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Writing biomedical research papers in English - a challenge for non-Anglophone authors

Pisanje biomedicinskih istraživačkih radova na engleskom jeziku - izazov za autore kojima engleski jezik nije maternji

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Introduction

English has emerged as the main language for publication of scientific and medical research and is often used in international gatherings of specialists in biomedicine. This trend facilitates smoother communication between scientists and, consequently, more rapid progress in science. Because English is recognized as the primary medium of international specialized publication, non-English speaking scientists like rather to publish in English than in their native language. However, rules for scientific writing are not always easy to follow for authors writing papers in a foreign language.

Clear writing is essential for effective convenience of information in written form, but one of the major problems in scientific communication in English is the correct use of this language by authors for whom English is not a mother tongue. There are at least two reasons for this [1]: the first, to be sure that you yourself know what you mean and the second, to be sure that you get your message across to your reader. Many books and papers have been written on how to improve style and publish scientific papers in English. The aim of this paper was to provide guidelines on how to achieve clarity in biomedical scientific writing in English for non-English speaking (non-Anglophone) authors. These guidelines refer to: writing style (choice of simple, precise and, whenever possible, short words; proper use of tense and voice (active or passive); mechanics (avoidance of unnecessary words and phrases, abstract terms, jargon, and excessively long compound terms, so-called "freight-train phrases"; and, avoidance of non-English expressions and grammatical errors.

Medical research papers – style and structure

The term style has at least two meanings [3]. In its literary sense, style is a manner of language expression, such as a "prose style", or "writing style" can be used. However, style is also used to denote in more specific terms the custom followed in punctuation, abbreviation, capitalization, reference citation, format and content. This is known as "publication style" [2], or "house style" [3].

Writing style helps achieve brevity and clarity [4]. Many publications recommend how to accomplish that goal [1–4]. Some suggestions are intended for non-Anglophone authors and refer to the proper use of English. More precisely, they indicate the need not only for grammatically correct English, but also for simple and clear expressions that are readily understood by readers, regardless of their native language.

Scientific language does not need complicated or convoluted expressions, or words transliterated or derived from other languages where English words suffice [5]. For example, it is preferable to say "now" instead of "at the present moment" or "at this point of time"; "because of" instead of "as a consequence of"; "most" instead of "a majority of"; "believed" instead of "was of the opinion that", etc [6]. There are many more examples of how inexperienced authors mistakenly think that pretentious and abstract words will improve the scientific content of their papers; they forget the importance of simple and short words for the necessary clarity of scientific communication [6].

Authors should select words that accurately, precisely and correctly convey the intended meaning (Table 1) [2]. Certain words can be confused or misused for various reasons: some sound the same although they are spelled differently and have different

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meanings (homophones). Mistakes can occur if the author is uncertain of the spelling and misuses one word for its homophone pair. The most common errors occur when authors fail to make precise distinctions among words of similar meaning. Table 1 gives some examples of real or apparent synonyms, together with their correct usage. "Which" and "that" are often misused, and their incorrect usage can change the meaning of the sentence substantially. "That" begins an essential adjectival clause (fundamental to the meaning of the sentence), and "which" begins a non-essential adjectival clause (one that merely adds interest to the sentence and could be omitted) [4]. Table 1 gives examples: the first sentence where "which" indicates that all oral bacteria are sensitive to penicillin compared to the second sentence where "that" indicates that only some oral bacteria are sensitive to penicillin, and that they cause dental infection.

Table 1

Similar words and their precise use*

Words	Meaning / Explanation	Examples
among	relationship involving more than two units of the same kind	Among oral *penicillins*, amoxicillin is the best choice
between	relationship involving two units of the same kind	They chose an appropriate antibiotic between *penicillin* and *cephalosporin*
as	has temporal sense	As we were completing the paper, new evidence came to light
because	shows cause	Because clinical experience in patients with severe liver disease is limited, caution should be taken when administering the drug.
since	preferably shows temporal relation	He has done nothing since he recovered.
compared to	compared, to emphasize contrast	Compared to us, they have achieved much better results
compared with	looking for similarities or differences	*Lidocaine* was compared with *procaine*
majority	a number of items greater than half of total	The majority of the patients had received prior chemotherapy.
most	preferred when quantitative expression is not needed	Most operations are successful. The most he can hope for is a symptom-free interval.
presently	currently, soon, shortly	The MR machine is presently out of order.
at present	now	No effective drug is available on the market at present.
varying	changing	Because of the varying prices medical material has become very expensive.
differing	to have unlike characteristics	The two methods, although differing greatly in their technology, are equally used in practice.
different	to have unlike characteristics	Different therapies are used for cancer treatment.
which	used in non-restrictive sense	Oral bacteria, which are sensitive to *penicillin*, also cause dental infections
that	introduces an essential clause	Oral bacteria that are sensitive to *penicillin* also cause dental infections
while	indicates a period of time under consideration	While there is life there is hope.
although	should be used for a conditional state	Although breast cancer maps provide visuals, they don't tell the whole story.

