

Writing Research Reports

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Clear writing makes manuscripts easier to understand. Clear writing enhances research reports, increasing clinical adoption and scientific impact. We discuss styles and organization to help junior investigators present their findings and avoid common errors. (Anesth Analg 2018;126:330–7)

CLARITY ENHANCES COMPREHENSION

Your goal in writing a paper is to communicate a scientific result and your conclusions about its meaning. Your goal is to be as clear as possible. Do not make simple concepts appear complicated and therefore important. Do not pad your paper with unnecessary references. Do not drag readers through personal disputes.

Clarity is your responsibility. Science is compromised when authors force readers to struggle unnecessarily. Reviewers do not like unnecessarily complicated papers. Readers will skip them too. Poorly written research reports, when published at all, are unlikely to advance science, patient care, or your career.

Professor Andrew Sessler's sage advice, offered as director of the Lawrence Berkeley Laboratory to a young Dan Sessler 45 years ago, was "write what you mean." It might seem obvious, but often authors fail to explain methods, skip logical steps, or present ambiguous conclusions. Readers are left guessing. Say what you mean. Present your findings carefully, and draw valid conclusions clearly, so readers can follow your paper without mental gymnastics.

For example, the paragraph below is grammatically correct and scientifically accurate:

There are compelling mechanistic reasons to believe that supplemental inspired oxygen might reduce infection risk.^{1–3} Greif et al⁴ reported that supplemental perioperative oxygen halves the risk of surgical site infection in 500 patients. Belda et al⁵ reported a factor-of-two reduction in 300 patients. Meyhoff et al⁶ reported no benefit in 1,400 patients. Kurz et al⁷ reported no benefit in 550 patients.

But this paragraph presents a series of unlinked and seemingly contradictory facts. Perhaps the author's point is that the literature is a confusing morass of contradictory findings. Perhaps the author is showing how more recent studies fail to confirm basic science results and smaller pilot studies. Is the author's point that supplemental oxygen reduces risk or has no benefit?

The paragraph below guides readers through the logical steps leading to the author's conclusion:

Consistent with mechanistic reasons to believe that supplemental oxygen might reduce surgical site infections,^{1–3} two initial trials with a total of 800 patients reported that supplemental perioperative oxygen halves the risk of surgical site infection.^{4,5} However, more recent trials (n=1,400 and 550) did not identify any benefit.^{6,7} It is unclear why benefit was not seen in the more recent trials, but inconsistent results among large studies suggests that the benefits of supplemental oxygen are not readily reproducible.

In this second example, sentence transitions and logic help readers understand that the author is explaining the difficulty of interpreting the existing literature. The author invites readers to be appropriately skeptical when large studies give inconsistent results.

A common taxonomy of writing styles is narration, description, exposition, and argumentation⁸. Narration is used to tell a story. Description is used to describe an event or activity. Exposition is used to explain something. Argumentation is used to convince readers. Scientific writing should generally be descriptive: describe your study, describe your results. There is a role for narrative as well. You are describing your adventure, something in which you invested part of your life. It is acceptable to share with readers a sense of adventure, mostly through the use of active voice. Exposition helps readers understand your methods and explain scientific or medical principles that underlie your findings.

Argumentation has a role in the introduction and discussion. The introduction should convince readers (just as you earlier convinced yourself) that this work is important. The discussion should help readers understand how you reached conclusions from your data, why you believe your findings support some previous studies, and why you believe your data provide evidence against conclusions drawn from other studies.

Argumentation must be done with a light touch. Professor Lewis Sheiner, one of Dr Shafer's mentors, advised his trainees to "let the data speak."^a Letting your data speak requires that you draw conclusions from your data honestly and without hyperbole, bias, selective reporting, or cherry picking published confirmatory research. Importantly, if you let your data speak, then your paper will always contribute to the sum of knowledge even if your conclusions are eventually proven wrong.

