

How to Write a Scientific Article

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Abstract

There is a significant expectation for trainees to publish. However, the preparation and submission of a manuscript to a peer-reviewed journal is a daunting process for which trainees are often poorly prepared. In the first of two articles we provide a step-by-step guide to allow authors to create the manuscript of a scientific paper with more confidence. We outline the "pearls and pitfalls" of scientific writing and the process by which submittable work is produced. In a subsequent article we will outline the steps required to take the work to print including journal selection, submission, review and avoiding rejection.

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Background

There is a constant and significant pressure on surgical trainees to make contributions to the scientific literature. Publication in a peer-reviewed journal remains the pinnacle of these achievements, although numerous other fora are available for the dissemination of scientific knowledge (for example the internet, conference proceedings or dissertations). However, for many trainees, the concept of

performing research, analysing data, and then writing and submitting manuscripts for publication remains very daunting. Nevertheless, trainees are often in possession of interesting clinical information (for example through the process of mandatory clinical governance), but they lack the skills and supervision to take their work to print. This is particularly evident from the numbers of posters and presentations at annual scientific meetings that fail to achieve publication in peer-reviewed journals¹. We have prepared two

articles to aid (predominantly) trainees with the latter tasks. In this first article “How to write a scientific article” we will guide trainees through the process of manuscript preparation. In the article “Publishing a scientific paper” (which will appear in a subsequent issue of this journal) we will outline some strategies of how to select appropriate journals and deal with the submission / revision / rejection process. Deliberately, we have not addressed the steps involved in project design, data collection and analysis that lie outside the scope of these articles.

General Principles

A good scientific article should present a logical story in a succinct fashion that is appropriate to its target readership. These are the features that must shine out to editors (and reviewers) during the process of article selection and peer-review. To maximise the chance of acceptance a manuscript must be prepared from the outset with a specific journal in mind. This allows the author(s) to focus on three key factors: the material to be presented, the target audience and the agreed format. The importance of this last factor cannot be stated strongly enough. Every journal will have a section on “Instructions to Authors”. Failure to comply with these will result in instant rejection of even the best manuscripts.

Manuscript preparation can only begin once all of these core components have been decided on

(and agreed by all parties in multi-authored papers). The standard layout of manuscripts (Introduction, Materials & Methods, Results and Discussion) stems from the four important questions “Why did you start?; What did you do?; What did you find?; and, What does it all mean?”² These simple questions should be kept in mind throughout the writing process. However, manuscripts should not be written in the order that they are eventually read and we recommend, initially, outlining each section in bullet points and not in full prose. The first section to write is the Results, where the key nuggets of data are presented in an appropriate and accessible format (refer to ItoA). Next the Material and Methods section should be formulated, followed by the Introduction and, finally, the Discussion section.

Once the whole manuscript has been outlined it can then be constructed in tight, readable prose written in the active voice and confined to the relevant information³. Avoid multiple TLAs (three letter abbreviations), clichés and superfluity. Keep your manuscript as short as possible. Always write with your target audience/journal in mind and keep the language at an appropriate level. Short sentences using simple vocabulary have the greatest clarity and impact. As a guide there are several indices of readability including the Flesch Reading Ease score, Flesch-Kincaid Grade Level score and Gunning Fog Index^{4,5}. These tools are often included with modern word-processing software. This section has a Flesch Reading Ease score of 51 suggesting that

	Parametric	Non-parametric
Data Distribution	Normal	Skewed
Central Tendency	Mean	Median
Spread	Standard Deviation	Interquartile Range
Compare 2 unrelated samples	Independent t-test	Mann-Whitney U test
Compare 2 related samples	Paired t-test	Wilcoxon matched pairs
Compare multiple samples	Analysis of variance (ANOVA)	Kruskal-Wallis

Figure 1. Appropriate summaries and simple statistical tests according to data type

1. *Justify the purpose(s) of every proposed use or transfer*
2. *Don't use it unless it is absolutely necessary*
3. *Use the minimum necessary*
4. *Access to it should be on a strict need-to-know basis*
5. *Everyone with access to it should be aware of their responsibilities*
6. *Understand and comply with the law*

Figure 2. Caldicott principles for handling of patient-identifiable information⁶.

it is readily accessible to an undergraduate audience. Finally, do not rely on computer spelling and grammar checkers. Read through the final text carefully to check for errors, reduplications and grammatical consistency. It is a good idea to ask colleagues to appraise the final manuscript. This should be mentioned in the "Acknowledgement" section.

Results

"There are three kinds of lies: lies, damned lies, and statistics."

Mark Twain, Autobiography, 1904.

"Statistics are like bikinis. What they reveal is suggestive, but what they conceal is vital."
Professor Aaron Levenstein

In this section, present the important results upon which your conclusions are based. These data should be given in a clear format and should facilitate the reader to understand what it is that you have found. It is important to understand your data fully – is it parametric (normally distributed) or non-parametric? This

will determine how to summarise it and which statistical tests are appropriate (Figure 1). Where possible use tables to summarise data and figures or graphs to highlight important findings. The format of these must adhere to the Instructions to Authors. Colour figures are often not necessary and not using them will avoid unnecessary printings costs. Appropriate statistics must be used to demonstrate the validity of important points. Do not be tempted to discuss your findings in the "Results" section – this should be left for the "Discussion".

