

How to write and publish a scientific paper

Lineke Brenninkmeijer¹, Frank Eitner², Jürgen Floege¹

¹ Division of Nephrology, RWTH Aachen University Hospital, Aachen, Germany.

² Kidney Diseases Research, Bayer Pharma AG, Wuppertal, Germany.

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INTRODUCTION

After one has gone through the considerable effort of performing research, be it clinical research or basic research at the bench, the final goal is to communicate the work and results obtained. The most effective way of doing this is by having the work published in the peer-reviewed scientific literature. No matter how original and excellent the research results may be, getting one's hard work published is yet again another skill.

Preparing a manuscript for a medical journal is not easy, and the entire process should not be taken for granted. One must find an equilibrium between providing a complete description of the findings and their meaning and writing these findings up concisely. It is important to attract the reader's interest while explaining the results comprehensively. Considering all this, a systematic approach to writing a manuscript is indispensable.

The present article will elucidate ten different aspects that are necessary for writing a good paper. Most importantly, the paper must be written in the proper manner to improve the chances of getting it accepted and published.

1. Research and gathering data

Before starting the actual research, it is important to define the research goals within the group correctly and to assign these goals in the correct manner. The various individual experiments of each researcher must

complement each other and work towards the same hypothesis and final results. Having well-structured research will obviously make the presentation of the results more precise and understandable on paper. Often, writing up the data is also a very useful exercise for putting the information in a logical order and for discovering what data, control experiments or other information might be missing.

2. Authorship

Authorship can be a difficult issue. Generally, it is important to strive towards finding a healthy balance between the facts being communicated and giving fair acknowledgement to the people involved, including a healthy general self-appraisal. The chronology of the authorship should be listed starting with the first author who contributed the most work. The last author is almost always the supervisor of the entire research project. Importantly, all authors should always have fulfilled the ICMJE criteria¹ and thus should have contributed to the work in a significant fashion.

The ICMJE criteria are as follows:

- Authorship credit should be based on 1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published. Authors should meet conditions 1, 2, and 3.

- When a large, multicentre group has conducted the work, the group should identify the individuals who accept direct responsibility for the manuscript. These individuals should fully meet the criteria for authorship/contributorship defined above, and the editor will ask these individuals to complete journal-specific author and conflict-of-interest disclosure forms. When submitting a manuscript authored by a group, the corresponding author should clearly indicate the preferred citation and identify all the individual authors as well as the group in the Acknowledgements. The NLM indexes the group name and the names of individuals the group has identified as being directly responsible for the manuscript; it also lists the names of collaborators if they are listed in Acknowledgements.
- Acquisition of funding, collecting of data, or general supervision of the research group alone does not constitute authorship.
- All persons designated as authors should qualify for authorship, and all those who qualify should be listed.
- Each author should have participated sufficiently in the work to take public responsibility for the appropriate portions of the content.

Another frequent discussion relates to the issue of whether to write several small papers (*i.e.* the “salami” strategy) or combine data into one major manuscript. Clearly, the latter is the preferred option to stem the inflationary tide of publications. Basically, major manuscripts are more complex to realise, and not all authors may identify as strongly with the subject matter as would be in the case of several shorter papers. One or more authors may have played a major role in producing a consistent manuscript. Moreover, given that one major work often combines the work of many, it is then often meaningful and justified to have joint first authorships.

3. Publication strategy: to which journal is it best to submit?

Four important aspects should be considered when deciding where the manuscript will be submitted.

First of all, depending on how original and important the research is, one can choose a more prestigious journal. As a rule, the more prestigious the journal, the higher the rejection rates². For example, of high-impact journals, *The Journal of Clinical Investigation* has 3500 annual submissions, of which 69% are immediately rejected and 7.7% are ultimately published. *The Lancet* has 11000 annual submissions, of which 80-90% are immediately rejected and 5% are ultimately published. A medium-impact journal, such as *NDT*, has nearly 2500 annual submissions, of which about 15% are ultimately published. *The Clinical Kidney Journal* publishes 48% of the manuscripts submitted.

Prestige is often proportional to the impact factor. The impact factor is calculated annually by the Institute of Scientific Information and is based on citations of articles in a given journal divided by the number of articles published in that journal. Not all types of articles count towards the impact factor, however, and there is some mystery surrounding its calculation. We will not go into an in-depth discussion of the many other problems concerning the impact factor (the interested reader is referred to Garfield E, *et al.*, *JAMA*³), but it is clear that this cannot be the only criterion to select a journal. Visibility of, and access to the manuscript are essential. If one’s manuscript is difficult to access due to lack of online access to the journal, or if the journal is not listed in major databases, this will have negative consequences for the visibility of and access to your work and how often your paper will be cited. The citation rate is considered to be one of the prime indicators for the importance of your work. If the results are groundbreaking and fundamental, a high-profile journal can be chosen. However, there is no guarantee that the manuscript will even be accepted for the review process. For example, top journals such as *Science* and *Nature*, which publish on a range of scientific disciplines, reject most manuscripts on the basis of editor decisions without ever sending them out for review. If the work is not of top quality, always make it a priority to select a journal from your own field. It is also clear that there is no point in submitting and publishing your work in an exotic journal that none of your colleagues will read and which can only be found in a specific search for your work in the databases.

