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Review Article

An author's guide to mastering academic writing skills: Discussion of a medical manuscript

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ABSTRACT

Skilled scientific or academic writing is of great importance to research communication and journal publication ultimately. The four fundamental sections of a scholarly manuscript are introduction, methods, results and discussion. The discussion serves to interpret and analyze the study results in view of the existing body of evidence. Moreover, it serves to transform the usually rigid numerical statistical data of the results section into practical and clinically utilizable information. A well-formulated discussion can provide readers with informed decisions on the validity of the results and their exact generalizability to the broader community. It can also isolate shortcomings of the existing literature. Despite the extensive growth in biomedical publications lately, little attention has been paid to the importance of medical writing in general and to the discussion section of a medical manuscript in specific. This applies to curricular education and medical literature. The implications of well-executed studies with important findings can go unnoticed if authors are less skilled at writing a comprehensive discussion and conclusion among other manuscript sections. I intended to convey the experience I have accumulated in authoring and peer-reviewing for leading society journals and supervising in-house academic theses and dissertations. The objective of this article was to help authors present and communicate their research findings methodically, efficiently and impartially. Orthopedic research was taken as a practical example.

Keywords: Academic writing skills, Scholarly communication, Medical writing, Research report, Teaching

MEDICAL WRITING: NATURE AND EXTENT OF CHALLENGES

According to the National Library of Medicine https://www.nlm.nih.gov/bsd/stats/cit_added.html, 952,919 biomedical publications worldwide have been indexed and added to MEDLINE during the fiscal year 2020. Despite this enormous number of publications, relatively insufficient literature exists on how to systematically prepare and critically appraise a medical journal manuscript, including the discussion section [Figure 1].[1,2] The scholarly community is becoming aware of the importance of teaching scientific writing and research presentation or communication skills in various undergraduate and postgraduate curricula of medical schools worldwide.[3-9] The use of English as the language of instruction among non-native students and faculty has been blamed for reduced academic performance, increased levels of plagiarism in scientific writing[10,11] the increased need for professional medical writing services[12-16] and prompted educational approaches to overcome these challenges.[14-18] Likewise, publication pressures and hyper-competitive work environments have been blamed

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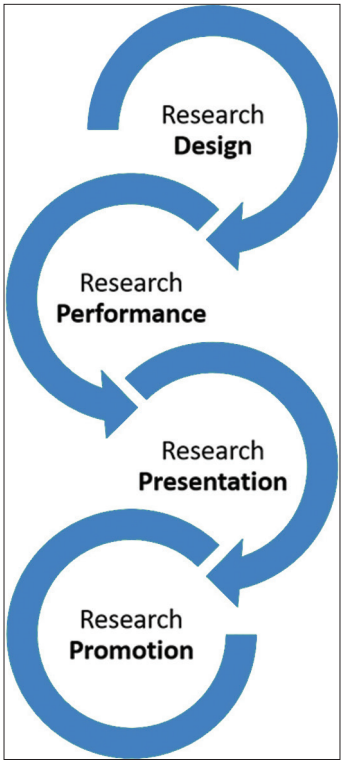

Figure 1: Principal phases of the research process.

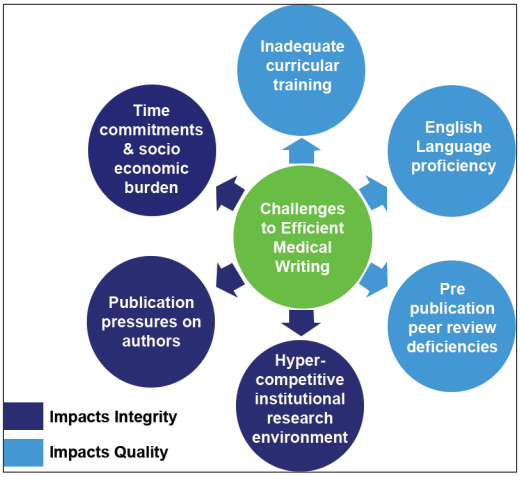

Figure 2: Challenges to efficient medical writing.

for reduced academic performance in terms of quality and integrity of reporting research findings in the discussion and conclusion sections of medical manuscripts [Figure 2].[19,20] All previous remarks call for more efforts to prioritize curricular and extra-curricular education to enhance research presentation and communication skills among authors and peer reviewers alike. And call for efforts to overcome barriers to efficient and professional research communication.[21] The objective of this review was to highlight the basic pitfalls occurring during the preparation of the discussion section of a medical manuscript. Another objective was to provide basic tips on how to write a comprehensive and scientifically insightful discussion with orthopedics as a practical example.

