

Screening

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Session Objectives

- Distinguish screening from diagnosis
- Understand the basic principles of screening
- Distinguish between reliability (repeatability) and accuracy (validity)
- Distinguish between efficacy and effectiveness
- Calculate sensitivity, specificity, predictive value positive, and predictive value negative
- Describe the effect of prevalence on each of the above measures

Screening Programs

Screening Tests

To screen

or

not to screen?

Screening Definition

Screening is the presumptive identification preclinically of asymptomatic disease by using tests, examinations, or other rapidly conducted procedures. Persons with a suspicious finding must be referred for follow-up diagnostic tests and necessary treatment. Screening implies a public health intervention applied to populations, whereas diagnosis implies a clinical intervention applied to individuals.

Screening - Summary

Population: healthy

Disease: asymptomatic

Test: not diagnostic

The decision to screen

- Disease
- Screening test
- Follow-up
- Social and economic factors

Principles of Screening

The disease

- Important
- Latent stage
- Natural history understood

The screening test

- Suitable
- Acceptable

Follow-up

- Policy
- Available Diagnostic Test
- Available Treatment
- Acceptable treatment
- Available facilities
- Impact on prognosis

Social factors

- Costs
- Process
- Ethics

Factors influencing screening test performance

Intrinsic

- Properties of the test

Extrinsic

- Characteristics of the population
- Skill and judgment of the screener

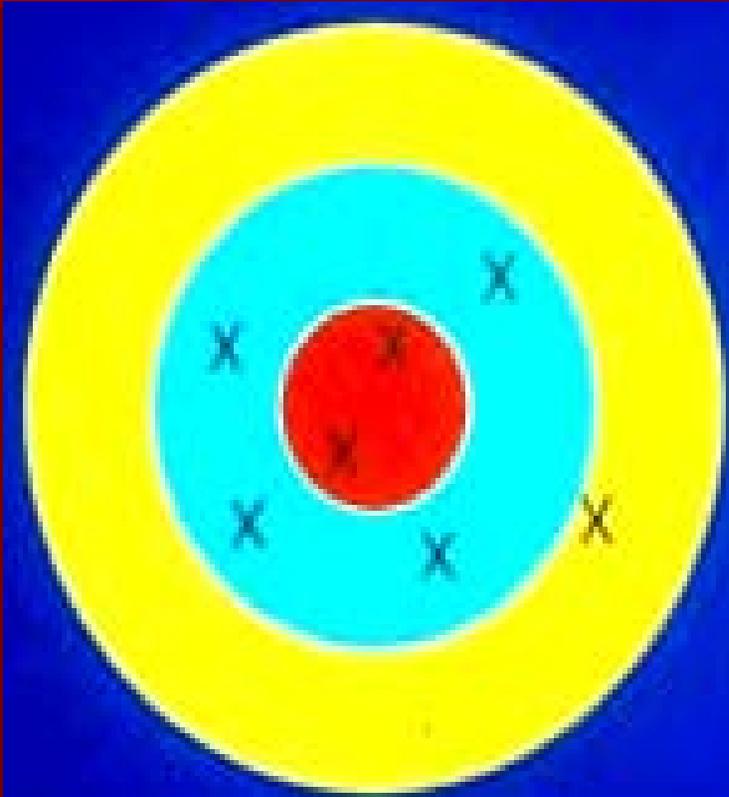
Efficacy of a Screening Test

Efficacy refers to the ability of the screening test to produce a precise result under ideal conditions. Efficacy is related to the intrinsic properties of the test: namely, its reproducibility (reliability) and its accuracy (validity).

