Surgical paper

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How to Prepare a Scientific Surgical Paper
A practical approach

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Whether or not one wholly subscribes to the "*publish or perish*" adage, there is no question but that the goal of scientific research is publication. The publication of research results is an essential part of the research process. Thus, the scientist must not only "*do*" science ; he must "*write*" science. And to the question 'What is a biomedical scientific paper ?', the more succinct answer ever provided was 'A drug is any substance which, when injected into a laboratory rat, produces a scientific paper' (1).

Although good writing does not lead to the publication of bad science, bad writing can – and often does – prevent or delay the publication of good science. Unfortunately, the education and training of young surgeons are often so overwhelmingly committed to clinical work that the communication arts are neglected or ignored. Furthermore, surgeons are impatient perfectionists. They have little time to spare for reading outside their subjects, and what reading they do is probably done while travelling, between operations, or late at night. Even more worrying is the fact that some of them never read anything. It is not surprising, therefore, that they are prepared to tolerate – both in their reading and writing – convoluted prose, sloppy analyses, careless presentations, and unfounded conclusions (2). In short, many good surgeons are poor writers, and certainly many surgeons do not like to write. As Charles Darwin already said more than a century ago : "*A scientist's life would be a happy one if he had only to observe and never to write*" (3).

Obviously, there is nothing new in the ideas included in this paper, for scientific writing is ageless. The modest purpose of this paper, however, is to help our fellow surgeons to prepare manuscripts that will have a reasonable probability of being accepted for publication and of being understood when they are published. Because the requirements of journals vary widely, even within the same discipline, it is not possible to offer recommendations that are universally acceptable. In this paper, we attempt, nevertheless, to present the basic principles that are accepted in most surgical journals.

The genesis of this paper occurred some years ago based on my experience as one of the editors of the Acta Chirurgica. I was even more stimulated after I got numerous requests for the slides show of the lecture given at the session of the Belgian Association of Surgical Trainees during the 2012 Belgian Surgical week. This led me to realize how deeply many young surgeons wanted and needed practical information about writing and organizing data. Therefore, I unearthed my old reference book - Robert Day 1979 classical manual (1) "*How to write and publish a scientific paper*" - and did compare it with the more recent 2001 "*A surgeon's guide to writing and publishing*" (4), and with the web site of San Francisco Edit (5). This interesting web site will be widely quoted in this paper. Indeed, it is mainly an electronic re-enactment of Robert Day's 1979 book.

In addition, I dug up several editorials written about this topic in the Acta Chirurgica (6-15) as well as many ideas that I picked up from discussions with colleagues over the previous decades.

Last but not least, in the Bibliography, the reader will find references of one well-known stylebook (14), and two celebrated books (16, 17) about statistical methods that do not require knowledge of mathematics beyond an elementary level.

Like a cookbook, a "*how to*" article presents many recipes that the author has collected over the years. A few of the recipes may be original. Some may be variations of someone else's originals. Many of the recipes presented in such an exercise are, however, "borrowed" intact from other sources. Anyway, I hope that the reader will profit from this exercise knowing that he will not find all the answers.

With appropriate humility, I just tried through this tutorial paper, to tell you a few things that may be of use in preparing a reasonably well written paper instead of a badly organized mess. Indeed, a *tutorial* is a method of transferring knowledge and may be used as a part of a learning process (18, 19). More interactive and specific than a book or a formal lecture, a tutorial seeks to teach through examples and supply the information to complete a certain task. This is not that far from the way surgery is taught and learned. Depending on the context, a tutorial can take one of many forms, ranging from a set of instructions to complete a task to an interactive

problem solving session. This tutorial paper has deliberately been written in the form of simple checklists (1-15) related to each section of a scientific manuscript. The paper is also full of metaphors and analogies that should not be taken at face value but with a pinch of salt, especially the figures which are illustrating a second degree ironic approach and - to put it in a British way - my '*tongue in cheek humour*'. In order to set the tone, please find as an appetizer, four quotations that are directly related to the topics of this tutorial paper.

Basic requirement before writing something !

"You don't write because you want to say something ; you write because you have got something to say."
From Scott Fitzgerald, author of *the Great Gatsby* (among other bestsellers) who reminds us that whatever is our declared motivation for wanting to write a paper, we must admit that the reason resides somewhat within our ego. At the same time, this sentence advises us whether our ego trip is worthwhile because originality in scientific publication – as opposed to the non-scientific literary world – is measured in current terms. In fact, when what we know may be obsolete in five years, the idea of the would-be author has to be original against what is available now – not 10 years ago (4).

This leads us directly to the second quotation from Sir James Matthew Barrie (1860-1937), the Scottish author best remembered today as the creator of Peter Pan and friend of Arthur Conan Doyle, creator of Sherlock Holmes : *"The man of Science appears to be the only man who has something to say just now – and the only man who does not know how to say it"*. The final wording being that 'writing comes more easily if you have something interesting to say'.

What you must consider while writing a paper !

"Writing is the only thing that, when I do it, I don't feel I should be doing something else."
From Gloria Marie Steinem, the American feminist who became recognized as a leader of the women liberation movement in the 60s and 70s. This quotation is dedicated to some of our women fellow surgeons as a token of esteem for their sagacity.

What you should not consider while writing a paper !

"History will be kind to me for I intend to write it."
From Winston Churchill, a great writer, who oftentimes falsified the realities of politics. He ultimately was awarded the 1953 Nobel Prize in Literature "for his mastery of historical and biographical description as well as for brilliant oratory in defending exalted human values".

How to Focus on your Central Message (1-15, 18)

This is one of the most important parts of writing your paper, and one that is often overlooked.

Think carefully about what it is that you want your readers to understand about your work (Fig. 1). Remember, *we are all busy* and we need to absorb your message quickly and clearly. And above all, keep in mind that the Journal Editor is very busy too ; your manuscript must not exasperate him.

When you intent to start writing your manuscript, do try these exercises :

1. Write down the three central points of your paper.
2. Summarize your paper in one sentence.
3. Describe your work to a colleague in one minute.

These might sound easy, but try them and you will find out they are not. This exercise is meant to focus your thinking on the central issues. It is not going to form the published abstract. So, if you really can not squeeze your key message into one sentence don't worry. Try to do it in two (5). If you cannot do that, then you need to take a careful look at the reasons. So work at it keeping in mind that your clinical reasoning, as well as the reader's, involves knowledge, experience and logical rules. Talk to your colleagues and see if between you it is possible to highlight the central message of your work. But at this early stage, there is one simple rule to follow : *One paper, one message. Two messages, two papers !* Such a practical rule, calling for simplicity, is well in the line of thinking of three giants of the XXth century in quite different fields :

- "There is nothing more practical than a good theory" (Albert Einstein).
  Actually, Einstein picked the wording from Aristotle, who proposed the division of logical reasoning into theoretical and practical.
- "The limits of my language are the limits of my own world" (Ludwig Wittgenstein) (20).
- "What is simple is false. What is not is useless" (Paul Valéry).

How to Develop an Effective Outline (1-15, 18)

To develop an effective outline does not require editorial technique ; it requires *strategy*. And if you worry about things that might happen, just relax : a lot of the things you worry about will not happen.

1. Develop the central message of the manuscript.
2. Define the materials and methods.
3. Summarize the question(s) and problem(s).
4. Define the principal findings and results.
5. Describe the conclusions and implications.
6. Organize and group related ideas together.

