UNIVERSITY OF KWAZULU-NATAL
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Screening

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Learning Objectives

- Know what is screening and why it is done
- Understand the criteria for screening tests
- Assess the validity of screening tests

Outline

- Definition
- Purpose
- Criteria
- Assessment of screening tests

Definition

- Screening is population testing to identify disease or precursors of disease in asymptomatic individuals
- " presumptive identification of unrecognised disease or defects by means of tests, examinations or other procedures that can be applied rapidly" (WHO)

Common Screening Tests

- Fasting blood sugar for diabetes
- Pap smear for cervical cancer
- Mammography for breast cancer
- Prostate specific antigen (PSA) for prostate cancer
- Ocular pressure for glaucoma
- Fasting blood cholesterol for heart disease

Why screen?

- Can identify:
  - a pre-disease abnormality
    - early disease
  - disease risk marker
- Basic assumption is that early detection and diagnosis will lead to improved prognosis i.e. reduce morbidity and/or mortality

Purpose of screening

- Prevention of serious outcomes of existing disease (asymptomatic)
  - Screening for cancer
- Prevention of development of a disease
  - Hypertension or hypercholesterolaemia
- Occupational:
  - Army recruits, airline pilots – scope of duty
  - HCW and TB
- Insurance
- ? Case finding
  - Identification of cases unknown to the health sector

Screening Tests

- Can be simple & inexpensive
  - questions, clinical examination
- Advanced & costly
  - mammography, DNA tests

After screening

- Screening tests usually not diagnostic
- Positive result →further definitive tests

Adverse effects of screening

- Discomfort/ inconvenience of undergoing the test
  - Subsequent extra diagnostic tests for the false positives
- False results
  - false reassurance
  - unnecessary anxiety
- Loss of ‘wellness’
- ‘Certificate of health’ effect
- Over diagnosis of abnormalities of questionable clinical significance
- Longer morbidity if outcome not improved