FUNCTIONS OF THE DISCUSSION

The discussion section of a medical manuscript aims at putting the results into meaningful clinical practice and public health context.[22] In other words, a properly presented discussion can help readers understand the implications and limitations of the study results when applied to both the specific patient population studied and to the wider array of patient populations. The discussion section is the right place to draw relevant correlations between one's work and similar works in a contextual manner. In addition, make leading inferences from the results and provide credible reasoning, especially behind any seemingly unexpected results a study may yield.[22-24]

Generally speaking, busy clinicians are most interested in the discussion section and its implications for their clinical practice than the typically sophisticated details of a study methodology. Likewise, busy academics are most interested in contrasting the results with their previous research findings and implications for future research topics. A robust discussion is the only available tool to simplify and transform the results section's rigid and complex statistical data into scientifically meaningful and clinically utilizable information.[22] An efficient discussion should also caution readers against the routine generalization of the study results to the broader disease population and warn readers of absolute and unjustified belief in the validity of the results. On the other hand, an inaccurately written discussion could distort the true implications of research and intended messages to readers.[22] This particular scenario can occur despite an otherwise well-designed, well-performed, and bias-controlled research work. This happens because the academic skills needed to design and perform research differ from those needed to present and communicate research.

STRUCTURING THE DISCUSSION

Designing a general framework of ideas is indispensable to the production of a relevant and informative discussion. The first subsection of the discussion should present a summary of evidence and key points of the study's results. The focus of this subsection should pivot on answering the research question. The authors are required to comment on, compare and correlate their results with similar works but not repeat and detail them. In addition, the authors' own inferences from the results, suggestions and any novelty

of findings should appear in this subsection. The second subsection can include the study's limitations and strengths and its implications for upcoming research designs. A final subsection should be dedicated to writing a carefully curated conclusion that is in line with study results.[22] In addition, relevant recommendations that include future research plans should appear in this subsection. The clarity of English is ultra-important to conveying the true scientific meaning. Ambiguous and low-quality language can cause reader confusion and distraction. Tips for writing a purposeful discussion are presented in Table 1.

ESTABLISHING STUDY ASSOCIATIONS

Authors are advised not to restrict the discussion to comparing study results with others totally. Although important, this is not the only function of the discussion section. The notion that the discussion section is mainly restricted to comparing one's study results with other published literature rests on a misconception. Rather, authors should draw inferences from these studies based on evidence, scientific reasoning and careful review of their methodological robustness. Authors should also indicate possible avenues for future research and focus on study limitations and strengths and so forth.[22-24]

Table 1: Thirteen tips for writing a purposeful discussion.

1 Structure the discussion before starting to write.
2 Use clear, simple, unambiguous English or resort to language-competent personnel or language-editing services.
3 Ensure that the original study objectives are addressed, and the research question answered clearly.
4 Compare your results contextually and consider all study settings.
5 Compare ideas and concepts, not simply numerical results of literature citations.
6 Discuss beyond local study settings and consider suitability and applicability of research findings to a wider context, for example, disease populations, geographical regions, low resource settings and so forth.
7 Cite relevant and updated references and acknowledge flaws in the methods or limitations in the references you cite.
8 Avoid citing references based solely on reading the conclusion section or abstract. Rather check the original methods/results to substantiate the validity of the conclusions.
9 Provide your own scientifically sound assumptions for unexplained or unexpected study results.
10 Acknowledge your own study limitations and pinpoint strengths or innovations.
11 Avoid exaggerated/overstated conclusions that are not substantiated by the study results.
12 Conclusions should refer to the significance of the results rather than simply summarizing the results.
13 Make a clear distinction between statistical significance and clinical significance when formulating your final conclusions.