Fig. 1
What is it you want your readers to understand about your fantastic idea and work ?

7. Construct headings and sub-headings that could be used in both the Material and Methods section and the Results section.
8. Identify the references that pertain to each key point.
9. Develop the Introduction.

When you get all your data and your effective outline, it is time to try to write an abstract.
At this early stage, such an exercise could be most valuable as it will demonstrate your ability (or not) to phrase the essentials of your message in about 200 words.

How to Prepare an Effective Abstract (1-15, 18, 21)

To learn to write well, you should read good writing. Read your surgical journals, but also read William Shakespeare, for instance. You will find the expression *"This is the short and long of it."* from his play The Merry Wives of Windsor that summarizes what an effective abstract should be : the substance and the plain truth of your study (1, 19).

An effective abstract serves 2 functions : (a) when accompanying the complete article, it is a useful preview ; (b) when published alone (for a meeting presentation), it provides for wide acquaintance with the work and its source.

Experienced writers prepare their Abstract after the full text of the paper is written, even though by placement the Abstract comes first. Personally, I favour writing the Abstract before as it represents a real effort of

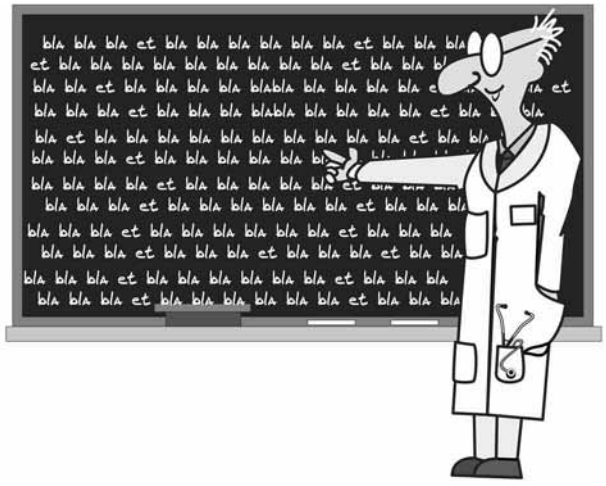

Fig. 2
The abstract must be concise, easy to read and cover the most important points.

concision, precision and synthesis. By doing so, the first thing I settle in writing is what I will put in first in the manuscript. Indeed, there is no better exercise than to prepare an Abstract that properly convey to the reader all that you did or found, and what it means (4).

An appropriate abstract must be accompanied by carefully chosen key words (15). Ideally the abstract should be structured in several short sections : Objective, Design, Patients and Methods, Main Outcome Measure, Results and Conclusion. Indeed, an abstract is a condensed version of the manuscript : which highlights the major points covered ; concisely describes its content and scope ; reviews its material in abbreviated form.

The Abstract is usually the first section that *sets the tone* of the paper for the reviewer. It must be concise (Fig. 2) and easy to read, and must cover the important points of the paper. Many journals have a required style for abstract (6, 21-24). Stay within the publisher's guidelines, or your manuscript might be rejected. Writing an abstract involves summarizing a whole manuscript and providing as much new information as possible in a minimum of space and words.

The best way to write an effective abstract is to start with an effective outline of the manuscript and follow the following 10 steps (1-5) :

1. Identify the major objectives and conclusions.
2. Identify phrases with keywords (15) in the methods section.
3. Identify the major results.
4. Assemble the above information into a single paragraph.
5. State your hypothesis or method used in the first sentence.
6. Omit background information, literature review, and detailed description of methods.

7. Examine every word with care. Remove extra words and phrases. If you can tell your story in 100 words, do not use 200.
8. Revise the paragraph so that the abstract conveys only the essential information.
9. Check to see if it meets the guidelines of the targeted journal (200 to 250 words according to the journal).
10. Give the abstract to a colleague (preferably one who is not familiar with your work) and ask him/her whether it makes sense.

Writing an effective abstract will improve the chances of your manuscript being accepted, will encourage people to read it, and increase its impact (1, 2, 4, 5). A number of studies have indicated that a badly written abstract with poor use of English, even with good science, has less chance of being accepted and published. The use of clear significant words will impress the editors, whereas the use of abstruse, verbose constructions is very likely to provoke a check in the "reject" box on the review form sent to the reviewers (2).

Abbreviations

1. Define any abbreviations or specialized terms early on while starting to write.
2. Be wise to keep abbreviations to a minimum and do not pollute the scientific literature with undefined abbreviations. Just remember how annoyed you felt when you were faced with these conundrums while coming across undecipherable abbreviations in a paper.
3. Introduce the abbreviation by spelling out the word or term first, followed by the abbreviation within parentheses.
4. Never use an abbreviation in the title of an article.
5. Abbreviation should almost never be used in the Abstract, and if you use one you must define it at first use in the Abstract. Remember that the Abstract will stand alone in whichever abstracting publications that cover the journal in which your paper appears or in database that will be searched.
6. Accepted standard abbreviations have a habit of changing and of covering several topics. For instance AAA can stand for Abdominal Aortic Aneurysma and for American Automobile Association. Furthermore, today's abbreviations may be unrecognizable a few years from today.

How to Develop an Effective First Draft of your Manuscript (1-15, 18)

At this stage, you should now have detailed notes you can use to write your draft paper because you already prepared an effective outline for each section which includes a number of major headings, sub-headings and paragraphs covering different points. At this point you will need to convert your notes and outline into *narrative* form. The word « *narrative* » derives from the Latin verb *narrare*, "to recount", and is related to the adjective *gnarus*, "knowing" or "skilled". In fact, we are somewhat faced with the now very popular concept of *storytelling*. Nevertheless, sound storytelling does not match with boring material. Unfortunately, surgical publishing may oftentimes deal with boring material. Despite that storytelling should not be in itself boring. The secret of being a bore is to tell everything. Thus, use simple, clear and precise language ; be concise ; just tell the truth and stop dithering.

Some people recommend that you begin with the Introduction and continue through each section of the paper to help ensure flow. Others suggest that you begin with the easiest sections, which are usually the Methods and Results, followed by the Discussion, Conclusion, Introduction, References and Title. Nevertheless, the main thing is to begin writing and filling up the blank screen or the empty piece of paper.

The 13 steps to Developing an Effective First Draft of your Manuscript are (1-7)

1. Consolidate all the information (i.e., data, references, drafts of tables and figures, etc).
2. Target a journal. Choose the audience (general, specialized, local journal). Do not submit a technical paper to a theoretical journal. When you have determined the journal to which you plan to submit your manuscript, examine several recent issues of the targeted journal, and tailor your manuscript to the chosen journal.
3. Start writing. When writing the first draft, the goal is to put something down on paper, so it does not matter if the grammar and spelling are incorrect, provided that the main points and ideas have been captured. Write without distractions ; write when your energy is high, not when you are tired.
4. Write quickly. Leave gaps if necessary. Keep the flow going. Leave space for words that do not come to mind immediately.
5. Write in your own voice. Expressing yourself in your own way will help you to say what you mean more precisely.
6. Write without editing. Do not try to get it right the first time. Otherwise, you will tend to get stuck and waste time.
7. Keep to the plan of your outline. Use the headings and sub-headings from your outline to focus what you want to say. If you find yourself wandering from the topic, stop and move on to the next topic in the

Fig. 3
Look at your abstract and manuscript as a stern critic

outline (just like you would do during a multiple choices exam).

