

Discussion: The Heart of the Paper

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The discussion section explains the meaning of results to the readers, and addresses the implications of the findings emanating from the particular study. Authors should compare their results with previous reports, and attempt to explain similarities and differences. It is useful to outline the limitations and strengths of the study, and suggest a future line of work. A concise, convincing and meticulous discussion with scholarly referencing is the key to a lasting impression.

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The purpose of 'Discussion' is to interpret the meaning of results, justify their significance and suggest avenues for further research. This section explains how the research questions or hypotheses presented in the Introduction [1] have been addressed by the results [2], and their impact on the understanding of the research problem. Formulating the discussion requires analytic thinking for synthesis and interpretation of findings and defining key messages that emphasize the implications of research [3]. Drafting an articulate discussion requires scholarly confidence and an ability to think and write creatively. For the majority of authors, this section of the research paper is the most challenging!

This article endeavors to simplify this seemingly tough task by outlining its key components (**Box 1**). The discussion is crafted around the following questions: What do the results mean? How true and relevant are the findings? Why are they important or unique? How does this study expand current knowledge? Do they have any clinical implications? Is there a "take home message"?

WRITING DISCUSSION SECTION

Interpret and Highlight Importance of Results

The analogy of an inverted funnel is used to describe the discussion; the flow of information goes from narrow (focused and precise) to broad [4]. Therefore, the opening paragraph should be a clear and succinct answer to the research question that was posed at the end of Introduction [1,5]. Several illustrations highlight the importance of a direct and explicit opening.

- In a recent paper in the NEJM, Hoberman, *et al.* [6] begin the discussion as follows: "Antimicrobial prophylaxis in children with vesicoureteral reflux diagnosed after a first or second urinary tract

infection was associated with a halving of the risk of febrile or symptomatic recurrences. Differences between the prophylaxis and placebo groups were apparent early-on, and increased over a two-year period. Children with bladder and bowel dysfunction at baseline and children whose index infection was febrile derived particular benefit from prophylaxis, with reductions in recurrences of approximately 80% and 60%, respectively" [6].

- In a randomized controlled study in patients with steroid resistant nephrotic syndrome, Gulati, *et al.* [7] state: "Results of this trial show that treatment with tacrolimus and alternate-day prednisone was effective and safe in inducing and sustaining remission in patients with newly diagnosed, steroid-resistant nephrotic syndrome" [7].
- A recently published randomized study in the NEJM [8] begins the discussion as follows: "The results of our trial showed that withholding parenteral nutrition for 1 week in the pediatric ICU was clinically superior to providing early parenteral nutrition; late parenteral nutrition resulted in fewer new infections, a shorter duration of dependency on intensive care, and a shorter hospital stay. The clinical superiority of late parenteral nutrition was shown irrespective of diagnosis, severity of illness, risk of malnutrition, or age of the child" [8].

Two additional points need emphasis. While the most relevant findings are explained, how the results support the answer to the research question should be defined at the beginning of the discussion. Repetition of background information or results is unnecessary and tedious. It also increases the length of the manuscript and reduces reader interest. Secondly, the significance of the study results may not immediately be as apparent to the

Box 1 KEY COMPONENTS OF DISCUSSION

- *Opening paragraph:* Summarize what was done and what was found, e.g., “In order to determine the genetic factors implicated in autism, we used next-generation sequencing to examine 44 genes in 108 patients and 100 controls. We found variations involving multiple genes”
- *Limitations and strengths:* Identify and acknowledge the limitations, than to have them pointed out by the reviewers. Discuss concerns of internal and external validity and generalizability of the results. Mention positive attributes (randomized trial, homogeneous population, large cohort, novelty) without ‘claiming the first’ and sounding pompous.
- *Subsequent paragraphs:* Explain the key findings, one by one. For each, summarize what was found and explain how it confirms or refutes what is known on the topic. If there are methodological differences or limitations in the present study, discuss how they impact the results.
- *In the next 1-2 paragraphs,* focus on the primary outcome. For example, if you found a novel mutation associated with autism, describe the mutation, its population frequency, and properties and function of the translated protein. Discuss what is known about the gene and protein in relation to brain development, and association with other diseases. Scholarly references enhance the discussion.
- *Concluding paragraph:* Conclude with a sentence each on the main finding(s) of the study and its clinical relevance. Make focused suggestion for research that would further improve the understanding of the disease or result in better therapies.

readers, as it is to the author who has devoted a significant amount of time to review the literature, design and conduct the study, and analyze the data [5]. The discussion should attempt to ensure that the readers grasp the importance and uniqueness of the study the very first time they read the manuscript. The central message and relevant findings should be expressed convincingly enough not to be overlooked, even with a quick reading of the discussion.

