

Structure and Format of Peer-Reviewed Scientific Manuscripts

Paul R. Manske, MD

From the Department of Orthopaedic Surgery, Washington University School of Medicine, St. Louis, MO.

In the early 17th century, Sir Francis Bacon popularized the scientific method of investigation. This method of inquiry advances knowledge by a structured process of experimental design, observation, and testing of a hypothesis. Medical journals have become the vehicle whereby investigators present the results of their studies. At some point, most medical professionals become involved in writing scientific manuscripts, often as physicians/surgeons in training or as young practitioners; however, residencies and fellowships traditionally offer little or no formal instruction concerning the structure and format of a scientific article. Authors often learn the writing process simply by reading published articles in peer-reviewed medical journals with little direction or guidance from mentors. Although reading and critiquing scientific articles can be a valuable tool for becoming a medical writer, good scientific writing requires a basic understanding of the structure and format of peer-reviewed scientific manuscripts.

The purpose of this presentation is to set forth the essential elements of a peer-reviewed scientific article. It is anticipated that such a discussion will be of value not only to potential authors of scientific manuscripts, but also to readers of peer-reviewed journals. Although this presentation is concerned principally with writing for the *Journal of Hand Surgery*, it is relevant to medical journal writing in general.

The process of writing a scientific manuscript is analogous to telling a story. Like every well-written story, a scientific manuscript should have a beginning (Introduction), middle (Materials and Methods), and an end (Results). The Introduction presents the topic and identifies the purpose of the study, the Materials and Methods section tells what the author did to address that purpose, and the Results section presents what was observed. The Discussion (the moral of the story) puts the study in perspective. The Abstract is an opening summary of the story and the Title gives the story a name. Generally speaking, the author should first write the Introduction, Mate-

rials and Methods, and Results sections as a unit because the 3 are so entwined and interdependent. Only after these sections are written can the author fully discuss the study, accurately summarize it, and give it an appropriate name. A clear understanding of the essential components of each of these sections is critical to the successful composition of a scientific manuscript (Table 1).

Introduction

The Introduction should focus the reader's attention on the message the author intends to convey. To accomplish this, the Introduction must include 2 essential elements. First, the author must **introduce and provide a focused review of the specific topic** being presented. This review succinctly identifies the controversies, informational deficiencies, differences of opinions, and so forth in the current literature, including citations of salient references of previous publications to exemplify and support the review. It should be carefully crafted to provide the reader with a clear understanding of the specific issue the manuscript is addressing. For example, if a study involves investigation of whether a K-wire should be placed to provide temporary stabilization for resection arthroplasty of the basal joint of the thumb, the author must briefly review the various techniques for performing basal joint arthroplasties. The author should not, however, present an extensive dissertation on the pathophysiology of the degenerative process of the carpometacarpal joint; this would be beyond the scope and focus of the study.

Second, the author must clearly **state the purpose of the manuscript**. The purpose identifies the question(s)/issue(s) to be addressed: what is unique or novel about the study, what distinguishes it from previous publications, and what new information it adds to the hand surgery literature. The author should not assume the reader will intuitively grasp the importance of the study. *The statement of purpose is the most important element* of the entire manuscript. It is the centerpiece, shaping and orienting the presenta-

Table 1. Structure and Format of a Scientific Manuscript

Introduction
Introduce and provide focused review of topic
Identify purpose of the study
Materials and Methods
Present study design clearly
Identify and describe measurement parameters
Results
Organize presentation of the collected data
Discussion
Summate data and present conclusions
Compare results with previous literature
Acknowledge limitations of the study
Structured Abstract
Purpose
Methods
Results
Conclusions
Title
Reflect the purpose of the study

tion of the rest of the study; all other sections (Materials and Methods, Results, and Discussion) should flow from the stated purpose. Without a clear statement of purpose, a manuscript has no direction; accordingly, the author should continually keep the stated purpose foremost in mind throughout the composition process.