There are several excellent texts on clear writing. We recommend the classic book *The Elements of Style* by Strunk and White.⁹ Strunk and White⁹ advocate simple, declarative sentences well suited to scientific writing. There are additional style guides.^{10,11} The International Committee of Medical Journal Editors promulgates widely accepted guidelines for

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manuscript preparation.¹² Neill¹³ offered an excellent set of guidelines in the *Journal of Clinical Investigation*. *On Writing Well* by Zinsser¹⁴ offers advice on precise English. The 2010 *Anesthesia & Analgesia* Guide for Authors has specific instructions for clear writing.¹⁵ Many of our recommendations are adapted from these sources.

There are consensus guidelines for randomized trials (CONSORT),¹⁶ registry analyses (STROBE),¹⁷ meta-analyses (PRISMA),¹⁸ and prediction analyses (TRIPOD).^{19,20} These guidelines were developed to improve the clarity of research reports. Competent reviewers will expect all components of the relevant guideline to be included in a manuscript.^b

STRUCTURE OF A RESEARCH REPORT

Cover Page

The title is the most visible part of your article. It should convey as much information as practical. When possible, specify the study population (or species or cell line), the type of study, and the primary outcome. For example, the title “Mild Intraoperative Hypothermia Increases Blood Loss and Allogeneic Transfusion Requirements During Total Hip Arthroplasty in Elderly Patients: A Randomized Trial” is far more useful to readers than “Hypothermia and Blood Loss.” Titles, along with key words, are used by search engines; an accurate title thus increase the chances of your article being identified and potentially cited. Elia and Tramèr²¹ offer helpful recommendations on writing good titles.

Authorship can be a source of conflict among collaborating investigators. A detailed discussion is beyond the scope of this paper, but the International Committee of Medical Journal Editors guidelines offer widely accepted criteria for authorship.²²

Abstract

Most journals offer explicit instructions about the abstract structure and format. The abstract should mirror both the organization and the focus of the manuscript, which may only be evident after the manuscript is completed. We thus prefer to write the abstract after the manuscript.

The basic elements of an abstract are the background section, the methods section, the results section, and the conclusions section. The background section should be brief, with typically 1 or 2 sentences. The methods section should state the population studied, the basic methodologies in the study, and the statistical analysis used. The results section should state the number of subjects studied and the key findings including point estimates, confidence intervals, effect sizes, and *P* values. The conclusions section should state in 1 or 2 sentences precisely what the study data support. Since few studies are definitive, avoid claiming that you have proven that a theory is true or false.

Introduction

The introduction explains why the study was done. Good science starts with a good question. The introduction is where you convince the readers (and reviewers) that your question is important. In a few succinct paragraphs, educate your readers about the importance of the topic, explain

what aspects remain controversial or unaddressed, and identify the specific hypotheses that will resolve the debate or fill in missing knowledge.

The introduction is not a review article. In designing and completing studies, you become expert in the field. You can demonstrate your expertise by condensing the information succinctly into exactly what the readers need to know to interpret the study that follows.

A conventional 3-paragraph introduction proceeds, funnel-like, from general context to the controversy or missing information to study questions to specific hypotheses. Each sentence becomes more specific than the proceeding one.

For a clinical study, an epidemiologic perspective can immediately set the stage:

About 2% of surgical inpatients die within 30 days, corresponding to some 4 million annual deaths worldwide.²³ In fact, if the postoperative period were considered a disease, it would be the third leading cause of death in the United States.²⁴ There is little evidence that postoperative mortality is improving, making death after surgery a major cause of potentially preventable mortality.

The second paragraph narrows the focus:

Postoperative mortality is not randomly distributed. Instead, it is highly predictable from baseline characteristics and, to a lesser extent, the proposed procedure.²⁵ However, these risk factors are for the most part unmodifiable. In contrast, perioperative hemodynamic management is very much under anesthesiologists' control.

