Statistics in Evidence Based Medicine II

Lecture 1: Understanding *p* values and confidence intervals

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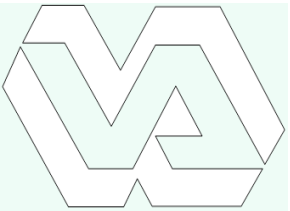

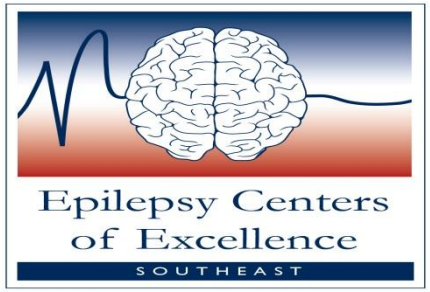

Course Objectives

- Learn some basic medical statistics and improve understanding of statistical concepts
- Become a better reader/smart user of medical statistics
- Practice evidence based medicine

Audio Information: Dial 1-855-767-1051
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Course Topics

- *p* values and confidence intervals
- Regressions and correlations
- Diagnostic tests
- Survival analysis
- Survey research

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Course Textbooks

Main: Statistics at Square One (2010)

M J Campbell & T D V Swinscow

http://www.phsource.us/PH/EPI/Biostats/

Secondary (if interested):

- Basic and Clinical Biostatistics (2004)

Beth Dawson, Robert G. Trapp

http://www.accessmedicine.com/resourceTOC.aspx?resourceID=62

Overview

- Definition of *p* value
- Misinterpretation of *p* value
- Definition of confidence intervals
- Understanding confidence intervals
- Misinterpretation of confidence intervals

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p Value and Statistical Inference

- Hypothesis testing
  - Establish research and null hypotheses
  - Choose a significance level α
  - Conduct the study
  - Compute the probability *p* of observed outcome or extreme, if the null hypothesis is true.
  - Use *p* value to make a decision about null hypothesis.

Neyman & Pearson (1933)

p Value and Statistical Inference

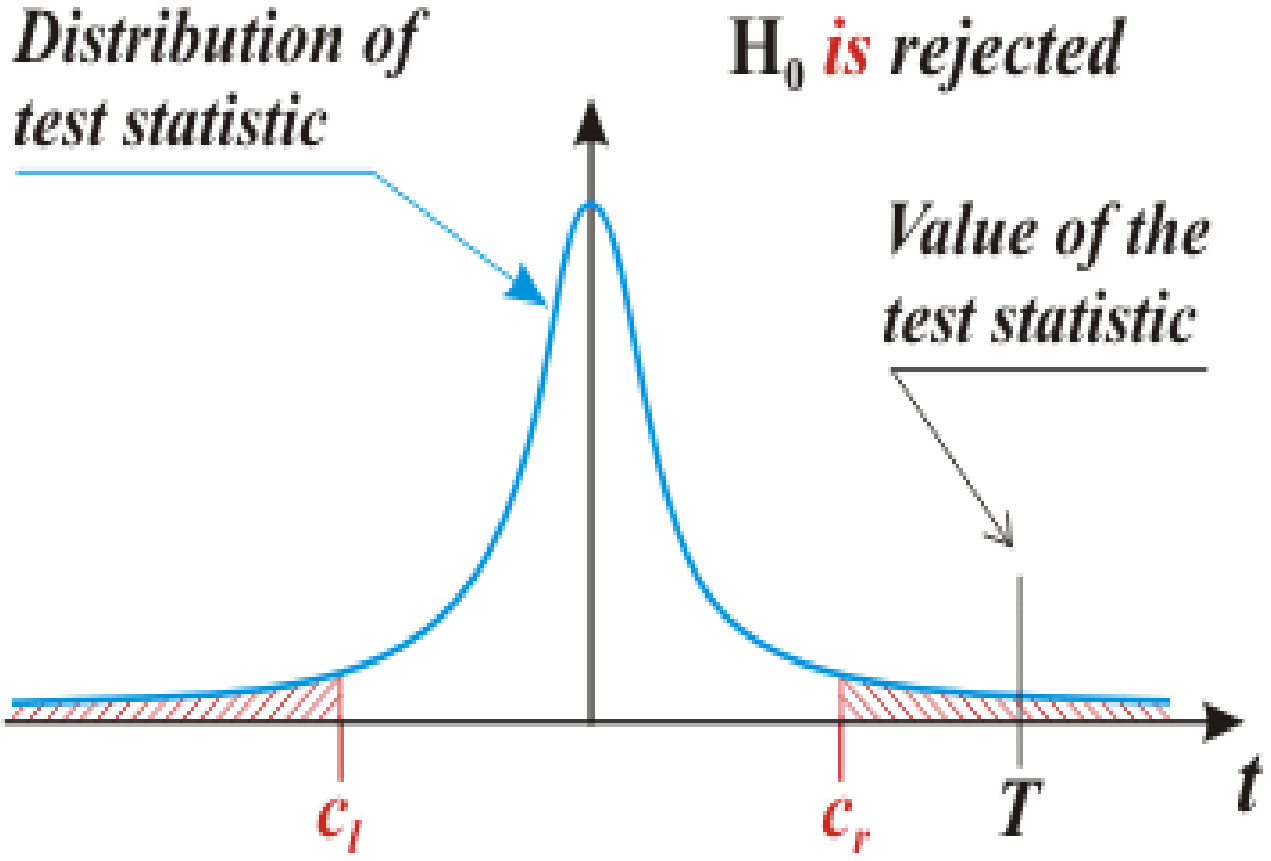
- Hypothesis testing
  - Establish research and null hypotheses
  - Choose a significance level α
  - Conduct the study
  - **Compute the probability *p* of observed outcome or extreme, if the null hypothesis is true.**
  - Use *p* value to make a decision about null hypothesis.

