

A Practical Guide to Manuscript Writing With Particular Relevance to the Field of Pediatric Hospital Medicine



abstract

Publishing manuscripts in peer-reviewed journals, such as *Hospital Pediatrics*, is critical for both the academic development of practitioners in pediatric hospital medicine and the scientific advancement of our field. Understanding the purpose of scientific writing and developing a structured approach to the writing process is essential. Doing so will improve the clarity of your work and likely the ease at which your research is published and disseminated throughout the scientific community. The purposes of this article are to detail the structure of a scientific manuscript, to highlight specific writing strategies, and to provide writing tips that may help or hinder publication. Our ultimate goal is to advance the field of pediatric hospital medicine and its growing membership by promoting the dissemination of high-quality research.

BACKGROUND

Publishing original research is critical to the growth and advancement of any scientific field, and pediatric hospital medicine (PHM) is no exception. The rapid evolution of our field has yielded a remarkable cadre of pediatricians with particular expertise in the care of hospitalized children and has also energized the development of novel areas of scientific inquiry. Pediatric hospitalists have published in a number of areas, including clinical, translational, basic science, and health services research. We have also embraced newer methodologies such as quality improvement and comparative effectiveness research. Yet few in our field have received formal training in scientific writing.¹ In light of this, our commentary is uniquely focused on the needs of those new to scientific writing, with particular relevance to researchers in PHM. Drawing on our own collective experiences, as well as that of others,²⁻¹¹ our goal is to review the scientific writing process and discuss best practices and common pitfalls. We structured these points in sections that correspond to a typical scientific manuscript (eg, Abstract, Introduction, Methods, Results, and Discussion). We hope this will enable new investigators to overcome inertia in the writing process and assist in the dissemination of new knowledge in our field.

ABSTRACT

After the title, abstracts are the first (and often only) opportunity to capture your audience. As such, abstracts should convey, clearly and concisely, the key and/or

AUTHORS

Ronald J. Teufel II, MD, MSCR,^a Anne L. Andrews, MD, MSCR,^a and Derek J. Williams, MD, MPH^b

^a*Department of Pediatrics, Medical University of South Carolina, Charleston, South Carolina; and*
^b*Department of Pediatrics, Vanderbilt University School of Medicine, Nashville, Tennessee*

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ABBREVIATION

PHM: pediatric hospital medicine

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Address correspondence to Ronald J. Teufel II, MD, MSCR, Department of Pediatrics, Medical University of South Carolina, 135 Rutledge Ave, MSC 561, Charleston, SC 29425. E-mail: teufelr@musc.edu

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novel elements of your research. Depending on journal style and article type, a structured abstract or brief and unstructured abstract may be required. Structured abstracts typically mirror the major sections of the body of the manuscript, including introduction/objectives, methods, results, and conclusions. Be sure to consult your chosen journal's formatting requirements to ensure compliance. Reviewing published examples of abstracts from the journal you intend to submit may also be helpful. A well-written abstract will not ensure acceptance, but a poor or hastily written one will certainly jeopardize or prolong time to publication.

When writing the abstract, pick out only the most important points from later drafts of the manuscript. Consider writing the abstract last to better determine the most important manuscript points. A 1- or 2-sentence background is usually sufficient. Include a statement of your purpose that is clear and concise. Highlight essential methods and the most important results. Remember to compare data and reconcile discrepancies between the abstract and the body of the manuscript because it is not uncommon for presented data to be inconsistent.¹² End with a logical but compelling conclusion. Be careful to not overstate your conclusions. Once completed, the abstract can help ensure the entire presentation of your research is clear and logical. Consider reviewing your final abstract while contemplating a few simple questions. Is the purpose of your study clearly stated? Do the methods convey the essence of your study design, population, and main analyses? Do your results address your stated purpose? Are your conclusions justified?