From 2 succinct paragraphs, readers know that the study topic is the relationship between hemodynamic control and postoperative death. It is not helpful to add “Important predictors of postoperative mortality include a history of cardiovascular disease, cancer surgery, advanced age, and urgent or emergent surgery. Other potentially modifiable factors include anesthetic technique, guided fluid management, and discharge to a skilled nursing facility.” These 2 sentences, although true, would distract readers from the ever-narrowing funnel guiding readers to the hypotheses.

The final paragraph of the introduction should establish the specific question to be addressed and state the hypotheses:

There is a strong association between intraoperative hypotension and myocardial injury^{26,27} and death,²⁸ and a weaker association between hypotension and acute kidney injury.^{26,27} But it remains unknown whether these associations are causal or simply reflect underlying disease. We thus tested the primary hypothesis that preventing and aggressively treating intraoperative hypotension reduces a collapsed composite of 30-day myocardial infarction and death in patients having non-cardiac surgery. Secondarily, we tested the hypothesis that preventing intraoperative hypotension reduces the risk of acute kidney injury.

In most cases, the last sentences of the introduction should be the primary and secondary hypotheses. Hypotheses are not vague aims; should be expressed in the present tense; and include the species/population, intervention/exposure, outcome including measurement timing, and expected direction of effect. This sample introduction contains <200 words; more would not help.

Methods

Reproducibility is fundamental to science. The methods are the most important part of a research report; they create the

^b“Manuscript” and “paper” are not synonymous. A manuscript is text before it is published, whereupon it becomes a paper.

framework for reproducibility. It is your responsibility to describe the methods in sufficient detail that another investigator can reproduce your study.

The methods may be the easiest part of a research report to write if you can cut-and-paste them from the protocol submitted for ethics review, external funding, or departmental review. Include enough detail so that one skilled in the art can replicate the study. Specific references to published methods, techniques, or procedures should be cited rather than repeated. In a clinical trial, “standard-of-care” details do not need to be reported.

However, it is annoying to read a paper that cannot be interpreted without looking up previously published papers, which may be unavailable. Find the right balance between adequate and excessive detail. Peer reviewers can provide feedback on how much detail is necessary.

If you use the same methodology as in a prior study, then describe the methodology in the same words. Otherwise, readers may wonder why you changed the description. Do not worry about self-plagiarism; it is an oxymoron.²⁹ Match the order of your results to the order in your methods. While the methods and results sections will never be perfectly parallel, if they proceed in roughly the same order, readers will more readily understand your study.

Typically, the methods section consists of 4 subsections: subject selection, protocol, measurements, and data analysis. This order should be respected whether or not you use subheaders.

Subject Selection. In an animal study, subject selection includes the species, size, age, and source. In a clinical study, the subject selection describes the inclusion and exclusion criteria. It is also where investigators specify the nature of institutional approval and study registration.

Protocol. The protocol section describes what was done, with a focus on research-related interventions. Excessive detail, such as how anesthesia was managed, should be reduced to something like “general anesthesia was induced with propofol, opioid, and a muscle relaxant, and maintained with a volatile gas.”

Nonstandard research interventions should be precisely described. In particular, fully describe the randomization process and assigned interventions. The randomization section should include the method (ie, computer generated), blocking, stratification, ratio, and how allocation was concealed. If the study is blinded, the study should describe who was blinded and what interventions were made to ensure blinding. The interventions should be described in detail. If one of the interventions is “standard management,” explain what this means at your institution.

Measurements. Avoid excessive detail about routine measurements that are not critical to the study such as “values from routine anesthetic monitors were recorded at 1–5-minute intervals.” Study-specific monitoring should be described in detail. A study about hemodynamics and myocardial injury would include how blood pressure was measured (ie, oscillometric versus direct) and which troponin assay was used (ie, generation 4 troponin T). It would also include exactly how often these measurements

were obtained. Technical aspects of nonstandard measurement should be provided, including the accuracy and precision of research assays.

Data Analysis. The data analysis section defines the outcomes in detail. In our example above, we identified myocardial infarction as a component of our primary composite. In the data analysis subsection, we would specify that infarctions were defined by the third universal definition of myocardial infarction,³⁰ that both troponin elevation and signs or symptoms were required, and that outcomes were centrally adjudicated by investigators blinded to treatment.

