Screening for disease

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Screening for a disease

- Screening
  - Mass screening
  - Selective screening
  - Multiple screening
- Diagnosis
  - Diagnostic test
  - Reference test or gold standard

Screening for a disease

- Selective screening , High risk population

  Single screening

  Multiphasic screening

- Mass screening

  Single screening , Mammography

  Multiphasic screening , Biochemical profiles

Screening test

- Validity
  - Sensitivity
  - Specificity
- Reliability or Repeatability
- Yield
  - Sensitivity
  - Prevalence
  - Extent of previous screening
  - community concern
- Predictive value

Standard diagnostic test

- True negative
- False negative
- True positive
- False positive

Screening test

Test	disease	Non-disease	total
positive	True positives	False positive (α)	All w/ positive test result
negative	False negative (β)	True negatives	All w/ negative test result
total	All w/disease	All w/o disease	Total number screened

validity

screening test

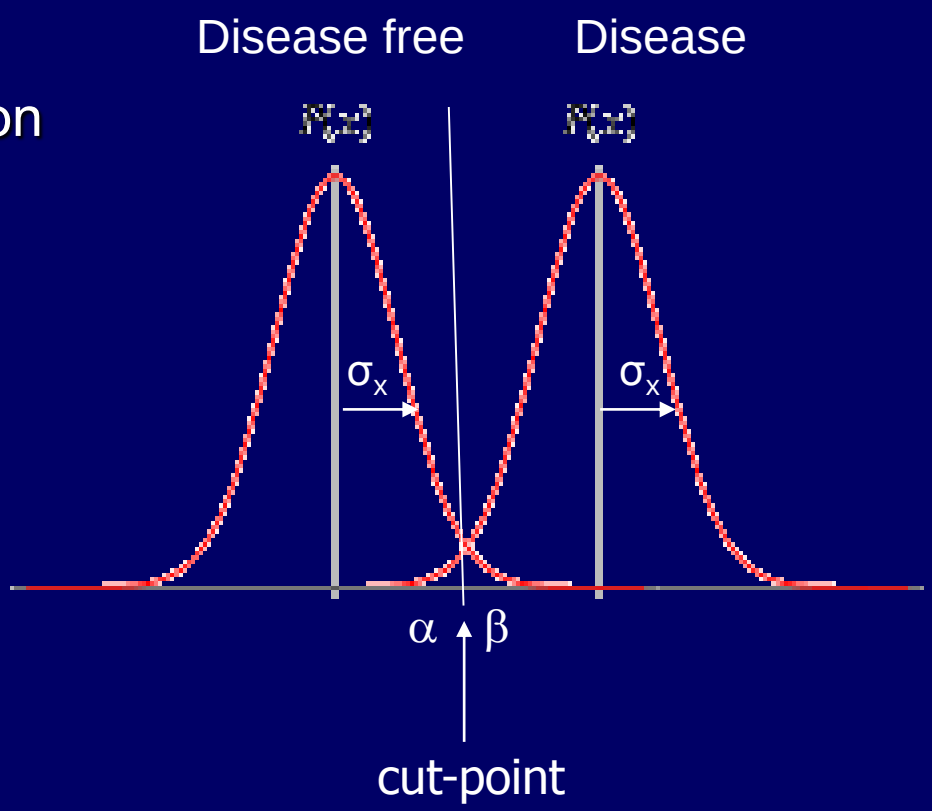
- Sensitivity) screening test (Correctly identify those with the disease)
- specificity) screening test (Correctly identify those without the disease)

Screening test

Test	disease	Non-disease	total
positive	True Positives a	False positive (α) b	All w/ positive test result
negative	False negative (β) c	True Negatives d	All w/ negative test result
total	All w/disease	All w/o disease	Total number screened

Visualizing α and β

- Pr (Type 1 Error) = Area under disease from cut point to the left on the tail of the curve
- Pr (Type 2 Error) = Area under disease free from cut point to the right on the tail of the curve



% of Correctly identify those with the disease

$$\text{Sensitivity} = \frac{\text{true positives}}{\text{all w/ disease}}$$

% of Correctly identify those without the disease

$$\text{Specificity} = \frac{\text{true negatives}}{\text{all w/o disease}}$$

% of people correctly identified by the screening test

$$\text{Overall validity} = \frac{\text{true positives} + \text{true negatives}}{\text{total number of people tested}}$$

(The more close to 100% the more effective)

- Most screening tests yield a number, and the physician must decide on a cut-point above or below which the disease is assume to be present.

