter its final outcome.

Criteria for Screening Diseases



Criteria for Screening Tests

1

Acceptability:

- A screening test should be acceptable to people at whom it is aimed.
- Painful (bone marrow biopsy), discomforting or embarrassing (rectal/vaginal exam) examinations are not acceptable to the population in mass campaigns

2

Repeatability:

- A screening test must give consistent results when repeated more the once on the same individual under the same conditions

3

Validity:

- Refers to what extent the test accurately measures which it claims to measure
- For example: Glycosuria vs Glucose tolerance test (GTT) to diagnose diabetes (glycosuria is a useful screening test however GTT is more valid)

1. In other words, the prevalence should be high. If the disease wasn't an important health issue the costs will exceed the benefits making the screening program not cost effective.
2. We can't screen for rapidly fatal diseases or diseases with short preclinical stage because there'll be no time between screening and diagnosing and this will make the screening program not efficient
3. So that we can know at what stage the process ceases to be reversible
4. For example the number of lives saved

Components of Validity

Sensitivity	Specificity
Predictive value of a positive test	Predictive value of a negative test
Percentage of false-negative	Percentage of False-positive

TABLE 3–A

Screening test result by diagnosis

Screening test results	Diagnosis: Diseased	Diagnosis: Not diseased	Total
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

1 Sensitivity and Specificity

(NOT complementary to each other)

	Sensitivity	Specificity
Definition	The ability of the test to identify correctly all those who have the disease, that is true positive - Percentage of true positives	The ability of a test to identify correctly those who do not have the disease, that is true negatives - Percentage of true negative
Example	90% sensitivity means that 90% of diseased people screened by the test will give a "true-positive" result and the remaining 10% a "false negative results"	90% specificity means 90% of non-diseased people will give "true-negative" result, 10% of non diseased people screened by the test will be wrongly classified as "diseased" when they are not
Formula	(a) Sensitivity = a/ (a + c) × 100	(b) Specificity = d/(b + d) × 100

Screening test results	Diagnosis: Diseased	Diagnosis: Not diseased	Total
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

Example

Diagnosis of brain tumours by EEG

EEG results	Brain tumour: Present	Brain tumour: 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	Brain tumour: 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

2 Predictive Accuracy

Definition	• Reflects the diagnostic power of a test • Depends upon the sensitivity, specificity and disease prevalence • It is 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	
Predictive Value	**Predictive Value of a Positive Test**	**Predictive Value of a Negative Test**
Formula		

Screening test results	Diagnosis: Diseased	Diagnosis: Not diseased	Total
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

(c) Predictive value of a positive test = a/(a + b) × 100	(d) Predictive value of a negative test = d/(c + d) × 100

Example

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

3 Percentage of False +/-

Definition	• Opposite to sensitivity and specificity and is more important to clinicians	
Percentage	**Percentage of False-Negative** [1]	**Percentage of False-Positive** [2]
Formula	(e) Percentage of false-negatives = c/(a + c) × 100	(f) Percentage of false-positive = b/(b + d) × 100

1. False-negatives: The term "false-negative" means that patients who actually have the disease are told that they do not have the disease. It amounts to giving them a "false reassurance". The patient with a "false-negative" test result might ignore the development of signs and symptoms and may postpone the treatment.
2. False-positives: The term "false-positive" means that patients who do not have the disease are told that they have the disease. In this case, normal healthy people may be subjected to further diagnostic tests, at some inconvenience, discomfort, anxiety and expense - until their freedom from disease is established.

Summary

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The search for unrecognized disease or defect by means of rapidly applied tests, examinations or other procedures in apparently healthy individuals.</td><td>Examples:
-Pregnancy (eg. Anemia)
-Infancy (eg. Visual defects).
-Middle aged men and women (eg.. Hypertension).
-Elderly (eg. Glaucoma).</td></tr>
<tr><td>Lead Time</td><td colspan="2">- Lead time is the advantage gained by screening presented by alteration in the outcome.

- It is defined as the period between diagnosis by early detection (screening) and diagnosis by other means

.- The benefit of the program must be seen in terms of its outcome, so if there's no benefit in early detection the lead time is considered a bias and doesn't provide critical info.</td></tr>
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 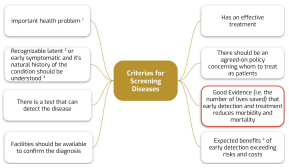
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• Repeatability
• Validity</td></tr>
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• Predictive Accuracy
• Percentage of False Positive/Negative</td></tr>
</table>

Summary

	Definition	Formula
Sensitivity	The ability of the test to identify correctly all those who have the disease, that is true positive -Percentage of true positives	$= a/(a + c) \times 100$ نمشي على الأعمدة
Specificity	The ability of a test to identify correctly those who do not have the disease, that is true negatives -Percentage of true negative	$= d/(b + d) \times 100$ نمشي على الأعمدة
Predictive value of a positive test	- Reflects the diagnostic power of a test - Depends upon the sensitivity, specificity and disease prevalence -It is 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	$= a/(a + b) \times 100$ نمشي على الصفوف
Predictive value of a negative test		$= d/(c + d) \times 100$ نمشي على الصفوف
Percentage of false-positive	Opposite to sensitivity and specificity and is more important to clinicians	$= b/(b + d) \times 100$
Percentage of false-negative		$= c/(a + c) \times 100$

Practice Questions

This is A cross tabulation of the results of a screening test and confirmatory test for prostate biopsy.

Clinical diagnosis	Biopsy results		Total
	+	-	
Positive	100	150	250
Negative	75	175	250
Total	175	325	500

Q1: Based on this table above. What is the predictive negative value?

A. 70%	B. 30%	C. 53%	D. 40%

Q2: Based on this table above. What is the sensitivity of this test?

A. 53.84%	B. 57.14%	C. 46.15%	D.42.85%

Q3: The ability of a test to identify correctly those who do not have the disease, that is true negatives Percentage of true negative is :.

A. Sensitivity	B. Specificity	C. Predictive value of positive test	D. Predictive value of negative test

Q4: Which one of the following diseases is suitable for screening programs?

A. A disease with high mortality	B.Diseases with no effective treatment	C. A disease with high prevalence of asymptomatic cases	D. A disease with rapid development of signs

Answer key:
1 (A) , 2 (B) , 3 (B) , 4 (C)

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من المحتمل ألا تستطيع التحكم في الظروف ، ولكنك تستطيع التحكم بأفكارك ، فالتفكير الإيجابى يؤدي إلى الفعل الإيجابي والنتائج الايجابية.

- إبراهيم الفقي