INTRODUCTION

The goal of the introduction is to provide just enough background to orient readers to the issue at hand without diverting the readers' attention with extraneous details. A simple approach is to draft the introduction initially as 2 or 3 paragraphs. This may not represent the final product but is a reasonable way to start. We also suggest visualizing the introduction as an "inverted triangle" (Fig 1). With this common approach, the first paragraph (the base of the triangle) introduces the big picture theme of your paper and should identify why the topic you are addressing is relevant and important to potential readers. For example, an article discussing asthma or pneumonia might begin with a sentence addressing disease prevalence or morbidity because both conditions are common and associated with significant morbidity in children. An article focused on health system innovation such as the electronic medical record might highlight the rapid adoption of such technology. The next few sentence(s) should help to further orient the reader to your specific topic area (eg, asthma and treatment outcomes or electronic medical records and patient safety). For PHM

researchers, highlighting the relevance of the problem in inpatient settings is also important and may emphasize your study's novel approach.

In subsequent paragraph(s), authors should further focus, discussing only those areas directly relevant to their current research. Describe briefly what is known and the specific knowledge gap that your project addresses. Those new to scientific writing should be aware of the common pitfall of including information unrelated to your study's objectives. The introduction should also not represent an author-biased summation of the research topic. A concise, balanced introduction can be a great first impression for reviewers and readers, whereas a prolonged introduction with clear biases and omission of relevant research may cause others to question the quality of the remainder of your work.

End the introduction with a concise and clear explanation of the purpose or objective of your study (the point of the inverted triangle). This typically includes a 1- or 2-sentence summation of the importance and relevance of your research along with an explicitly stated purpose (eg, "The purpose of our study was ...").

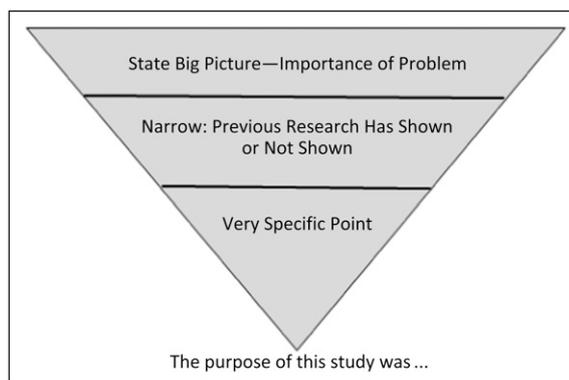


FIGURE 1 The "inverted triangle" approach to the introduction.

METHODS

For the casual reader, the methods section is likely the least read part of your finished product, yet it is the section most critical to fully understanding your research. Not surprisingly, it is also likely the section examined most critically during the peer-review process. Reviewers will focus on the methods to ensure that your results are valid and conclusions justified.⁵ Your goal should be to describe the research in enough detail that another investigator could relatively easily replicate your study. A good rule of thumb for this section is the more detail provided, the better. Don't be surprised if reviewers ask for more information. Also remember that in scientific writing more detail does not always mean more words, and remaining concise is critical.

The methods section is typically organized by subheadings. Although specific subheadings may vary depending on the type of research, a general guideline includes study design and participants, dependent (disease or outcome) and independent (intervention or exposure) variables and other measures, and statistical analysis. Keep in mind that this section may be written almost entirely before obtaining any results. Consider also drafting table shells based on your planned analyses. This helps organize your thoughts and will make drafting your results more efficient.

Study Design and Participants

This section describes your overall methodologic approach and should include a description of your study design (eg, retrospective cohort, case-control, randomized trial), any data sources (eg, administrative database,

medical record review, survey), and the population under study. Be sure to include relevant definitions, study inclusion and exclusion criteria, and the study period. Justification for key decision points with or without a cited reference is also sometimes helpful. Clearly state how the data were collected and/or how participants were recruited. For prospective studies, describe recruitment and enrollment as well as randomization procedures. For studies using a secondary data set, include details that allow readers to understand the population represented and types of data contained. A flow diagram may be helpful. Finally, most journals require a statement of ethical approval for human subjects research.