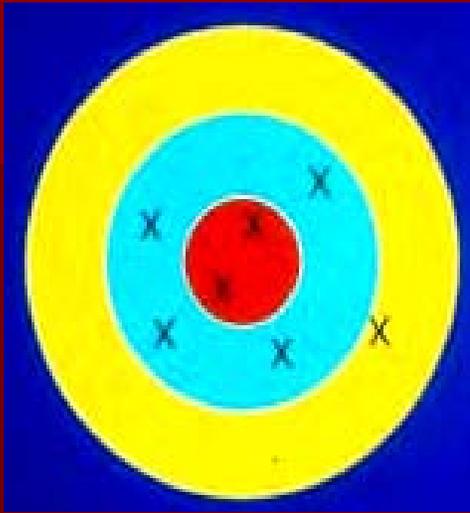
Intrinsic test properties

- Validity - *Accuracy*
- Reproducibility - *Reliability*

Validity vs Reproducibility



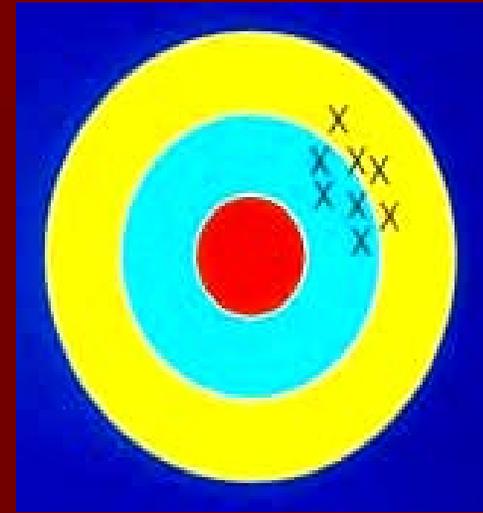
Efficacy—Intrinsic Property



Accuracy
(validity)

Measure by:

- Sensitivity
- Specificity
- Predictive value positive
- Predictive value negative



Reproducibility
(Reliability, Consistency, Precision)

Variation:

- Biologic
- Test Method
- Intraobserver
- Interobserver

Reproducibility

Reproducibility (reliability) is the ability of the test to achieve the same result when repeated. Concerning reliability, there are four sources of possible variation:

1. Biological variation
2. Test method variation
3. Intraobserver variation
4. Interobserver variation

Accuracy- validity

Accuracy is the test's ability to do what it is supposed to do and is measured in terms of four indices: sensitivity, specificity, predictive value positive, and predictive value negative (see table below).

