

EDITORIAL

Let me be clear...

Daniel I. Sessler* 

Center of Outcomes Research, Department of Anesthesiology, UTHealth, Houston, TX, USA

*Corresponding author. E-mail: Daniel.Sessler@UTH.TMC.edu

Summary

Well-written scientific and medical manuscripts convey precise meaning and are therefore likely to sway opinions and effect change. Clear publications disseminate ideas and perspectives, making them likely to be published, read, and cited. Here, I share some suggestions that make writing forceful, easy to understand, and more effective.

Keywords: grammar; manuscript preparation; medical writing; scientific communication; writing

There are many articles about manuscript preparation,¹ writing in general,^{2–5} and even articles on how to write concise and informative titles.^{6,7} Building on these, I offer suggestions that will make writing clearer, easier to read, and more forceful. None of these suggestions is specific to scientific writing and each will enhance almost any professional text.

Clear writing requires clear logic

In July of 1985, I received one piece of mail during my initial week as a faculty member at the University of California in San Francisco. It was a university report on a subject I no longer recall. Not yet being experienced enough to toss that type of mail, I read the executive summary. The writing was exquisite and the logic was perfectly clear; no previous knowledge was assumed, and every word conveyed meaning. It was an epiphany, and I remember saying to myself 'this is how to write'.

I should have learned earlier. I will never forget a mentor's all-too-evident frustration, saying 'write what you mean, write what you mean'. It was great advice. Although it might seem obvious, clear writing requires a clear understanding of the message you seek to deliver. Merely putting text on a page will not fix logical flaws. It is therefore best to delay writing until you firmly grasp your logic and arguments. Once the logic is clear in your mind, crafting sentences becomes easy. Similarly, avoid writing 'around the topic', which forces readers to

guess what you are trying to say. Too often, they will guess incorrectly and lose the thread of your logic.

Write concisely and precisely

From another mentor, I learned to write concisely. She had two rules. The first was to always use the most precise word available to transmit as much information as possible. The English language is blessed with more words than most languages, and each word has a specific meaning and connotation, and often more than one (I recognise the challenge this presents to non-native English speakers). Select words that convey exactly the meaning you want. For example, use 'case-control', 'retrospective cohort', or 'trial' rather than the generic term 'study'. Use 'randomised' rather than 'assigned', and 'concentration' rather than 'value'. If all your subjects are female, write 'women' rather than 'patients'. Similarly, consider the following sentence: 'We hypothesise that patients receiving perioperative ketorolac will have a significantly shorter hospital length of stay compared with patients receiving a placebo.' It is accurate but would apply perfectly well to an observational analysis. If describing a trial, it would be clearer to write: 'We will test the hypothesis that hospitalisation is shorter in patients randomised to perioperative ketorolac than placebo.'

Along those lines, do not make readers guess what you mean. Use directional words when possible such as 'improve' rather than 'affect', and 'reduce' rather than 'change'. For example, consider the following: 'Anaesthetic selection is

considered a critical factor in perioperative management and clinical outcomes. The rationale is that anaesthetic management during this critical phase may affect long-term neurological recovery by impacting haemodynamic stability and potentially involving immune modulation.' Those sentences will leave readers trying to guess what you mean, and they will sometimes guess incorrectly. Instead, write exactly what you want them to understand, such as: 'Optimal anaesthetic management may improve long-term neurological recovery by maintaining haemodynamic stability and reducing activation of harmful inflammatory cascades.'

The second rule was that if a word can be removed from a sentence without changing the meaning, it should be. For example, 'was found to be' means the same thing as 'was'. Also, consider the following sentence: 'The analysis of exhaled breath has emerged as a promising, noninvasive approach for detecting a wide variety of substances and diseases, offering new perspectives for both clinical diagnostics and pharmacological research.' The sentence is grammatically correct and accurate. But it is flabby and forces readers to sort many words to identify ones that convey meaning. It is better to eliminate superfluous words, leaving only the ones that matter. Resulting sentences will be clearer and more forceful. For example, 'Analysis of exhaled breath is a promising noninvasive approach for detecting disease and quantifying drugs' conveys the same meaning in half the number of words, leaving no ambiguity. The same is true for paragraphs: if a sentence can be removed without changing the meaning, it should be. Perhaps the most common example is 'Our study has several limitations. The first is...' Instead, simply start the paragraph with 'A limitation of our analysis is...'

