

Preparing Manuscripts for Submission to Medical Journals: The Paper Trail

SELECTED TOPICS

H. GILBERT WELCH, MD, MPH

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CONTEXT. Preparing a manuscript for publication in a medical journal is hard work.

OBJECTIVE. To make it easier to prepare a readable manuscript.

APPROACH.

Start early—A substantial portion of the manuscript can be written before the project is completed. Even though you will revise it later, starting early will help document the methods and guide the analysis.

Focus on high-visibility components—Pay attention to what readers are most likely to look at: the title, abstract, tables, and figures. Strive to develop a set of tables and figures that convey not only the major results but also the basic methods.

Develop a systematic approach to the body of the paper—A standard framework can make it easier to write the introduction, methods, results, and discussion. An obvious organization with frequent subheadings and consistent labels makes the paper easier to read.

Finish strong—Improve the paper by sharing it with others and by learning how to elicit and receive their feedback. Take the time to incorporate useful feedback by revising frequently.

Preparing a manuscript for publication in a medical journal is hard work. Authors must strike a balance between being comprehensive and being clear. They must engage the reader's interest and communicate results succinctly. And, to continue to have the time to do research, they must develop a systematic approach to manuscript preparation.

Without a systematic approach, the effort can easily become haphazard. This consumes more time and produces an inferior product, which frustrates authors, editors, and readers alike. Worse, good researchers can easily become discouraged—resulting in unwritten research or unpublished papers.

Although others have provided useful guidance in the proper style and structure of scientific writing,¹⁻³ this article offers a different level of guidance: how to develop a systematic approach to manuscript preparation. The emphasis is on writing original research articles, but this guidance also applies to other kinds of papers. My goal is simple: to make it easier to prepare a manuscript and to explain how to make manuscripts easier to read.

Starting Early

Writing a good paper is a complex task. It requires both creative energy and quiet reflection. The road to the finished product is never straight, is often rough, and may well involve a few dead ends. In short, writing takes time. It is easier if it is not left until the last minute.

You can start writing three components of the paper before the work is completed. Sketch out the introduction at the time the investigation is conceived (or when external funding is being sought). Draft the methods while the research is

The abstract of this paper is available at ecp.acponline.org.

being conducted as a running account of what is being done as it is being done. Finally, develop skeleton forms of numeric data (often called dummy tables) early on.

Putting something down on paper early is valuable even though you will revise it later. Clarifying the motivation for the paper in the introduction helps you identify a context in which to place your work. Early documentation of the methods helps avoid having to reconstruct subtle steps of the research long after they have occurred. The structure of dummy tables helps focus your analytic effort. Most important, writing forces critical thought about your work.

In particular, invest some time thinking about the main message of your paper.⁴ Work to distill it into a few succinct points that address the following: why you did what you did, what you did, what you found, and what it might mean. Further crystallize these points by articulating them to your colleagues; you may want to try several variations. Although only some journals will use them (e.g., "Key Messages" in *BMJ*, "Take-Home Points" in *ecp*), all papers should be guided by them.

Focusing on High-Visibility Components

Although the audience of a medical journal can be heterogeneous, one thing that professionals generally have in common is that they are busy. Physicians, managers, and policymakers may only look at your work briefly, if at all. Although most authors know this, they may not consider it when they sit down to describe their own work. Most could do better by thinking more like a reader and by paying more attention to what readers are most likely to look at: the title, abstract, tables, and figures.

Title and Abstract

Too many authors choose a title and tack on an abstract immediately before submission. Yet these are the first (and often the only) parts of the paper that will be read. Furthermore, they are often the only parts of the paper accessible electronically (e.g., MEDLINE and World Wide Web sites). Equally important, they are the components of the paper that the journal editors first review. They should, therefore, be composed early in the process and subjected to the same level of critique as the body of the paper.

Tables and Figures

Visual elements are critical.^{5,6} If readers go beyond the abstract, they are likely to examine the tables and figures next. Tables are typically used to display precise numeric values—a tool to make a paper more readable by removing numeric data from the text.⁷ Tables can also

be used to synthesize existing literature, to explain variables, or to present the wording of survey questions.

A figure provides visual impact and thus is often the best way to communicate the primary finding. Figures are traditionally used to display trends and group results but can also be used effectively to communicate processes or to display detailed data simply. Clear, informative figures are invaluable; think creatively about how to use them. Work to develop a coherent set of visual elements that can stand alone—that is, tables and figures that not only convey the major result but also the basic methods.

