18th lecture:

Screening

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Lecture objectives:

By the end of the session the students should be able to;

- **Define main concepts used in screening**

- **Understand purposes and strategies of screening**

- **List properties of an ideal screening test**

- **Understand and interpret parameters used for assessment of screening tests**

HEADLINES

- Definitions
- Purposes of screening
- When do we screen?
- Strategies of screening
- Properties of ideal screening
- Examples of screening tests
- Screening parameters

Definition 1: Screening

- The **early detection** of

  – disease
  – precursors of disease
  – susceptibility to disease

in individuals who do not show any signs of disease, otherwise they are considered as cases.

Definition 2: Screening Test

Screening test -- specific technology (survey questionnaire, physical observation or measurement, laboratory test, radiological procedure, etc.) used to help identify persons with unrecognized disease or unrecognized risk factors for disease. So it is applied to **asymptomatic apparently healthy individuals.**

Purposes of Screening

– Classifying people with respect to their **likelihood** of having a particular disease
– Identifying persons at increased risk for the presence of disease, who warrant further evaluation
– Reducing morbidity and mortality from disease among persons being screened

Diagnosis ≠ Screening

– Screening tests can also be used as to suspect a certain diagnosis
– Such diagnosis is subject to confirmation of presence or absence of disease
– Screening is generally done among individuals who are not suspected of having disease

Comparison between screening and diagnostic tests

| Screening tests	Diagnostic tests
Done to those who are apparently healthy or asymptomatic	Done to those with suggestive signs or symptoms
Applied to a group of individuals	Applied to a single person
Results are based on **one criterion**	Results are based on the evaluation of a **number of symptoms, signs and investigations**
Results are **not conclusive**	Results are **conclusive and final**
Less accurate	**More accurate**
Less expensive	**More expensive**
Not a basis for treatment	**Basis for treatment**

Natural History of Disease

When do we do the screening test? Before onset of symptoms
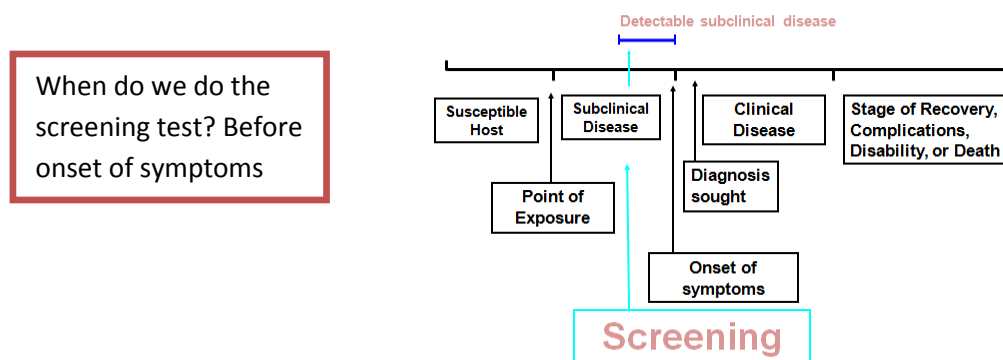
Not all diseases can be detected by screening, some have very short incubation or asymptomatic period.

Screening Strategies

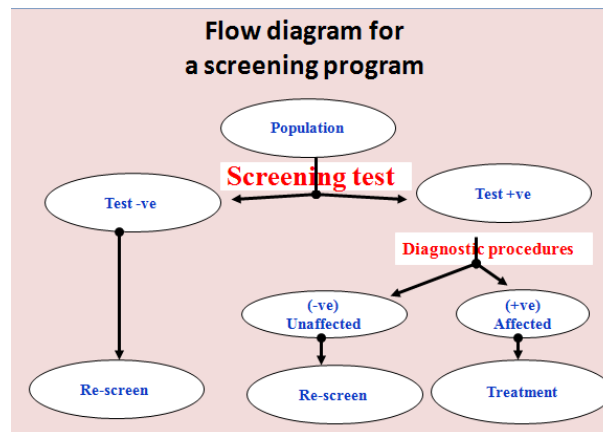| High-Risk Strategy	Population Approach
• Cost-effective • Intervention appropriate to the individual • Fails to deal with the root causes of disease (only modification) • Subjects motivated • Small chance of reducing disease incidence	• Potential to alter the root causes of disease • Large chance of reducing disease incidence • Small benefit to the individual (can prevent disease from developing) • Poor subject motivation • Problematic risk-benefit ratio

Properties of Ideal Screening

1. Screening is simple, inexpensive, and easily diffused through the population (population accept it easily).
2. The act of screening is safe and acceptable.
3. The screening test is reliable.
4. The screening test is accurate.

