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## Review Article

# Writing Manuscripts Better: Part I (The Introduction, Methods, Results, and Discussion Format)

Subramanian Shankar, Hegde Arun<sup>1</sup>

Commandant, Command Hospital (AF), Bengaluru, Karnataka, <sup>1</sup>Senior Advisor (Medicine) and Rheumatologist, Command Hospital, Lucknow, Uttar Pradesh, India

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### Abstract

Many young researchers face extreme difficulties while writing scientific articles, and there is seldom any specific training imparted as a part of under and postgraduate curriculums toward the art of presenting research work in written format. Yet, the publication is considered essential toward career advancement and for obtaining academic qualifications. We herein discuss the basic steps to follow in writing a scientific article using the Introduction, Methods, Results, and Discussion format. The Introduction explains the scope and objective of the study in the light of current knowledge on the subject; the Materials and Methods describes how the study was conducted; the Results section reports what was found in the study; and the Discussion section explains the meaning and significance of the results and provides suggestions for future directions of research. We enumerate the main elements that should appear in these sections, and some pointers for making the overall result attractive and acceptable for publication. We also have placed special emphasis on the methods section (Finer nuances of data collections, Informed consent, steps to seek approval by the Institutional Ethics Committee and authorship directives as per IJCME guidelines), Results (How to highlight the results of the study using illustrations, charts, and legends, and Discussion section ("Structured approach" and the "Divide and rule" approach). A hastily written article with incorrect methodology remains the primary reason for rejection by the journal reviewers, and following the above directives would contribute toward obtaining a fruitful result.

**Key Words:** IMRAD, Scientific writing, Manuscripts

### Address for correspondence:


Prof. Subramanian Shankar,  
Command Hospital (AF),  
Bengaluru - 560 007, Karnataka,  
India.  
E-mail: [shankarsid@gmail.com](mailto:shankarsid@gmail.com)

## A Historical Perspective of Scientific Writing

The advent of the 17<sup>th</sup> century marked the birth of scientific writing. Initially, the articles used to be published as descriptive letters and narratives that were arranged in a chronological order.<sup>[1,2]</sup> The next two centuries did not witness a great change in the style of scientific writing, barring the fact that the articles continued to be published in a commonly accepted format. It was possibly Louis Pasteur in 1876, in his book titled "Etudes sur la Biere" (studies on fermentation), who formulated the first Introduction, Methods, Results, and Discussion (IMRAD) like the structure of writing with separate sections dedicated to "Introduction," "Methods," and "Discussion."<sup>[2]</sup> The acronym IMRAD, stands for: Introduction (What question was asked?) Methods (How was it studied?) Results (What was found?) And Discussion (What do the findings mean?). By the early

1940s, the IMRAD format found an acceptance in scientific journals, and by the late 1970s, it was the most dominant format for research papers in all major scientific journals [Figure 1]. The format got approved as the desired format by the American National Standard in 1972 for the preparation of scientific papers, for written or oral presentations.<sup>[3]</sup> However, the IMRAD format does have a few limitations. First, medical writing in the form of Case reports and Case reviews cannot be fitted into this rigid structure, except maybe systematic reviews. This form of medical writing has also received criticism at the hands of eminent scholars like Peter Medawar, a Nobel laureate, who felt that it limited the thought process of the researcher.<sup>[4]</sup>

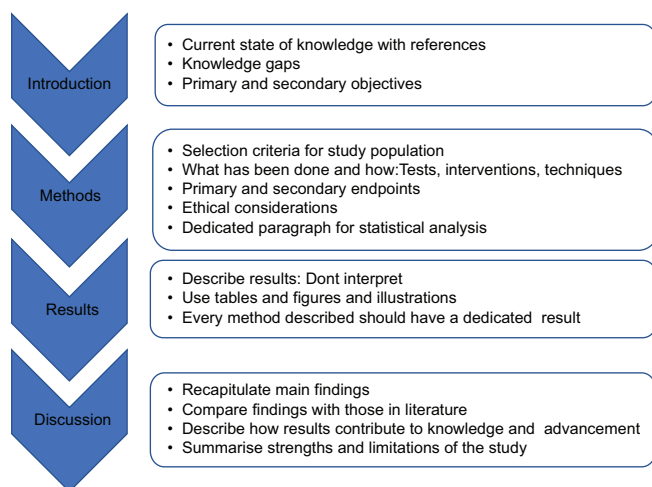
Noticeably, some scientific journals, such as Nature and Science, do not follow the IMRAD structure strictly. The Methods section in these journals is often published at