When submitting the manuscript, it may seem a tempting strategy to submit it to various journals at once. However, by consensus this is forbidden, since it would waste the time of reviewers and editors.

4. Journal instructions to authors

Each scientific journal has its own rules as to how the manuscript should be formatted. These instructions are mostly available online, and it is essential to read these rules through carefully and to adhere to them before submitting the paper so that at least the basic criteria are fulfilled. The requirements for the cover letter, suggestions for possible reviewers, corresponding author details, the file types that are accepted, requirements for the paper's structure, font type, text formatting, figures, tables and reference format and supporting information formats are some of the aspects stated.

Given that the volume of a journal is an important financial issue (especially concerning print costs) and that the number of pages is often more restricted in journals with a high impact factor, most journals do have relatively strict length restrictions. Sometimes it is not even possible to submit a paper online if the length does not comply with journal standards.

5. Ethics in scientific publishing

When presenting facts or data or results from other researchers or other sources of information, this must be clearly and explicitly mentioned by means of a reference to the respective source of information. This might be from articles, books, encyclopedia, Web-based information, journal articles and so on. Many journals now use tracking software to screen texts for passages that have been copied in a one-to-one fashion from other work.

When information is used that is supplied to the authors of the article by third parties that are not in the open literature, it can be referred to as a "personal communication". Also, most journals state how such a source should be mentioned and many journals will require a written permit from the cited party.

The innate rule of science, namely that results presented are true and honest, and that work by

others is properly acknowledged, is for most scientists overwhelmingly self-evident.

6. Focus on optimal presentation

Readers often jump from reading the title and browsing the abstract to looking straightaway at tables and figures. These visual elements are thus amongst the most important parts of the paper. Tables are mostly used to concisely and precisely present numerical data and data from questionnaires and surveys.

Figures can be in the form of graphical information or photographic material. They provide a vast amount of information in a very compact form. The fraction of figures presented in colour is large and continues to increase. It is important to structure figures carefully and to create precise, coherent, clear and informative figures. When graphs are involved, the axes must be properly labelled. The figure caption should help the reader to interpret the figure. The caption should not be an excerpt from the text of the paper, or even a minipaper written for the figure itself. Conversely, information concerning the figure should be given in the caption and preferably not in the text. Also, be sure to avoid using too many abbreviations in the figure. An ideal figure can be understood without reading the paper, i.e. it should be self-explanatory.

7. Start early and use a systematic approach to writing

In our experience, a relatively easy way of composing a paper is to use the sequence rather than following the chronological order:



Method

Given that the Method section is the easiest to write, this should always go first, and in fact we recommend that this section is at least written in a draft form while performing the experiments.

The main goal of the Method section is to provide enough detailed information so other scientists in

the research field can reproduce the experiment. Here one must find a balance between conciseness (avoiding the description of each detail) and sufficient information. Almost always, references to technical papers and previous work are needed. Some journals have the option to publish details of the methods and supporting data as supplementary material.

Results

The next step should be the design of the tables and figures (see above) and composing the text by writing the results.

The results presented should be limited to those data that are relevant for answering the research question. These include the results that support or contradict the research question. The results should be clear and concise. Figures and tables can fulfill these criteria quite well. Make sure to present the confidence intervals, significance (p-value) and standard deviations etc. in the figures. The results can be presented chronologically or ranked by importance. Data shown in the tables and figures in the text do not need to be repeated in the text. Authors should refrain from stressing nonsignificant findings or trends; if a p-value of <0.05 is defined as significant, then anything above this limit is nonsignificant and should be treated as such.

In presenting the results, there is often some discussion instead of a “dry” listing of the results. However, this discussion should not preempt the real Discussion (see below). One can discuss the specifics of the results, for instance links to the methodology used, but the interpretation should be confined to the Discussion section where the results are put into a wider context. Nevertheless, a clean separation between Results and Discussion can represent a challenge.

Title

It is obvious, but everyone reads the title first, so devising a good title requires much attention! A good title should be clear, concise, descriptive and limited to ten words including conjunctions. Even using only ten words, there are thousands of alternative titles, which makes finding the optimal title a challenge. Words from the title are often used as keywords by search engines, such as Pubmed etc. Colleagues should be able to discern from the title

what the article is about. With highly specialised topics, this is often difficult, and titles are mostly incomprehensible for nonexperts. The title should be as informative as possible. Many big journals discourage any interpretation of the data in the title, so that the key message should be in the last sentence of the abstract rather than the title. Examples of good titles include⁴: “Iron metabolism regulates graft immune tolerance in human liver transplantation”, “Effect of XYZ vaccine in active and latent tuberculosis” or “Notch signalling pathways in pancreatic cancer progression”

Introduction

If an introduction is written well, the reader is more likely to continue to read the paper, having become curious to see the results. The introduction should very briefly introduce the topic to the non-expert reader and explain why the work was done. Here, it should be made clear that the current knowledge of the field of research had deficiencies and relevant gaps in knowledge had to be filled.