The most common error made by authors of scientific manuscripts is the failure to clearly articulate a statement of purpose. Sometimes that is because the study has no purpose. More often, however, authors fail to articulate a clear statement of purpose simply because they have not taken the time to identify the specific question(s) they wish to address. This is because many research projects, particularly retrospective clinical studies, do not start at the beginning. Ideally, a research project is performed in the order the manuscript story is told, beginning with the identification of the specific question, followed by designing the methodology, and then collecting the data. In reality, many investigators reverse this process and start at the end; that is, they begin by collecting data on a general subject (eg, reviewing medical records of patients having a common diagnosis or treatment) without first posing or identifying the specific question they intend to address. Although this reverse-order methodology of performing an investigative study can be effective, authors need to sift through their collected data and identify the specific question and purpose of the study before they begin writing. Otherwise, they will give readers the impression that they were collecting data in anticipation that

a unique purpose would suddenly jump out at them; and when it did not, they simply gathered the information they had accumulated and put it in the form of a manuscript. Such a manuscript is usually of limited value to the reader.

At other times, authors err by defining a purpose that is not sufficiently narrowed, unique, or different from previous articles. For example, an article reporting the results of surgical treatment of radial tunnel syndrome in the proximal forearm, in and of itself, would not constitute an appropriate purpose; there are several previously published manuscripts on this topic and another general presentation would not add to the hand surgery literature. A more specific investigation of particular aspects of radial tunnel syndrome (eg, the relationship between radial tunnel syndrome and lateral epicondylitis, the use of electrophysiologic studies in diagnosing radial tunnel syndrome, a correlation of results with various anatomic features of the proximal forearm anatomy, and so forth) would in fact be unique and potentially publishable. Framing the appropriate question and identifying the particular niche a study occupies within the framework of the defined subject often requires creative thinking on the part of the author.

Generally speaking, a well-written manuscript has a narrowed and pertinent focus, often requiring authors to exclude some of their data. Authors should selectively include data to fit the defined purpose, rather than devise a broadly stated purpose to include as much of their collected data as possible. An appropriate statement of purpose frequently begins, "The purpose of this study is . . ." Statements such as "We decided to look-up . . ." or "We reviewed our experience with . . ." should be avoided. Although the process of looking up or reviewing an experience may prove helpful to an author in analyzing his own practice, it will not necessarily benefit the hand surgery community at large.

Materials and Methods

The Materials and Methods section describes how the study was conducted. It is perhaps the most difficult section to write. Many authors struggle to convert technical thoughts and concepts into words that are understandable and meaningful to the reader. Often authors are so involved and familiar with the various aspects of the project that they forget that the readers do not have the same intimate knowledge of the experimental design and therefore fail to adequately describe the study's methodology. Nevertheless, the transposition of technical ideas into words

that are readily understandable to the reader is essential to scientific writing. In general, it is preferable to choose simple terms and concepts in explaining the study methodology.

The Materials and Methods section includes 2 essential elements. First, the author must make a **clear presentation of the study design**, describing the various components of the experiment in a logical order that is easy for the reader to follow. This order is not necessarily the chronologic order in which they were performed; at times describing the various experimental steps in a different order will make the methodology more understandable to the reader.

Generally, authors have more difficulty presenting the study design of clinical investigative studies than basic science studies. Therefore, the following comments are directed primarily to authors of clinical investigations.

- Demographic information (age, gender, number of subjects in groups, follow-up time, specific characteristics of compared groups, and so forth) that describes the subjects and the study groups belongs in the Materials and Methods section. At times, authors inappropriately place such information in the Results section, which is reserved for the measurement data.
- In describing the methodology, authors must clearly identify the indications/entrance criteria for inclusion in the experiment. For example, if the purpose of a study is to compare 2 surgical procedures, reduction osteotomy versus wafer resection of the distal ulna articular cartilage for the treatment of ulnar impaction syndrome, authors need to define the specific entrance criteria they used for making the diagnosis of ulnar impaction syndrome in all patients included in the study.
- Authors also must indicate the methodology used to assign individual patients/subjects to different groups, such as a randomization process, the time period when the patient presented for evaluation or treatment, surgeon preference, and so forth.
- Authors should be clear about what entities are being compared, that is, the number of patients versus the number of wrists/hands versus the number of digits. For example, the investigation of the treatment of basal joint arthritis should focus on the number of wrists involved, not the number of patients, because the condition may be bilateral in some patients; similarly an investigation of treatment of lacerated flexor tendons should focus on

the number of digits, not the number of hands or the number of patients.

