APIC

Online Education Center

Basic Statistics

for Infection Preventionists

VIRTUAL LEARNING LAB

Week 2: Inferential Statistics

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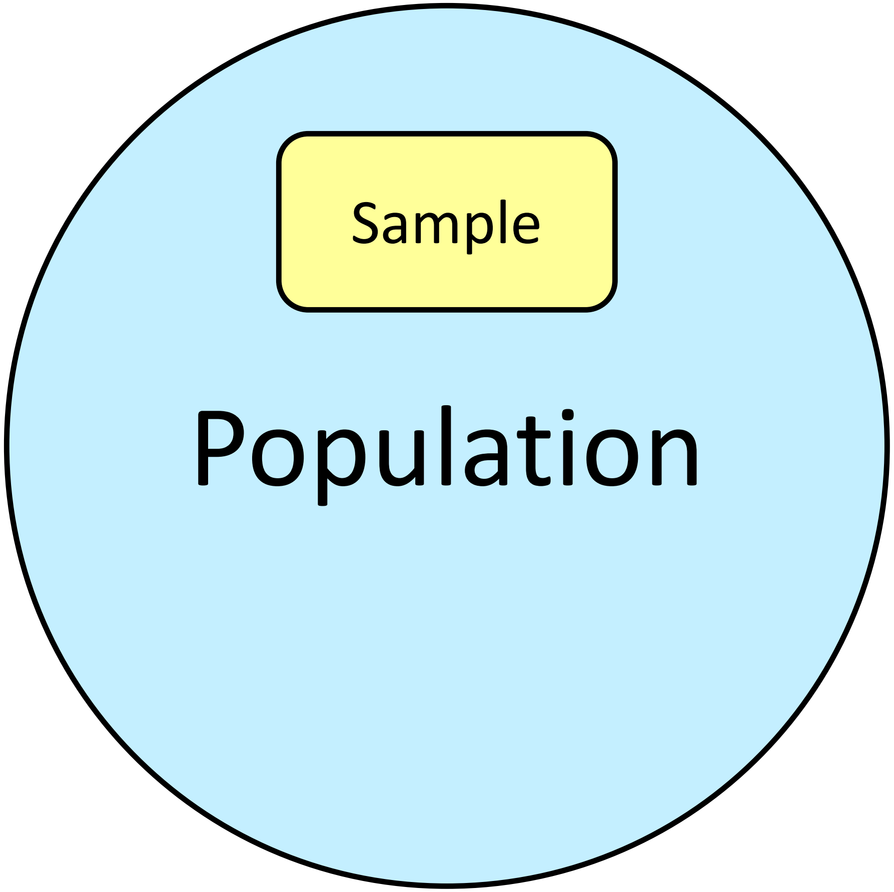
No conflicts of interest to disclose.

Inferential Statistics



The Joint Commission
Performance Improvement
Project Guidelines

Population	Sample Size
<30	All
30 - 100	30
101 - 500	50
>500	70

Uselton JP, et al. *Assuring Continuous Compliance with Joint Commission Standards: a Pharmacy Guide*; 2010.

Steps in Any Hypothesis Test

- Step 1: Determine the null and alternative hypotheses
- Step 2: Choose a significance level (e.g. $\alpha = 0.05$)
- Step 3: Select statistical test and verify necessary data conditions
- Step 4: Calculate the appropriate test statistic and p-value
- Step 5: Interpret the results

Hypotheses

- Null hypothesis: values are equal.

- Alternative hypothesis: values differ.

- These statements are mutually exclusive.
  - They cover all possible outcomes.
  - In the end, only one can be selected.

Determining Hypotheses #1

Surgeon A has a <u>different</u> infection rate than Surgeon B.

<u>Null</u>		<u>Alternative</u>
	$A = B$	$A \neq B$
	$A > B$	
	$A < B$	

Determining Hypotheses #2

Surgeon A has a <u>larger</u> infection rate than Surgeon B.

<u>Null</u>		<u>Alternative</u>
	A = B	
	A > B	
	A < B	

Determining Hypotheses #3

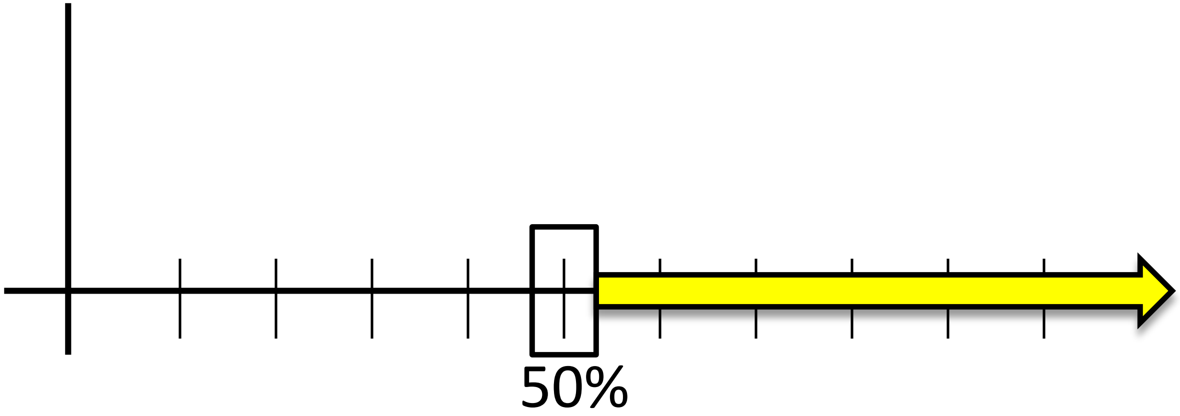
Surgeon A has a <u>smaller</u> infection rate than Surgeon B.

<u>Null</u>		<u>Alternative</u>
	A = B	
	A > B	
	A < B	

One-Sided vs. Two-Sided Tests

- One direction = one-sided test
  - A.K.A. One-tailed test

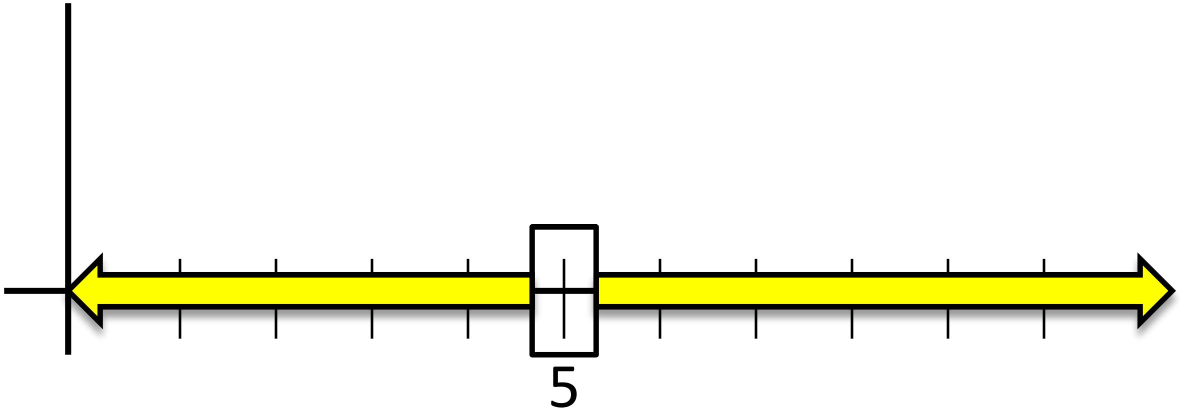
- Example: Mean HH compliance rate > 50%



