

The Art of Research and Scientific Writing in the Clinical Sciences: A Practical Guide

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Clinicians have a greater impact in academia when they demonstrate mastery in both clinical and research domains. However, planning a research project and writing a manuscript are among the most intimidating and difficult activities for the clinical faculty. This manuscript aimed to provide a thoughtful and informative description of the fundamental elements of research and essential writing guidelines of a scientific paper. This document was created using personal experiences and literature guides related to research and scientific writing. The article provided stepwise guidelines and pearls to help the clinical faculty, residents, and medical students improve their research and writing skills. This manuscript outlines the essential steps of research and scientific writing. It provides an informative introduction to the fundamental elements of scientific writing guidelines. This initiative is expected to enhance the faculty's research and writing abilities. At the same time, the information should benefit the residents and medical students with their research projects.

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Research and scientific writing are demanding and time-consuming. Planning a research project and writing the manuscript are among the most intimidating and challenging tasks for the clinical faculty. Most clinical faculty members and trainees have not received training in scientific writing (1). Most of them have been involved in little or no research. Those who lack experience or formal training need to develop research knowledge to refine their writing skills (2, 3). Residents should have a dedicated research rotation with a specific curriculum and adequate faculty mentorship (2, 4, 5). Due to their clinical workload, the clinical faculty often consider research and scientific writing secondary activities. However, clinicians have a greater impact in academia when they demonstrate mastery in both clinical and research domains. Publishing productivity has been regarded as a key objective measure of academic achievement, influencing promotion and academic rank (6-9). However, this should not be the principal motivation for a publication. The primary goals of publishing are to advance scientific knowledge and enhance patient care by influencing current clinical practice (1).

The objective of research is to formulate and test hypotheses, draw conclusions, and teach them to others. Research is a systematic and focused investigation aimed at developing or contributing to generalizable knowledge on a specific topic or issue (10). Every research can potentially make a significant contribution to the scientific community (11). Writing is an instrument of communication and provides a permanently recorded document. A scientific paper is a written report that describes original research results (12). The purpose of scientific writing is to have an idea, perform an experiment, and present the results and conclusions in a report. With the report, you will share and disseminate knowledge to the scientific community. Scientific writing unites specialists from diverse cultures and countries (8). You should write a scientific manuscript in a format that allows readers and reviewers to follow and learn from it (13). Essential qualities of a good research paper include originality, specificity,

attainability, authenticity, clarity, conciseness, coherence, accuracy, measurability, precision, verifiability, generalizability, and proper formatting (14). A published article is the culmination of an idea that becomes a reality (15).

The objective of this manuscript was to describe the essential stages of developing an investigation and the steps for writing a good scientific manuscript. This review provided a thoughtful and informative introduction to the fundamental elements of scientific writing guidelines. The document was created using the author's personal experiences and literature guides related to research and scientific writing. A schematized outline described the key concepts to achieve the study's objective. The University of Puerto Rico Institutional Review Board (IRB) evaluated the protocol (2504391255) and determined that IRB oversight or approval was not required.

Steps for successful research

The most common types of research and scientific writing include basic science research, clinical research, case reports, short communications, literature reviews, systematic reviews, and reports on procedures and techniques. A literature review integrates information from multiple articles about a topic. A systematic review is a high-level research on a specific formulated research question. It systematically identifies, selects, evaluates, and synthesizes all high-quality research evidence relevant to the research question to provide an answer. Systematic reviews employ statistical methods that combine data from the selected individual

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research studies and utilize the pooled data to reach a conclusion. Meta-analysis is a statistical approach used to integrate data from multiple studies for a systematic review and to produce a summary result. Register systematic reviews in the Prospective Register of Systematic Reviews (PROSPERO) database to prevent research duplication.

Pursuing a project that interests you is crucial, as you are expected to devote much of your free time to the research. Scientific writing is often a solitary work. As a first author, it is recommended to focus on one or two articles per year. Research involves several essential steps. First, you must formulate a scientific question and develop a hypothesis. Then, you need to conduct a background search and design an experiment to either prove or refute your hypothesis. You will then collect data, analyze the results, test the hypothesis, and present an answer to your scientific question. Lastly, you must publish the findings. Research is not completed until it is published.

