Medicine & the **Media**
The Challenge of Reporting on Medical Research

Limited Role of Statistics

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Il Pensiero Scientifico Editore

ProMIS

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Why results might be wrong?

May not be valid

Biased study design or execution

Confounding: Heart attacks may be lower in supplement takers but it may have nothing to do with the supplements.

Just reflect chance

Flip a coin 10 times and get 4 heads

Flip it another 10 times and get 7 heads

Differences are expected

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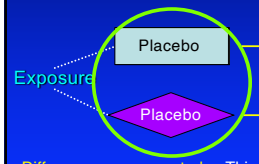
Thought experiment



Count Death

Count Death

But exactly??

Should be the same!

Differences are expected: Things vary just by chance*

Synonyms: luck of draw, random variation, sampling error

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p-value

Is the difference bigger than what you'd expect just by chance?

The p value says how often you would expect to see a difference this big (bigger) IF IN FACT treatment really had no effect*.

Just like in the thought experiment where we tested the effect of placebo vs. placebo in identical groups of patients – in which case, the observed differences only reflect chance.

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p-value

Is the difference bigger than what you'd expect just by chance?

The p value says how often you would expect to see a difference this big (bigger) IF IN FACT treatment really had no effect*.

p-values are calculated by:

- Assuming the drugs are the same: "null hypothesis"
- Judging if the observed data disprove this assumption

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p-value

The "p" means "probability", (so it ranges from 0 to 1):
eg, p=0.03 means a 3% chance of seeing a difference this big or bigger if treatment actually had no effect

Low p value means you are less likely to see results this extreme if null hypothesis were true (ie, treatment really made no difference)

If p is really small (by convention < 5%) you "reject" the null hypothesis, ie, the observed difference is too unusual to just reflect chance variation

The result is "statistically significant"

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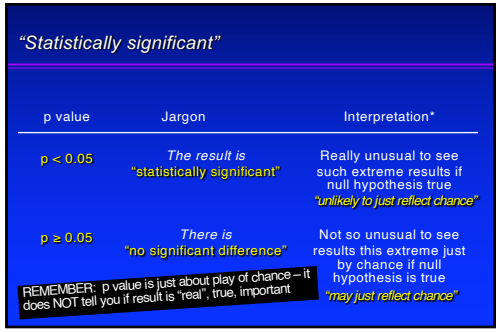

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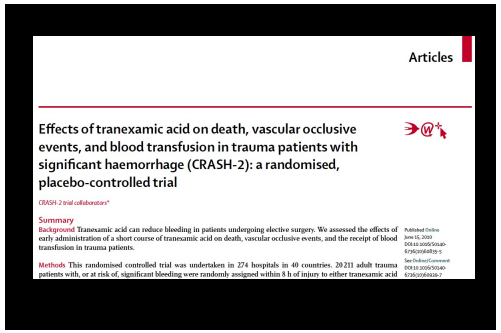

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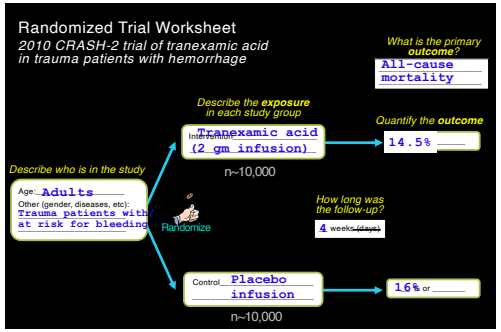

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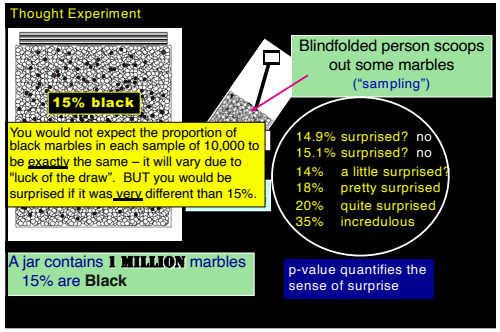