- Authors often include a technical description of a surgical procedure in the experimental methodology. Authors should be aware that the readership is composed primarily of hand surgeons who do not need detailed information about general principals and commonly understood technical aspects of hand surgery. For example, it is unnecessary to state, "The arm was exsanguinated with a Martin wrap and the tourniquet was increased to 300 mm Hg." Such detail is too elemental for the readership. Furthermore, if the technique has been previously published, an extended and detailed description is unnecessary and redundant with the previous literature. Rather, authors should cite the previous publications, briefly pointing out their modifications of the published technique.
- The presentation of the study design also must include the methodology used for statistical analysis.

Next, the author must identify and describe the **measurement parameters used to evaluate the purpose of the study**. Failure to enumerate these parameters in the Materials and Methods section is the second most common error made by authors.

- It is important that the chosen measurement parameters are appropriate evaluators of the stated purpose. For example, if the purpose of a study is to evaluate the results of treatment of carpal abnormalities, measurement of wrist range of motion would be an appropriate measurement; however, measurement of forearm pronation and supination would not be because these rotational measurements do not evaluate motion of the carpal joints. Similarly, if the purpose of a study is to evaluate the results of digital nerve repair or reconstruction, measurements of sensibility are appropriate; however, measurements of digit range of motion are not because digital motion is not related to digital nerve function. Finally, if an author is conducting a basic science study in human cadavers that evaluates various tendon repair techniques, parameters to evaluate ultimate tensile strength would be appropriate. Measurements of resistance to tendon gliding as a measure of adhesion formation are not appropriate, however, because adhesions are not present in an *in vitro* study; an *in vivo* investigation would be necessary. The importance of choosing measurements that appropriately address the stated purpose cannot be overemphasized.

- In a similar vein, authors should debride irrelevant measurements and information that do not address the stated purpose. Authors are inclined to present data simply because they have collected it in performing the experimental studies, even if those data do not address the specific purpose of the study or contribute to the message of the manuscript. This is particularly true when authors begin investigations by collecting data from medical records without first identifying the purpose of the study, as noted previously. Such irrelevant information confuses and obscures, rather than expands, the presentation of important material.
- It is helpful for authors to divide the measurement parameters into subsections (including subsection headers) to make the presentation more easily understandable to the reader. For example, authors may organize the measurements according to subjective evaluation, objective evaluation, radiologic evaluation, histologic evaluation, and so forth. Again, the measurement parameters should be placed in a logical order; this may not be the order in which they were performed.
- In describing the measurement parameters, authors need to define their evaluation terminology. Terms such as *excellent*, *good*, *poor*, and so forth should be defined by specific criteria. When using subjective measurements such as *pain*, *satisfaction*, *functional outcome*, and so forth authors should use measurement scales, classification categories, and so forth to objectify these subjective evaluations to the extent possible. Some measurements such as *cosmesis* and *appearance* are particularly difficult to define and should be avoided. If authors cannot provide defining criteria for any given measurement parameter, they should delete it from the study.

Results

The Results section has as its single essential element the **organized presentation of the collected data**. This is often the easiest section to write, assuming there is a clear statement of purpose in the Introduction and a clear description of the measurement parameters used to evaluate that purpose in the Materials and Methods section. If an author has difficulty writing the Results section, it is likely that the Introduction and/or Materials and Methods sections are not properly developed and should be revisited before continuing.

The following comments address common mistakes made in the composition of the Results section.

Although they may appear to be simplistic and obvious, these problems are frequently encountered.

- The resultant data should be presented in the same order as it was in the Materials and Methods section to make it easy for the reader to follow. For example, if authors ordered the measurement parameters in the Materials and Methods section according to subjective, objective, and radiologic evaluations, they should present the resultant data in the same consistent order.
- Everything that authors propose to measure in the Materials and Methods section must be reported in the Results section. Similarly, authors should not present data in the Results section that does not have measurement methodology described in the Materials and Methods section.
- Authors should choose the method of presentation (ie, text, tables, figures) that most effectively conveys their message. Figures and tables should expand text information rather than repeat it.
- Tables should summate data rather than present spreadsheets of computer-generated information that provide meaningless and pedantic details. If authors do, in fact, believe it necessary to present tables containing extensive amounts of detailed information, they should do so in an appendix. Most peer-reviewed journals include appendices only in the on-line version. Thus, this information is available to the interested reader, but does not clutter the print publication.
- Numbers in the tables should add up and be internally consistent with the remainder of the text. For example, the text should not refer to 25 patients divided into 3 groups, and the tables show groups of 10, 11, and 7 patients; these numbers do not add up. Furthermore, authors should be clear as to what their numbers refer to (eg, patients, extremities, digits).
- Illustrations should add to the author's message and not be included simply to portray a good clinical result. Similarly, authors should not present multiple clinical or radiographic views when a single view is sufficient to convey the message. Illustrations should be cropped to focus on the important features. For example, a clinical photograph or an x-ray that presents degenerative arthritis of the basal joint of the thumb need not include the entire distal forearm, wrist, and hand. Furthermore, important features in the illustration should be highlighted with arrows or other markings to focus the reader's attention. Oftentimes a simple line draw-