Outcome Measures and Other Variables

This section varies depending on the type of research you are presenting but generally refers to anything measured and reported for your study. This includes outcomes/dependent variables, predictors/independent variables, and all covariates. For prospective studies, be sure to also detail any interventions. Regardless of study type, it is important to carefully define each measure and how it was assessed. For example: "Race and ethnicity are self-identified at the time of application for Medicaid. In this dataset, race/ethnicity was defined as white, black, Hispanic, or other. In our final analysis, we dichotomized race to nonminority versus minority race/ethnicity."¹³ Each variable included in your analysis should be described in similar detail. Use commonly accepted and/or validated definitions whenever possible. Referencing published articles that use similar methods can

also be helpful. Establishing an order to how variables are presented at this point is important, and this order should be carried throughout the manuscript (eg, results, tables, and figure).

Statistical Analysis

The last paragraphs commonly focus on statistical analysis. This section may be brief for straightforward comparisons or may require substantial detail for more complex analytic methods. Describe how variables were reported (eg, frequency, mean, median), statistical tests and measures of association, and some indication of statistical significance (eg, *P* value or confidence limits). Order this section to coincide with presentation of your results. Typically, this means reporting descriptive statistics and bivariate analyses first, followed by analysis for the primary outcome and any secondary outcomes or subgroup analyses. Justification for your chosen analytic method including references is also helpful. It is common to report any statistical software used.

RESULTS, TABLES, AND FIGURES

Draft results immediately after the methods section and in the same order described in that section, also known as writing in parallel. A consistent and logical order is helpful. Subheadings may also be helpful if several analyses are being presented. The text section of the results generally begins with a description of your study population (often corresponding to Table 1 of your manuscript) followed by results from each step of your statistical analysis. Keep in mind that your tables and figures are part of this section and typically do a much better job of highlighting key data compared with text.

TABLE 1 Scientific Manuscript Checklist for New Authors

Title	Does the title clearly and succinctly describe my project?
Abstract	Does the background specify the study's purpose? Are the essential methods represented? Are the key findings (and measures of association) included in the results? Does the abstract flow concisely and logically from beginning to end? Is the stated purpose answered in the conclusions?
Introduction	Does the introduction highlight briefly the scope of the problem and the need for this research? Is the background literature represented accurately and fairly (unbiased) with appropriate references? Does the introduction follow a logical order culminating in the purpose of your study? Is the purpose stated explicitly?
Methods	Does the first paragraph deliver a concise synopsis of my study design? Is the study design described? Is the study population and setting described? Does the article discuss how the data were obtained? Are dependent and independent variables and other measures defined? For human subjects research, is a statement ensuring human subjects protection included? Are novel or uncommonly used methods referenced? Is the statistical analysis plan described? Are the methods presented with sufficient detail such that someone could replicate the study?
Results, Tables, and Figures	Is the study population described? Does the presentation of the results follow a logical order that also parallels the methods? Are key findings displayed in tables and figures and appropriately referenced in text? Are tables and figures presented clearly and interpretable when removed from the manuscript? Are data already presented in tables and figures removed from the text?
Discussion	Does the first paragraph include the study's most important findings and address the study's purpose? Are novel findings and important results highlighted and discussed in the context of other literature? Are conclusions presented logically and clearly without being overstated or biased? Is the discussion free of editorialized or unrelated content? Are important limitations addressed? Do you highlight areas for continued research?
Overall	Does the manuscript flow logically and clearly from beginning to end? Does it address and answer a novel question? Is the manuscript free of typos and grammatical errors, including tense? Did you solicit critical feedback from senior colleagues not associated with the manuscript? Did you consult your chosen journal's instructions to authors?

The text should complement, not replicate, your tables and figures. Doing so is redundant and reviewers and editors will not want to take up space for duplicated information. With this in mind, 1 approach is to draft tables and figures first and use the text to fill in the gaps.

