



Writing Biomedical Manuscripts Part II: Standard Elements and Common Errors

Rédaction biomédicale partie manuscrits II: Eléments standard et erreurs communes

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ABSTRACT

It is incumbent on, satisfying and rewarding for researchers to have their work published. Many workers are denied this satisfaction because of their inability to secure acceptance after what they consider a good research. Several reasons account for rejection or delay of manuscripts submitted to biomedical journals. A research poorly conceptualised and/or conducted will fail to fly but poor writing up of the completed work accounts for a greater majority of manuscripts that get rejected.

The chances of manuscript acceptance can be increased by paying attention to the standard elements and avoiding or correcting the common errors that make for the rejection of manuscripts. Cultivating the habit of structuring every department of the manuscript greatly improves chances of acceptance. The final paper should follow the universally accepted pattern of aim, introduction, methods, results, and discussion. The sequence of putting the paper together is different from the order in the final form. Follow a pattern that starts with the Tables and Figures for the results section, followed by final version of the methods section. The title and abstract should be about the last to be written in the final version of the manuscript. You need to have results sorted out early as the rest of what you will write is largely dictated by your results. Revise the work several times and get co-authors and third parties to help read it over. To succeed follow the universal rules of writing and those of the target journal rules while avoiding those errors that are easily amenable to correction before you submit your manuscript. *WAJM 2011; 30(6): 389–399.*

Keywords: Writing manuscript, biomedical, attributes, common errors, standard elements.

RÉSUMÉ

Il incombe à, satisfaisante et enrichissante pour les chercheurs de publier leurs travaux. De nombreux travailleurs se voient refuser cette satisfaction en raison de leur incapacité à assurer l'acceptation, après ce qu'ils considèrent comme une bonne recherche. Plusieurs raisons expliquent le rejet ou le retard de manuscrits présentés aux revues biomédicales. Une recherche mal conçue et / ou conduites ne parviendra pas à voler, mais les pauvres rédiger des comptes de travail effectuées pour une grande majorité des manuscrits qui se rejettent.

Les chances d'acceptation manuscrit peut être augmentée en faisant attention à des éléments standards et d'éviter ou de corriger les erreurs courantes qui rendent le rejet de manuscrits. Cultiver l'habitude de structurer chaque département du manuscrit améliore considérablement les chances d'acceptation. Le document final devrait suivre le modèle universellement acceptée de but, l'introduction, méthodes, résultats, et la discussion. La séquence de mettre le papier ensemble est différent de l'ordre sous la forme définitive. Suivre un cycle qui commence avec les tableaux et figures pour la section des résultats, suivie par la version finale de la section des méthodes. Le titre et le résumé doit être d'environ le dernier à être écrit dans la version finale du manuscrit. Vous avez besoin d'avoir des résultats triés tôt que le reste de ce que vous allez écrire est largement dictée par vos résultats. Réviser le travail plusieurs fois et d'obtenir des co-auteurs et des tiers pour l'aider à lire plus. Pour réussir suivez les règles universelles de l'écriture et ceux des règles de journal cibles tout en évitant les erreurs qui sont facilement susceptibles d'être corrigés avant de soumettre votre manuscrit. *WAJM 2011; 30 (6): 389–399.*

Mots-clés: manuscrit d'écriture, le biomédical, les attributs, les erreurs courantes, des éléments standard.

INTRODUCTION

There are several reasons why completed research works fail to get published. Lack of success may arise from not following simple universal rules of biomedical writing or demands of a particular journal.¹⁻⁵ A well conceptualised and executed research deserves publication. This will be possible if the flaws in manuscripts leading to their rejection¹⁻⁵ are taken care of or avoided *ab initio* by the authors. Using simple guidelines and following rules in writing can help reduce such flaws and enhance chances of acceptance. The objective of this two-part article is to encourage researchers to write and to provide them with a simple guide that will aid them towards writing an acceptable manuscript.

In the first part of the contribution,⁶ we covered general guides on writing a biomedical manuscript, types of biomedical research, study aspects impacting on manuscript writing, the anatomy of a scientific manuscript, why manuscripts get rejected, general tips and the manuscript publication process. In this second part we discuss the following sections and elements of a research or primary publication:

1. Title and Title Page including Authorship
2. Abstract and Keywords
3. The Introduction Section
4. Methodology (a.k.a. Subjects, Materials, and Methods)
5. The Results Section
6. Tables, Illustrations, and Abbreviations
7. The Discussion and Conclusion Section
8. The Acknowledgement Element
9. Reference Section
10. Writing Sequence and Proportions
11. Miscellaneous Issues
12. Cover Letter and Responding to Editors / Assessors
13. Summary and Conclusion

For each element or section, the approach and qualities of good writing are first highlighted and then the common correctible errors found in submitted manuscripts are outlined.

1. TITLE AND TITLE PAGE

The contents of the title page may vary with individual journals but generally they will include most of the following: title of the article, name/s of author(s) and their affiliation, conflict of interest, name and address of author for correspondence, source of support in the form of grants, equipment, and drugs as well as a running title.

Title and Authorship

The title is the first attraction of the manuscript. Every effort and time must be made to craft an appropriately suitable title for the article. Thus it must not be written in a hurry. You may start with a draft title but the definitive title should be about the last component of the manuscript to be finalised.