The statistical portion of the data analysis must contain sufficient data to help the journal’s statistical reviewer—and eventually the readers—assess whether the analysis was appropriate. Always explain why you decided to perform a study of a certain size. Ideally, your sample size was based on a formal a priori power analysis. However, if you enrolled patients until you ran out of money for the study or until your fellow finished training and left the institution, then say so. You stopped your study for a reason; to interpret your results, readers need to know why.

State the outcome you considered the primary outcome, the outcomes that were secondary outcomes, and how you adjusted your statistical analysis for multiple tests. If your outcomes changed during the study or analysis, explain when and why. Explain the statistical tests you performed, and how you validated that your data conformed to the assumptions of the statistical tests used. Explain how you calculated confidence intervals, effect sizes, and *P* values. Explain procedures for handling missing or improbable data. Describe any simulations you performed. If you statistically compared your results with previously published results, explain how you did so.

Rigorous statistical analysis is hard. Statistics have advanced well beyond the *t* and χ^2 tests we learned in medical school. Focusing on “*P* < .05” produces meaningless research. *P* values are so widely misused that some journals now refuse to publish them at all. Unless you have formal training in statistics, get help from a statistician.

Results

The results are the second-most important part of a scientific paper. You will generally want to follow the organization of the methods section. Start by describing the population. Give an overview of the data. Then address each measurement and discuss what you saw. From there, progress to your primary and secondary outcomes, then their detailed statistical assessment. You might conclude with simulations or statistical comparisons with other studies such as an updated meta-analysis. This approach provides a roughly parallel structure between your methods and your results.

We recommend that you start with tables that show your study population, your measurements, and your key outcomes. Wherever there is a point you want to make about your results, show it with a figure. If you think that the distribution of age in the study population is interesting, show it with a figure. If you think that the 2 groups in your population differ (eg, randomization failure), show it with a figure. Graph your key primary and secondary outcome measurements. The reason to use figures rather than tables

is that you want your readers to literally see what you see in your data. If you think you found something interesting, then find a way to graph your data so that anyone can see it. If you cannot create a graph of your data clearly showing a finding, then the finding is probably not important.

Every paper should include a “takeaway figure” that captures your primary result. This is the figure that (you hope) others will use when presenting your results in review articles, book chapters, and refresher courses. This is the figure you will include in your future presentations of the work. There are a number of published guidelines on how to present figures, the most famous being “The Visual Display of Quantitative Information” by Tufte.³¹ Here are several suggestions for your figures:

1. Remove “chart junk.” If any line, legend, or pixel does not contribute to the information, remove it. Figures 1 and 2 show how eliminating chart junk improves clarity.
2. Do not use 3-dimensional plots for 2-dimensional data. It just adds chart junk (see Figure 3).

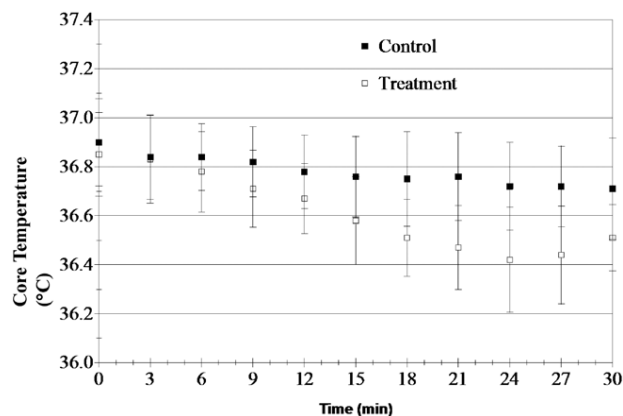


Figure 1. A poorly designed figure that contains 123 nondata elements versus only 44 data elements. Thus, only 26% of the figure elements provide real information.

