# Screening

**BY**

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# *Iceberg Phenomenon of Disease*

- ***The submerge portion of the iceberg represents the hidden mass of the disease (e.g. subclinical cases, carriers, undiagnosed cases). The floating tip represents what the physician sees in his practice.***

# *Concept of Screening*

- ***Defined as "the search made for detecting hidden disease or defect among apparently healthy individuals in the community by means of rapidly applied tests, examinations or other procedures"***

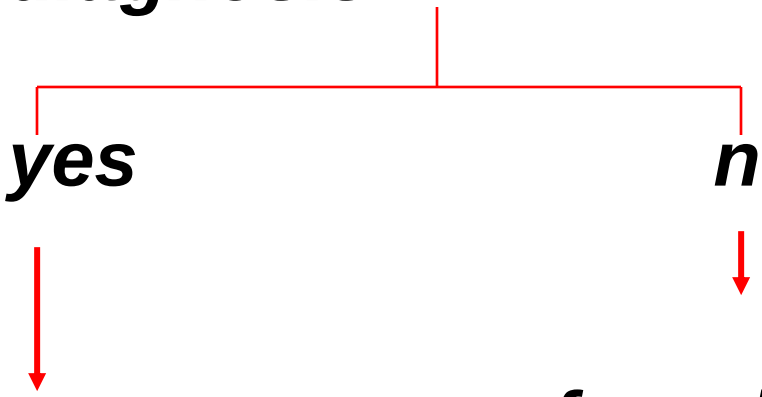
# Screening for Disease Control

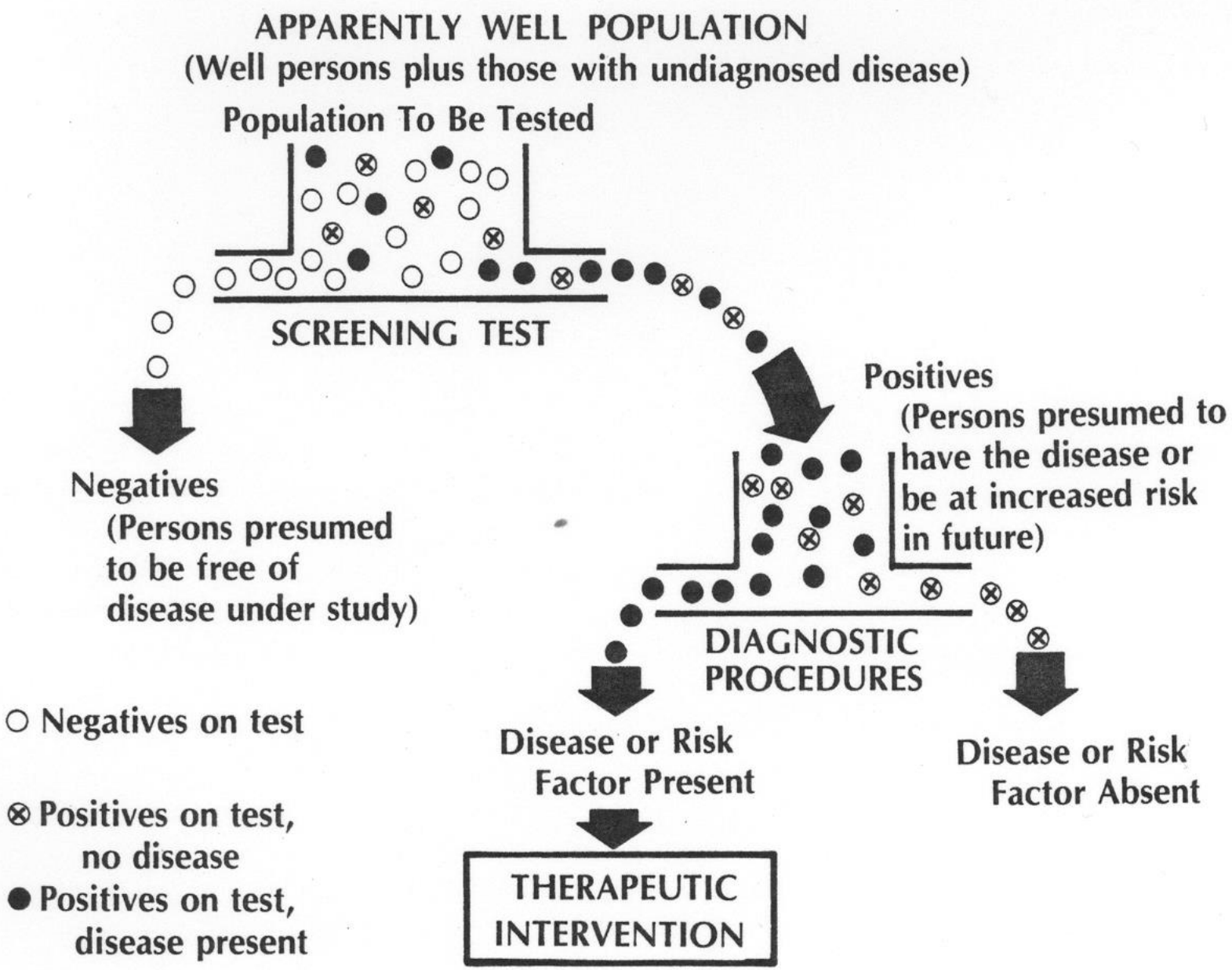
- ***Examination of <u>asymptomatic</u> people***