8. Write the paper in parts. Do not attempt to write the whole manuscript at once, instead, treat each section as a mini essay.
9. Put the first draft aside for at least a couple of days. A day or a week between creation and critique helps. Encourage yourself by repeating the brilliant sentence pronounced in 1942 by Churchill after the El-Alamein's battle : "Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning". Whenever you will continue with your manuscript, reread the latest draft from the beginning. You will be surprised how many flaws will appear in your manuscript when you put it aside for a while (1).
10. Revise it and be prepared to do this several times until you feel it is not possible to improve it further. The objective is to look at your work as a stern critic (Fig. 3). *Does each sentence make sense ? In long sentences, can you keep track of the subject at hand ? Do long paragraphs follow a single idea, or can they be broken into smaller paragraphs ?*
11. Revise for clarity and brevity. Revise sentences and paragraphs with special attention to clearness. Most sentences should be about 15-20 words. For a scientific article, paragraphs of about 150 words in length are considered optimal. Avoid using unnecessary words : *because* is better than *on account of ; except* is shorter than *with the possible exception of ; but* is the same as *it may, however, be noted that* ; *useful* can save space compared with *of great theoretical and practical importance*. There is some analogy between Writing and Surgery. Do not worry about being fast ; worry about being efficient and effective. Speed in operating is nothing more than economy of movement ; writing improves in direct ratio to the number of words we can keep out of it. A good operation deserves a good operative note ; a good scientific paper deserves clear and good writing.
12. Be consistent. Often a manuscript has more than one author and therefore the writing may be shared. However, the style needs to be consistent throughout. The *first author* must go through the entire manuscript and make any necessary editorial change before submitting the manuscript to the journal.
13. Be honest. Always state the facts clearly : it is better to be wrong than dishonest.

How to Write an Effective Introduction (1-15, 18, 19)

The purpose of the Introduction is to introduce the paper ! Thus, the cardinal rule to be followed is the definition of the problem in a reasonable and understandable way. Otherwise the reader will have no interest in your solution and do not expect him to labour through your paper to get the essentials of your message. In other words, the purpose of the *Introduction* is to stimulate the reader's curiosity and to provide pertinent background information necessary to understand the rest of the paper. For instance, if you are preparing a manuscript about the Ogilvie's syndrome, keep in mind that many physicians do not even know what it is all about. Thus, start with a short description.

The authors must summarize the problem to be addressed ; give background on the subject ; discuss previous research on the topic ; explain *exactly* what the paper will address, why, and how. Besides motivating a reader to read your manuscript and to care about your results, the Introduction section is useful also to the journal's reviewers and editors in judging the importance of your manuscript.

An Introduction is usually 300 to 500 words long depending on the journal and the topic. Therefore, the Introduction needs to be very concise, well structured, and inclusive of all the information needed to follow the development of your findings.

Nine Steps to Writing an Effective Introduction (1-5)

1. Begin the Introduction by providing a concise background account of the problem studied, the scope of the research, the motivation of the study and the purpose of the paper.
2. State the objective of the investigation. Your research objective is the most important part of the introduction.
3. Establish the significance of your work. Why was there a need to conduct the study ?
4. Introduce the reader to the pertinent literature. Do not give a full history of the topic. Only quote previous work having direct bearing on the present problem and on how you attempted to resolve it.

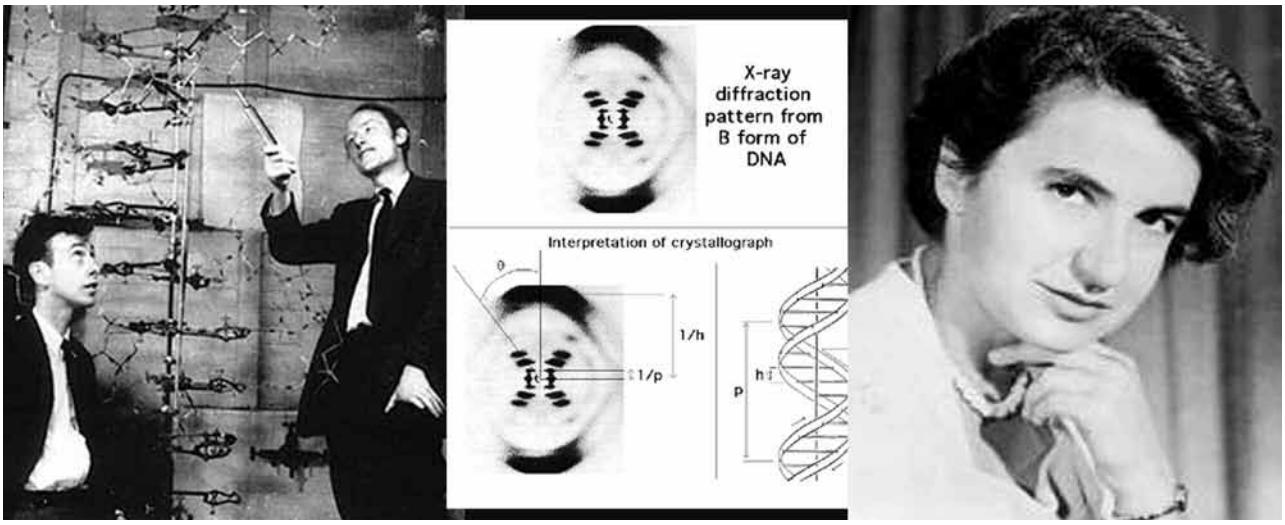

Fig. 4
X-ray diffraction images of DNA (central panel) obtained by Rosalind Franklin (right panel) that led to the discovery of the DNA double helix by Watson and Crick (left panel).

5. Clearly state your hypothesis and the variables investigated, and concisely summarize the methods used.
6. Define any abbreviations or specialized terms early.
7. Avoid SMS spelling like ASAP (*as soon as possible*) or BTW (*by the way*). More and more of us, who are permanently in a hurry, tend to write the SMS language instead of the proper language because we are so used to typing in shortcuts. Get rid of it while writing a scientific paper.
8. Provide a concise discussion of the findings of other studies, so the reader understands the big picture.
9. Describe how *findings* presented in your manuscript would contribute to the larger field of research and *quote your sources* !
   About quoting your sources, it is useful here to recall the story of Rosalind Elsie Franklin (1920-1958). This British X-ray crystallographer was working in John Randall's laboratory at King's College, London in the same field as Maurice Wilkins (1916-2004). She made critical contributions to the understanding of the fine molecular structures of DNA (Fig. 4). Her work on the X-ray diffraction images of DNA led to the discovery of DNA double helix. According to Francis Crick and James Watson, her data was "*the data we actually used*" to formulate in 1953 their famous hypothesis regarding the structure of DNA. In fact, between 1951 and 1952 Rosalind Franklin already came very close to solving the DNA structure. She was beaten to publication by Crick and Watson in part because of the friction between Maurice Wilkins and herself. At one point, Wilkins showed Watson one of Franklin's crystallographic portraits of DNA. When Watson saw the picture, the solution became apparent to him, and the results went into an article in Nature almost immediately. Franklin's work did appear as just a supporting article in the same issue of the journal. Anyway, the debate about the amount of credit due to Franklin continues. What is clear is that she did have a meaningful role in learning the structure of DNA and that she was a scientist of the first rank. She died in 1958 from cancer of the ovaries and could not share Watson and Crick 1962 Nobel Prize, but Maurice Wilkins did !

