



Education

HOW TO WRITE A MANUSCRIPT

Adam J. Singer, MD* and Judd E. Hollander, MD†

*Department of Emergency Medicine, Stony Brook University, Stony Brook, New York and †Department of Emergency Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

Reprint Address: Adam J. Singer, MD, Department of Emergency Medicine, University Hospital, L4-515, Stony Brook, NY 11794-7400

□ **Abstract—Background:** Writing a scientific manuscript is an important component of academic medicine. For most novice writers, this task may seem quite formidable. **Discussion:** This article will review the basic processes of writing a manuscript, with emphasis on the proper structure and organization of the article. The likelihood of a manuscript being accepted is highly dependent on its content and structure. A structured outline is the cornerstone of a successful manuscript. **Conclusion:** The current article presents the tools necessary for writing a successful manuscript. © 2009 Elsevier Inc.

□ **Keywords—manuscript; scientific paper; IMRAD; emergency medicine**

INTRODUCTION

The peer-reviewed process for scientific manuscripts originated in England and France nearly 300 years ago. Since then, there has been a proliferation of scientific journals and manuscripts. It is estimated that there are over 20,000 scientific journals and over 2,000,000 manuscripts published annually. Having an original manuscript published in a peer-reviewed medical journal is one of the most rewarding experiences for any academician. The process of writing a manuscript can be both exhilarating and frustrating and, for a novice, may appear as a daunting task. Most journals require a structured format that makes writing a scientific manuscript easier than before. The current article will discuss how to write a manuscript.

Before Getting Started

There are multiple reasons why one would want to write a manuscript. The ultimate reason for writing a manuscript is to disseminate your results and, hopefully, advance knowledge. Other less altruistic motives may include the desire to advance yourself or your institution. Publishing scientific articles can help you achieve promotion, enhance your profile, increase your scientific ability, and gain national and international recognition.

Before writing your manuscript you should be able to answer the following questions: Is your research novel or important? Has it been done before? If published before, is it better or bigger than before? Will anyone care? If the answers to these questions are negative it is best not to proceed with the manuscript at all (1).

Getting Started

The key to good writing is good organization (2–4). Most journals require that the manuscript be structured. A useful mnemonic that addresses all of the sections in a manuscript is IMRAD, which represents the Introduction, Methods, Results, and Discussion (5). A well-written manuscript will also have a section on the study limitations and will end with a Conclusions section. It is vital to review the targeted journal's instructions to the authors because there may be subtle variations in the structure of the manuscript.

A well-written manuscript will answer the following five fundamental questions: Why did you do it? What did you do? How did you do it? What did you find? What does it mean?

- For many manuscript writers, the first step is to select the target journal and review the author instructions. The choice of the target journal should be based on the intended reader audience and the quality of the study. Do you want your manuscript to be read by a wide range of clinicians from multiple disciplines, or is it intended only for Emergency practitioners? Are you targeting clinicians, researchers, or both? Many writers aim for the highest quality journal based on its scientific impact factor. However, it is also important to be realistic and not overestimate the importance or quality of your manuscript.
- Even if you are not sure where to begin, it is best to get something down on paper. As you think about your manuscript you should prepare notes and points you wish to make. Then prepare an outline and arrange your points in a logical sequence of ideas. Remember that writing a manuscript is like telling a story. You must set the stage for the reader and lead him or her along your journey. Start by making headings and sub-headings. Then fill these with ideas and data. You should also sketch out figures and diagrams to help clarify your results.
- It is often helpful to print out the most important references that you found while doing an extensive background literature search. Highlight the most important findings or messages in each reference and arrange the references in a logical order in which they will appear in your introduction or discussion. Then when you sit down to write, paraphrase the highlighted findings or messages in the order of your references, using appropriate citations. Avoid the temptation to skim over abstracts. Always read the original reference and full manuscript whenever published.
- The process of writing your manuscript often begins when you design your study. Many investigators finish writing the introduction and methods even before the results are obtained. Remember that the purpose of a scientific manuscript is to convey your data in the most direct and simple form. Use short sentences and simple words. Avoid vague words and clever remarks. Also avoid jargon and unnecessary abbreviations that force the reader to search for their meaning.

MANUSCRIPT STRUCTURE

Title

In today's era of information overload and ease of electronic data retrieval, it is more important than ever that your title accurately reflect your study. Many times, this is the only opportunity that you have to try and entice readers to read your manuscript. The title allows readers to establish the nature of the study and decide if they wish to read it. It is important to avoid clever or witty titles; always think about the "readability" of the title. The title may be in the form of a statement, question, or answer. If your study was a randomized clinical trial, this should be included in the title. Many journals have a limited number of characters allowed in a title. Once you've decided where to submit your manuscript, make sure that your title does not exceed this limitation.