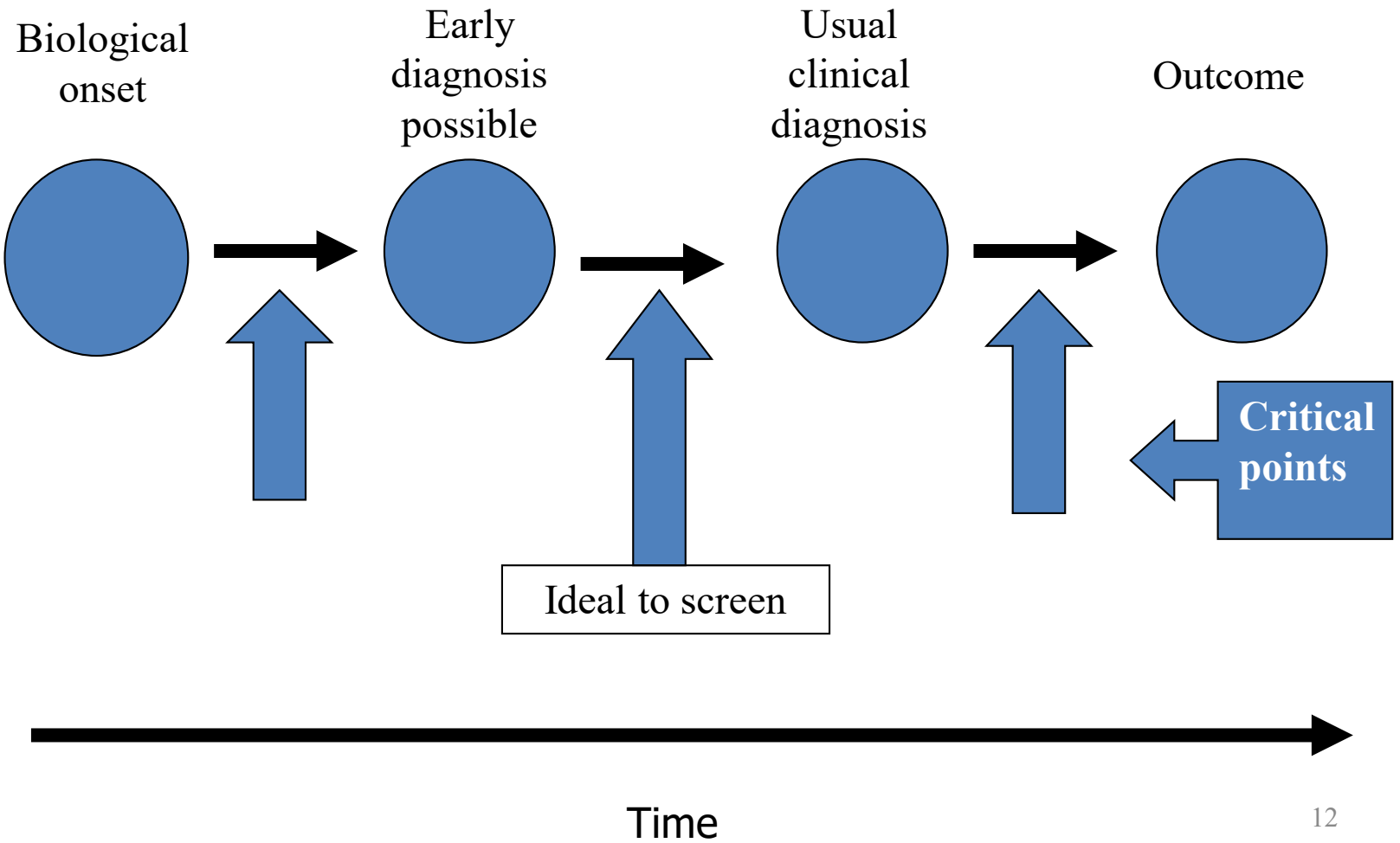
Criteria for screening

- Wilson and Jungner (1968)
  - WHO guidelines: *Principles and practice of screening for disease.*

a) Knowledge of disease

1. The condition being screened for should be an important public health problem: burden of disease
   - Prevalence
   - Morbidity and mortality
2. There should be a detectable early stage
3. The natural history of the condition should be well understood
4. Treatment at an early stage should be of more benefit than at a later stage

Natural history of disease



Criteria for screening

b) Test

5. There should be a suitable test for the early stage.
6. The test should be acceptable to the population being screened
7. Intervals for repeating the test should be determined
    - Case-finding should be a continuing process and not a “once and for all” project

Criteria contd.