Some other points to writing an effective introduction are important :

1. Move from general to specific : from the problem in the real world to the literature related to your research.
2. Write in the *present* tense except for what you did or what you found, which should be in the *past* tense.
3. Be concise.
4. Be aware of who will be reading your paper and make sure the Introduction (as well as the full paper) is properly directed to this type of audience (Fig. 5).
5. Technical terms or definitions likely to be unfamiliar to the reader must be concisely explained.

How to Write an Effective Materials and Methods Section (1-5, 18,19)

Quoting from Claude Bernard : "Man can learn nothing unless he proceeds from the known to the unknown. In biological sciences, the role of method is even more important than in other sciences, because of the complexity of the phenomena and the countless sources of error".

Fig. 5
Be aware of who will be reading your paper and make sure it is directed to that audience.

Fig. 6
Mention the approval for the study by the Ethics Committee when appropriate.

In the Materials and Methods section, you must explain *clearly* how you conducted your study in order to enable readers to evaluate the work performed and to permit others to replicate your study. You must describe exactly what you did ; what and how experiments were run ; how much, how often, where, when, and why ; which equipment and materials were used. However, you should maintain a balance between *brevity* (you cannot describe every technical issue) and *completeness* (you need to give adequate details so that readers know what happened). Actually, this should be the easiest section to write.

Since each journal has different requirements, review the journal's guidelines before beginning to write this section. At this stage, it is also very useful to check the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (21-24), in order to have a consistency of style and an accuracy of reporting on which readers come to rely.

Twelve steps to Writing an Effective Materials and Methods (2-4, 8)

1. Order your procedures chronologically or by type of procedures using sub-headings, where appropriate, to clarify what you did.
2. Use the past tense and the third person to describe what you did. For example : "The sample was incubated at 37°C for 3 days" and not "I incubated the sample at 37°C for 3 days."
3. Describe your experimental design clearly, including the hypotheses you tested, the variables measured ; how many replicates you had, controls, treatments, etc.
4. Explain why each procedure was done. Reference may be made to a published paper as an alternative to describing a lengthy procedure.
5. Identify the source of any specific type of equipment, which was critical to the success of the experiment.
6. Describe in detail any modifications to equipment or equipment constructed specifically for the study and, if pertinent, provide illustrations of the modifications.
7. Precisely quantify measurements (all metric) and include errors of measurement.
8. Describe the dates and the site where your field study was conducted including physical and biological characteristics of the site, if pertinent to the study's objectives (e.g., surgery in the space or in a submarine ; in an academic hospital or on the battlefield).
9. Identify variable or treatment using the variable or treatment name, rather than an ambiguous name or number (e.g., for an organ transplantation study use "healthy donors group" rather than "group 1"). For chemical substances or pharmaceutical drugs use chemical or generic names instead of trade names.
10. If human subjects are used, the criteria for selection should be described, and an "informed consent" statement should be added to the manuscript if required by the journal. Mention also the approval for the study by the relevant ethics committee(s) (Fig. 6). Never forget that it is the patient who is the

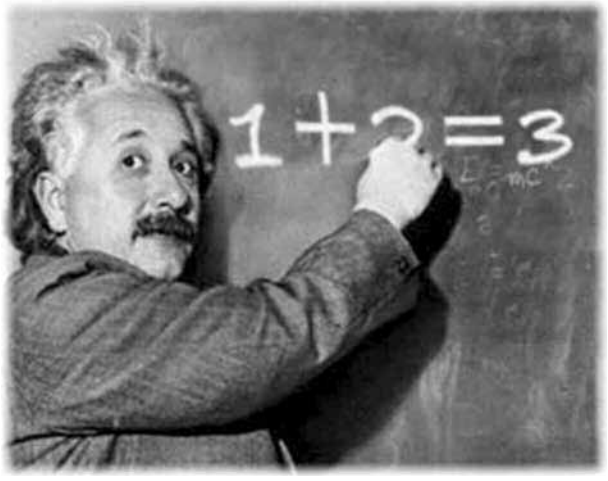

Fig. 7
Ordinary statistical methods do not require further comment. Ask your colleagues whether they would have difficulties in repeating your study.

real pioneer for surgical innovation. You, as surgeon, are not operating a patient. You are operating *on* a patient. The word *patient* is often used to mean *person*. Indeed, there is no such thing as "untreated patient" or "normal patient" in the hospital population.

11. Describe statistical tests and the comparisons made. Ordinary statistical methods can be used without comment (Fig. 7) ; advanced or unusual statistical methods may require a literature citation, a specific sub-heading or an appendix (25, 26).
12. Show your Materials and Methods section to a colleague and ask whether he would have difficulty in repeating your study (Fig. 7). Show it in order to assist you, to make fun of you (that can be very useful too), to argue with you, or to bring you back to the basics ! It is quite possible that, in reading about your Materials and Methods, your colleague will pick up a glaring error that you missed simply because you were holding your nose too close to the grindstone.

Some other points to Writing an Effective Materials and Methods (1-5, 9) :

1. Don't mix results with procedures.
2. Don't include information that is irrelevant to the reader, such as what colour ice buckets you used, or which individual logged the data in the database.
3. The Material and Methods section is the first section of the paper in which sub-headings can be used. Whenever possible, construct sub-headings at the time you develop the effective outline. These sub-headings should match those to be used in the Results section in order to maintain coherence and clarity. The writing of both sections will be easier if you strive for internal consistency, and the reader will be able to grasp rapidly the relationship of a particular Methodology to the related Result (1), and even later on to the specific part of the Discussion.

Fig. 8
Results should be presented in an orderly and logical sequence.

How to Write an Effective Results Section (1-5)

The purpose of a Results section is to present the *key results* of your research without interpreting their meaning. As Winston Churchill once wrote : "*I pass with relief from the tossing sea of Cause and Theory to the firm ground of Result and Fact*". The results should be presented in an orderly sequence (Fig. 8), using an outline following the sequence of the Methods section upon which the results are based. Ideally, for every result there must be a method in the Methods section. In this section, it is important to carefully plan the *Tables* and *Figures* to ensure that their sequence tells a story. The Results section cannot be combined with the Discussion section.

Another 12 Steps to Writing an Effective Results Section (1-5)

1. Determine which results to present by deciding which are relevant to the question(s) presented in the *Introduction* irrespective of whether or not the results support the hypothesis(es). The compulsion to include everything, leaving nothing out, does not prove that you have unlimited information and exhaustive data ; it proves that you lack discrimination.
2. Organize the data in the *Results* section in order of most to least important. Within each paragraph, the order of most to least important results should be followed.
3. Determine whether the data are best presented in the form of *text, figures, graphs* or *tables*.
4. Summarize your findings and point the reader to the relevant data in the text, figures and tables. The text should complement not repeat the same information. The most common fault is the repetition in words of what is already crystal clear to the reader from examination of the figures, graphs and tables.
5. Describe the results of the controls and include observations not presented in a formal figure or table, if appropriate.
6. Provide a clear description of the magnitude of a response or difference. If appropriate (series of more than 50 cases), use percentage of change rather than exact data.
7. Make sure that the data are accurate and consistent throughout the manuscript. It is often important to report even the negative aspects of your experiments because someone else may find different results under different conditions. Absence of evidence is not evidence of absence.
8. Summarize the statistical analysis and report actual P values for all primary analyses.
9. Use the *past* tense when you refer to your results.
10. Number figures and tables consecutively in the same sequence they are first mentioned in the text (10). Depending on the journal, they should be in order at the end of the manuscript after the References section.
11. Provide a heading for each figure and table. Depending on the journal, the title of the tables and legend of the figures should be listed separately or located above the table or below the figure. Each figure and table must be sufficiently complete that it could stand on its own (Fig. 9). They must be *self-explanatory*, that is clear and easy to understand without needing any extra explanation.
12. Write with accuracy, brevity and clarity. Although the Results section of a paper is the most important part, it is often the shortest, particularly if it is preceded by a well-written Materials and Methods section and followed by a soundly argued Discussion (1).