Abstract

Most journals require a structured abstract and allow a limited number of words, ranging from 150 to 250. Because many readers will read only the abstract, make sure that the abstract is accurate and contains all of the vital information that is in your manuscript. A structured abstract should contain an introductory statement that ends with a specific aim or hypothesis, followed by the methods, results, and the conclusions. Detailed discussion and speculation should always be avoided.

Introduction

The introduction should be brief, generally limited to three to four paragraphs, and should be used to set the stage for your study (6). The first paragraph should describe the current status and a brief description of the problem to be studied and previous work done in the same area. There is no need to mention all references. Generally, less is better than more. The second paragraph should identify the gaps in the current knowledge and demonstrate the need for the current study. Finally, end this section by stating the specific goals or aims of your study and the hypothesis to be tested.

Methods

The Methods section is one of the most important parts of the manuscript (7). The purpose of this section is to

give the reader enough detail to replicate the study. Unfortunately, the Methods section is often the weakest portion of the manuscript, especially with novice writers. Although many readers are tempted to skip directly to the conclusions, the seasoned reader will often start by reading the methods. As a rule, if the methods seem flawed there is no reason to continue reading the manuscript. For a more detailed description of the requirements for writing the results of a randomized clinical trial, the reader should refer to the CONSORT statement (8). Although originally intended for randomized trials, the CONSORT statement is also helpful in writing the Methods section for other types of studies.

Study design. Describe the design used in your study. This should include the sampling methods, such as convenience vs. consecutive. This is very important in determining whether there was any selection bias.

Ethical considerations. Most journals will require a declaration of Institutional Review Board or Animal Right's Committee approval as well as information regarding whether and how study subjects were consented.

Subjects. This section allows the reader to judge the generalizability or external validity of the study. Explicit inclusion and exclusion criteria should be detailed. For human studies, basic demographic information such as age, sex, race, and health status should be noted. However, the exact number of subjects actually recruited, as well as their age, race, and sex breakdown belongs in the Results section. For animal studies, the species, breed, gender, and weight should be described.

Setting. Describe the type of clinical setting (rural vs. urban; academic vs. community; trauma level designation) in which the study was conducted. For Emergency Department-based studies, indicate the annual census.

Interventions. This section should describe the experimental protocol in enough detail to allow replication by another investigator. If the study used previously described or validated methods, these should be referenced. For novel methods or models, greater detail will be required. Consider establishing the validity of a new model in a separate article. For animal studies, describe the methods of sedation and anesthesia. Give generic names of medications administered with manufacturer, dose, and concentration.

Describe the baseline conditions and measurements followed by the sequence of manipulations of the independent variable, followed by subsequent measurements of the dependent variables (the factor of most interest).

Describe any clinical management not controlled by the protocol. Briefly state the rationale and assumptions on which the experimental procedures are based.

Measurements and calculations. Describe the variables that were measured and how measurements were made. Where relevant, give instrument manufacturer and model with city and state. You may also need to justify why and how the variables were measured.

Outcomes. In many studies, multiple outcomes are measured. For each study you must establish the primary or main outcome of the study *before ever conducting the study*. Selection of the primary outcome will drive the study aims, hypothesis, results, and conclusions. In negative studies where the study hypothesis is rejected, it is often tempting to overemphasize secondary outcomes. However, it is important to focus on the primary outcome first. Describe any planned secondary outcomes next.

Data analysis. Describe how the data will be presented (for example, mean vs. median) and which statistical tests were performed for inferential data. Indicate what the level of significance is (type I error) and describe how you calculated the sample size. It is recommended to solicit the help of a professional statistician for this section. Of course, a statistician is also very important when designing the study.

Results

This is probably the next most important part of the manuscript (9). Include only data, not background or methods. The Results section should include all the main findings, including negative findings. Start by describing the general population then sub-groups in the first paragraph. Be clear and concise and use tables and figures appropriately. Data included in tables or figures should not be detailed in the body of the text. Provide data that are relevant to the research question; observations beyond the primary research question may be included if they strengthen your case. Do not interpret the data or introduce results that were not described in the Methods section. The primary outcome should be described first in the second paragraph, whereas secondary outcomes or sub-group analyses should follow. Start with the descriptive data. Next, describe the effects of the independent variables on the dependent variables. Univariate comparisons should precede multivariate analysis and interaction effects. Unexpected or incidental findings should be at the end of the Results section.