*** Adapted from: "The CBE Manual for Authors, Editors, and Publishers" [2].**

Short sentences are the crux of good scientific writing [4]. Sentences with fewer words not only convey their meaning clearly at first reading, but also provide fewer opportunities for non-English constructions and grammatical errors. Short sentences provide text clarity and make it easier for authors to follow basic linguistic rules.

Objectivity

Information and facts are more important than personal opinions. It is the task of the writer to address the topic in an objective manner. An objective style puts a certain distance between the writer and the arguments proposed.

Clarity

Apart from accurate reporting the results of the study, clarity is the most important element in medical scientific writing. The reader should be told why the study was performed and what the research is about (introduction), what was done (material and method), what was found (results) and what the results mean (discussion). This presentation style is known as the Introduction, Material and Method, Results and Discussion (IMRaD) structure. A paper with the IMRaD structure, is generally preceded by an abstract.

Abstract – An abstract provides a shortened version of the full paper. Since abstracts may be reprinted without the full paper, they must be self-explanatory. Abstracts describe the purpose of the research, how the research was conducted, what the main findings were, any limitations of the applied method, what the findings mean and what can be recommended for further research. Abstracts do not include information not in the paper itself, tables or diagrams, or citations of other work.

There are two kinds of abstract. A descriptive abstract tells what is in the paper; what the author will attempt to prove, rather than a synopsis of the results. It is appropriate for longer papers, such as review articles and can be written before the paper itself is drafted. An informative abstract not only describes what is in the paper, but also summarizes factual information, including methods, results and conclusions. This type of abstract is suited to reports about original

research and is usually written after the paper is finished. A structured abstract, similar to the informative one, follows the IMRaD formula but uses specific content headings instead of a single paragraph format.

Introduction – The introduction to a research paper presents the topic in general and expresses the central research question or hypothesis to be proved through evidence and examples. It should tell readers why the study was done and why it is important. Only those references that are essential to justify proposed study should be cited.

Material and Method(s) – This section of a research paper describes all of the specific method used. Every detail is important and must be completely documented so that other researchers can repeat the studies and verify the results. The failure to list relevant variables will call into question the reported results and conclusions. A writer should consider three basic questions: Where? (location of the work, if relevant); What? (equipment and other materials used); How? (procedures and methods used in the research).

How could the research be done differently to verify the findings?

Conclusion – This is an optional part of the research paper. It can summarize the main points and the obtained results.

The Proper Use of Tenses – the problem of tense is not merely a grammatical point. It relates to style of particular sections of the research paper. The convention commonly in use requires that the present tense be used to quote previously published work as a sign of respect for established knowledge. When referring to one's own work, the past tense should be used, as this work is not presumed to be established knowledge until after it has been published [7]. Generally, the Abstract is written in the past tense because it refers to the author's present results. Likewise, the Material and Method and Results sections should use the past tense. On the other hand, much of the Introduction and Discussion should be in the present tense (Table 2).

