

How to write a research paper

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Abstract

Writing a good quality research paper and having it published is possibly the most important step in the research process. A paper which communicates key findings can potentially change clinical practice and ultimately improve patient care.

When you are writing your paper, it is imperative that you write clearly and succinctly from the Introduction through to the Conclusion. The present paper will provide recommendations to assist you in improving your writing style and presenting the content and will provide guidance to help you submit the best paper you can.

Keywords manuscript rejection; manuscript revision; manuscript submission; medical writing; scientific paper

Introduction

A good paper has several key elements which are clearly communicated to the reader: the introduction presents a robust and well defined research question, the Methods Section describes a well-designed and well-executed study, the results are clearly presented and there is an intelligent and succinct discussion of the implications of the study. If your research question is not robust, or your study poorly designed or executed, or if your results are misinterpreted or not contextualized, then no matter how well you write, you are unlikely to succeed in getting your work published.

The research question

High impact journals such as the Journal of the American medical association may receive more than 6,000 papers each year, and publish less than 10% of those submitted, so your paper needs to be relevant, novel and original to stand out from the crowd. Research that has already been published is unlikely to be published. Similarly research on areas of little interest or relevance is also unlikely to be published. To be publishable your paper must have a clearly appreciable research question and the question must be relevant and original. The question is usually stated in terms of

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aims or hypotheses. These must be clearly defined and, for the paper to be valid, the study design must be able to answer the question and achieve the aims. The results should focus on answering the defined question and the conclusion must be relevant to the question. The research question forms the core of the paper.

When defining the question (or aim or hypothesis) it is useful to think in terms of: Population, Intervention, Comparator, Outcome and Time frame – PICOT. In observational studies, “Exposure” takes the place of “Intervention” and the acronym becomes PECOT. For study designs where PICOT or PECOT do not apply, it is still important to consider who the Population is and the Outcome. There should be one primary outcome which is defined before the study starts. There may however be many secondary outcomes. It should be clear how the primary outcome is central to the relevance and originality of the question.

Timing

Once the study has been finished, it is easy to get distracted and delay writing the paper – particularly if it has been part of a degree or it has already been presented at a meeting or conference. Remember that if it is not published it effectively never happened. You also have an ethical responsibility to publish so don't delay. Find or make the time to write up your results soon after completing your data analysis. This way, if there are queries about methods, data or analysis, you are well placed to address them. If you delay the write up you risk forgetting, or not being able to follow-up, vital pieces of information. In addition, depending on your research area, your data may become dated and less relevant. Another issue is that someone else may publish a similar paper to yours, subsequently making it very difficult to get yours published. You may be able to secure funding and thus progress with your research more quickly if you can provide details of work that is published or “in press” in grant applications. Ideally you will commence writing (e.g. the Methodology Section) prior to completing the study.

Choose your words carefully

i. Terminology

Ensure you use research terminology correctly. Some terms are consistently confused and misused. For example, “incidence” is not the same as “prevalence” and “important” is not the same as “relevant” or “critical”. Be sure to use terminology relevant to your study appropriately (e.g. sensitivity, specificity).

ii. Tense and voice

Traditionally original research in medical journals has been written in the past tense and the third person. The passive voice is used to sound neutral and impartial. For example,

We investigated the effect of sunshine exposure on mothers becomes The effect of sunshine exposure on mothers was investigated.

While many prefer the passive voice, it makes clumsy and dull reading and thus increasingly scientific writers are using some first person and active tense (such as in this review). However excessive use of first person should be avoided. Familiarize yourself with the style commonly used in papers published by the journal you're interested in submitting to.

iii. Short and sharp

Check the word count of your paper and be sure to adhere to the journal's guidelines. Delete all superfluous words, phrases and paragraphs. This can be difficult to do when it's your own work, but you may be surprised how easy a task it is for your peers to edit your work!

Turn long paragraphs into short paragraphs, long sentences into short sentences (e.g. *We performed some analyses on hen eggs* becomes *Hen eggs were analyzed*) and long words into short words (e.g. *close proximity* becomes *near*).

iv. Style counsel

- Utilize the spell-check function in your word processing program.
- Avoid clichés! You are writing about fact, not fiction.
- Use punctuation marks correctly. The reviewer of your paper may be distracted from your findings if they are irritated by misplaced apostrophes or misused colons.
- Vary your choice of words, e.g. others have found, observed, reported.
- Make sure the transition between paragraphs flows.
- Consider adding tables and figures to your paper. Remember that a picture tells a thousand words. Check that the number of decimal places is consistent throughout individual tables.
- Refer to the "Instructions to Authors" page for guidance on line spacing, line numbering and page numbering.
- Use generic names for medications.