- ***Classification as***
  - ***probably to have a disease***
  - ***probably not to have a disease***

# Screening for Disease Control

- *"Unlikely"* → *referred to next screening cycle*
- *"Likely"* → *further testing for diagnosis*




APPARENTLY WELL POPULATION
(Well persons plus those with undiagnosed disease)
Population To Be Tested
SCREENING TEST
Negatives
(Persons presumed
to be free of
disease under study)
Positives
(Persons presumed to
have the disease or
be at increased risk
in future)
DIAGNOSTIC
PROCEDURES
Disease or Risk
Factor Present
Disease or Risk
Factor Absent
THERAPEUTIC
INTERVENTION
○ Negatives on test
⊗ Positives on test,
no disease
● Positives on test,
disease present

# *Screening and Diagnostic Tests*

- ***A screening test is not intended to be a diagnostic test.***
- ***Those who are found to have positive test results are referred to a physician for further diagnostic work-up.***
- ***There are some tests which are used both for screening and diagnosis, e.g., test for anemia and glucose tolerance test.***

- **SCREENING TEST**

- Done on apparently healthy people
- Done on groups
- Done by epidemiologist
- Purpose is to do community diagnosis, to launch a control program
- Less expensive
- Initiative is from the epidemiologist

- **DIAGNOSTIC TEST**

- Done on sick people
- Done on individual cases
- Done by physician
- Purpose is to make a diagnosis in the patient to give treatment
- More expensive
- Initiative is from the patient

# *Aim*

- ***The basic purpose of screening is to sort out, from a large group of apparently healthy persons, those having the disease and those not having the disease***

# *OBJECTIVES*

- ***To provide treatment to those detected persons, so that the disease is controlled in the community***

# *Uses of screening*

- ***a) Case detection** - the presumptive identification of unrecognized disease, which does not arise from a patient's request. To make sure that appropriate treatment is started early.*
- ***b) Control of disease** - People are examined for the benefit of others, e.g., screening of immigrants from infectious disease such as tuberculosis and syphilis to protect the home population.*

# *Uses of screening*

- ***c.) Research purposes - e.g. cancer, hypertension. Screening may aid in obtaining more basic knowledge about the natural history of such diseases.***
- ***d.) Educational opportunities - screening programs (as for example, screening for diabetes) provide opportunities for creating public awareness and for educating health professionals.***

# *Types of Screening*

- ***Mass screening***
- ***High risk selective screening***
- ***Multiphasic screening***
- ***Multipurpose screening***
- ***Opportunistic screening***