8. There should be adequate health service capacity to absorb the extra clinical workload from the screening

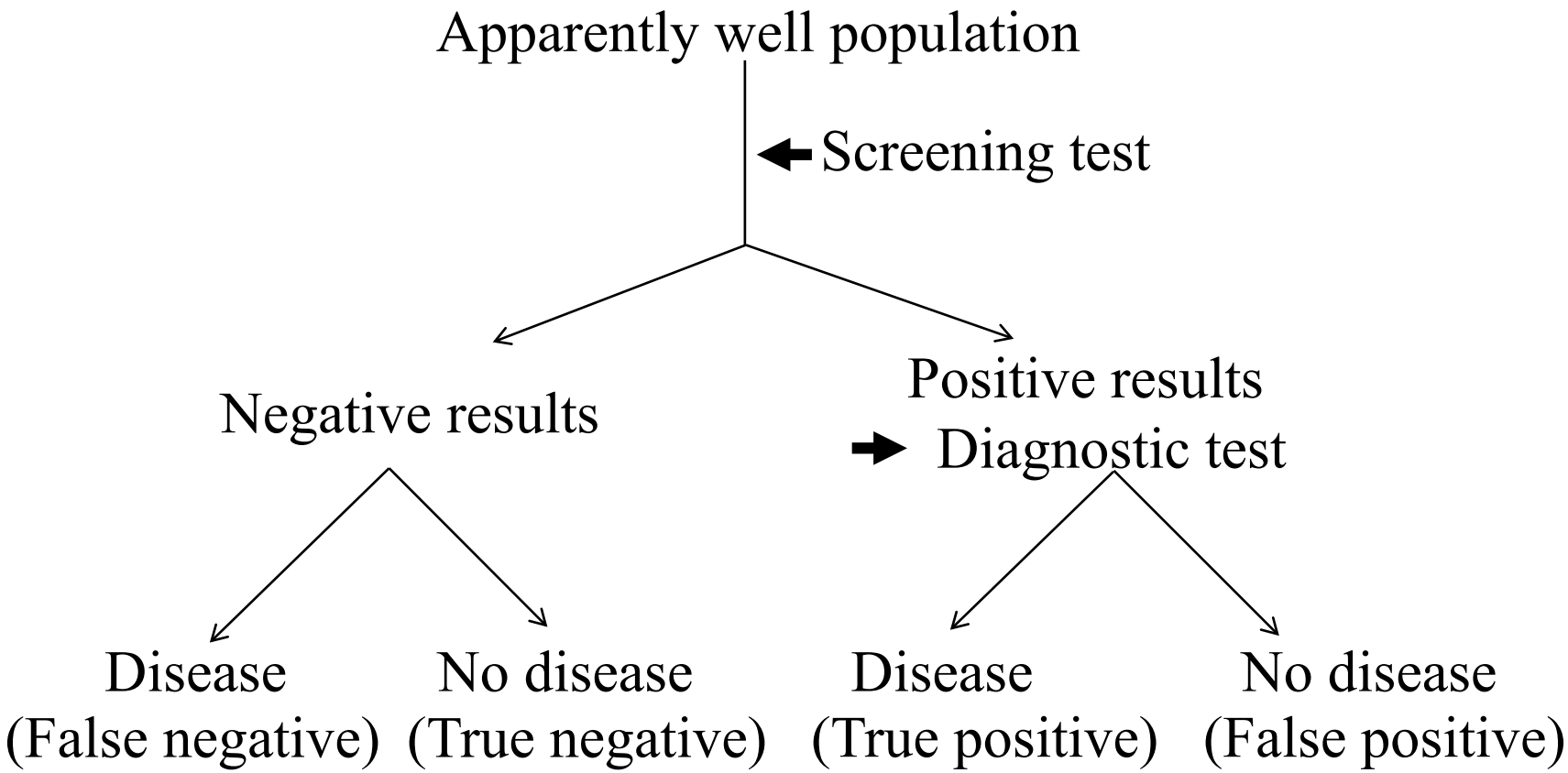
9. The risks, both physical and psychological should be less than the benefits

10. The costs should be balanced against the benefits
    - Costs of the screening programme
    - Costs of the additional diagnostic tests for those that screen positive

Assessment of screening tests

- Validity
  - degree to which a screening test accurately distinguishes between subjects with the condition and those without the condition
  - Sensitivity
    - Ability to correctly identify those who have the disease
    - Proportion of true positives correctly identified
  - Specificity
    - Ability to correctly identify those without disease
    - Proportion of true negatives correctly identified

Logic of screening



		True disease status: Positive	True disease status: Negative	
Test Result	Positive	a True positive	b False positive	a+b
	Negative	c False negative	d True negative	c+d
		a+c	b+d	

Assessment of screening tests

- Sensitivity: a/(a+c)
- Specificity: d/(b+d)
- Determining sensitivity and specificity requires that you are able to accurately determine the disease status for each candidate i.e. need a gold standard
- Trade-off between sensitivity and specificity

Sensitivity and Specificity

Screening Results	True Characteristics in Population		Total
	Disease	No Disease	
Positive	80	100	180
Negative	20	800	820
Total	100	900	1,000

