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How to read, understand, and write 'Discussion' sections in medical articles. An exercise in critical thinking

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Summary

Writing and reading 'Discussion' sections in medical articles require a procedure as exact and structured as that involved in raising questions, choosing materials and methods and producing results for a health research study. The medical article as a whole can be considered an exercise in modern argumentation and its 'Discussion' section, a systematic critical appraisal of a path from theses to conclusions. The methodology of modern critical thinking applies perfectly to article writing, reading, and understanding. Structuring the 'Discussion' section as a review of argumentation benefits more than the study and its authors. It allows the reader to grasp the real relevance and validity of the study and its usability for his or her decision-making in clinical and community care, research and health policies and program proposal, implementation, and evaluation.

key words:

medical article writing and interpretation • critical thinking in medicine • argumentation • uses of evidence appraisal • 'Discussion' sections in medical articles

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"The very act of writing for publication imposes a discipline that forces issues to be thought through in a logical way, allowing you to detect weaknesses in an argument. ... In today's world of evidence-based medicine, a clinician's ability to critique research publications, discern the nature and quality of the scientific content and interpret its significance is a crucial skill."

FL Rosenfeldt et al. 2000.

BACKGROUND

The most difficult part of writing a medical article is perhaps the 'discussion' section [1-3]. Are there better ways to write 'Discussion' sections in medical articles? Let us attempt to at least partially answer this question by providing some suggestions.

We often do not realize that medical articles, be they original research reports or health policy papers, are not simple accounts of facts, but rather logical arguments for or against a given idea: a particular treatment works, exposure to a dangerous chemical harms, a new diagnostic procedure is effective, a health policy or program is successful. Medical articles are an exercise in argumentation as originally proposed by two eminent medical journal editors, Edward Huth of the *Annals of Internal Medicine* [4,5] and Richard Horton of *The Lancet* [6]. These articles are another example of a process of proposing, defining, explaining and valuing considerations designed to support and justify some claim (conclusion) [7]. Their vehicle is a logical argument that must be critically appraised once it is advanced. The 'Discussion (with Conclusions)' section should be a principal component of this type of appraisal and not simply an explanation of numerically listed topics that are more or less related, however relevant they might be.

With the recent spectacular development of general informal logic and critical thinking in the past two or three generations, fundamental and clinical epidemiology, and Evidence-Based Medicine now all offer practical tools to apply this part of philosophy to medicine as the general principles and ideas underlying our understanding, views, and decisions about health, disease, and care.

This essay, supported by newer views of critical thinking, proposes that 'Discussion' sections in any health science article, whether in the field of medicine, nursing, nutrition, public health or other specialties and basic research (laboratory), be a critical evaluation of an argument personified by the written message of the article as a whole. In our conclusion, we will present a short outline on how to write and read their message as an exercise in critical thinking.

INFORMAL LOGIC AND CRITICAL THINKING TODAY

Articles in health sciences are not written in a symbolic manner, but rather in natural language. Informal logic identifies, analyzes, interprets and evaluates reasoning as it happens in the context of everyday life.

Critical thinking today takes into account not only classical ways of reasoning (Aristotelian categorical syllogisms or ancient Nyaya Indian school of argumentation), but also enriches them tremendously through Toulmin's modern argument and argumentation [8,9]. It is now offered for consideration and applications in medicine [7,9,10]. As defined today [11-16], critical thinking tells us about reasonable and reflective ways to believe and do [11]. It is the intellectually disciplined process of conceptualizing, applying, synthesizing and/or evaluating information gathered for, or generated by observation, experience, reflection or communication as a guide to belief and action (abridged from Scriven and Paul [12]). However, as in any newer field, an increasing number of definitions of critical thinking now exists [7] and both applications and adaptations abound [14-16].

Argumentation as a vehicle of critical thinking is now seen by Carr [17] (based on Toulmin [8], Shankar and Musen [18]) as well as by others, as a process of making assertions (claims) and providing support and justification for these claims using data, facts, and evidence. A medical article is the embodiment of such a process.