One-Sided vs. Two-Sided Tests

- Two directions = two-sided test
  - A.K.A. Two-tailed test

- Example: Mean CLABSI rate ≠ 5



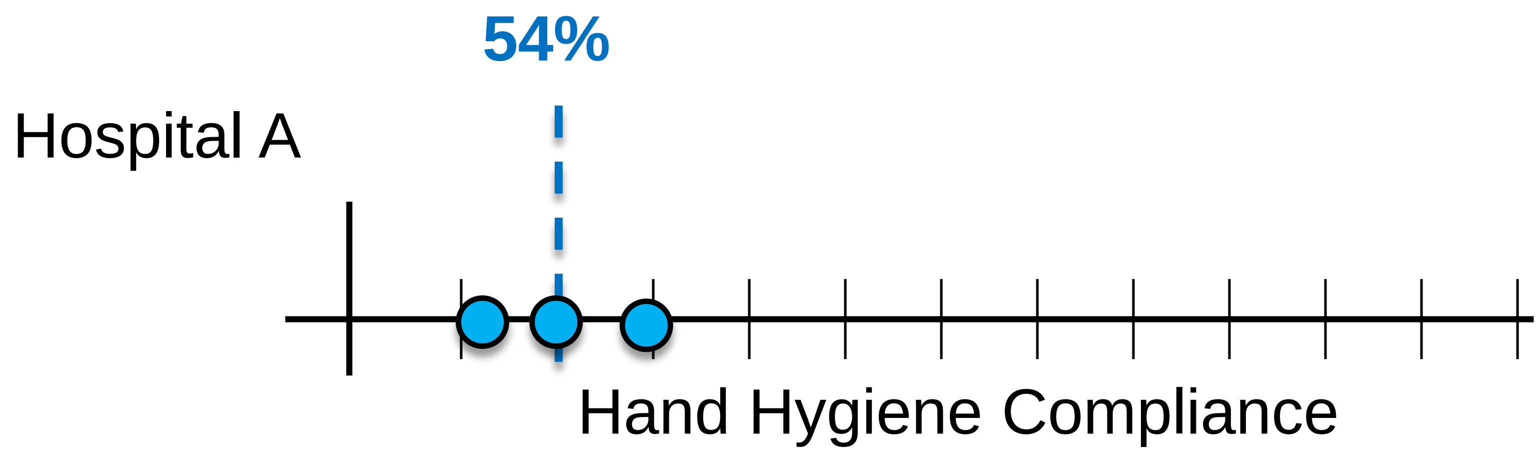
Quiz Question #1

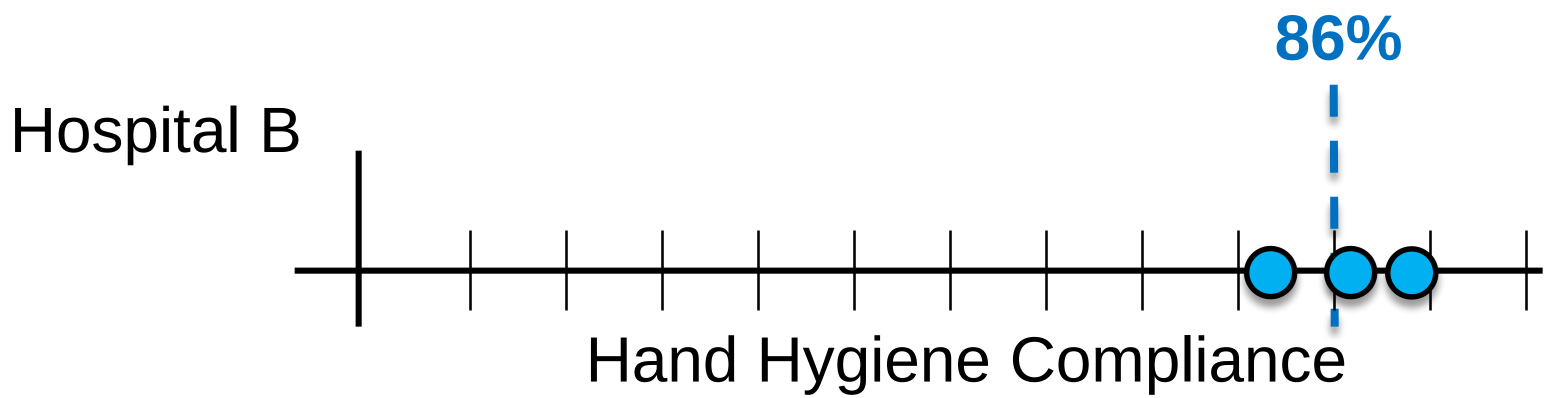
- Which of the following are null hypotheses?
  A. Unit A's infection rate is the same as Unit B's.
  B. The CLABSI rate is equal to or higher than the CAUTI rate.
  C. The SSI rate after the intervention is less than or equal to the SSI rate before the intervention.
  D. All of the above.

Hospital A vs. Hospital B

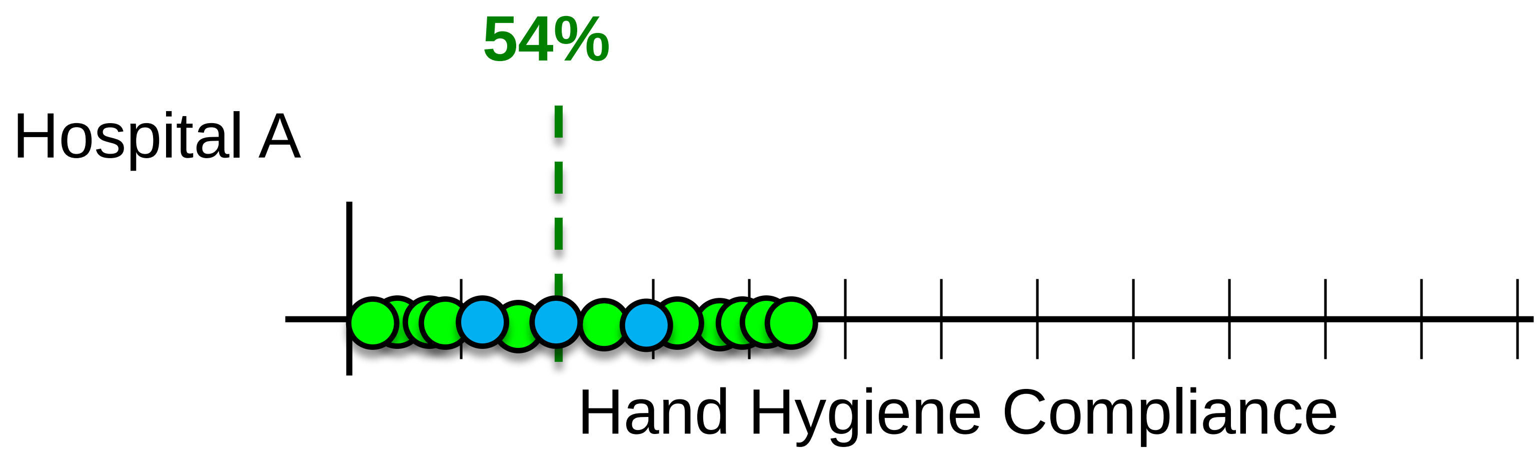
- Null hypothesis:
  - The average levels of hand hygiene compliance at Hospital A and Hospital B <u>are the same</u>.

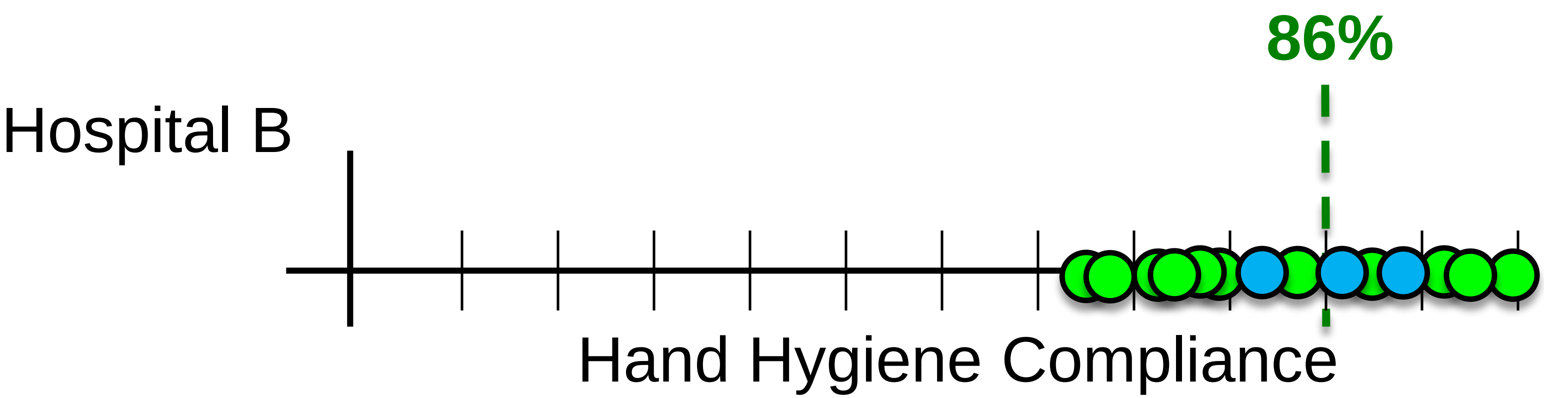
- Alternative hypothesis:
  - The average levels of hand hygiene compliance at Hospital A and Hospital B <u>are different</u>.


