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Writing for Clinical Orthopaedics and Related Research

Richard A. Brand, MD

Because of the growing need for publication space, Clinical Orthopaedics and Related Research (CORR) was established in 1953 by the Association of Bone and Joint Surgeons to provide an alternative source of publication to the Journal of Bone and Joint Surgery (then the only orthopaedic specialty journal).[5] Clinical Orthopaedics always has striven to provide readers with high quality, peer-reviewed articles in the form of original research and survey material. High quality depends on the nature of the work and on the reporting. Although there is no surfeit of excellent material on medical reporting and writing,[3,8,9,11,13,23] none is directed to CORR contributors. In the spirit of that goal, I will provide some guidelines to authors for effective reporting.

It first is important to understand that standards of reporting, no less than standards of scientific conduct, change. Although ethics always have played a critical part in science, recent societal and regulatory expectations impose certain new requirements, while scientific advances require others. These changes have stimulated considerable discussion[4,6,10,16–20] and CORR contributors are specifically directed to the publications of the International Society of Medical Editors[12] and The Committee on Publication Ethics for general guidelines.[4] Clinical Orthopaedics adheres to these guidelines, particularly regarding ethical issues with specific manuscripts. Clinically relevant scientific advances in recent years include use of contemporary outcome measures, more sophisticated statistical approaches, and increasing use and reporting of well-formulated research plans (particularly in clinical research). Although these changing standards of reporting will not be detailed in my review, I will explicitly note several issues.

Scientific writing, no less than any other form of writing, reflects a demanding creative process, not merely an act: the process of writing changes thought. The quality of a report depends on the quality of thought in the design and the rigor of conduct of the research. Well-posed questions or hypotheses interrelate with the design. Well-posed hypotheses imply design and design implies the hypotheses. The effectiveness of a report relates to brevity and focus. Attention to few points will allow authors to focus on critical issues. Brevity is achieved in part by avoiding repetition (with a few exceptions to be noted), clear style,[13] and proper grammar.[21,23] Few original scientific articles need to be longer than 3000 words. Longer articles may be warranted if substantially novel methods are reported, or if the article reflects a survey of literature. Although writers should avoid redundancy, effectively

Reprint requests to Richard A. Brand, MD, Editor-in-Chief, Clinical Orthopaedics and Related Research, 3550 Market St., Suite 220, Philadelphia, PA 19104. Phone: 215–349-8375; Fax: 215–349-8379; E-mail: dick.brand@clinorthop.org.

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communicating critical information often means repetition of the questions (or hypotheses or key issues) and answers. The questions should appear in the Abstract, Introduction, and Discussion, and the answers should appear in the Abstract, Results, and Discussion.

Styles of writing are as numerous as authors, although most journals publish guidelines for formatting a manuscript, and many have more or less established writing styles (eg, the American Medical Association Manual of Style).[1] Clinical Orthopaedics and Related Research traditionally has used the AMA style as a general guideline. However, few scientific and medical authors have the time to learn these styles. Therefore, within the limits of proper grammar and clear, effective communication, we will allow individual styles.

Introduction (500 words)

The Introduction, although typically the shortest of sections, is perhaps the most critical. The Introduction must effectively state the issues and formulate the rationale for those issues or questions. Its organization might differ somewhat for a clinical report, a study of new scientific data, or a description of a new method. Most studies, however, are published to: (1) report entirely novel findings (frequently case reports, but sometimes substantive basic or clinical studies); (2) confirm previously reported work (eg, case reports, small preliminary series) when such confirmation remains questionable; and (3) introduce or address controversies in the literature when data and/or conclusions conflict. Apart from surveys and other special articles, one of these three purposes generally should be apparent (and often explicit) in the Introduction. The first paragraph should introduce the general topic or problem and suggest its importance, a second and perhaps a third paragraph should provide the rationale, and a final paragraph should state the questions, hypotheses, or purposes.