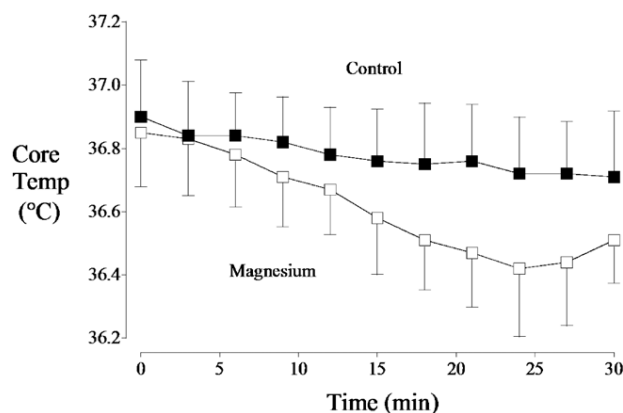


Figure 2. A well-designed figure showing the same information as in Figure 1. This case has only 32 nondata elements versus 44 data elements. Thus, 59% of the figure elements provide real information. A high ratio of data to “chart junk” enhances clarity. Important differences include: fewer axis values, horizontal text, elimination of gridlines and unnecessary tick marks, nonoverlapping error bars, series labels rather than a legend, and elimination of the upper and right axes.

3. Most journals will accept full-color graphics. Use color to add clarity to the figure. But since your figure may be reproduced on black-and-white copiers, vary your data symbols and line types, so that the figure is interpretable in black and white.
4. Link series across time or in the relevant dimension. Do not force readers to look across data types to see the relationship of interest. Figure 4 is an example where readers have to “overlook” sweating and vasoconstriction to see dose dependence of the shivering threshold—which is the major study outcome. This figure also uses a legend that is harder for readers than simply labeling data series. Figure 5 shows the same data, properly presented, with the dose dependence for each threshold clear at a glance.

Use an appropriate number of significant digits. Generally, the fewer significant digits the better. For example, “age 67.4 ± 5.8 years” is not warranted when age is reported to the year and is harder to understand than “age 67 ± 6 years.”³³

Once you have your tables and graphs, the results will nearly write themselves. You are a guide, giving the readers a tour of your findings. Using a descriptive style, describe

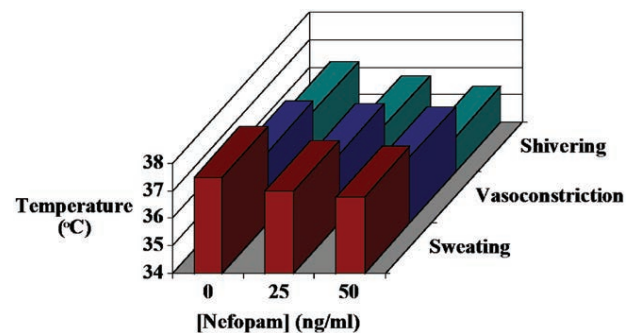


Figure 3. A poorly designed figure showing data from a study that evaluated the extent to which nefopam reduces the thresholds (triggering core temperatures) for vasoconstriction, shivering, and sweating.³² Note inappropriate 3-dimensional presentation of 2-dimensional data. It is usually hard to relate 3-dimensional values to specific axis values, often making the figures essentially useless. Try, for example, to estimate the threshold for vasoconstriction at 25 $\mu\text{g/mL}$.

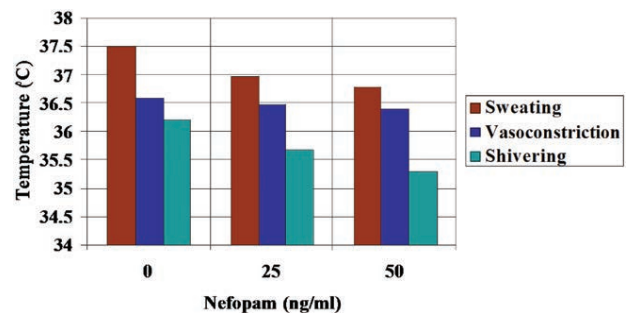


Figure 4. The data from Figure 3 now expressed in 2 dimensions. But this figure is also suboptimal in that it forces readers to look across data types to see the relationship of interest. Specifically, it forces readers to “overlook” vasoconstriction and shivering to see dose dependence of the shivering threshold—which is the major study outcome. This figure also uses a legend that is harder for readers to interpret than simply labeling data series.

