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REVIEW ARTICLE

Writing Biomedical Manuscripts Part I: Fundamentals and General Rules

Rédaction Biomédicale partie Manuscrits I: Fondamentaux et au Règlement général

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ABSTRACT

It is a professional obligation for health researchers to investigate and communicate their findings to the medical community. The writing of a publishable scientific manuscript can be a daunting task for the beginner and to even some established researchers. Many manuscripts fail to get off the ground and/or are rejected. The writing task can be made easier and the quality improved by using and following simple rules and leads that apply to general scientific writing .The manuscript should follow a standard structure:(e.g. (Abstract) plus Introduction, Methods, Results, and Discussion/Conclusion, the IMRAD model. The authors must also follow well established fundamentals of good communication in science and be systematic in approach. The manuscript must move from what is currently known to what was unknown that was investigated using a hypothesis, research question or problem statement. Each section has its own style of structure and language of presentation. The beginning of writing a good manuscript is to do a good study design and to pay attention to details at every stage. Many manuscripts are rejected because of errors that can be avoided if the authors follow simple guidelines and rules. One good way to avoid potential disappointment in manuscript writing is to follow the established general rules along with those of the journal in which the paper is to be published. An important injunction is to make the writing precise, clear, parsimonious, and comprehensible to the intended audience.

The purpose of this article is to arm and encourage potential biomedical authors with tools and rules that will enable them to write contemporary manuscripts, which can stand the rigorous peer review process. The expectations of standard journals, and common pitfalls the major elements of a manuscript are covered. WAJM 2011; 30(3): 151–157.

Keywords: **IMRAD, Biomedical manuscripts, Guidelines, Structure, Rules, IMRAD, Scientific writing, Writing guidelines, Study design, Qualitative research, Primary publications, Secondary publications.**

RÉSUMÉ

Il s'agit d'une obligation professionnelle pour les chercheurs en santé à la recherche et de communiquer leurs résultats. L'écriture d'un manuscrit publiable scientifique peut être une tâche intimidante pour les débutants et quelques chercheurs établis. De nombreux manuscrits ne parviennent pas à décoller et / ou sont rejetées. La tâche d'écriture peut être rendue plus facile et la meilleure qualité en utilisant et en suivant des règles simples et conduit qui s'appliquent à l'écriture scientifique générale Le manuscrit doit suivre une structure standard: (p. ex. (Résumé) et Introduction, Méthodes, Résultats et Discussion / Conclusion. Le modèle IMRAD les auteurs doivent également comprendre les fondamentaux bien établis d'une bonne communication en science et en être systématique dans l'approche. Le manuscrit doit passer de ce qui est actuellement connu pour ce qui était inconnu qui a été étudiée en utilisant une hypothèse, la question de recherche ou de l'énoncé du problème. Chaque section a son propre style de la structure et la langue de présentation. Le début de la rédaction d'un bon manuscrit est de faire une bonne conception de l'étude et l'attention aux détails, à chaque étape. De nombreux manuscrits sont rejetés à cause d'erreurs qui peuvent être évités si les auteurs suivre les directives simples et des règles. Un bon moyen pour éviter les déceptions potentielles dans l'écriture manuscrite est de suivre les règles établies en général et ceux de la revue dans laquelle le journal est d'être publiés. Une injonction importante est de rendre l'écriture précise, claire, parcimonieuse , et compréhensible pour le public visé. Le but de cet article est d'armer et d'encourager les potentiels auteurs biomédicale avec des outils et des règles qui leur permettront de rédiger des manuscrits contemporains, qui peuvent supporter le processus rigoureux d'examen par les pairs. Les attentes des revues standard, et les pièges courants des éléments majeurs d'un manuscrit sont couvertes. **WAJM 2011; 30(3): 151–157.**

Mots-clés: manuscrits biomédicale, lignes directrices, structures, règles, IMRAD, l'écriture scientifique, des directives par écrit, à la conception de l'étude, la recherche qualitative, les publications primaires, secondaires publications.

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Abbreviations: IMRAD, Introduction, Methods, Results, and Discussion**; TAIMRAD**, Title, Abstract, Introduction, Methods, Results, and Discussion; **RCT,** Randomized Controlled Trial.