One may think of formulating rationale and hypotheses as Aristotelian logic (a modal syllogism) taking the form: If A, B, and C, then D, E, or F. The premises A, B, and C, reflect accepted facts whereas D, E, or F reflect logical outcomes or predictions. The premises best come from published data, but when data are not available published observations (typically qualitative), logical argument, or consensus of opinion can be used. The strength of these premises is roughly in descending order from data to observations or argument to opinion. D, E, or F reflect logical consequences. For any set of observations, any number of explanations (D, E, or F) logically follow. Therefore, when formulating hypotheses (explanations), researchers designing experiments and reporting results should not be wed to a single explanation.

With the rare exception of truly novel material, when establishing rationale authors should generously reference representative (although not necessarily exhaustive) literature. This rationale establishes novelty and validity of the questions and places it within the body of literature. Writers should merely state the premises with relevant citations (superscripted) and avoid describing cited works and authors' names. The exceptions to this approach include a description of past methods when essential to developing rationale for a new method, or a mention of authors' names when important to establish historic precedent. Amplification of the citations may follow in the Discussion when appropriate. In establishing a rationale, new interventions of any sort are intended to solve certain problems. For example, new implants (unless conceptually novel) typically will be designed according to certain criteria to eliminate problems with previous implants. If the purpose is to report a new treatment, the premises of the study should include those explicitly stated problems (with quantitative frequencies when possible) and they should be referenced generously.

The final paragraph logically flows from the earlier ones, and should explicitly state the questions or hypotheses to be addressed in terms of the study (independent, dependent) variables. Any issue not posed in terms of study variables cannot be addressed meaningfully. Focus of the report relates to focus of

these questions, and the report should avoid questions for which answers are well described in the literature (eg, dislocation rates for an implant designed to minimize stress shielding). Only if there are new and unexpected information should data be reported apart from that essential to answer the stated questions.

Materials and Methods (1000–1500 words)

In principle, the Materials and Methods should contain adequate detail for another investigator to replicate the study. In practice, such detail is neither practical nor desirable because many methods will have been published previously (and in greater detail), and because long descriptions make for difficult reading. Nonetheless, the Materials and Methods section typically will be the longest section.

When reporting clinical studies authors must state approval of the institutional review board or ethics committees according to the laws and regulations of their countries. Informed consent must be stated where appropriate. In the United States IRB approval is required for studies using any information with patient identifiers, even if patients are not seen, although expedited review may be appropriate.[15] Similarly, animal studies require approval of institutional animal welfare committees. Such approval should be stated in the first paragraph of Materials and Methods.

At the outset the reader should grasp the basic study design. Authors should only briefly describe and reference previously reported methods. When authors modify those methods the modifications require additional description. In clinical studies, the patient population and demographics should be outlined at the outset. Clinical reports must state inclusion and exclusion criteria and whether the series is consecutive or selected; if selected, criteria for selection should be stated. The reader should understand from this description all potential sources of bias such as referral, diagnosis, exclusion, recall, or treatment bias. Given the expense and effort for substantial prospective studies, it is not surprising that most published clinical studies are retrospective. Such studies often are criticized unfairly for being retrospective, but that does not negate the validity or value of a study. Carefully designed retrospective studies provide most of the information available to clinicians. However, authors should describe potential problems such as loss to followup, difficulty matching, missing data, and the various forms of bias more common with retrospective studies.

If authors use statistical analysis, a paragraph should appear at the end of Materials and Methods stating all statistical tests used. When multiple tests are used, authors should state which tests are used for which sets of data. All statistical tests are associated with assumptions, and when it is not obvious the data would meet those assumptions, the authors either should provide the supporting data (eg, data are normally distributed, variances in groups are similar) or use alternative tests. Choice of level of significance should be justified. Although it is common to choose a level of alpha of 0.05 and a beta of 0.80, these levels are somewhat arbitrary and not always appropriate. In the case where the implications of an error are very serious (eg, missing the diagnosis of a cancer), different alpha and beta levels might be chosen in the study design to assess clinical or biological significance.