# *Types of Screening*

## *a.) Mass screening*

***It is offered to all, irrespective of the particular risk individual.***

# Types of Screening

## b.) High risk or selective screening

- *Screening will be most productive if applied selectively to high risk groups, One population subgroup where certain diseases (e.g., diabetes, hypertension, breast cancer) tend to be aggregated in the family. By screening the other members of the family (and close relatives) the physician can detect additional cases.*
- *More recently, epidemiologists have extended the concept of screening for disease to screening for "risk factors"*

# *Types of Screening*

## *c.) Multiphasic screening*

***This is the screening of the population by applying different tests in different phases, for the diagnosis of one disease***

# Types of Screening

## d) Multipurpose screening:

*This is the screening of a group of population by application of two or more tests, at one time to detect more number of diseases. For example, Screening of pregnant mothers with blood for Hb%, VDRL, Elisa for HIV, surface antigen for HBV , for blood grouping and Rh-typing, Urine for albumin sugar and microscopy ;*

# *Types of Screening*

## *e)Opportunistic screening*

***This is the screening of a patient, who consults the doctor for some other purpose***

***This is also called as 'Case finding screening'***

# *Criteria for Screening*

- ***Before a screening program is initiated, a decision must be made whether it is worthwhile, which requires ethical, scientific and if possible financial justification.***
- ***The criteria for screening are based on two considerations:***
  - ***DISEASE to be screened***
  - ***TEST to be applied.***

# *Criteria for Screening*

## *1- Disease:*

***the disease to be screened should fulfill the following criteria before it is considered suitable for screening:***

- ***The condition sought should be an important health problem (in general, prevalence should be high)***
- ***The natural history of the condition, including development from latent to declared disease, should be adequately understood (so that we can know at what stage the process ceases to be reversible)***
- ***There is a test that can detect the disease prior to the onset of signs and symptoms***

# *Criteria for Screening*

## *Disease*

- ***Facilities should be available for confirmation of the diagnosis***
- ***There is an effective treatment***
- ***There is good evidence that early detection and treatment reduces morbidity and mortality***
- ***The expected benefits (e.g, the number of lives saved) of early detection exceed the risks and costs.***
- ***When the above criteria are satisfied, then only, it would be appropriate to consider a suitable screening test.***

# *Criteria for Screening*

***2- Screening test,*** ***The test must satisfy the criteria of:***

- ***Acceptability***
- ***Repeatability***
- ***Validity***
- ***Simplicity***
- ***Safety***
- ***Rapidity***
- ***ease of administration***
- ***cost.***

# *Criteria for Screening = Screening Test*

## *1) Acceptability*

- ***Since a high rate of cooperation is necessary, it is important that the test should be acceptable to the people at whom it is aimed.***
- ***In general, tests that are painful, discomforting or embarrassing (e.g. rectal or vaginal examinations) are not likely to be acceptable to the population in mass campaigns***

# *Criteria for Screening = Screening Test*

## *2.) Repeatability*

- ***An attribute of an ideal screening test or any measurement (e.g. height, weight) is its repeatability (sometimes called reliability, precision or reproducibility).***
- ***That is the test must give consistent results when repeated more than one on the same individual or material, under the same conditions.***
- ***The repeatability of the test depends upon three major factors, namely observer variation, biological (or subject) variation and errors relating to technical methods.***

# *Criteria for Screening = Screening Test*

## *A. Observer variation*

***Types:***

***1.) Intra-observer variation or within observer variation.*** ***This is a variation between repeated observations by the same observer on the same subject or material at the same time. Intra-observer variation may often be minimized by taking the average of several replicate measurements at the same time.***

***2.) Inter-observer variation.*** ***This is a variation between different observers on the same subject or material, also known as between observer variation.***

# *Criteria for Screening = Screening Test*

***Observer errors can be minimized by:***

- ***Standardization of procedures for obtaining measurements and classifications***
- ***Intensive trainings of all the observers***
- ***Making use of two or more observers for independent assessment, etc***
- ***It is probable that these errors can never be eliminated absolutely.***

