

SOME ASPECTS OF USING MATHEMATICS IN MEDICAL SCIENCES

Ivana Ilic

The aim of the paper was to present some new possibilities of using mathematics in medical sciences and medical practice. The so-called mathematical way of thinking is presented, which is, basically, the starting point of usual way of thinking, and also the essence of scientific and technological literacy, necessary for the development of theoretical and practical modern medicine. The aim of the paper was to show that it is reasonable to choose certain mathematical points of view, present them to the students of medicine, and thus, help them to use that knowledge in their future studies in order to be more successful in their professions. Modern mathematical and statistical methods are important in professional and scientific work in clinical and laboratory environment. *Acta Medica Medianae 2008;47(1):52-54.*

Key words: *scientific literacy, mathematical literacy, medical informatics, medical practice*

Faculty of Medicine in Niš

Contact: Ivana Ilić
Faculty of Medicine
81 Dr Zoran Djindjic Bulvd.
18000 Niš, Serbia
Phone: 018/226644 lok 230
E-mail: ivana@medfak.ni.ac.yu

Introduction

Today in 21st century is crucial to have the best experts possible. Societies that focus on human resources have chances to answer the challenges of modern time we live in. To accomplish the wanted level of scientific and technological literacy of professionals, it is needed to reconstruct the old school system into new one, where we could change points of view, concepts and relationships. First of all, we must make a new concept of a teacher, student, study, teaching and new relationship between teachers and students. It is also important to modernize the relations among all the participants in the process of education. Teachers should always have in mind that the only way to come to scientific results is in corporation with each other within a certain project. In developed countries, this way of communication among scientists, is at the highest level, as the most important national priority. The mathematics itself is in the basis of technological and scientific literacy, and this paper is going to explain these relationships, focusing medical sciences and medical practice.

Scientific and technological literacy

Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making,

participation in civic and cultural affairs, and economic productivity. It also includes specific types of abilities. Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy has different degrees and forms; it expands and deepens over a lifetime, not just during the years in school. But the attitudes and values established toward science in the early years will shape a person's development of scientific literacy as an adult.

Technological literacy means computer skills, but also the ability to use other technology to improve productivity and performance. The health care environment is becoming more dependent on computer systems and is changing so dramatically that physicians who do not continually update their computer literacy skills might not be able to deliver services in the future. Surgical simulations and virtual environment are educational tools not only for doctors but also for patients (1). Also, statistical softwares are now widely used for new researches in medical field. There are so many various analysis that can be done using different softwares. Beyond the standard statistical analyses we can use, for example: Fitting of Exponential, Weibull and Extreme Value Distributions (2) to Complex Censored Survival Data Using GLIM, then we can perform Meta analysis, which is very important statistical method for medical researches, using

Comprehensive Meta Analysis, we can perform a comparative analysis using Functional MRI statistical software packages, etc.

The central distinguishing characteristic between science and technology is a difference in goal: The goal of science is to understand the natural world, and the goal of technology is to make modifications in the world to meet human needs. Technology as design is as parallel to science as inquiry. Technology and science are closely related. A single problem often has both scientific and technological aspects. The need to answer questions in the natural world drives the development of technological products; moreover, technological needs can drive scientific research. And technological products, from pencils to computers, provide tools that promote the understanding of natural phenomena. In the basis of these processes lies the mathematical way of thinking, as well as mathematical methods of concluding, deriving and proving. Thus, it is very important, that young population gets mathematically educated very well. This is because in future this generation should contribute a great deal in medical sciences, and in science in general.

Mathematical literacy

Usual understanding of mathematics for the people who do not deal with it professionally, is basic simple calculation which considers numbers and arithmetic operations. As a science, it has no attraction for amateurs, for it doesn't give space for incorrectness and improvisation. You either know it or you don't, there is nothing in between. „No other science is more unpopular than mathematical science, science about numbers and geometrical shapes, although it exists on the edge between consciousness and unconsciousness, at the very start of the beginning of human thinking and understanding“ (3).

Understanding of mathematical science demands the knowledge of mathematical language, its vocabulary and grammar. In order to understand the meaning of mathematical words, one must comprehend mathematical notions and objects, to which those words refer in the realm of mathematics. The language of mathematical science contains lots of everyday words, which will get the same or different meaning in mathematical language. Our everyday vocabulary refers to the objects which really exist round us, and the objects we think exist in the real world. On the other hand, mathematical language refers to mathematical notions and objects which exist according to the mathematical point of view. This is basically the reason why those two languages differ. Every single idea of mathematical objects and relations must be completely logical, so one should learn mathematical logic, that is to say mathematical way of thinking. Practically speaking, one should know how to conclude, derive and prove. Knowing basic mathematical notions and concepts, and knowing so called mathematical way of thinking, makes mathematical literacy. Mathematics stands for the model of universal science, in which one can implement a body of any other science, such as medical sciences for example. It is due to its specific structure.

Mathematics considers certain number of formal mathematical theories, which are based on the so called Set Theory. Each of those theories, consists of four segments: language, a set of basic notions, a set of objects the theory refers to, and mathematical logic. Each object within the theory is determined by a set of certain properties. Based on some or all these properties we can identify and classify objects. Considering this universal structure of mathematics, it is useful for everybody who deals with scientific work, to adopt basic mathematical principles and a way of thinking (4).

