The anatomy of an article: Title, abstract, and introduction

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"Clarity, concision, organization and simplicity in a scientific report are legitimate aspirations for a reader who is going to devote time to learn about the investigation."
—Naim Sauaia, MD, PhD, 1982[1]

Scientific research articles have followed the basic architecture of introduction, methods, results, and discussion (IMRAD, Fig. 1) since the late 1970s, when the National Information Standards Organization published guidelines to standardize the reporting of original research.[2] Since then, there have been several initiatives addressing the content of these keystones of scientific communication, in an effort to standardize scientific reporting of medical research, many of which are cataloged by the international initiative titled EQUATOR (Enhancing the QUAlity and Transparency Of health Research) Network.[3] While the use of these reporting guidelines is strongly encouraged by the *Journal of Trauma and Acute Care Surgery*, they often lack sufficient granularity to guide authors on how to actually write scientific articles.

This is the second in a series of articles aimed at assisting authors in writing clear reports of their surgical investigations, while following the previously mentioned reporting guidelines and facilitating the translation of the findings into clinical practice. We started with the discussion section because it is a section for which reporting standards are relatively vague.[4] We now focus on the front matter of research articles, which encompasses the title, abstract, and introduction. The final article of this series will address the remaining elements of a research paper of the typical IMRAD format (methods and results sections).

TITLE: CATCHY BUT NOT MISLEADING

The title of an article must strike a balance between being succinct and informative while staying true to the data. It should be compelling enough to grab the attention of the audience, but the readers should not feel as though they have been hoodwinked or let down once they invest the time to read the entire report. Of course, journals have their own rules about articles, and the authors must abide by them when crafting their titles. When possible, we encourage titles that briefly summarize the main finding, such as "Multiple organ failure can be predicted as early as 12 hours after injury"[5] or "Limb salvage after complex repairs of extremity arterial injuries is independent of surgical specialty training."[6] As long as the data support such a statement, the title can inform the reader why they should read the article. Cals and Kotz[7] suggested that authors use key words (more on keywords in a subsequent section in this article) and verbs to formulate the title. In the two examples earlier, the key words *organ failure*, *injury*, *limb salvage*, *arterial injuries*, *specialty*, *medical* were linked by verbs to describe the main finding of the studies. A good title highlights the study's uniqueness, making it stand out from other articles in the same area.

In the ever-expanding electronic publishing world, traction is often gained via the title. Search engine algorithms, including those used by the National Library of Medicine and Google, assign the greatest weight to titles.[8] As of this writing, PubMed contained more than 23.6 million citations for biomedical literature.[9] Other less selective search engines such as Google Scholar reach much larger numbers. To improve the likelihood that readers would find your article in their online searches, construct a title that includes the most obvious search terms. The transition from a print to online readership, coupled with the proliferation of new publications, has increased the odds of research being overlooked. An example of a lost message is the 1982 publication entitled "Major abdominal vascular trauma—a unified approach."[10] In that publication, one of the current authors first described the "bloody vicious cycle," rediscovered two decades later as the "the lethal triad."[11]

If a journal accepts both basic and clinical studies, the title should also state whether the article reports basic or clinical research. Specific study designs such as randomized controlled clinical trials, multicenter and case-control studies, systematic reviews, meta-analyses, and long-term follow-ups should be highlighted in the title. The period covered by the investigation when presenting temporal trends and the geographic location, if it has an impact on the translation of the findings to individual clinical practices (e.g., Firearm injuries of children and adolescents in 2 Colorado trauma centers: 2000–2008[12]) may be included in the titles as well.

In summary, we recommend that the authors choose title terms that are informative. An ideal title would define a study without extrapolating findings beyond what can be supported by the data, while avoiding unnecessary verbiage.

ABSTRACT: THE MOST TRUTH IN THE LEAST SPACE

Although nearly all journals require structured abstracts for original articles, the form itself is relatively new. First

