

# ABCs of Statistical Consultations

Tony Panzarella



# Statistical Consultations

Who, what, when, where , why, how?

# Statistical Consultations

## WHO?

- Client(s)
- Statistician



# Statistical Consultations

## WHAT?

Assistance with:

- study design
- data collection instruments
- statistical analysis plan
- randomization schedule
- sample size determination or justification
- data analysis
- interpretation of results
- incorporating covariates, confounders, other stat. issues
- graphical presentation of findings
- writing portions of a grant application, protocol, research project, abstract, manuscript
- addressing journal or grant reviewer comments

# Statistical Consultations

## WHEN?

- Prior to the start of a study
- During a study
- After completion of a study

# Statistical Consultations

WHEN? Prior to the start of a study

- study design
- data collection instruments
- statistical analysis plan
- randomization schedule
- sample size determination or justification
- write Statistical Analysis Methods section of grant application, protocol, or research project

# Statistical Consultations

WHEN? *During a study*

- Randomization issues
- Problems with recruitment, retention, or adherence
- Study design changes
- Interim analyses

# Statistical Consultations

WHEN? *After completion of a study*

- data analysis
- interpretation of results
  - computer outputs
  - research findings (can be complicated)
- incorporating covariates, confounders, and other statistical issues
- graphical presentation of findings
- writing Statistical Analysis Methods section of abstract, manuscript
- assisting in writing Results section of abstract, manuscript
- addressing journal reviewer comments



# Statistical Consultations

## WHERE?

- Statistician's office?
- If an office is not available choose a meeting room with
  - a positive physical setting, and
  - where you will likely not be disturbed
- Make the client feel comfortable before the start of the meeting
  - Make eye contact and smile
- Forward your office phone and turn off any smartphone
- Conducive to taking notes during the consult

# Statistical Consultations

## WHY?

- Grant or funding application
- Research project
- Protocol development
- Conference abstract
- Research presentation
- Journal manuscript
- Response to journal or grant reviewer comments

# Statistical Consultations

## How?

- That is the subject of the remainder of the talk!

# Consulting Example

Your telephone rings. A doctor at your hospital has collected some data in order to compare the effects of 4 anesthetic drugs, and wants some help in analyzing the data. A meeting is arranged and the statistician is assured that ‘it won’t take long’ (sure it won’t)

# The Data

31 variables on 80 patients undergoing surgery for a variety of conditions. The doctor asks ‘How should the data be analyzed?’

# Part of the Data

Patient No.	3	5	14	27	42
Group	A	B	D	A	C
Sex	M	F	F	F	F
Age	38	38	42	41	54
Operation	RIH	Mastectomy	TAH	Laparotomy	Appendix
Premed time	?	?	116	90	56
Vapour	/	/	/	HAL	/
T1	3	4	3	10	1
T2	3	4	3	10	1
T3	48	?	110	108	38
Antiemetic	?	200	25	60	/
Condition	2	2	1	3	1

# Six Rules (Guidelines) to tackle a statistical problem

## Rule 1:

Do not attempt to analyze the data until you understand what is being measured and why.

- Find out whether there is any prior information about likely effects
- Ask questions to clarify objectives, meaning of each variable, units, meaning of special symbols, previous experiments etc.

# Six Rules (Guidelines) to tackle a statistical problem

## Rule 2:

Find out how the data were collected

- Were treatments randomly allocated?
- How NB is the operation on after-effects?
- How reliable are the measurements?



# Six Rules (Guidelines) to tackle a statistical problem

## Rule 3:

Look at the structure of the data

- Are there enough observations?
- Are there too many variables?
- Can we reduce the number of variables?
- Distinguish the type of variables
  - Demographic, explanatory, response

# Six Rules (Guidelines) to tackle a statistical problem

## Rule 4:

Examine the data in an exploratory way ,  
before attempting any sophisticated analysis

- Why are some data items missing?
- Are there any obvious errors?
- Calculate summary statistics and plot data for each group
- Are the groups comparable?
- Was the same surgeon and anesthetist involved?
- Look at response variables

# Six Rules (Guidelines) to tackle a statistical problem

## Rule 5:

Use your common sense at all times!

# Six Rules (Guidelines) to tackle a statistical problem

## Rule 6:

Report the results in a clear, self-explanatory  
way

# Stages of a Statistical investigation

1. Understand the problem and formulate it in statistical terms
2. Plan the investigation and collect the data in an appropriate way
3. Assess the structure and quality of the data
4. Carry out initial examination of the data
5. Select and carry out formal statistical procedures
6. Compare the findings with previous results
7. Interpret and communicate the results.