54%
Hospital A
Hand Hygiene Compliance

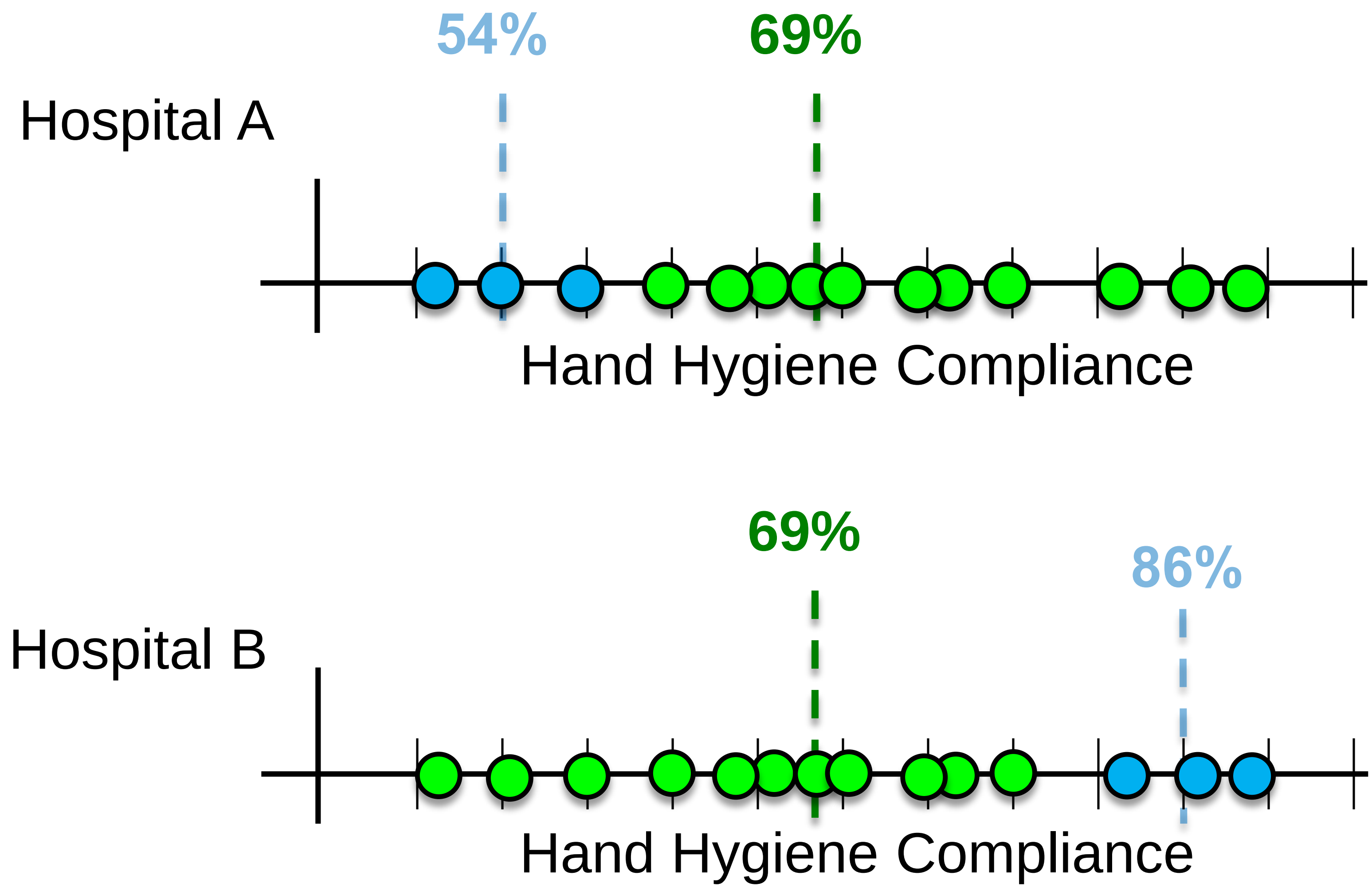

86%
Hospital B
Hand Hygiene Compliance

Alternative Hypothesis





Null Hypothesis



Error Options

	Your Conclusion	
Reality	**Same (null)**	**Different (alt)**
Same (null)	Correct	False Positive
Different (alt)	False Negative	Correct

The False **Positive** Scenario (Type I Error)

Your Conclusion

There is a difference.

(Alternative Hypothesis)

Reality

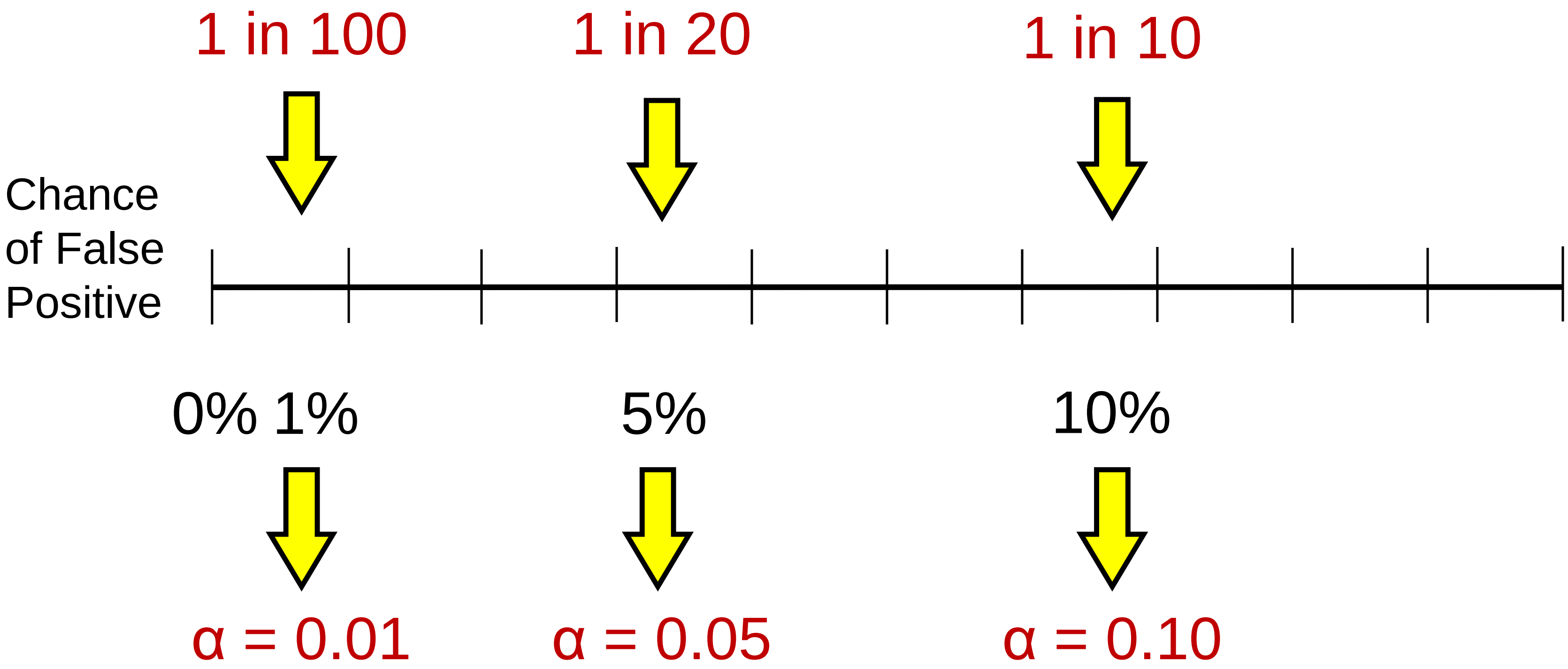
There is NO difference.

