EBDM

Diagnostic Efficacy

Definitions

Evidence Based Decision Making: Clinical decisions by integrating the best available research evidence

Epidemiology: The study of the distribution and determinants of heath and disease in populations

Biostatistics: The application of statistical methods to biological health and medical data

Diagnostic Efficacy: The accuracy and usefulness of a diagnostic test

Risk: Probability of developing the diseases over a specific time period

<u>Levels of Prevention</u>

Level	Definition	Example
Primary	Prevent disease before it occurs	Vaccinations, lifestyle counseling
Secondary	Detect disease early to halt or slow it	Pap smear, mammogram
Tertiary	Reduce impact of an established disease	Rehabilitation, physical therapy, chronic disease management

<u>Scales</u>

- Nominal Data: Categorical Data with no order
- Ordinal Data: Categorical Data but with a ranked order
- Interval Data: Numeric Data with equal intervals

<u>Prevalence</u>

Point = $\frac{\text{Existing cases at a specific time}}{\text{Population at that time}}$

Period = $\frac{\text{Existing cases during a period}}{\text{Population during that period}}$

<u>Incidence Rate</u>

Cumulative = $\frac{\text{New cases in a time period}}{\text{Population at risk at start of period}}$

Density = $\frac{\text{New cases}}{\sum \text{(time each person is at risk)}}$

<u>Thresholds</u>

Diagnostic Threshold: Cut-off value of a test result that distinguishes between a positive and negative test

Treatment Threshold: Above this probability disease is likely enough to initiate treatment without testing

Testing Threshold: Below this probability disease is so unlikely further testing is not needed

Core Measures

$$\text{Prevalence} = \frac{\#\text{ subjects with disease}}{\#\text{ subjects who could have disease}}$$

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\text{Sensitivity} = \frac{TP}{TP + FN} = P(\text{Positive Test} \mid \text{Disease})$$

$$\text{Specificity} = \frac{TN}{TN + FP} = P(\text{Negative Test} \mid \text{Healthy})$$

$$\text{False Negative Rate} = 1 - \text{Sensitivity}$$

$$\text{False Positive Rate} = 1 - \text{Specificity}$$

<u>Predictive Values</u>

Positive Predictive Value (PPV)

$PPV = P(\text{Disease} \mid \text{Positive Test}) = \frac{TP}{TP + FP}$

Effect of Prevalence: Increases with higher prevalence.

Effect of Threshold: Raising threshold increases specificity, reduces FP, increases PPV.

Negative Predictive Value (NPV)

$NPV = P(\text{Healthy} \mid \text{Negative Test}) = \frac{TN}{TN + FN}$

Effect of Prevalence: Decreases with higher prevalence.

Effect of Threshold: Lowering threshold increases sensitivity, reduces FN, increases NPV.

1 - NPV

$1 - NPV = P(\text{Disease} \mid \text{Negative Test}) = \frac{FN}{TN + FN}$

Interpretation: False-negative probability.

Testing Methods

<u>SPin vs SNout</u>

SPin: Specific test to rule in disease

SNout: Sensitive test to rule out disease

<u>Parallel vs Serial</u>

Serial: Tests done one after another; paired with SPin

Parallel: Tests done simultaneously; paired with SNout

<u>Likelihood Ratio</u>

Positive Likelihood Ratio (LR+): How much more likely a positive test is in a pt with the disease compared to a pt without the disease

$LR+ = \frac{Sensitiviy}{1 - Specificity}$

Negative Predictive Value (NPV)

$NPV = P(\text{Healthy} \mid \text{Negative Test}) = \frac{TN}{TN + FN}$

Effect of Prevalence: Decreases with higher prevalence.

Effect of Threshold: Lowering threshold increases sensitivity, reduces FN, increases NPV.

Odds and Risks

Risk Ratio: $\frac{\text{P(Getting Disease} \mid \text{Exposure)}}{\text{P(Getting Disease} \mid \text{No Exposure)}}$

Odds Ratio: $\frac{\text{Odds of (Getting Disease} \mid \text{Exposure)}}{\text{Odds of (Getting Disease} \mid \text{No Exposure)}}$

Attributable Risk: Risk of (Getting Disease | Exposure) − Risk of (Getting Disease | No Exposure)

Attributable Risk Reduction: Risk of (Getting Disease | Control) − Risk of (Getting Disease | Treatment)

Attributable Risk Proportion: $\frac{R_{\text{exposed}} - R_{\text{unexposed}}}{R_{\text{exposed}}}$

Number Needed to Treat/Harm: $\frac{1}{\text{AR(R)}}$

Rates

Case Fatality Rate: $\frac{R_{\text{exposed}} - R_{\text{unexposed}}}{R_{\text{exposed}}}$

Disease Morbidity Rate: $\frac{R_{\text{exposed}} - R_{\text{unexposed}}}{R_{\text{exposed}}}$

NNS PSR Historical Study

Research Design

Sampling

Population: Group of people you are interested in studying
Sample: Subset of the population to collect data from
Sample Frame: List or database the sample is taken from

Sampling Factors

Procedure: How the sample was selected
Size: The size of the sample
Participation Rate: How many people of the sample participated

Validity

External Validity: The degree to which your study as being generalized to other situations, peoples, and settings

- Population Validity: The degree your sample can be generalized to a larger population
- Ecological Validity: The degree you study can be generalized to real-world settings

Internal Validity: The degree to which your study shows a true cause and effect relationship

Statistical Significance

Observed Group Differences

- Independent Variable
- Systemic Error: Consistent, repeatable bias in measurement or research that skews results
- Random Error: Unpredictable variation in measurement or data caused by chance

Hypothesis Testing

Definitions

p-value (p): The probability under H_0 that the observed group difference occurred due to chance

Significance Level (α): The probability of making a Type I error
Type I Error: Rejecting H_0 when it is actually true; i.e. false positive
Fishing: Running many tests to find significance by chance. The expected false positives after n tests is

$$E[\text{errors}] = n \cdot \alpha$$

Steps

1. **State the Null Hypothesis ($\mathbf{H_0}$):** Assume it is true by default (e.g., $\mu = \mu_0$).
2. **State the Alternative Hypothesis ($\mathbf{H_1}$):** The claim you are testing against H_0 (e.g., $\mu \neq \mu_0$).
3. **Compute the Test Statistic:** Calculate a value based on sample data (e.g., Z, t, χ^2).
4. **Decision Rule:** Compare the test statistic or p-value to the significance level α.
   - If $p \leq \alpha$: Reject H_0.
   - If $p > \alpha$: Fail to reject H_0, does not mean accept it either!

Reducing Type 1 Error

- Make fewer statistical decisions
- Set smaller α
- Repeat the study