Make your perspective clear

Technical writing is usually designed to deliver a specific perspective. One way to convince readers is to present a series of plausible and referenced sentences leading to a conclusion that makes your perspective explicit. A useful format is: 'Something is true. [references] Something else is true. [references] And this is true too. [references] Therefore, (some conclusion follows).' Readers will stay with you so long as each sentence rings true and the conclusion follows logically. Use a series of such paragraphs to build your argument. Do not skip logical steps or assume previous knowledge. Instead, make your logic irresistible. So long as readers are convinced by each sentence and the conclusion of each paragraph, it will be hard for them to avoid the specified conclusion for your article.

Many languages have noun and preposition forms that vary with context and guide readers to the conclusion. In such languages, verb position is less critical, and verbs are sometimes positioned near the end of sentences. But in English, it is best to position verbs near the beginning of sentences so readers will know its purpose. For example, consider the sentence: 'In our medication protocol, after completing the initial examination and confirming that patients met fasting requirements with stable vital signs, the anaesthesiologist prescribed the sedation regimen.' This 26-word sentence is not technically wrong. But it is hard to understand because readers will not know what it is about until word 23. English sentences are far clearer when verbs are positioned towards the beginning (and excess words are eliminated). For example, 'Patients were sedated after they completed an initial examination, fasting was confirmed, and vital signs were stable.'

Use transition terms to link sentences

Transition terms guide readers from sentence to sentence. Words such as 'therefore', 'consequently', and 'in contrast' indicate the relationships among ideas. For example, consider the following paragraph:

If the month after surgery were considered a disease, it would be the third most common cause of death worldwide. Complications with the highest attributable risk are bleeding, myocardial injury, and sepsis. Myocardial injury after noncardiac surgery is defined by troponin elevations believed consequent to cardiac ischaemia. Most myocardial injury is asymptomatic. At least four national bodies including the American Heart Association recommend routine troponin screening in moderate-to-high-risk surgical patients. One in seven patients with perioperative myocardial injury will have a myocardial infarction within 16 months. Treatments include aspirin, statins, angiotensin converting enzyme inhibitors, anti-coagulation, heart rate and blood pressure control, and lifestyle interventions.

There is nothing technically wrong with this paragraph. The grammar is correct, and the statements are true. But it lacks guidance about the relationship among the sentences. Many readers will not make the mental effort to guess your logic. Others will try but come to conclusions that you did not intend. Consider how much clearer the same series of sentences is after insertion of just two guiding words:

If the month after surgery were considered a disease, it would be the third most common cause of death worldwide. Complications with the highest attributable risk are bleeding, myocardial injury, and sepsis. Myocardial injury after noncardiac surgery is defined by troponin elevations believed consequent to cardiac ischaemia. **Because** most myocardial injury is asymptomatic, at least four national bodies including the American Heart Association recommend routine troponin screening in moderate-to-high-risk surgical patients. One in seven patients with perioperative myocardial injury will have a myocardial infarction within 16 months. **Consequently**, patients with perioperative myocardial injury should be considered for treatments including aspirin, statins, angiotensin converting enzyme inhibitors, anti-coagulation, heart rate and blood pressure control, and lifestyle interventions.

Avoid large parenthetical clauses

There is a role for parenthetical clauses, for example: 'Patients given propofol experienced one-third as much nausea as those given sevoflurane (11% vs 29%, $P=0.023$).' But in general, sentences that require substantive parenthetical text are structurally flawed. It is generally best to discard the original and start anew. Often, substituting two sentences for the original results in clearer text. For example, consider: 'Movement-evoked pain intensity (pain score was assessed during three forced coughs or deep breathing, with the highest NRS score being recorded) and pain intensity at rest were evaluated daily during the initial three postoperative days.' The sentence is clearer rephrased as: 'Pain intensity at

rest and with movement were evaluated daily during the initial three postoperative days. Pain with movement was defined by the worst NRS score during deep breathing or three forced coughs.'

Avoid abbreviations

My first paper was a review of malignant hyperthermia for the *Journal of Pediatrics*. My submission was returned by the editor-in-chief with a forest of red ink on the typed pages (what a gift to a resident!). Notably, he eliminated my abbreviation 'MH' throughout the article. Avoiding 'MH', even in a review on the topic, trivially increased manuscript length while markedly enhancing comprehension. It was an important lesson.

Your job is to express information as clearly as possible, not to save journal space, especially because we are increasingly just dealing with electrons. Abbreviations that seem normal to you (ASA, PACU, and MAC) will not be clear to readers from other fields. They may also be misinterpreted, such as minimum alveolar concentration vs monitored anaesthesia care. Abbreviations must be defined, of course. But defining abbreviations is less helpful than avoiding them because most readers jump through text rather than reading linearly. Readers thus often miss abbreviation definitions, even if they could remember all of them. Facing a word salad of abbreviations, few will go back and try to find the definitions; most will simply skip to the next article. Your article will be more influential and more often cited if you avoid abbreviations other than standard units. Along those lines, avoid meaningless group designations. 'Group P' has no intrinsic meaning, whereas 'patients randomised to paravertebral analgesia' will be clear even to a reader who starts mid-article, as many do.