Developing a Systematic Approach

A systematic approach to the body of the paper can make the job of writing easier. As a first step, it is useful to have some idea in which journal you would like to publish. Once you know your target journal, a quick glance at its instructions for authors is time well spent. In particular, focus on the various articles and the associated limitations on manuscript length. For most medical journals, much of the remaining information is similar and can be found in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals.⁸

Several strategies can be used to encourage readers to move into the text itself. Perhaps the most important is brevity. Do not equate complexity with sophistication. Sentences should be short, simple, and direct. So should the paper. But be aware that such brevity does not come quickly or easily—it may require a great deal of time.

A readable paper also requires an obvious organization.¹ Every paragraph needs a purpose. Describe it in the topic sentence, and make sure every sentence is congruent with that purpose. Paragraphs must be linked and produce a sequence of thought that reflects the "argument" for the central message. An obvious organization is facilitated by the conventional framework used in medical journals: introduction, methods, results, and discussion.

Introduction

The paramount job of the introduction is to motivate the audience to read the paper and to care about the results. In addition, it may be useful to help reviewers and editors judge the paper's importance. Address why the work was done and, equally important, why the reader should care. Table 1 outlines a general framework for a three-paragraph introduction. The first paragraph describes the general problem or situation that motivated your work. The first sentence, in particular, must be strong and catch the reader's atten-

TABLE 1

Framework for a Three-Paragraph Introduction

PARAGRAPH	QUESTION	EXAMPLES OF CENTRAL IDEA		
		EXAMPLE 1	EXAMPLE 2	EXAMPLE 3
1	What is the general problem or current situation?	Otitis media is the most common reason that children receive antibiotics.	Evidence is accumulating that carotid endarterectomy reduces stroke risk in many patients with carotid stenosis.	Diabetic nephropathy is the most common cause of end-stage renal disease.
2	What is the specific problem or controversy?	Many patients receiving the diagnosis of otitis media have no microbiological evidence of infection.	Despite increasing information, decision making about carotid endarterectomy remains difficult.	Although screening for microalbuminuria is recommended for all diabetic patients, many physicians do not comply with the recommendation.
3	How will this study help?	To better delineate the vagaries of the otologic examination, we studied interobserver variability in the diagnosis of otitis media.	To help clinicians assess the relative benefits of carotid endarterectomy, we calculated the number of operations needed to prevent one major stroke or death under different conditions.	To investigate a simpler strategy for diabetic nephropathy, we used a decision model to simulate the effects of treating all patients with angiotensin-converting enzyme inhibitors.

tion. The second paragraph focuses on the specific problem that the research addresses. It may detail relevant issues with which readers are unfamiliar. This paragraph may also focus on gaps in the existing literature. The third paragraph describes the motivation behind the study itself. By the end of the introduction, the reader should be eager to read the rest of the paper.

Methods

The methods section must give a clear overview of what was done. Recognize that there is an obvious tension between brevity (you cannot describe every technical issue) and completeness (you need to give adequate detail so that readers know what happened). Striking this balance is first the author's job, then ultimately the job of editors and reviewers. The methods section should also give the reader some information relevant to generalizability (e.g., How did participants get included? From what population were they sampled?).

Pay particular attention to what you name things (and ideas) that appear repeatedly in the text. Think hard about these labels. They should be brief yet intuitive. What are you going to call the intervention? What

is the one word that describes the outcome measure? Develop a list of frequently used terms to be sure that you use them consistently. Nothing is more confusing than having the same thing go by different names (with the possible exception of having different things go by the same name).

A rigid structure makes writing the methods section a fairly mechanical process. This structure has been particularly well delineated for randomized trials.⁹ Use subheadings (e.g., overview, setting, exclusions, primary outcomes, secondary outcomes, analysis) frequently; think creatively about their names, and tailor them to your research. Even if you delete them later, subheadings will help organize your writing by imposing a structure. Consider a figure as a way to depict processes (e.g., study design, patient selection, and computer algorithms), as shown in Figure 1. Use appendices to provide details of the analysis or specific data collection instruments (of interest to reviewers or researchers who wish to replicate your work).

Results

The results should be short and to the point. Be sure to distinguish primary from secondary results and report primary results first. Use tables and figures to reduce the

Flow Diagrams

Use simple drawings to communicate any process. Although most familiar in the context of sample selection (e.g., to detail the number of participants who were eligible, were excluded, or consented), flow diagrams are equally useful to describe computer algorithms, guidelines, or study design.