INTRODUCTION

The final rung of a successful research endeavour is dissemination of the findings to the scientific community. Such dissemination takes various forms such as presentation or abstract publication at a scientific meeting, as a monograph and as a full length article in learned journals. Of all the means of dissemination, publication in a peer-reviewed medium such as in a journal appears to be the most credible. The goal of most, if not all, researchers is to have their work published for the joy of it in a respectful outfit. For some, publishing research work informs progression or perishing. Unfortunately , a very large proportion of apparently completed research works cannot get into learned journals.[1,2]

There are several reasons why completed research works fail to get published. Some workers find it hard to be able to write up – even when failing to publish is at their own peril. Of manuscripts submitted, many are rejected.[3–7] Of those accepted editors and publishers often have to work hard at many flaws to make them become more reader-friendly.

The flaws in manuscripts leading to rejection arise from a number of causes such as laziness, ignorance, lack of or failure to follow simple guidelines and lack of or improper mentorship. Using simple guidelines and following rules in writing can help reduce such flaws and enhance chances of acceptance.

The objective of this article is to encourage researchers to write and to provide them with a simple guide that will aid them towards writing a publishable manuscript. We believe that following the rules and suggestions in this paper, your chances of getting your work published in a reputable outlet will be enhanced. Usage of the information here is without prejudice to what is generally available in the public domain and journals on writing medical manuscripts.[8–12] Rather the information here should complement those sources and instructions.

How to Use this Guide

The information here should be used as a guide. You may skip any part of the paper and jump to the section you find to be of immediate help as you craft your potential publication. You should for a good start, however, read all the preliminary fundamentals covered in Part I of this two-part paper before going on to address individual sections of a biomedical scientific manuscript. In the first part we shall discuss general aspects of pre-publication and the fundamentals of biomedical manuscript writing. In the second part of the paper we shall address the attributes and common flaws of the major components of a primary/research biomedical scientific manuscript. Qualitative research and secondary publications will not be covered in this paper.

Sources on Writing Biomedical Manuscripts

There are many sources of information on how to prepare biomedical manuscripts from technical and grammatical points of view.[8–13] Most journals provide information about their manuscript requirements. The details of such instructions may be short while others may be very long. It is mandatory for potential authors to consult their target journal before initiating writing as prescribed rules may vary considerably from one journal to another. This variation can create confusion in the mind of the beginner-author, who has, besides appreciating specific journal demands, to know some generic rules on scientific writing.

Of the resources providing help and information to biomedical authors, the ICMJE website[9] is a must-read. This website provides generic and quite detailed information on most features of biomedical manuscript preparation, peer review, and other aspects of medical publications. This should serve as free ready reference material for would-be medical authors and reviewers. The generic information obtained from these sources would need to be domesticated for your chosen journal.

There are several types of journals; these may be generalist journals (eg BMJ, WAJM, JAMA, NEJM) or specialist journals devoted to specialties such as Cardiology, Neurosurgery, Paediatrics, Biochemistery, Anatomy, and Psychiatry. Your choice of place for publication of your work should be partly informed by the audience you have in mind and the type of research you have conducted and thus the type of manuscript.

Types of Biomedical Research and Manuscripts

A biomedical publication derives from the type of research which generated the information for dissemination. There are two principal forms of biomedical research and thus publications, *primary and secondary research or publication*. A primary publication derives from actual research work while secondary research/publication summarises available studies in the form of meta-analyses and reviews. Primary scientific research publications may be further classified into *qualitative and quantitative* (analytical and descriptive studies.[14,15] Analytical studies test hypothesis while descriptive studies tend to generate hypothesis. Box 1 outlines the main types of biomedical studies/publications. In clinical research, two main forms are most common-observational and experimental studies. Observational works are in the large majority of published clinical research.

The fate of a manuscript dependents on the research design, execution, and the write-up of the manuscript. No matter how well written a manuscript is, if the study *ab initio* was poorly designed and/or executed, it is unlikely to be accepted by a journal of repute. On the other hand a well designed and executed study that is poorly written up will suffer the same fate.

Study designs for most clinical and epidemiological works are either observational or interventional (e.g. drug trials). Observational studies may be descriptive or analytical and range from case reports to cohort studies. Irrespective of the form of study or design, the biomedical manuscript resulting must have a rigid structure[2,9] to which you have to adhere , with some variation in details between journals.

