Scientific Writing
Development Series

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I have no financial relationships to disclose.

I will not discuss off label use and/or investigational use in my presentation.
Session 4 Objectives

1. Explain readers’ expectations for the content and organization of the discussion section and title.

2. Identify common problems in the discussion section and title.

3. Apply specific writing/revision strategies to improve discussion sections and titles.
Titles - Importance

- Read by thousands
- Indexing and abstracting rely on titles
Effective Titles

- Attract readers
- Relate to research question
- Easy to understand
- Accurate
- Informative, specific
- Not too long, not too short
- Grammatically correct
Evolution of a Title

Action of antibiotics on bacteria

Action of streptomycin on *Mycobacterium tuberculosis*

Inhibition of growth of *Mycobacterium tuberculosis* by Streptomycin

Titles - Things to Avoid

- conclusive titles
- abbreviations
- jargon
- proprietary names
- unusual or outdated terminology
1. Steroid-sparing effect of omalizumab for ABA and CF.

2. Increasing weight is a risk factor for asthma in children.

3. An investigation into the effects of suboptimal viewing conditions in screen-film mammography

4. Pain experience after simple tooth extraction
5. The prevalence of dementia in a statewide sample of new nursing home admissions aged 65 and older: diagnosis by expert panel

6. Depression and ischemic heart disease mortality: evidence from the EPIC-Norfolk United Kingdom Prospective Cohort Study

7. Multiple infections among newborns resulting from implantation with *Staphylococcus aureus* 502A.
Start with a sentence

My study showed that women were more likely than men to discuss diet and exercise with their doctors.

Transform this into a label

Effects of patient gender on patient-physician communication about diet and exercise.

Craft working title, try out different titles

Titles

Questions and Comments
Discussion - Readers’ expectations

**Overall:**

Clear, honest, well-reasoned, logical explanation of what you found, what it means.

To readily understand and appreciate the implications of your work.
Why is writing the discussion section a stumbling block for many investigators?
One explanation

“Perhaps because writing a discussion evokes feelings reminiscent of the terror they felt writing an essay in freshman English. Panic sets in, with the all too common result being a dull discussion: the author reiterates the results, assembles a boring summary of previous studies, mentions a limitation or two, repeats the results a third time, and tacks on an insipid conclusion.”

Auguste RODIN
France 1840-1917
The Thinker
1880, reduced 1903
(date of cast unknown), Paris
Bronze
On loan from a private collection

Think before you write!
What do my results mean? How strongly do I believe this?

Other interpretations of my results?

Why are my results exciting? Innovative?

Why are my results exciting? Innovative?

Recommendations?

Implications?

Speculation?

What have others found?

Strengths and weaknesses?

What research should happen next?
“Before you write” Strategies

Read (re-read) the literature as you analyze your results:

• Identify relevance to your work
• Note support for/disagreement with your results
• Note similarities/differences in design, endpoints, sampling, etc.
• Get ideas for points covered in discussion sections
“Before you write” Strategies

*Distill your myriad “discussion ideas” into a single main message*

What is the sound bite?
“Before you write” Strategies

*Take your ideas for a “test drive”*

- Present your results and discussion ideas at suitable seminars, conferences.
- Circulate your main message in writing to coauthors, other trusted colleagues for feedback.
Discussion - Readers’ expectations

Specifically,

- **Answer to research question**
  (+ assessment of its credibility)
- **Specific contribution, new knowledge**
- **Recommendations, implications**
- **Limitations**
- **Concise, well-supported conclusion**
Writing Problems, Solutions

*Problem*

*Answer* to study question is buried.

*Solution*

Begin discussion with the answer.

Was your hypothesis supported?
**Discussion:**

“Our original hypothesis is not supported by the results of this prospective treatment trial. Rather, we observed that women who were randomized to quit smoking in the follicular phase of their menstrual cycle had worse smoking cessation outcomes than women who were randomized to quit in the luteal phase.”

*Addiction. 2008;103:809–821*
Use “inverted funnel” or pyramid structure

1. **Answer to research question (+ supporting results, as needed)**
2. **Implications of your results**
3. **Comparisons with prior studies; limitations**
4. **Conclusions, recommendations**
The Structure of the IMRAD Paper

Introduction
Why did you study this problem?

the question

Materials and Methods
What did you do?
How did you do it?

Results
What did you find?

And

the answer

Discussion
What does it mean?
How does it relate to previous work in this field?
Discussion - Organization

Discussion of multiple outcomes?

Organization?
The answer should:

- Be a generalization from your results, not a repetition of your results.

- Synthesize, summarize

- Present “principles, relationships, and generalizations shown by the results” (p. 46)

Example - Summarize results

“Overall, anemia was found to be a risk factor for poor response and short survival time in dogs with lymphoma that were undergoing chemotherapy.”

Example - Summarize results

“This large placebo-controlled study establishes the safety, efficacy, and lack of pharmacodynamic or adverse interaction between coadministered amlodipine and atorvastatin in a clinically relevant population, consisting of patients with multiple cardiovascular risk factors.”

*J Clin Pharmacol 2007;47:1555-1569*
The answer should:

- Be expressed in similar terms as the question that was posed in the introduction.
Example - Wording of answer

Introduction: “The goal of this study was to determine whether dietary composition can influence the physiological adaptations of a weight-reducing diet…”

*JAMA* 2004;292(20):2482-2490
Example - Wording of answer

**Introduction:** “The goal of this study was to determine whether dietary composition can influence the physiological adaptations of a weight-reducing diet…”

**Discussion:** “The primary finding of our study was that physiological adaptations that serve to defend baseline body weight can be modified by dietary composition.”