THE IMRAD MEDICAL ARTICLE

The Introduction – (Material and) Methods – Results – And – Discussion (*cum* conclusions) format [7-23] is used not only in medical writing, but in other sciences as well [24-37]. Its structured message is now enhanced by an equally structured abstract [38] and better-defined research question(s) [39,40].

The IMRAD contains in its sections answers to several important questions [19,35;modified]:

- 'Why? What is the problem?' (Introduction).
- 'When? Where? How much? How can it be found?' (Material and Methods).
- 'What? What did I find and how?' (Results).
- 'So what? What does it mean?' (Discussion).

For Horton [41], the IMRAD format already reflects the Aristotelian *Art of Rhetoric's* four elements of oratory: 'introduction – narration – proof – epilogue'. Within this framework, an article should be a coherent expression of logical thinking [42,43]. This author also draws our attention to the fact that medical articles should reflect Toulmin's model of argument and argumentation [6].

THE MODERN ARGUMENT

The modern argument proposed by SE Toulmin in the fifties [8] consists of a reasoning path from first hand evidence (grounds) to an ensuing claim as a resulting proposal and statement. It links six building blocks: Claim, grounds, backing, warrant, qualifier and rebuttals. Since the fifties, Stephen E. Toulmin, now an iconic Professor of Philosophy at the University of Southern California, has questioned the classical Aristotelian categorical syllogism. He has also proposed a "modern" model that is constantly gaining in acceptance, uses and applications in a wide array of human endeavors. Figure 1 presents a flow chart of modern argumentation in medicine and other health sciences adapted by us, primarily based on Toulmin's model of argument.