Fig. 9
Self-explanatory figures must be clear and easy to understand without needing extra explanation.

How to write an Effective Discussion Section (1-5, 8)

The *purpose* of the Discussion is to state your interpretations and opinions ; explain the implications of your findings ; make suggestions for future research. *But stick to the facts !*

The Discussion is usually the hardest section to write. Many papers are rejected by journal editors because of a faulty Discussion. In fact, the true meaning of the data may be completely obscured by the interpretation presented in the Discussion. Why ? Because good judgment is based on experience and experience is often based on a series of bad judgments. Practically, the main *function* of the Discussion is to answer the questions posed in the Introduction. Thus, explain how the results support the answers, and how the answers fit in with existing knowledge on the topic.

The Discussion is considered the *heart* of the paper and usually requires several writing attempts. Before beginning you should try to develop an outline to organize your thoughts in a logical form. You can use a cluster map, an issue tree, numbering, or some other organizational structure in order to organize your thoughts (Fig. 10). To make your message clear, the discussion should be kept as short as possible while clearly and fully stating, supporting, explaining, and defending your answers, as well as discussing other relevant issues. Side issues should not be included, as these tend to obscure the message. Once more : "One paper, one message. Two messages, two papers". Care must be taken also to provide only a commentary and not a reiteration of the results.

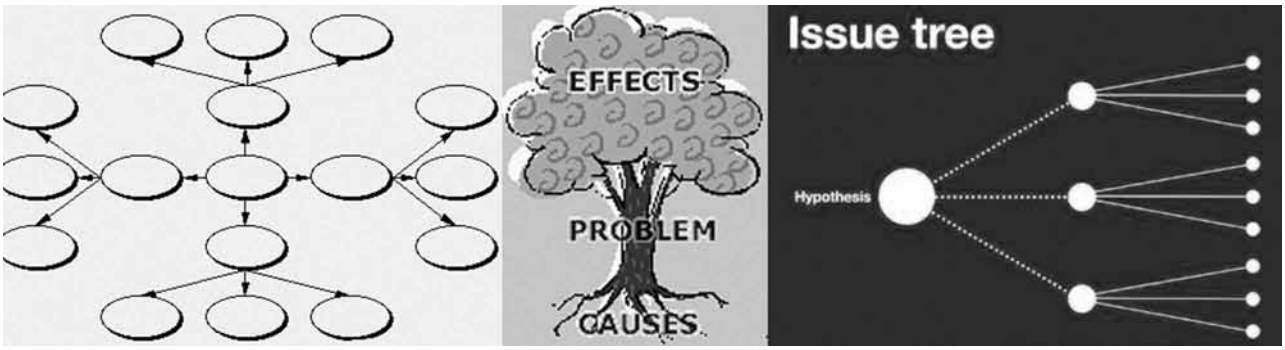

Fig. 10
Organize your thoughts in cluster map or issue tree in order to provide a logical Discussion section

Fifteen Steps to Writing an Effective Discussion Section (1-5, 8)

1. Organize the Discussion from the specific to the general. From your findings to the literature, to theory, to practice. Do not be shy ; discuss the theoretical implications of your work, as well as any practical applications. In a good Discussion, you discuss ; you do not recapitulate the results.
2. Use the same key terms, the same verb tense (present tense), and the same point of view that you used when posing the questions in the Introduction.
3. Begin by re-stating the hypothesis you were testing and the questions posed in the introduction.
4. Explain how your results relate to expectation and to the literature, clearly stating why they are acceptable and how they are consistent with previously published knowledge on the topic. In simple terms, the primary purpose of the Discussion is to show the relationships among observed facts. But do not extrapolate to a bigger picture than that shown by your data. By doing so, you will undermine your data-supported conclusions and cast them into doubt.
5. Address all the results relating to the questions, regardless of whether or not the findings were statistically significant. Clinically significant is not similar to statistically significant. A negative result can be useful as well.
6. Describe the patterns, principles, and relationships shown by each major result and *put them in perspective* (Fig. 11). The sequencing of providing this information is important : first state the answer, then the relevant results, and cite the work of others. If necessary, point to a figure or table to enhance the "story".
7. Defend your answers, if necessary, by explaining both why your answer is satisfactory and why others are not. Only by giving arguments from both sides can you make your explanation convincing.
8. Discuss and evaluate conflicting explanations of the results (Fig. 11). This is the sign of an honest discussion. By disclosing in the Discussion, the deficiencies of your study you can disarm malicious reviewers thanks to your frankness and sincerity.
9. Discuss any unexpected findings. When discussing an *unexpected finding,* begin the paragraph with the finding and then describe it.
10. Identify potential limitations and weaknesses and comment on the relative importance of these to your interpretation of the results and how they may affect the validity of the findings. When identifying limitations, avoid using an apologetic tone. Negative results can be as important as positive one.
11. Summarize concisely the principal implications of the findings.
12. Provide recommendations for further research. Do not offer suggestions which could have been easily addressed within the study, as this shows there has been inadequate examination and interpretation of the data. Do not shoot yourself a bullet in your own foot.
13. Explain how the results and conclusions of this study are important and how they influence our knowledge or understanding of the problem being examined.
14. In your writing of the Discussion, discuss everything honestly, but be concise, brief, and specific. When you describe the meaning of your little bit of truth, do it simply. Leave the "the truth the whole truth and nothing but the truth" to the lawyers who loudly proclaim its discovery every day.
15. The Discussion should end with a short summary or conclusion regarding the *significance* of the results. Many a paper loses much of its effect because the clear stream of the discussion ends in a swampy delta (1).

Fig. 11
Let's step back and look at the big picture in order to put your results in perspective before discussing unexpected findings or conflicting explanation of the findings.

How to Design Effective Tables and Figures (1, 4, 5, 10)

The great Russian writer Ivan Sergeyevich Turgenev (1818-1883) once wrote : «A picture may instantly present what a book could set forth only in a hundred pages» (Fig. 12).

The *purpose* of tables and figures is to report data too numerous or complicated to be described adequately in the text and to reveal trends or patterns in the data.

Tables and figures are critical. If readers go beyond the abstract, they are likely to examine the tables and figures next. Before writing the first draft of your manuscript, it is important to *organize the data* you plan to present in the manuscript. By preparing the tables and figures, their titles and legends, and appropriate statistical analyses, you will be certain of your results before you start to interpret them. At this time you will also be able to determine if you have all the data you need.

