

CONCEPTS

Practical Guidance for Crafting Original Research Manuscripts

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Scientific writing relies on an extensive array of written and unwritten rules to balance clarity, relevance, and economy. Careful development can strengthen each element of original research manuscripts. Some strategies are straightforward, including general organization and compliance with submission guidelines. Some aspects are more controversial, such as the subtleties of organizational structure, including claims of novelty, and presentation of limitations in the text. Manuscript crafting is usually improved through mindfulness of economy in presentation and objective restraint in interpretations. Submission to credible peer-reviewed journals can help refine the product. Practical guidelines can help develop reports that are readable, objective, and informative.

Keywords: authorship, communication, guidelines, publication, science in literature, writing

Introduction

Active publication in the scientific literature is important to advance in many professional careers. Scientific writing relies on both written and unwritten rules, and knowing them can improve the work, balancing clarity, relevance, and economy. Despite the importance of this, there is relatively little formal training in scientific communication. Some written guidance is available through journal guidelines for authors and in a variety of publications,¹⁻³ but the idiosyncrasies of the available guidance, target journals, and material to be developed put substantial demands on authors. High-quality mentorship can provide a great source of direction, but this is not readily available to all would-be authors. The strategy of learning from published work can also be effective but less reliably so with the increase in predatory journals, which, by their nature, do not follow best publication practices. Inadequate peer

review and editorial sloppiness hidden behind slick formatting can result in poor examples being confused with good ones.

Submission guidelines vary among journals, but understanding fundamentals can strengthen any product. The aim here is to describe the content appropriate for classic elements of original research manuscripts, consider some controversial aspects, and provide examples of common errors or weaknesses to avoid. The approach has 2 parts: first as a stepwise walk through manuscript components and then with a list of additional considerations.

Title

Titles should be short, clear, and informative. The nature of the work and the key outcomes should be communicated in the title, if feasible, without intrigue or mystery. The simplest form is desired, for example, “A retrospective survey of...”

THINGS TO AVOID

- 1) Titles posed as questions or mysteries.
- 2) Unhelpful wordplay or acronyms, especially nonstandard or biasing acronyms (eg, “The SMART study...”).

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- 3) Editorial claims such as “A novel analysis...” or “The first report....”
- 4) Unnecessary compound phrases such as those ending in “case report and literature review.” The nature of the report can be more simply clarified with “A case of...” (if necessary), and manuscript word limits make it extremely unlikely that the selective referencing in a case report is sufficiently comprehensive to describe the report as a literature review.

Author and Affiliation Lists

Based on material contributions, the International Committee of Medical Journal Editors (ICMJE) has established 4 criteria to be met for a person to be credited with coauthorship (<http://www.icmje.org>).^{4,5} All coauthors are accountable for the accuracy and integrity of the work, but the order of the author list is generally expected to adhere to conventions unless an alphabetic order is used (typically reserved for extremely large author panels). The first author is normally the person who takes chief responsibility for developing the manuscript. The last author is the senior (advising) author when relevant. If there is no senior author, the order of authors following the first should be ranked from greater to lesser contributions. One of the ways to raise the profile of an author not in the first position is to designate them as the corresponding author. Requests to have 2 (or more) authors recognized for “first author” or “equivalent contribution” status may be accommodated through footnotes by some journals; however, these attributions are not recognized by indexing services.⁶

It is appropriate for a tentative authorship order to be discussed at the outset of a project, but it should also be understood that the order can change based on actual contributions. The authorship order often includes some struggle, and it is best to get an understanding of normal practice before the situation arises. Trusted mentors can help with this. The best writing teams are fully engaged and generous in offering credit to coauthors; the worst serve as examples of what to avoid in the future. Ranking contributions is never easy, but appropriate patterns of recognition can be achieved through accumulated publications.

Meaningful professional affiliations should be listed for all coauthors. The rules regarding the listing of degrees and other credentials vary by journal. Securing or providing research funds is not an accepted criterion for coauthorship.

THINGS TO AVOID

- 1) Including persons as coauthors who do not meet the ICMJE criteria. Lesser contributions may be appropriate for acknowledgments or not at all.
- 2) Submitting an author roster out of proportion to the work being reported.

Abstract

The abstract provides a condensed summary of the contents of the manuscript. The structured abstract is most common in original research reports, with introduction, methods, results, and conclusions sections. Readability and clarity are important, but the grammatical flow may be modestly compromised to deliver high content density. A high content density is important because abstracts stand alone in literature search engines and should fairly summarize the contents of the manuscript. As one example of important details, the registration numbers of clinical trial reports should be included.⁷ Less structured narrative abstracts are most commonly used for other article types.