1. Orientation and Planning:

The initial step for any research is establishing a question or research idea (16). For the research idea, perform a literature search and explore the topic. This search will inform you if a comparable study has been previously conducted or reported. The answer to the question can add new information to the topic's current knowledge or confirm a previous observation. You can confirm or strengthen the existing body of literature in a given field. You must establish the purpose of the research project and clearly define the specific questions and objectives you aim to address. You need to develop a justification for the study. Research must provide novelty or, at the very least, explore a question from a different and new angle. Explore the feasibility of performing the study. Seek input from your mentor and experts in the field. Determine the sampling method to be used for the study. Prepare a research proposal describing how the problem will be addressed (17, 18). Most studies require IRB evaluation and approval. The investigators must adhere to all relevant ethical regulations regarding the use of humans and animals.

2. Data Collection and Preparation:

To collect data, create data extraction tools. After the extraction tools are developed, begin extracting data from medical records or the experiments that have been performed. Ensure consistency and accuracy in data compilation.

3. Data Analysis and Interpretation:

Organize the collected data to ensure an adequate analysis. Utilize appropriate statistical methods to support or reject your research questions. For complex data analysis, a statistician is recommended.

4. Manuscript Preparation:

Determine the readership you will be writing for (19). The readership could be specialty-oriented, general scientific, or non-scientific. The readership will have some control over the manuscript's structure. Review the journal's aims, scope, and author guidelines to which you plan to submit the manuscript. You must perform a thorough literature search to write a solid

background of what others have done and to compare your results with those already published. When reviewing the literature, preparing notes of essential points or phrases that may later be used for your manuscript introduction and discussion is valuable. Most scientific papers should include a title, an abstract, an introduction, materials and methods, results, discussion, and a conclusion. It is crucial to write a compelling introduction that captures the reader's attention. The methods section provides a detailed description of how the research was conducted. In the results section, you must report all the data obtained, including the statistical analysis, but without any interpretation or discussion of the results. In the discussion, analyze the significance of your results, compare them to those in the literature, and explain their importance. In the conclusion, present the study's key findings and inform the readership about how your paper contributes to the existing literature. Write the abstract last to summarize the study concisely and clearly.

5. Editing and Proofreading:

The key to successful writing may lie in the editing process (20). After finishing your first draft of the manuscript, revise and polish it. With multiple writers contributing to the text, inconsistencies in language are likely to occur, particularly in word choices, sentence lengths, and sentence variety (21). The principal author should edit all sections to maintain consistency. Re-read every section several times, from start to finish, to maintain a logical flow of ideas. The goal of a successful manuscript should be for the text to flow smoothly from sentence to sentence and paragraph to paragraph. Begin the subsequent sentence by establishing a connection with the previous one. Ensure that a common thread ties each paragraph to the preceding one. Decide the order of authorship based on the significance of each author's contributions. The senior author is frequently listed last. Share the manuscript with your colleagues for feedback. Your colleagues can provide critical suggestions on how to improve the manuscript. Before sending the final manuscript to a journal, all authors must thoroughly review and approve it.

Detailed Manuscript Components

Each manuscript component should be created and completed by answering specific questions. Detailed sections of the manuscript are described below, commencing with those particular questions in mind. Artificial intelligence helps correct grammatical errors and improve clarity, enhancing readability. However, it should not be used to generate scientific text, as this would compromise the integrity and authenticity of the research process and academic writing. The structure format is usually based on the "IMRAD" structure, i.e., introduction, methods, results, and discussion (22). The manuscript's sentence structure should be in the third person (22).

Title:

What is the research about?