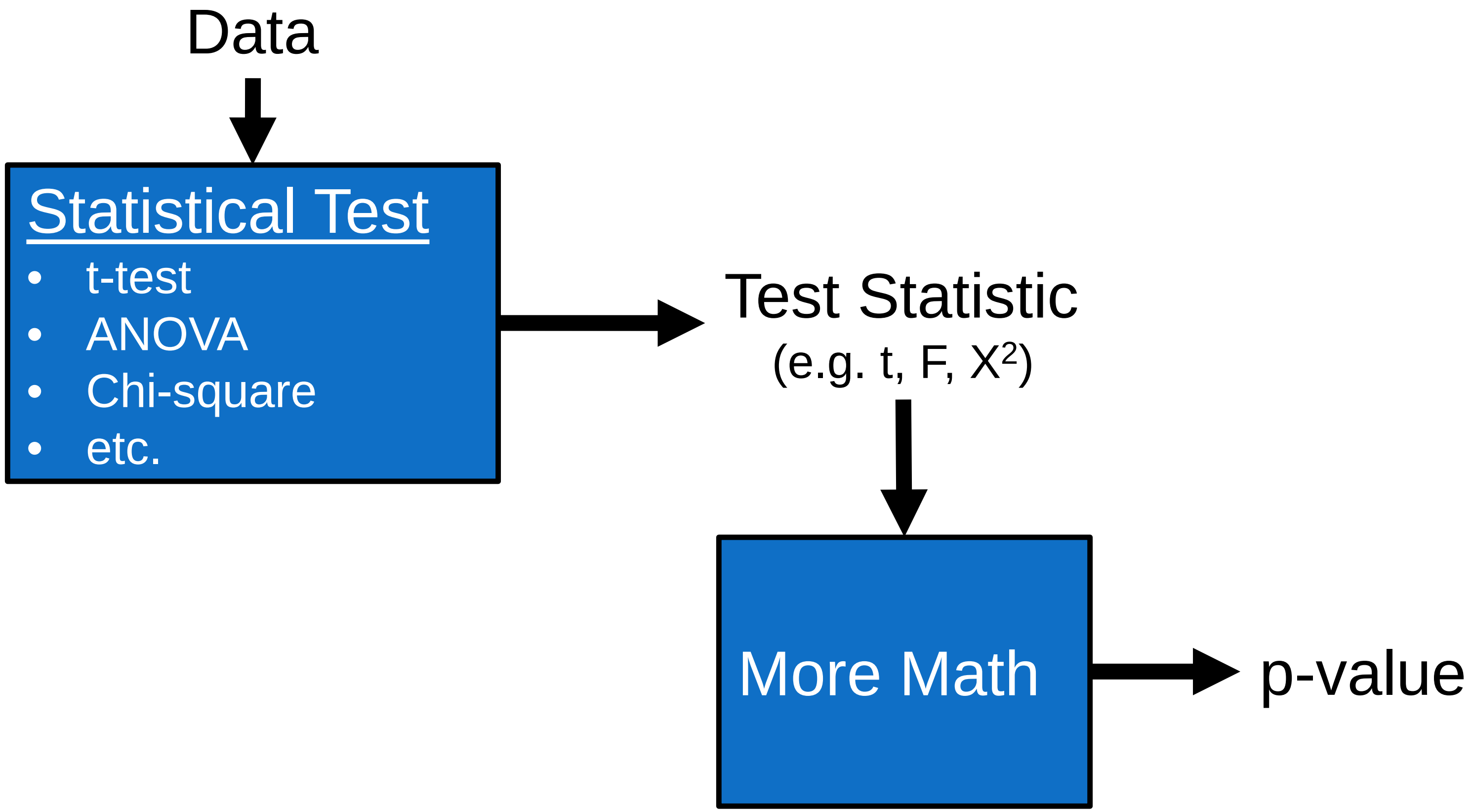
(Null Hypothesis)

Alpha (α)

- The probability of concluding a difference is real when it is actually just random variation (a false positive).