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**Figure 1: Summary of IMRAD format. IMRAD: Introduction, Methods, Results and Discussion**

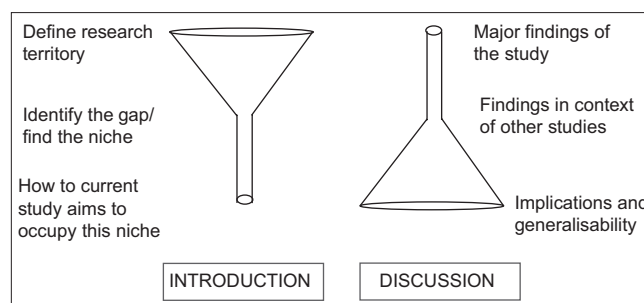
the end of the scientific paper, usually in a smaller font. Other journals, especially those that publish research papers with many sequential experiments, tend to combine the Results and Discussion sections. This is done to explain the implications of initial experiments first and assist the readers to understand the results of subsequent experiments.

## Introduction

*"The beginning is perhaps more difficult than anything else, but keep heart, it will turn out all right." Vincent Van Gogh*

A good Introduction is important to grab the reader's attention. It should also be able to hook the reviewer's attention during the review process. In this section, it is explained as to why the study was undertaken, what aim was achieved by doing it, and how this adds up to the existing body of evidence on the topic.

A good introduction is relatively short and would contain 3–4 paragraphs and not more than 400 words. The first paragraph should comprise a short summary of what is known in literature about the attempted research area. The second paragraph is about contextualization and should contain what work other researchers have done in that field. The third paragraph highlights the knowledge gap. The last paragraph, which is also the most important, should highlight the aim of doing the study. It should contain the working hypothesis, followed by the objective (s), and very briefly, the strategy that would be implemented to achieve these goals. It should not be very expansive because by doing so, it would make the reader lose interest in the study.<sup>[5]</sup> It can be thought of as a funnel that leads to the aim, while the discussion section is the exact opposite in the form of a reverse funnel [Figure 2]. References cited should be minimal, and current. Weak evidence should be disregarded, and only the most relevant and valid studies should be cited as a reference.<sup>[6]</sup>



**Figure 2: The funnel analogy for introduction and discussion**

## Methods

Methods remain the most important part of manuscript writing. Ambiguous methods remain the most common reason for manuscript rejection.<sup>[7,8]</sup> Editors tend to judge the study on whether the methods were adequate enough to answer the specific aim or hypothesis. A method has to be described for every result that is included in the results section.<sup>[5]</sup> This section should be exhaustive in nature, to enable any author who wishes to reproduce it to do so. It is usually written in the past tense and should comprise only the information available at the time of designing the study. The information to be included is summarized in Table 1.

An important aspect of data collection that requires to be highlighted is interview-based studies. There are three fundamental types of research interviews: structured, semi-structured, and unstructured. Structured interviews comprise verbally administered questionnaires, wherein a list of predetermined questions is administered, without variations or scope of follow-up questions. Responses do not warrant elaboration. Advantages being they are relatively quick and easy to administer, while the disadvantages are that they only allow limited participant responses, and are found lacking if a little "depth" in responses is required. Conversely, unstructured interviews do not represent any preconceived theories and require little or no organization. The disadvantage is that they are time consuming, difficult to participate in, and manage, as the lack of predetermined interview questions provides little guidance on what to talk about. Their use is primarily where virtually nothing is known about the subject area. In semi-structured interviews, there are several key questions that help in defining the areas to be explored, but allow freedom to the interviewer or interviewee to diverge, so as to pursue a particular idea or response in more detail. This format finds use frequently in health-care settings as it provides participants with some guidance on what to talk about.<sup>[9]</sup>

Another important concept that needs to be highlighted is pilot studies. These are like a trial run of the entire study from start to finish. They are conducted to test the entire research process, usually from a methodological standpoint, like sampling and recruitment strategies,