The title is the most important phrase of the manuscript and must accurately describe the paper's content (23). Write the title with the fewest possible words. A short title is easier to understand and can attract a broader readership, thereby increasing the paper's influence (24). Shorter titles receive more citations per manuscript

(24). The reader should be able to discern the article's content from the title. A well-written title is balanced in being informative, accurate, and concise, while also attractively conveying the main topic and emphasizing the importance of the study (25). Titles written as questions may be ambiguous; therefore, use them sparingly. However, they can be used in a review article that discusses controversial issues (25). The final title should be unambiguous, unique, captivating, and informative (25). Do not repeat titles used previously in the literature.

Introduction:

What is the problem or topic?

What is known and what is unknown?

What hypothesis did I want to test?

What did the study aim to accomplish?

Why is the study important?

The introduction must clearly present the problem and the purpose of the experiment, summarize the topic's background, identify knowledge gaps about the subject, state the research question or hypothesis, and express the objectives and expectations (14, 26-28). The introduction typically consists of one to three paragraphs. The introduction can be constructed using a funnel or an inverted pyramid model, where the largest part of the funnel at the top documents the general topic and the importance of the study; the funnel then narrows down to present the gap of knowledge, and ends with the aim of the research and the methodological approach used (27, 29, 30). The introduction should begin by familiarizing the reader with the problem and the need for the current study, thereby capturing the reader's attention and interest. Write a concise background of what others have done that relates directly to your experiment. This background should include key literature relevant to the topic or problem. However, it should not include a very detailed review of the literature or include well-known facts. Citations should be selected from recent papers with higher impact factors (31). State what information is unknown to demonstrate that your research is unique. Briefly describe the methodological approach used for the study. The introduction should conclude by clearly stating the primary and secondary objectives, so the reader understands the problem being investigated and the direction the paper is taking. Use the past tense to express the study's aims; however, some authors prefer the present tense.

Methods and Materials:

How was the research done?

What methods for statistical analysis were used?

Present the methods in chronological or logical order. Use the past tense to describe what you did. You may use subheadings if appropriate. The subheadings may comprise study design, data collection, and statistical analysis. A well-organized section permits other scientists to assess the study findings and repeat the experiments (32). Describe the study's design. Identify the study population, materials used, and study period. Specify the study inclusion and exclusion criteria (22, 32). Write a characterization and definition of the materials, methods, and measurements used. Describe how the data were gathered. If the study was randomized, describe the process used for randomization. State

if the investigation included a control group. Describe all the statistical tests utilized and specify the significance level used. Robust statistical analysis reinforces the credibility and validity of the results (33). Mention the IRB used and declare that the study complied with all relevant and ethical regulations (32). Confirm that informed consent was obtained from all subjects involved. This section should contain enough detail to repeat your study and reproduce the results. Science that others cannot verify is not worth publishing (33). The ultimate purpose of this section is to provide clear and precise descriptions that enable readers to ascertain precisely how the authors executed the experimental design (34).

Results:

What were the data and results?

What were the data analysis results?

The results section should communicate the facts, measurements, and observations collected (22). The results should be concise yet precise, avoiding excessive wordiness. Results may be presented in chronological order, general to specific order, most to least important order, or may be organized according to the topic/study groups or experiment/measured parameters (35). Present all the results in the past tense. Many authors begin with this section when writing a paper (33). When presenting a large amount of data and findings, organize the results section using separate headings (35). Results should be summarized in tables and figures. The use of tables and figures might improve the understanding of the results. However, repetition should be avoided (22). Don't simply repeat data included in the body of the text. The most critical data are usually presented in both formats (36). Tables should be self-explanatory. Maintain a clear table and avoid crowding too much information into a small space. Complex tables are difficult to read and should be kept to a minimum. Use tables for data such as baseline characteristics, outcomes, and treatments, where the same variables are described across two or more groups (37). All tables or figures used must be referred to within the body of the text (22). Tables and figures should be labeled appropriately with titles and the correct units. If you have very little data to present in a table, do not use a table and include the results only in the body of the text. For normal distribution data, report the mean and standard deviation. Use the median and interquartile range for data with non-normal distributions. Do not interpret the results or compare the results with those of previous studies in this section (35). A short or incomplete follow-up period can confound the interpretation of results (33).

Discussion:

What did the results mean?

Did the results yield a new finding?