THE STRUCTURE OF A BIOMEDICAL SCIENTIFIC MANUSCRIPT

A biomedical scientific manuscript has a particular structure with well

Box 1: Biomedical Study Designs and Manuscripts

PRIMARY RESEARCH

Primary Qualitative Research

- Participant observation
- In-depth interviews
- Focus groups

Primary Quantitative Research

DESCRIPTIVE STUDIES

- Case report
- Case serieso
- Survey
- Ecological studies

ANALYTICAL STUDIES:

Examine causal associations, to establish link between a predictor/risk factor and an outcome.

Analytical Non-experimental (observational studies):

- retrospective or prospective.o
- **Case-control/ Cross-sectional: Retrospective:** investigator works "backward" (from outcome to predictor)
- **Prospective Cohort Studies** (follow-up, longitudinal study): comparative, observational study in which subjects are grouped by their exposure status; optimal design for observational studies
- **Retrospective Cohort Studies:** All events including measurement of predictor variables, follow-up and measurement of outcomes completed as at time of study.

Analytical Experimental/Intervention Studies

- **Randomized Controlled Trials (RCTs):** interventions allocated randomly
- **Quasi-randomized. Controlled Experiment:** allocation done using schemes such as odd or even, date of birth order of recruitment.
- **Non-randomized Controlled Experiment:** allocation to different groups done arbitrary allocation, follows no pattern
- **Uncontrolled trial:** experimental group only (no comparison)

SECONDARY RESEARCH AND PUBLICATIONS

Reviews

Meta-analysis: A review article with quantitative summary ; combines results of several experimental studies.

defined sections and elements. Initially this structure (besides the title) consisted of the Introduction, Methods, Results, and Discussion sections, popularly referred to as the IMRAD approach.[2,9]

This core IMRAD model has now been expanded to include the title, authors, abstract, and keywords, introduction, methods, results, discussion, (*TAIMRAD)* and References. Generally the components of a biomedical manuscript are as shown in Box 2. Failure to adhere to a journal-prescribed structure is a common reason for manuscript rejection.

WHY MANUSCRIPTS GET REJECTED

The success or failure of the whole manuscript writing effort depends on some critical sections of the manuscript. Table1 summarises the frequent reasons why manuscripts are rejected. In the discussion that follows, each of the major manuscript components will be addressed in some detail, highlighting the standard that is expected of the section and the common major flaws that need to be avoided.[3–8,10,13,16,17]

Many of the reasons for rejecting manuscripts are rectifiable or avoidable if you pay attention to details, instructions and /or seek help when needed.[18,19] Before discussing each of the manuscript components (see Part II), let us briefly describe the strategy for initiating the writing of the manuscript and the general process leading to manuscript submission and publication.

STRATEGY FOR MANUSCRIPT WRITING

A scientific manuscript is a technical document emanating from a research work. The message intended to be conveyed must be solid, defensible, valid, original (new), verifiable, and the process reproducible. The presentation must follow an established order and sequence, there being limited room for creativity in writing style as in the works of art. You have to follow the established rather rigid order universally accepted.[3,9] As shown in Box 2. However, in initiating writing the manuscript, the sequence of writing does not usually follow the final rather rigid format of TIAMRAD. A possible sequence of developing a manuscript is as summarised in Box 3.

Remember to re-arrange the draft components into the traditional IMRAD format at first revision and keep same format at subsequent revisions. It is not easy to say how many revisions will be needed but this cannot be less than four. Revise the manuscript for gobal content and congruity between various sections, and check paragraphs for topic and supporting sentences and then paragraph by paragraph and then line editing looking for bad language, redundancies, and correct use of terms. It is a good practice to keep the paper away for some days after the first set of revisions before revisiting it.

Inputs from your coauthors (to be so qualified) must be made. With some authors, the parts of the paper are shared out with the senior or corresponding author doing the co-ordination and harmonisation of inputs from both coauthors and third parties. Third party input which may be grammatical, contextual or statistical is very important

Box 2. Core Components of a Biomedical Research Manuscript

Title page
- **T**itle, Authors and place of study etc.