α = Probability of a False Positive

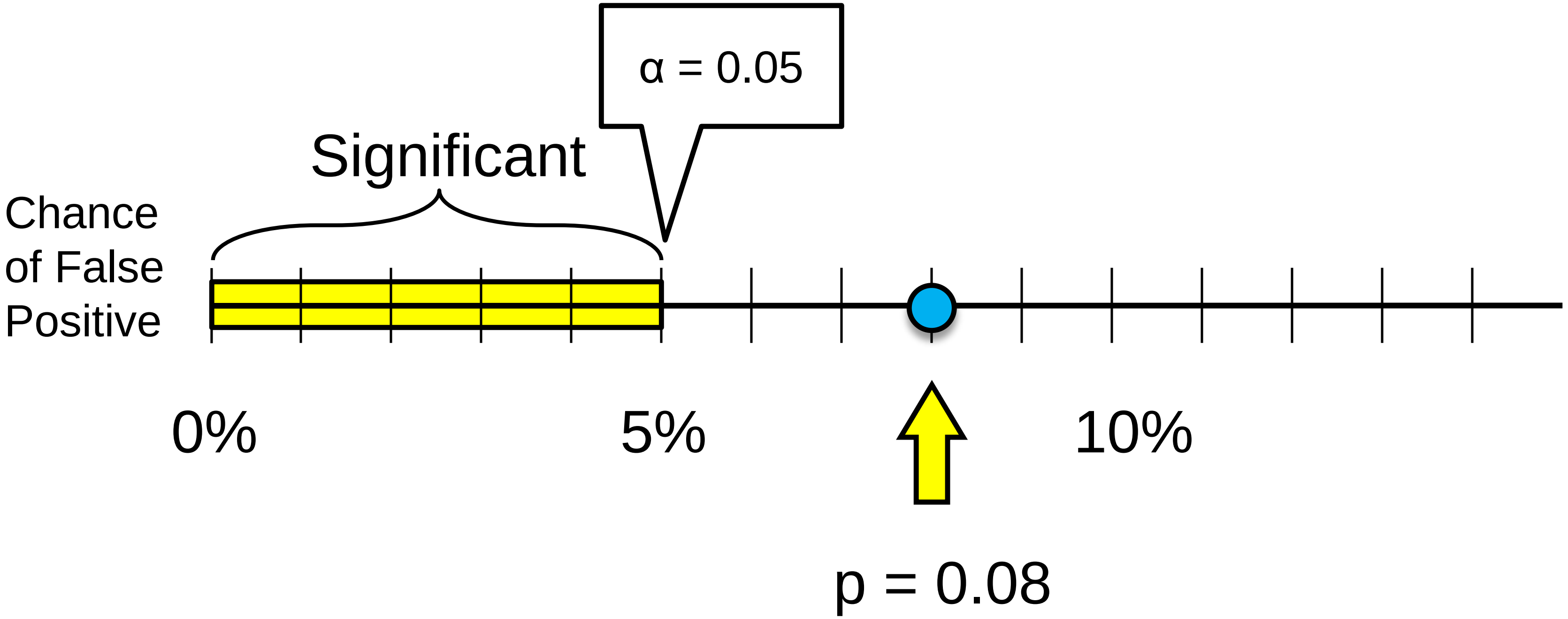




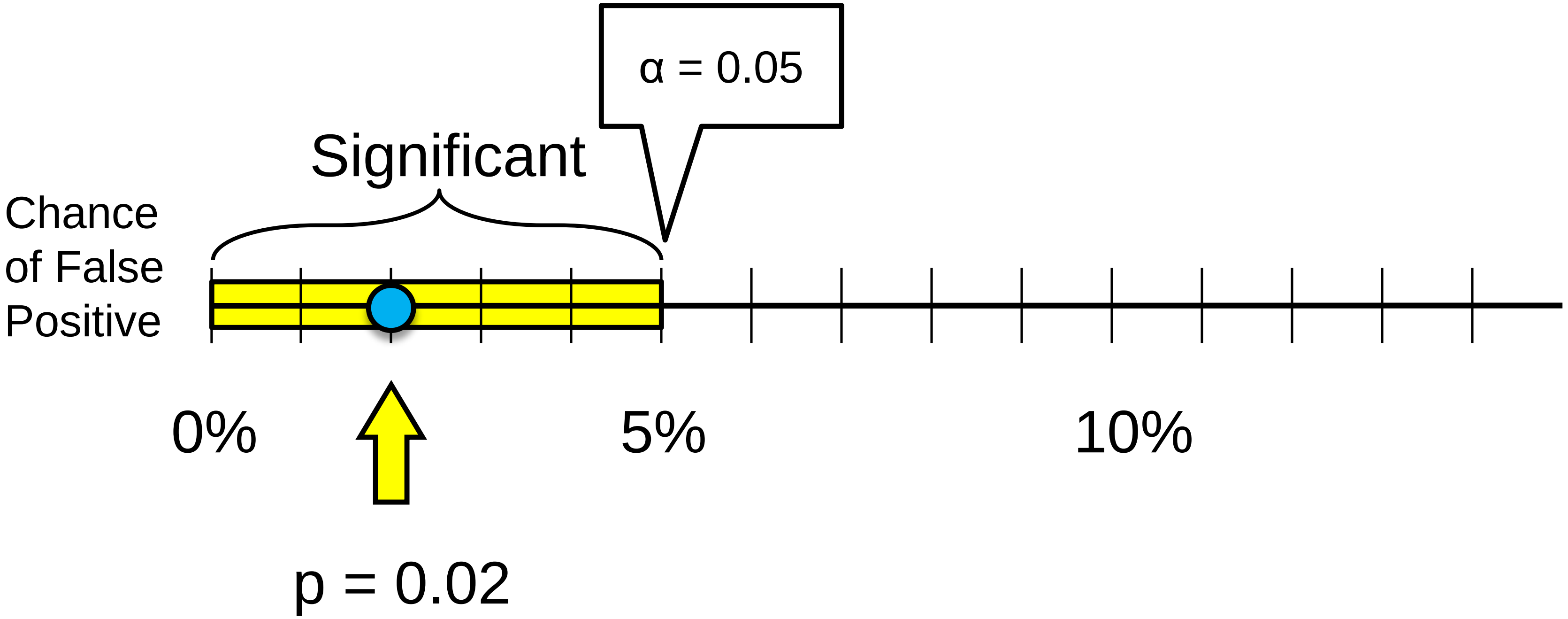
p-value: the probability that this difference (or a more extreme one) was caused by random chance if the null hypothesis is true.

Risk of a False Positive

Alpha vs.	p-Value
• The amount of risk you are willing to accept.	• The amount of risk present.



- p-value **>** α
- The risk of a false positive is too high.
- Conclude there is no difference.



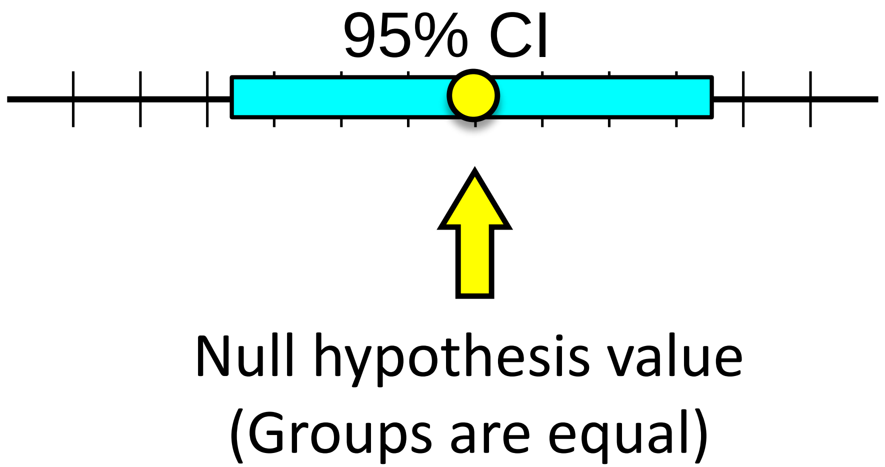
- p-value < α
- The risk of a false positive is acceptable.
- Conclude a difference exists!

Quiz Question #2

- You run a statistical test using an alpha of 0.01 and get a p-value of 0.05. Which hypothesis should you go with?

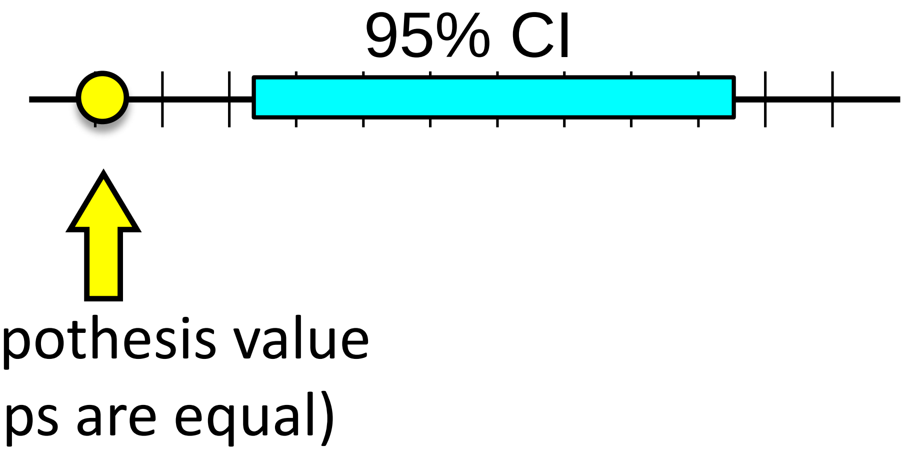
A. Null hypothesis
B. Alternative hypothesis

Confidence Interval (CI)



- Null hypothesis value inside CI.
- Conclude there is no difference.

Confidence Interval (CI)

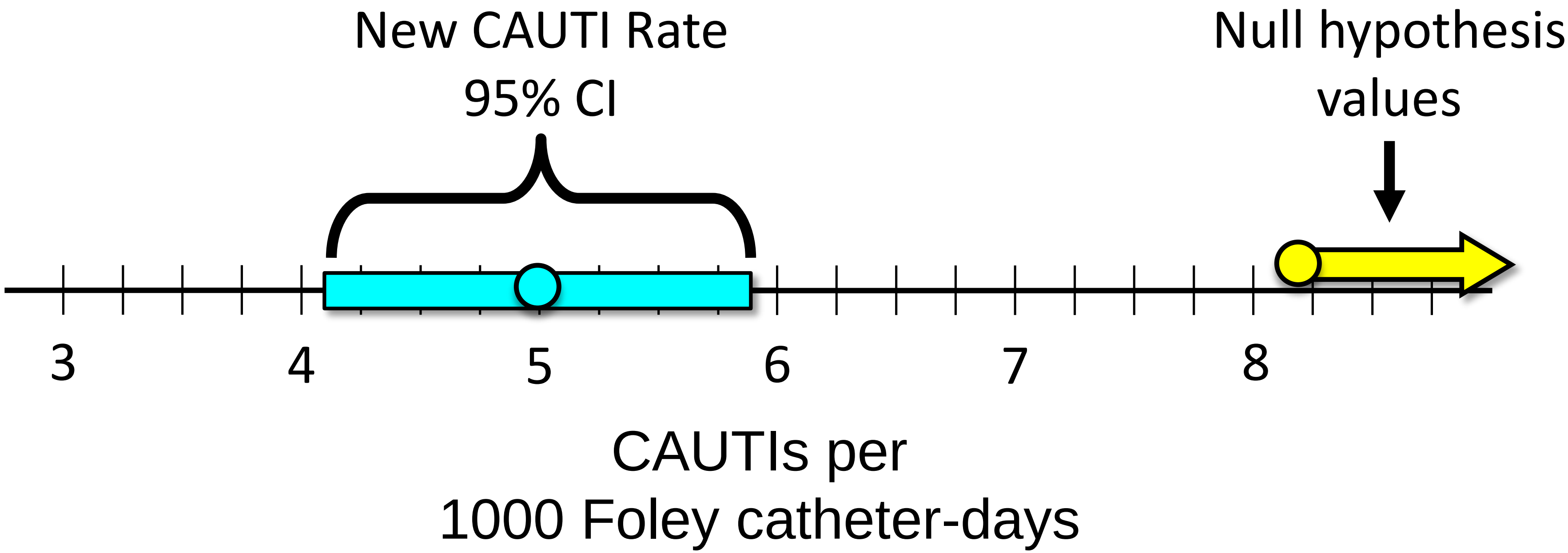


- Null hypothesis value outside CI.
- Conclude there is a difference.