Choose a journal carefully

Choose a journal to submit your paper based on the relevance of your work to the areas covered by the journal. Try to choose the journal with the highest impact factor in your area of interest as this can influence how frequently others will cite your paper in future papers. Familiarize yourself with the type, style, and length of papers published in your area of interest.

One approach when writing a paper to be published in a medical journal is to have a particular journal in mind before you start writing, thus targeting the paper specifically for the journal. An alternative approach is to write the best possible paper you can, then ask others in the field for advice on appropriate journals to submit to. Also consider the papers that you have referenced in your paper – what journals were they published in?

When considering your research paper, editors will consider whether your paper, if published in their journal, is likely to be heavily cited, thus enhancing the standing and reputation of their journal.

Prepare your data

It is important to publish your results, regardless of whether they are positive or negative. If you achieve results that are "negative" or unexpected, it is essential to write them up as a paper and submit them for publication as such results still advance scientific knowledge in the area and may prevent others from doing the same research. Publishing negative results is an important way to reduce publication bias, where treatments appear more effective than they really are because only positive results are written up and published.

Decide on what data you want to include. If you are conducting several small but connected studies, you may be more likely to be published in a high impact journal if you write the results up in one large paper, rather than presenting your findings piecemeal. If you are conducting a study which includes a follow-up period after an intervention period is complete, consider whether or not to publish just the intervention data initially then the follow-up data later, or publish both together.

Ensure your data are up-to-date, "clean" and backed up. The journal you are submitting to may request that the raw data from your study be made available, so you will need to be confident in the accuracy of your data and appropriateness of the statistical tests performed. Journal editors look closely at the statistical analyses and power calculation. Some journals also employ statistical consultants.

Make certain that direct identifiers are removed from the data. If you are using any material which is copyrighted, confirm that you have permission to use the material.

Writing the paper

You will find information in the journal's "Instructions to Authors" on what headings need to be included in your paper. To assist you further, reporting guidelines have been developed for different study designs. The EQUATOR network is an excellent source of reporting guidelines (<http://www.equator-network.org/home>). Here you will find information on the CONSORT statement which was devised to assist people reporting on randomized controlled trials. A similar statement which guides reporting on observational studies is the STROBE statement. By following guidelines appropriate to your study you are likely to improve your paper and thus increase your chances of being published.

Title

Decide on a title which is concise, easy to understand and gives an accurate picture of the paper's methodology and content. Consider the words and syntax carefully to ensure that your title is detected by fellow researchers searching literature databases. Usually titles should not be sentences stating facts, but some journals request "more informative titles". Check with the journal you are submitting to for guidance.

Abstract

Grab and hold the reader's attention with an interesting and well-written abstract. You are limited by word length but do not exclude key information. State your objectives clearly, briefly describe the study design and population, explain your findings and state why they are important.

Introduction

The purpose of the introduction is to explain to the reader what the research question is, how it is original, how it is important and succinctly outline how the study intends to answer it.

It is critical that the paper starts with a brief introduction to the topic which clearly describes how and why the research question has arisen. Provide adequate background information using relevant literature to acquaint readers with the topic but do not include a detailed literature review. Ensure you have quoted key papers and findings, and then highlight the knowledge gaps and how your study provides further information on the area.

Explicitly state the importance of your research as the reader may not necessarily make the leap in logic that is obvious to you.

The introduction should end with the aims being clearly stated. If the study is addressing a hypothesis then the hypothesis should be stated here too.

Methods

For your study to be valid the methods must be able to achieve the aims and answer the research question. The Methods Section should provide sufficient detail for a reader to be able to easily reproduce your study procedures. It should be clear and unambiguous.

Key points in the Methods Section are:

1. describe all aspects of the study design,
2. describe the study site (e.g. setting, where ethics approval was obtained),
3. describe the study population including their eligibility criteria,
4. describe recruitment methods (e.g. where and when subjects were recruited from),
5. describe data collection in detail (e.g. who, what, when, where, how),
6. describe details of all measurements and organize the descriptions in a logical manner. Give precise details of materials (e.g. type, amount) and equipment (e.g. make, model) used,
7. describe your statistical analysis (dependent and independent variables, primary and secondary analyses) and provide reproducible details of the statistical methods used, including software package used. Define what is statistically significant (e.g. p -value < 0.05) and describe what techniques were used to minimize bias (e.g. randomization method). Include your *a priori* justification of numbers where relevant, noting that this should relate to the primary outcome.