Examples of Screening Tests

- Questions
- Clinical Examinations
- Laboratory Tests
- Genetic Tests
- X-rays

Flow diagram for a screening program

Population → Screening test → Test -ve / Test +ve

Test -ve → Re-screen

Test +ve → Diagnostic procedures → (-ve) Unaffected / (+ve) Affected

(-ve) Unaffected → Re-screen

(+ve) Affected → Treatment

Validity of Screening Tests

Validity tells us how accurate is the screening test as compared to the confirmatory diagnostic test or the Gold Standard test.

Validity can be measured by:

- Sensitivity
- Specificity

Results of a screening test compared to the gold standard

	Present	Absent	
Screening Test Positive	a	b	a + b
Screening Test Negative	c	d	c + d
	a + c	b + d	N

Results of a screening test compared to the gold standard

	Present	Absent
Screening Test Positive	True positives	False positives
Screening Test Negative	False negatives	True negatives

Sensitivity

- Proportion of individuals who have the disease who test positive (a.k.a. true positive rate)

- tells us how well a "+" test picks up disease

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

Specificity

- Proportion of individuals who don't have the disease who test negative   (a.k.a. true negative rate)

- tell us how well a "-" test detects no disease

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

Example

- Sensitivity: a / (a + c)

  - Sensitivity = 90%

  - i.e. Screening test will correctly identify 90% of all true cases.

- Specificity: d / (b + d)

  - Specificity = 95%

  - i.e. Screening test will correctly classify 95% of all non-cases as being disease free.

  Sensitivity: a / (a + c) = 90%

  False negative Rate=c/a+c=10/100=10%

  Specificity: d / (b + d) 95%

False Positive Rate=b/b+d=5/100=5%

Screening Principles

- **Sensitivity**
    - the ability of a test to correctly identify those who have a disease
        - a test with high sensitivity will have few false negatives
- **Specificity**
    - the ability of a test to correctly identify those who do not have the disease
        - a test that has high specificity will have few false positives

Positive Predictive Value

- Proportion of individuals who test positive who actually have the disease
- i.e. *The ability to predict the presence of disease from test results.*

Disease

	yes	no	
+	a	b	a + b
-	c	d	c + d
	a + c	b + d	N

$$P.P.V. = \frac{a}{a + b}$$

Negative Predictive Value

- Proportion of individuals who test negative who don't have the disease
- *i.e. The ability to predict the absence of disease from test results.*

Disease

	yes	no	
+	a	b	a + b
-	c	d	c + d
	a + c	b + d	N

$$N.P.V. = \frac{d}{c + d}$$

A test is used in 50 people with disease and 50 people without. These are the results.

Calculate:

- Sensitivity
- Specificity
- Positive Predictive Value
- Negative Predictive Value

Disease

	Present	Absent	
Positive	48	3	51
Negative	2	47	49
	50	50	100

Answers:

- – Sensitivity = 48/50
- – Specificity = 47/50
- – Positive Predictive Value = 48/51
- – Negative Predictive Value = 47/49

Net effects from screening

1. True positives are exposed to the costs, inconvenience, and hazards of screening, follow-up diagnostic evaluations, and therapeutic interventions. Only true positives have an opportunity to **benefit** from medical therapy.

2. True negatives are exposed to the costs, inconvenience, and hazards of screening. True negatives may be **reassured** by knowledge of a negative screening test result.

3. False positives are exposed to the costs, inconvenience, and hazards of screening and follow-up diagnostic evaluations. The falsely positive screening test result may cause psychological and **emotional distress**.

4. False negatives are exposed to the costs, inconvenience, and hazards of screening. False negatives may be **falsely reassured** by knowledge of a negative screening test result. False negatives represent lost opportunities to prevent adverse outcomes from disease.

3,4 are called adverse effects or errors of screening

Generalities:

1. Specificity is often the major determinant of the costs and feasibility of a screening program.

2. Sensitivity establishes the maximum extent (upper bound) to which a screening program is capable of producing health benefit

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References:

- Raffle A, Gray M. Screening: Evidence and practice. Oxford: Oxford University Press, 2007

- Songer T. Screening and its useful tools. South Asian Cardiovascular Research Methodology Workshop

- Weissfeld JL. Screening and early detection