CAUTI Reduction Project
Phase 1 vs. Phase 2

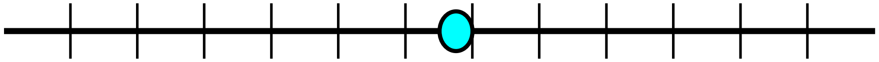
- Null hypothesis:
  - The infection rate with the care bundle in place is equal to or greater than 8.2 CAUTIs per 1000 Foley catheter-days.
- Alternative hypothesis:
  - The infection rate with the care bundle in place is less than 8.2 CAUTIs per 1000 Foley catheter-days.
- Alpha = 0.05 (accepting 5% risk of false positive)
  - Cut-off for p-value
  - Expect 95% confidence interval

CAUTI Reduction Project Results

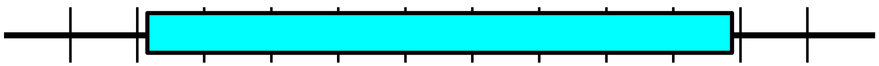
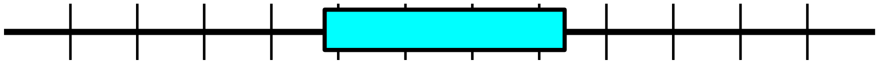


- Null hypothesis values outside CI.
- Conclude there is a difference.

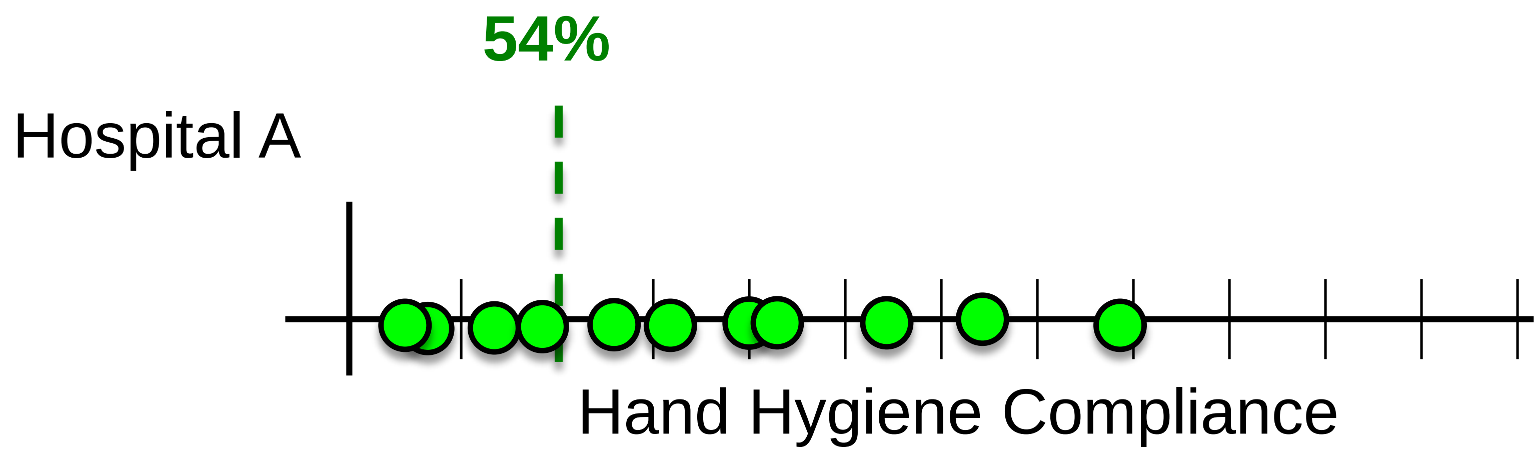
Confidence Interval Width

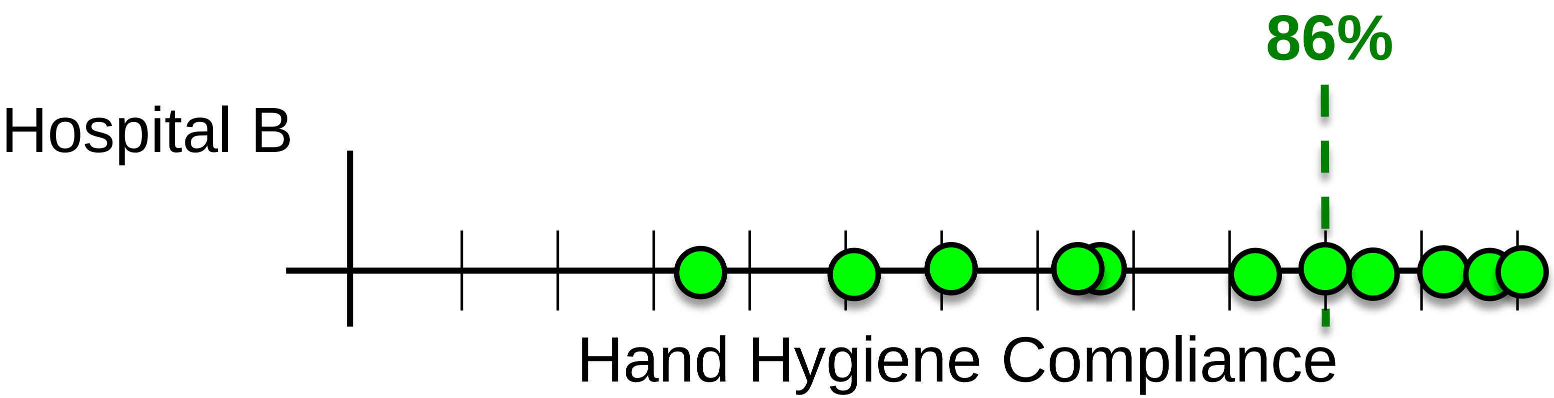
<u>Sample Size</u>	<u>CI</u>
Small	
Large	
All	