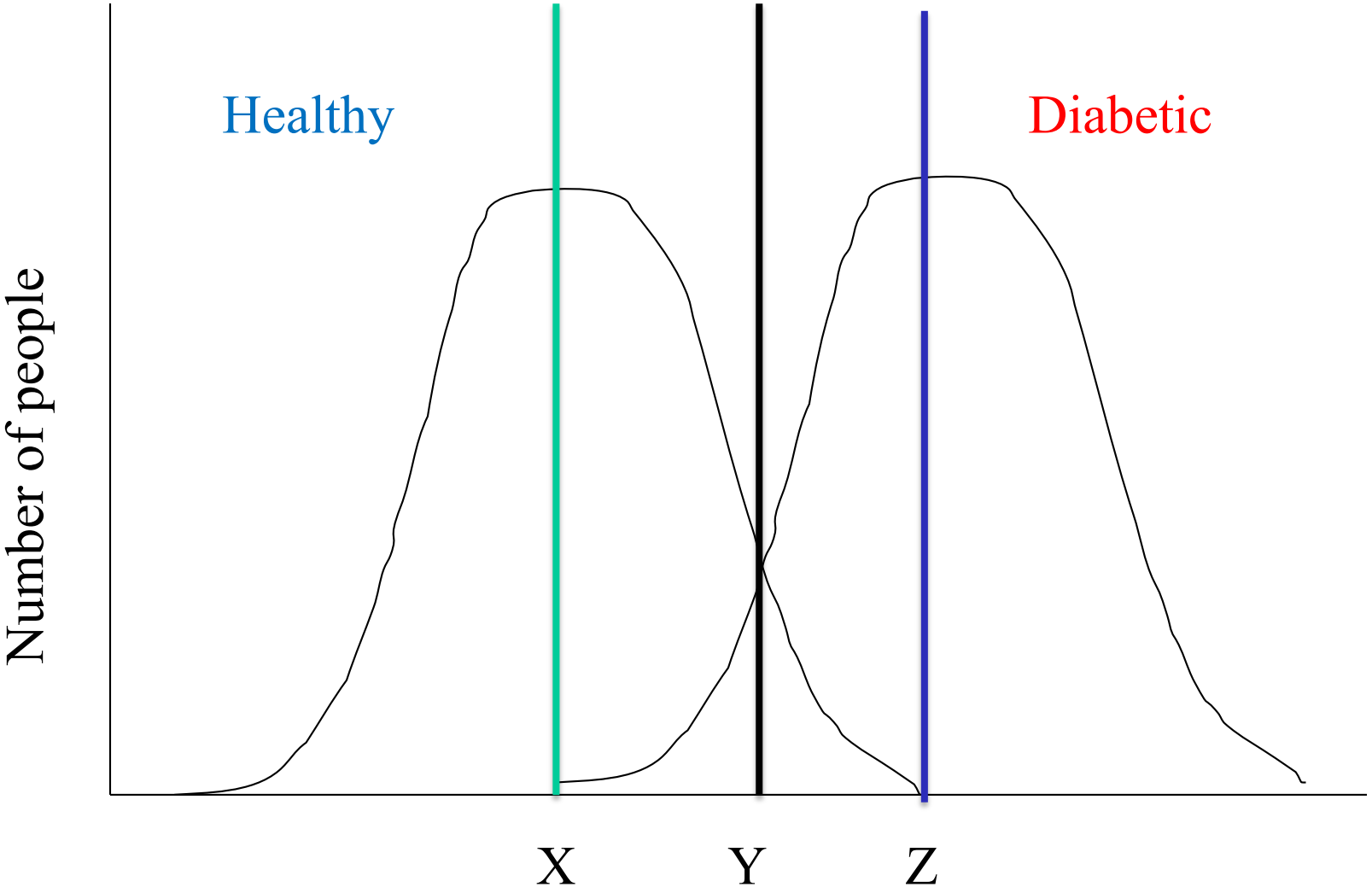
Sensitivity = 80/100 = 80%

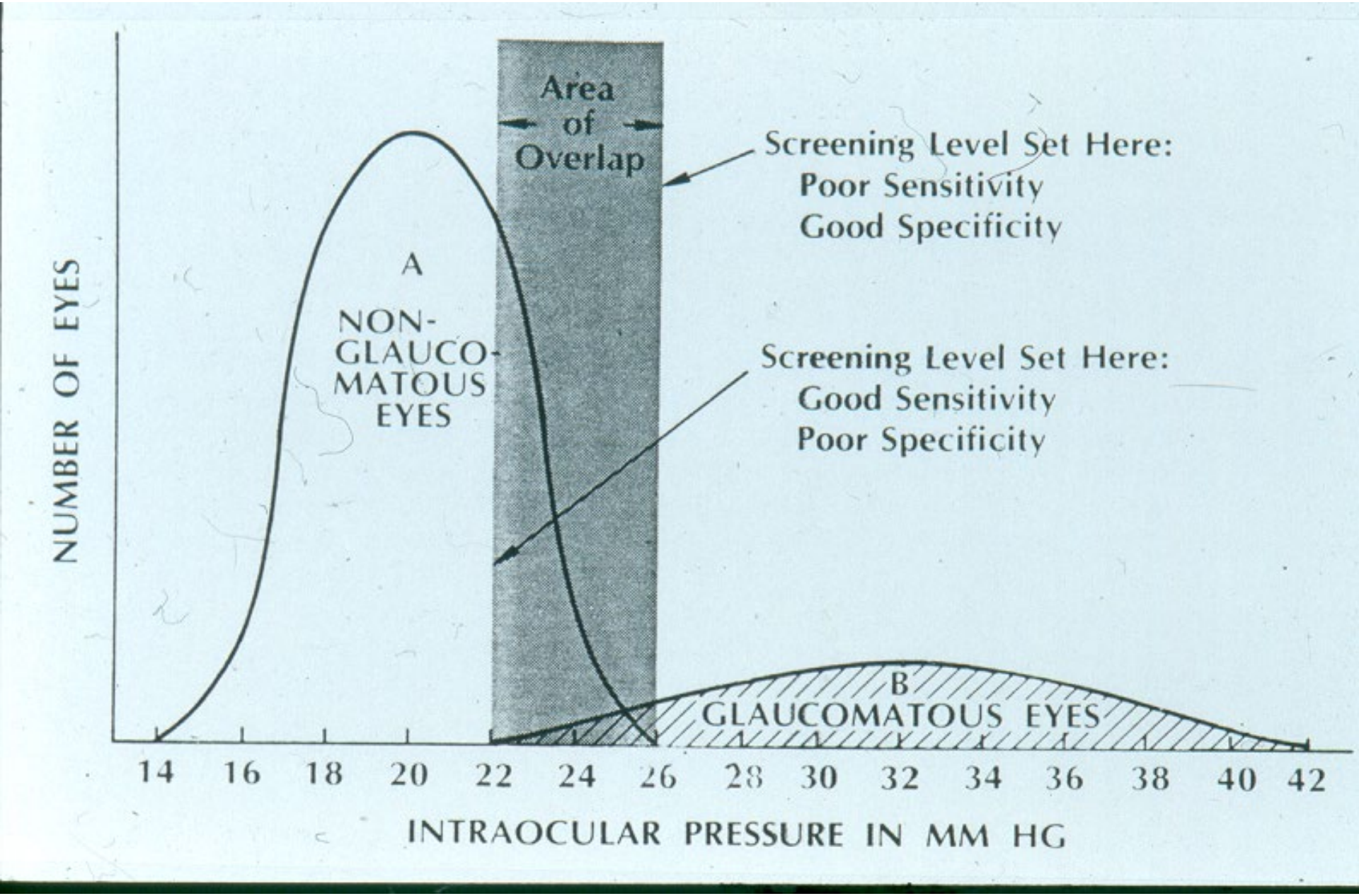
Specificity = 800/900 = 89%

Among those **with disease**, the screening tests detects 80%

Among those **without disease**, the screening test correctly identifies 89% as disease free