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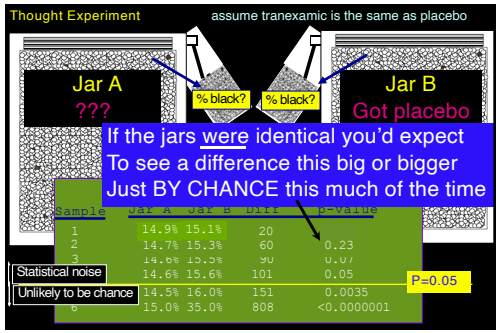

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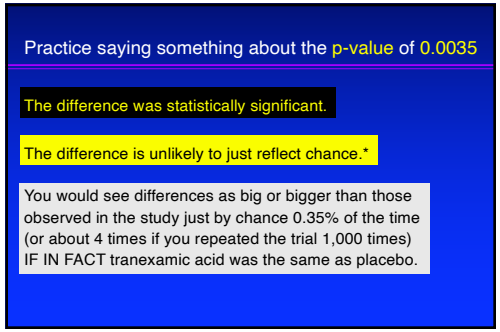

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What makes p-values higher or lower?

p values are lower with: bigger differences

Study	% Heart attack Placebo	% Heart attack Drug	Absolute difference	Number in each group	p value
A	50%	45%	5%	100	0.48
B	50%	30%	20%	100	0.004

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p values are lower with: bigger groups (more outcomes)

Study	% Heart attack Placebo	% Heart attack Drug	Absolute difference	Number in each group	p value
A	50%	40%	10%	20	0.53
B	50%	40%	10%	2,000	<0.0001

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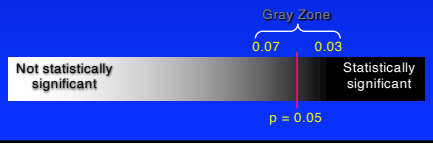
Now you try:

Women without breast cancer on a low fat diet for 5 years developed fewer cases of breast cancer: 20 vs 22 cases per 1000, p = 0.07



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p values - Take home points

1. Differences among two groups are the norm.
2. The p value is the probability an observed difference is due to chance.
3. If the p value is > 0.05 – that is 5% - or greater, we say the observed difference may just reflect chance ("not statistically significant").
4. If the the p value is less than 0.05, we say it is unlikely to just reflect chance ("statistically significant").

Advanced point

5. The 0.05 (5%) cut-off is an arbitrary convention (no theories or data to support it). So p values near 0.05 should be interpreted cautiously.

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p-values are good, confidence intervals are better!

Statistically Significant?

p values (arbitrarily) dichotomize the world (statistically significant or not)

Fewer deaths with tranexamic acid than placebo:
14.5% vs. 16%, p value for the 1.5% difference: p=0.0035

Confidence Intervals (CI's) are a step up because they *also* show you the plausible range of values .

Fewer deaths with tranexamic acid than placebo:
14.5% vs. 16%, CI for the -1.5% difference: -2.5% to -0.5%

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U.S. Presidential Poll

If the presidential election were held today, who would you vote for?

Biden		Trump		What is B's lead?
50%	-	45%	=	5%

Margin of error version

Margin of error ± 3%

Best guess (lead): 5%

Plausible range: 2% to 8%

Confidence interval version

95% CI: 2% - 8%

Best guess (lead): 5%

Plausible range: 2% to 8%

Confidence interval = Margin of error

Only better – it does the addition/subtraction for you!

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Randomized trial

How many people were cured?

Bidenex™		Placebo		Absolute difference
50%	-	45%	=	5%

Confidence interval version

95% CI: 2% - 8%

Best guess (difference): 5%

Plausible range: 2% to 8%

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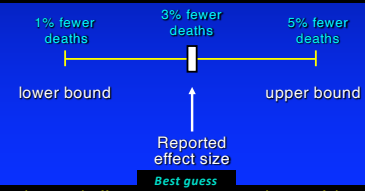
95% CIs - a visual representation

We are confident that the truth lies within this range (acknowledge that we will be wrong 5% of the time)



The observed effect size is just an estimate of the truth.