**Table 1: Contents to include in methods section**

To include	Details
Type of the study	Prospective/retrospective, randomized or nonrandomized, double-blind or open-label, controlled, crossover, factorial
Study population	Volunteers, patients, animals, etc. Control group, if any
Inclusion and exclusion criteria	For retrospective studies, mention source data and the final number of case records and/or patients selected For prospective studies, the final number of patients included is considered as a result and not in the methods Mention rationale for inclusion criteria and procedures to identify eligible patients (whether it was through consultations, new admissions, daily rounds, etc.)
Place of the study	Along with the study duration
Sample size calculation	The working hypothesis for the frequency of the outcome and its variance, the differences that are expected to be observed and the alpha and beta risks used for calculations must be mentioned
Sampling method	How the randomization process was generated and how many of each branch completed the study and why some of them were withdrawn
Variables	Define clearly. If the variables have any type of division or categorization into two or more groups, the methodology by which the cut-off points are established must be made explicit. The references for defining variables must also be mentioned
Measurement and monitoring criteria	Include details of the instruments (model, brand, manufacturer data) used to measure the variables, how were they measured, who did the measurements (including experience they possessed) and how many times the measurements were done
Description of procedures	Depending on the type of design, include a description of all the clinical procedures, the interventions and the time sequence to which the subject has been subjected
Data analysis	State details about data presentations in the beginning like, qualitative data are presented as numbers (percentage) and quantitative, normally-distributed data are presented as means with standard deviation, or median (interquartile range) for nonnormally distributed data. List the specific statistical approaches-which test for which type of variable; type of multivariate analysis and the variable the statistical tools used (including the computer software used), the <i>P</i> value chosen to indicate the statistical significance and the measures of effect magnitude used (odds ratio, relative risk, number of patients to be treated, etc.). If any unusual analysis used, the appropriate literature citations should be provided

**Table 2: Common errors in methods section**

Type of study whether prospective or retrospective is not mentioned
Duration of the study not mentioned
Inclusion criteria are not stated explicitly
Sample size calculation is not mentioned or has not been done
Type of statistical analysis has not been mentioned, and statistics and related paragraphs figure in the middle of the methods section
Explicit exclusion criteria are not indicated
Sampling methods are not mentioned
Primary outcome is not clearly defined
Method used in a test not defined

administration, data collection, and analysis in all field conditions. The general rule of thumb is to pilot test the survey on 30–100 pilot participants. Once pilot testing is complete, final revisions can be made, and the survey is ready for full-scale administration.<sup>[10]</sup>

All the information in the methods section should ideally be structured under five paragraphs. The first paragraph should be about participant selection. The second to fourth paragraphs should comprise variables and procedures for each primary and secondary objective and the last paragraph should be about analytic methods. Common

errors usually committed in the methods section are mentioned in Table 2.

Another important aspect, often taken lightly by the authors, pertains to the ethical approval of the study by the Institutional Ethics Committee (IEC) and informed consent (IC). The Helsinki declaration and the subsequent amendments to it, which have duly undergone ratification by the World Medical Association lay out guidelines for conducting research in an ethical manner when the subjects involve humans. Herein, the risks to the participants, versus the potential benefits of study participation, should be given a thorough consideration, and the study should be proceeded only if the benefit outweighs the risk. The rationale of the study should be explained to the participants before obtaining IC. The right to withdraw from a study at any given point of time in the future, would solely rest with the participant, and he/she should be apprised of the same. Refusal to provide consent should in no way hamper his rights to avail future healthcare-related facilities that are due to him from the hospital or doctor concerned. Wherever children are involved, the consent of parents or guardian(s) of the child would be required. Assent of the child is also needed in the case of older children. The International Committee of Medical Journal Editors (ICMJE) guideless implies that any

study that involves the participation of humans requires to undergo review and ratification, by an independent IEC, in accordance with locally relevant guidelines, before starting of the study. Such IECs, at their discretion, have the capacity to provide a waiver of IC. However, no research study is permitted without IEC overview. The Indian Council of Medical Research guidelines (published in 2017), lay down situations wherein IC may be waived, Examples being retrospective anonymous reviews of medical records and educational surveys additionally, most journals have a requirement that the date of approval by the ethics committee needs to be specified, along with file number. Local regulations regarding IC and RECs may vary; cite these, if deviations exist from the norm. All randomized clinical trials should be preferably registered with an approved clinical trial database like [www.ctri.nic.in](http://www.ctri.nic.in), and the registration number should be cited.<sup>[11]</sup> Case reports would entail a requirement of written consent to publish from the patient. For Review articles, relating to drug therapy, any relations with pharmaceutical companies that manufacture or marketing the drug(s) should be declared.

## Results

*"Quality is never an accident. It is always the result of intelligent effort." John Ruskin*

The results section forms the core section of the paper since it presents new knowledge. This section answers the query "What was found?" and reports the results of the investigations which were described in the methods section. It comprises words (which tell the story), tables (that depict the evidence), illustrations (highlighting important findings), and statistics (that support the statements). The results must be presented lucidly in just the right number of words, avoiding verbosity.<sup>[12]</sup> One must describe a result for every method that was outlined in the methods section, in the same order as the methods. Similarly, the use of subtitles (again, the same ones as used in the methods section), can help to break down the results into easy-to-follow sections. Normally, the results section would comprise two-three pages of text, figures, and tables, as strictly necessary, not exceeding 1000 words over 4–9 paragraphs; usually without references.