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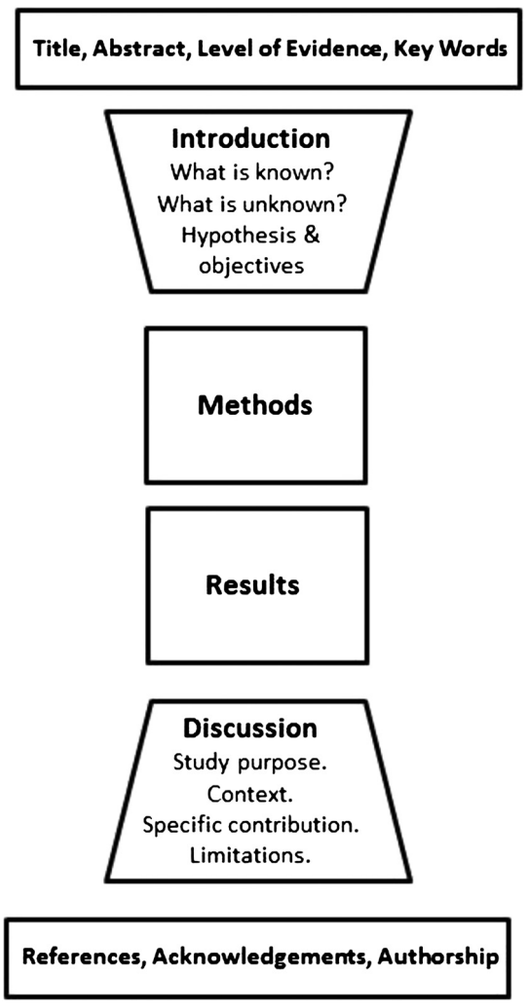

Figure 1. Diagram of the modified IMRAD [introduction, methods, results, and discussion] structure for research papers.

standardized in the late 1980s and early 1990s,[13] abstracts following the IMRAD format are now endorsed by both the International Committee of Medical Journal Editors: Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication (http://www.icmje.org, accessed January 22, 2014) and the CONSORT Group, the well-known international initiative to increase transparent reporting of trials.[14,15] Their ubiquity established, the importance of a well-written abstract cannot be underestimated. The conventions of online dissemination virtually assure that more people will have access to an abstract than its associated article; likewise, a poorly executed abstract may ensure that few will invest the time to actually read an article.

Abstracts, much like titles, call for economy of expression and completeness. If the journal enforces an upper word count—many, including the *Journal of Trauma and Acute Care Surgery*, limit abstracts to 300 words—every sentence must be maximally informative. Writing a short, informative abstract takes time and effort. Recall Mark Twain's famous quote, "I apologize for the long letter, I did not have time to write a short one."

We recommend starting with a broad statement of the problem at hand or immediate context of the study question (e.g., "Recent studies suggest that intraluminal pancreatic enzymes play a major role in the initiation of the inflammatory cascade by the gut after hemorrhagic shock."[16]) This should be followed by a clear statement of the present study's design and objectives ("The objective of this study was to determine whether enteroclysis with nafamostat mesilat would improve the clinical outcomes in swine after hemorrhagic shock and intestinal hypoperfusion."[16]) Methods provide a systematic overview of the experimental design, including details about the setting from which samples were drawn and the main outcome measures. However, methods are usually standardized and well-known. Thus, this section (of the abstract) is the priority to cut if a word limit is exceeded. Results should convey effect size using confidence intervals. The abstract's conclusion distills the final paragraph of the article into one final take-away message. As noted by the American Medical Association, the abstract format is too condensed to accommodate detailed explanations of statistical analyses used, but basic explanations are certainly appropriate.[17] Finally, for reports of clinical studies, the *Journal of Trauma and Acute Care Surgery* asks that abstracts close the level of evidence.[18]

Finally, a word about key words. Typically the last element of a published abstract, key words have their origin in the print-only past, when they were compiled into annual subject indices for all articles in a volume. These holdovers have since been adapted to the Web, where their function is less important. Search engines may privilege titles, but key words also play a complementary role. To enhance discoverability in PubMed, we suggest selecting key words from the National Library of Medicine's Medical Subject Headings (MeSH). To find these, the MeSH Browser (http://www.nlm.nih.gov/mesh/MBrowser.html) can be used.

INTRODUCTION: FIRST, "THE KNOWN"; SECOND, "THE UNKNOWN"; THIRD, "THE OBJECTIVE(S)"

In a recent article, Plaxco[19] decisively defined the purpose of the introduction section: "The introduction has precisely one purpose: to convince your readers that they should read your paper," while Annesley in the smartly titled commentary, "It was a cold and rainy night: set the scene with a good introduction" recommended a more "theatrical" approach by which the authors should "set the scene" in this part of the scientific article.[20] We propose a concrete framework for the introduction, a short section consisting of fundamentally three short segments, starting with what is known about the subject ("what is known"), followed by the knowledge gap ("what is not known") and ending with the objective(s) of the study. This is in agreement with current reporting standards, as detailed in Table 1. Our proposed three-section framework allows the reader to follow the journey previously charted by the authors to develop their research question. One method to initiate this process is to simply list key facts as bullet points, before writing this section. For example,

I. "What is known"
- Uncontrolled bleeding is the leading cause of death in injured patients who survive to reach the hospital (References i, ii).