http://ocw.jhsph.edu/courses/fundepi/PDFs/Lecture11.pdf


Healthy
Diabetic
Number of people
X
Y
Z
Blood glucose concentration


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

Predictive Values

- Positive predictive value (a/a+b)
  - If the test is positive, how likely are you to have the disease
- Negative predictive value (d/d+c)
  - If the test is negative, how likely are you to NOT have the disease

- These measures are influenced by the prevalence of the disease in the population and by the validity of the test (sensitivity and specificity)

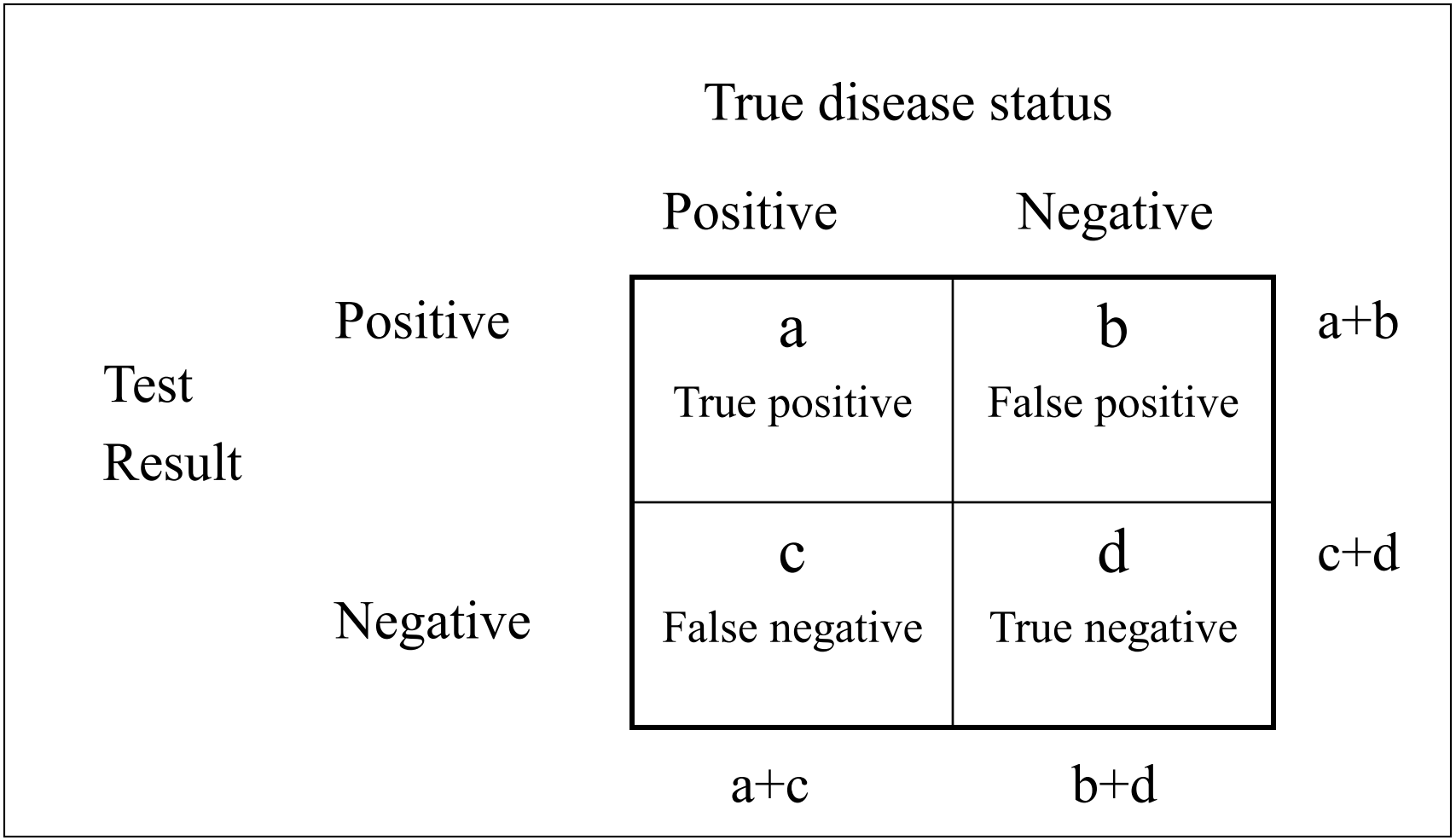
Predictive Values

Positive predictive value = 80/180 = 44%

Screening Results	True Characteristics in Population		Total
	Disease	No Disease	
Positive	80	100	180
Negative	20	800	820
Total	100	900	1,000

Negative predictive value = 800/820 = 98%

ttp://ocw.jhsph.edu/courses/fundepi/PDFs/Lecture11.pdf



Sensitivity = a/(a+c) Specificity = d/(b+d)

PPV = a/(a+b) NPV = d/(c+d)

Example

- You are testing a new screening test on 1000 patients. 200 people are known to have the disease. The screening test finds 220 patients positive for the disease, of which 180 are known to have the disease
- Calculate the sensitivity, specificity, PPV and NPV

Answers

		True Disease Status		
		Positive	Negative	Total
Test Result	Positive	180 (a)	40 (b)	220
	Negative	20 (c)	760 (d)	780
	Total	200	800	1000

Answers

- Sensitivity = a/(a+c) = 180/200 = 90%
- Specificity = d/(b+d) = 760/800 = 95%
- PPV = a/(a+b) = 180/220 = 81.8%
- NPV = d/(c+d) = 760/780 = 97.4%

Additional Example

- Try and work out the examples before looking at the answers provided
- You are testing a new screening test on 1000 patients