# *Criteria for Screening = Screening Test*

## *B. Biological (subject) variation*

***The fluctuation in the variate measured in the same individual may be due to:***

***(a) changes in the parameters observed. For example, subject variation of blood pressure is a common phenomenon.***

***(b) variations in the way patients perceive their symptoms and answer***

***Whereas observer variation may be checked by repeat measurement at the same time, biological variation is tested by repeat measurements over time.***

# *Criteria for Screening = Screening Test*

***C. Errors relating to technical methods***

- ***Lastly, repeatability may be affected by variations inherent in the method, e.g. defective instruments, erroneous calibration, faulty reagents; or the test itself might be inappropriate or unreliable.***

# *Criteria for Screening = Screening Test*

## *3.) Validity (accuracy)*

- ***The term validity refers to what extent the test accurately measures which it purports to measure.***
- ***In other words, validity expresses the ability of a test to separate or distinguish those who have the disease, from those who do not***
- ***Validity has two components : sensitivity and specificity***

# Outcomes of a Screening Test

| Screening Test | True Disease Status: Positive | True Disease Status: Negative | Total |
|---|---|---|---|
| Positive | True Positives (TP)  | False Positives (FP)  | TP+FP |
| Negative | False Negatives (FN)  | True Negatives (TN)  | FN+TN |
| Total | TP+FN | FP+TN | TP+FP+FN+TN |

# Validity of Screening Tests

| Results of Screening Test | True Disease Status: + | True Disease Status: - |
|---|---|---|
| + | a | b |
| - | c | d |

*a = true positive*
*b = false positive*
*c = false negative*
*d = true negative*

# *Criteria for Screening = Screening Test*

- ***Sensitivity*** *- the ability of a test to identify correctly all those who have the disease, that is "true positive".*
- *A 90% sensitivity means that 90% of the diseased people screened by the test will give a "true positive".*
- *(Percentage of the diseased persons, showing the test result positive)*

# Validity of Screening Tests

| Results of Screening Test | True Disease Status + | True Disease Status - |
|---|---|---|
| + | a | b |
| - | c | d |

$$\text{Sensitivity} = a / (a + c) \times 100$$

***Specificity*-is defined as the ability of a test to identify correctly those who do not have the disease, that is "true negatives".**

**A 90% specificity means that 90% of the non-diseased people give "true negative"**

**(Percentage of the non- diseased persons, showing the test result negative)**

# Validity of Screening Tests

| Results of Screening Test | True Disease Status + | True Disease Status - |
|---|---|---|
| + | a | b |
| - | c | d |

$$\text{Specificity} = d / (b + d) \times 100$$

# Validity of Screening Tests

| | | Breast Cancer + | Breast Cancer - |
|---|---|---|---|
| Physical Exam and Mammo-graphy | + | 132 | 983 |
| | - | 45 | 63650 |

**Sensitivity:**

Sensitivity = a / (a + c)

**Specificity:**

Specificity = d / (b + d)

# Validity of Screening Tests

| | | Breast Cancer + | Breast Cancer - |
|---|---|---|---|
| Physical Exam and Mammo-graphy | + | 132 | 983 |
| | - | 45 | 63650 |

a / (a + c) **Sensitivity:**
Sensitivity = 132 / (132 + 45)χ100 = 74.6%

**Specificity:** d / (b + d)
Specificity = 63650 / (983 + 63650)χ100 = 98.5%

# Validity of Screening Tests

***Sensitivity:***

***Sensitivity = a / (a + c)χ100***

***=132 / (132 + 45)χ100 = 74.6%***

***Specificity:*** ***d / (b + d)χ100***

***Specificity = 63650 / (983 + 63650)χ100 = 98.5%***

***Sensitivity:*** ***Screening by physical exam and mammography will identify 75% of all true breast cancer cases.***

***Specificity:*** ***Screening by physical exam and mammography will correctly classify 98.5% of all non-breast cancer patients as being disease free.***