TABLE 1. Guidance on the Introduction and Objectives Section by Reporting Standard

Reporting Standard	Introduction/Objectives Guidance
Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement (http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp)	3. Introduction: background and objectives •Provide an explicit statement of the broader context for the study. •Present the study question and its relevance for health policy or practice decisions.
CONSORT (CONsolidated Standards Of Reporting Trials)*	2a. Introduction: describes •Scientific background and general study outline, •Rationale to justify need for new study, •Evidence of benefit/harm of proposed interventions, and •Plausible explanation for how intervention might work, •Reference to a systematic review of previous similar trials or a note of the absence of such review or such trials.
	2b. Objectives: questions that the trial is designed to answer; hypotheses amenable to statistical testing.
CONSORT extension for non-inferiority trials*	2. Background: scientific background and explanation of rationale, including the rationale for using a noninferiority or equivalence design
	5. Objectives: recommendation to state specific objectives and hypotheses, including the hypothesis concerning noninferiority or equivalence in the methods section
CONSORT extension for studies on harms of an intervention*	2. Background: balanced presentation of possible benefits and harms of the intervention; trials focusing primarily on harms should clearly state this interest when describing the objectives in the introduction section and in defining these objectives in the methods section.
	5. Objectives: trials focusing primarily on harms should clearly state this interest when defining the objectives in the methods section.
PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses)[22] (http://www.prisma-statement.org/)	3. Rationale for the review in the context of what is already known
	4. Objectives: explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS framework[19])
STARD (STAndards for the Reporting of Diagnostic accuracy studies)[23] (http://www.stard-statement.org/)	2. Introduction: state the research questions/study aims, such as estimating/comparing diagnostic accuracy between tests or across participant groups
STROBE (STrengthening the Reporting of OBservational studies in Epidemiology)[24] (http://www.strobe-statement.org/)	2. Background/rationale: scientific background and rationale for the investigation being reported
	3. Objectives: state specific objectives, including any prespecified hypotheses
TREND (Transparent Reporting of Evaluations with Nonrandomized Designs)[25]	2. Background: scientific background and explanation of rationale and theories used in designing behavioral interventions

*CONSORT statements and extensions are all available at http://www.consort-statement.org/. Accessed January 29, 2014
All these guidelines can be accessed at the EQUATOR Network at http://www.equator-network.org/ and/or their own sites or references as indicated.
Presented in alphabetical order; the numbers in the "Introduction/Objectives Guidance" column represent the number of the topic in the correspondent reporting standard checklist.

- Hyperfibrinolysis is a significant component of trauma induced coagulopathy (References iii, iv).
- Tranexamic acid inhibits fibrinolysis by preventing the binding of plasminogen to fibrinogen (Reference v).
- Tranexamic acid has reduced postoperative mediastinal bleeding following coronary artery bypass graft procedures due to fibrinolysis (References vi, vii).

II. "What is not known"
- Tranexamic acid in has not been evaluated in the acutely injured patient.

III. Objective and hypothesis
- Purpose: This study aimed to determine the role of tranexamic acid in postinjury coagulation through a randomized control trial.
- Hypothesis: The group receiving tranexamic acid will have lower rates of coagulopathy (as measured by international normalized ratio values at 6 hours after injury), will require less blood products in the first 12 hours, and will have lower rates of adverse outcomes (mortality, ventilator days) compared with the group receiving placebo.

The "what is known" section provides background information on the clinical relevance of the topic and concisely describes what is generally known. If it is a topic about which little or nothing has been written, the investigators should cite related studies leading to the proposed arena and describe the void in knowledge about the area and the need to fill it. This should take no more than one to two paragraphs. It is not necessary nor appropriate to review in detail all that is known.

If the authors suspect that the audience may be unfamiliar with the matter at hand, they can reference a review article, such as the high-quality, systematic reviews in the Cochrane Library.[21]

The "what is not known" section clearly pinpoints the knowledge gap in the literature and explains how filling this knowledge gap would help advance research and/or improve clinical practice. The knowledge gap (examples of which can be found in Table 2) could refer to what is not known about an intervention, about a well-known intervention not yet used in a different population, about temporal trends of a risk factor or intervention outcomes, or costs of a condition or procedure, and so on. It can also represent a controversy in the topic. It is most important to clearly define this breach in knowledge and how bridging it will deliver results upon which further studies can build and ultimately advance patient care. One paragraph should be sufficient for this section.