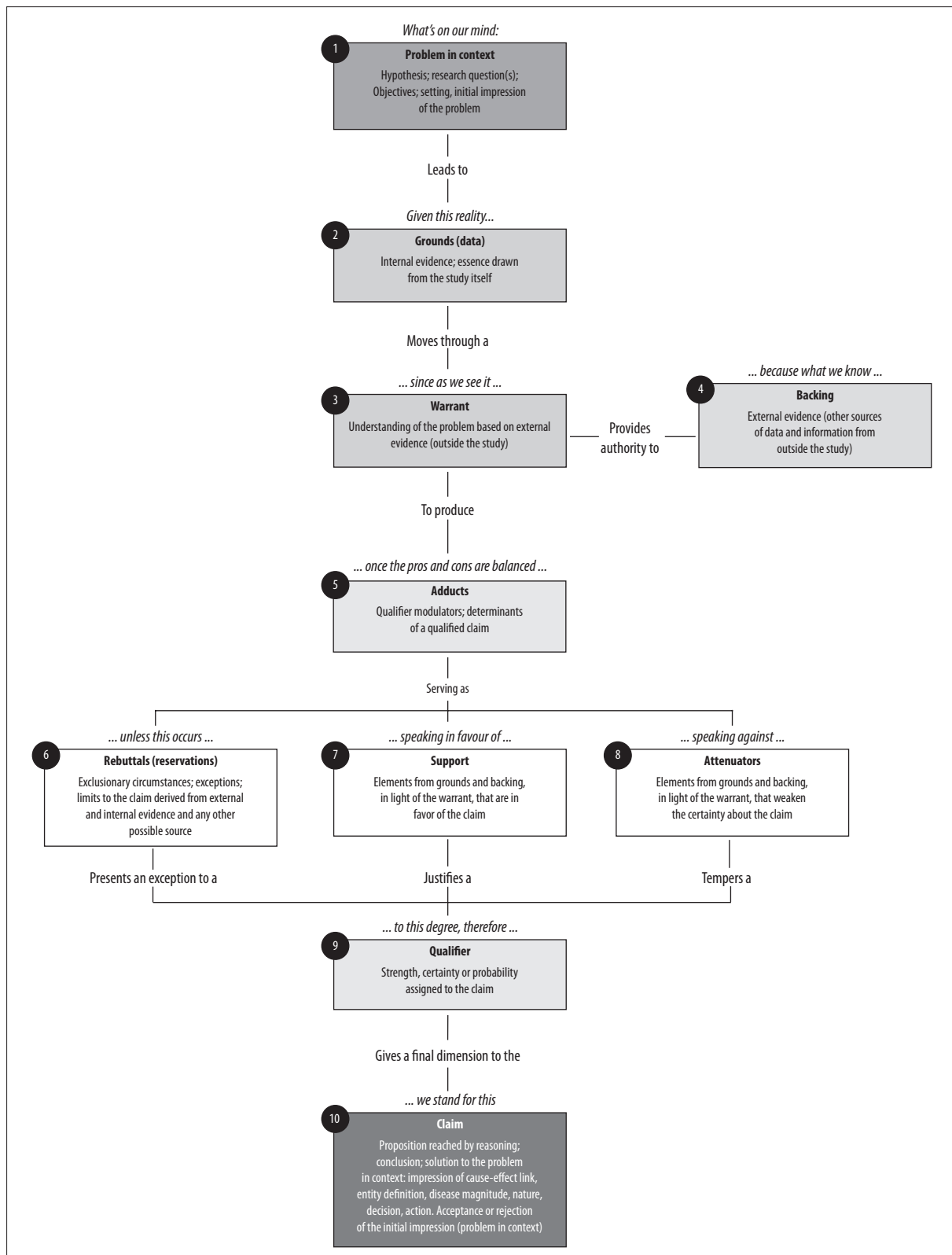


Figure 1. Layout of a modern argument in medicine. Source: Adapted from Toulmin [8], Carr [17, see also 54] and Shankar and Musen [18] with modifications for medicine, public health and other health sciences [7].

In their monograph [9], Toulmin, Rieke and Janik proposed its applications in various domains including medicine. Later, Horton again drew our attention back to pos-

sible uses of the Toulmin model in medical article writing [6]. This model was also introduced to various readerships [44–52] and applied to general science [52], legal rea-

soning [17,53,54], business [55,56] and engineering [57] among others.

Essential building blocks already exist, but are somehow "hidden" in various medical articles. As might be expected, thesis may be found in the Introduction, grounds in Material, Methods and Results sections, backing and warrant in the Review of the literature and Discussion, rebuttals in Discussion as well and claim often appears in the Title itself and Conclusions of the article. Table 1 represents an overview of original Toulmin's argument blocks ('organs within a living system of argument' as he calls them) and indicates a possible location of these building blocks in a medical article. While reading literature, we may quickly notice that there is no formal rule where they should be found. Usually, they are scattered so far in bits and pieces across the IMRAD sections.

So why not write medical articles in their entirety as an argument, as already proposed by Huth [4,5]? Besides the well established and proven IMRAD structure, the best place for an overview of the message as a modern argument seems to be the 'Discussion (with conclusions)' section.

THE 'DISCUSSION' SECTION AS IT STANDS NOW

Several ad hoc papers with a particular interest in the 'Discussion' section of scientific articles are available [3,58–60]. The 'Discussion' sections of articles focused on articles as a whole suggest a vast array of relevant and useful information to be covered and included in the 'Discussion' section [61–72] among others. Table 2 shows a simple non-directional enumeration of items that should not be omitted rather than a structured coverage and evaluation of the reasoning path represented in this kind of medical writing. The second part of the table summarizes 'what not to do' in writing a 'Discussion' section.

Based on the *vox populi* in the literature listed in Table 2, it appears that the most frequently requested topics of discussion should be: summary of major findings, explanation of underlying mechanisms and their meaning, comparisons with the literature, warranted conclusions, directions on what to do next, links between various study sections and steps, proposals of alternative interpretations, and an overview of study strengths, weaknesses, and limitations.