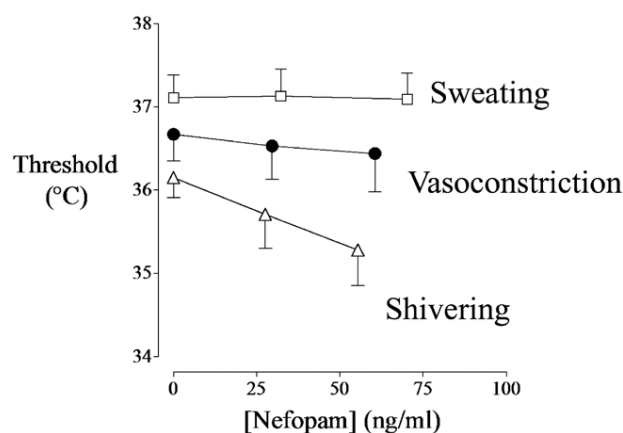


Figure 5. The same data as in Figures 3 and 4, now properly presented, with the dose dependence for each threshold clear at a glance.

the tables and graphs in approximately the same order that you introduced them in the methods section. Find the right level of detail. Just as a London tour guide will not describe every brick in Big Ben, you should not restate details from the tables or graphs in the text. Conversely, a tour guide will say more about Big Ben than “there is a clock on the left.” Do the same with your figures and tables. Your readers will appreciate your identifying salient aspects in the tables and graphs that merit attention.

Maintain focus in your results. Limit your tables and graphs to those that lead, as linearly as possible, to the formal analysis of your primary and secondary outcomes. Extra figures that lead elsewhere (eg, “Figure 45 shows the hemodynamic response in patient 27”) distract your readers from the logical progression from your observations to your primary and secondary outcomes.

It is surprisingly difficult to align language with the rigor required by formal statistical analysis. For example, consider a study with only 3 patients. The 2 patients who received drug A had a better outcome than the 1 patient who received drug B. You may want to say “most patients in group A did better than did patients in group B.” This is technically true but misleading. Similarly, consider the apocryphal report: “three-quarters of the animals improved with treatment—and the fourth goat ran away.” Use wording that is both accurate and honest. Words matter.

Discussion

The discussion is the least important part of a scientific paper. Some purists even recommend that readers skip the discussion section and draw their own conclusions. Science is about what you did and what you observed: the methods and the results. The discussion adds little to the scientific importance. This is why discussions are often brief in basic science papers. But that said, it is usually helpful to provide context and interpretation for readers.

You have likely drawn conclusions about what your results mean. You also have insight into whether your results support or refute previous research findings. These can be presented using an argumentative style so that the reader understands how your data logically lead to your conclusions. It is okay to write persuasively, provided that

you are not cherry picking your research results, are objective in your logical arguments, and consider previous study results with equipoise.

One approach to writing a scientific discussion is to qualitatively remind readers of each major result, contrasting each with previous relevant reports. Summarizing the relevant result for each specific paragraph generally works better than starting the discussion with a summary of all results. It is also helpful to present results semiquantitatively. For example, readers are more likely to understand and remember that “pain lasted half as long in patients given the test analgesic” than if you present the exact results and variance. This typically requires a succinct paragraph for each outcome. Continuing with the theoretical results from our fictional study of tight hemodynamic management, we might have an initial discussion paragraph that reads:

Our primary result is that randomization to aggressive hypotension avoidance and management reduced the composite of myocardial infarction and death by about a third. The reduction was highly statistically significant with relatively narrow confidence intervals, suggesting that the benefit is robust. The reduction was presumably mediated by nearly a 50% reduction in time-weighted mean-arterial pressure <65 mmHg. It is apparent from our results that at least a fraction of the previously observed association between hypotension and myocardial infarction is causal and therefore amenable to intervention. Interventions to reduce the amount of hypotension may thus reduce the risk of myocardial infarction — which is the leading attributable cause of 30-day postoperative mortality.³⁴

This paragraph qualitatively reminds readers of the primary result, identifies the strength of the study, proposes a mechanistic explanation, and presents a clinical recommendation. Had there been relevant previous work, we would have included a comparison and discussion of similarities and differences in approach and outcomes.