THINGS TO AVOID

- 1) Exceeding word count limits (typically 250).
- 2) Vague and uninformative descriptions. Text such as “The results will be discussed,” “Differences were found,” and “Clinical care is described” is unacceptable.
- 3) Failure to name statistical test(s) used when statistical results are presented.
- 4) Inappropriate sectioning of contents (discussed in detail later).
- 5) Contents that are not fully harmonized (consistent with prioritization and tone) with the manuscript.

Keyword Lists

A limited number (often 6 to 8) of keywords or terms are used to flag articles in electronic searches. The best terms are those that interested readers are likely to think of when conducting searches. Preliminary lists can be checked against medical subject heading (MeSH) terms maintained by the National Library of Medicine (<https://www.ncbi.nlm.nih.gov/mesh>). A combination of MeSH and non-MeSH terms may be best, with the latter most relevant in highly specialized fields. Journal guidelines may specify whether words in the title should be

excluded. Exclusion may be a good default position because they are already captured in keyword searches.

THINGS TO AVOID

- 1) Failure to comply with keyword or term guidelines.
- 2) Including words or terms that are either too general or too specific.

Introduction

The introduction, sometimes called the background, sets the stage for the report. The introduction provides the foundation for the work, best progressing from general statements to specific. It should include citation of the most relevant, valid research to help the reader arrive with anticipation at the statement of purpose. The final sentence should be the statement of purpose: a simple, plain-language statement describing the broad goal(s) of the work.

Some journals may partition the introduction into specific sections such as background or literature review and theoretical framework. The organization can change, but the core content is generally similar.

THINGS TO AVOID

- 1) Poor organization that leaves the reader unclear on the need for the current work when reaching the statement of purpose.
- 2) Excessive complexity or presenting any of the findings of the current study.
- 3) Including methodologic detail in the statement of purpose.
- 4) Excessive referencing. Key examples are required but rarely to exhaustion.
- 5) Unnecessary use of direct quotes. Paraphrasing and referencing are the standards for most original research communication. This rule applies throughout the manuscript.

Methods

The methods provide the recipe for how the research was conducted. Sufficient detail is required for a reasonably trained person to replicate the work. Describing the effort in a stepwise manner is most logical, starting with statements on research ethics approval, followed by subject selection, equipment and procedures, data capture, presentation format, and data analysis. Descriptions of statistical testing should be unambiguous.⁸ Schematics or timeline charts may be effective in summarizing complex experimental designs.

Clinical trial registries were developed to improve research transparency and reduce publication biases. The most widely used international registry is US-based (ClinicalTrials.gov). The ICMJE recommends that medical journal editors require clinical trial registration prior to enrollment of the first patient as a requisite for publication.⁹ The registration numbers of clinical trials should be included when available.

Methods should describe the process only, with no results. A frequent point of conflict is whether subject characteristics should be included. Since the numbers planned for a study may be different from the number captured, it is best to leave the number captured for the results.

THINGS TO AVOID

- 1) Inclusion of unnecessary (and often pejorative) study names or acronyms.
- 2) Failure to include the institutional name of the research ethics board granting approval. Inclusion of the approval or protocol number is often at the discretion of the journal and/or authors and/or ethics committees.
- 3) Confusing descriptions regarding exempt research. It may seem counterintuitive, but ethics committees evaluate research protocols to determine whether they should be classified as exempt. The “exemption” is not from review but from further review as long as there are no changes in the protocol. It is not the authors who decide that work is exempt. Ethics boards exist to protect subjects, institutions, and researchers.
- 4) Failure to secure research ethics approval. Approval is required for both retrospective and prospective work as well as for both observational and interventional research. As a rule, no study has zero risk. For example, the loss of privacy associated with a researcher reviewing medical files constitutes a risk that must be evaluated against the benefits of the planned research.
- 5) Unclear wording on ethics statements. It is ambiguous to say “Participants signed consent forms.” It is more appropriate to state “Participants provided fully informed, written consent.”
- 6) Confusing sex and gender. “Sex” is most appropriate when the grouping is biological (male or female), and “gender” is most appropriate if grouping includes sociological distinctions (identity, psychosocial, or cultural).
- 7) Failure to adequately describe methodology, including statistical testing and any associated a priori thresholds used to indicate significance.
- 8) Nonstandard units of measure.