Table 2

Tenses in scientific writing*

Section	Correct use of tense
Abstract	The antimicrobial activity of three root canal sealers on five standard bacteria strains was tested
Introduction	The root canal sealers have antimicrobial activity against some bacteria
Material and Method	The antimicrobial activity of three root canal sealers was tested against five standard bacteria strains
Results	The tones of inhibition were greatest with Endomethasone against all of the tested bacteria
Discussion	Antimicrobial activity of Endomethasone against oral bacteria is doubtful

*** Adapted from "Todorović G, Matejašev S, Todorović Lj. How to Make Writing in English Easier for Non-Anglophone Authors. *Balk J Stom*, 2003; 7:66-70"[7]**

Results – This section presents the data and findings from the research. Data may be effectively presented in charts, tables, graphs, diagrams, or figures, which should be accompanied by explanatory text. Descriptions within this section may refer to trends or preference. Some of the useful vocabulary items for describing tables and graphs include: "to increase, to rise, to grow, to improve, to go up"; or "to decrease, to fall (off), to drop, to decline, to go down, to slip"; "to remain stable, to stay at the same level, to remain constant, to stagnate, to stabilize". The degree and speed of change may be described by some of the following adjectives and adverbs: "dramatic/dramatically", "considerable/considerably", "slow/slowly", "significant/significantly", "quick/quickly", "slight/slightly", substantial/substantially", "sudden/suddenly", "rapid/ rapidly", "moderate/moderately", "steady/steadily", "gradual/ gradually".

Discussion – The discussion section may restate the hypothesis or intent and follow with the interpretation of findings and an evaluation of the research. It determines whether the work supported the hypothesis or failed to do so. This section may also discuss the limitations of various research methods and how the studies might be done differently. It considers the following questions: 1) Did the research support the hypothesis? 2) What interpretations can be made from the results? 3) Were the research methods adequate? 4)

Grammar Matters

For some, grammar is a mystery or a collection of incomprehensible rules; for others, it is about knowing why something reads badly and how to fix it [6]. Although most native-English speakers simply "know" when a sentence reads well, non-English authors must learn certain rules of grammar to help them write efectively [4]. Apart from learning the basic rules of grammar, the best way to avoid making mistakes in English is to analyse the troublesome sentences and errors after correction by reviewers.

Authors who do not distinguish between singular and plural forms of nouns often fail to match subjects and predicates correctly [7]. Such errors are most frequently made with words taken from other languages, especially Latin-derived nouns. Plural endings of these words differ from the English, although there are some anglicised forms, such as index-indices/indexes, fungus-fungi/funguses (Table 3, section a).

The agreement in number between subject and predicate is also a problem in sentences containing numerals [6]. For example, verbs should be in the plural for all values greater than one, even if these are less than two (Table 3, section b). Noun-verb agreement also pertains to fractions.

Gerund (the -ing form with features of both noun and verb) can sometimes be substituted by an infinitive. How-

ever, the gerund, and not the infinitive, should be used in these instances [8]: a) after words followed by preposition; b) after verbs such as avoid, risk, or stop; c) after some adjectives (busy, worth); and d) after certain phrases - look forward to, or it's no use (Table 4).

The frequent use of the passive voice in medical writing is impersonal and objective and creates a certain distance between the writer and the arguments proposed.

Unneeded Words and Phrases, Abstract Nouns, and Jargon

Lengthy sentences are tiresome to read [6]. The reader has to search for the main message while trying to remember and place all of the subtopics and asides [3]. Table 5 gives examples for using unneeded and wordy phrases.

Table 3

Agreement in number between subject and predicate*

	Incorrect	Correct
a	Words are media of expression.	Words are a medium for expression.
	Patients with following criteria i**s** not eligible for randomisation.	Patients with following criteria are not eligible for randomisation.
	Drug resistance phenomena was recognised very early in the history of cancer chemotherapy.	Drug resistance phenomena were recognised very early in the history of cancer chemotherapy.
b	Twenty percent of time are spent on administration.	Twenty percent of time is spent on administration.
	Four-fifths of the area are contaminated.	Four-fifths of the area is contaminated.
	A number of respondents was verbose in their answers.	A number of respondents were verbose in their answers.
	The number of respondents were surprising.	The number of respondents was surprising.

*** Adapted from: Todorović G, Matejašev S, Todorović Lj. How to Make Writing in English Easier for Non-Anglophone Authors. *Balk J Stom*, 2003; 7:66-70[7]**

Table 4

Misuse of the infinitive*

	Incorrect	Correct
a	He is a man capable to judge art.	He is a man capable of judging art.
	We insist to check all records.	We insist on checking all records.
	You should not risk to get your life in danger.	You should not risk getting your life in danger.
	He can't stop to talk about his illness.	He can't stop talking about his illness.
b	He was busy to get ready for his journey.	He was busy getting ready for his journey.
	His books are not worth to read.	His books are not worth reading.
c	I always look forward to hear from you.	I always look forward to hearing from you.
	It's no use to ask her for an advice.	It's no use asking her for an advice.