ing is more effective than a photograph in presenting the message.

Discussion

An author has substantial latitude in structuring the Discussion section. Generally, authors should **summarize data and present the important interpretations and conclusions**. In addition, there should be a **comparison of the results of the current study with those published in the previous literature**, noting similarities and controversies. In so doing, authors should offer a scientific explanation for the differences and discrepancies, and explain and discuss interesting or new observations; authors are allowed a reasonable amount of speculation. The Discussion of a basic science investigation should include the clinical relevance of the experimental observations, particularly in a journal read principally by practitioners. Finally, authors should **acknowledge the limitations of the study**.

The following comments are suggestions for avoiding commonly made errors in writing the Discussion section.

- Authors should not include information that is unrelated to the stated purpose of the manuscript. It is important to keep in mind that the Discussion section in a peer-reviewed scientific article should not be a review of the entire subject; such an extended review is the province of a review article. If the information does not directly support or contest the conclusions of the study, it is not relevant and should be excluded.
- Similarly, authors should not repeat detailed data that were previously presented in the Results section.
- In reviewing the pertinent literature, authors should not pedantically synopsise and restate the observations of previous articles, but rather should interpret and critically analyze the previous results as they relate to the specific focus of their study.
- Finally, authors should not present new data in the Discussion section (which, in fact, belongs in the Results section), or new details about surgical technique, entrance criteria, and so forth (which belong in the Materials and Methods section).

Abstract

Although the Abstract is the last section to be written, it is perhaps the most important because it is usually the first to be read and often determines whether the reader will read the entire article. The

Abstract is a concise synopsis of the manuscript, not a minipaper. *The Journal of Hand Surgery* requires a **structured abstract**, which serves to focus and highlight important information. The structured abstract is limited to 300 words and must include the following headings: **Purpose** (state the purpose/question[s] that the study addresses); it should be similar, if not identical, to the statement of purpose in the Introduction; **Methods** (what was performed to address that purpose); **Results** (present the important data); and **Conclusions** (direct, not speculative).

Title

A good Title should be clear, brief, and specific. It should **reflect the purpose of the study**, stating the issue(s) that the investigation addressed rather than the conclusions of the study. It should not be in the form of a question or contain clever or catchy words and phrases.

A well-written scientific manuscript proceeds from a well-executed scientific investigation. Presenting this investigative story in the form of a peer-reviewed article requires time, effort, discipline, and ingenuity. Authors must clearly understand the basic structure and format of a scientific manuscript. They must also be attendant to stylistic elements, such as appropriate sentence structure, correct grammar and syntax, effective use of specific words with precise meaning, active rather than passive voice, avoidance of euphemistic and ambiguous terms, medical lingo, jargon and neologisms, and so forth. These aspects are well covered in other articles and texts, such as Flatt's¹ insightful essay *Words and Strunk and White's*² time honored work *The Elements of Style*. Unless a manuscript's composition embraces the basic structural elements, however, proper writing style alone will not effectively communicate the author's message.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Corresponding author: Paul R. Manske, MD, Department of Orthopaedic Surgery, Washington University School of Medicine, One Barnes Hospital Plaza, Suite 11300, St. Louis, MO 63110; e-mail: manskep@wudosis.wustl.edu.

Copyright © 2006 by the American Society for Surgery of the Hand
0363-5023/06/31A07-0001\$32.00/0
doi:10.1016/j.jhsa.2006.06.018

References

1. Flatt AE. Words. *J Hand Surg* 2000;25A:201–210.
2. Strunk W Jr, White EB. *The elements of style*. 4th ed. New York: Allyn and Bacon; 1999.