*JAMA* 2004;292(20):2482-2490
The answer should:

- Be limited to the appropriate population (subjects) studied.
Example - To whom the answer applies

“In this national prospective cohort study of patients who had chronic kidney disease and began receiving dialysis, statin use was associated with a large and statistically significant reduction in the incidence of sepsis….”

*JAMA.* 2007;297:1455-1464
“*In this cohort of term births to nondiabetic women*, high weight gain was associated with multiple adverse neonatal outcomes in both the univariable and multivariable analyses.”

*Obstet Gynecol* 2006;108:635–43
Writing Problems, Solutions

**Problem**
No discussion of results’ meaning and importance (if not obvious)

**Solution**
Explicitly answer these questions:
- What new knowledge did you produce?
- How might this knowledge be used?
  By whom?
Example - Meaning, Implications


“Overall, anemia was found to be a risk factor for poor response and short survival time in dogs with lymphoma that were undergoing chemotherapy.”

Meaning, implications

“The results…suggested that prospective evaluation of anemia management in dogs with lymphoma is warranted. Veterinarians should also be aware that anemia might negatively affect the prognosis of dogs with lymphoma that are undergoing chemotherapy.”
Implications

- Clinical
- Biologic
- Methodologic
- Economic
- Policy-related
- Ethical
Example - Implications

“Our findings suggest that with regard to neonates born at term, the lower limit of the IOM guidelines [for weight gain during pregnancy] may be slightly high, whereas the upper limit seems appropriate.”

Obstet Gynecol 2006;108:635–43
Example - Implications

“Classification of tumors by gene expression patterns [rather than light microscopy of stained tissues] has the potential to provide additional useful information that is free of observer bias and variability and aid in tumor classification and diagnosis.”

J Lab Clin Med 2006;147:250–267
Indicate strength of your convictions

- These findings demonstrate that effective therapy for advanced melanoma is possible.

- Our results suggest that effective therapy for advanced melanoma is possible.

Indicate strength of your convictions

- A reasonable explanation [but not the only one!] is that effective therapies for advanced melanoma can be developed.

- On the basis of our results, it is at least theoretically possible that an effective therapy for advanced melanoma will be developed.

Differentiate among the following:

- **Recommendations**
  A specific action, directly supported by your findings

- **Implications**
  No direct data, but a logical extension of your findings

- **Speculations**
  Imaginative, requires several leaps. Use tentative language.
The credibility of your answer and the implications of your results must also be considered in light of existing knowledge.
## Research paper as critical argument

<table>
<thead>
<tr>
<th>Section of research paper</th>
<th>Element of critical argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Problem (question)</td>
</tr>
<tr>
<td>Results</td>
<td>Evidence (the data); initial answer</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>Credibility of evidence</td>
</tr>
<tr>
<td>Discussion and Conclusion</td>
<td>Your valid evidence; <em>supporting evidence from others; contradictory evidence; final assessment of all evidence</em>; final answer!</td>
</tr>
</tbody>
</table>

Example - Credibility of results in context of prior work

“Although contrary to our original hypothesis and the findings from some studies [cites], our phase relapse results are congruent with other clinical studies of addictive drugs [cites].”

Addiction. 2008;103:809–821
Example - Implications in context of prior work

“Previous studies have found that foot examinations are beneficial in patients with diabetes. Along with our results in patients with nondiabetic neuropathy, this suggests that neuropathy, per se, rather than just diabetes, is associated with the development of foot ulcers.”

Problem
Limitations not adequately considered

Solution
Acknowledge limitations

- Sample size, bias, measurement error, generalizability
- Available data (funding, dataset)
- Results interpretation
Example - Limit to generalizability

Study of postpartum health of employed mothers:

“While study findings are internally valid, they can be generalized only to employed women of comparable demographic and income levels.”

*Ann Fam Med* 2006;4:159-167
Limitations in results interpretation

- Not enough information to distinguish between alternative explanations of your results
- Results are statistically significant, but not clinically significant
Writing Problems, Solutions

Problem

- Limitations are overblown.

- Description of limitations seem to invalidate the study
Writing Problems, Solutions

Solutions

• Explain why, despite limitations, your results still have value.

• Potential limitations – but how likely?

• Include strengths as well as limitations
Example - Value in spite of limitations

“A limitation of this study is the assignment of SES.... the SES information in this study was limited to individual educational attainment and zip code. … This approach may decrease the precision and accuracy of our area-level SES measures. Nonetheless, the strong association between individual educational attainment and the area-level household income supports the use of our measures.”

“Measurement error is inherent in self-reports of behavioral risk factors. Participants may underreport unsafe sex, a socially undesirable behavior. However, risky sexual behaviors are more likely to be accurately reported in an anonymous survey, such as the one we used, than in an interview (Finer, Darroch, & Singh, 1999; Turner, Miller, & Rogers, 1997).”

Arch Sex Behav 2006;35:587-595
Example - Study strengths

“….our ability to adjust for prior psychiatric hospitalization and concurrent substance use, and to examine completed suicide rather than attempted suicide or ideation, is a unique strength of this study and may also have resulted in findings that diverged from some of the previous research on this topic.”

If you recommend more research:

**Don’t be vague**

- Additional research is needed.
- Further studies to confirm these findings would be helpful.

**Do make (a few) specific suggestions**

- Studies of patients earlier in the course of the disease would be enlightening.
- Future research should follow patients for a longer period of time.

End on a high note!

Your conclusions!
Writing Problems, Solutions

**Problem**

Conclusions not justified by the results

**Solution**

- State what your results really mean, not what you would like them to mean!

- Ask readers: Do they come to the same conclusions that you do?
Lastly, remember:

Your research is not likely to “illuminate the whole truth.”

Your research will “shine a spotlight on one area of the truth.”
Discussion

Questions and Comments
Evaluation!