The results section can start with describing the baseline characteristics of the study population. These should be presented in table format and not as figures. Presentation of baseline characteristics helps in generalization of the results. Herein, the comparability of the control and the study groups, as well as the distribution of the variables in each group, needs to be presented.

The next section would be related to the findings of the study. Tables should be used liberally to present the results and to demonstrate if the conclusions are statistically valid. Illustrations should be used to over emphasize important points.<sup>[5,12]</sup> It needs to be emphasized that both the tables

and the illustrations should be capable of an independent identity. They must contain sufficient information such that the reader of the article need not have to refer back to the text every time. There should be no repetition of information. Whatever is written in the table should not be again repeated in the text. Negative data must be included only if useful for interpreting the results.

Every table and figure should be cited in the text by number. Care should be taken to avoid verbose expressions. All tables should be basically structured in the same way, with four main parts: title, column headings, body, and footnotes. The title should be brief and should relate clearly to the contents of the table. Identical key terms should be used in the title and column headings. The column headings should be capable of identifying the items listed in the columns below, subheadings (if required), and units of measurement (if required). Column headings should be kept brief. Each table should have a title that should guide the reader on how to interpret the contents. The results should be presented in columns where the changes run from the left most column. It is helpful at times to present data in columns as the percentage changes from the initial value. Finally, the way of presenting data in the tables should match the statistical analysis that was performed. Information for graphs should include whether data represent individual, mean, or median values; whether error bars represent standard deviations, standard errors of the mean, confidence intervals, or ranges; and the sample size ( $n$ ). For bar graphs, values compared by statistical analysis should be stated, the significance value ( $P$  value), and the statistical test should also be stated. SI abbreviations for units should be used for measurement. Graphs should be carefully chosen. For line graphs, the independent variable (should be on the x-axis and the dependent variable should be on the y-axis. Various types of figures that can be used in the Results section are depicted in Table 3.

It is essential to have good illustrations to get across a clear message. Various types of illustrations can be used like graphics (e.g., bar charts, histograms, pie charts, or scatter plots), drawings (e.g., flow charts), photographs, or micrographs. These should be tailored to the journal requirements [Table 2]. The anonymity of patients should be protected at all costs. Photomicrographs need professional production. The photos should be of high

**Table 3: Types of figures to use in results section**

Type of figure	Used for
Bar	For comparison
Histogram	Frequency distribution
Pie	Part of a whole
Line	Usually, event in relation to time
Scatter	Association between variables
Flow charts	Algorithms, study design
Photographs	Before or after surgery surgery/treatment

quality as they have to go through a large number of processes before printing. While reproducing photographs, written, IC should be taken. Facial features should be covered. Permission needs to be sought from the copyright holder to republish photographs, as this forms a legal requirement. Permission should also be taken from the author, as a common courtesy. Standard permission forms are available at the publisher's website. Reference should be cited in the figure legend and should be stated that the permission for republication has been taken. Credit is usually given at the very end of a figure legend.

Legends should accompany illustrations. A figure legend refers to the descriptive statement that is placed next to the figure. It is essential to make the figure self-explanatory without the reader having to refer to the text. The figure legend comprises four components: a brief title, experimental details, various definitions (for example, of symbols or abbreviations), and statistical information. The title brief avoids the use of abbreviations. The statistical information required in the figure legend depends on the type of illustration.

## Discussion

By the time we have reached this section, we would already have answered three questions: "Why was the study done? (Introduction), "How was it done?" (Methods) and "What were the findings?" (Results). The discussion would now answer the question, "So what?" The discussion is usually the most extensive part of the manuscript relating to word count comprising 1000–1500 words contained over 10 paragraphs; including a paragraph on the conclusion. Some journals, however, treat the conclusion as a separate heading. Discussion is where the author interprets and explains the importance of the results, and how the results fit into the larger picture of what has already been observed and reported on the same topic. The discussion usually has 10–20 references, with some of them possibly appearing in previous text sections. It is the hardest section of the paper to write. If the discussion is long and verbose, the true data could get obscured, rendering the paper uninteresting.<sup>[13]</sup>

One may resort to two approaches to write the discussion, which are the "Structured approach" and the "Divide and conquer" approach. The "structured approach" was advocated by Docherty and Smith, who proposed writing the discussion under the following headings:<sup>[14]</sup>

- An introductory statement on the principal findings of the study (probably in one sentence)
- A paragraph elucidating the strengths and weaknesses of the study
- A paragraph describing the strengths and weaknesses of the study in comparison with other studies, stressing particularly any differences in findings
- A paragraph conveying the meaning of the study with implications for clinicians

- A concluding paragraph on unanswered questions and vistas for future research.