As a whole, this Table lists recommendations and required information from the study itself as well as from sources and domains other than the study reported. Most of these items are elements produced by vertical thinking (conventional logical process), within the study itself. The rest are derived from parallel or lateral thinking, a term coined by De Bono [75] in the sixties for this kind of expanded, 'collateral', 'parallel' or 'multidirectional' reasoning process by unorthodox and apparently illogical methods. In fact, in the spirit of De Bono's ideas, all writers and readers of medical articles should be offered a distinction between what is related to the study (subject of vertical thinking of the article itself) and other considerations beyond it, relying on general experience imagination and other more specific sources of external information, subject of lateral thinking complement and counterpart.

Can we give these important points an even more meaningful logical structure that would further help in the understanding of the problem under study? Certainly, and this can be done by also making the 'Discussion' section a critical appraisal of the paper as an argument, its building blocks, and how they are used and lead to the article's claim (conclusions).

HOW TO WRITE, READ AND UNDERSTAND A STRUCTURED, MORE "LOGICAL" DISCUSSION. A BRIEF TUTORIAL AND GUIDELINES

Even if the structured form of a 'Discussion' section as proposed by Horton [73] and Alexandrov [76] (combined) were to be adopted (*Summary of key findings – novelty of findings – controversies and contradictions with previous research – interpretation, strength and limitations in the context of the totality of evidence – potential significance of findings – future research directions*), in order to include all relevant points in a single 'Discussion' section structured as a simple repertory by enumeration [3,60,74], a voluminous treatise might be required. However, for reasons of space, many medical journals would then reject it. In fact, a critical appraisal of the study as an argument offers another dimension to the reader's understanding of the relevance of advanced claims.

Besides the enumeration of the most important points in Table 2, their selective coverage should contain two distinct parts: 1. The first should essentially be focused on the study itself in terms of mainly vertical thinking. 2. The second should explicitly show that its statements are mainly the product of lateral thinking beyond the study itself.

1. **In terms of vertical thinking and medical articles as a modern argument, the 'Discussion' section should be the critical appraisal not only of such an argument as a whole and of all evidences that compose it, but also of the links between them.** Hence, it should cover the critical appraisal of the thesis (problem in context), grounds, backing, warrant, qualifier, rebuttals, and ensuing claim together with the assessment of the whole path from thesis to its confirmation or rejection by the claim as well as offers of all alternatives and future work on the health problem under study. In the preferred wording of any medical writer, the 'Discussion' section should:
 - Step 1. Revise and summarize major findings (**claims**) of the study.
 - Step 2. Succinctly remind the reader of the original thesis (**statement of the problem**) of the study.
 - Step 3. Critically appraise the evidence in **grounds** and its relevance to the study and its claims.
 - Step 4. Critically appraise both the supporting and contradictory evidence (if any) in **backing** and its relevance in connection to grounds and claims).
 - Step 5. Critically analyze and appraise the value, relevance and biological, social and technical (if any) plausibility of the **warrant** in general, and specifically as pertains to the study.
 - Step 6. Assess the **link** between argument building blocks and the relevance of their content to the final conclusions (claims).
 - Step 7. Present the final conclusions (**claims**) stemming from the study (or refer to Step 1), corroborating with or contradicting the original thesis as stated in Step 2.

Table 1. Building blocks of the modern argument: Definition, their meaning, types and categories and location in medical articles. The following list includes six original parts (building blocks) of Toulmin’s model of argument analysis (points 1-6): Claim(s), grounds, warrant(s), backing, qualifier(s), and rebuttal(s), with the argument as a whole and the problem in context (thesis) added. Reworked from several sources [7–10,42,43,49].