Do not discuss each author/article separately and extensively rather, discuss similar or contrasting concepts or findings collectively and concisely. Instead, a manuscript can group relevant authors/articles sharing common findings or providing similar messages, write a single paragraph about their viewpoint and reference it accordingly. This represents a more organized, efficient and reader-friendly mode of scientific writing. It also presents a logical flow of scientific ideas. Each manuscript requires more attention to word economy and journals' specific requirements.[22-24]

Authors should avoid comparing the results with similar studies in an absolute manner. When comparing one's study results with similar studies, one should draw correlations contextually and within the confinements of these studies' limitations and strengths. For example, similar studies with apparently similar findings may still exhibit scientifically relevant discrepancies regarding various research settings as authors' level of expertise -especially in interventional studies-, environmental, racial, socio-economic, and health-policy related factors. Failure to compare studies contextually and not absolutely might lead to overstatements or understatements and subsequent misleading conclusions.[22-24] Authors are required to avoid drawing comparisons based exclusively on numerical parities or disparities between their study and the literature. Such comparisons are often devoid of practical clinical context. For example, if the prevalence of cerebral palsy in a low-resource country equates to that of a rich/developed country, one has to look into the infant mortality rate and epidemiological research methodology used to calculate this prevalence in each study.[25]

SEARCHING FOR STUDY IMPLICATIONS

Do not forget to consider the applicability of research methodologies and outcomes to different disease and patient populations. Discussing the remote and broad implications of scientific concepts and principles is just as trustworthy as discussing specific details, for example, of a specific technique or methodological approach. Research concepts apply by default to a wider area of knowledge, which can be extrapolated to diverse clinical scenarios.[22,25] Therefore, it is crucial to discuss the implications of research findings for practice beyond the specific settings in which one's research originated. For example, the concept or premise behind a certain surgical technique or drug therapy protocol in a carefully selected pediatric patient population may be potentially relevant to an adult patient population with a similar disease. Likewise, the validation and adaptation of a new assessment tool on a specific pediatric orthopedic patient population as cerebral palsy may be potentially relevant to other subtypes of the same disease or even to different disease populations like those

with other forms of childhood-onset motor developmental delays.[26]

Further, it may be relevant to draw broad correlations between similar methodological approaches in spite of the fact that they are implemented on two entirely different disease populations. For example, it may be scientifically insightful to discuss the implications and potential limitations of survey research aimed at demonstrating surgeons' preferences and perspectives on the diagnosis and management of developmental dysplasia of the hip[27] and ankle equinus in cerebral palsy children.[28] In that regard, the point of interest would be how survey research can uncover knowledge to practice gaps in pediatric orthopedics? Authors must not forget to make personal inferences from the study results and suggestions or recommendations for decent future research points. This is likely a commonly overlooked aspect of the discussion, especially among early career researchers. Authors are encouraged to make relevant inferences from the study's data and provide scientifically sound and new assumptions, especially for unexplained and unexpected study findings.[22] This becomes a strategy of critical importance to the discussion when rare diseases with insufficiently understood underlying pathoetiologies are studied. Authors are equally encouraged to suggest future research avenues. This can be based upon accommodating for limitations of their own study or on suggesting new research questions or designs that the study's results may have dictated. A future research design may include studying a relevant correlation between two factors that have not been addressed in one's study because of its scope. It may also be wise to suggest a research question that accommodates for bias control of an important confounding variable that has not been accommodated for in one's study. For example, survey research aimed to compare the general orthopedic versus pediatric orthopedic surgeons' preferences for managing ankle equinus in cerebral palsy children.[28] In the discussion of the previous study, it may be insightful to suggest a new research question, namely, comparing the preferences of pediatric orthopedic surgeons with in-depth clinical experience in cerebral palsy and pediatric orthopedic surgeons without such an experience.

CITING THE LITERATURE

Authors must not underestimate the importance of reference selection. Credible references are essential to support the claims the manuscript presents. A comprehensive and updated literature search is paramount to promoting the research question and providing due justification of its importance or novelty. Citation/reference irrelevance, outdatedness, and low-quality and low-level evidence references can undermine the trustworthiness of an otherwise systematically conducted research.[29-33] In addition, quotation errors can produce a similar effect.[33,34] Beware, old references are not necessarily outdated. However, references reporting information that has been surpassed in terms of scientific validity and reliability are regarded as such and should be used in a historical or chronological context only. Citing studies based solely upon reading the conclusion section or abstract only can result in an inconclusive and counterproductive discussion. This is because the conclusion of any particular study may occasionally misrepresent the true findings of the study.[33,35] Authors are advised to self-revise the methodology and results of any cited study to verify the claims stated in the conclusion or abstract. Authors should avoid citing quoted references and are urged to read the original references thoroughly. Relatedly, assertions made by authors of review articles about certain references should not be taken for granted. Authors should also avoid writing a biased discussion. Therefore, they should be keen to present all conflicting or controversial viewpoints on the research question in a scientifically impartial manner.[19,36] Note that initially captured references may need to be updated by the time one starts writing the discussion section. The unwary inclusion of references from predatory journals to support statements made in the discussion can be counterproductive in many ways. It can lead to the production of inaccurate or baseless study conclusions and contaminate the scientific literature in general.[37-39]