Results

All information obtained during the study belongs in the Results Section.

Key points in the Results Section are:

1. present your results in a logical order, beginning with subject enrolment. Consider using a diagram or table to better describe subject flow (e.g. numbers screened, enrolled, randomized, withdrawn). Demographic data is usually presented next, often in a table accompanied by a descriptive statistical comparison if there are randomized groups,
2. report the findings directly related to the question and aims first, followed by peripheral, secondary or incidental findings,
3. ideally, check with a statistician that you have analyzed and interpreted your results correctly, and that you're using statistical terms appropriately. Be sure to comment on how you've dealt with missing data,
4. be sure to report actual data (differences, coefficients, ratios etc) and wherever possible the 95% confidence intervals, not just p -values. This allows the reader to differentiate between statistical and clinical significance,
5. present data for similar variables consistently (e.g. Time in weeks or days, not both),
6. tables, graphs, flow charts and figures can complement the text and may be a more efficient way of reporting your data.

Ensure that they are well-designed and clear. In the text, describe the data in qualitative terms, do not simply repeat the data in the table, graph, flow chart or figure. Check that they are:

- correctly and clearly labelled,
 - cited correctly and summarized in the text,
 - simple and self-explanatory and not a repetition of the written text,
 - consistent in their format, with abbreviations explained and units provided for each variable,
 - accurate. Ensure that numbers in tables add up and are consistent with numbers described in the text,
 - each accompanied by a clear legend.
7. do not omit unexpected results or results which do not satisfy your hypothesis. Report them and discuss your analysis of them in the Discussion Section. Readers of your paper may have found such results too, or may be able to suggest a reason for the findings. Similarly, do not omit reporting adverse events.

Discussion

The discussion needs to be comprehensive, unequivocal and convincing. Do not simply repeat the Introduction or Results in this section. Similarly do not introduce new results in the Discussion.

Key points in structure of the Discussion Section are:

1. begin with the result of the primary outcome which should most clearly relate to the aim and research question. Comment on where it sits relative to previous findings and current knowledge. Emphasize new information your results provide. Follow the same process with secondary findings ranked by importance,
2. confine the discussion to your results and comparison of your results with other directly relevant data in the published literature. An extensive literature review is not needed. Focus the discussion on the primary outcome and not secondary findings,
3. where relevant outline the mechanisms which may explain your results but avoid excessive speculation,
4. make the distinction between statistical and clinical significance, if relevant,
5. indicate the limitations when reporting surrogate endpoints (e.g. bone density) as these endpoints do not necessarily result in clinical outcomes,
6. discuss any limitations of your study. Acknowledge any problems with data (e.g. small sample size), study design (e.g. limited follow-up time), data collection, analysis or interpretation. Similarly discuss strengths of your study,
7. discuss the implications of your findings, including the implications of adverse event outcomes,
8. provide insight into future directions.

Editors often comment that the Discussion Section is too long. This is usually due to restating all the results, an unfocused review of past literature, excessive speculation on mechanisms or too much discussion about secondary outcomes.

Conclusions

Conclusions should be clear. They should be fully supported by the results presented, but also limited to their boundaries. Conclusions should be based on fact and logic, not supposition or speculation.

Some authors use the Conclusions Section to mention any future research required to further understanding in the area but a paper should never end with “more research is needed”.

References

Avoid excessive references and outdated references. When preparing the references carefully refer to reference guidelines for the journal you are submitting to. Incorrect formatting gives the impression that you don't really care about your work. Excellent research is done by pedantic researchers and sloppy presentation leaves the reviewers and editors with an unfavourable impression. Use full-length papers from peer-reviewed journals. Papers accepted for publication but not yet in print (i.e. “in press”) may also be used. Avoid using abstracts. Ensure that all information in the reference list is complete and accurate. Most authors use a bibliography program. This saves time and helps avoid errors but references should still be checked as errors can occur with these programs.