How do your findings compare to those of others?

Are there any practical implications of your work?

The discussion should include five major topics: interpretation of the essential findings from the data; presentation of the meaning and implications of the findings; comparison of the data to the literature; statement of the strengths and limitations of the current study; and declaration of the clinical or scientific importance with suggestions for future research (38, 39). Write the discussion in

the past tense except for the future recommendations. Shorter discussions are easier to read; thus, write with an economy of words and avoid repetition. Try to use the active voice to make your writing more precise, explicit, engaging, and easier to follow. The active voice identifies the person or thing performing the action described in the sentence. Begin with a concise paragraph that summarizes the study's key results and indicates whether they support or reject the hypothesis. Do not repeat your results. Summarize the results as a whole, rather than presenting them individually. The data must provide sufficient evidence to support key conclusions. It is crucial not to show results for the first time within the discussion section (22). Address the study's objectives and discuss the significance of your results. Describe the outcomes and explain how your results correlate to the literature cited in your introduction. Mention congruities and discrepancies between your results and those previously published. Discuss possible reasons for unexpected findings. A well-conducted study that yields no positive results is still a valuable contribution to the current body of evidence (37). Articles documenting negative results should be reported. Results that fail to show a significant difference do not imply that there is no actual difference; this may be due to the study design.

Present the implications and applications of your results. No study is perfect, and every study has limitations (39). Write a statement acknowledging the study's limitations. This declaration allows readers to realize that you are aware of your shortcomings and provides an opportunity to defend yourself on specific points (37). Describe what additional investigation may need to be pursued based on your research. The statement about additional studies can be included at the end of the conclusion section, rather than the discussion. Avoid making unsupported opinions or interpretations. For case reports and literature reviews, include a table summarizing similar case findings. Occasionally, the last paragraph of the discussion serves as the conclusion, summarizing the findings and presenting future research work.

Conclusion:

What hypotheses were proved or rejected?

Why does the study make a difference?

Summarize the conclusion of the paper in three to four sentences. The paragraph should be impactful yet concise, providing the reader with a clear understanding of the significance of your work and its potential implications (33). The conclusion should present the study's final message. Do not extend your conclusions beyond those directly supported by your results. Avoid speculation. Close with a statement indicating how the study contributed to the existing literature and providing suggestions for future investigations. Avoid making general statements about the necessity for more investigations; instead, provide clear recommendations for further studies (39). Do not include citations in this section.

Abstract:

How can the study be summarized?

Do the abstract last to present a condensed version of the manuscript. The abstract is a summary of the article and is typically structured into "background/objective, methods,

results, and conclusions" (22, 40). An abstract has three main functions: it provides a summary of the paper, "sells" the paper to editors, reviewers, and potential readers, and helps with its indexing (40). The abstract should concisely state the principal objectives, the scope of the investigation, the basic methods used, the results obtained, and the principal conclusions. Do not include a discussion section. Include enough information that a reader searching the literature can evaluate the article's scientific value and assess if the paper is worth reading. The editor's decision to proceed to the peer review process is often based on the clarity of the information presented in the abstract (41). Reviewers usually use the abstract to decide whether to accept or decline a journal's invitation to review (41). Observe the word count limit, which is typically 250 words. Do not include citations in the abstract. All the information in the abstract should be included in the main text of the manuscript. Determine whether the manuscript requires a structured abstract with sections or an unstructured abstract (42). Unstructured abstracts require a logical flow of sentences. Write the abstract in the past tense, primarily for the methods and results. The objective and conclusion can be in the past or present tense (40).

Keywords:

Which words can be used to search the manuscript?

Choose five to six keywords that will be used for database searches. Write them in alphabetical order. Try to avoid using words included in the title, as these will also be used for database searches. The judicious use of keywords can make it easier for interested scientists to find the article in a database search (22).

References:

What were the sources used?