One begins with what is known from previous research reported in the literature, the “state of the art”. Subsequently, one strategically works towards the hypothesis, what motivated the work, and finally the research question. Sometimes the last paragraph of the introduction is a brief summary of the results. However, in times of length restriction we discourage this practice.

Discussion

The discussion is one of the most difficult parts of the manuscript. The length of a manuscript neither correlates with nor indicates its scientific impact. The discussion is used to summarise the work, including the hypothesis and research question, and to put it into perspective. It is important to present an exact correlation between the question and the answer which can be supported by literature quotations. A more precise literature review supporting the work can be presented here. A good way of structuring the discussion is by starting with “...Our first major finding was that...”, then discussing this finding, then going on to the second major finding, etc. Contradictions with or differences from previous research in the same area should be discussed here. However, avoid mere repetitions of the results in the Discussion section, or even worse, giving results that had not even been mentioned in the Results section.

It is always useful to discuss towards the end of the Discussion the limitations of the work, being self-critical about possible limitations of the study. Finally, the clinically relevant implications and what questions remain to be answered in further research can be stated. Speculations should generally be avoided in the Discussion. If used, they should be clearly labeled as such to pave the way for a thoughtful introduction to future research.

In particular young, inexperienced authors often tend to view the Discussion as a review of the entire field, which clearly is not the purpose of a Discussion in an original paper. This is what editorials and in-depth reviews are designed for!

Abstract

After the title, the abstract is the second most crucial part of the work, because many readers will read only this. Several databases show the titles of papers and optionally also the abstract. Based on this information, or on knowing the names of the authors, one may download a PDF file of the manuscript or view it via a Web interface.

Writing a good abstract is an art in itself. For many, it is easier to write the abstract retrospectively, and this is why we suggest doing so in the last step. A good abstract has no more than 250 words and follows the “10-20-60-10 rule”. Introductory material should not overburden the Abstract and should be limited to 10% of the text. About 20% should be reserved for the methods. It is the results that the reader would like to be informed about in the shortest, clearest-possible way and this should take up 60% of the space. The remaining 10% of the space is then used for a concise summary and/or conclusion.

8. Finishing

Before submitting a manuscript, it is very helpful to receive feedback. Giving a paper to others for feedback and using this feedback critically will help make the paper even better and also give you an idea of how well your paper communicates the key messages. Make sure to get feedback from colleagues. One should try to remove all errors and to have no omissions or weaknesses in logic.

A spell-checker is a minor tool for checking. For nonnative speakers, it is usually more than helpful to send the paper to a native speaker, be it a professional service or colleague. Nothing ruins the best results more than unclear language!

In terms of style, long sentences can sometimes be better cut in half, but avoid staccato style. Scrutinise the logic of how the many statements in the paper are formulated. It takes a lot of energy to do a good job.

The lead author carries the main responsibility for the paper and must make sure that all co-authors have consented to the manuscript and its submission and have all read the manuscript.

9. Submission and selection of reviewers

We encourage authors to suggest reviewers to the journal editors. When doing so, choose people who are competent and know the field of research well. Usually, writing the discussion should give clues. Simply suggesting very good friends who know little of your topic or even work in another field is useless.

When excluding certain individuals, one must have good reasons for doing so and to be able to explain why. A standard reason is that that individual may be doing the same research and that this might create a conflict of interest.

10. Feedback and response to criticism

Often two to three, and sometimes more, reviews are obtained. When receiving critical feedback, it is at times difficult not to take the remarks too personally, because most of us closely identify with the work and the effort invested. As a standard rule, unless the review is highly positive, wait twenty-four hours before starting to write a rebuttal, because one will be less emotional then. Allow time to think about the review, reflecting on, whether, perhaps, the discussion with co-authors was clear and detailed enough. The vast majority of reviewers are not enemies but rather attempting to improve the work. If two reviews contradict one another, or are too critical, it is legitimate to point

this out to the editor and, for example, ask for a third reviewer.

Short, very critical reviews that destroy your paper are hard to handle. Short positive reviews can mean that unfortunately the reviewer has not spent much time on your manuscript. The best is to get extensive critical reviews as they help to improve the paper.

It is very important to structure the author responses well, using sound argumentation and responding to each point of criticism. The response should remain brief and absolutely non-emotional. Explain what was done in response to the reviewer and explain where one changed the manuscript in response. Journals ask that the changes be highlighted in the revised version of the manuscript. When one doesn't see the necessity for changes or new experiments, it is important to state strong and plausible arguments why this is not necessary. Authors sometimes make the mistake of responding as if in a scientific discussion with the reviewer, rather than seeing the review as a mechanism for improving their work.

Once all the above has been taken into account, one can increase the rather small chance of having

a paper accepted for publication. Of course, the above is just a very general guideline and specific requirements for each journal or for particular works may differ.

Good luck!

Conflict of interest statement. None declared.

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Correspondence to:

Dr Lineke A. Brenninkmeijer
Division of Nephrology and Clinical Immunology
University Clinic of the RWTH Aachen
Pauwelsstrasse 30
52074 Aachen
Germany