Attributes of a Good Title

Table 1 is a summary of the characteristics of what constitutes a good manuscript title as well those errors commonly found in manuscripts submitted to biomedical journals.⁵⁻⁷

Table 1: Attributes of a Good Title and Common Mistakes

A Good Manuscript Title should

- indicate the content of the study.
- include some of the searchable keywords
- attract readers and search engines.
- be short and simple (7–15 words or a maximum of 100 characters).
- be succinct, informative, and unambiguous.
- begin with an important (MeSH) word to attract readers and search engines.
- be purposely directed at a specific target group or audience
- be modest in claims.
- include some independent and dependent variables of the study.
- spell out symbols e.g. say *beta* instead of β .

Common Mistakes in the Manuscript Title to be avoided:

- being too scholarly or too cute making it prone to misunderstanding.
- complex grammar
- presence of subtitles (if possible, but may sometimes be needed)
- acronyms or abbreviations and excess of punctuation
- redundancies: e.g. *A Study or Investigation of Tetanus in Lagos...*
- noun-clusters – three or more nouns together e.g., Skull circumference report publications
- Use of jargon

Running Title

On the title page provide a short running title for the manuscript. This should be less than 50% of the full title – no longer than 40 characters, (including letters and spaces) and should occupy less than a third of a line. In your manuscript to be submitted you can also insert the running title as a footer or a header.

Authors' Names, Affiliations, and Funding

Several journals require the first name, middle initial, and last name of each author along with the highest degrees, position/designation and institutional affiliations. The institution where the work was done must be clearly identified. Any source of funding should also be mentioned on the title page in addition to what is presented in the acknowledgement section.

Order of Authors

The manner in which authors should be arranged is a matter for the authors, rather than for the journal. Generally the lead writer of the manuscript is designated senior author (even if she/he be the most junior in rank). The tendency is to rank authors, with first author/senior author presumably contributing the most, and the last the least. When there is a mentor to the group and who qualifies to be an author, such a mentor's name, if not the senior author, should come last.

Corresponding Author

One of the authors – usually the senior author – is designated the corresponding author whose name, postal address, email address, phone number and fax number should be provided. He corresponds with the journal, and when the manuscript is published, he may also correspond with the readership.

2. ABSTRACT AND KEYWORDS

The abstract, after the title, is the most widely read component of the paper. The abstract should be easy to comprehend, informative, appealing and yet not too detailed.^{7,8} Whether the reader would go on to read the main work often depends on his assessment of the

abstract. In writing the abstract, therefore, always put your best foot forward. The abstract should distil and summarise each of the major parts of the paper i.e. Introduction or background, objectives, methods, results, and discussion/conclusion. It should, therefore, be written only when the whole paper is completed.

Abstract Structure and Length

The abstract should be written in a structured manner (consisting of *Background, Objective, Methods, and Conclusion*) or unstructured in which case the whole abstract is one paragraph.⁷ Whether structured or unstructured, the abstract must capture the *background and rationale* for the study, *how the study was carried out*, what *results* were obtained and the *conclusion* reached. It is highly recommended that the structured model be used especially at the draft stage of the manuscript. If a particular journal does not use a structured format, the structured one can easily be collapsed into a single paragraph. The maximum number of words of a structured abstract should be about 250 words and 150 words for an unstructured abstract.

Elements of a Structured Abstract

A structured abstract should consist of the following sub-sections: *Background or Introduction, Objective(s), Methods, Results, and Conclusions*. Some journals collapse the background and objectives into one section, often labelled as introduction or background or objective. As a beginner, keeping them separate in your draft helps you to focus and not to leave out any element.

Background: In *one or two sentences* state the rationale for the study. This section is the introduction (of the manuscript) reduced to one or two sentences. Introduce the topic, stating what was previously *unknown* and the gap in knowledge.

Objective: In *one sentence*, state the purpose of the study. This information should derive from the research question or hypothesis as stated in the last paragraph of the introduction section.

Put it simply as : The objective of this was to... or the hypothesis was ...

Methods: Provide only an outline of the basic procedures and variables, selection of subjects or animals, and the study design. This section should consist of *only three to five sentences*.

Results: State the major findings in relation to the research question or objective. You may add a few sentences on findings in support of or related to the major findings. This section should contain no more than *three to five short sentences*, but should include summary numbers, some specific *results* and their statistical significance.

Conclusion: This should be *no more than two sentences*. Indicate the answer to the research question or purpose and the implications of the findings. Establish congruence between the conclusion and the study objectives and results. You may lift or paraphrase this section from the last paragraph (the summary) of your discussion/conclusion.

General Characteristics of a Good Abstract

A good abstract should possess certain qualities and be devoid of the common flaws associated with poor manuscript writing. To produce a good abstract, follow standard rules and avoid such common errors as listed in Table 2.

Style in the Abstract

Different parts of the abstract require use of different tenses as indicated below:

Use *present tense* to write the background.

Use *past tense* to write the objective or purpose. The purpose of this study was to ...

Use *past tense* to write the methods (what was done, and how it was done).

Use *past tense* to write the results section. The fasting plasma glucose decreased in 208 (70%) of...

Write the conclusion in the *present tense*: Our results show that grey rabbits *are* very fertile.

KEYWORDS

Keywords are used to assist

Table 2: The Manuscript Abstract: Good Qualities and Common Errors to Avoid

A good abstract

- reflects faithfully the story of the paper.
- is succinct, yet appealing.
- is easy to read, yet informative.
- should stand and be understood on its own, without reference to other parts of the paper.
- calls attention without inviting extra explanation.
- aligns the conclusion with the study purpose and results.
- exhibits some summary data results.
- avoids (or defines, if any limited) abbreviations or acronyms.
- follows journal's instructions including word limit.
- exhibits congruence between its various parts and other parts of the paper.
- contains some of the keywords of the paper.