- No screening test is perfect and it is near impossible to correctly determine all individuals with and all individuals without the disease no matter how well the cut-point is chosen

Low cut-point

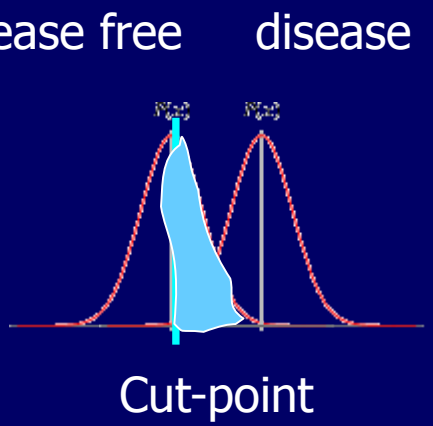
All diseased individuals are classified as diseased

- Perfect sensitivity (no false -)

Many disease free individuals are classified as diseased

- Low specificity (many false +)

Proportion of correctly classified individuals small due to the large number of false positives



Center cut-point

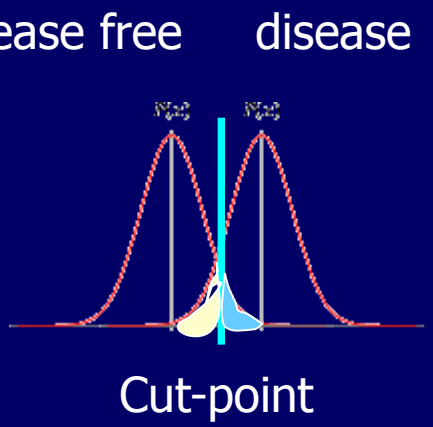
Some diseased individuals are classified as diseased free

- Reduce sensitivity (some false -)

Some disease free individuals are classified as diseased

- Reduce specificity (some false +)

Proportion of correctly classified individuals fairly high due to the low number of false positives and false negatives



High cut-point

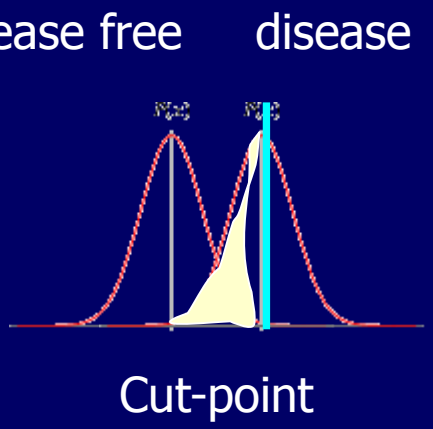
Many diseased individuals are classified as diseased free

- low sensitivity (many false -)

All disease free individuals are classified as diseased free

- Low specificity (no false +)

Proportion of correctly classified individuals small due to the large number of false negatives



Predictive value

- Screening / diagnostic test
- predictive value positive
- predictive value negative

Predictive value positive

(the likelihood that an individual with a positive test have the disease)

- PV + ve = $\frac{\text{True positive}}{\text{All positive tests}} \times 100 = \frac{a}{a+b} \times 100\%$

Predictive value negative

(the likelihood that an individual with a negative test does not have the disease)

- PV - ve = $\frac{\text{True negative}}{\text{All negative tests}} \times 100 = \frac{d}{c+d} \times 100\%$

- The screening test for congenital syphilis produces many false positives among crack/cocaine users.
- Assume we know that 30 of our study subjects have congenital syphilis and 85 do not. We want to see how well the screening test reflects this information.

test	disease	non-disease	total
positive	28	12	40
negative	2	73	75
total	30	85	115

- Sensitivity = $\frac{\text{true positives}}{\text{all w/ disease}} = \frac{28}{30} = 0.933$ or 93.3%

- Specificity = $\frac{\text{true negatives}}{\text{all w/o disease}} = \frac{73}{85} = 0.859$ or 85.9%

- Overall validity = $\frac{\text{true positives + true negatives}}{\text{total number of people tested}}$

$$= \frac{28+73}{115} = 0.878 \text{ or } 87.8\%$$

Conclusions: The test is very sensitive, but not as specific.

The overall validity is near 90%

What types of problems may the lack of specificity cause?

- Healthy people might get treated
- Wrong conclusions about crack/cocaine use and congenital syphilis might be drawn
- Cause the incorrect of health prevention plan.

Predicted value

- Positive predictive value

$$= \frac{\text{true positives}}{\text{all w/positive test result}} = \frac{28}{40} = 0.7 \text{ or } 70\%$$

- Negative predictive value

$$= \frac{\text{true negatives}}{\text{all w/negative test result}} = \frac{73}{75} = 0.973 \text{or } 97.3\%$$

Reliability

Need to consider two types of variation:

1. Variation inherent in the method
   - Instruments
   - Substance being measured
   - Reagents used

2. Observer variation
   - Inter-observer variation (different observers)
   - Intra-observer variation (same observer at different times)

- Reliability: Comparing different test results
- Validity: Comparing and clinical results

Question: Does high reliability imply high validity?

Answer: No…but high validity does lead to high reliability.

Note: There may be some chance agreement. We can calculate Cohen's Kappa to determine whether there is more agreement than would be expected by chance.

Reference

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