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## Effective scientific communication in biomedicine\*

**KEYWORDS:** Science; Medicine; Writing; Publishing; Communication

### ABSTRACT

*Effective scientific communication in biomedicine is the basic mechanism of existence and progress of science. For effective written scientific communication it is not enough only to publish report of obtained scientific results. Scientific article must be written in a way to be easily noticed and understood by the reader. Moreover, effective scientific communication includes the response of readers (feedback) to published information. In this article several facts, important for effective scientific communication, are emphasized: publication is an integral part of scientific method of knowledge, the reasons why the results of scientific research must be published and the way to write and publish to be included in effective scientific communication.*

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### INTRODUCTION

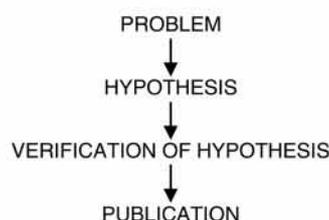
Science is not private thing. Scientific investigation does not terminate by satisfaction of anybody's curiosity or keeping results in a drawer. Scientific work is doing its job only when it is published, when obtained results have the chance to belong to other people. Therefore, the final phase of all scientific processes is writing report of results in the form of scientific article (1-3). Keeping scientific "results" unpublished most often indicates two possibilities: research is not finished or is finished but unsuccessfully. In every case, if you do not publish the results of scientific research it is the same as if you did not work at all.

The main purpose of the scientific writing is to transfer ideas and information to other people. To transfer information, in the first place, to the person who needs them is fundamental for effective scientific communication. This is the best done through original scientific article published in scientific journals. The job of scientific article effectively written is to communicate information.

### PUBLICATION AS INTEGRAL PART OF SCIENTIFIC METHOD

There are many reasons (ontological, sociological, authorship, and so on) why it is necessary to publish the results of scientific research. The most important ones are consequence of the fact that the publication is an integral part of the scientific method of knowledge (4).

Scientific method is the best thing thought out up to now to get new and true knowledge or information. Research of any problem using scientific method of knowledge (Figure 1), in short, begins by formulation of hypothesis and its verification in practice (observation or experiment). The final phase of all scientific processes is publication of the obtained results in the form of scientific article (1-3).



**Figure 1.** Scientific method of knowledge

Publication of the scientific results in the medicine, basic or clinical, from the reasons of medical ethics, is of special importance. Namely, in this field of science full importance has the paraphrases of sentence "To work, to finish, to publish" (Faraday): investigation is not terminated when it is finished but when it is published.

### WHY TO PUBLISH?

The main reasons for publishing the results of scientific investigation elicited from the scientific methods are following (4).

*Teaching about truth.* The aim of the science is truth. New information (knowledge) obtained by scientific method is objectively true. One of the criteria of the objectivity of the scientific results is their intersubjective reproducibility. Namely, any scientist or competent person, if hypothesis and condition of its verification are clearly defined should, in repeated experiment, obtain nearly identical results. But to check these scientific results must be published.

Since the aim of science is the truth, the same is in professional clinical work or investigation. In clinics as in basic science nobody believes on the nice words, eg. without objective scientific facts. How to know and test that some doctors successfully and better treat the patients than others if such facts are not explained and published? Therefore, writing and publishing is obligation of every modern medical doctor. For those who read scientific and professional journals, who systematically and prospectively organize his or her

everyday professional work or investigation, publication of obtained results will not be difficult at all (5,6).

*Scientific information as a resource.* Besides matter and energy, the two basic entities for world existence, information today is a third entity for existence of life, e.g. source of new value. But, contrary to matter and energy, published information during scientific communication elicits special quality: by use its value does not waste, by distribution its value does not decrease. Just opposite, its truth and value in the process of communication increase. It makes ennobled. That is why, any societies today can be viewed as economically rich, military powerful, cultural progressive and so on depending on how much available information possess.

*Valuation of scientific work.* Publication is the final product of scientific research. The highest value is reached when new information is included in scientific communication, when scientific information, as published material, becomes a part of the world fund of knowledge. There is no better indicator of value of something than the fact that it is adopted or cited from the large number of people. Only at that time, when final scientific product, e.g. published scientific information reach the highest value - its authors, institutions and community should be valued.

*Ethical character of scientific information.* Scientific research, in its essence, is positive and directed to improve conditions of life for all. Science does not know for frontiers between states and differences in social, religious, race, sex and economic status, differences between groups and individuals. Scientists publish their results in international journals making them available to all interested in. In this way science expresses widest ethical character.

## EFFECTIVE SCIENTIFIC COMMUNICATION

*Writing is communicating (7).* It is not enough only to publish the results of scientific research. According to some models of communication, till the process of writing, information must be directed and transferred to other people. If information is published but not transferred to person who needs them it is as a half bridge was built - information is published but failed to communicate. In the process of effective scientific communication information generated in one mind must be received from other.

Moreover, in effective scientific communication, it is very important to know the response of other persons to our information (feedback). This indicates that communication, and not only transmission, is taking place. In written communication, feedback is less obvious. But written response of the editor, when the manuscript is sent back, response of the departmental head or data about citation of our article (echo, impact factor) could be clear indicator for effective scientific communication.

## HOW TO PUBLISH EFFECTIVELY?

Whenever we have something important to say, e.g. at least one new and important information we should publish it. But, we should always have in mind following principles during writing (7).

*First principle: To define the aim of writing and to know who the readers are.* If information is to be communicated effectively, it must be more than only scientifically accurate and grammatically correct. Effective communication is transfer of information to other people, or to person who is interested in. Two questions are of the primary importance here and must be clearly defined. First, what is the aim (purpose, task) of writing? It may be: to describe, to explain, to instruct, to teach a method, and so on. Each aim will begin with different way. Second, who are the readers? Are they the same as we are? Are they alike or are they a mixed group? What do they already know about the topic? What do they need to know? Presented scientific information must be easily noticed and understood by the readers. It should be written in a way that will satisfy the readers, but not the authors.

*English language - language of science.* To reach the highest value during the process of communication, information must be written in language, which,

as a means of communication, has the widest scientific communicability. Today, English language, in the real sense is international language of science.

*Sufficient information and basic structure of article.* Scientific article is a document, which contains sufficient information to enable readers to critically assess information and to repeat the experiment. The basic structure of such scientific article is given by the well-known acronym IMRAD (Introduction, Methods, Results, And Discussion).

*Selecion of information.* Very important for efficient communication is selection of really relevant information from the obtained and available material. Selection must be made on the needs and interests of the readers.

*Arrangement of information.* Selected information must be arranged. The most attractive scientific article is when new information is arranged in order of importance from the reader's point of view. The best organization is a pyramid structure: at the top of pyramid are title and new information in short (abstract), and at the base are methods with most detailed information. This arrangement enables to majority of readers quick, clear version of the essence of new information and the story that is to come.

Today, nobody will show interest and read published material that is not regularly structured, carefully selected and arranged in order of importance for reader. This is the easiest way to stay away from effective scientific communication.

Effective scientific communication between people and societies of different level of development and different cultures is the basic mechanism of existence and progress of science and harmonious development of world. Failure to be prepared and not taking part in scientific communication, at the time of very fast development of science and media of communication, can lead to dangerous falling behind and inferior status comparing to other.

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