Common mistakes in writing the abstract

- Being too short (making the abstract meaningless) or too long (making it uninviting to read);
- Providing excess background information;
- Not stating clearly what the purpose of the study was;
- Inserting tables or other illustrations;
- Citing references in the abstract;
- Making references to Tables/figures in text;
- Using unexplained acronyms or abbreviations;
- Confusing results with conclusion sections;
- Its results section lacks data;
- Conclusion bears no relationship to objective or findings.

indexing bodies such as *Index Medicus* in cross-indexing the published article. You may coin your own words or phrases but it is widely recommended that terms from the list of medical subject headings (MeSH) of *Index Medicus* be used. You can access the list at <http://www.nlm.nih.gov/mesh/>.⁹

From the MeSH (9) list select 4–10 words or phrases that apply to your article. Some of such words or phrases should also appear in the manuscript title and abstract. Use of appropriate keywords helps to increase how often the paper will be cited and/or accessed by search engines.

3. THE INTRODUCTION SECTION OF THE MANUSCRIPT

Purpose of the Introduction

The principal function of the *introduction* in the manuscript is to highlight the domain of study and provide the rationale and justification for the study. This section should establish the topic of interest- medical education, communications, specific disease etc. From overview of the literature, identify gaps in knowledge and the like and then move on to state what the purpose of the study was.^{3,5,6,10, 11}

In a funnel-shaped manner the introduction should be completed in three to five moves or paragraphs, moving from known areas through unknown areas to specific questions. This funnel or inverted pyramid model of the structure of the introduction can be written by answering the following simple questions with relevant citations:

Paragraph 1: What's *known* about the broad issue or disease?

Paragraph 2: What's *unknown* about the broad issue?

Paragraph 3: What are the *gaps* in knowledge this study will fill?

Paragraph 4: What is the *research question or objective* ?

You may add one or more paragraphs, but do not make it too long. Each paragraph should convey one idea.

Approach to Writing the Introduction

The Initial Paragraph of the Introduction

Answer the question in one short paragraph: What's known about the broad issue or disease? Start with a known big problem-e.g. an aspect of diabetes mellitus such as microvascular or macrovascular complications. State what is known about the big problem (e.g. of diabetic microangiopathies). Of the various types of diabetic microangiopathies you may choose diabetic nephropathy. You may state that diabetic nephropathy is a major cause of morbidity and mortality in certain category of people with diabetes mellitus.

Second or Middle Paragraph/s of the Introduction

State what's unknown about the broad issue or an aspect of it ? Take an aspect of the big issue (e.g. screening, diagnosis, treatment, or prevention of diabetic nephropathy) and dwell on that particular aspect (e.g. difficulty of early diagnosis of diabetic nephropathy). Paragraph 2 or second move should be informed by one or more of the following or other reasons as to why you embarked on this study:

- A follow-up to your own previous work (arising from 'the next move in the conclusion of the work');
- You found an essential problem for which there is no apparent answer in the literature;
- There are contradictory or inconclusive statements about a particular theme or issue;
- To replicate a previous study in a new group or place to see if this is reliable or whether the results differ or agree;
- Observed deficiency in reported works concerning the issue.

What gaps in knowledge did this study set out to be filled?

The middle parts of the funnel or triangle should address what is *unknown* about a particular aspect of the big problem. In this middle paragraph/s of the introduction indicate the aspect of the big problem that attracted your attention to embark on this study, *vide supra*. State clearly what the gap is in knowledge that you intend to fill. Cite a few *primary* relevant previous publications to drive this point home. Using a transition sentence, move to the last paragraph of the introductory section.

The last paragraph of the Introduction and objective of study.

What was the research question or objective of your work? The last paragraph/s (and narrowest part of the inverted pyramid) is the small area of interest that you have chosen to help fill in the gaps. In this paragraph state the research question or hypothesis arising from the previous paragraphs. Explicitly state the purpose of the work and its potential relevance. End this paragraph

with a sentence like: The purpose or objective of this study *was* to determine the amoebicidal effects of bitter leaf extract. Go on to state how relevant the results of the study could be.

The Introduction Section: Attributes and Common Errors

These are summarized in Table 3.

Table 3: Introduction Section: Attributes and Frequent Errors

Desirable Attributes: A good introduction

- is simple and easy to read.
- sets the stage to want to read the work.
- moves from broad issues through the unknown to the research question.
- must contain three principal areas: the big picture or disease, the problem or gap to be addressed, and the research question.
- contains 3–5 paragraphs in 300 – 500 words
- cites literature that is succinct, recent and relevant to problem and limited to 3–5 primary publications instead of secondary publications.
- ends with the objective, research question, problem statement or hypothesis.
- uses some keywords from the title.
- casts what is known about the topic in the *present tense*,
- uses the *past tense* for previous findings, yet to be accepted as universal facts
- uses the *past tense* to state what the objective or research question was.

Common Errors to avoid in the Introduction

- Making the *Introduction too long*
- Failure to transit from broad view through gap to research question
- Lack of explicitly stated research question or hypothesis
- Doing extensive literature review and making the background (paragraph 1) too long
- Failure to state the 'gap' in knowledge
- Failure to use a structured approach to the Introduction
- Using names of other investigators rather than dwell on their findings.

4. METHODOLOGY (a.k.a. SUBJECTS, MATERIALS, AND METHODS)

The function of the methodology section is to provide sufficient and necessary information for other

competent researchers to be able to repeat the study if they so desire. This section should describe clearly what was done to answer the research question or test the hypothesis.^{4,7,12} Information on subjects, animals, tissues, sample origins, field site description, data collection protocol, equipment used, data analysis software and the like should be clearly described in this section.