Avoid false precision

Avoiding false precision enhances clarity and accuracy. Consider the following result: 'Median opioid use in morphine equivalents was 50.45 mg (IQR, 17.82–121.98 mg) and 57.76 mg (IQR, 24.34–150.87 mg).' Even one decimal is not justified by interquartile ranges that exceed 100 mg. But even if the decimals were statistically justified, they are clinically meaningless because no one cares about a fraction of a milligram of morphine. How much clearer and accurate the sentence was as originally written: 'Median opioid use in morphine equivalents was 50 mg (IQR, 18–122 mg) and 58 mg (IQR, 24–151 mg).' Use decimals sparsely, and only when justified both statistically and clinically. From a clinical perspective, fractions of milligrams, kilograms, mm Hg, etc., are rarely justified. Similarly, unless you have at least 500 patients per group, percentages of patients should be expressed as whole numbers. Even then, fractions of a percent are rarely clinically justified. By convention, odds ratios and relative risks are usually expressed to two decimals, and P values to three.

Strategies to enhance clarity

Use words accurately. Do not write 'consecutive patients' unless you enrolled every single one. 'Bias' is defined by nonrandom group allocation; it is not a general term for anything that can go wrong. For example, subject selection criteria influence generalisability, but do not constitute bias as selection occurs before randomisation. 'Rate' refers to an outcome

that varies over time; incidence is not a rate. 'Trend' similarly refers to results changing over time; it does not mean 'nearly significant'. The biological variable is 'sex' not 'gender'. 'Blockade' is a naval manoeuvre; nerves are 'blocked'. Along those lines, use the simplest form of words and simple rather than complex words: 'advancement' means the same thing as 'advance'; 'usage' means the same as 'use'; 'dosage' means the same as 'dose'; 'underwent' just means 'had'.

A simple trick is to use plural forms to avoid clumsy 'he or she' phrasing. For example, 'If a patient has an elevated postoperative troponin concentration, he or she should be referred to cardiology' (17 words) would be better written as 'Patients with elevated postoperative troponin concentrations should be referred to cardiology' (10 words). The revised sentence is shorter and clearer, and every word conveys meaning.

Avoid 'respectively' sentence structures which are easy for writers but hard on readers. For example, consider the sentence: 'Patients with a score of 0, 1, 2, or 3 had expected 30-day mortality of 5.2% (95% CI, 3.3–7.4), 10.2% (95% CI, 6.5–11.9), 19.0% (95% CI, 8.7–24.3), and 32.5% (95%, 10.6–45.9), respectively.' The difficulty is that readers must jump back to the beginning of the sentence to understand what condition each clause refers to, and that it is easy to miscount and attribute an outcome to the wrong condition. How much clearer the sentence is written as: 'Patients with a score of 0 had a 30-day mortality of 5.2% (95% CI, 3.3–7.4); those with a score of 1 had a mortality of 10.2% (95% CI, 6.5–11.9); those with a score of 2 had a mortality of 19.0% (95% CI, 8.7–24.3); and those with a score of 3 had a mortality of 32.5% (95%, 10.6–45.9).'

Well-written articles are most likely to be accepted, read, and cited

Professional writing is not colloquial and should use standard English. It should also be vivid. Stilted writing is hard to read and understand. A good rule-of-thumb: professional writing should resemble a conversation with a respected senior colleague. Text that does not sound natural when read aloud will benefit from revision.

Once, after he published an article in a prominent journal, my chemist brother commented that the paper was a 'triumph of writing over science'. He was joking, of course. His science was superb. But it was also true that the article probably would not have been accepted if the writing had been marginal. In summary, then, make yourself convincing. Concise, forcefully written manuscripts disseminate your ideas and perspectives effectively, and are likely to be published, read, and cited.

Declaration of interest

DIS serves on advisory boards and has equity interests in Calorint (Philadelphia, PA, USA), TransQtronics (Philadelphia, PA, USA), the Health Data Analytics Institute (Boston, MA, USA), Medasense (Tel Aviv, Israel), and Perceptive Medical (Newport Beach, CA, USA). He consults for Dynacardia (Cambridge, MA, USA), Diagnostix (Groningen, The Netherlands), and Forge Laboratories (Lubbock, TX, USA). He occasionally consults for temperature-related companies, with all fees donated to charity. He is a Senior International Fellow at the Population Health Research Institute, McMaster University (Hamilton, ON, Canada). None of these potential conflicts is relevant to this editorial.

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