Disease

Gold Standard

Present

Absent

Positive

A

B

true positive

false positive

Test

Negative

C

D

false negative

true negative

Sensitivity

- Proportion of persons with the condition who test positive

Specificity

- Proportion of persons without the condition who test negative

Disease

+

-

+

A

B

Test

-

C

D

Total

A + C

B + D

$$\text{Sensitivity} = \frac{A}{A + C} \times 100$$

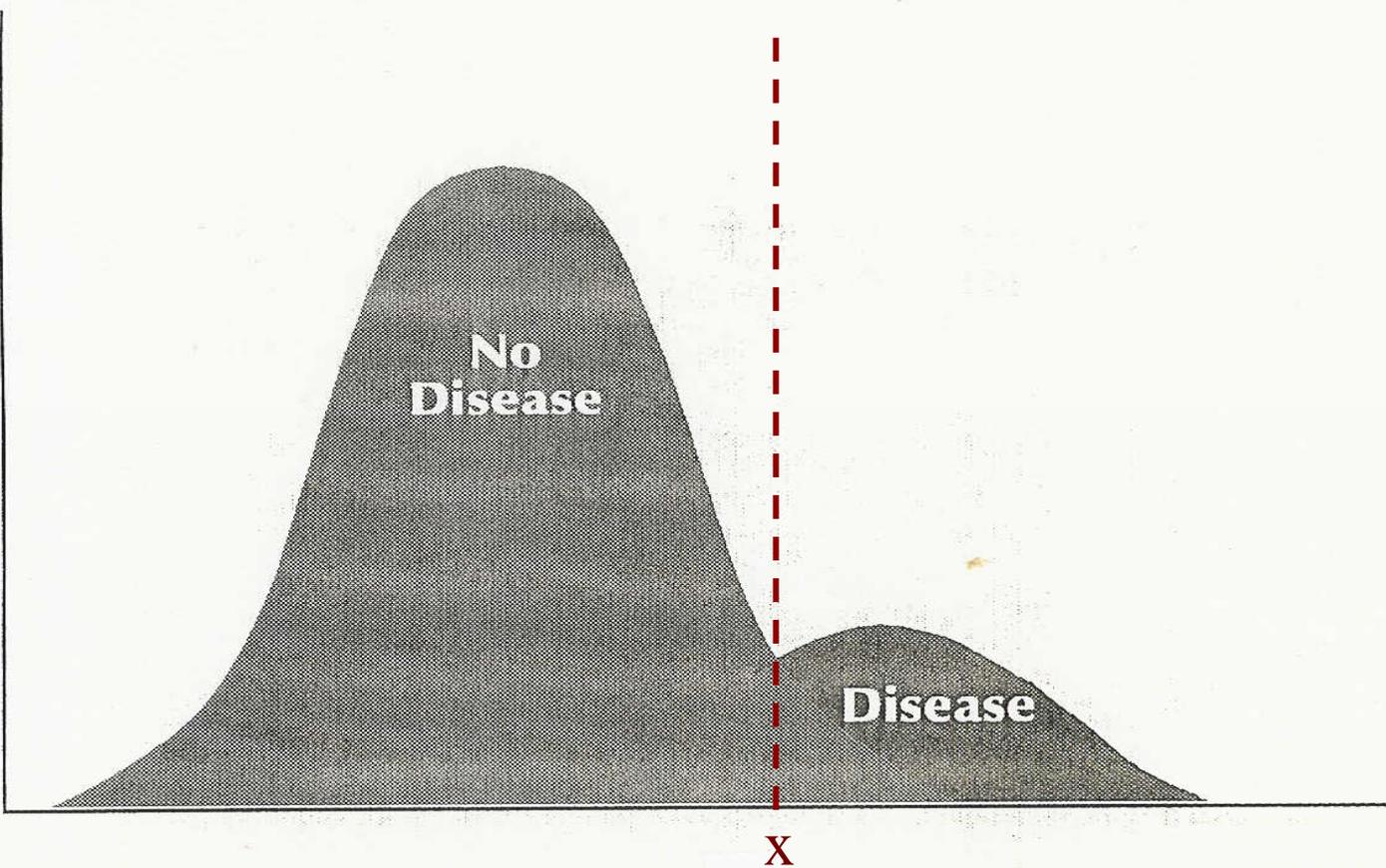
$$\text{Specificity} = \frac{D}{B + D} \times 100$$