Thirteen steps to Developing Effective Tables, Graphs and Figures (2, 4, 9)

1. As a general rule, do not construct a table or a graph unless repetitive data must be presented.
2. Decide which results to present, paying attention to whether data are best presented within the text *or* as figures or tables. In any one table, a single category of responses is always the centre of the attention. The table is constructed to illustrate the variations in that category (the dependent variable) with respect to some other sets of data (independent variables). For instance, in a survey on smoking among surgical patients the dependent variable would be whether the respondent smoked, and the independent variables could be any of several other categories or facts, such as person's sex, alcohol abuse, etc.
3. Limit the number of tables and figures to those that provide essential information that could not adequately be presented in the text.
4. Include only results which are relevant to the question(s) posed in the introduction, irrespective of whether or not the results support the hypotheses.
5. Design each table and figure to be understandable on its own, without reference to the text. Once again : each figure and table must be *self-explanatory*, that

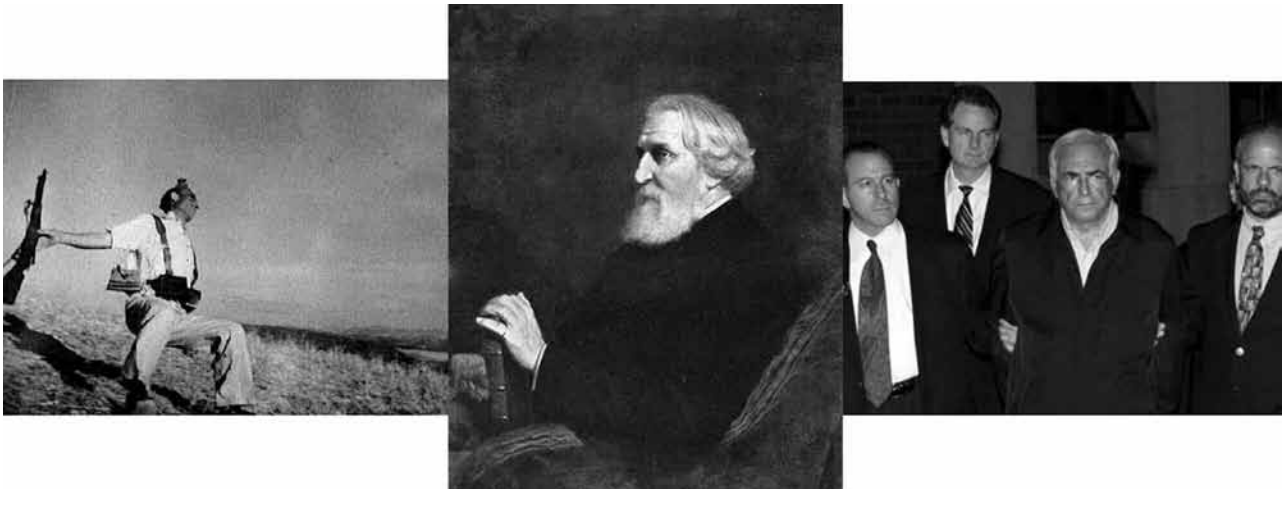

Fig. 12
Ivan Turgenev (1818-1883) : «*A picture may instantly present what a book could set forth only in a hundred pages*»

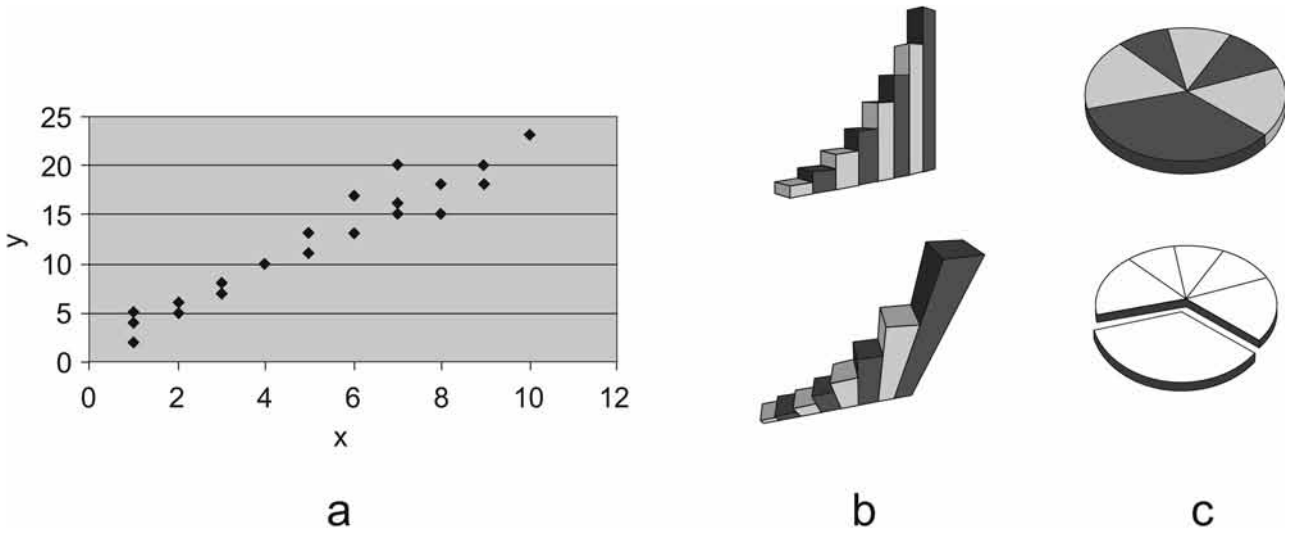

Fig. 13
From left to right, examples of scattergram, bar graph and pie chart

is clear and easy to understand without requiring any extra explanation.

6. Number each figure and table in the order in which they are referred to in the text (Figs. and tables are numbered separately).
7. Organize the tables and figures in such an order that they tell a story (Figs. 1 to 12).
8. Check with the targeted journal, but typically tables and figures are located in the manuscript on separate pages that follow the *References* section.
9. Do not wrap text around tables and figures.
10. Be sure all figures and tables are correctly referenced in the text of the manuscript (e.g. "you can find in Table 3 & in Figure 2…". In fact, there is neither Table 3 nor Figure 2 to be found). So check and re-check your manuscript before submitting it.
11. Obtain permission from the copyright holder (usually the publisher) and acknowledge the source if you are including a table or figure that has already been published.
12. Write the table caption and figure legends on a separate sheet.
13. In the caption and legends, provide information regarding what is presented in the table or figure, but not a summary or interpretation of the results.

In summary, Tables and Figures are used to make an article more readable by removing numeric data from the text, to synthesize existing literature, to explain variables, to present the wording of survey questions. Never present the same data in more than one way : present the data in the text, *or* in a table, *or* in a figure.

NUTS and BOLTS to prepare a Table

1. Create tables with your PC table function (pull down menu) in Microsoft Word, for instance. Mac has similar functions. Do not use tabs.
2. Use column headings and table notes accurately to simplify and clarify the table. In most cases, the meaning of each column should be apparent without reference to the text.
3. Since a table has both left-right and up-down dimensions, you have two choices. The data can be presented either horizontally or vertically, but the data should be organized so that the like elements read down, not across. That format is more compact and it is easier for the reader to grasp the information.
4. Most journals want the table and its title on the same page, with each table on a separate page in numerical order.
5. Give careful thought to the footnotes to your tables. If abbreviations are to be used and defined, you often can give all or most of the definitions in Table 1. Then, next tables can carry the simple footnote : "Abbreviations as in Table 1".

NUTS and BOLTS to prepare a Figure or a Graph

Certain types of data should neither be tabulated nor be turned into figures. Then, we can use *graphs* which are basically pictorial tables (which are also called *line drawings* in printing terminology). Do not think, however, that a graph somehow adds importance to the data. An experienced peer reviewer or editor will easily deduce that the meaning of your nice curve could have been stated in just a few words.

