Statistical issues in writing for *Radiology*

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Radiology
Statistical Issues

- Power and sample size
- Multiple Comparisons
- Clustering
- Lesion level specificity
- Correlation
- Study Variability
Power and Sample Size

- Negative conclusions should be supported by power analysis:
Are all comparisons supported by statistical tests (p-values)?

- **B** is more effective than **A**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 year</td>
<td>50%</td>
<td>83%</td>
</tr>
<tr>
<td>survival</td>
<td>(2/4)</td>
<td>(5/6)</td>
</tr>
</tbody>
</table>

- Fisher exact test p=0.5
“Screening with yearly mammography and physical examination of the breasts . . . had no impact on the rate of death from breast cancer up to 7 years' follow-up from entry.”
Power and sample size

- Significant differences in small studies:
  - adequate representation of full spectrum of disease?
Multiple Comparisons

- The more tests performed (p-values), the greater the chance of at least one coincidental significant result.
Multiple Comparisons

- Multiple outcome variables
  - Measures, organs, regions, time points etc
  - Multivariate or Bonferroni-type adjustment

<table>
<thead>
<tr>
<th>Physical Characteristics and Pancreatic Microcirculatory Quantitative Parameters in Patients with and Those without Type 2 Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
</tr>
<tr>
<td>Modified Censini score*</td>
</tr>
<tr>
<td>Microcirculatory quantitative</td>
</tr>
<tr>
<td>$K_{trans}$ (min$^{-1}$)</td>
</tr>
<tr>
<td>$v_0$</td>
</tr>
<tr>
<td>$v_p$</td>
</tr>
</tbody>
</table>

Yu C, Radiology 2009: 252;704-711
Multiple Comparisons

- Multiple divisions of population
  - Prognostic factors, findings, thresholds, etc
  - Pairwise comparisons
  - Preliminary ANOVA, multiple regression or adjustment

Lipton ML, Radiology 2009: 252;816-824
Multiple Comparisons

Avoid “cherry-picking”
Clustering

- Independent observations
- Clustered
  - Detection of one alters threshold for others
  - Response to (systemic) treatment
- Requires analysis by methods incorporating possible correlations
  - GEE, Mixed model, etc.
Clustering

- Independent observations
- Clustered
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Gurel S, Radiology 2008
249:1077-1080
## Lesion Level Specificity

<table>
<thead>
<tr>
<th></th>
<th>Sens.</th>
<th>Spec.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pt</strong></td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>(Segment, breast, etc.)</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td><strong>Lesion</strong></td>
<td>✅</td>
<td>?</td>
</tr>
</tbody>
</table>

Hertzog C, Radiology 2007 244:112-120
Correlation – Not causality
– Not identity
Correlation and causality

- Correlated does not mean caused
  - Storks : babies
  - Marriages : suicides
  - Ice cream, soda consumption : polio*
  - Screening exams : cancers

- Randomization needed for causality

- Prospective studies

* For Today’s Graduate, Just One Word: Statistics S. Lohr, Aug. 5, 2009
Correlation v. identity

- Correlated does not mean equal
  - Fahrenheit and centigrade are correlated

- Significant p-value only implies related
  - Height and weight correlated.

- Does not test “is the same as”
  - Tumor size before v. after Tx
Correlation v. identity

Regress x and y

Test both intercept = 0 and slope = 1
Indicators of Study Variability

- Confidence Intervals
  - Malignancy rate of 38%
  - Malignancy rate of 38% (3/8)
  - Malignancy rate of 38% (95% CI: 8.5% - 75.5%)

- P-values
  - Greater enhancement/attenuation etc
  - 123 v. 87 HU
  - 123 (95% CI: 91 - 155) v. 87 (95% CI: 59 - 115) HU
  - 123 v. 87 HU (p= 0.59)
Conclusion

Consult your biostatistician early in the process of preparing your project and manuscript!
Publishing in Radiology:
What You Always Wanted to Know and Never Asked