- Sensitivity 98% specificity 95%
- Calculate positive and negative predictive value if:
    a) Disease prevalence 20%
    b) Disease prevalence 5%

Answers (a)

Sensitivity 98% *Specificity 95%* *Prevalence 20%*		True Disease Status		
		Positive	Negative	Total
Test Result	Positive	196(a)	40 (b)	236
	Negative	4 (c)	760 (d)	764
	Total	200	800	1000

Answers – (a)

- PPV = a/(a+b) = 196/236 = 83.1%
- NPV = d/(c+d) = 760/764 = 99.5%

Answers – (b)

Sensitivity 98% *Specificity 95%* *Prevalence 5%*		**True Disease Status**		
		Positive	Negative	Total
Test Result	Positive	49(a)	47 (b)	96
	Negative	1(c)	903(d)	904
	Total	50	950	1000

Answers – (b)

- PPV = a/(a+b) = 49/96 = 51%
- NPV = d/(c+d) = 903/904 = 99.9%

Answers

	Sens 98 Spec 95	
Prevalence	20%	5%
Positive Predictive Value	83.1%	50.7%
Negative Predictive Value	99.5%	99.9%

Likelihood Ratios

- Determine how much the utilization of a particular test will alter the probability
- Positive likelihood ratio (LR+) is the "**probability that a positive test would be expected in a patient divided by the probability that a positive test would be expected in a patient without a disease**"
  - = the true positivity rate divided by the false positivity rate
- Positive Likelihood Ratio= Sensitivity/(1-Specificity)

Likelihood Ratios

- Negative likelihood ratio (LR-) is "**the probability of a patient testing negative who has a disease divided by the probability of a patient testing negative who does not have a disease**"
- Negative Likelihood Ratio = (1- Sensitivity)/Specificity

Likelihood Ratios

LR > 1 : test result is associated with the presence of the disease

LR < 1: test result is associated with the absence of disease

QUESTIONS??