

# Chapter I

## Data, Information and Knowledge

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### ABSTRACT

*This chapter introduces the basic concepts of medical informatics: data, information, and knowledge. Data are classified into various types and illustrated by concrete medical examples. The concept of knowledge is formalized in the framework of a language related to objects, properties, and relations within ontology. Various aspects of knowledge are studied and illustrated on examples dealing with symptoms and diseases. Several approaches to the concept of information are systematically studied, namely the Shannon information, the discrimination information, and the decision information. Moreover, information content of theoretical knowledge is introduced. All these approaches to information are illustrated on one simple medical example.*

### INTRODUCTION

Healthcare is an information-intensive sector. The need to develop and organize new ways of providing health information, data and knowledge has been accompanied by major advances in information

and communication technologies. These new technologies are speeding an exchange and use of data, information and knowledge and are eliminating geographical and time barriers. These processes highly accelerated medical informatics development. Opinion that medical informatics is just a computer application in healthcare, an applied discipline that has not acquired its own theory is slowly disappearing. Nowadays medical informatics shows its significance as a multidisciplinary science developed on the basis of interaction of information sciences with medicine and health care in accordance with the attained level of information technology. Today's healthcare environments use electronic health records that are shared between computer systems and which may be distributed over many locations and between organizations, in order to provide information to internal users, to payers and to respond to external requests. With increasing mobility of populations, patient data is accumulating in different places, but it needs to be accessible in an organized manner on a national and even global scale. Large amounts of information may be accessed via remote workstations and complex networks supporting one or more organizations, and potentially this may happen within a national information infrastructure.

Medical informatics now exists more than 40 years and it has been rapidly growing in the last decade. Despite of major advantages in the science and technology of health care it seems that medical informatics discipline has the potential to improve and facilitate the ever-changing and ever-broadening mass of information concerning the etiology, prevention and treatment of diseases as well as the maintenance of health. Its very broad field of interest is covering many multidisciplinary research topics with consequences for patient care and education. There have been different views on informatics. One definition of informatics declares informatics as the discipline that deals with information (Gremy, 1989). However, there are also other approaches. We should remind that the term of informatics was adopted in the sixties in some European countries (e.g. Germany and France) to denote what in other countries (e.g. in USA) was known as computer science (Moehr, 1989). In the sixties the term informatics was also used in Russia for the discipline concerned with bibliographic information processing (Russian origins of this concept are also mentioned in (Colens, 1986)). These different views on informatics led to different views on medical informatics. In 1997 the paper (Haux, 1997) initiated the broad discussion on the medical informatics discipline. The paper (Zvárová, 1997) the view on medical informatics structure is based on the structuring of informatics into four information rings and their intersections with the field of medicine, comprising also healthcare. These information rings are displayed on Figure 1.

*Basic Information Ring* displays different forms of information derived from data and knowledge. *Information Methodology Ring* covers methodological tools for information processing (e.g. theory of measurement, statistics, linguistics, logic, artificial intelligence, decision theory). *Information Technology Ring* covers technical and biological tools for information processing, transmitting and storing in practice. *Information Interface Ring* covers interface methodologies developed for effective use of nowadays information technologies. For better storing and searching information, theories of databases and knowledge bases have been developed. Development of information transmission (*telematics*) is closely connected with methodologies like coding theory, data protection, networking and standardization. Better information processing using computers strongly relies on computer science disciplines, e.g. theory of computing, programming languages, parallel computing, numerical methods. In medical informatics all information rings are connected with medicine and health care. Which parts of medical informatics are in the centre of scientific attention can be seen from IMIA Yearbooks that have been published since 1992 (Bemmel, McCray, 1995), in the last years published as a special issue of the international journal "Methods of Information in Medicine".

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