Definition	What it does	Classification, examples, comments. Location in an article
Argument as a whole:		
Structured path from an initial idea, across series of considerations (building blocks), leading to a conclusion (claim) confirming, rejecting, or modifying the triggering thought about the problem	Defines the problem in context(structured question, hypothesis, setting), gathers and critically appraises each argument building block with an attention to a proper link between them up to the final claim	Simple: A single claim in support of the arguer’s contention. Chain: Series of claims linked so that they build on one another. Cluster: A number of claims independently pointing to the same conclusion
A “does it make sense, what was learned, what next?” statement		It’s the article as a whole
Problem in context or thesis:		
An ensemble which includes to a various degree hypothesis, research question(s), setting, study objectives, initial impression of the problem under reflection	Proposes an original operational and structured idea to be evaluated by an argument process	To be meaningful and useful for interpretation, the original idea must be supported by a clear hypothesis, question, setting of the problem, and objective(s) of the critical process of argument building, analysis, and evaluation
A “what exactly is the question” statement		It’s in the ‘Introduction’ section
1. Claim:		
Conclusion drawn by the end of reasoning path (argument); thesis drawn from or evaluated by the study	Confirms or modifies the thesis initiating the argument; generates a new thesis from findings	Factual: Does it exist, what is, was, or will be. Definitional: What it is, how to classify it? Causal: What caused it, what will this produce? Value asserting: Is it harmful or beneficial? Good or bad? Policy/direction giving: What we should do
A “what do we think about it” statement		It’s in the ‘Title’ and at the core of the ‘Conclusions’ of the article
2. Grounds: (syn. data, support)		
Data and/or information that support the claim	Provide essential and direct basis for the claim	It’s in the ‘Material and Methods’ and ‘Results’ sections
A “facts and evidence” statement		
3. Backing		
Information which justifies and makes explicit the warrant. Experimental and theoretical foundations from other sources	Provides additional information and clarification(s) for the warrant. Justifies the move from grounds (data) to the claim. Offers cultural assumptions, support, and the theoretical basis for the warrant	It’s usually in the ‘Literature Review’ section
A “given that” statement		
4. Warrant:		
Explanation of how grounds support the claim; general (other) statements, assumptions, prepositions bridging claim and data. Information about arguer’s reasoning	Shows how grounds support the claim. Justifies the move from data and/or backing to the claim	It may be located in several sections of an article
A “general wisdom about” statement		

Table 1. Continued. Building blocks of the modern argument: Definition, their meaning, types and categories and location in medical articles. The following list includes six original parts (building blocks) of Toulmin's model of argument analysis (points 1-6): Claim(s), grounds, warrant(s), backing, qualifier(s), and rebuttal(s), with the argument as a whole and the problem in context (thesis) added. Reworked from several sources [7-10,42,43,49].

Definition	What it does	Classification, examples, comments. Location in an article
5. Rebuttals (syn. reservations):		
Circumstances invalidating the claim	Defines limits of the claim. Offers counter-arguments. Specifies conditions under which the claim does not apply	They should be in the 'Discussion' section
An "unless" statement		
6. Qualifier (syn. modality)		
Arguer's degree of belief or certainty about the claim	Quantifies strengths and limitations given by the reasoning process and its building blocks to the claim	<i>Some, many, often, probably, certainly, quite, presumably, surely, definitely, almost certainly, may, with a 75% probability, etc.</i>
A "conviction" statement		
		It should be located in the 'Conclusions' section of the article

Step 8. Specify and justify the degree of certainty about the final claim. Specify all important qualifier modulators, i.e. elements strengthening or weakening the final claims). Quantify in the most realistic way possible the certainty about the claim (**qualifier**). If relevant and appropriate, specify critically the technical and factual limitations of the study and the circumstances and conditions in which its claim does not apply (**rebuttals**). Wherever required, assess how fulfilling the criteria of causality met by the study results justifies the certainty about the final claim. Set the qualifier.

Step 9. In presenting the **argument as a whole**, make clear if 'all this makes sense, what was learned, and what to do next'.

Case by case, the elements listed in Figure 1 and Tables 1 and 2 help clarify, specify and complete the ten above-mentioned 'logical' components of the article's 'Discussion' section and beyond. How solid is each and every argument building block as evidence? Does each block really follow from the block that precedes it? Does each block specifically and sufficiently support the blocks that follow it?

2. **In terms of lateral thinking**, you may consider quoting additional impressions and gut proposals as **considerations substantiated by sources beyond the study**.

Topics, such as:

- **What it means in the larger context** (implications of results for practice and research),
- **Future endeavors** (directions on what to do next, assessment of the relevance of findings),
- **Other ways to consider** (alternative interpretations and hypotheses) the,
- **Essence of the problem** (balanced analysis of arguments from various perspectives), or,
- **Other points to ponder** (identification of findings that suggest alternatives beyond the study) all largely rely on lateral thinking.

