

The heart and science of medicine.
UVMHealth.org/MedCenter

Hypothesis or Hypotheses: that is the question

Elizabeth Hipp, PhD

THE
University of Vermont
MEDICAL CENTER

Conflicts of Interest

None to disclose

THE
University of Vermont
MEDICAL CENTER

Outline

- Null and alternative hypothesis
- Comparing two groups
- Parametric data
- Non-parametric data
- Multiple comparisons
- Conclusion

THE
University of Vermont
MEDICAL CENTER

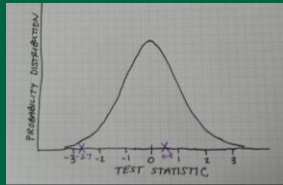
The null and alternative hypothesis

- A clinical research hypothesis is not the same as a statistical hypothesis
- Formulate a hypothesis
 - H_0 null
 - H_1 alternative
- Compute the appropriate test
- Determine if you reject the null hypothesis
- Assess what this statistical hypothesis means for your clinical research inquiry

University of Vermont
MEDICAL CENTER

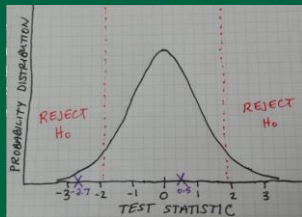
The null and alternative hypothesis

- H_0 – the null hypothesis: there is no association
- This will be rejected with varying degrees of confidence
- One sided – testing for the direction of the association
- Two sided – testing for association without direction



University of Vermont
MEDICAL CENTER

What is a p value?



- P value tells us the probability that our conclusion is wrong
- Low p value = unlikely that we wrongly rejected H_0
- Why $\alpha = .05$ as the standard?

University of Vermont
MEDICAL CENTER

Comparing two groups

- One sample
 - Dr Awesome has seen 12 of the 315 patients she treated using radioactive seeds develop urinary strictures
 - The published average is 5%
 - How does Dr. Awesome compare?
- Two sample
 - Dr Awesome hypothesized that primary tumors and metastatic tumors would be visible on diffusion weighted MR imaging

University of Vermont
MEDICAL CENTER

Z test and t test

- Continuous, parametric data (normal distribution)
- Observed difference between means
- T test
 - N < 30
 - Variance of the population (not just your sample) is unknown
 - Paired (e.g before and after)
 - Unpaired (independent, unrelated samples)

$$Z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

$$t = \frac{\bar{x} - \mu}{s / \sqrt{n}}$$

University of Vermont
MEDICAL CENTER

Unequal variance: non-parametric

- Chi squared
 - Fisher Exact
 - McNemar
- Mann Whitney
- Wilcoxon signed rank

University of Vermont
MEDICAL CENTER

Chi-squared

- Used with categorical data
- Determines
 - whether two (or more) independent populations are homogenous
 - whether two (or more) characteristics are independent
- Tests for independence

	Malignant	Benign	Total
Non-enhancing	15	5	20
Enhancing	7	42	49
Total	22	47	69

University of Vermont
MEDICAL CENTER

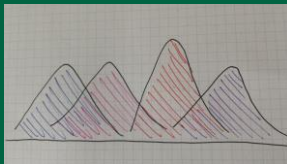
Unequal variance: non-parametric

- Mann Whitney
 - Compares two independent population distributions
 - Does not assume a distribution
- Wilcoxon Signed rank
 - An alternative to the paired t test
 - Assumes distribution is symmetric with respect to its median

University of Vermont
MEDICAL CENTER

Multiple comparisons: ANOVA

- Compares the means of two or more independent groups
- Assumes a normal distribution



University of Vermont
MEDICAL CENTER

Multiple comparisons: Bonferroni

- Adjusts the threshold for significance based on the number of variables being considered
- Reducing the level of significance also reduces the power of the test
- Most conservative approach
- Alternatives: Holm, Sidak

University of Vermont
MEDICAL CENTER

Erroneous relationships due to data mining

- Follow up imaging for two arms of a study (control and treated)
- Initially you only look at diffusion coefficient, then want to compare other image metrics

Number of independent variables	Probability of erroneously declaring one significant
1	5%
3	14%
13	50%
30	80%

University of Vermont
MEDICAL CENTER

Conclusion

- Formally write out your null hypothesis before you run any tests
- How many hypotheses do you have? Are they related?
- Now choose your tests
- If you start analyzing your data and running tests in excel, take a moment and go back and write it out

University of Vermont
MEDICAL CENTER