STUDY LIMITATIONS AND STRENGTHS

Elaborating on study limitations helps readers to interpret the research findings within a proper scientific context and plan their future research accordingly.[22,24] Failure to do so may devalue an otherwise high-quality study. For example, limitations may be related to various factors as optimal appropriateness of the chosen research design or study type for the study objectives, sample numbers, degree of sample homogeneity, methodological performance bias, the validity of a scoring system, post-intervention follow-up period and logistic barriers and so forth. Authors should also make a distinction between study limitations arising from the above-mentioned research-related factors and those arising from an inherent patient- or disease-related factor as disease rarity or lack of definitive and recognized disease diagnostic tools and so forth. If study limitations are deemed critical to the interpretation of the study findings, present them under a separate subtitle. Noteworthy, serious and preventable methodological flaws that fundamentally affect the validity and reliability of the study's conclusions are not considered study limitations, for example, failure to recognize or develop a methodological strategy to deal with confounding variables of significance. These flaws are generally irreparable, incompatible with sound science. Any

discussion or conclusions based on such serious flaws are groundless.[40]

Study strengths and limitations are equally crucial to the interpretation of the results and conclusions. Study strengths may relate to the same above-mentioned factors for study limitations. Study strengths are likely to impact the validity, generalizability of conclusions positively. Pinpointing the study strengths can help readers rank the level of evidence and trustworthiness of a study's results and its conclusions. They may represent a form of innovation in research that should be explicitly revealed to readers. For example, compensating for a methodological deficiency of a previous study performed on the same patient population and that addressed the same research question is one form of innovation and strength in research. Similarly, the study of a certain research point employing a different research type, for example, a randomized control trial instead of a previously reported non-randomized trial may help build evidence on the same research point. Alternatively, employing a different research methodology, for example, a subjective physician survey study instead of an objective patient interventional study may constitute another form of innovation and study strength. Likewise, redoing a research topic while overcoming inconsistencies of the previously implemented assessment tool or applying the same surgical technique to treat the same orthopedic deformity in an unexplored patient population are other forms of innovation and strength in research. For example, reusing the already established guided growth technique to correct angular knee deformities in an unexplored population as children with nutritional rickets is worthy of emphasis in the discussion.[41]

PREPARING FINAL STUDY CONCLUSIONS

The conclusion is usually the most eye-catching part of a manuscript, especially among busy clinicians. However, a scientifically inaccurate or poorly worded conclusion can be misleading and put patients at risk of complications. Therefore, caution should be exercised when phrasing the conclusion, especially regarding undue generalizations beyond the confinements of the studied patient population or the subtype of the investigated disorder and so forth. The same applies to the undue or full justification of the validity of the results. Likewise, conclusions should be articulated in light of the follow-up period in interventional studies, even if results were correctly generalizable to a larger population. Shortly said, one should keep an eye on the study limitations and avoid concluding remarks that are not substantiated by the study results. Moreover, avoid writing overinflated or exaggerated study conclusions.

The conclusion of a manuscript and summary of the results is occasionally used interchangeably by some early career researchers. Actually, they represent two distinct entities of a medical manuscript. The summary of the results represents a brief description of the overall results and statistical analysis. Contrastingly, the conclusion represents the inferences drawn from these occasionally complex numerical/statistical results and their linguistic interpretation in view of the existing academic and clinical evidence.[22] Thus, authors should not simply write a summary of study results as concluding remarks, rather interpret or write down the implications of the results to both clinical practice and public health. Failing to do so can deprive readers of a practical take-home message and limits the clinical utility of research. Beware to avoid misinterpreting the results and writing discrepant conclusions. Never equate statistical significance to clinical significance.[42]