Confidence Interval Width

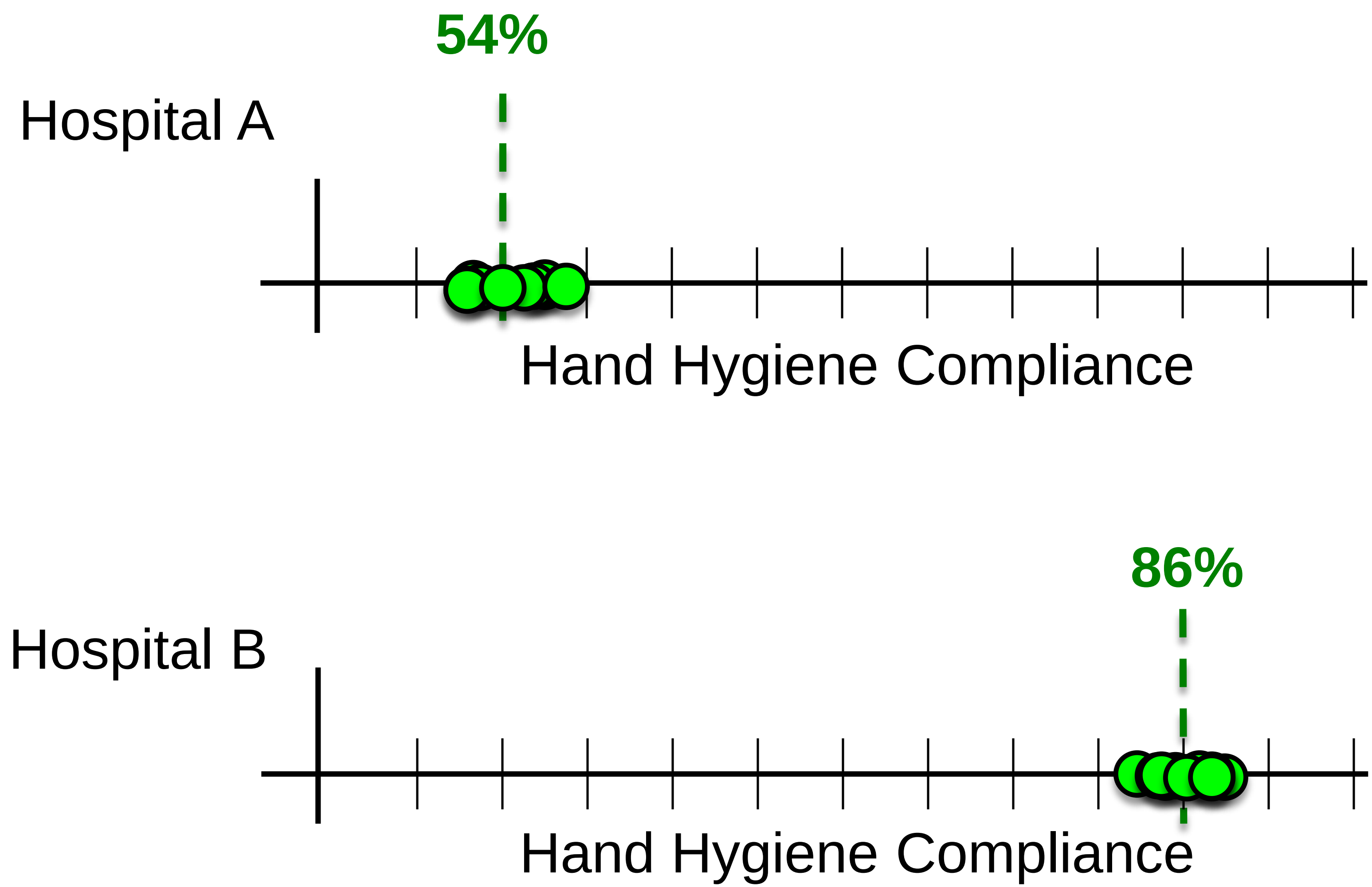
Data Variability	CI
Large Variability	
Small Variability	

Large Variability



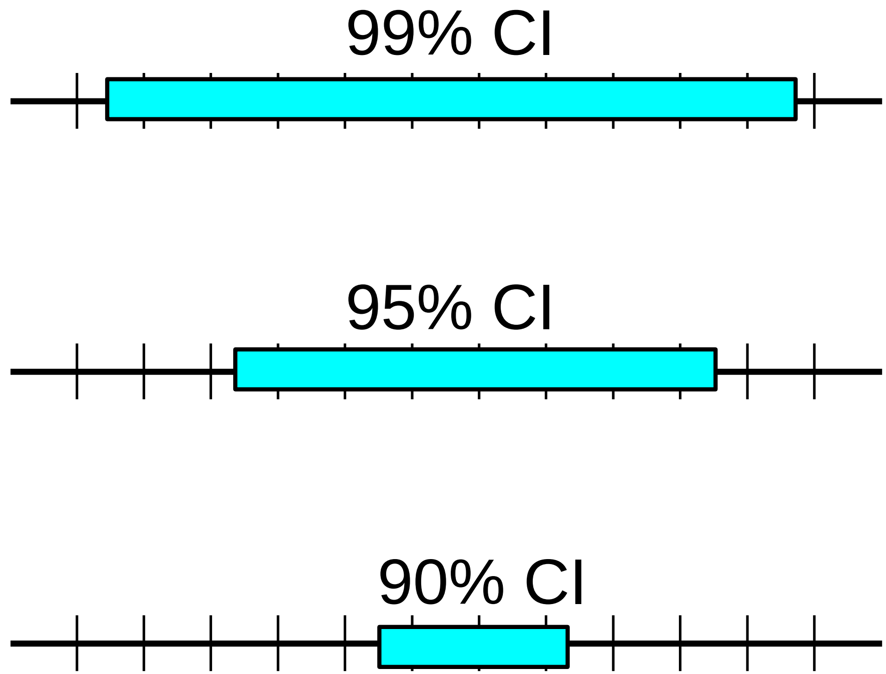


Little Variability



Confidence Interval Width

Alpha (α)	CI
0.01	99% CI
0.05	95% CI
0.10	90% CI



Error Options

	Your Conclusion	
Reality	**Same (null)**	**Different (alt)**
Same (null)	Correct	False Positive
Different (alt)	False Negative	Correct

The False **Negative** Scenario (Type II Error)

Your Conclusion

There is NO difference.

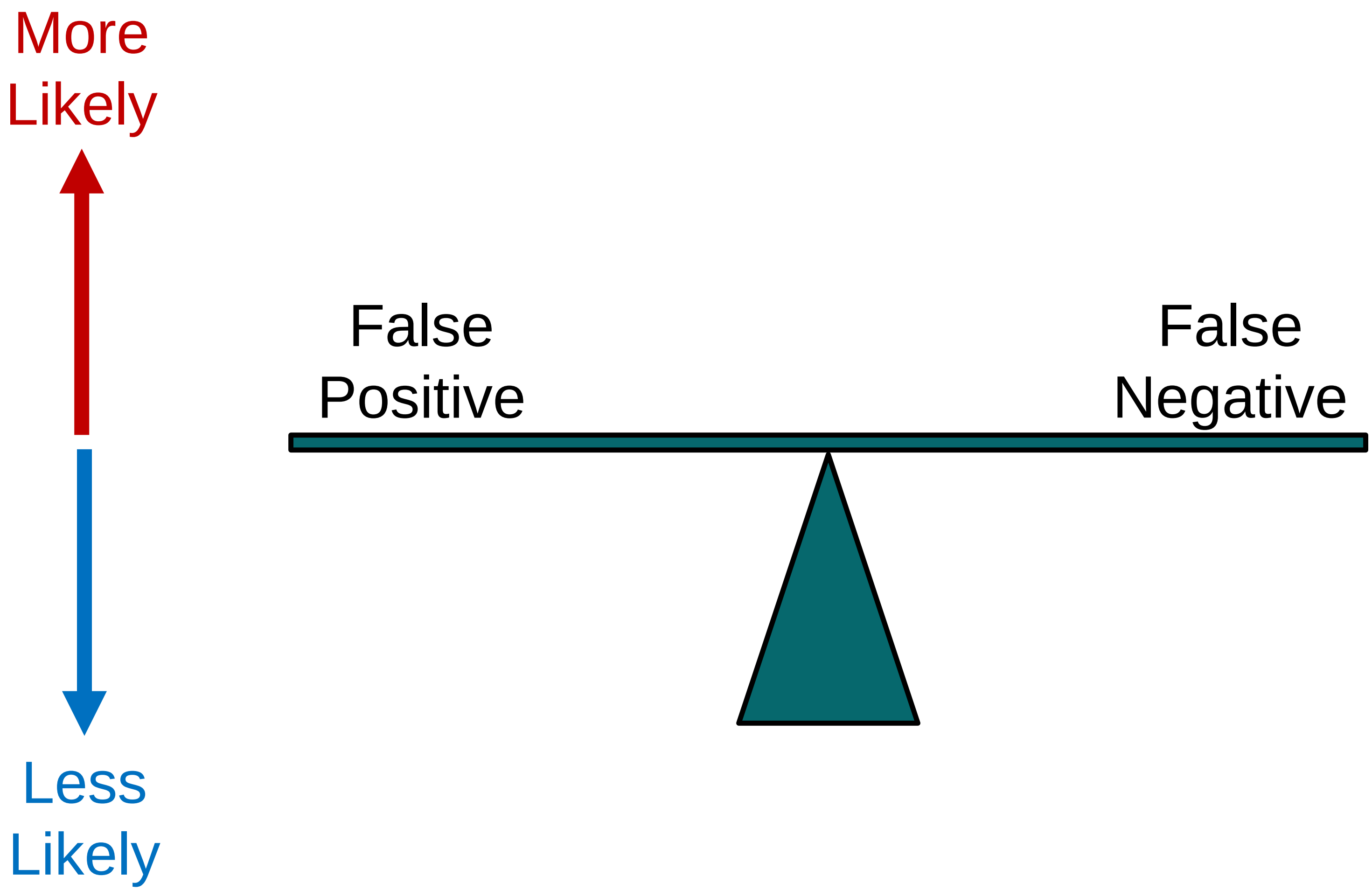
(Null Hypothesis)

Reality

There is a difference.