Discussion

The main purpose of the discussion is to explain the meaning of the results (10). Most journals begin this section with a brief summary of the main findings. No new data should be introduced in this section. The next paragraph should describe why the findings are important and how they relate to prior similar studies. This is where the author should try to convince the reader of the merits of the study. Discuss how questions raised by prior studies may have served as motivation for the current study. Do the findings of other studies support yours? Also, point out how your study differs from other similar studies. Carefully select the most pertinent references. Remember that your manuscript is not intended to be a comprehensive review article. Consider alternative explanations to your findings; carefully consider all possibilities. Remember that the purpose of your study is to discover, not just to prove. Always state the clinical relevance or implications of the findings. To which patients do the study findings apply? A separate section or paragraph should acknowledge the study limitations. All studies have limitations, and it is better for the author to identify them than for the reviewers or readers to point them out. You may also make suggestions for future studies. What questions remain unanswered? What new questions have arisen? Finally, end the manuscript with a brief "take home message" in the form of a conclusion. What do you want the reader to remember most?

Some of the more common mistakes encountered in the Discussion section are repeating the introduction or presenting new data. Over-interpretation of the results and unwarranted speculation should be avoided. Also, avoid the temptation to inflate the importance of the results. Make sure that the conclusions are fully supported by the data. In general, there should be a direct relationship between the study hypothesis, the results, and the conclusions. Finally, the temptation to use the old generic "Further study is required" should be avoided and used only if appropriate.

Tables and Figures

Many authors find it helpful to prepare the key tables and figures before writing the Results section. Use the tables and figures to present the data and relationships that matter most. The first table should describe the baseline characteristics of the study sample and treatment groups. The second table should present the outcomes of the study. When appropriate, mean differences together with 95% confidence intervals supply considerably

more information to the reader than p values or levels of significance. When there are very few findings or results, they may be presented in the text of the results and there may be no need for any tables or figures. Make sure that the numbers in the table add up and correspond to the numbers in the abstract or the text. Again, the specific author instructions should be consulted for specifications.

References

Before submitting your article, be sure to check the authors' instructions to verify that you used the appropriate system for citing your references. The purpose of the reference section is to list the sources cited in the text. Many novice writers use an extensive number of references. However, this is inappropriate for most original manuscripts. Limit your reference list to the best, the latest, and those references most relevant to your study. The most commonly used method to cite references in medical journals is the Vancouver system, in which the references are cited in the order in which they appear, using superscript. Several commercially available software packages are available to help manage manuscript references.

Final Checks

Before submitting your manuscript, be sure to check the authors' instructions to verify that you used the appropriate system for citing your references. Writing a manuscript can be time-consuming and frustrating. After completion, many authors' first impulse is to immediately send out their manuscript for submission. However, you should always resist this temptation and ask colleagues to review your final draft. When finished, put the article aside for several days and come back and review it. Do a final MEDLINE search and update your introduction and discussion. Always double-check the instructions for authors of the journal to which your manuscript will be submitted.

Conclusions

Writing a scientific manuscript is an important and rewarding part of the life of an academician. Whenever possible, seek the input of a mentor or respected colleague to get a fresh look at your manuscript. Adherence to a structured format and following the simple rules

above should help the novice writer to perform this important task with greater ease and finesse.

REFERENCES

1. Lilleyman JS. How to write a scientific paper—a rough guide to getting published. *Arch Dis Child* 1995;72:268–70.
2. Shambaugh GE Jr. How to write (and publish) a medical paper and how to deliver it. *Laryngoscope* 1982;92:494–6.
3. Chambers DW. How to write a research paper. *J Am Coll Dent* 1997;64:53–6.
4. Alexandrov AV. How to write a research paper. *Cerebrovasc Dis* 2004;18:135–8.
5. Paton A. Writing and speaking in medicine. How I write a paper. *Br Med J* 1976;2:1115–7.
6. Foote M. How to make a good first impression. A proper introduction. *Chest* 2006;130:1935–7.
7. Kallet RH. How to write the methods section of a research paper. *Respir Care* 2004;49:1229–32.
8. Begg C, Cho M, Eastwood S, et al. Improving the quality of reporting of randomized controlled trials. The CONSORT statement. *JAMA* 1996;276:637–9.
9. Hicks ML. How to write the results section of a scientific paper. *J Endod* 1993;19:479–81.
10. Hess DR. How to write an effective discussion. *Respir Care* 2004;49:1238–41.