# *DENOMINATORS OF THESE RATES*

- ***Note that all the denominators of the four rates so far defined (sensitivity, specificity and the false + and false – rates) are DISEASE STATES***
- ***The denominators of sensitivity and the false negative rate is PEOPLE WITH DISEASE***
- ***The denominators of specificity and the false positive rate is PEOPLE WITHOUT DISEASE***

# *PREDICTIVE VALUE*

***Positive predictive value is the proportion of all people with positive tests who have the disease.***

***Negative predictive value is the proportion of all people with negative tests who do not have the disease.***

# *PREDICTIVE VALUES DEFINED*

- ***POSITIVE PREDICTIVE VALUE =***

***All people with disease***

***All people with a positive test***

- ***NEGATIVE PREDICTIVE VALUE =***

***All people without disease***

***All people with a negative test***

# *False positives*

***These are the percentage of non-diseased persons wrongly indentify as having the disease because the test result is positive***

***False positive=b/b + d x 100***

# *FALSE NEGATIVES*

***These are the percentage of diseased persons wrongly indentified as not having the disease because the test result is negative***

***False negatives=c/a+ c x 100***

# *POINTS TO NOTE*

- ***Note that the numerators and denominators are reversed compared to sensitivity and specificity. In predictive values, the denominator is the test result, and the numerator is disease or non-disease***
- ***In general, the positive predictive value is the one most used. Positive predictive value and sensitivity are perhaps the two most important parameters in understanding the usefulness of a test under field conditions.***

# *CRITICAL DIFFERENCE BETWEEN DISEASE-DENOMINATORED AND TEST-DENOMINATORED MEASURES*

- ***Sensitivity and specificity do not vary according to the prevalence of the disease in the population.***
- ***Predictive value of a test, however is HIGHLY DEPENDENT on the prevalence of the disease in the population***

# CALCULATING THE RATES

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

| | | Disease | | |
|---|---|---|---|---|
| | | + | - | |
| Test | + | 48 | 3 | 51 |
| | - | 2 | 47 | 49 |
| | | 50 | 50 | 100 |

| | | Disease | | |
|---|---|---|---|---|
| | | + | - | |
| Test | + | 48 | 3 | 51 |
| | - | 2 | 47 | 49 |
| | | 50 | 50 | 100 |

***Sensitivity = 48/50 = 96%***

***Specificity = 47/50 = 94%***

***Positive predictive value = 48/51 = 94%***

***Negative predictive value = 47/49 = 96%***

***A new screening for a certain disease was administered to 480 persons,***

***60 of whom are known to have the disease.***

***The test was positive in 50 of the persons with the disease as well as in 20 persons with out the disease. Evaluate the screening test by all the measures.***

## True Disease Status

| Results of Screening Test | + | - | Total |
|---|---|---|---|
| + | a(50) | b(20) | a+b=70 |
| - | c(10) | d(400) | c+d=410 |
| Total | a+c=60 | b+d=420 | a+b+c+d=480 |

# Sensitivity

***Sensitivity***

$$= a/a + c \times 100$$

$$= 50/60 \times 100$$

$$= 500/6$$

$$= 83.33\%$$

# *Specificity*

***Specificity***

$$=d/b + d \times 100$$

$$=400/420 \times 100$$

$$=4000/42$$

$$=95.24\%$$

# *PPV*

***Predictive value of a positive test***

$$=a/a+b \times 100$$

$$=50/70 \times 100$$

$$=500/7$$

$$=71.43\%$$

# *NPV*

***Predictive value of a negative test***

***=d/c+ d x 100***

***=400/410 x 100***

***=4000/41***

***=97.65%***

# *False positive*

***False positive***

$$=b/b+ d \times 100$$

$$=20/420 \times 100$$

$$=200/42$$

$$=16.67\%$$

# *False negative*

***False negatives***

$$=c/a+ c \times 100$$

$$=10/60 \times 100$$

$$=100/6$$

$$= 16.67\%$$

# *YIELD*

*"Yield" is the amount of previously unrecognized disease that is diagnosed as a result of screening efforts*

*It depends upon many factors*

- *sensitivity and specificity of test*
- *prevalence of disease*
- *participation of the individuals in the detection program*