The terminology for this section varies among different journals. Terms such as *Methods; Materials and Methods; Methodology; Subjects, Materials and Methods*; or some other modifications thereof are frequently used. The term methodology tends to encompass most forms. In human studies the description '*Subjects, Materials, and Methods*' (SMM) is to be preferred⁷ while basic medical science studies prefer writing it as *Materials and Methods*. Whatever terminology used should, however, be informed by the requirement of the particular journal. For the purpose of ease of writing and simplicity we shall use here the structured form of *Subjects, Materials, and Methods (SMM)*.

Elements of the Methodology Section

Using the SMM model as indicated above, the principal parts of the methodology section should consist of *Subjects* (plus allied matters), *Materials* including equipment, and the *Methods* (encompassing the clinical and/or laboratory procedures as well as statistical methods of data analysis used).

Subjects

Under this subhead should be included a statement about Institutional Review Board approval and informed consent, the study location, design of study, subject recruitment, and sample size.

Design of study: state whether the study was a case report, case series, case-control, cohort, clinical trial, experimental or other.⁶ Regarding data collection state whether this was retrospective or prospective. Indicate if there was any blinding.

Subject Recruitment or Selection

Describe clearly how the participants were selected, be they human beings (subjects) or laboratory animals. How were the subjects allocated, e.g. by randomisation? State the statistical method used for selection of subjects. Beware of the term *randomly selected being often misused*. You should describe the *inclusion and exclusion* criteria here as well as selection and justification of controls if any were used.

Ethical issues and guidelines on use of human and/or laboratory animals including approval by ethics committee and process of securing informed consent must be described.⁷ If you have no access to an Ethics Committee, follow the principles outlined in the Helsinki Declaration Guiding Physicians in Biomedical Research including human subjects.¹³ The demographics should also be described here in a retrospective study but move them to the result section in a prospective study.

Materials, Procedures, and Techniques

(i) *Specify reagents and apparatus* (including model, manufacturer's name and place) used. **Drugs and chemicals must** be clearly identified, with doses and administration routes. Use generic names instead of brand names or brand/generic names for drugs showing adverse reaction or those used in comparison of different preparations of the same agent

(ii) *Provide details of what was done and how things were done step by step.* Describe protocols and analytical methods used. If using established protocols and methods, you need not describe them in full but just reference them. If, however, an established method is modified in the process, give the reference along with a summary of the modifications. Adduce reasons for use and modifications of established techniques with evaluation of their limitations.

(iii) The *protocol* should indicate the independent/manipulated variable and the dependent or measured variable.

(iv) *Terms and measures.* State clearly operational definitions and criteria for classification, diagnosis etc used in the study. If standard definitions or criteria are used, give authoritative references.

If you used your own definitions or criteria give reasons or explanations; example – hypertension may be defined as BP greater than 160/90 mmHg or 140/90 mmHg depending on the guideline used.

(v) *Sample size:* This may stand alone or be described under subjects or less desirably in the statistics section. Justify the sample size used and the formula/software used to calculate same. Show clearly how the right formula for the type of study was used. Many papers get rejected because of inadequate power arising from too small a sample size.

(vi) *Data management:* Describe succinctly how the data were collected and validated. How was data quality assured? Was there double data entry? Describe the type, if any, of blinding used.

(vii) *Statistical Analysis:* This should be a paragraph on its own. Describe the statistical tests in the order in which they were applied; and/or with regard to the objectives/hypothesis. The usual sequence of statistical tests should be as follows: First present the **descriptive statistics** of the study and control populations, then describe **tests of comparison** between and within populations followed by a description of **tests of association** to describe effects or relationship. Use global tests of significance for multiple comparisons before making pair-wise comparison (e.g. ANOVA v t-test).

Clearly identify the independent or predictor variables and the measured dependent (outcome) variables. State how average values are presented including any measure of central tendency (e.g. mean, median) and measure of scatter (SD, SEM, or CI). Know when it is appropriate to use these indices. State the statistical software used including its version.

Level of Statistical Significance: The last sentence in this paragraph should state what *p* value represents acceptable level of statistical significance, usually this is taken as $p \leq 0.05$. You should stick to the stated level of statistical significance. Do not give different *p* values such as $p < 0.001$, $p < 0.0001$, $p < 0.000$ in different parts of the same manuscript.

Table 4: Good Attributes of, and Common Errors in, the Methodology Section.**A Good Methodology Section Should**

- have a maximum of about 1000 words.
- describe concisely and faithfully what was done.
- provide enough details for the study to be reproduced elsewhere .
- use subheadings to clarify presentation.
- state the study design and method of data collection
- describe in clear terms the method of recruiting subjects
- address ethical issues
- clearly describe protocols and/or cite appropriate references for established methods and/or procedures.
- provide operational definitions of terms and criteria and define statistical terms, acronyms, symbols etc used.
- describe quality assurance of data.
- justify the statistical power and sample size, describe statistic parameters and tests applied ; and distinguish between descriptive and inferential statistics.
- describe proper use of parameters of measurements and levels of statistical significance or clinical effect/ importance.