Screening test results

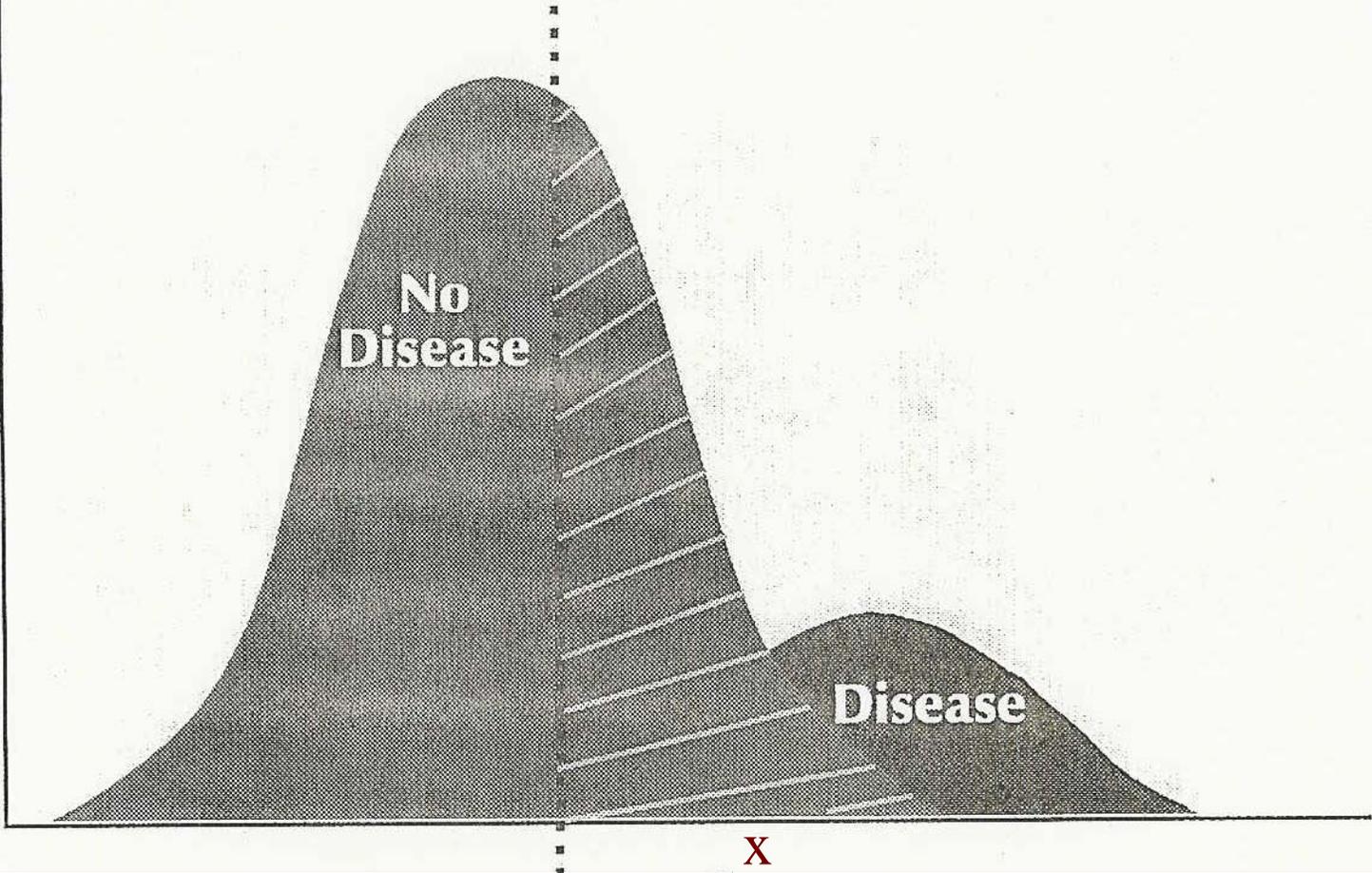
Dichotomous: culture
(positive/negative)

Continuous: blood pressure (mm Hg)
serum cholesterol (mg/dl)