- *For example*

*By limiting diabetes screening program to persons over 40 years, we can increase the yield of the screening test*

*High risk populations are usually selected for screening,---------- thus increasing yield*

# *COMBINATION OF TESTS*

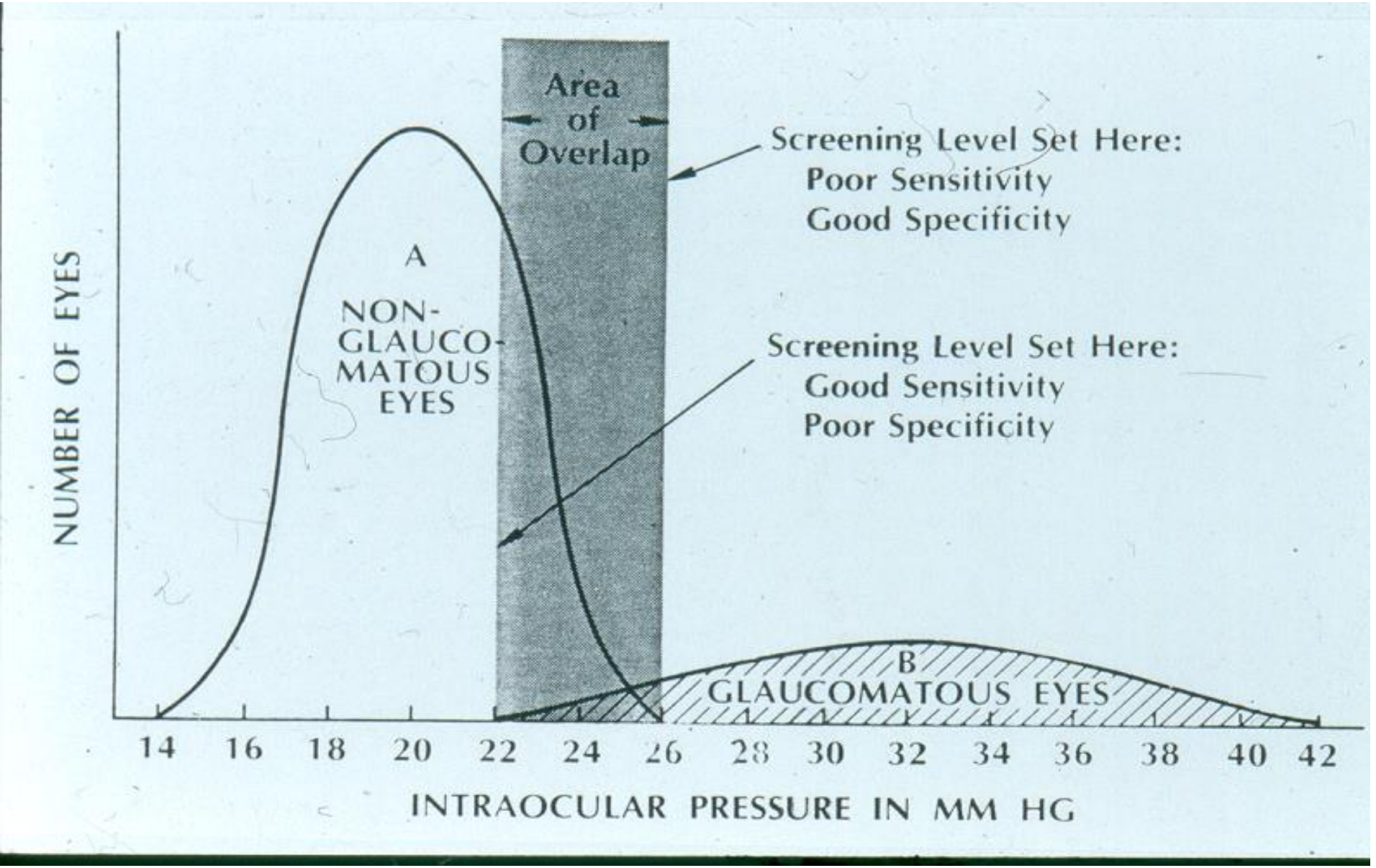
***Two or more tests can be used in combination to enhance the specificity or sensitivity of screening.***