Results (500 words)

If the questions or issues have been adequately focused in the Introduction, the Results section need not be long. Generally, one may need a paragraph or two to persuade the reader of the validity of the methods, one paragraph addressing each explicitly raised question or hypothesis, and finally, any paragraphs to report new and unexpected findings. The first (topic) sentence of each paragraph should state the point or answer the question. When the reader considers only the first sentence in each paragraph in Results, the logic of the authors' interpretations should be clear. Parenthetic reference to all figures and tables forces the writer to textually state the interpretation

of the data; the important material is the authors' interpretation of the data, not the data.

Statistical reporting of data deserves special consideration. Stating some outcome is increased or decreased (or greater or lesser) and parenthetically stating the p (or other statistical) value immediately after the comparative terms more effectively conveys information than stating something is or is not statistically significantly different from something else (different in what way? the reader may ask). Additionally, avoiding the terms statistically different or significantly different lets the reader determine whether they will consider the statistical value biologically or clinically significant, regardless of statistical significance. Although a matter of philosophy and style, actual p values convey more information than stating a value less than some preset level. Furthermore, as Motulsky notes, "When you read that a result is not significant, don't stop thinking . . . First, look at the confidence interval . . . Second, ask about the power of the study to find a significant difference if it were there."[14] This approach will give the reader a much greater sense of biological or clinical significance.

Discussion (1000 words)

The Discussion should contain specific elements: a restatement of the problem or question, an exploration of limitations and assumptions, a comparison and/or contrast with information (data, opinion) in the literature, and a synthesis of the comparison and the author's new data to arrive at conclusions. The restatement of the problem or questions need be only brief for emphasis. I prefer an exploration of assumptions and limitations next rather than at the end of the manuscript, because interpretation of what will follow depends on these limitations. Failure to explore limitations suggests the author(s) either do not know or choose to ignore them, potentially misleading the reader. Exploration of these limitations need be only brief, but all critical issues must be discussed, and the reader should be persuaded they do not jeopardize the conclusions.

Next the authors should compare and/or contrast their data with data reported in the literature. Generally, many of these reports will include those cited as rationale in the Introduction. Because of the peculiarities of a given study the data or observations might not be strictly comparable to that in the literature, it is unusual that the literature (including that cited in the Introduction as rationale) would not contain at least trends. Quantitative comparisons most effectively persuade the reader the data in the study are "in the ballpark," and tables or figures efficiently convey that information. Discrepancies should be stated and explained when possible; when an explanation of a discrepancy is not clear that also should be stated. Conclusions based solely on data in the paper seldom are warranted because the literature almost always contains previous information. The quality of any report will depend on the substantive nature of these comparisons.

Finally, the author(s) should synthesize their data with that in the literature. No critical data should be overlooked, because contrary data might effectively refute an argument.* That is, the final conclusions must be consistent not only with the new data presented, but also that in the literature.

Abstract (200 words)

Generally, an Abstract should be written after the entire manuscript is completed. The reason relates to how the process of writing changes thought and perhaps even purpose. Only after careful consideration of the data and a synthesis with the literature can author(s) write an effective abstract.

Many readers now access medical and scientific information via Web-based databases rather than browsing hard copy material. Regardless of access, since the reader's introduction occurs through titles and abstracts, substantive titles and abstracts more effectively capture a reader's attention. Whether a

*From a logical point of view, many consistent observations do not confirm an explanation because a single inconsistent observation can disprove an explanation.

reader will examine an entire article often will depend on an abstract with compelling information. A compelling Abstract contains the questions or purposes, the methods, the results (most often quantitative data), and the conclusions. Each of these may be conveyed in one or two statements. Comments such as "this report describes . . ." convey little useful information.

Title (80 characters, including spaces)

Just as the Abstract is important in capturing a reader's attention, so is the title. Titles raising or answering questions in a few brief words will far more likely do this than titles merely pointing to the topic. Furthermore, such titles as, "Bisphosphonates reduce bone loss," effectively convey the main message and readers will more likely remember them.