Common Errors to Avoid in the Methodology Section

- Nontechnical uses of technical terms such as sample, normal, random, and significant
- Poor description of study protocols
- Mix-up in tenses, describing procedures in the present or future tense (carryover from proposals)
- Failure to describe and distinguish between independent and dependent (outcome) variables
- Use of multiple *p* levels of statistical significance
- Using means, SD, SEM, and t-tests for *non-normally* distributed data
- Inadequate description of statistical techniques
- Providing too little information on methods
- Mixing up information in methodology with that in introduction and/or results
- Too small a sample size, thereby decreasing statistical power. Failure to describe sample size and power calculation.
- Poor description and/or poor standard of selecting participants.
- Failure to include control group when these should be included
- Failure to describe data management and quality assurance
- Failure to revise the methodology section in the light of the data analysis and the results being presented

Characteristics of and Common Errors in Writing the Methodology Section.

Report the methods employed using the past tense. Many workers use active rather than passive voice to describe what was done but some journals accept both.

The *working methodology* section should be written before the study starts. When writing the manuscript, the methodology section should be revisited and revised (if necessary) to align it with the results reported. Not all the experiments carried out need be reported in a single paper. Delete aspects that are irrelevant to the current message.

Table 4 is a summary of the characteristics of the methodology section as well as commonly made mistakes.

5. WRITING THE RESULTS SECTION

Preamble: The results section is the heart of the paper. All the other sections revolve around it. The results section, therefore, needs to be addressed early, probably only after the earlier draft (in the proposal) of the methodology. The main purpose of the result section is to present and illustrate a *summary and distillate of the data* obtained in a concise, simple, and easy to understand manner.⁴⁻⁷ The sequence of presenting the results should be based on importance or chronological order. Results should be presented in a combination of narration (text), tables, and figures – *complementing one another and not duplicating information*. As much as possible summary results should be quantified such as N(%), mean (SD) with statistical importance indicated. Where possible results should be presented in same order as in the methods. The section should be structured with sub-headings and/or second order headings .

Structure of the Results Section

The results section can be organised in several ways, but particular attention should be paid to the journal style. Advisedly, the section should consist of a number of paragraphs (say six to ten paragraphs), each dealing with a specific idea or objective and consisting

of some narration and/or a Table or Figure. The Results Section usually proceeds from central/general findings to more specific findings.

Proceed as follows:

- The *first paragraph of the results section* should provide *basic descriptive statistics* of the study population (in a prospective study) and compare groups, if groups exist, such as sex, age, or other variables. Present the descriptive statistics in text, tables and/or figures.
- The next stage should depend on the number of research questions / hypotheses and the types of statistical analyses. Each hypothesis or type of analysis should have at least a paragraph to itself. Where several aspects are to be presented, you may provide a preview of the entire results in a preliminary paragraph before giving details of each subsection. Thus results involving t-tests, ANOVA, correlations etc should be presented separately.
- The *middle paragraphs* present the results of *tests/procedures* and outcomes. Sort results into categories, indicating measures of data variability.
- The next paragraphs should describe measures of *data validity and results of statistical analysis*. For a single outcome, indicate the effect of several factors for assessing clinical importance in addition to statistical significance.
- Exploratory Analysis and Incidental Findings*
It is not uncommon in the course of your analysis, to stumble onto interesting but unexpected findings. It is tempting to spend time and space on these sometimes interesting but incidental findings from results of “exploratory” analyses that were not predicted in advance. Resist this temptation. You may simply point them out, offer a brief possibility or two for why they happened, and indicate if they may be worth pursuing by future researchers in your recommendation.

Attributes of and Common Errors in the Results Section

A well written results section

- first presents demographics or simple descriptive statistics.
- describes the most important or primary outcome first, followed by less important results.
- uses a combination of text, tables, and figures to present the results.
- quantifies results with appropriate indicators of centrality, scatter, and probability and uses sound statistical tests and indicates statistical significance appropriately
- matches every result to a corresponding section under methodology.
- includes both test and control results; and states /accounts for losses or dropouts.
- focuses on results related to the objective/ research question.
- has a maximum number of Tables and Figures of about six and presents one result or idea in a paragraph and /or table, with each table or figure being able to stand alone.
- provides separate headings as in methods or by categories.
- has results written in the past tense
- uses words describing relationship of numeral/mathematical variables e.g. greater than, correlated with etc in an analytical study.

Common Errors to Avoid in Writing the Results Section and its Elements

In the results section make every attempt to avoid the following frequently made errors :

- Attempting to report all analyses including those unrelated to the thesis of the work;
- Comparing present results with those of previous reports (reserved for discussion);
- Using words like markedly, greatly, huge, robust;
- Using varying p levels of statistical significance;
- Using too many Tables and/or Figures and/or long or complex tables;
- Discussing and interpreting results (prematurely);

- Duplicating same results in text and tables or figures;
- Presenting raw instead of summary data;
- Missing data; and /or values in column and rows not adding up;
- Creating small tables or figure for data that may be better expressed as text;
- Data lacking units of measurements;
- Overcrowded tables or figures and improper use of symbols;
- Using statistics not described in methods; and
- Not following specified rules.

6. TABLES, ILLUSTRATIONS, AND ABBREVIATIONS

Most research publications contain a number of Tables and illustrations. Illustrations in manuscripts are principally in the form of charts, images, diagrams, graphs etc.^{7, 14, 15}

6a. Manuscript Illustrations, Captions and Legends

Figures or illustrations are used to demonstrate *relationships between variables* and/or aid visual appreciation.¹⁴ Figures in a manuscript should be used sparingly, being space- and cost-intensive. They may be in the form of graphs (most common), maps, photos, and technical diagrams. Graphs and charts (e.g. scatter plots, line graphs, histograms, and bar charts) aid the reader better than Tables in visualising trends in the data.