Tables and figures are the most effective tools for conveying detailed information quickly to a reader.³ They are prominently featured in most journals and should be fully interpretable without additional information. As such, reviewers and editors often request additional detail or suggest

revisions for this material. A practical strategy to determine if your tables and/or figures convey your data appropriately is to ask a colleague to interpret your study's findings based on these materials alone. The title of tables and figures should detail the content of the material as well as the population under study. For example, it is not enough to say "Multivariable Results." Instead, consider a title such as "Multivariable Analysis of Factors Predicting Outpatient Follow-up After Hospital Admission for Asthma Among Children Admitted to the World's Best Children's Hospital in 2012." A brief footnote may also be included to highlight details of the data analysis as well as the meanings of all abbreviations and/or study definitions.

All tables and figures should be referenced within the text. Journals typically limit the number of such materials, but most also allow for supplemental content in the form of online-only materials. Always consult your chosen journal's instructions to authors for style and formatting requirements for tables and figures as well as other types of multimedia (eg, photographs, video content).

DISCUSSION

The discussion is your chance to interpret the study's findings and implications. The format for the discussion is opposite of that for the introduction (ie, an upright triangle; Fig 2). Using this approach, the discussion typically begins with a short, 2- or 3-sentence summary of the study's most important findings and a statement on how the results address your stated purpose. This also helps to focus readers and prepare them for the next several paragraphs.

The next few paragraphs further unpack your study's findings. The format will

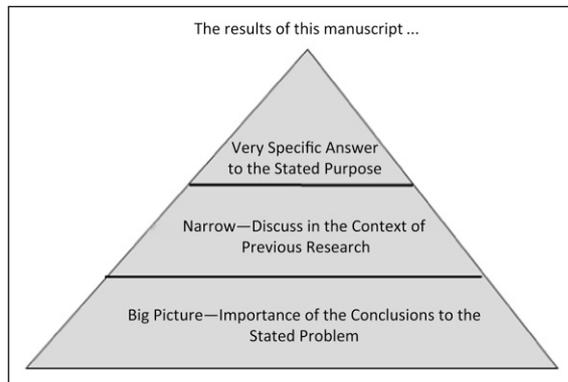


FIGURE 2 The “upright triangle” approach to the conclusions.

vary, but several general themes are important to keep in mind. Begin by expanding on the most important findings mentioned in the first paragraph, followed by a discussion of other interesting observations from your study. Be sure to place your results in the context of previous research but also highlight what is novel about your findings. Without being overly speculative, consider plausible alternative explanations for your findings. If your study contradicts previous knowledge, say so and respectfully explain why you believe your findings are correct. Be sure to also discuss the clinical relevance of your results and highlight knowledge gaps that your study addresses as well as new or interesting gaps that remain. Much like the introduction and perhaps even more important here, do not overstate your findings, and be careful to present a balanced, unbiased discussion of related literature. Also, do not editorialize and avoid discussion of unrelated topics. In short, know the limits of your data and interpret your findings objectively and with caution. Not doing so often leaves reviewers with a bad first impression that is difficult to overcome.

Your discussion should also include a paragraph or several sentences

addressing the limitations of your research. This is a good second to last paragraph because most authors try to avoid ending on the limitations of their work. Remember, it is usually better for the authors to point out important limitations (and provide a defense for the approach) rather than a reviewer. Major design flaws and/or threats to the validity of your study (eg, bias) should be noted along with justification for why you believe your findings remain correct. However, it is not necessary to point out every imperfection of your study or limitations outside the study’s scope (eg, this was not a double-blinded, placebo-controlled randomized trial; therefore, our results are not valid). Strike a balance between a discussion of limitations with major omissions to one that is overly detailed. Either extreme likely leaves a poor impression on reviewers. One way to approach this is to consider including only those potential limitations that could materially change your results. An understanding of common forms of bias inherent in various study designs is also helpful (eg, confounding, selection bias, selective loss of data).

The discussion usually ends with a brief concluding paragraph, typically just 2 or 3 sentences. Similar to your

abstract’s concluding statement, this paragraph should restate only your primary and most important findings along with a simple interpretation of what these findings mean. Consider also including specific directions for future study.