- 9) Describing single thresholds for statistical significance in the methods section and then providing multiple threshold levels in the results.
- 10) Failure to provide appropriate power analyses to validate sample size targets.
- 11) Failure to describe how data are presented (such as, “Data are presented as mean \pm standard deviation (SD) with range for normally distributed data and as median (interquartile range) for nonnormally distributed data.”).
- 12) Inclusion of any research results, including subject counts and/or characteristics.

Results

The results describe the findings of a study without unnecessary interpretation. Thoughtful organization can economically convey a tremendous amount of information. This is generally achieved with a combination of text, tables, and figures.¹⁰ The text should summarize key findings and refer to tables and figures but should not repeat the data presented in those constructs. Tables can provide a substantial density of data but should contain only contents germane to the topic and discussion. Tables can sometimes, though, be structured to provide additional future utility. An example is when multilevel data are grouped for analysis in the current work. Presenting ungrouped data in tables could allow for reanalysis by future readers, if warranted. Figures can be very effective in depicting relationships, but they must deliver a sufficient density of data to warrant inclusion.

The choice of figures deserves careful consideration of the strengths and weaknesses of each for the available data.¹¹⁻¹³ As one example, although simple summary plots of means and SDs are commonly employed, spaghetti plots deliver the same information along with insightful visual depictions of individual patterns for small sample sizes.² The goal should be to provide the fairest, clearest, and most informative form for the available data. There is room for creativity, but care is required to avoid letting it compromise clarity and utility.

Numbers should be presented only to meaningful levels of precision that reflect the sensitivity of the measure and/or instrument. For example, if the age of subjects is recorded in whole years, it should be reported in whole years. Similarly, percentages >1 are almost never meaningful beyond whole numbers for biomedical topics. Computational precision should be not confused with meaningful precision.

Statistical reporting must be thoughtful and conservative.^{14,15} Statistics open the door to discussing data but rarely prove truth. Nonsignificant P values may indicate

that the null hypothesis is true or that the data are inconclusive. Significant P values may indicate that differences are likely not due to chance, but they do not determine the importance of an effect, particularly as the sample size increases. P values that approach significance might merit a comment on “trending toward significance,” but it is not then appropriate to discuss the contrast as significant. It is more appropriate to report all P values instead of only the compelling ones, and it is generally preferable to report exact P values instead of reiterating P value thresholds.

THINGS TO AVOID

- 1) Inclusion of text describing methods.
- 2) Conflicts with described methodology.
- 3) Unnecessary interpretive or editorial comments.
- 4) Failure to provide both absolute and percentage values where warranted. Absolute values should be reported alone for small sample sizes, but both should be provided for substantial sample sizes. There is no universal agreement on the appropriate threshold for percentages, but denominator cutoffs ≥ 20 may be a reasonable minimum.
- 5) Reporting pooled data only when data stratification (eg, by sex) is warranted.
- 6) Failure to provide appropriate measures of variability with measures of central tendency. Once defined in the methods, the text of the results should only refer to the parameter (eg, “Subject age was $x \pm y$ ”) instead of referring to only one of multiple measures (eg, “Mean age was $x \pm y$ ”).
- 7) Reporting numbers that exceed meaningful precision.
- 8) Unmatched levels of precision in paired measures, for example, mean and SD. If the measure is valid only as a whole number, both should be presented as whole numbers.
- 9) Failure to provide estimates of effect size when warranted.
- 10) Unnecessary repetition in the text of material clearly presented in figures or tables.
- 11) Failure to reference figures and tables in the text.
- 12) Inappropriate figure and/or table constructs.
- 13) Insufficiently informative table titles and/or figure captions. The data shown and the nuances of data depiction must be clear. For example, if a whisker and box plot is shown the details of what each element depicts should typically be described.
- 14) Poor figure economy. A sufficient density of data is required to justify figures. For example, if mean \pm SD is to be reported for a single measure and a small number of groups, the information could simply be

provided in the text. Similarly, pie charts, as a rule, should be replaced with tables showing absolute and percentage values in a rank-ordered structure. As a final note on the rank order structure, “unknown” or “miscellaneous” categories should be placed at the end of the ranked list and not in it because, by definition, the contents of an undefined group cannot be considered a single type.