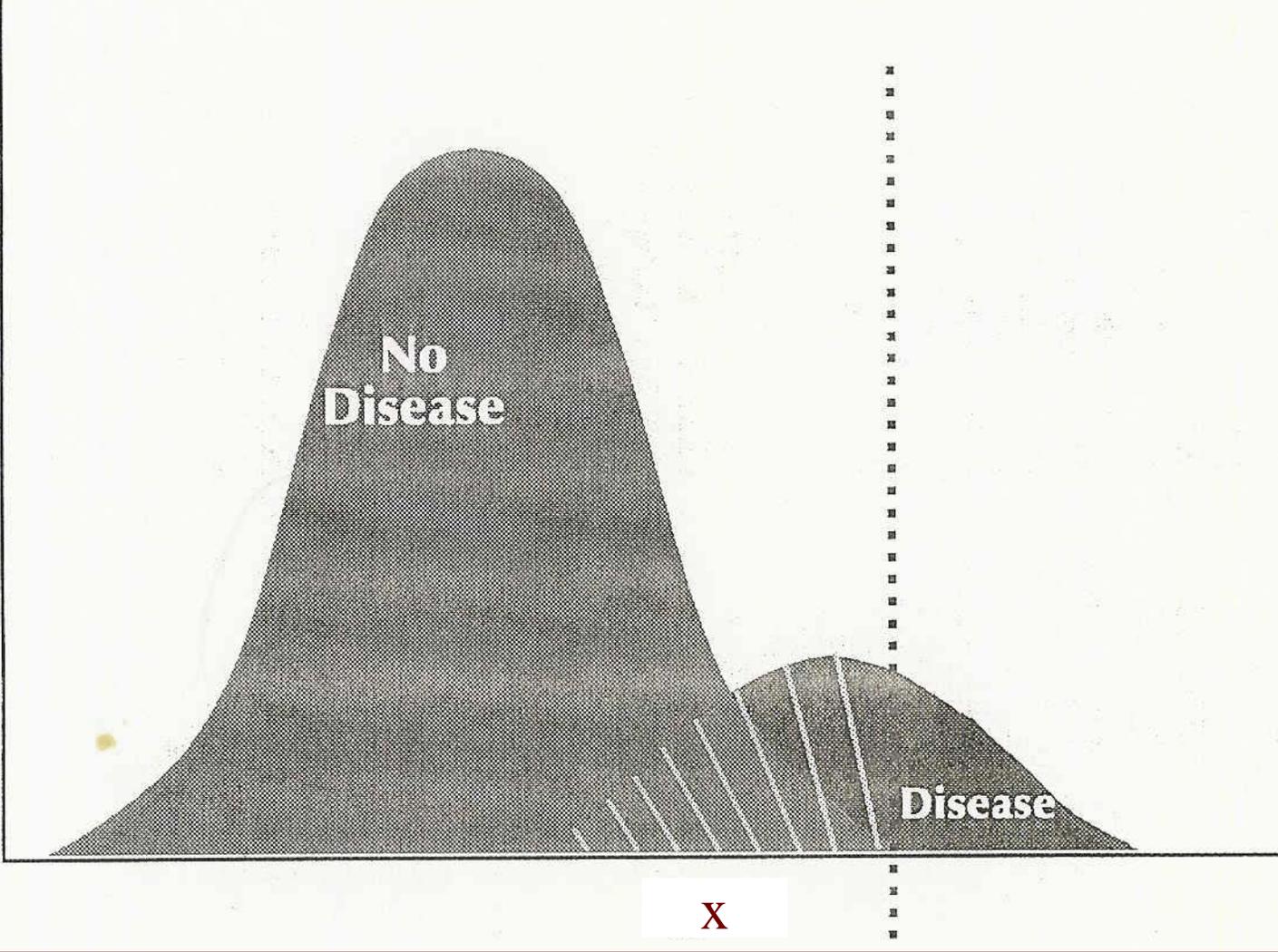
Number of Persons



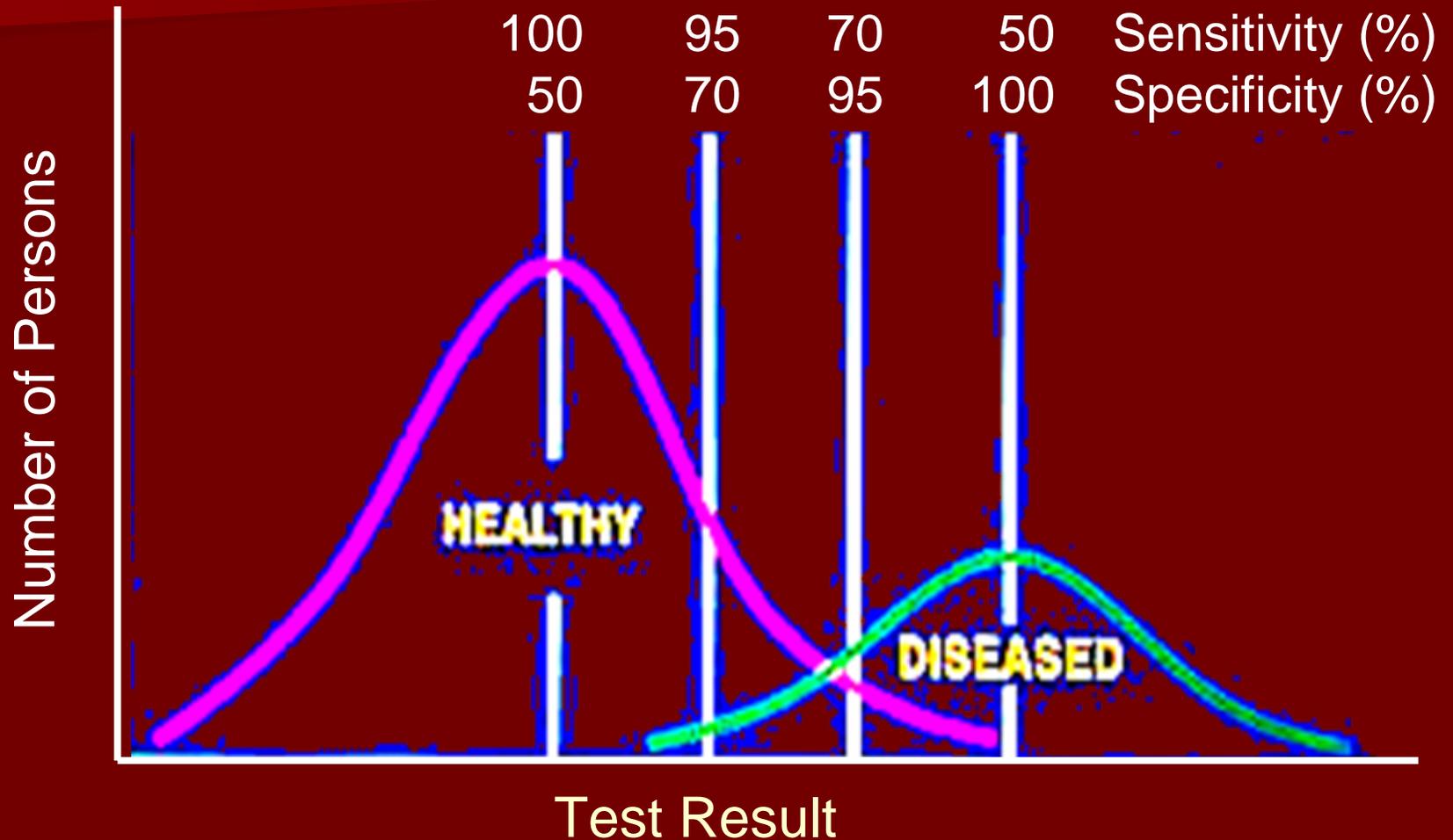
Number of Persons



Number of Persons



Effects of varying the diagnostic threshold on sensitivity and specificity



Costs of false positives

- Unnecessary tests
- Labeling

Costs of false negatives

- Care for advanced disease
- Premature death or disability
- Expose others to infections