Strategies for Effective Writing and Revising

Successful approaches to scientific writing vary based on personal style, the type of study, and individual aspects of the project. No 1 method fits all projects, but we attempt to list a few approaches here that may be beneficial. We also encourage readers to review work written by others on this topic for additional insights.²⁻¹¹ Reviewing published manuscripts and accepting invitations to review for journals in your field can also be beneficial.

Begin with a basic outline that includes each of the major sections along with key points to include. Use your data tables to help focus. Remember also that you are describing a study that has already occurred. As such, refer to your study (objectives, methods, and results) in past tense. The methods section is often the easiest to draft because it is simply a description of your study approach. It is also the only section that can be fully drafted before reviewing your results. Write the results next and after making preliminary decisions on tables and figures to avoid overly redundant text. Write the discussion and introduction sections last, using your results as a guide. Begin using reference-managing programs (eg, EndNote and RefWorks) during early drafts to create a library of important articles. These programs typically have functions that permit importing references,

changing the location of any given reference, and editing the style of the reference section with minimal effort. The abstract is usually best saved for later drafts, once you have solidified the main points you highlight in the manuscript. Finally, choose a title that is concise and presents an accurate representation of your work. Regardless of what order or style you choose, always consult your chosen journal's instructions to authors for important tips regarding formatting and style recommendations.

Overcoming inertia to just getting started is one of the most challenging barriers to successful manuscript completion. Using a consistent and standardized approach tailored to your style can be instrumental. Recall also that the first draft of any manuscript rarely resembles the final published version. If you've previously presented your research in abstract form, reviewing a copy of the abstract can be helpful to building an outline and just enough to get you started. Some researchers actually begin writing the first draft of the manuscript immediately after an abstract presentation at a scientific meeting when project details are most familiar. At the least, use insightful comments received from previous presentations of your work to help guide the manuscript-writing process, and block off time to prioritize this important task.

Once your first draft is completed, set the manuscript aside for a few days. Doing so can give you a fresh perspective and energy to push forth through subsequent drafts. When reviewing, look for sentences or sections that could be trimmed without loss of meaning; verbosity rarely improves clarity. We have included a

list of questions to ask yourself (Table 1) as you review this draft after setting it aside. It is also helpful to solicit feedback from experienced faculty colleagues and mentors. Choose only 1 or 2 people and ask them to review with an overly critical eye from the perspective of a peer reviewer. Giving some guidance on specific areas of need will help your colleagues focus and ensure the advice you receive is useful. Although it feels nice to get a "great job" from a colleague, this type of feedback is rarely helpful. Soliciting targeted input from a methods expert can also provide valuable feedback. Once you've received this feedback, decide what to incorporate and move forward preparing a final draft for submission. Finally, do not allow perfect to be the enemy of good. Write with clarity and purpose but do not agonize over every single sentence, and resist the temptation to revise revisions of revisions. Doing so is counterproductive and serves only to create frustration and prolong the writing process.

Authorship

Authorship should be discussed openly and early and should be guided by established principles, which include (1) conception and design or analysis and interpretation of the data, (2) drafting the manuscript or revising it critically for important intellectual content, and (3) approving the version of the manuscript to be published.¹⁴ Ultimately, the first author is typically the submitting and corresponding author, and he or she is also responsible for all discussions and decisions regarding authorship. Collaborators should realize that authorship is determined by contribution to the project over time. Discrepancies in regard to authorship expectations may require

the first author to seek assistance from senior faculty not involved with the project.

CONCLUSIONS

Good scientific writing is vital to the careers of researchers from all fields of medicine, including PHM. Understanding the framework and purpose of scientific writing as well as potential pitfalls is critical to developing a personal writing style that is effective and highly productive. We hope this commentary provides members of our field and others with useful tips and skills that will aid in the development of their own writing style and in the preparation and successful publication of future manuscripts.

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