Surveys

The format for surveys necessarily differs from those reporting original data. However, many of the principles noted above apply. A survey still requires an Abstract, an Introduction, and a Discussion. The Introduction still requires focused issues and a rationale for those issues. Authors should convey to readers the unique aspects of their surveys which distinguish them from other available material (eg, monographs, book chapters). The issues should be posed in the final paragraph of the Introduction. As with an archival article reporting original material, the Introduction to a survey typically need not be longer than four paragraphs. Longer Introductions tend to lose focus, so the reader is not sure what novel information will be presented.

The sections after the Introduction are nearly always unique to the particular survey, but need to be organized in a coherent fashion. Headings (and subheadings when appropriate) should follow parallel construction and reflect analogous topics (eg, diagnostic categories, choices of methods, choices of surgical interventions). If the reader considered only the headings, the logic of the survey (as reflected in the Introduction) should be clear.

Discussions synthesize the reviewed literature into a coherent whole and within the context of the novel issues stated in the Introduction. The limitations should reflect those of the literature, however, rather than a given study. Those limitations will relate to gaps in the literature which preclude more or less definitive assessment of diagnosis or selection of treatment, for examples. Controversies in the literature should be briefly explored. Only by exploring limitations will the reader appropriately place the literature in perspective. Authors should end the Discussion by summary statements similar to those which will appear at the end of the Abstract in abbreviated form.

In general, a survey requires a more extensive literature review than an archival article, although this will depend on the topic. Some topics (eg, osteoporosis) could not be comprehensively referenced, even in an entire monograph. However, authors need to ensure that a survey is representative of the entire body of literature, and when that body is large, many references are required.

References

References should derive primarily from peer-reviewed journals, standard textbooks or monographs, or well-accepted and stable electronic sources (eg, NIH or FDA Websites). For citations dependent on interpretation of data, authors generally should use only high-quality peer-reviewed sources. Abstracts and submitted articles should not be used because many in both categories ultimately do not pass peer review.[2,7,22] Accepted articles in press in peer-review journals may be used if the anticipated date of publication is within a time frame for the final citation to be completed in *CORR* galley proofs).

Figures and Tables

Figures and tables should complement, not duplicate material in the text. They compactly present information, which would be difficult to describe in text form. (Material which may be succinctly described in text should rarely be placed in tables or figures.) Clinical studies,

for example, often contain complementary tables of demographic data, which although important for interpreting the results, are not critical for the questions raised in the paper. Well focused papers contain only one or two tables or figures for every question or hypothesis explicitly posed in the Introduction. Additional material may be used for unexpected results.

Well constructed tables are self-explanatory and require only a title. Every column contains a header with units when appropriate. Figures, however, may need some explanation, including meaning of symbols. In addition to whatever data descriptions are required, a figure legend should contain the major point within the framework of the questions raised; explanations should be written in complete sentences. A reader should be able to read the questions in the last paragraph of the Introduction, and then find the answers in the first sentence of each paragraph in Results and in the figure legends.

Practical Tips

1. Read only the first sentence in each paragraph throughout the text to ascertain whether those statements contain all critical material and the logical flow is clear.
2. Avoid in the Abstract comments such as, ". . . this report describes . . ." Such statements convey no substantive information for the reader.
3. Avoid references and statistical values in the Abstract.
4. Avoid using the names of cited authors except to establish historical precedent. Instead, state the point documented in the article or articles and provide citation by superscripting.
5. Avoid in the final paragraph of the Introduction purposes such as, ". . . we report our data. . ." Such statements fail to focus the reader's (and writer's!) attention on the critical issues (and do not include mention of study variables).
6. Parenthetically refer to tables and figures and avoid statements in which a table of figure is either subject or object of a sentence. Parenthetic reference places emphasis on interpretation of the information in the table or figure, and not the table or figure.
7. Regularly count words from the Introduction through Discussion.
8. Read the guidelines for publishing in CORR (or any other journal) before submission. Those guidelines generally will need to be met in any case.

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