Submitting the paper for publication

Proof reading

This is probably the least satisfying part of the process, but it is vital. Preparing a paper often involves multiple drafts with many sections being “cut and pasted”. This makes it easy for simple errors to slip into the paper. It's much better if you pick up mistakes than have them picked up by a reviewer who might have a low tolerance for them. Pay attention to small details like consistent font size and superscripts in tables. Read your paper thoroughly to check grammar, syntax and punctuation. Read it aloud to check that it flows. Put it away for a few days, then take it out and read it again. It is a lengthy process but a well-written paper that doesn't have errors will be appreciated by reviewers. Also consider giving the paper to somebody who is less familiar with the study. They can identify errors that you miss, and importantly they can also help identify areas that are ambiguous or lack clarity.

Electronic submission

Today most journals accept electronic submissions of papers. Organize your paper for submission and ensure that you have followed the instructions on the journal's website very carefully. You may need to separate out tables, figures and figure legends from the paper and upload these documents separately. You will receive an email to confirm that your paper has been successfully uploaded. During the on line submission process you will be provided with log in details. Following submission you will be able to check on your paper's progress through the review process.

Confidentiality

Be responsible and ethical in your reporting, ensuring that subject names and hospital numbers are not revealed. Ensure that in any photos of subjects their eyes are obscured so they cannot be identified. Ensure subjects have provided consent for the publication of their photos. Always protect subject confidentiality.

Authorship

Decide on who will be listed as an author on the paper, and what order they will be listed in. Ideally this discussion takes place well before the paper is even written. The International Committee of Medical Journal Editors (ICMJE) report lists criteria

to assist in distinguishing what constitutes an author compared with other contributors. All authors must see the paper and have time for comment before it is finally submitted.

Conflict of interest

Any relationships which could be viewed upon as a conflict of interest need to be declared by the authors. This aids in upholding trust in the credibility of published papers. An example of a conflict of interest may be one of the authors sitting on the advisory board of a medication being trialled in the paper being submitted. Sources of funding for the study should also be listed.

Registration

Biomedical journals are increasingly adopting a policy whereby studies must be registered in a public trials registry as a condition of consideration for publication in the journal. The registration number may be required to be mentioned at the end of the abstract. The ICMJE member journals do not advocate a particular registry, but journals may specify suitable registries to use in their “Instructions to Authors” pages.

Coping with rejection

When a decision has been made, an email will be sent to you notifying you that your paper has been accepted, requires revision, or is rejected by the journal. It is rare for a journal to accept your paper outright. More commonly it may be accepted pending revisions such as providing clarification in certain areas, providing further data or even removing a section. The journal may also invite you to make revisions, with any decision on acceptance pending the revisions. Be prepared for multiple revisions.

Accepted, pending revisions

If you are invited to resubmit your paper with revisions, be sure to do so promptly. Delaying your response may give the editor the impression that you are not interested in your own work.

When responding to the editor's letter, thank them for the opportunity to make revisions and for the suggested changes. Craft a response that is polite, thoughtful, clear and detailed. Avoid a defensive or confrontational tone. Integrate useful suggestions provided by the editor or reviewers and calmly and courteously explain your point of view when you disagree.

You are not required to make every suggested change, but you do need to address all of the comments. The journal may require revised and original copies of the paper with the changes made clearly marked.

Rejection

If your paper is rejected by the editor and has not been sent out for peer-review, it may be that the editor does not consider the subject matter or format of your paper appropriate for the journal. This is the most common reason for papers being rejected. Do not be discouraged. Keep in mind that journals receive thousands of papers for consideration each year, and only a small percentage is accepted. There are other journals that you can submit your paper to.

Your paper may have been sent out by the journal's editor to be peer-reviewed by reviewers who recommended that it be rejected. Reviewers are experts in the field; their opinion is to be respected, even if you don't agree with it. They have been chosen

for their expertise by the journal's editor whose job it is to ensure only high quality papers are published in their journal.

Consider the reviewers' comments. You might be able to improve your paper by incorporating suggestions they may have and submit it elsewhere.

Remember that if your research question is unoriginal or your study is fundamentally flawed it doesn't matter how well your paper is written, you are unlikely to succeed in publishing your paper in any journal. Your research must be of a high standard from start to finish in order to produce a high quality research paper.

Conclusions

Whilst the actual process of getting your paper published can be arduous and frustrating, seeing the results of your original research published can be a satisfying and rewarding experience. If your research question is interesting and relevant, your study well-executed and your paper well-written, you will not find it difficult to find a high quality journal that is happy to publish your work. ◆

FURTHER READING

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