Predictive Value Positive

- Proportion of persons with a positive test who have the condition

Predictive Value Negative

- Proportion of persons with a negative test who do not have the condition

Disease

		+	-	Total
Test	+	A	B	A + B
	-	C	D	C + D

$$\text{Predictive value positive} = \frac{A}{A + B} \times 100$$

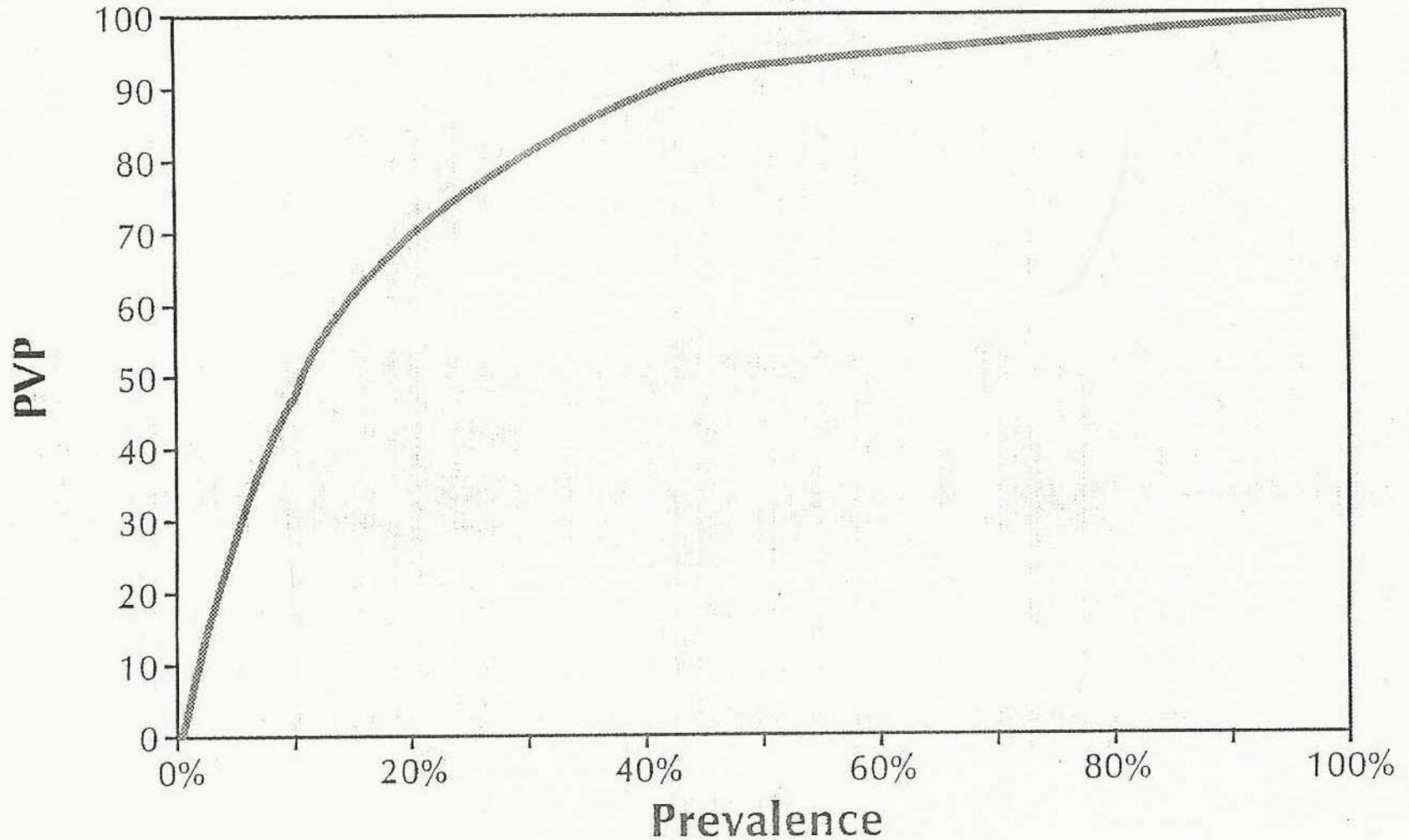
$$\text{Predictive value negative} = \frac{D}{C + D} \times 100$$