# 1. Understand the problem and formulate it in statistical terms

- “An approximate answer to the right question is worth a great deal more than a precise answer to the wrong question”

John Tukey

# 1. Understand the problem and formulate it in statistical terms

- Possible Study Objectives
  - Increase general understanding
  - Test a specific hypothesis
  - Assess a particular relationship
  - Choose a course of action from a set of pre-determined possibilities
- Note that the objectives may be even unclear to the person who has asked the statistician for help
- Giving the ‘right’ answer to the wrong question is not uncommon (so called Type III error)

# 1. Understand the problem and formulate it in statistical terms

- Find the right question may be harder than finding the right answer
- There may not be one unique answer but a range of answers depending on a range of assumptions
- Find a near optimal answer over a range of conditions is to be preferred than full optimality under strict artificial conditions.
- Problem formulation comes through practice and learning from mistakes in practice!
- Ask for relevant background information



Basically,

- **What are your  $X$ s?**
- **What are your  $Y$ s?**
- **What do these variables look like?**
- **Do you want to estimate or compare?**
- **What do you want to compare to what?**
- **When do you want to compare them?**
- **How do you want to measure/compare them?**

## 2. Plan the investigation and collect the data in an appropriate way

- Valid conclusions are based on ‘good’ data
- Data collection affected by type of study
  - Clinical trial
  - Sample survey
  - Observational study
- Select an appropriate sample size
- Knowing the limitations of the data can be helpful in analyzing the data

# Example: Canadian Bladder Cancer Survey

- A survey of oncology specialists who treat bladder cancer
- Objective: Understand the factors influencing the low rates of neo-adjuvant chemotherapy in treating bladder cancer
- Survey sent to all specialists in Canada
- Response rate amongst urologists was 25/90 and 32/36 for medical oncologists

# The phases of an analysis

- Look at the data. Evaluate the quality of the data and modify if necessary
- Formulate a sensible model
- Fit the model to the data
- Check the fit of the model
- Check underlying assumptions
- Present the conclusions

# The phases of an analysis: helpful dichotomies

- Exploratory vs. Confirmatory
- Descriptive vs. Inferential

# Researcher Expectations of Consultation

1. knowledge leading to independence
2. critical knowledge
3. answers to specific questions
4. affective and logistical concerns

Finch H. Client Expectations in a University Statistical Consulting Lab. *The Statistical Consultant* 1999. 16(3):5-9.

# Researcher Expectations of Consultation

## 1. *knowledge leading to independence*

**to gain information about statistical analysis to use in the future without the aid of a statistician**

- 2. critical knowledge
- 3. answers to specific questions
- 4. affective and logistical concerns

Finch H. Client Expectations in a University Statistical Consulting Lab. *The Statistical Consultant* 1999. 16(3):5-9.

# Researcher Expectations of Consultation

1. knowledge leading to independence

***2. critical knowledge***

**understanding why a procedure is  
used and what problems might be  
associated with it**

3. answers to specific questions

4. affective and logistical concerns

Finch H. Client Expectations in a University Statistical Consulting Lab. *The Statistical Consultant* 1999. 16(3):5-9.



# Researcher Expectations of Consultation

1. knowledge leading to independence
2. critical knowledge

## *3. answers to specific questions*

**need only the answer to a specific  
statistical problem and not  
necessarily wanting more than that**

4. affective and logistical concerns

Finch H. Client Expectations in a University Statistical Consulting Lab. *The Statistical Consultant* 1999. 16(3):5-9.

# Researcher Expectations of Consultation

1. knowledge leading to independence
2. critical knowledge
3. answers to specific questions

## 4. *affective and logistical concerns*

**timing is important and quick feedback  
was needed to meet a deadline or keep  
research momentum; need the  
consultant to have patience**

Finch H. Client Expectations in a University Statistical Consulting Lab. *The Statistical Consultant* 1999. 16(3):5-9.

# Researcher Expectations for Role of Statistician

## 1. *guide*

provide help in deciding on a statistical strategy to analyze data and answer research questions

## 2. *teacher*

interested in understanding why a statistical procedure is appropriate for a given scenario and how the procedure works

## 3. *data analyst*

number-crunch, manipulate data

## 4. *quality assessor*

check for accuracy and integrity and point out errors or problems

Finch H. Client Expectations in a University Statistical Consulting Lab. *The Statistical Consultant* 1999. 16(3):5-9.

# Consulting Statistician Role

**to assist investigators in  
conducting scientifically  
valid research.**

# Some Tips in Statistical Consulting

- Assess the client's knowledge of statistics
- You need to understand and speak the language of your client.
- Listen carefully, and don't be afraid to ask for clarifications. Ask the same questions several times in different ways! It is key to confirm our understanding of the client's problem.
- Don't just deliver an answer, help the client improve their project or process.

Mann BL et al. What my Mother Never Told Me: Learning the Hard Way. *The Statistical Consultant* 1999. 16(3):2-5.