At this stage, the reader should be convinced that a new study to fill the knowledge gap is justified. Once the gap is clearly spelled out, the objectives of the study or its purposes are a natural segue. Although the reporting standards vary on where the objectives should be placed (Table 1), we recommend that the authors conclude their introduction section by presenting clearly stated objectives and how they will close the knowledge gap or will provide the necessary building blocks for future research.

We believe that the optimal means by which to state a study objective is through a well-formulated hypothesis. With the occasional exception of purely descriptive articles, most objectives can be restated as hypotheses that will be tested in the study. In fact, as a rule of thumb, if a statistical test was used (i.e., a p value was reported), then a hypothesis existed. Although the distinction between objectives and hypotheses is somewhat ambiguous, in general, hypotheses are a restatement of the objectives amenable to statistical testing. In other words, hypotheses are the objectives reiterated in a statistically testable format. All hypotheses can be defined using the following model:

Variable X distribution in Group A
is *different* (or *not different*) from
Variable X distribution in Group B

Despite its simplicity, this is a widely applicable model for constructing hypotheses. It sets the stage for elements that must be included in the methods section. The authors must define what characterizes Group A and Group B and what makes them comparable (aside from Variable X). Variable X, which is the variable of interest, must be defined in a way that allows the reader to completely understand how the variable is measured. The hypotheses should be defined using the PICO [Population, Intervention, Comparator, Outcomes] framework whenever possible. For example, "we hypothesize that trauma patients (P) receiving pharmacoprophylaxis for venous thromboembolism (I) will have fewer venous thromboembolisms (O) than patients without

TABLE 2. Potential Gaps in Knowledge That Can Be Addressed by a Scientific Publication and Examples Within *Journal of Trauma and Acute Care Surgery*

Type of Study	Knowledge Gap and How it Impacts Scientific Advancement	How the Proposed Study Will Fill the Gap: "Therefore, we conducted a study…"
Therapy/care management	A condition lacks an intervention, or existing interventions are not ideal (costly, high morbidity/mortality, low adherence, technically difficult, etc.), and a new intervention exists.	"… to test the hypothesis that Intervention A results in improved outcomes (morbidity, mortality, costs, adherence, etc.) for Condition X compared with existing treatment."
Therapy/care management	Interventions for a condition have not been tried in different populations.	"…to test the hypothesis that Intervention A results in improved outcomes (morbidity, mortality, costs, adherence, etc.) for Condition X compared with existing treatment among a specific population."
Prognostic/epidemiologic	No agreement on definitions of a condition hinders comparison between studies.	"… to validate and compare current definitions against a criterion standard or objective outcome."
Guidelines	There is controversy about how to manage a condition in specific populations; resolving the controversy would improve outcomes and/or would lead to a recommendation/guideline.	"…to systematically review the evidence about the management of the Condition X and propose a management guideline." or "…to directly compare different management strategies for Condition X in different populations."
Prognostic/epidemiologic	There are insufficient epidemiologic data about a condition	"…to provide a comprehensive epidemiologic description of Condition A using a validated, long-term registry."
Prognostic/epidemiologic	Not enough is known about risk factors for a condition; when knowing them, the condition could be prevented/treated earlier or better, and/or better entry criteria for clinical trials could be developed	"…to define early risk factors for Condition X among a defined population in a mature trauma system."
Diagnostic	Current existing diagnostic tests for a condition are not ideal (costly, low accuracy, low adherence, etc.), and there is a new diagnostic test.	"…to compare the new diagnostic test to a criterion standard to define and compare its accuracy to existing tests in diagnosing Condition X."
Economic evaluations	Current costs of different management strategies of a condition (which have equivalent outcomes) are not known; knowing the costs would assist in determining cost-effectiveness.	"…to conduct a cost-effectiveness, value-based analysis of two management strategies for Condition X and recommend indications for each strategy."