***For example syphilis screening affords an example whereby all screenees are first evaluated by an RPR test . This test has high sensitivity, yet will yield false positives. All those positive to RPR are then submitted to FTA-ABS, which is a more specific test, and the resultant positives now truly have syphilis.***

# *PROBLEM OF BORDER-LINE*

***The question arises which of the qualities is more important in screening***

***Figure is a bimodal distribution of variable in the normal and the diseased populations. Note that the two curves overlap. If the disease is bimodal, the shaded area or the border-line group will comprise a mixture of persons with the disease and persons with out the disease. The point at which the distribution intersect is frequently used as the cut-off point between the normal and diseased persons.***


Area
of
Overlap
Screening Level Set Here:
Poor Sensitivity
Good Specificity
A
NON-
GLAUCO-
MATOUS
EYES
Screening Level Set Here:
Good Sensitivity
Poor Specificity
B
GLAUCOMATOUS EYES
NUMBER OF EYES
14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
INTRAOCULAR PRESSURE IN MM HG

# Where do we set the cut-off for a screening test?

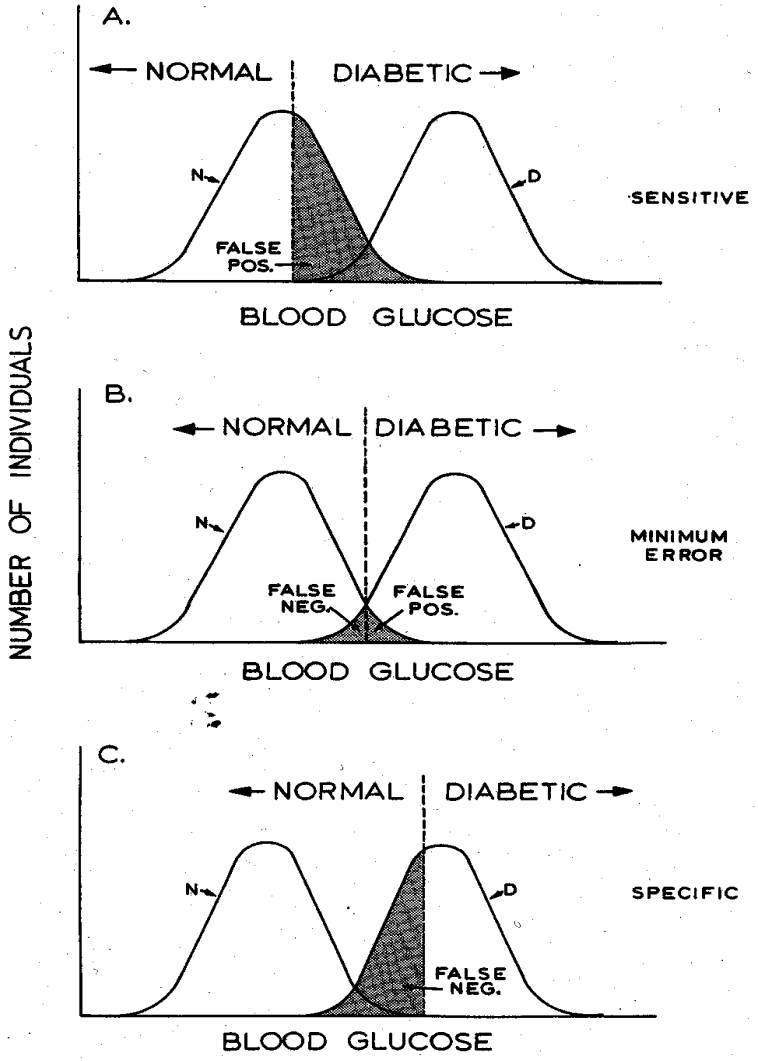


*Figure is a unimodal distribution.*

*Many physiological variables such as*

*blood pressure,*

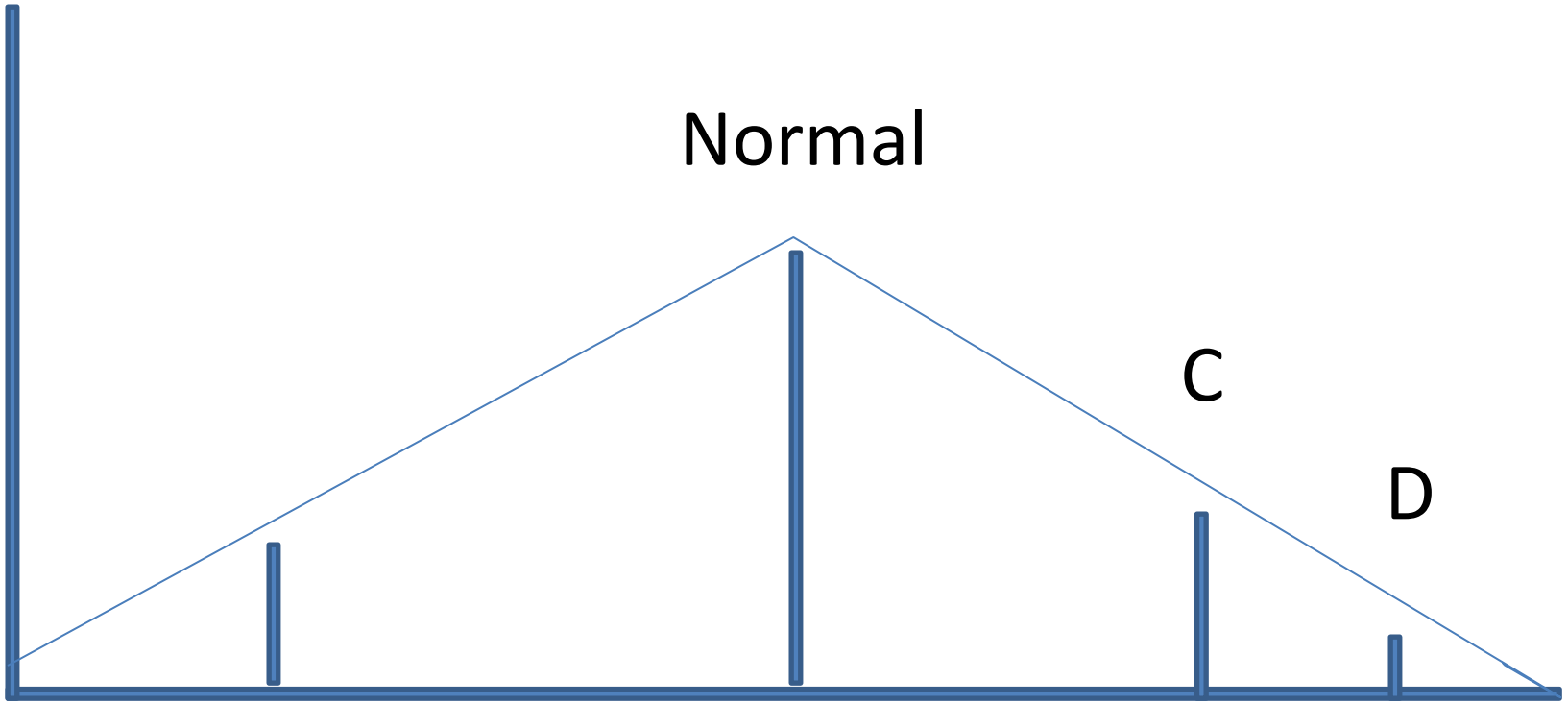
*blood sugar*

*and serum cholestrol*

*show this type of distribution.*

*Their values are continuously distributed around the mean , confirming to a normal or skewed distribution.*

*In these observations, there is no sharp dividing line between the "normal" and "diseased". "The border" line group will comprise a homogeneous sample of persons. The questions arises whether the cut-off point between " disease " and "normality" should be set at C or D as Figure*


Normal
C
D


Thanks