- 15) Poor figure format. The most common problems are insufficient text size and poor contrast. Variable text size is particularly problematic when images have to be scaled down for publication. Color should generally only be used in print publications when scientifically necessary. Whether color is used or not, figures should be prepared using unique lines and markers to improve clarity if printed in gray scale.
- 16) Misleading figure scales, overemphasizing or underemphasizing differences.
- 17) Unmatched figure scales, typically y-axes, in paired figures.
- 18) Claim of “trends” in *P* values that are not extremely close to decision thresholds.
- 19) Inappropriate use of standard error when SD would provide a more relevant representation of sample variability.
- 20) Overstatement or misstatement of statistical results.
- 21) Inclusion of data not discussed in the report.

Discussion

The discussion serves to interpret the results and put them in context with the published literature. The format of this section is the most flexible but should generally start with the main findings and end with limitations.

The critical goal of research is appropriate application of research methodologies and fair interpretation of findings. This should include consideration of alternative explanations for any findings. Determining the absence of a relationship is as important as determining the presence of one for a meaningful open question. There should not be an exaggerated focus on unimportant findings simply because they cross a threshold of statistical significance. Consideration of practical or clinical importance must follow tests of statistical significance.

The limitations subsection is a critical component of the discussion. Burying flaws is counterproductive for science. All shortcomings should be clearly and directly described to put the work in the appropriate context with the world. The limitations should not include text that minimizes or distracts from existing issues. Crafting the subsection as “limitations and strengths” is not recommended. The reality is that the majority of the discussion focuses on the

strengths of the work. The limitations should be an extremely readable summary of the shortcomings for perspective but without apology. Informed readers will appreciate what work may need to be done to overcome these shortcomings, so suggestions for future research may be superfluous. If they are warranted, they should not be conflated with the text describing limitations.

THINGS TO AVOID

- 1) Unnecessary repetition of research objectives, methods, or results text.
- 2) Unsupportable or unnecessary claims of novelty or superiority of the current work.
- 3) Inappropriate or biased interpretation of research findings, including unwarranted speculation.
- 4) Incomplete or inappropriate limitations subsection.
- 5) General statements along the lines of “more work needs to be done.”

Conclusions

The conclusions summarize the key findings and/or interpretations of the study. They may close the discussion or be placed under their own section name. In any case, they should provide plain-language text free of unnecessary acronyms and jargon. They should be fully informed, that is, constrained, by the limitations of the work. The conclusions cannot include new information not developed in the manuscript. The conclusions must be harmonized with the conclusions of the abstract. The text is often expanded in the main body, but prioritization and tone must be consistent between the two.

THINGS TO AVOID

- 1) Repetition of discussion text.
- 2) Statements that exceed the strength of the findings, particularly those failing to consider the limitations of the work.
- 3) Introducing concepts or material not developed in the manuscript.
- 4) Unnecessary jargon.

Acknowledgments

The acknowledgments recognize important support for the work. Permission must be received from any individual, organization, or institution before they are named. Journals may separate general acknowledgments from those regarding funding support. In any case, acknowledgment text should be extremely concise and unambiguous.

THINGS TO AVOID

- 1) Acknowledging anyone with coauthorship credit.
- 2) Ambiguous language (eg, “We would like to thank...” instead of the more unequivocal “We thank...”).

Disclosures

The disclosures should acknowledge any situations and/or relationships that may, or may be presumed to, create a bias on the part of the research team. Disclosures acknowledge conflicts of interest, real or potential.

THINGS TO AVOID

- 1) Failure to include relevant elements.
- 2) Text that seems to be more for self-aggrandizing than meaningful disclosure.

References

Peer-reviewed manuscripts are generally informed by, if not founded upon, peer-reviewed literature. Only credible citations should be cited, when feasible. Fatally flawed or retracted articles should not be cited. If badly flawed work is to be addressed, it is best done by citing published letters that describe critical shortcomings, thus withholding credit for the flawed work that any citation provides.

Referencing is challenging with the range of information available electronically.¹⁶ Optimally, reference lists should be restricted to formally published material, that which has an author, publisher, version and/or publication date, and a form that is expected to remain stable and accessible for the foreseeable future. When available, digital object identifier alphanumeric strings should be included. Informally published material held in written form (eg, letters, emails, and dynamic webpage content) can be identified in parenthetical text citations, essentially personal communications, but generally should not be included in the reference list.