It is important to remember that all raw and published data that includes patient information must be kept in a way so as to comply with Caldicott Principles (Figure 2) and may only be used with appropriate informed consent⁶. The inclusion of clinical photographs is subject to the guidance of "Confidentiality: NHS code of practice" (2003)⁷ (Figure 3). Specifically it is the responsibility of the authors to obtain specific consent for publication from their patients. These consent forms are often journal-specific and images submitted without appropriate consent will result in automatic rejection of the manuscript.

Materials and Methods

The aim of this section is to give the reader sufficient information to replicate your study in its entirety (should they wish to). It must contain a concise and logical account of what you did and how you did it. It should be as reliable and easy to follow as a Delia Smith recipe. Most authors put insufficient information into this section as they (incorrectly) assume that the readers know this already. Poorly designed studies can be identified by a paucity of information in this section.

It is important to state how the sample size was determined (including pilot studies and/or

power calculations if possible). The methods of patient selection, inclusion and exclusion criteria should be clearly defined. How interventions were performed and how measurements were made are important. Attempts to minimise sources of bias (for example randomisation methods, independent observers) should be highlighted and details given. Data storage, interpretation and analysis methods should be outlined. This should include the statistical methods used and software employed.

Introduction

The first few sentences of the introduction are critical to grab the attention of the reader. Sequential sentences should start from a broad perspective (relevant to your target audience / journal) and rapidly focus down on the study topic. The “Introduction” should report and analyse the current literature on the subject with the inclusion of appropriate references (particularly if these are written by you or published in your target journal). All arguments that you plan to refer to in the “Discussion” should be outlined and referenced in the “Introduction” section. Ideally, no new arguments or references should be introduced in the “Discussion”. Consequently, in reality, the writing of the “Introduction” evolves alongside that of the “Discussion”.

At the end of the introductory paragraphs, the astute reader should have been given enough information to determine what deficit in the literature you plan to address with your study. At this point it is important to define your hypothesis clearly and outline the aims and objectives of the study. The hypothesis should be carefully worded, as the data presented in the results and its subsequent discussion should link back to it precisely.

Authors must be able to:

1. *Justify the purpose(s) of using the photographs.*
2. *Avoid the use of patient identifiable information unless deemed absolutely necessary*
3. *Use the minimum necessary patient-identifiable information*
4. *Where possible remove any identifiable parts of images.*
5. *Ascertain consent for photographs specific to the situation they are being used in.*

Figure 3. Summary of the use of clinical photographs from “Confidentiality: NHS code of practice” (2003)⁷

Discussion

The first few sentences of the “Discussion” should summarise the facts of your important results. Following this comes your interpretation of these findings. During this stage the strengths of the study and its design should be emphasised, while the potential shortcomings should be acknowledged. Strategies for improving and addressing these design weaknesses will demonstrate a maturity of thinking and a readiness to progress. The results and their interpretation should be linked back both to the arguments constructed in the “Introduction” (with reference to the relevant literature) and particularly to your hypothesis. You do not need to discuss everything found in the study, just explain and elaborate the major points, related to your hypothesis and aims.

Towards the end of the “Discussion” the reader should be clear on the principle findings of your study, their relationship to the current literature and how your work adds to advance knowledge and understanding. It is important to stress what sets your study aside from similar work and why your findings are current and relevant in moving forward in this area of research and its application to day-to-day practice. Recommendations for further work should also be included.

The “Discussion” should close with a succinct summary paragraph that highlights the salient points in your research and draws the reader to a logical conclusion. This is the “take-home” message you want them to remember.

Additional Sections

Abstract:

This should be written last and should take the form of a punchy but comprehensive summary of each section. Many readers will claim to have read a paper when they have only perused the abstract. Use vocabulary that will attract the reader’s attention and increase their interest in reading the complete manuscript. Most journals require abstracts to be written in a prescribed format with a strict word limit. Consequently, writing a good abstract is often difficult and requires multiple drafts.

Acknowledgements:

These are often under-used but should allow the author(s) to thank those people who have helped with the study but have not owned the work in the way that the co-authors have. These include statisticians, proof-readers, data collectors and even non-supervising consultants. Many journals require a detailed breakdown of the contribution of each author at the time of submission. Remaining contributors should be added to the “Acknowledgements” sub-section.

References:

These should be accurate, contemporary, avoid of reduplication and focus on key arguments. Editors like citations from their own journal. Do not use references from existing papers without reading the cited journal first – your conclusions may be very different. Again the “Instructions to Authors” will give detailed instructions on the number and format of references the journal requires. Specific software packages to collect, format and integrate references into the manuscript text are widely available and are to be recommended.

Supplementary Data:

Some journals allow additional material that supports the study to be submitted. These are usually files such as raw data, diagrams, radiographs, photographs or video that will not be included in the printed article but will be available online for interested readers. These facilities are very journal-specific and details will be found in the “Instructions to Authors”.

Conclusion

We hope that by following these easy steps, trainees will have the confidence to write up their findings in a logical, structured and easy-to-follow way. To have any chance of success, it is vital to adhere to the “Instructions to Authors”. By focussing on the strengths of their studies while acknowledging the weaknesses, authors should be able to convince journal editors and ultimately the journal readers of the value of their work.

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