Acknowledge Limitations and Strengths

Authors can engage their readers effectively with a balanced presentation that emphasizes the strengths but acknowledges the limitations. One should consider all possible alternative reasons for the study results, without being prejudiced to consider only those explanations which support the proposed hypothesis. Secondly, while it is relevant to address limitations on study design, methods or patient number, their implication on validity of the results should be stated [3,10]. Common concerns related to internal validity are issues related to study design, measurement and statistical power. Threats to external validity include sample bias and patient/sample characteristics that limit generalizability of findings. The author(s) may present counter-arguments to mitigate the limitations, or mention strengths to end on a positive note [11].

As an example, while accepting limitations, Gulati, *et al.* [7] state: “*This study was not stratified on renal histology, although there was equal distribution of*

histopathologies in both arms. While the NIH trial was limited to patients with FSGS, we also included patients with minimal change disease. Although not powered for subgroup analysis, we found that therapy was effective in patients with minimal change disease and FSGS. The strengths of this adequately sized trial were that randomization, data collection, and analysis were performed centrally. The baseline characteristics were well balanced, and a widely accepted definition of steroid resistance was used. Safety monitoring was ensured and nonresponders were managed appropriately. The results of this study on children with initial and late resistance and major biopsy diagnoses are therefore generalizable” [7].

Challenge and Expand Scientific Knowledge: Relate to the Literature

Subsequently, to broaden the scope of discussion according to the inverted cone analogy, the research should be compared and contrasted with other studies to add to existing knowledge [4]. Questions left unanswered by previous studies may have driven the current research; all such work which support and strengthen the authors’ findings should be comprehensively cited. However, a cluttered description of all similar studies should be avoided. Earlier research is best covered in a well-articulated manner, aiming to reflect a clear set of ideas that enable logical conclusions. One technique is to construct separate paragraphs for each salient finding, covering relevant literature and concluding with a specific

summary point [9]. While the key findings are discussed in this manner, care is taken to avoid discussing each and every finding [3].

Appropriate and scholarly referencing is important to validate the present research and credit the work of others [10]. While results should be discussed in the context of similar findings from prior reports, it is important not to overlook findings that are contrary to published literature [5]. Conflicting results should be mentioned with transparency, and an attempt to determine the cause(s) of contrary data, which might include differences in design, methods and patient population. If a reason for the difference is not found, this should be acknowledged clearly.

Clinical Implications and Suggestion for Further Research

The fundamental goal of all medical research is to improve patient-care. Therefore, when applicable, practical and clinical implications of the study should be included. Recommendations for practice change may be offered [5]. In the study cited earlier [6], the authors write: “*We suggest that in early CKD clinicians should understand the limitations of the creatinine-based equation, and preferably use cystatin-C based equations*” [6].

Next, the author should attempt to provide a specific agenda of research that would further our understanding on the subject [3]. While making such suggestions, it should be remembered that the hypothesis that was tested, the outcome measures, and the statistical analyses have nothing to do with the concept of requiring further testing [10].

The “Take Home Message”

The discussion should conclude with a strong, concise statement(s) that summarize the study. The content and tone of the concluding sentences should be congruent with the rest of the manuscript. The final perspective is presented, without overstating or introducing any new information. The conclusion may also provide suggestions for practice change, if relevant. In examples given above, the concluding sentences were:

- “*Therapy with tacrolimus and low-dose prednisone should be preferred to cyclophosphamide as the initial therapy for patients with steroid-resistant nephrotic syndrome, as it is effective and safe in inducing and maintaining remission of proteinuria*” [7].
- “*In conclusion, in critically ill children, withholding parenteral nutrition for 1-week while administering micronutrients intravenously was clinically superior to providing early parenteral nutrition to supplement insufficient enteral nutrition*” [8].