Abstract and Keywords

Manuscript Body
- **I**ntroduction
- **M**ethods (Subjects, Materials, and Methods)
- **R**esults (and)
- **D**iscussion / Conclusion
- **R**eferences
- **A**cknowledgement

Additional issues, Sections and elements /style
- Conflict of interest
- Abbreviations
- Units of Measurement
- Tables and Illustrations
- Running Title

Manuscript Submission and Beyond
- Cover letter
- Responding to criticisms of editors and reviewers

Table 1: Frequent Reasons for Manuscript Rejection

Manuscript Element	Frequent Flaws
Research Question or hypothesis	Weak or Lacking
Ethical issues	Unethical, or no ethical clearance
Relevance	Lacks relevance to practice or science
Usefulness	Publication of little application
Originality	No new or useful information
Incongruence	Between various parts; especially results and conclusion
Study design	Inappropriate for research question or not described
Methodology	Ambiguous methods: Too many methodological errors, inadequate description. Disorganised study design
Data Quality	Poor. Problem with sample size and inadequate power
Results	Ambiguous
Salamasation	Study published in bits in a bid to increase number of publications from same study
Organisation and Language	Poor organisation, major language problems , poorly written, spelling errors etc
Target Journal and Audience	Manuscript not compatible with the journal's goals or audience
Guidelines and Instructions	Failure to follow generic and journal guidelines
Statistics	Inappropriate statistics used
Cohesion	Lacking; poor flow and illogical
Discussion section	Too long discussion
Definition of terms	Inadequate or lacking
Response to reviewers' suggestions and criticisms	Ignoring or over-contesting reviewers' suggestions.

as this may be an unbiased criticism . Whatever inputs are received the group or senior author must decide what to accept and incorporate and what to reject. Before rejecting third party input remember that you are writing for an identified audience and not for yourself or your group. Some general tips will help you address your readership more than yourself or your group.

MANUSCRIPT FUNDAMENTALS AND WRITING TIPS

Before discussing each segment of a standard manuscript, some general aspects of good writing deserve emphasis.[2, 5, 12, 19, 20]

a. Initial Issues

- Have a well designed study
- Remember to write for the audience not for yourself.
- Having analysed your data, construct a clear message for your audience.
- Reduce the message to *one sentence*. Do not send too many messages in one manuscript.
- Keep the manuscript simple, short, but succinct and acknowledge study limitations.

b. Manuscript Sections

Use the extended core TAIMRAD model to organise the main work. For each section, provide an outline that will guide your writing process. The section should be proportionately related. The introduction should be the shortest with the methods or results being the longest.

c. Paragraphs and Elements of Writing

Provide a *topic sentence* for each paragraph. Each paragraph should be concerned with only one concrete idea or message. One sentence should convey just one thought about an idea.

Write simple sentences: subject – verb – object pattern and do not start sentences with numbers in Hindu-Arabic or acronyms.

Box 3. Sequence of Writing up draft of a Research Manuscript

Stage I: Pre- writing Events

- Identify a problem.
- Frame a research question or hypothesis or objective.
- Write a proposal with good design and get approval.
- Complete data collection and management and statistical analysis.
- Identify your target audience and choose a journal.
- Set time frame to complete writing manuscript parts or phases.
- Use appropriate software and/or consult a statistician .

Stage II: Writing the Body of the Manuscript

1. Generate Tables and Figures from raw or summary data.
2. Using the Tables and Figures, construct summary statements or paragraphs.
3. Review and edit Tables and Figures.
4. Draft the results section using summary statements/paragraphs linked to the Tables and Figures.
5. Complete writing the Results Section. Select and present only main results that deal with intended message or research question.
6. Update the methods section (from study proposal satge) with emphasis on those methods dealing with results intended for current publication.
7. Write draft of the discussion and conclusions.
8. Introduction: Write the introduction after results for publication are known or decided.
9. Title. Final Title and Abstract should be last parts to be written.
10. Revisions: Revise several times until you are satisfied.
    a. Revise draft with parts in standard or journal order including references.
    b. Do second and further revisions of draft.
11. Seek opinion of coauthors and third parties. Assess feedback . Discuss and then do a final revision, incorporating or rejecting suggestions.
12. Final Actions
    - Write Final Title
    - Write Conclusion paragraph of discussion.
    - Write Abstract , including keywords.
    - Keep the manuscript away for some time.
    - Read it all over again and do your last revision including proof reading by you or third party.
    - Finally do a target journal checklist and be ready to submit.

III. Post-manuscript writing.

- Write a covering letter to the Editor.
- Submit manuscript with the covering letter and await response.
- Respond to assessors' comments

d. Manuscript Flow

Make a connection between end of one sentence, paragraph or section and the next, making the transition clear especially in the introduction, results, and discussion

This provides cohesion for the whole manuscript.

e. Specificity and accuracy

Say exactly what you intend or mean. Beware of improper use of such terms as 'they' or 'it' without being clear which nouns they represent. If in doubt repeat the concept. Say man instead of male (could be boy), dog instead of just saying an animal. Avoid weak expressions like 'may be concluded'.