Elements of mathematics in medical practice

For the last 20 years, mathematics has been used as very important method in acquiring knowledges in biology and medical sciences. It integrates with biology and engineering, and becomes an inevitable source of new scientific results in medical sciences and medical technology. Although few physicians today would regard mathematics as a fundamental ingredient of medical science, the fact is that, today clinical medicine has become permeated by statistics as a mathematical discipline. But, at first, when few physicians started to use mathematical rules and principles in the form of "calculus of probabilities", many others responded with outrage and resistance. It was unimaginable to make medical conclusions on the basis of group of patients, instead of traditional believe that every patient is unique case and has unique disease, based on individual imbalances. Over the last 200 years there were many problems (5) and disagreement to accept mathematics as an inevitable tool in medicine (6).

Beside in scientific researches as a statistical tool, mathematics is permanently used in medical practice. Doctors must determine how often a patient needs to take their medication, and for how long, in order to keep enough medicine in the patient's body to work effectively, but without overdosing. The amount of medicine in the body after taking a medication decreases by a certain percentage in a certain time (perhaps 10% each hour, for example). So, if a patient takes a pill that has 200 mg of a certain drug, the decrease of medication in their body each hour can be expressed as follows: 200, 20, 2, 0,2, 0,02,.... The sequence of numbers shown above is geometric because there is a common ratio between terms, in this case 1/10. This means that each hour, the amount of medication decreases by 1/10. Doctors can use this idea to quickly decide how often a patient needs to take their prescribed medication.

Medical workers must be able to determine a drug dosage which should be given to the patient depending on his (her) weight, and on needed time of its elimination out of the system. More, one often needs to calculate the drug dosage depending on the clearances and the functional state of kidneys and liver, and on the degree of the patients hydration.

There was an excellent example of math and medicine that came from the PBS Teacher Source website. The example given said, "Each

morning a patient must take a pill containing 50mg of a certain medicine. One of the things that our bodies do is wash stuff out of our systems. In the process of doing this, 40% of the medicine this patient takes is gone the next morning when it is time to take the next tablet." Doctor would have to use his basic arithmetic skills and multiply 50 mg by 40 and then he would have to subtract the product from 50 mg. The doctor would have to do the basic calculation:

$$\begin{aligned} 50 \times 40\% &= ? \quad \leftarrow \text{first equation} \\ 50 \times 0.40 &= 20 \quad \leftarrow \text{Multiply 50 with 0.40 to calculate} \\ 50 - 20 &= 30 \quad \leftarrow \text{the amount of washed out drug} \\ &\quad \leftarrow \text{The amount in the body next day} \end{aligned}$$

Numbers provide informations about the condition of the patient to doctors. Numbers help doctors analyse medical state of the patient, and warn them about possible infections and diseases (blood values, sedimentation, and other indicators).

Mathematical calculations are needed in every single step, not only in clinical practice, but also in general medical practice ordinations.

Identifying various indexes, as Body Mass Index (BMI), or ratio waist/hip, or ideal body mass help in diagnose illness and providing suitable therapy.

Conclusion

The structure of mathematical theories is universal for any of the scientific theories, and also for the set of scientific theories usually called medical sciences. At this point, it is important, for anyone who has an intention to deal with scientific work in medicine, should get familiar with the structure of basic mathematical theories. Also, medical students must be familiar with the basis of mathematical calculus, so that every day medical practice becomes more accurate and beneficial.

Literatura

- Grobe S. Nursing Informatics 1997 (post-conference on patient guidelines and clinical practice guide-lines: the state of our knowledge and a vision). Journal of the American Medical Informatics Association, 1998; 5(3):315-6.
- Ilic I. Ocenjivanje indeksa pravilne promenljivosti korišćenjem ekstremnih statistika. Univerzitet u Beogradu; 2006.
- Adamović D. Razgovor sa savremenicima Privredna štampa Beograd 1982.
- Bellman ER. Mathematical Methods in Medicine. World Scientific Publishing Co., Inc. River Edge, NJ, USA
- Feinstein RA. Two Centuries of Conflict Collaboration Between Medicine and Mathematics J. Clin. Epidemiol. 1996;49(12):1339-43.
- Breslow EN. Are Statistical Contributions to Medicine Undervalued? Biometrics 2003;59(1):1-8.
- Grobe SJ. Nursing informatics competencies. Methods of Information in Medicine, 1989; 28(4):267-9.

NEKI ASPEKTI KORIŠĆENJA MATEMATIKE U MEDICINI

Ivana Ilić

Namera ovog članka je da predstavi neke nove mogućnosti korišćenja matematike u medicinskim naukama i medicinskoj praksi. Predstavljen je matematički način mišljenja, koji stoji u osnovi uobičajenog načina mišljenja, a takodje i u osnovi naučne i tehnološke pismenosti neophodne za razvoj teorije i prakse savremene medicine. Cilj ovog rada bio je da pokaže da ima smisla izdvojiti neke matematičke sadržaje, predstaviti ih studentima medicine, te tako dati doprinos njihovom osposobljavanju da se u budućnosti bave naukom i bolje obavljaju svoju profesiju. Savremene matematičke i statističke metode su neophodne za realizaciju stručnih i naučnih analiza u kliničkoj praksi i laboratorijskom radu. *Acta Medica Medianae* 2008;47(1):52-54.

Ključne reči: naučna pismenost, matematička pismenost, medicinska informatika, medicinska praksa