1. Label each axis including units of measurement and clearly identify the data you are displaying (e.g. label each line in a graph).
2. Figures and graphs should be of high image quality, with minimal pixelization.
3. Graphs are usually in black and white.
4. Photographs of subjects should be used only if written, informed consent was obtained prior to the taking of the photograph.
5. Choose the correct figure format (Fig. 13) : a) if independent and dependent variables are numeric *: line diagrams* or *scattergrams*, b) if only the dependent variable is numeric : *bar graphs,* c) for proportions : *pie charts*.
6. The size of the lettering must be large enough to withstand the photographic reduction to which graphs are normally subjected.
7. Figures, especially graphs and charts, should be placed as close as possible to their first references in the text. Nevertheless, there are sometimes sound reasons for grouping all the illustrations, if they are of one type, at the end of the paper or putting them in *appendix*.

APPENDIX

An appendix, though by no means an essential part of a paper, is a useful device to make available material that is relevant to the text but not suitable for inclusion in it. An appendix is a group of related items. For instance, the appendix may contain certain tables and figures too detailed for text presentation : a large group of histological illustrations, copies of documents not generally available to the reader, technical notes on method such as sophisticated statistical tests. In my experience, this statistical item was illustrated by the request made in 1990 by the editorial board of the Journal of Thoracic and Cardiovascular Surgery to prepare an appendix giving full details about the statistical technique of the Receiving Operating Characteristic (ROC) curves that was most probably used for the first time in the Journal (25).

How to Prepare an Effective Title (1-5, 11)

The title defines the contents of your manuscript in as few words as possible. An effective title "sells" your manuscript to the reader immediately and influences whether or not a reader will read the manuscript. The title is essential in bringing your manuscript to the readers' attention, especially where the database being searched does not include the full abstract of the article.

The title should include all essential words in the right order so the topic of the manuscript is accurately and fully conveyed. An excellent title is the key to ensuring your article will be found. An improperly titled paper may get lost or ignored.

Some points to Developing an Effective Title

1. Do criticize the title the same way you do for any other section of the manuscript. "A good title should be like a good metaphor ; it should intrigue without being too baffling or too obvious" (quote of Walker Percy in ref.4).
2. A title should be the fewest possible words that accurately describe the content of the paper (the recommended length is 10-12 words).
3. The golden rule is : *express the main idea or subject in your title*. Let the title reflect the essence of the paper while being catchy but not too gimmicky (4).
4. Put important words first in the title.
5. Use *key words* in the title which highlight the main content of your manuscript and can be understood, indexed, and retrieved by a database search.
6. Be concise. Omit all waste words such as "*A study of ...*", "*Investigations of ...*", "*Observations on*". The title must be a label made out of key words suitable for the indexing systems used by Science Citation Index, Index Medicus, and others. Keep in mind that the majority of potential readers of your paper will become aware of the paper via secondary sources.
7. Eliminate redundant words such as verbs and articles so the title functions properly as a label rather than a sentence. As the title is simpler than a sentence, the order of words becomes even more important. For instance, the verb "*is*" is a waste word, in that it can be readily deleted without affecting the comprehension of the title. Furthermore, the inclusion of the "*is*" results in a title that seems to be a loud assertion sounding like a dogmatic ring.
8. Use simple word orders and common word combinations.
9. Be as descriptive as possible and use specific rather than general terms.
10. Make certain that your title and abstract match the final version of your article.
11. Never use an abbreviation in the title of an article.

How to Select a Journal

There are numerous factors to consider when choosing a journal. However, there is one essential feature you should not compromise on. *Manuscripts must be peer reviewed for publication if they are to be considered research articles*. Decide early before the writing begins. Once you decide on a journal, obtain and read that specific journal's *Instructions to Authors*. This document describes the format for your article and provides information on how to submit your manuscript. That way you can write for the journal's audience (Fig. 5) and according to its guidelines. While preparing your manuscript

compare your work with some good articles published in the same journal. You will get lots of helpful hints.

Some basic questions to be answered (1-5)

1. Is the journal *peer reviewed* ?
2. Does the journal currently publish papers on subjects such as yours ? For papers like your own, in which journals would you look ?
3. Which journals have the best reputation in your field ? Is the Editorial Board composed of leaders in their fields ?
4. Which journals are most likely to be cited in your field ?
5. Is the journal published by a society ? *Society journals* are usually the most prestigious and have the largest circulation. Publish also in the 'local' journals of your own country. Being famous internationally and poorly known locally negates the purpose of writing (4).
6. Be wary of new journals (in print or on the internet), especially those not sponsored by a scientific society.
6. Is the journal indexed in the major electronic databases such as Medline, Biological Abstracts, Index Medicus, Current Contents, etc. ?
7. Which journals have the kind of expertise that would ensure your paper is given a "fair hearing" ?
8. Are there journals whose readership you need or want to influence ?
9. How often is the journal published ? What is the usual time lag between receiving and publishing papers ? Using the "*date submitted*", the "*date accepted*", and the date of the issue of *published* articles you can estimate the length of the review process as well as the time from acceptance to publication in print.
10. Is the journal published in English ? English is the language for international scientific communication. The English language literature is by far the most cited. This means that the diffusion of knowledge and the recognition of the authors among peers are greatly enhanced if the work is published in English. Practically, it is always better and safer to ask a native English-speaking colleague to review the final draft of a manuscript. Experiences with commercial translators may be disappointing, expensive, and the meaning and message of the manuscript may be altered or lost in the translation, simply because most translators lack adequate comprehension of medical subtleties (4). As for Surgery, success in translating is ultimately in the details.

Once you have decided on a journal, you must obtain a copy of the most recent author guidelines. It's worth recalling that the Instructions to Authors for the Acta Chirurgica (6) were refreshed in 2006. You can usually obtain a copy of any journal's *Instructions to Authors* on the website or in the first issue of a new volume.

Some Tips for the Effective Use of Numbers and Statistics (1, 2, 12, 16, 17, 26)

1. The misuse of numbers and statistics can jeopardize the acceptance of your manuscript by the journal.
2. Numbers and data are the core of most scientific research.
3. Statistics should be used to substantiate your findings and help you to state objectively your significant results.
4. Statistics in text should include sufficient information, be reported accurately, and permit the reader to corroborate the analysis. It is always wise to have a statistician check your work before submitting your manuscript.

Numbers

- Put a space between numbers and units : for example, 62 kg. *The exception : 80% for some journals*.
- When you quote numbers, make sure you use the minimum number of significant digits or decimals. For example, 23 ± 7 *years* is appropriate but not 23.4 ± 6.6 years ; the loss of accuracy is not important because the measurement is not significant to the first decimal place. However 23.4 ± 0.6 is correct because this measurement is accurate to the first decimal place (i.e., 0.6).
- Preferably use Arabic rather than Roman numerals.
- When beginning a sentence with a number, spell out the number (same for 1 to 9 : *one* to *nine*).It is usually better to rewrite a sentence so you don't start it with numbers.
- Use numbers and words to express large numbers : a budget of $1.6 million ; 3 million kilometres.
- Use hyphenation to reduce confusion when there is more than one modifier : *twenty 2-week-old mice*.

Statistics (16, 17, 26)

The purpose of statistical methods is to put numerical data into a context by which their meanings can be better judged. Some familiarity with statistical methods is essential for two reasons. Firstly, just as discussing his data in words often helps an investigator to understand them better, so testing the numerical results statistically by his own effort gives him a clearer view of their significance. Secondly, professional statisticians are not always available to solve the fairly simple clinical questions or problems.

