

# Chapter 1 **Structure of a scientific paper**

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The research you have conducted is obviously of vital importance and must be read by the widest possible audience. It probably is safer to insult a colleague's spouse, family and driving than the quality of his or her research. Fortunately, so many medical journals now exist that your chances of not having the work published somewhere are small. Nevertheless, the paper must be constructed in the approved manner and presented to the highest possible standards. Editors and assessors without doubt will look adversely on scruffy manuscripts – regardless of the quality of the science. All manuscripts are constructed in a similar manner, although some notable exceptions exist, like the format used by *Nature*. Such exceptions are unlikely to trouble you in the early stages of your research career.

The object of publishing a scientific paper is to provide a document that contains sufficient information to enable readers to:

- assess the observations you made;
- repeat the experiment if they wish;
- determine whether the conclusions drawn are justified by the data.

The basic structure of a paper is summarised by the acronym IMRAD, which stands for:

Introduction (What question was asked?)

Methods (How was it studied?)

Results (What was found?)

And

Discussion (What do the findings mean?)

The next four chapters of this book each deal with a specific section of a paper, so the sections will be described only in outline in this chapter.

## 2 How to write a paper

### Introduction

The introduction should be brief and must state clearly the question that you tried to answer in the study. To lead the reader to this point, it is necessary to review the relevant literature briefly.

Many junior authors find it difficult to write the introduction. The most common problem is the inability to state clearly what question was asked. This should not be a problem if the study was planned correctly – it is too late to rectify basic errors when attempting to write the paper. Nevertheless, some studies seem to develop a life of their own, and the original objectives can easily be forgotten. I find it useful to ask collaborators from time to time what question we hope to answer. If I do not receive a short clear sentence as an answer, then alarm bells ring.

The introduction must not include a review of the literature. Only cite those references that are essential to justify your proposed study. Three citations from different groups usually are enough to convince most assessors that some fact is ‘well known’ or ‘well recognised’, particularly if the studies are from different countries. Many research groups write the introduction to a paper before the work is started, but you must never ignore pertinent literature published while the study is in progress.

An example introduction might be:

It is well known that middle-aged male runners have diffuse brain damage,<sup>1-3</sup> but whether this is present before they begin running or arises as a result of repeated cerebral contusions during exercise has not been established. In the present study, we examined cerebral function in a group of sedentary middle-aged men before and after a six month exercise programme. Cerebral function was assessed by . . .

### Methods

This important part of the manuscript is increasingly neglected, and yet the methods section is the most common cause of absolute rejection of a paper. If the methods used to try to answer the question were inappropriate or flawed, then there is no salvation for the work. Chapter 3 contains useful advice about the design of the study and precision of measurement that should be considered when the work is planned – not after the work has been completed.

The main purposes of the methods section are to describe, and sometimes defend, the experimental design and to provide enough detail that a competent worker could repeat the study. The latter is particularly important when

you are deciding how much to include in the text. If standard methods of measurement are used, appropriate references are all that is required. In many instances, 'modifications' of published methods are used, and it is these that cause difficulties for other workers. To ensure reproducible data, authors should:

- give complete details of any new methods used;
- give the precision of the measurements undertaken;
- sensibly use statistical analysis.

The use of statistics is not covered in this book. Input from a statistician should be sought at the planning stage of any study. Statisticians are invariably helpful, and they have contributed greatly to improving both the design and analysis of clinical investigations. They cannot be expected, however, to resurrect a badly designed study.

## Results

The results section of a paper has two key features: there should be an overall description of the major findings of the study, and the data should be presented clearly and concisely.

You do not need to present every scrap of data that you have collected. A great temptation is to give all the results, particularly if they were difficult to obtain, but this section should contain only relevant, representative data. The statistical analysis of the results must be appropriate. The easy availability of statistical software packages has not encouraged young research workers to understand the principles involved. An assessor is only able to estimate the validity of the statistical tests used, so if your analysis is complicated or unusual, expect your paper to undergo appraisal by a statistician.

You must strive for clarity in the results section by avoiding unnecessary repetition of data in the text, figures and tables. It is worthwhile stating briefly what you did not find, as this may stop other workers in the area undertaking unnecessary studies.

## Discussion

The initial draft of the discussion is almost invariably too long. It is difficult not to write a long and detailed analysis of the literature that you know so well. A rough guide to the length of this section, however, is that it should not be more than one-third of the total length of the manuscript (Introduction + Methods + Results + Discussion). Ample scope often remains for further pruning.

## 4 How to write a paper

### Box 1.1 Writing the discussion

- Summarise the major findings
- Discuss possible problems with the methods used
- Compare your results with previous work
- Discuss the clinical and scientific (if any) implications of your findings
- Suggest further work
- Produce a succinct conclusion

Many beginners find this section of the paper difficult. It is possible to compose an adequate discussion around the points given in Box 1.1.

Common errors include repetition of data already given in the results section, a belief that the methods were beyond criticism and preferential citing of previous work to suit the conclusions. Good assessors will seize upon such mistakes, so do not even contemplate trying to deceive them.

Although IMRAD describes the basic structure of a paper, other parts of a manuscript are important. The title, abstract and list of authors are described in Chapter 6. It is salutary to remember that many people will read the title of the paper and some will read the summary, but very few will read the complete text. The title and summary of the paper are of great importance for indexing and abstracting purposes, as well as enticing readers to peruse the complete text. The use of appropriate references for a paper is described in Chapter 8; this section is often full of mistakes. A golden rule is to list only relevant, published references and to present them in a manner that is appropriate for the particular journal to which the article is being submitted. The citation of large numbers of references is an indicator of insecurity – not of scholarship. An authoritative author knows the important references that are appropriate to the study.

Before you start the first draft of the manuscript, carefully read the 'Instructions to Authors' that every journal publishes, and prepare your paper accordingly. Some journals give detailed instructions, often annually, and these can be a valuable way of learning some of the basic rules. A grave mistake is to submit a paper to one journal in the style of another; this suggests that it has recently been rejected. At all stages of preparation of the paper, go back and check with the instructions to authors to make sure that your manuscript conforms. It seems very obvious, but if you wish to publish in the *European Annals of Andrology*, do not write your paper to conform

with the *Swedish Journal of Androgen Research*. Read and reread the instructions to authors.

Variations on the IMRAD system are sometimes necessary in specialised circumstances, such as a letter to the editor (Chapter 11), an abstract for presentation at a scientific meeting (Chapter 12) or a case report (Chapter 13). Nevertheless, a fundamental structure is the basis of all scientific papers.