Guidelines on what can be included in reference lists and the required reference format vary widely among journals. Some adhere to standard style manuals (eg, *American Medical Association* and *Chicago Manual of Style*), whereas others can deviate in minor or major ways. Reference management software is also available, often offering journal-specific formatting options. Automated formatting may or may not be correct, and it remains the authors' responsibility to ensure compliance with all submission guidelines.

THINGS TO AVOID

- 3) Inclusion of nonreferenceable materials (eg, landing pages and dynamic webpages).
- 4) Citing fatally flawed or retracted papers.
- 5) Exceeding reference count limits.
- 6) Failing to fully comply with journal format guidelines in presenting references.

Additional Considerations

There are many additional factors that can strengthen manuscripts and the product of publication. The following is a short list to help with crafting:

- 1) Submission guidelines—Manuscripts should be prepared in full compliance with the author guidelines of any target journal prior to submission.
- 2) Economy of presentation—Well-crafted manuscripts should be clear and readable but also economical. A small number of well-chosen words will be more effective than meandering text. Section subheaders may be appropriate for complex presentations, but the paragraph structure alone provides sufficient separation for uncomplicated reports. Author names are best avoided in the text when numerical referencing is used to reduce clutter and word count. This information is already available in the reference list.
- 3) Reporting guidelines—Reporting guidelines have been developed to promote effective reporting of many types of work (<https://www.equator-network.org/reporting-guidelines>). Consolidated Standards of Reporting Trials guidelines address randomized clinical trial data (<http://www.consort-statement.org>).⁷ Other examples include Preferred Reporting Items for Systematic Reviews and Meta-analyses (<http://www.prisma-statement.org>), Strengthening the Reporting of Observational Studies in Epidemiology,¹⁷ and Consensus-Based Clinical Case Reporting.¹⁸ Application of such guidelines is increasingly expected, and they often come with checklists that can form part of the basis for evaluation of manuscripts.
- 4) Logic gaps and overstatement—Author credibility is harmed by illogical interpretations, overstatement, and other meaningless claims. Dispassionate and restrained interpretations and conclusions are more likely to sit well in the literature over time. Claims of novelty or superiority are common problems. Novelty is typically difficult to confirm and often irrelevant. Claims of superiority over other work may be perceived as posturing. Ultimately, it should be left to the reader and history to decide what findings are important, novel, and/or superior.

- 5) Use of tense—The statement of purpose, methods, and results should all be consistently written in past tense. Introductory text can be a mix of past tense when referring to published work and current or even future tense in setting the stage for the current work. The discussion is a mixture of tenses, past while referring to research findings and limitations, present for interpretation, and possibly future for applications.
- 6) Journal shopping—The explosive growth of predatory publications and the confidence-inspiring names that many of them use pose a threat to unwary authors. Although credible work may be published by predatory publishers, items appearing in such journals can be perceived with suspicion of flaws in the process or product of scholarship. This can have negative career consequences and is best avoided. The best strategy is to identify the most credible journals in the professional field of interest and tailor manuscripts for those journals. It is reasonable to follow a 2-journal submission plan.¹⁹ The first step is to submit to the most prestigious journal with an appropriate focus for the work. If fatal flaws are uncovered, the work should not be submitted further. If the manuscript is rejected without fatal flaws, it can be refined in light of any feedback received and then submitted to the backup journal. Manuscripts should be carefully prepared before any submission to fully comply with the author guidelines of the target journal. Paying attention to detail can affect reviews and outcomes.
- 7) Preprint release—Preprints are manuscripts released to the public prior to successful navigation of peer review. There may be situations in which getting new information out to the community as quickly as possible is desirable, but this goal is in conflict with the standards of peer review. Preprint material may vary substantially from a form accepted after peer review, or the material may not be accepted for publication in any form. Both of these situations can create confusion. Careful thought should be given to whether preprint release will be a positive service to the community.
- 8) Academic misconduct—There has been a disconcerting increase in the number of published papers found to represent academic misconduct, including plagiarism, fabrication, and intellectual theft.²⁰ An increasing number of journals are employing plagiarism detection software to review submissions. Although scrutiny can eliminate some problematic submissions, those making it through may still be subject to retraction,^{21,22} which can have major adverse career implications that should be avoided.

Conclusions

Scientific writing relies on an extensive array of written and unwritten rules to deliver useful product to the readership. Careful development can strengthen each element of original research manuscripts. Manuscript crafting is usually improved through mindfulness of economy in presentation and objective restraint in interpretations. Submission to credible peer-reviewed journals can help refine the product. Practical guidelines can help develop reports that are readable, objective, and informative.

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