Graphs and charts should have *horizontal axis* (containing *independent variables*) and a *vertical axis* (containing values of the *dependent variable*, the effect or the outcome measured). Label the axes clearly showing the type of variables and units of measurements.

A descriptive *caption along with a legend* should be placed *below* a Figure. The legend should highlight what message the Figure is conveying. Figures should be able to stand alone without having to refer to the text. Remember to follow the journal and/or standard guidelines, otherwise follow the Vancouver style.⁷ Number Figures consecutively and in order of reference in the text. Provide foot notes in italics to explain units, symbols, discrepancies etc.

A figure should technically be of high quality, prepared in Photoshop or JPEG, TIFF or similar formats. It should be clear, concise, and informative. Colour graphs are not recommended for a manuscript; black and gray scale formats are to be preferred except generally for histological slides. You may need technical help here.

6b. Manuscript Tables

Tables appear more frequently in reports than figures. A manuscript Table consists of rows and columns; it is used when many variables are being reported and to complement rather than duplicate results in text format.¹⁵ *Every Table must have a simple descriptive title heading (placed above the table) and labelled consecutively usually in Hindu-Arabic numerals.*

A numerical Table presents a list of numbers and text in columns and rows. The Table *rows* should contain the *dependent measures* or their categories while the *columns* should contain *groups or independent variables*. A manuscript Table should be self explanatory and be able to stand alone. Tables should not be too big, with a maximum size of one page and ten columns. On the other hand Tables of only one or two rows should be avoided. Ensure that values add up correctly across rows and down columns. Provide foot notes in italics to explain units, symbols, discrepancies etc. Where indicated you should show statistical implications of comparisons.

6c. Acronyms and Abbreviations

Abbreviations used should be in conformity with the style of the journal and/or in universally accepted formats.¹⁸ Therefore, carefully read the journal instructions to the authors. You should use standard abbreviations instead of using full words e.g. kg instead of kilogram, *cm instead of centimetre* and *ml instead of millilitre*.

All non-standard abbreviations must be defined at first usage, thereafter use the abbreviation as appropriate. Provide a list of all non-standard abbreviations in alphabetical order with definitions. In a figure or Table always define the abbreviation in a foot note or legend.

Leave a space between numbers and units e.g. 5 ml, 30 ft, except degrees (86° not 86 °) and percent, 47%, not 47 %. Use a non-standard abbreviation for a term only when that term is used more than three times in the text, if less spell it in full at each use.

Do not start sentences with an abbreviation or acronym; the abbreviation should be spelt in full if it has to start a sentence. Alternatively recast the sentence to relocate the abbreviation within the sentence. Abbreviations should not be pluralised e.g. write *30 ml* rather than *30 mls*. Standard abbreviations such as kg, cm, and SD need not be spelt out except if using the abbreviated form would violate some other writing rules. In general, avoid use of abbreviations excessively and in particular avoid abbreviations in an article title, running title, and titles of illustrations or tables.

7. THE DISCUSSION AND CONCLUSION SECTION

General Comments on Discussion

The purpose of the discussion section is to *provide answer to the research question or hypothesis*. This is the section for doing a critical interpretation of the work and its findings. The data or findings make little sense if they are not properly interpreted and explained. The discussion section provides the opportunity to confirm or reject the hypothesis or provide an alternative hypothesis. The discussion should be written in a manner that flows.^{4,5, 7, 16, 17}

Start with a recap of the research question, providing an answer to the research question, explaining the findings and/or discrepancies and stating the importance, limitations, and future implications of the findings. You must link the conclusion with the objectives of the study using your results.

The discussion should be structured with appropriate subheadings, except if it is very short. Discuss the results step by step chronologically as in the objective and results sections. Alternatively discuss the major findings or outcomes first, followed by supporting but less important findings. Devote a paragraph or two to each subheading

without making the discussion too long, but it should not be too short either. A one- or two- paragraph long discussion cannot be taken seriously.

Generally the discussion should consist of five to eight paragraphs contained in about 20% of the manuscript text. The constituent paragraphs should be arranged in groups of **initial** or beginning, **middle**, and **concluding** subsections.

Initial and Middle Paragraphs of the Discussion Section

i. In the *initial paragraph/s* you should recap briefly the objective or research question. Then go on to provide the answer to the question posed in the last paragraph of the introduction by summarising the principal findings. Discuss specifically the principal findings as they address the research question, without recapitulating details of data from the results section.

ii. The *middle subsection* is where you *interpret* your results. You should provide support for, and defence of, your answers to the research question. Discuss your key results in relation to available information in the literature. Citing relevant works, compare and explain your findings. How are your results consistent or inconsistent with previous reports? Discuss any unexpected findings as well as any discrepancies with findings of other researchers. Make suggestions for any such disagreements found. You should then go on to state the clinical and/or scientific implication of your findings. You may offer a speculation here as to why these would be.

In comparing your findings with published ones you may use one or both of the following approaches: State your findings first, then compare these with those of others: *Our finding of influence of weight on glucose tolerance is consistent with...* or State literature findings first, then state how your current findings relate to them: *Previous studies (cite reference/s) have demonstrated the salutary effect of adding a small dose of thiazide to an antihypertensive regime. Our results confirm these findings in hypertensive diabetic subjects.*

iii. Next devote a paragraph to the limitations and weaknesses of the study without undermining the validity of your study.

iv. Concluding Paragraph of the Discussion Section

This is the real summary and concluding paragraph. It should be strongly written with a concrete message. Restate your principal findings and conclusions. State the clinical and / or scientific implication of the findings. Suggest the logical next step or future work (if indicated from the results). It is mundane to just say as many are wont to do that "more research is needed to confirm these findings".