The discussion is an appropriate place to defend the selection of one measurement technique approach over another; the dose, route, and duration of drug administration; and the choice of study population. This discussion is also the place to defend your primary and secondary outcomes and speculate how the results might have differed had alternatives been chosen.

All studies have important limitations. The discussion of limitations is an opportunity to thoughtfully present them and help readers understand the extent to which they might affect the results and conclusions. Being transparent about substantive limitations is also a matter of academic integrity and will be appreciated by reviewers. A reasonable approach is to include relevant specific limitations in the paragraphs that discuss various results and present broader limitations in a paragraph near the end of the discussion section. Focus on limitations that are real and substantial, and provide guidance as to their relative importance. Continuing with our sample report:

The components of our composite primary outcome were myocardial infarction and death. Death was included to limit survivor bias since myocardial infarction is the leading cause of 30-day postoperative mortality³⁴; but as might be expected, death was far less common than infarctions and our study was thus under-powered for death as a separate outcome. The effects of hypotension prevention and treatment on overall survival thus remains unclear.

As for any single-center study, results will likely differ elsewhere. Other centers, for example, might routinely tolerate less hypotension, thus reducing the benefit of aggressive intervention. Perhaps more importantly, our study was restricted to high-acuity surgical inpatients in a major medical center. Patients at lower risk will presumably benefit less. Surgical outpatients, for example, rarely have myocardial infarctions and rarely die; they are thus much less likely to benefit from aggressive hemodynamic management.

Our study was restricted to adult non-cardiac surgery. Pediatric patients seem less likely to benefit from preventing intraoperative hypotension — at least in terms of myocardial infarctions which are rare in the population; in contrast, we speculate that cardiac surgical patients may benefit more. Neosynephrine is the first-line treatment for hypotension at the Cleveland Clinic. While it seems likely that benefit was mediated by improved blood pressure control, results might well differ if hypotension were prevented by reducing anesthetic administration, guided fluid management, or use of an alternative vasopressor.³⁵

Discussion of preclinical studies should not focus on clinical implications, and discussion of clinical studies should not focus on putative mechanisms. Clinical investigators understandably discuss the clinical significance of their research findings. A sentence or 2 is fine, but be cautious extrapolating from a single result to an entire field, or opining on how the results should alter patient care. Drawing extensive medical inference from a single clinical trial, no matter how well powered and conducted, distracts from good scientific reporting. The broad inference should be done by editorials, reviews, meta-analyses, and consensus statements. Be a scientist. Discuss your results as a scientist. Let others, in an appropriate venue, draw the broad clinical conclusions and determine whether you have settled a controversy or finally slain a recurring medical myth.

The discussion usually ends with a summary paragraph that qualitatively presents the major results, along with their implications.

TIPS

Respect the section divisions in manuscripts. It is disconcerting for readers when elements are presented in the wrong place.

Scientific writing should be simple. Stilted language degrades writing, makes reports hard to read, and reduces comprehension and scientific impact. Write in a conversational tone, as if responding to a colleague who asked about your work. It is sometimes helpful to read text out loud. If you cannot imagine yourself saying what you just read, it should be rewritten until it resembles something you could naturally tell a colleague.

Wherever possible, write in the first person. The third-person singular passive voice reads as though the study performed itself: “blood pressure was recorded every 10 minutes.” Really? That just happened? Wow! Of course, the study did not perform itself. You and your colleagues are real people who invested time, energy, and tears in the study. Do not be afraid to say “we measured the blood pressure every 10 minutes.” It is more engaging for the reader. You are the narrator of the story. It is OK to be in it.