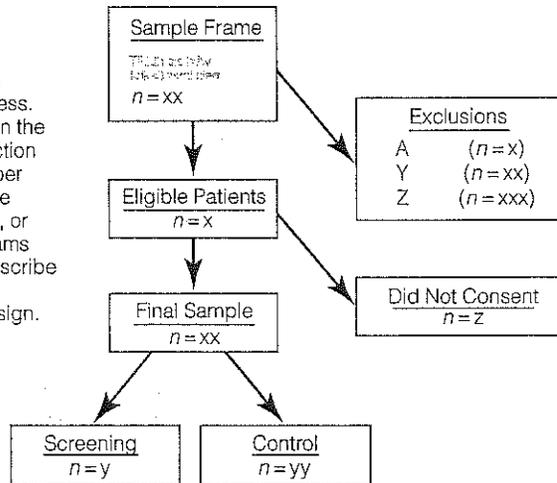


FIGURE 1. Flow diagrams can illustrate processes that relate to a study's method.

amount of text. In addition to your primary finding, use figures to present multiple confidence intervals or individual data points (Figure 2).

Discussion

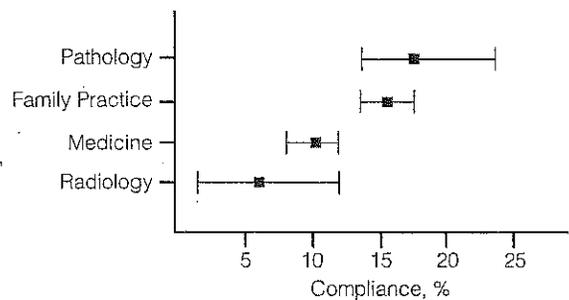
As shown in Table 2, authors should use the discussion section to summarize their work and put it in perspective. First, this section is a good place to restate the major finding of the paper. This finding can then be put in the context of other work by using a more thorough literature review than is appropriate in the intro-

duction. Second, potential limitations must be identified, particularly those that threaten the study's validity. Valid criticisms should simply be acknowledged and discussed. No paper is perfect; the key is helping the reader gauge what can be confidently learned and what is more speculative. Expected criticisms that are not valid should be introduced and rebutted. Third, the work should be put in perspective. Assess its generalizability, and consider its clinical implications. Speculate a little, but not too much. Finally, consider the question, "What next?"

FIGURE 2. Two settings in which authors could use figures more frequently to communicate a study's results.

95% Confidence Intervals

Consider a figure whenever you are reporting several confidence intervals using the same metric. Although most commonly seen in reporting relative risks or odds ratios, a figure is an option whenever the confidence intervals refer to the same variable.



Individual Data Points

Communicate the distribution of data by graphing individual data points when feasible (i.e., moderate sample sizes).

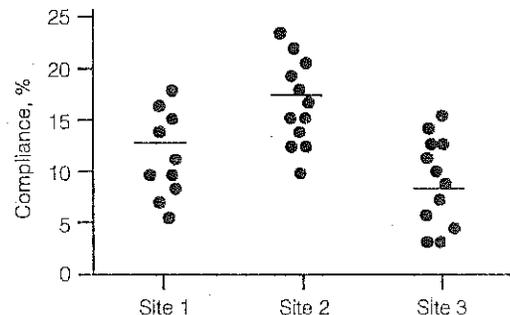


TABLE 2

Framework for the Discussion Section

QUESTION TO ADDRESS	CONTENT															
What's the central finding?	Restate finding. Place in the context of other work.															
Could it be wrong?	Identify and deal with threats to validity. Consider alternative explanations for your findings given the study design:															
	<table border="1"> <thead> <tr> <th>BEFORE/AFTER</th> <th>OBSERVATIONAL</th> <th>RANDOMIZED TRIAL</th> </tr> </thead> <tbody> <tr> <td>Temporal trend</td> <td>Loss to follow-up</td> <td>Inadequate blinding</td> </tr> <tr> <td>Regression to the mean</td> <td>Low response rate</td> <td>Ascertainment bias</td> </tr> <tr> <td>Selection bias</td> <td>Recall bias</td> <td>Loss to follow-up</td> </tr> <tr> <td></td> <td>Unmeasured confounding</td> <td></td> </tr> </tbody> </table>	BEFORE/AFTER	OBSERVATIONAL	RANDOMIZED TRIAL	Temporal trend	Loss to follow-up	Inadequate blinding	Regression to the mean	Low response rate	Ascertainment bias	Selection bias	Recall bias	Loss to follow-up		Unmeasured confounding	
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Temporal trend	Loss to follow-up	Inadequate blinding														
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Selection bias	Recall bias	Loss to follow-up														
	Unmeasured confounding															
What does it mean?	Put your work in perspective. Assess its generalizability, and speculate about its implications. Specify what you think should happen next.															