Attributes of a Good Discussion and Common Errors

A standard discussion section while providing a non-numerical response to the research question should constitute about 20% in about 5–8 paragraphs of the manuscript text. This section should use appropriate *discussion terms such as causes, influences, outcome, consistent with, results, produces etc.* Here interpret and explain the findings without recapitulating the full data as well as discuss expected and unexpected findings. It is very important that in the discussion section the results are interpreted in the context of current literature, describing both conflicting and/or consistent results from the literature while acknowledging and describing the study limitations. Be systematic in going about this: stating sequentially summary of findings, interpretation of findings, comparison of findings with those in relevant literature, and conclusion.

The discussion should link the conclusion with the objectives of the study and provide a good terminal summary as the last paragraph with a reinforcing message.

Common Errors to Avoid in the Discussion

These include making the discussion being too long or too short and making too many speculations unrelated to current findings. Extensive literature review should be avoided as is combining or repeating results with discussion.

Do not bring into the discussion data not previously presented in the results section or excessively recapitulate results instead of making statements. Avoid providing too much information and being verbose. Lack of structure and/or sequence destroys the discussion.

Failure to discuss unexpected or discrepant findings or overstating the importance of current findings or too much emphasis on irrelevant and incidental findings should be avoided. Hiding results that are not in support of expected trend or failing to describe limitations of the study are common but should be avoided. The discussion fails if you do not deliver a clear message in the summary.

8. ACKNOWLEDGEMENT ELEMENT

The contents of this section should include recognition and appreciation of all those who contributed to the successful completion of the study and the writing of the manuscript. The details of suggestions for the content of this subsection can be found at the ICMJE website.⁷

This should include general support by a head of unit or department, financial and material support (state nature of support), secretarial or word processing, and intellectual input (data collection, critical review. Technical support should be acknowledged in a paragraph separate from that acknowledging other contributions where names are stated. It is your duty as the author to seek consent of such individuals to be so named, as such an association tends to suggest endorsement of the work.

9. REFERENCE CITATION LISTING

The main function of the reference section is to provide a list of works and sources related to your study. The style should be according to that of the journal but the Vancouver style⁷ is popular and is recommended for general writing.

The relevant issues concerning references in the manuscript include format and style, currency and number of references, selectivity or bias in citation, and citing unpublished work or abstracts of unpublished work. You may use a reference library programme such

as *End Note*, *ProCite* and *Reference Manager* to attach references to statement in text at a cost.

The Attributes of a Good Reference List

A good manuscript reference list

- includes only recent/relevant published papers.
- uses the correct format for a particular journal.
- cites original or primary sources – not just secondary citations mentioned by reviewers.
- in the text cites more of referenced ideas rather than names of authors.
- shows permissions sought to cite/quote unpublished data.
- cites accessible peer reviewed journals and books.
- cite references from potential referees.
- follows instruction on listing authors: first three or first six before adding *et al* or as instructed.

Listing references using the most common format – Vancouver style – should include names of authors, full title of paper, standard abridged name of journal (as in *Medline*), year of publication, volume, and inclusive pages.⁷

Common Errors to avoid in Referencing

The following mistakes commonly found in manuscripts should be avoided:

- Citing abstracts of unpublished works;
- Listing unpublished observations or personal communication or uncited references (although references to written, not oral communication, may be inserted in parenthesis in the text);
- Failure to verify references against original documents;
- Discrepancies between text references and reference list;
- Citing more than maximum number of references allowed;
- Failure to stick to one style of referencing;
- Inappropriate usage of the terms *et al*.

10. WRITING SEQUENCE AND PROPORTIONS

In the first part of this article the anatomy of a biomedical manuscript was

well outlined and its components briefly described. The sequence of writing the manuscript usually should follow a pattern but not necessarily as in the standard structure. You need to have results early; the rest of what you will write is largely dictated by your results. Table 4 shows a suggested sequence as well as the proportions of space or words to be allocated to each section or element of the finished manuscript.

These are mere suggestions; you may approach the problem in your own or other informed manner.

11. MISCELLANEOUS ISSUES

Table 4: Sequence of Writing and Proportions/Sizes of Manuscript Sections

Element	Writing Order	Approximate Size or Proportion
Title	8	Maximum 15 words
Abstract and Keywords	6	250 words
Introduction	4	3 to 5 paragraphs; 500–1000 words
Methods (final)	3	15% of text
Results	2	20% of text
Discussion	5	20% of text, twice
Acknowledgments	9	Introduction Short Paragraph or two
References	7	Maximum 30
Tables and Figures, plus summary statements	1	Maximum 6
Cover letter	10	One page

The following topics will be covered in this section: formatting the manuscript eligibility for authorship, duality or conflict of interest disclosure, plagiarism and other forms of misconduct.^{19–21}

Formatting the Manuscript

Before submitting, read the journal's *Instructions to Authors* again and carefully. Ensure that you have adhered to all the requirements of the journal. Some journals have a final checklist for you. Faithfully complete this.

Eligibility for Authorship

There has been controversy as to who qualifies to be labelled an author of

a manuscript. There are a variety of authors: *true authors*, *gift authors* (names inserted without making significant contribution to the publication) and *ghost authors* (those who write for others but are not named in the author-ship). True authors should be distinguished from other contributors who may be mentioned under acknowledgement.