Definition of *p* Value

The probability of the observed result, plus more extreme results, if the null hypothesis were true.

p value=Prob (Data|H_0)

p Value and Test Statistic



For a two tailed test *p* = 2×P(test statistic *T*)

Misconceptions about *p* Value

- If p=0.05, the null hypothesis has only a 5% chance of being true.
- A nonsignificant result (p>0.05) means there is no difference between groups.
- A statistically significant finding is clinically important.

Misconceptions about *p* Value

- p=0.05 means that we have observed data that would only occur 5% of the time under null hypothesis.
- p values are properly written as inequalities.

  i.e., $p \leq 0.02$ when p=0.015
- Studies with the same p value provide the same evidence against the null hypothesis.

Rejecting the Null Hypothesis when $p<\alpha$

An arbitrary division of results into significant or "not significant" according to ***p*** value was not the intention of founders of statistical inference.

In Fisher's world "significance" was merely worthy of notice in the form of meriting more experimentation, but not proof in itself.

Problems with Hypothesis Testing

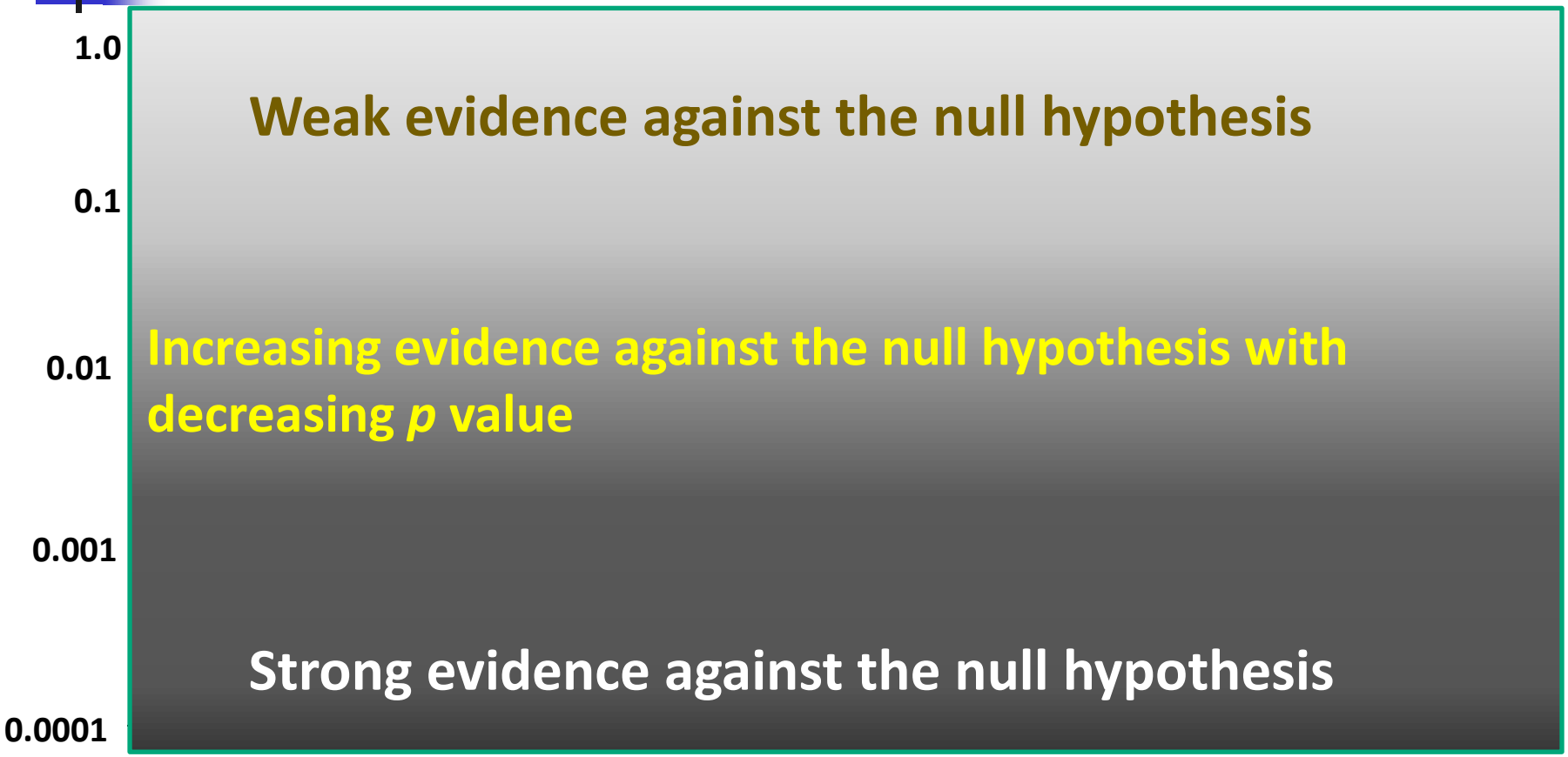
- Significance tests furnish irrelevant information.
- Significance tests are based on trivial null hypothesis.
- *p* values alone don't permit any direct statement about the direction or size of a difference.
- Definition of a significance limit is arbitrary and *p*-values can be given without a limit.