References chosen must directly relate to the study's question. A good citation enhances the paper's scientific reputation and makes it more useful to the reader (43). Citations help readers understand the work, justify the conclusions, and assess the novelty and scope of the manuscript (44). Always cite the original reference. Secondary referencing is not a good academic practice and does not give credit to the original author. To avoid inaccurate quoting, the authors should review the original article to check the facts (43). The most important and recent sources should be selected for citation (31, 43). Before submitting the manuscript, perform another literature search to identify relevant articles published after your initial inquiry (20). Prepare the reference list in alphabetical order or the order of appearance, as specified by the journal guidelines. Confirm that all references in the manuscript are numbered correctly. Late additions during editing and revisions will alter the original order. For most journals, only the first three authors, followed by the abbreviation et al., are mentioned.

Pearls for Scientific Writing

- Designate a writing schedule.
- Devote adequate time and concentration to the article.
- When working with other members, define individual roles before beginning the study.
- Write an outline to help organize your ideas.
- Develop a framework to insert information in an organized and systematic manner.

- The best writing is simple and direct. Seek brevity, clarity, and precision.
- Use simple and short words. Create sentences that are easy to read.
- Avoid repetitions of words within a sentence.
- Be sure to use proper English. Do not overlook the importance of grammar.
- Common errors involve commas, apostrophes, prepositions, using 'this' alone, incorrect similar-sounding words, wrong verbs, wrong tense, subject-verb agreement, sentence fragments, and incorrectly joined sentences.
- When beginning a sentence with the word 'this', include the subject to which it refers.
- The word 'however' is preceded by a semicolon and followed by a comma to separate the ideas within a sentence. Do not use 'however' or its synonyms more than once in a single paragraph.
- When using the words 'which' or 'that', use 'that' when the information is needed to understand the sentence, and 'which' when the information is supplementary.
- Employ consistent tenses throughout the text.
- Do not use words that readers can interpret in multiple ways.
- Avoid terms like 'recently', as they can quickly become outdated.
- The words "criteria" and "data" are plural. Criterion and datum are singular. Use the correct verb tense for these nouns.
- Don't over-explain your findings.
- Discussing the findings and significance of the study using words like 'support' or 'suggest', rather than 'prove' or 'means', is recommended.
- Utilize short or medium-length paragraphs that contain 5-10 sentences.
- Define abbreviations at first mention. Write out the full name followed by the abbreviation in parentheses. If a word is used only twice, do not abbreviate it.
- Do not use an abbreviation at the beginning of a sentence.
- Numbers under 10 should be spelled out, whereas numbers over nine are written in figures. However, if a number starts a sentence, it should be written as the word.
- Place a space between numbers and units.
- Cite any statement or fact that does not originate from the authors.
- Do not copy phrases directly from articles.
- Figures benefit from arrows to guide readers to their most important aspects. Arrows should be described in the figure legends.
- For histopathological figures, the magnification should be noted.
- Illustrations should have arrows and annotations.
- Tables contain titles above them, while figure legends are placed below the figures.

Manuscript Submission Strategy

After the manuscript is finished and proofread, submit it to a relevant journal. Select a suitable journal based on the manuscript's context. Acceptance rates are typically low in prestigious journals, as they are very selective. However, it is

important to choose journals that are indexed in major databases. Also, consider the journal's impact factor. Always include a cover letter to the editor indicating the work's importance, novelty, and relevance. There are three principal publishing options. For the subscription-only option, the authors do not have to pay a publication fee. However, the manuscript will only be available to subscribed readers in the print or online version. For the open-access option, the authors pay a publication fee, and the manuscript will be freely available to all readers. In a hybrid journal, authors can pay a fee to make their work freely available or opt for a subscription-only publication.

Beware of submissions to predatory journals. Predatory journals offer a highly problematic open-access publishing business model that manipulates the peer-review system. They charge publication fees without providing adequate, transparent editorial services, posing a substantial threat to the integrity of scientific research. Avoid citing from predatory journals, as they can underrate the validity of your work (43). Consult Beall's list of predatory journals before deciding which journal to submit your manuscript to (45).