The issue of who is eligible to be entitled to authorship remains unsettled,^{7,19-21} but the ICMJE⁷ has provided a useful guide, which states as follows: “*Authorship credit should be based on:*

- i. Substantial contributions to the conception and design, acquisition of data, or analysis and interpretation of data
- ii. Drafting the article or revising it critically for important intellectual contents and
- iii. Final approval of the version to be published.

To be a contributor that can be designated as an author, such a person should meet conditions i, ii, and iii. Acquisition of funding, collection 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 publication responsibility for appropriate portions of the content”.

Duality or Conflict of Interest Disclosure

Most journals now demand disclosure of possible sources of conflict of interest on the part of authors (and reviewers). Authors and assessors should declare any relevant duality of interest with a company whose products or services are directly related to the subject matter of study. Relevant duality of interest situations in the preceding one year that has to be declared may include the following amongst others: being an employee, board member, or stock shareholder, and receiving honoraria for services, and grants/research support.

Disclosure of duality of interest does not detract from being an author. The journal will only disclose the duality of interest when the paper is published.

Plagiarism and other Forms of Misconduct

The common misconducts and frauds encountered in scientific publishing are listed in Table 6. The scientific community frowns seriously at people laying claim to the intellectual product of others. Common infringements include gift authorship, redundant publication, fabrication and falsification of data and hiding conflict of interest. These issues are extensively covered in reference.⁷

You must do all in your power not only to avoid plagiarising the work of others but also not even appear to have done that wittingly or unknowingly. Plagiarism may be direct or mosaic. In direct plagiarism the whole or part of the work is transplanted without reference to the original work. In mosaic plagiarism plagiariser’s work is interlaced with unreferenced cuttings or segments from an uncited work. Excessive paraphrasing without referencing or inadequate acknowledgement of the work of others also constitutes plagiarism.

To avoid being an innocent plagiarist fully acknowledge the work of others. If you must lift a sentence or more, put them in quote and provide appropriate reference.

Copyright infringement is an offence related to plagiarism but probably more of a legal issue than a moral or ethical one. Most published works are copyrighted, note the copyright sign of © on them. The implication of such a logo is that whole use of Tables, Figures, paragraphs etc can only be done with permission of the copyright holders, usually the publisher and/or the authors.

If you use materials such as Tables, figures etc from another work without permission from the publishers even if with a reference, a copyright offence is committed. If you lift materials without citing authorities or obtaining permission plagiarism is committed.

Some publications allow full use and quotation without seeking permission, but you must give due acknowledgement and citation. Most people are ever willing to allow you use their materials especially for educational and professional benefits. Therefore, your threshold for seeking permission to use such materials

should be very low. This saves you the embarrassment of copyright infringement or worse still the sin of plagiarism. For more information on plagiarism and copyright infringement, and related issues visit the ICMJE website: www.icjme.org.⁷

12. COVER LETTER AND RESPONDING TO EDITORS/ASSESSORS

Having completed all the final checks on the manuscript, you can now send it out (these days) electronically to the editor of your chosen journal and hope for the best. It is good practise to introduce your *great* manuscript to the Editor; for this you need to do a covering letter to the Editor.

The covering letter should be short paragraphs, but highly recommending the fruits of your labour of several months. In your letter justify why the paper should be published in a particular journal. This is marketing, although the letter may not materially affect the fate of the manuscript. An effective cover letter enlightens the Editor on the implications of your finding. Do not, however, over-market the paper by making long explanations. You would make it look suspicious.

Table 6: Common Infractions in Scientific Publishing

Misconduct	Description
Conflict of Interest	Failure to state explicitly association with a product or service
Redundant publication	Publishing the same material in different peer-reviewed journals. Rule does not apply to publication of conference abstracts
Falsification	Manipulating results, difficult to detect by reviewers
Fabrication	Inventing or faking results. Results difficult to reproduce by other researchers
Plagiarism	Using other people’s ideas, writings, data or other works without acknowledging them

As in the rest of your manuscript, let the cover letter follow a format, with each of the paragraphs serving a particular purpose. The first paragraph should introduce the study and list all those who laboured to get it through but limit this list to deserving authors. In the second paragraph, explain the fundamental premises of the study and why the findings are interesting and their clinical and/or scientific implications.

In a third paragraph you may suggest five or more possible reviewers for the manuscript.²¹ The Editor may or may not use these persons but do not get in touch with such potential reviewers personally. You may also indicate in this paragraph researchers who may be excluded from reviewing the paper; you may or may not give reason for 'blacklisting' a particular person. On the other hand avoid forwarding the names of your friends, mentors, former colleagues or any other person whose disclosure may appear unethical to review the paper.

In the last paragraph or so of your covering letter comment on your duality of interest. You should also state or vouch that the study has not been published and/or is under consideration by another journal. It is considered unethical to submit an article to two journals at the same time. Determine the outcome with one journal before sending it to another one if the first port of call is not helpful, and this is common.

In addition to the running title, you may add the name of the journal to the header or footer of the letter but do not include your name in these locations.

13. SUMMARY AND CONCLUSION

Successful manuscript writing for a scientific journal should be the product of a good study design and statistical analysis. The final structure of the manuscript should follow the expanded AIMRaD format. The writing sequence should not be just as the AIMRaD structure but should start with the results or methods first, with the abstract

and title being the last to be written. Manuscript writers should be familiar with the general rules of effective communication and technical writing. Before submission of the manuscript the writer must ensure that the manuscript conforms with all requirements of the journal to which it is to be sent. The rate of manuscript rejection by peer-reviewed journals is high but your chances of success can be enhanced by following general rules as contained in this paper and those of your target journal.

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