Predictive value positive
depends on what two
factors?*

*Answer at end of session

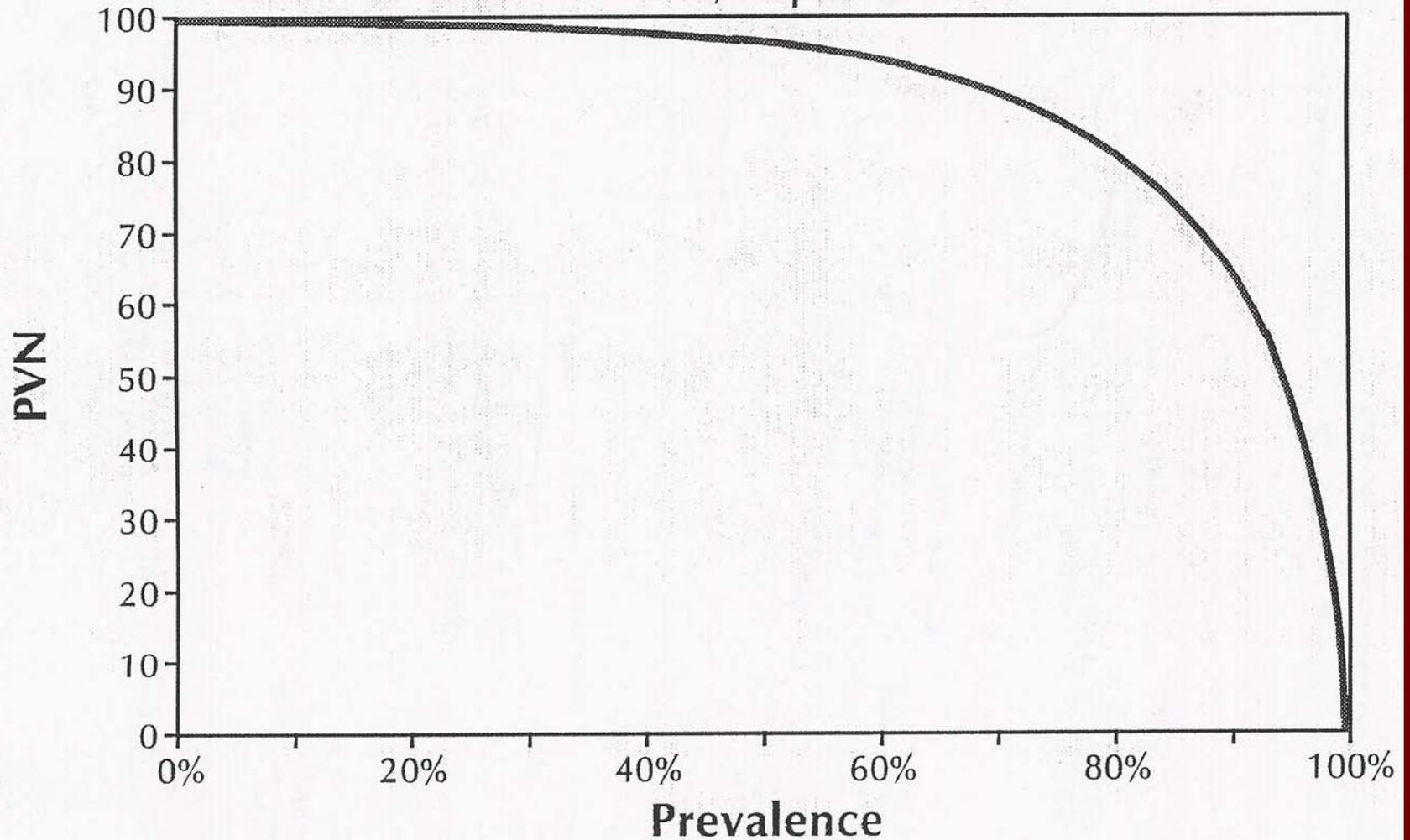
PVP by Prevalence

Sens = 95%, Spec = 90%



PVN by Prevalence

Sens = 95%, Spec = 90%



Predictive Value Positive and Prevalence

Testing Conditions

Size of Population = 100,000

Sensitivity of Test = 90%

Specificity of Test = 90%

Disease Prevalence = 1%

	Cancer Present	Cancer Absent	
Positive Test			
Negative Test			

$$\text{PVP} = \frac{A}{A+B}$$

Predictive Value Positive (PVP) and Prevalence

Testing Conditions

Size of Population = 100,000

Sensitivity of Test = 90%

Specificity of Test = 90%

Disease Prevalence = 0.1%

	Cancer Present	Cancer Absent	
Positive Test			
Negative Test			

$$\text{PVP} = \frac{A}{A+B}$$

How do you increase PVP in a
low Prevalence Diseases?

Perform a second screening test

Screening program should be followed by surveillance to evaluate the effectiveness of the screening program.

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Are these “screening” programs?

- Testing vision for driver’s license
- “Screen” an industry for risky work habit – are workers wearing safety helmets?
- Testing pregnant women for Down’s Syndrome
- Screening for diabetes
- Testing applicants for a job for drug use