Understanding *p* Value

A ***p*** value measures the strength of the belief in the null hypothesis.

smaller ***p*** value  strong evidence against null hypothesis

p Value as an Evidence



Interpreting p Value

p value	Interpretation
Greater than 0.10	little or no evidence of a difference or relationship
Between 0.05 and 0.10	weak evidence of a difference or relationship
Between 0.01 and 0.05	evidence of a difference
Less than 0.01	Strong evidence of a difference or relationship
Less than 0.001	Very strong evidence of a difference or relationship

Always keep in mind the size of the study.

Adapted from Bland, 2000

Confidence Intervals to Accompany *p* Value

- How far the computed value of a quantity of interest from a small data set be from the broader population's value?

  A confidence interval is a range of values which includes the true population parameter with a probability defined in advance.

- The confidence level of 95% is usually selected.

Interpretation of Confidence Intervals

- Confidence intervals are random variables and their width and location vary from replication to replication.
- For a difference between two population means if a study is repeated indefinite number of times and if a 95% confidence interval for difference is computed each time, the true difference will fall within 95% of these intervals

Misconceptions about Confidence Intervals

- There is 95% probability that the mean of another sample lies in the confidence interval range.
- There is a 95% probability that the true mean lies within the confidence interval range
- If the study is repeated with same sample size, the new result falls in the confidence interval 95% of the time.

Confidence Intervals Relay More Information

- Confidence intervals reflect the result at data measurement level.
- Conclusions about statistical significance, direction and strength of effect are possible with confidence intervals.
- Values below and above the confidence interval range are not excluded but are improbable.

p values and confidence intervals are not contradictory!

- The two statistical concepts are complimentary. Confidence intervals can be constructed from *p* values and vise versa with some known facts.
- Other approaches to statistical inference exist!

Some Interesting Papers

- Steven Goodman

A Dirty Dozen: Twelve *P*-value Misconceptions

Seminars in HEMATOLOGY 2008

- Jonathan A C Sterne, George Davey Smith

Shifting the evidence –what's wrong with significance tests?

Physical Therapy 2001

- Eduard Brandstätter

Confidence intervals as an alternative to significance testing

Methods of psychological research 1999

- Jean-Baptist du Prel, Gerhard Hommel, Bernd Röhrig, Maria Blettner

Confidence interval or p- value

Deutsches Arzteblatt International 2009

Thank you!

Questions/Comments

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For more information, program materials, and to complete evaluation for CME credit visit

www.epilepsy.va.gov/Statistics