ELEMENTS TO AVOID WHEN WRITING THE DISCUSSION

Scientific writing needs to be objective, modest and pragmatic. The results must be supported by data, and it is important to not go overboard while interpreting the results [5]. While the overall purpose of discussion is to justify the contribution made by this study to scientific literature, the writing should not appear exaggerated or pompous [5]. Large claims should be avoided; statements such as “first time”, “all the time”, “wholly explains” might inflate the actual worth of the results, and do not go well with the reviewers or readers (**Table I**). The writing should be respectful and should not attack or criticize past or contemporary researchers [5].

The discussion must focus on key messages that should be defined beforehand; tangential issues tend to dilute the major conclusion [5]. It is often tempting to report results of unplanned analysis, deviating from the original hypothesis, when the primary results are not as expected [10]. However, no new information should be introduced in the discussion and results as obtained from the original hypothesis must be reported as such. While discussion of data derived from post-hoc analyses is acceptable and might serve as the trigger for future research, it is useful to describe such issues with clarity for the readers.

Coherent Communication of Key Messages

An efficient and stimulating discussion is one that is written with the readership in mind. Most readers of medical journals, have limited time for reading, therefore read rapidly and may miss or misinterpret ideas at points that slow their reading [12]. This also implies that readers should be easily able to follow the author[s] train of thought, without having to decode or reconstruct the manuscript [12]. Clarity of expression is crucial, and imprecise words are better avoided. Authors should resist using complicated and less familiar words, avoid wordiness and delete unnecessary adverbs or adjectives. Phrases like “it is interesting to note that”, “it is often the case that”, “has the capability to”, “is of the opinion that” and “is unable to” can be replaced by: interestingly, often, can, believes and cannot.

Brevity allows readers to capture more information in a given time [13]. Vital ideas should be expressed by short and well-constructed sentences that have more impact. Each paragraph should convey a single major point which is clearly brought forward in the first sentence, and the idea is then developed through the paragraph [12]. Continuity must be ensured between paragraphs; sentences should be ordered logically to ensure a smooth flow of ideas. Sub-sectioning interrupts

TABLE I THINGS TO AVOID IN DISCUSSION

<i>Avoid</i>	<i>Comment</i>
Rewriting the results	Do not restate your results; discussion should focus on interpretation. Use bridge sentences that relate the result to interpretation.
Introducing new results	Do not present new findings in discussion.
Discussing every finding	Emphasize the key findings in a lively, crisp manner that holds attention; avoid tangential issues that distract readers.
Lengthy text	Length should be 20-25% of the overall text; avoid subtitles; references should be contemporary and focused.
Academic arrogance	Avoid claiming priority and alluding to work that is not yet completed.
Criticizing other workers	Findings that are contrary need to be handled professionally.
Over interpretation	Do not inflate importance or read more into the findings than supported by the data.
Unnecessary speculation	Emphasize the part that is a speculation, and not supported by data. Highlight need for further research.

this flow; therefore the discussion is best written unstructured, with transitions for moving between ideas [10]. Extensive paragraphing that interrupts flow and hinders communication of the main messages should be avoided. Clarity and conciseness often go hand-in-hand: writing that focuses directly on a point and maximizes meaning with minimum wordiness tends to be both clear and concise.

Perfecting the Discussion

The discussion invariably requires careful editing, reconstruction and several rounds of writing attempts until real messages emerge. Two strategies which help to overcome writing flaws are described. A colleague, not involved in the manuscript, can be requested to read and suggest areas that need clarity [11]. Another strategy is to distance oneself from the first draft after writing it, regain some objectivity, re-read the relevant literature and then review the manuscript again. On returning to the manuscript, authors are bound to discover flaws missed in the first draft [13]. Additionally, authors should also consult the website of the concerned journal for additional suggestions on writing the discussion *e.g.*, use of sub-headings or key messages in a text-box [14].

Practice makes perfect, and scientific writing is no exception. A concise, convincing and meticulous discussion with scholarly referencing is the key to a lasting impression.

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