*** Adapted from: Todorović G, Matejašev S, Todorović Lj. How to Make Writing in English Easier for Non-Anglophone Authors. *Balk J Stom*, 2003; 7:66-70 [7]**

Table 5

Unneeded words and phrases

Verbose	Concise
it is reported by Smith that	Smith reported
are of the same opinion	agree
as a consequence of	because
as far as our own observations are concerned, they show	we observed
despite the fact that	although
was of the opinion	believed

Modal verbs are also frequently used for hedging, or expression of tentativeness and possibility. This allows the author to present statements with appropriate accuracy and caution, by expressing possibility rather than certainty and prudence rather than overconfidence [9–11]. Hedging plays a major role in medical discourses [12, 13] where the accreditation of knowledge depends on the consensus of the research community. Where evidence must be evaluated, and there is a need to comment on its reliability, hedging helps to avoid potentially hostile responses, and it may facilitate acceptance of research claims. Research writing is necessarily a balance of fact and evaluation as the writer tries to present information as fully, accurately, and objectively as possible. Alternatively, a writer may wish to anticipate the possible negative consequences of being proven wrong and a claim disputed [10, 13, 14].

Abstract nouns formed from verbs (by adding "ion" at the end of the word) increase sentence length unnecessarily because of the need to add prepositions and verbs [6]. Examples include "interpretation" from "interpret" or "production" from "produce", etc. Replacing abstract nouns with their equivalent verbs makes the sentence more vivid [3] (Table 6).

Jargon [3] is often characterized by slang or obscure meaning. It is always preferable to use simple English words instead of foreign words, phrases or jargon [6]. For example, it is better to say "the patient could walk" than "the patient was mobile", or "arms and legs" than "upper and lower extremities". Furthermore, the use of informal idiom in a scientific paper can be quite unintelligible to many readers, especially the non-native English speaker.

Table 6

Replacement of abstract nouns*

Sentences with abstract nouns	Sentences without abstract nouns
A direct correlation between serum antibiotic concentration and resolution of infection was seen	The resolution of infection correlated directly with the serum antibiotic concentration
Following termination of the treatment, there was a substantial decrease of pain, resolution of bone infiltrates, and partial improvement of function	After the treatment, pain greatly decreased, bone infiltrates resolved, and function partially improved

*** Adapted from: Todorović G, Matejašev S, Todorović Lj. How to Make Writing in English Easier for Non-Anglophone Authors. *Balk J Stom*, 2003; 7:66-70 [7].**

"Verbosity" – the use of long instead of one-syllable words [7], should also be avoided. Words and phrases often used in medical conversation, such as "blood sugar" (glucose concentration in blood), should be avoided in scientific writing, as well as terms like "diabetics", "psychotics" and similar labelling of participants in the study. It is better to write "patients with diabetes" than "diabetic patients" even though the first expression is longer. The word "participant" is frequently used in clinical studies. The terms "subjects" and "individuals" are acceptable, but the term "participants" is more correct because it reflects the role of people in the research process [13]. Throughout papers on clinical studies, authors should refer to their patients rather than cases, and they should be careful not to dehumanise their participants (patients) by using the wrong pronoun. For example, it is correct to write "participants who" and dehumanising to write "participants that".

Un-English Expressions

When writing in English, non-Anglophone authors should always consider the need to transmit content, i.e. meaning and essence of the sentence rather than its form [6]. Errors often occur when authors translate expressions from their native language directly into English, following structure rather than meaning.

To sum up instead of a conclusion

Medical writing is a particular skill set in scientific communication. To accommodate an international readership, it needs to be clear and concise, and written in plain English, with the reader in mind. Research that furthers the progress of science deserves to be presented in the best possible way. The simple guidelines for the grammar and language of written biomedical communication described in this paper are intended to help authors improve the style and structure of their medical research papers. Acknowledging many difficulties of writing in a foreign language, before submitting a paper to an English-language journal, a non-English author is advised to seek review by a reader who knows the English idiom well [3]. This final step will ensure that the contents of papers are clear and enjoyable to read for a wide professional audience.

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