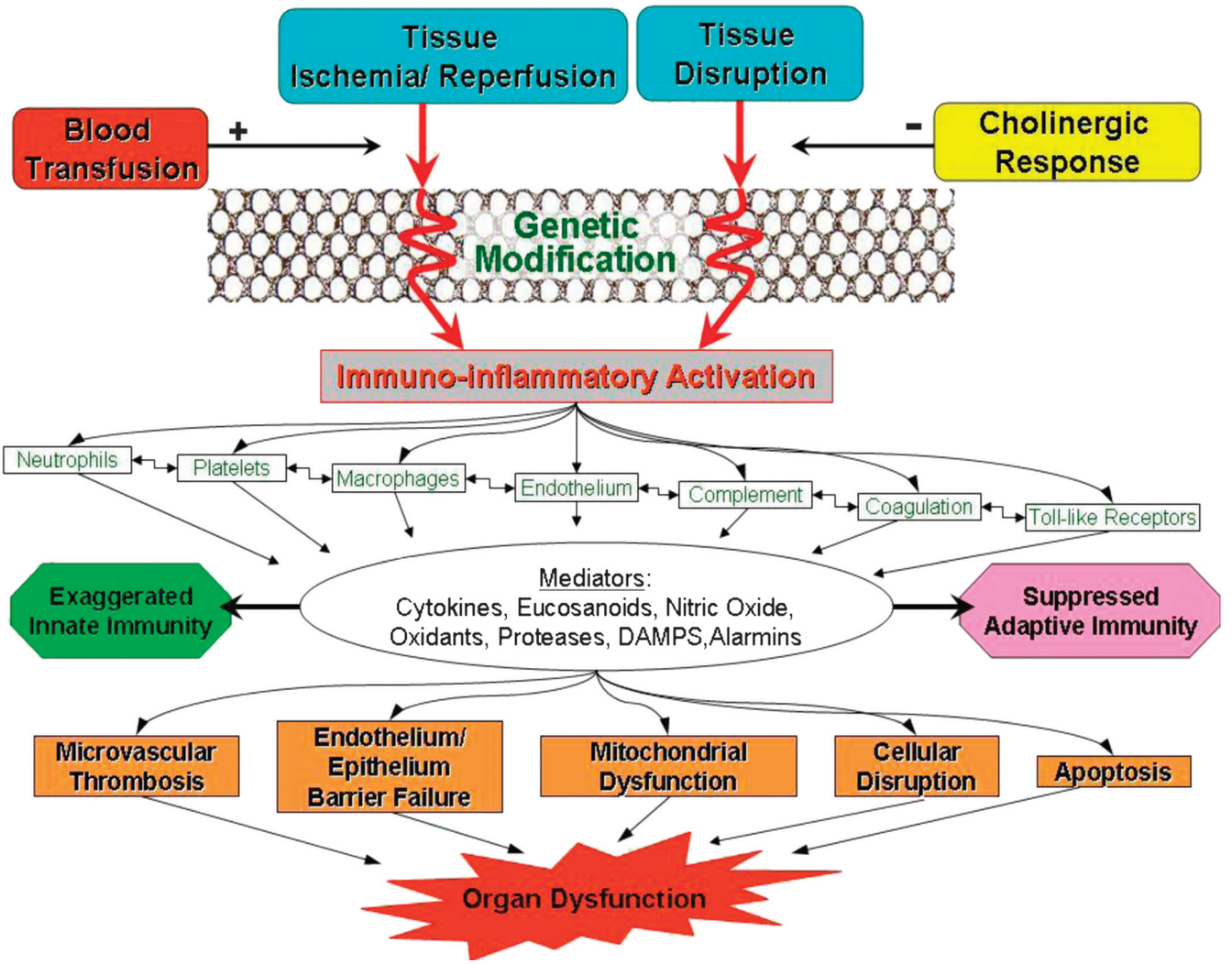

Figure 2. Graphic representation of the pathogenesis of postinjury MOF. Such graphic representations can be helpful to explain how the study's hypothesis (e.g., ''Platelet dysfunction is associated with postinjury MOF'') fits into what is known about the topic.

pharmacoprophylaxis (C)". We will present more details about this methodology in our next, final article of this series.

The hypotheses should be based on a conjectural mechanism that plausibly explains the expected effect (or lack thereof), which should be briefly described in this section. Graphical representations of the proposed theoretical framework and rationale for the proposed hypotheses can be very useful in guiding the reader through the thought process that motivated the study and in the interpretation of the findings. For example, Figure 2 contains a representation of a theoretical framework for multiple-organ failure (MOF) pathogenesis; such figures can be used by authors to demonstrate how a hypothetical study testing the association between platelet dysfunction and MOF fits in the larger context of MOF pathogenesis.

In summary, the introduction section must be concise and focused on the current study; authors must resist the temptation of delivering an extensive coverage of the topic. In general, three paragraphs is the ideal size to succinctly transmit to the readers the idea that inspired the authors to conduct and report their research.

DISCLOSURE

The authors declare no conflicts of interest.

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