Authors are required to make a clear distinction between statistical significance and clinical significance when formulating their final conclusions. This is because the statistical significance of results calculated according to *P*-value may not parallel the clinical significance or relevance of a given patient outcome. This is particularly important for quantitative research, be it primary or secondary as meta-analysis. A well-performed meta-analysis cannot compensate for the inherent methodological flaws of the included studies. For example, a correctly calculated *P*-value for plain radiologic or functional outcome measure in an interventional (pre-post) study may reveal a statistically significant improvement of the measured outcome. However, despite the difference, the improvement remains clinically irrelevant or does not reach the minimum clinically important difference to be considered of value by patients. In such scenario, basing one's conclusions on the statistical significance is misleading and clinically meaningless. Consequently, conclusions based solely on statistical values without contextual clinical interpretation can lead to unverified and erroneous interpretations. Dissemination of such erroneous take-homes among unwary or busy medical practitioners may put patients at risk of harm and practitioners at risk of malpractice. Authors must ensure that the conclusions at the end of the main manuscript are in complete agreement with those written in the abstract section. Common pitfalls of writing study conclusions are shown in Figure 3. Practical tips for improving the academic writing skills of early-career authors are presented [Table 2]. Authors who resort to medical writing services must acknowledge that in their manuscript. Unacknowledged medical writing services are usually referred to as ghostwriting, which is ethically concerning.[47-49]

TAKE-HOME MESSAGE

The discussion section of a medical manuscript is a principal means to convey the importance and relevance

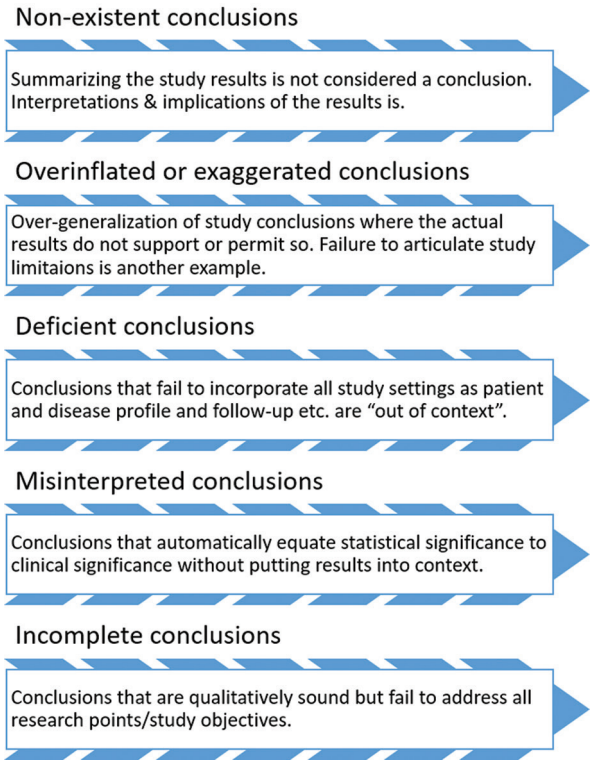

Figure 3: Common pitfalls of writing study conclusions.

Table 2: Practical tips for improving academic writing skills of early-career authors.

1 Read articles of high-ranking journals with an analytical and critical eye.
2 Read educational material geared for optimizing early-career authors' research writing/presentation skills.
3 When contributing to a research project, be keen to share in the drafting and preparation of the manuscript. A critical review of the drafted version by senior authors can help upgrade ones writing skills.
4 If medical/academic writing is not part of the curricular education, be keen to attend extra-curricular courses, workshops or seminars on academic writing and related topics.[43,44]
5 Attend thesis and master's degree seminars and defenses, even if not directly related to your research field.
6 Read published peer review reports and their corresponding articles on journals' websites.
7 Respond to peer reviewers' reports on your own manuscript in a comprehensive and organized manner.
8 Get involved in pre-publication peer review either directly or indirectly through a senior colleague/mentor, that is, as a co-reviewer.[45,46] A learning academy focused on peer review is another option*.

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of a study's outcomes to clinical practice and public health issues. Without adequate academic skills to present an intellectual discussion and conclusion, the clinical utility of research findings may go largely unknown to readers. This may also lead to wasteful, misleading and occasionally harmful research outputs. Therefore, academic skills required to conceptualize, design and implement research should go hand in hand with skills required to present and communicate research.

AUTHOR'S CONTRIBUTION

The author has critically reviewed and approved the final draft and is responsible for the manuscript's content and similarity index.

ETHICAL APPROVAL

The author confirms that this review had been prepared in accordance with COPE roles and regulations. Given the nature of the review, the IRB review was not required.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflict of interest

There is no conflict of interest.

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