You have to be thorough in writing and revising. Ensure accuracy of references with original sources and that numbers in abstract, text, tables, figures, legends, and text are consistent and correct.

f. Some Elements of Style Grammar and Syntax

The language is very important. The paper should exhibit correct usage of grammar and syntax. If in doubt seek help. Some journals ignore the language errors (to be addressed by copy editors) at the review stage but others may turn down your paper for this reason. Certainly not many reviewers are happy to battle with poor language. You may improve your grammar by reading or consulting simple short classics on style[12,20] to help you write better.

Use appropriate tenses and voice in the different sections. Describe *known facts in present tense* as in the first paragraph of the Introduction. In the *Methods section*, use *past tense* to describe what you did and in the *results section*, describe results of your current work in the *past tense.* Use third person and first person forms appropriately First person should be used infrequently , only to describe things uniquely done by you. Use active voice more often than the passive voice but in writing up the methods many authors use mostly third person passive voice. Learn to have an appropriate mix of use of person and voice. Ensure that nouns have appropriate verbs.

g. Parenthesis and Punctuations:

Avoid double parenthesis e.g *This is shown from the review, (fig 4) (ref 3)* should be recast as *Figure 4 shows — (ref 3).* Avoid unscientific punctuations such as an exclamation mark (!) or excessive punctuations.

h. Other Style Issues .

Keep a check on **redundancies and wordiness. W**ords or phrases that do not contribute to understanding should be avoided or removed e.g. expressions like *in order to, a study of*, etc add little information. As

always, pay attention to spelling, clarity and appropriateness of sentences and phrases. Ensure that you keep the manuscript simple and short. Do not exceed limits set universally or by your target journal.

These universal tips and rules should make your manuscript potentially publication-ready.

MANUSCRIPT PUBLICATION PROCESS

Original primary publication emanating from a research endeavours must undergo what is popularly referred to as the *peer –review* process before it gets published.[8,9,21–24]

In the peer review process, the editor sends the manuscript to (usually two) experts in the area for assessment. The fate of the paper depends to a large extent on the recommendations of the assessors, although sometimes editors may disregard or upturn recommendations from assessors.

A peer-review process typically works in the following manner:

a. The manuscript is submitted to the journal (most submissions are now electronic)
b. The journal sends acknowledgement and staff assigns an ID number.
c. The manuscript is then forwarded to an editor or editor-in-chief for a preliminary evaluation. The manuscript may be rejected at this stage.
d. If it scales the screening process, the paper is sent with the journal guidelines on assessing a manuscript to two or three experts in the area .
e. Reviewers are given two to four weeks to assess and make recommendations. This assessor-phase is the most difficult for many journals and causes the greatest delay in the process.
f. Recommendation: Assessor's summary recommendation is usually in one of the following forms:
   i. *Accepted outright or with minor typographical corrections* that can be dealt by the editor or publisher. This is a rare recommendation/outcome.
   ii. *Accepted with minor corrections, to be effected by the authors* and for the editors to vet. This is the most common form of recommendation for contributions with some hope of getting published.
   iii. For major revision, to be re-submitted to the assessor.
   iv. Outright rejection

Recommendation categories ii and iii require response from the author. It is important that you take the criticisms seriously and fully incorporate the suggestions of the reviewers and/or editors in the revised manuscript. Of course you do not have to accept all the suggestions. If you disagree with any suggestions, politely give a reason in your response why you do not agree with the suggestion. It helps the ditor and/or reviewer who is to re-assess if you itemise the criticisms along with your responses. You should also tell the Editor if any suggestions were helpful.

g. Once corrections are effected to the satisfaction of the editor and/or the assessor a letter of final acceptance is issued by the Editor.
h. After the acceptance, publication fees may be paid, copyright letters effected as well as any other necessary formalities. Note that some journals charge processing fees in addition to the final publication or page fees.
i. All accepted papers are subject to copy-editing for grammatical errors and to make them fit into the style of the journal.

The interval between first submission and final acceptance usually takes about three months. Another period of three to six months may expire before the article appears in the print version of the journal. Some journals publish the article at their website as ahead of print publication.

ELEMENTS STANDARDS AND COMMON ERRORS

The second part of this article will address these aspects.

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