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95% Confidence Intervals

Formal Definition

A range of values computed from the sample data which, were the study repeated multiple times, would contain the unknown parameter 95% of the time.

Working definition

95% of the time this range includes the truth.

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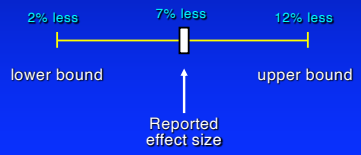
Our best estimate is that the intervention reduces cataract surgery **by 7 percentage points**. But this study says it's possible that the intervention may lower surgery by **as little as 2 percentage points** or **as much as 12 percentage points**.



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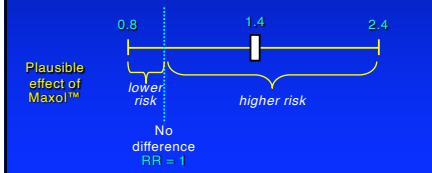
The study says it's possible that the risk of polyps may be 0.8 times **lower** with Maxol™ compared to placebo – but it might be 2.4 times **higher.** So, based on this study, we cannot conclude that Maxol™ is different than placebo.



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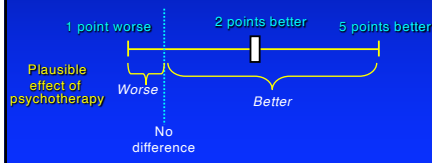
The study says it's possible that depression scores are **worse** by 1 point with psychotherapy – but scores might be 5 points **better.** So based on this study, we cannot conclude that psychotherapy is different than placebo.



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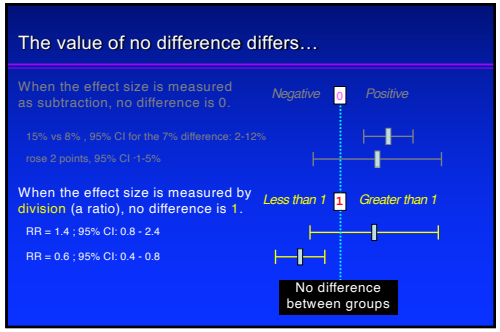

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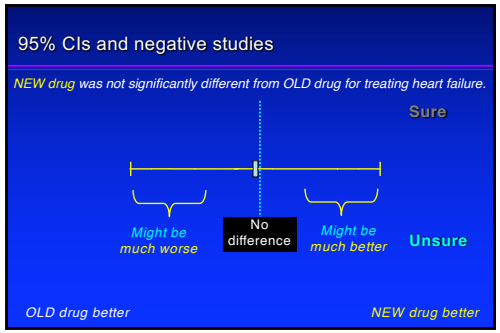

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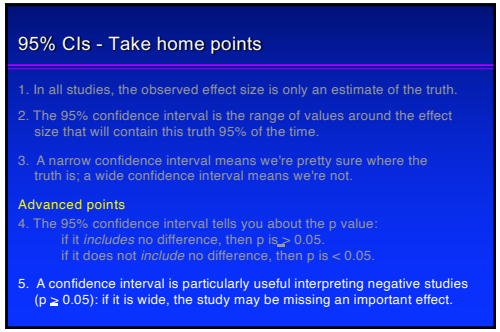

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Putting it all together:

Children using belt-positioning booster seats had a lower risk of injury than those using seat belts alone:

0.77% vs 1.95%, RR = 0.40 , 95% CI: 0.20 - 0.86

Statistically significant?

Could be due to chance?

Statistically significant, unlikely due to chance, but the apparent effect of booster seats may not be real (may be confounded).

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Final Caution

A study with a extremely low p value (*very* statistically significant) and an extremely narrow 95% confidence interval (*very* precise) can nonetheless be *very wrong*.

In observational studies, the observed relationship may be *confounded* by other variables.

In all studies, the focus may be on the *wrong patients*, the *wrong comparison* or the *wrong outcome*.

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