Finishing Strong

Getting Help

Good papers are the product of several revisions—revisions made in response to feedback from others. Testing how well your paper has communicated its case requires that others read it. Making it better requires that you respond to their feedback. Don't wait until the paper is done to get feedback; in fact, your colleagues may be more focused if given only discrete components (e.g., abstract, introduction, or tables and figures).

To get feedback, you need to develop a cadre of internal reviewers—colleagues who read and critique the paper before it is submitted for publication. "Big names" may not have the time or inclination to do the job well. Younger, more junior faculty may be equally capable, have more time, and be more highly motivated to do a good job.¹⁰ There are two broad categories of internal reviewers:

- *General reviewers*, whose primary job is to determine whether your writing can be understood. Anybody has the potential to be a good general reviewer, but the best person for the job is someone who will make the effort to read and think carefully. It is particularly useful if he or she reads your target journal but is not part of the "research culture" particular to your topic.
- *Expert reviewers*, whose primary job is to help prepare you for reviews by journal editors and peer reviewers. Here you need a member of the research culture who will look hard for flaws (What are the biggest threats to validity in this

study? Are there alternative interpretations of these results?). The ideal is a "hostile friend"—a person who meets two criteria. First, he or she must be supportive of or even a little invested in your work to make the effort required. Second, he or she must be (or be able to assume the stance of being) critical or even a little hostile to your ideas.

Good reviews take up valuable time.^{11,12} Once you have identified internal reviewers, it is prudent to consider how to use them efficiently. Figure 3 displays specific suggestions to maximize reviewers' contributions. These include tactics to elicit and receive feedback.

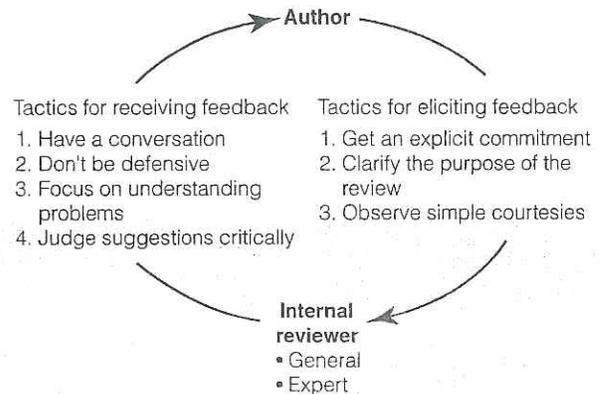


FIGURE 3. Tactics to maximize the productivity of the internal review process.

Eliciting Feedback

Having a cadre of good internal reviewers is extremely valuable to an author. Tactics that make their job easier and more rewarding are, therefore, very much in your own self-interest. You can maximize the commitment of your internal reviewers clarifying your expectations and by extending simple courtesies.

First, get an explicit commitment. Ask before you send a paper. Unannounced mail, electronic or conventional, is both poor form and is likely to go to the bottom of the pile. Establish a time (or at least a range) by which you will need the feedback. Also recognize that good reviewers have many demands on their time. If you must have feedback quickly, say so. If the reviewer cannot accommodate your needs, move on.

Second, specify the purpose of asking for a review. This will make your reviewers more efficient. Take the time to consider what it is you really need. Is it a general review? If so, at what level of detail? It could be broad-based (Does the argument flow? Do you understand the content?) or fine (e.g., stylistic concerns, typographical errors). You may want to focus expert reviewers on specific technical or theoretical questions you have (Is this an adequate description of the logistic model? Is this a confounder or in the causal pathway?).

Three simple courtesies are also important. First, provide your paper in a format that is easy to review. Triple-spaced text (to provide room for comments) and numbered pages (so you can each locate text) are particularly important. Second, avoid undermining the review by requesting a careful review of a "moving target." Nothing is more frustrating for a reviewer than to spend a lot of time on a section only to learn later that it has been deleted. Finally, have a conversation to get feedback. This will help make your reviewer feel more like a useful part of the process.