This article being not a tutorial about biomedical statistics, we will limit our comments by providing the ref-

erences of two handy, easy-to-read, and pocketsize books (16, 17), that include basic statistical procedures and concepts that are most appropriate for those training or practicing medicine and related health professions. Both books, reissued several times since the 70s, contain most of the basic material related to topics that are necessary in critically writing, reading and evaluating the technical and scientific literature in medicine, which is becoming increasingly quantitative. This is also the case of the 2004 Vade Mecum published in the Journal of the American College of Surgeons (26) that provides a series of non-technical explanations of basic statistical operations in biomedical sciences, coupled with intuitive examples drawn from the field of surgery.

Hereafter are just a few tips :

- Report the mean (average value) along with a measure of variability [standard deviation(sd)]. However, mentioning mean, median and ranges is indicated for data that are not normally distributed. To put it simply : the mean is sensitive to outliers (extreme values or data points that do not follow the pattern of most other points), the median is not.
- Summarize frequency data in the text with appropriate measures such as percents, proportions, or ratios. However, percentage should not be used at all if the total number is less than 50. Only if the total number is greater than 100, may percentage figures be given to one decimal place –and only one.
- For statistics tests, such as *chi-square* statistics, t statistics, and F statistics use two decimal. For *P* values, two significant digits are usually acceptable (e.g., p = 0.007, 0.04, 0.35). Do not adhere to the widely held belief that a paper without P values is unpublishable. This just demonstrates that many authors are ignorant of the purpose of hypothesis tests. This ignorance is amplified by the use of statistical package for personal computers allowing easy access to a bunch of statistical tests that seem to give credence to even the most inadequate data. If all active drugs have unwanted effects, now the same can be said of computers.
- Show 95% confidence intervals for effect statistics like linear regression or the difference between means.

How to Avoid Deadly Sins

1. Avoid *redundancy* in the Results section. The most common grave sin is the repetition in words of what is already apparent from the figures and tables.
2. Avoid *type III errors* that are ways in which the conclusions drawn are not supported by the data presented (2). Type III errors are completely different from type I and II errors, which are also to be avoided by appropriate hypothesis testing. Indeed, in statistical test theory the notion of statistical error is an integral part of hypothesis testing. The test requires an unambiguous statement of a *null hypothesis*. The null hypothesis typically corresponds to a general or default position. For example, the null hypothesis might be that there is no relationship between two measured phenomena or that a potential treatment has no effect. A *type I error* will occur when the null hypothesis (H_0) is true, but is rejected. It is asserting something that is absent**.** A type I error may be compared with a so-called *false positive*. A *type II error* occurs when the null hypothesis is false, but it is erroneously accepted as true. It is missing to see what is present. A type II error may be compared with a so-called *false negative*.
3. Prepare an effective *bibliography* (7). References quoted must have been read by the authors and must bring something effective to the manuscript. In other words, get the full text version of the references you plan to use in your bibliography. Citing Medline abstracts without having read the full text is easy but it means that you cheat yourself and the readers (4). Citation of secondary sources results in misquotations and incorrect citations. It is frustrating to seek a reference that is incorrectly cited (4). References to non-scientific publications ordinarily are not acceptable as listed references. Do not include references of mass-circulation magazines and newspapers unless special circumstances warrant such inclusion (if you do, mention it parenthetically in the text).
4. Take it from an erstwhile editor : "there are far more mistakes in the scientific literature cited section of a paper than anywhere else" (1). *Check and re-check your bibliography* before the manuscript is submitted, and maybe again at the galley proof stage.
5. Follow the *Instructions to Authors* when you prepare the References section. Generally a good standing journal will refer to the Vancouver Style and the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (22-24).
6. Check the Instructions to Authors for the *choice of units* : either the Scientific System of Measurements (USA & UK) or Système International (Europe & Canada). Guides from the World Health Organization and the New England Journal of Medicine (27, 28) are available for decades to make an effective transition from the Scientific System of Measurements to Système International if needed (e.g. Calcium : 8.82 *mg/dl* = 2.2 *mmol /l*). A microprocessor computer program to aid the conversion (29) from one system to the other is even available since the very beginning of the era of micro computers. Other tables of conversion can be easily found via Google (you do not even need to go on Google Scholar).
7. Do *quote all your sources* (Fig. 4). The best antidote to plagiarism is always to cite your sources (4).

8. *Plagiarism* is the worst deadly sin ! By definition, a research paper involves the assimilation of prior scholarship and entails the responsibility to give proper acknowledgement whenever one is indebted to another for either words or ideas (18). Flagrant omission of reference to work of other authors, which establishes their priority, is clearly fraudulent publication practice (24). On the other hand, self-plagiarism signifies lack of scientific objectivity and modesty (1).
9. The *Authorship* issue could justify by itself a full article in order to prevent another deadly sin. Authorship can be defined as the list of authors including only the authors, who actively and substantially contributed to the overall design and execution of the experiments and/or the preparation of the manuscript. The three most prestigious spots (4) on any list of authors are the first, the second and the last. The first author being acknowledged as the primary progenitor author of the work being reported and the second author being the primary associate. Unfortunately, there are no universal agreed-upon rules or accepted conventions. In many good standing journals, the last author is often an established senior "head" scientist not needing anymore indulgence of his ego or not seeking for more satisfaction by seeing his name in print on one more paper. However, this terminal spot can sometimes become a choice placement for somebody's presumed prestige. A better trend would be for the established senior scientist to give recognition (first-place listing) to a younger deserving colleague, thus encouraging the younger generation and promoting the continuance of good clinical science. The tendency to use the "laundry list and gift authorship" approach, naming as an author practically everyone in the laboratory or service is bad. The dilution effect of the multi-author approach adversely affects the *real* investigators, while adding an item to the curriculum vitae of people who got 'gift authorship', as free lunch, without even bothering to read the manuscript (4). More frustrating is the fact that each reference includes all authors when six or less ; when seven or more, only the first three authors will be listed followed by "*et al*".

Concluding Key Considerations

Be modest. *"If you are convinced that you are on the verge of a major breakthrough, and that you are in fact at the point where Chemistry leaves off and Physics begins, then you will have to drop the whole thing"*.

Be more impressed by how much you have still to learn than by how much you think you know.

Be reasonably demanding. *"If all else fails, lower your standards"*.

Be rational. *"If your reasoning is silly, illogical, irrational… sometimes it's beginning to make sense. But try to rephrase your message"*.

Be sure of one thing, however : you must learn how to write, because Science demands written expression. *To learn to write, you must learn to read. To learn to write well, you should read good writing*.

Be confident. Most probably, you know more than you think you do. Take your work seriously ; yourself less so. Confidence is essential ; arrogance is deadly.

Don't be afraid to explore unknown territories. *"If at first an idea is not absurd then there is no hope for it"*.

The only way to learn how to write a scientific paper, it is by writing a scientific paper. You may not be the strongest, you may not be the fasted, but you will be damned if you are not trying your hardest in order to learn how to use words and how to put them together. What you need the most to establish your ability to publish is courage. Courage is to realize that while you may not get everything you work for, you will certainly work for everything you get. Thus, courage is what it takes to sit down and fill up the blank screen of your computer or an empty sheet of paper. Courage is what it takes to begin writing a paper !

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