CONCLUSIONS

Is this drive for better argumentation in medical articles entirely new? Not quite. As an example, Clarke et al. [74,78] deplore the lack of search, evaluation and reference for systematic reviews in support of findings from clinical trials. The most important guidance for clinical trials reporting itself comes from the CONSORT (Consolidated Standards for Reporting Trials) Group [64]. Similar guidance is needed for other types of medical research and reporting. In other words, these authors are pleading for a better and more complete backing leading to a clinical trial's claim that the treatment works or not. Similar initiatives on how to improve other building blocks in medical argumentation will certainly follow.

If a health sciences article is also an expression of logical thinking as recommended by some [4-6,42,43], the critical appraisal of critical and logical uses of evidence and argument backed claim(s) from the standpoint of modern argumentation remains the essence of any discussion of a health problem and question under study. Moreover, it also values the essence of our contribution to medical problem solving. As already stressed elsewhere [79], elements of logic and critical thinking appear as a natural, additional and complementary domain to epidemiology and biostatistics that supports evidence-based medicine, nursing, and public health both at the patient and community level. An evidence-based approach to a health sciences article involves both the critical appraisal of each of the argument components ('evidences' themselves) and how such evidences are logically linked together on their path from original idea (thesis) to the final claim.

Let us now work on writing and reading 'Discussion' sections of medical articles in keeping with the indications above. The greatest challenge will be to ensure that the components and architecture of the modern argument are compatible with the IMRAD medical article structure. The second much less serious challenge for today's physician-writers remains changing their printer toner cartridge. But already, we digress.



Table 2. Topics and desirable characteristics of 'Discussion' sections in medical articles as they appear across the literature.

Topics and characteristics to cover and include
• Summary of major findings [8,11,19,22,24,36,37,58,60,73,74], what we learnt [68]
• Their interpretations. Mechanisms explaining findings and their meaning [43,60,62,68,69]
• Problems with methods and techniques used [62,64]
• Comparison of similarities and contrasts with other studies in the literature [19,24,35–37,61,64,66,67,70,72,75]
• Causal language only where warranted [68]
• Results' implications for practice and research [1,61,62]
• Conclusions made [22,24,37,61,62] as warranted by data including evidence for each conclusion [70]; understanding of the problem in light of the study [35]
• Directions for future research [3,19,20,22,31,37,60,62,64,69,73]
• Relevance of findings and domain(s) for which findings are relevant [59,65], including care [72,73] and health policies [77]
• Controversies [73,77], unresolved questions [3,58,60], biases [65]
• Assessing evidences for conclusions [65,66]
• Weak, missing, and desirable evidences listing [64]
• Link between theses, conclusions, study design, methods, findings [24,35,65,69]
• Study limitations [59,65,74] and uncertainties [66]
• Alternative interpretations and hypotheses [37,41,64,67]
• Statistical vs. practically meaningful differences [63,65,70]
• Subjective views in interpretation of findings [65]
• Anomalies in the data and their impact on conclusions [67]
• Study strengths, weaknesses and limitations [3,19,24,37,58,60]
• Balanced analysis of arguments from various perspectives [43]
• Findings that support study hypothesis and those suggesting alternatives [22,37,68,72]
• Unexpected results [20,25,72]
• Patterns seen in the data [20]
• Argument(s) is(are) coherent and logical [43]
• Logic used is described [37]
• Ideas follow a logical flow [42]
• Generalizability of findings [63]
• Significance (importance) of findings [1,74]
• Form and topics to be avoided
Form and topics to be avoided
• Statements that are too broad [67]
• Overrepresentation of results [59]
• Unwarranted speculations [59]
• Inflation of findings' importance [59]
• Tangential issues [59]
• Attacks (not critical appraisals) of other studies and their authors [59]
• Uncritical simple restatements of other studies [43]
• Emotional appeals to the reader [73]

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