Introduction: Not everything you read is true

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Conflicts of Interest

Research support: Elekta Instrument, AB
1. Learn about the presence of statistical problems in published studies

2. Identify common signs and symptoms of potential problems in various types of statistical tests

3. Learn methods for correctly implementing statistical analyses of the type commonly found in clinical publications

The truth is hard to come by
Cellphone use causes cancer

Major Cell Phone Radiation Study Reignites Cancer Questions

Exposure to radio-frequency radiation linked to tumor formation in rats

By Dina Fine Maron on May 27, 2016  Véase en español


Cellphone use causes cancer – maybe?

Study released before peer-review

Control rats showed less than expected natural rate of tumor incidence and died early

Incidence of tumor development correlates with age

Early control death magnified the statistical findings

http://arstechnica.com/science/2016/05/study-that-found-cell-phones-cause-cancer-in-rats-is-riddled-with-red-flags/
<table>
<thead>
<tr>
<th>Publication Year</th>
<th>Study</th>
<th>Type</th>
<th># participants</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Interphone Study Group</td>
<td>Case-control study</td>
<td>~5000 cases; ~5000 matched controls; 13 countries</td>
<td>No overall risk*</td>
</tr>
<tr>
<td>2001 (updated 2007, 2011)</td>
<td>Danish cohort study</td>
<td>Cohort study</td>
<td>358,000</td>
<td>No association</td>
</tr>
<tr>
<td>2013 (updated 2014)</td>
<td>Million Women Study</td>
<td>Prospective cohort study</td>
<td>791,710</td>
<td>Yes (acoustic neuroma), then no association</td>
</tr>
<tr>
<td>2014</td>
<td>CERENAT</td>
<td>Multicenter case control</td>
<td>447 cases, 892 matched controls</td>
<td>No association with regular use; yes association with heaviest use</td>
</tr>
<tr>
<td>2011</td>
<td>Swedish pooled analysis</td>
<td>Pooled analysis of 2 case control studies</td>
<td>1251 cases, 2438 controls</td>
<td>Increased risk of glioma</td>
</tr>
</tbody>
</table>

The result of studies of thousands of animals and hundreds of thousands of people is that we have no definitive answer to the question of cellphone use and cancer.

So….

How confident can we be about studies like this:
**SRS for lung cancer: Does morning or afternoon make a difference?**

**Abstract**

**BACKGROUND:** Circadian cell-cycle progression causes fluctuating radiosensitivity in many tissues, which could affect clinical outcomes. The purpose of this study was to determine whether outcomes of single-session gamma knife radiosurgery (GKRS) for metastatic nonsmall cell lung cancer (NSCLC) differ based on treatment time.

**METHODS:** Fifty-eight patients received GKRS between 10:00 am and 12:30 pm and 39 patients received GKRS between 12:30 pm and 3:00 pm. The mean peripheral dose was 16.6 Gy. The mean tumor size was 7.3 cm³. Magnetic resonance imaging was used to score local control at 3 months. Cause of death (COD) was categorized as central nervous system (CNS)-related or systemic.

**RESULTS:** Demographic and disease characteristics of the 2 groups were similar. Local control at 3 months was achieved in 97% (35/36) of patients who underwent GKRS early in the day versus 67% (8/12) of patients who underwent GKRS later in the day (chi-square, $P = .014$). Early GKRS was associated with better survival (median 9.5 months) than late GKRS (median 5 months) (Kaplan-Meier log-rank test, $P = .025$). Factors contributing to better survival in a Cox regression model included early treatment time ($P = .004$) and recursive partition analysis class ($P < .001$). Cause of death in the early treatment group was CNS-related in 6% (3/47) of patients versus 24% (8/34) of patients in the late treatment group (chi-square test, $P = .026$).

**CONCLUSIONS:** GKRS for metastatic NSCLC had better local control, better survival, and a lower rate of CNS-related cause of death when given earlier in the day versus later in the day. **These retrospective data should encourage future study in brain radiosurgery** and non-CNS stereotactic body radiotherapy series.

D. Rahn, et al., Cancer 177(2), 2011.

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**But...maybe we were onto something in this case.....**


**Morning vaccination enhances antibody response over afternoon vaccination: A cluster-randomised trial.**

Long JE¹, Drayson MT², Taylor AE³, Toellner KM², Lord JM⁴, Phillips AG⁵.

![Graphs showing antibody response over time](attachment:image.png)
Medicine increasingly relies on p-values

What we think is the truth often can't be replicated

One study’s result is not necessarily the truth

http://news.harvard.edu/gazette/story/2016/03/study-that-undercut-psych-research-got-it-wrong/
http://projects.iq.harvard.edu/psychology-replications/

Same Data, Different Conclusions
Twenty-nine research teams were given the same set of soccer data and asked to determine if referees are more likely to give red cards to dark-skinned players. Each team used a different statistical method, and each found a different relationship between skin color and red cards.

http://fivethirtyeight.com/features/science-isnt-broken/#part2
The number of retractions is sharply rising


A lack of statistical fluency may be part of the problem
Many medical physicists receive little training in practical statistics as applied to clinical outcomes studies. However...these studies are at the heart of our profession. How to recognize when the statistics don’t quite add up?

p-values just below 0.05 are over-represented

The distribution of probability values in medical abstracts: an observational study
There are many ways to achieve a desired story. peach your way to scientific glory.

Hack Your Way To Scientific Glory

You've got a hypothesis with a hook. The U.S. economy is affected by whether Republicans or Democrats are in office. Try to show that a connection exists, using real data going back to 1948. For your results to be publishable in an academic journal, you'll need to prove that they are "statistically significant" by achieving a low enough p-value.

1. CHOOSE A POLITICAL PARTY
   - Republicans
   - Democrats

2. DEFINE TERMS
   - What are the terms you've defined for the economy? How do you define what your hypothesis means?
   - བོད་འདྲི་བཞིན་དུ་ག་འཛན་ནི་ཁ་, བོད་དེ་བཟོ་དང་། དབང་རིག་པ་དེ་བཟོ་དང་།
   - བོད་དེ་བཟོ་དང་། བོད་དེ་བཟོ་དང་།
   - བོད་དེ་བཟོ་དང་། བོད་དེ་བཟོ་དང་།

3. IS THERE A RELATIONSHIP?
   - Comment: You've defined your terms, but the economy is better where your terms are better. Below represents one month of data.
   - བོད་དེ་བཟོ་དང་། བོད་དེ་བཟོ་དང་།
   - བོད་དེ་བཟོ་དང་། བོད་དེ་བཟོ་དང་།

4. IS YOUR RESULT SIGNIFICANT?
   - If there were no connection between the economy and politics, what is the probability that you'd get results at least as strong as yours? For that probability to be publishable, you need a p-value of 0.05 or less to get published.
   - བོད་དེ་བཟོ་དང་། བོད་དེ་བཟོ་དང་།
   - བོད་དེ་བཟོ་དང་། བོད་དེ་བཟོ་དང་།

Result: Almost

Your 0.06 p-value is close to the 0.05 threshold. Try tweaking your variables to see if you can push it over the line!

http://fivethirtyeight.com/features/science-isnt-broken/#part2

But...we can learn to be better