The "Divide and conquer" advocated by Şanlı *et al.* proposed that the discussion section should be written in three parts: an introductory paragraph, intermediate paragraphs, and a conclusion paragraph. For intermediate paragraphs, a "divide and conquer" approach can be used. Herein, the findings of the study are described in order of their importance, and a paragraph is drafted for each finding. Each paragraph commences with an "indisputable" introductory line about the topic to be discussed. This sentence primarily can be the answer to the question, "What have we found?" Then, a sentence associated with the subject matter to be discussed is espoused, followed by discussing the findings in the light of the current literature, which is finally followed by a concluding remark

The conclusion should comprise the last paragraph of discussion, with or without a subheading. It should project the main message contained in the manuscript in a concise manner without mentioning something that has not been described previously in the text. This would be followed by acknowledging those who have helped in conducting the study. These may be individuals, institutions, or organizations. Finally, any source of funding for the study should be declared.

Author contributions need to be mentioned at the end, as per ICMJE Guidelines. ICMJE recommends that authorship be based on the following four criteria:

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work
2. Drafting the work or revising it critically for important intellectual content
3. Final approval of the version to be published
4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.<sup>[16]</sup>

## Conclusion

Writing an article requires patience, and might appear daunting upfront. However, a combination of doing proper research before writing, along with a systematic writing approach, will contribute toward making the overall effort noteworthy. The above-mentioned rules and outlines can facilitate this process and will prevent unnecessary mistakes.

## Author contributions

SS was responsible for substantial contributions to the conception of the work involved and final approval of the version to be published; and would be accountable for all aspects of the work, and answerable for all questions related to the accuracy or integrity of any part of the work.

AH was responsible for the drafting of the work and revising it critically for important intellectual content.

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### **Conflicts of interest**

There are no conflicts of interest.

### **References**

1. Meadows AJ. The scientific paper as an archaeological artefact. *J Inf Sci* 1985;11:27-30.
2. Wu J. Improving the writing of research papers: IMRAD and beyond. *Landsc Ecol* 2011;26:1345-9.
3. Gastel B, Day RA. *How to Write and Publish a Scientific Paper*. 8<sup>th</sup> ed. Santa Barbara: Cal, ua, Greenwood; 2015.
4. Medawar PB. Is the scientific paper a fraud. *Listener* 1963;70:377-8.
5. Hall GM. *How to Write a Pap*. 3<sup>rd</sup> ed. London; BMJ; 2003.
6. Peat J. *Scientific Writing Easy When you know how*. London; BMJ Books; 2010.
7. Taylor DM, Brown AF. Analysis of the study design and manuscript deficiencies in research articles submitted to emergency medicine. *Emerg Med (Fremantle)* 2001;13:444-50.
8. Pierson DJ. The top 10 reasons why manuscripts are not accepted for publication. *Respir Care* 2004;49:1246-52.
9. Gill P, Stewart K, Treasure E, Chadwick B. Methods of data collection in qualitative research: Interviews and focus groups. *Br Dent J* 2008;204:291-5.
10. Ruel E, Wagner W, Gillespie B. Pretesting and pilot testing. In: *The Practice of Survey Research*. CA: SAGE Publications; 2010. p. 101-19.
11. Misra DP, Agarwal V. Integrity of clinical research conduct, reporting, publishing, and post-publication promotion in rheumatology. *Clin Rheumatol* 2020;39:1049-60.
12. Ecarnot F, Seronde M-F, Chopard R, Schiele F, Meneveau N. Writing a scientific article: A step-by-step guide for beginners. *Eur Geriatr Med* 2015;6:573-9.
13. Cooper ID. How to write an original research paper (and get it published). *J Med Libr Assoc* 2015;103:67-8.
14. Docherty M, Smith R. The case for structuring the discussion of scientific papers. *BMJ* 1999;318:1224-5.
15. Şanlı Ö, Erdem S, Tefik T. How to write a discussion section? *Turk J Urol* 2013;39:20-4.
16. International Committee of Medical Journal Editors. *Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals*. ICMJE Guidelines 2014.