The editor's decision can take several days or months due to the peer review process, which experts in the relevant topic area conduct. The primary functions of the peer review process are to help maintain standards and ensure that the reporting of research work is as truthful and accurate as possible (46). The following characteristics of the manuscript are relevant to reviewers and might influence their recommended decision: clarity, readability, organization, technical quality of the paper, appropriate title and abstract, proper use of figures, accurate tables, helpful discussion and conclusion, and length of the paper relative to its practicality (14). Infrequently, a manuscript is accepted without revisions, as reviewers often suggest recommendations to strengthen the study's scientific presentation. If the manuscript is accepted, do a meticulous proofreading of the proofs sent from the editorial office. Review for errors, make corrections, and perform any final editing. Place particular focus on the tables, which may have been reformatted or adjusted to comply with the page and column size. The proof offers the last opportunity to make changes.

The editor may recommend a revision of the manuscript. This decision provides an additional opportunity to produce a high-quality manuscript of scientific value. Thoughtful comments from reviewers led to refinements in the manuscript's presentation in several ways: improved writing clarity, enhanced descriptions, a more thorough discussion of relevant literature, clarification of methodological limitations, and downsizing of overly broad conclusions (46). Use the reviewer's comments as constructive feedback. Revise the manuscript as soon as possible to keep the work fresh in the reviewers' minds. An effective response to reviews includes expressing gratitude for the review and for the suggestions provided. Be specific in your responses to the reviewer's recommendations. Respond and address all points raised. Do not ignore difficult points. If pertinent, delete unnecessary information and shorten sections of the manuscript. With the resubmission, include another letter to the editor that details, point by point, how you have addressed the reviewers' concerns and recommendations. Clearly explain any disagreement with a reviewer's comment.

The principal reasons for rejection include insufficient statistical analysis, overinterpretation of the results, an inadequately described population, a small or biased sample size, an incomplete review of the literature, inadequate tables or figures, and a poorly written text (47). If the editor rejects the manuscript, the author should value the efforts of the reviewers and the editor. The journal editor will frequently provide a statement containing the reasons for the rejection and some recommendations for improving your manuscript. Utilize that guidance to revise the manuscript and consider submitting it to another journal. Sometimes, the editor may offer journal transfer recommendations that provide a rapid transfer without making extensive manuscript reformatting. The authors should decide if they want the manuscript reviewed at one of the recommended journals. Persistence and determination can pay off; therefore, do not give up.

Conclusion

Although planning a research project and writing a manuscript are among the most intimidating and challenging activities for the clinical faculty, this manuscript described the essential steps involved in research and scientific writing. The review provided an informative introduction to the fundamental elements of scientific writing guidelines. This initiative is expected to enhance the faculty's research and writing abilities. At the same time, it will guide residents and medical students in preparing their research manuscripts. Academia and scholars will benefit from the improved quality of published articles. The clinical faculty will be better prepared to mentor their students in creating scientific manuscripts. This writing was primarily directed to the clinical faculty; hence, the basic sciences faculty should expand on the concepts presented.

Resumen

Los facultativos clínicos tienen un mayor impacto en la academia cuando demuestran dominio tanto en el ámbito clínico como en el de la investigación. Sin embargo, planificar una investigación y redactar un manuscrito son algunas de las actividades más intimidantes y difíciles para los clínicos. El objetivo de este manuscrito fue proporcionar una descripción informativa y reflexiva de los elementos fundamentales de la investigación y de los pasos esenciales para la redacción de un artículo científico. Este documento se creó utilizando experiencias personales y varias guías literarias relacionadas con la investigación y la redacción científica. Se proporcionan pasos por etapas y consejos para ayudar a la facultad clínica, a los residentes y a los estudiantes de medicina a mejorar sus habilidades de investigación y de redacción. Este manuscrito describe los pasos esenciales para la investigación y la redacción científica. El artículo ofrece una introducción informativa a los elementos fundamentales de la redacción científica. La lectura de esta iniciativa debe ayudar a los clínicos a mejorar su conocimiento sobre la investigación y la redacción científica. A la vez, los residentes y estudiantes de medicina se beneficiarán de la información proporcionada para sus proyectos de investigación.

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