(Alternative Hypothesis)

Changing Alpha…




MAG-LITE

What Drives Power?

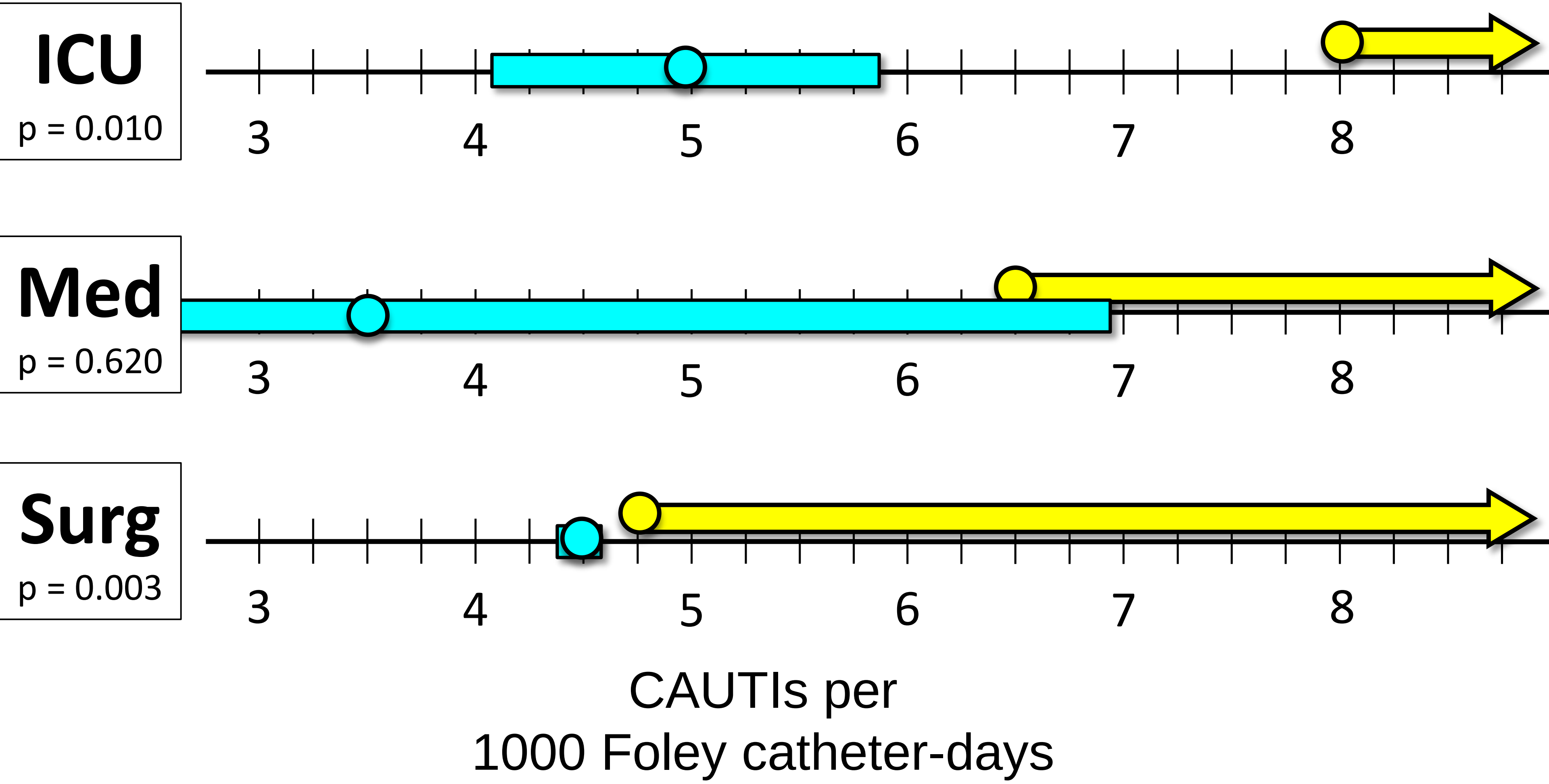
- Difference of interest
- Sample size
- Data variability
- Level of significance (α)
- Test used

Quiz Question #3

- Which of the following results can cause the size of the confidence interval to increase?
  A. Smaller sample size
  B. Less data variability
  C. Larger alpha
  D. All of the above

But…

Clinical Relevance



Garbage In, Garbage Out

Bad Data

Wrong Statistical Test

- t-test
- ANOVA
- Chi-square
- etc.

Test Statistic

(e.g. t, F, X^2)

More Math

p-value

Nothing is Certain

- Statistically significant result?
  - Alpha = 0.05
  - Wrong 1 time in 20
- No significant finding?
  - Power = 80%
  - Wrong 1 time in 5

Module 2 Summary

- Null hypothesis includes “equal”
- Alternative hypothesis looks 1 or 2 directions
- Alpha = acceptable chance of false positive
- p-value = current chance of false positive
- CI and p-value should give same answer
- Statistical significance ≠ clinical relevance
- Inferential statistics are never perfect…

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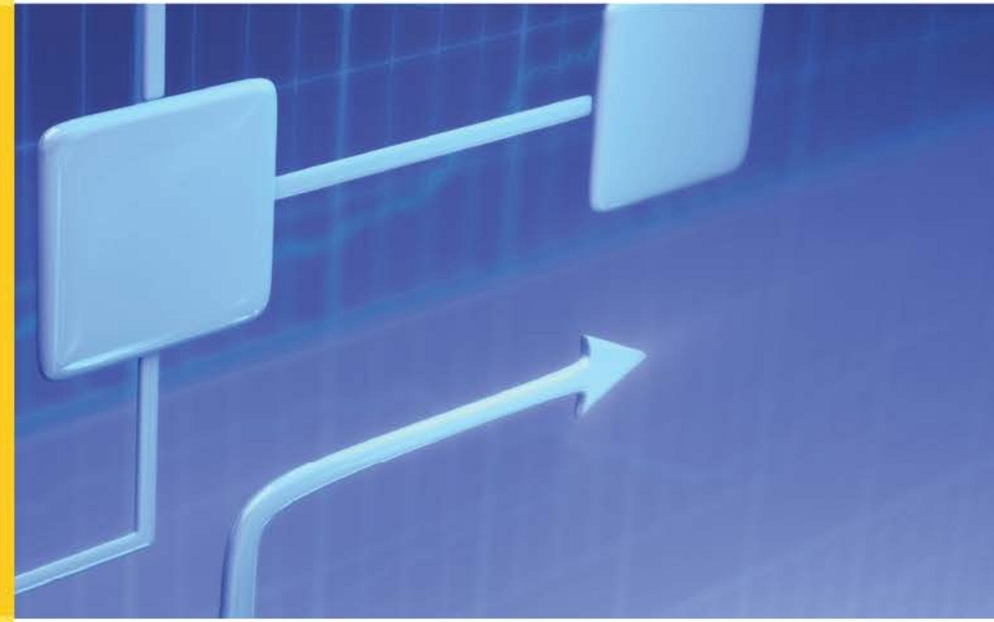

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