Receiving Feedback

There is an even more important reason to have a conversation—you can learn much more from sitting down with the person than you will from scribbled notes alone. Encourage reviewers to mark up the paper, but go over these comments in a conversation. Without this interaction, not only do you risk missing certain points (scribbled-up drafts are often difficult to read), you miss the motivation for the reviewers' concerns.

There are other important tactics for obtaining feedback. Most important is your own demeanor. Don't be defensive. Leave your ego at home. At this point, you want the best shots and the low blows. Such feedback only better prepares you for the journal's review process.

Focus on understanding problems. Assume that any time a reviewer is motivated to mark the draft, a

TABLE 3

Getting Better

BASIC APPROACH	COMMENTS
Improve the paper	
Don't rush the process	Allow yourself the time to step back, digest, and read your work with a fresh perspective
Revise frequently	Look hard at your structure again Check for consistency Eliminate repetition and clutter
Respond to reviews by journal editors and peer reviewers	Strike a balance between intransigence and acquiescence Detail what was changed (and make it easy to find the changes) Provide a rationale for what was not changed
Improve your skills	
Read and critique others	Serve as an internal reviewer for others Serve as a peer reviewer

legitimate problem exists. Make sure you understand the reason for concern. Explore the motivation behind each comment and work together to articulate what the problem is. This may take time because the precise problem may not even be clear in the reviewer's mind. The conversation should continue until you understand what the reviewer had in mind, not until one of you has convinced the other. Without some limits, you may lose the opportunity to learn about other issues.

Finally, be critical—not of your reviewer, but of his or her suggestions. Although we appreciate guidance, many of us get bogged down with conflicting advice. Taken at face value, problems identified by reviewers are generally valid; their proposed solutions, on the other hand, may be wrong. Separate issues of style from issues of substance. Take what are clearly good suggestions but think of alternatives for those that seem less good. When you find yourself reverting to prior revisions, it's probably time to stop.

Getting Better

Becoming a good writer takes time. To give yourself the opportunity to become a better writer, make the time.

As shown in Table 3, you will need time to improve the paper and time to improve your own skills.

To improve the paper, don't rush the writing process. Too many authors are impatient to get the paper off their desk and onto the editor's. First, get the general structure and message straight before fiddling with the fine detail. Then allow yourself the time to step back and read your work from a fresh perspective. This opportunity for digestion can be efficiently scheduled while your internal reviewers are doing their work.

You will then need to revise frequently. To do so, lower the barriers to revision. Do your own word processing—no technical advance has meant more to those of us for whom structure and prose do not immediately flow.^{13, 14} Look at the big picture, and scrutinize your structure again. Although it may have been obvious at first, it may now seem garbled. Check to see if the paragraphs are well connected. Don't hesitate to move things around and revise transitional phrasing. Everyone says to begin with an outline; try writing one again when you think you're finished.

Now get into the detail. Two points are particularly important. First, check for consistency. Both the data and the labels should be consistent across text, tables, and figures. Second, eliminate clutter—unintended repetition and peripheral points. Sift through the words until each can produce a "proper account of itself."^{15, 16} There are also other sources of clutter to attend to: unnecessary precision (e.g., 97.89%), jargon, and excessive abbreviations.

Ultimately, you will have to revise the paper in response to the reviews by journal editors and peer reviewers. Although this process is never enjoyable, it frequently produces a better paper. Don't fight it reflexively, but don't acquiesce to bad suggestions. Do make clear to the editor (in a cover letter) what you changed, what you didn't, and why.

To improve your skills, help others. Just as a single paper benefits from the cycle of review and revision, the author can benefit from the cycle of careful reading, critiquing others, and writing. By reading critically, you will grow comfortable with principles of organization and coherent argument. Serving as an internal reviewer for other authors will hone your skills. Identifying their mistakes will enhance your ability to find your own. Finally, take the opportunity to serve as a peer reviewer, particularly for journals you are interested in publishing in. Not only will you further develop your skills, you will learn something about the review process, how others review, and the characteristics of papers you are competing with.

Take-Home Points

- Start writing before your project is completed.
- Focus your attention on what readers are most likely to look at: the title, abstract, tables, and figures.
- Develop a systematic approach to the introduction, methods, results, and discussion.
- Improve the paper by learning how to get and incorporate useful feedback.

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Correspondence

H. Gilbert Welch, MPH, MD, *Effective Clinical Practice*, VA Outcomes Group (111ecp), Department of Veterans Affairs Medical Center, White River Junction, VT 05009; phone: 802-291-6721; e-mail: ECP@mac.dartmouth.edu.