Avoid abbreviations. The *Anesthesia & Analgesia* guide to authors offers this summary: “AAWP: Avoid Abbreviations Wherever Possible.” Your job is to make the manuscript

as readable as possible. Journal space is cheap, as are ink and electrons. Even abbreviations that are well known in the specialty may be novel to other readers. Quoting the *Anesthesia & Analgesia Guide for Authors*:

Write as you speak. An electrocardiogram might be called an ECG, or EKG, so it is acceptable to abbreviate it as ECG or EKG (after it is spelled out on first use). However, spell out words if there is any possible ambiguity. This will help clarify the manuscript on morphine sulfate kinetics in multiple sclerosis patients with severe mitral stenosis undergoing maxillary sinus surgery analyzed with Microsoft Excel.

Strong writing uses the fewest possible words:

Excess Words	Stronger Writing
It has been shown that mild hypothermia significantly increases blood loss and transfusion requirements	Mild hypothermia increases blood loss and transfusion requirements
In order to treat intraoperative hypotension	To treat intraoperative hypotension
Our results indicate that updating risk stratification models with more recent diagnostic codes and data improved performance modestly	Performance improved modestly when risk stratification models were updated with recent diagnostic codes and data
We included a total of 67,702 adult patients	We included 67,702 adults
Ketamine is a drug that has been shown to be beneficial for treatment of depression	Ketamine is effective for depression

Moderating adverbs and adjectives often usually weaken a sentence: “there is a very strong association” is weaker than “there is a strong association.” Use specific words whenever possible. “Patients who had vascular surgery” is clearer than “patients who underwent major surgery.”

Sentences should be short, simple, and direct. Break a compound sentences into simple sentences. Paragraphs should be no longer than required to present a single, logical construct. Use paragraph breaks to alert readers to a new topic or logical unit.

Have someone edit your work. Every paper benefits from another reader assessing whether the text is clear. This is particularly important if English is not your native language. Editors, reviewers, and readers will not make the effort to struggle through a paper with poor English.

Avoid sentence constructions that impose an unnecessary cognitive load on readers. For example, “time-weighted averages of mean-arterial pressure and heart rate were 88 ± 9 mmHg and 70 ± 9 beats/minute, respectively” is less clear than “time-weighted average mean arterial pressure was 88 ± 9 mmHg. Average heart rate was 70 ± 9 beats/minute.” Parenthetical comments often reflect poor sentence structure (eg, this one). Writing in plural tenses usually reduces the number of words required and avoids clumsy “he or she” constructions. For example, “he or she was asked to roll left” is clumsy compared with “we asked patients to roll left.”

Verb tense is frequently confusing. Try to maintain past tense. It is correct that Table 1 shows (in the present) that group 1 had higher blood pressure than did group 2. However, going back and forth in tense is awkward. Find a construction that allows you to maintain past tense: “Patients in group 1 had higher blood pressure (Table 1).”

Use references appropriately. In general, you should cite the most recent, best, and most relevant articles. For fundamental observations, cite the original reference if possible. Confirm that citations say what you think they say. Position the citations precisely. For example, “mild perioperative hypothermia causes surgical site infections,³⁶ coagulopathy and increased transfusion requirement,³⁷ delayed drug metabolism,^{38,39} prolonged recovery,⁴⁰ and thermal discomfort⁴¹” provide more information than the same sentence with the references clustered at the end.

In summary, even great science will have little effect if readers cannot understand why you did the study, what your results are, and what they mean. Do not assume that readers will fight through dense, poorly written prose to understand your meaning. Most will simply skip to the next article. Concise, thoughtful writing makes complicated topics clear and understandable—and will much enhance the impact of your work. ■■

DISCLOSURES

Name: Daniel I. Sessler, MD.

Contribution: This author helped write and revise the manuscript.

Name: Steven Shafer, MD.

Contribution: This author helped write and revise the manuscript.

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