## Some Tips in Statistical Consulting

- It's OK to say “I don't know”, as long as you are willing to dig up the answer. It is much better to do this than to flounder or give incorrect advice.
- Establish your role as a collaborator. Build credibility by selling yourself and your ideas, and build inter-personal relationships.
- Ensure you are recognized for your contributions.

Mann BL et al. What my Mother Never Told Me: Learning the Hard Way. *The Statistical Consultant* 1999. 16(3):2-5.

## Some Tips in Statistical Consulting

- Consider the “Rule of 3” in estimating the time it takes to get a job done.
- Set fees by checking with experienced consultants on what is “fair”.

Mann BL et al. What my Mother Never Told Me: Learning the Hard Way. *The Statistical Consultant* 1999. 16(3):2-5.

# Tips for Communicating with a Biostatistician ... or ... Maintaining the Biostatistician's Sanity

- To obtain the best statistical analysis plan, ask for a statistical analysis plan instead of asking if a particular statistical method is appropriate.
- Give a reasonable timeframe for meeting your request. The definition of “reasonable” is very consultant-dependent and seasonal.
- If you want the consultant to formally write a description of analysis plans or methods used, state that at the initial consultation.
- Avoid saying, “*I just have a simple (or quick) question.*”
- NEVER put a biostatistician's name on anything submitted or published without giving him/her an opportunity to review it first.



# Biostatistical Acknowledgement

Substantial efforts and important contributions by the statistician to the research project, whether they occur during the study planning phase, while the study is being conducted, or after data collection is completed, should be acknowledged in the appropriate collaborative way

(i.e., co-authorship, grant support, acknowledgement.)

# Common Design and Statistical Issues Raised by Grant and Protocol Reviewers

- No placebo or control group
- No sample size justification/power analysis
- Inadequate or no statistical analysis plan
- Inability to match hypotheses with corresponding statistical analysis.
- No adjustment for multiple testing of the same data
- Using wrong statistical analysis method
- Using a measure with which the reviewer is unfamiliar... needs explanation
- Using independent comparisons when matched/paired/repeated measures methods should be used
- Need to use longitudinal methods instead of cross-sectional

# Common Design and Statistical Issues Raised by Journal Reviewers

- Failure to address the potential problems of multiple comparisons
- Using wrong statistical analysis methods
- Failure to adjust for confounders/covariates
- Failure to mention inadequate power as a potential reason for non-significant findings
- CIs should be reported instead of (or with) *P-values*
- *P-values* should be reported instead of (or with) CIs

# Some General Remarks on Consulting by Sir David Cox

NOTE: This article first appeared in Liaison 13.1, February 1999

# Consulting

- 1. If possible, collaborate (i.e., work with an investigator over a period of time) rather than consult (i.e., some occasional discussion of very specific statistical issues with the investigator).
- 2. Be interested in the subject matter involved.
- 3. Aim to use the terminology of the subject matter field where it differs from common statistical usage.
- 4. If on reflection the investigation seems misguided, retreat from the consultation as soon as politeness and practicality permit.
- 5. If collaborating, go to subject matter seminars from time to time, and read journals in the field.
- 6. Discreetly determine how much understanding of statistical issues the investigator has. Mechanical use of significance tests to confirm overwhelming effects for example is a bad sign.

# Consulting

- ▶ 7. Frequently review what is being done to check that the statistical analysis addresses the correct questions. This may help the investigator clarify thinking as well as protect against the most common error in statistical work - answering the wrong question.
- ▶ 8. Aim, if feasible, to see some raw data, to understand the measurement processes involved, and to have some appreciation of the general quality of the data.
- ▶ 9. Enquire into aspects of the study design that might have a bearing on the appropriate analysis.
- ▶ 10. Begin with very simple methods.
- ▶ 11. If possible, end with simple methods.
- ▶ 12. Since nice ideas for analysis often do not work the first time, be prepared to do modifications.
- ▶ 13. Do not be frightened to make strong assumptions. When a preliminary answer has been obtained then consider which of the assumptions made might be crucial.

# Consulting

- ▶ 14. Take considerable care over presentation of conclusions.
- ▶ 15. If your work is to be acknowledged in a paper or a report, ask firmly to see what is written before it is submitted.
- ▶ 16. If you feel you should have been a coauthor and have not been invited to be, pause for a few days. If, on reflection, you still feel the same, speak quietly to the friendliest of the investigators pointing out, assuming it is true, that you have spent a lot of time and thought on the work.
- ▶ 17. Occasionally; very rarely one hopes; be prepared to say that the data are incapable of throwing useful light on the issues involved.
- ▶ 18. Find a good balance between thinking things out for yourself and obtaining advice from statistical colleagues (and, of course, therefore, finding time to help them in return) .
- ▶ 19. If more than ten per cent of what you do ends up by being directly useful, you are doing well.

# Books of Note

- Problem Solving: A Statistician Guide by Christopher Chatfield
- Statistical Consulting by Javier Cabrera & Andrew McDougall