Chapter 57
Decision Support Systems in the Process of Improving Patient Safety

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ABSTRACT

The chapter presents decision support systems in medicine, their basic principles, and structure. From the point of view of patient safety, the decision support systems can bring new unexpected sources of errors, which must be anticipated at the design, implementation, and validation stages. Nevertheless, a safe and easy-to-use system can greatly improve the quality of determining the diagnosis, prognosis, and therapy in healthcare. The authors of this chapter concentrate on the contribution of decision support systems to patient safety and on their potential to future contributions. A decision support system requires a user-friendly interface with the electronic health record and information system within the healthcare facility. The authors also present two examples of decision support systems from the genetics research.

INTRODUCTION

The objective of the chapter is to describe decision support systems and their role in the process of improving patient safety. While the modern technology undergoing a dynamic progress allows a more effective diagnosis and therapy, the increase in effectivity does not necessarily imply a higher safety of patients. Therefore the patient safety has evolved as a self-standing healthcare discipline. The safety of patients can be increased by means of decision support systems, which are both effective and safe. The physician can benefit from exploiting the decision support system in the everyday routine healthcare to increase its quality. At the same time introducing the systems to the everyday care would bring benefits for the patient safety. This requires physicians, nurses

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and other healthcare professionals not only to attain a sufficient level of computer literacy, but also to adopt positive attitudes and understanding for the processes of information extraction, decision making and for information sciences in a broader sense.

BACKGROUND

Healthcare requires reliable information as a basis for medical decision making. However, the concept of information is often used without a careful specification of its meaning, which has been changing throughout the history. In general, it describes such facts, events, things, persons, ideas or concepts, which reflect certain real or abstract objects or processes. Information usually consists of a syntactic (structure), semantic (meaning) and pragmatic (aim, purpose) component. Data and knowledge are two main sources to get information for decision support systems (Zvárová, Veselý & Vajda, 2009).

Decision making can be described as a process of selecting an activity or series of activities among several alternatives. Decision making integrates uncertainty as one of the aspects with an influence on the outcome. Medical decision making is one of concepts of e_3-health (Zvárová & Zvára, 2011). In medicine, the physician solves the task of medical decision making based on data and knowledge connected to the cognition and determination of diagnosis, therapy and prognosis.

Decision support systems are very complicated systems offering assistance with the decision making process. In a general context, they are capable to solve a variety of complex tasks, to analyze different information components, to extract information of different types, and deduce conclusions from them. In medicine, they compare different possibilities for the diagnosis, therapy or prognosis in terms of their risk. Thus, they represent an inherent tool of e-health technologies for diagnostic and prognostic purposes capable to help during the therapy. The search for the appropriate therapy is very complex and depends on many factors and only a few decision support systems aiming at therapy have been sufficiently evaluated up to now. In practice there exist specialized decision support systems for diagnosis and therapy in invididual medicine fields and also specialized prescribing decision support systems. There has been less attention paid to decision support systems for prognosis, while there are still obstacles to apply decision support systems in healthcare routinely, although diagnostics and therapy would greatly benefit from reliable interdisciplinary and multidisciplinary systems.

Many decision support systems use artificial intelligence methods. The history of expert systems originated in the 1970s when the first expert system MYCIN for diagnostics of infectious diseases and a proposal of an antibiotic therapy was developed at Standford university in USA. The first applications of artificial intelligence in medicine were described by Clancey & Shortliffe (1984). Other types of decision support systems are grounded in probability reasoning. The criterion for the quality of decision making is often expressed by the Bayes risk (Vajda & Zvárová, 2007). The decision making process is characterized by the mathematical concept of classification analysis (or machine learning) and may possibly exploit knowledge-based rules or methods of data mining. The systems may integrate different sources of information from the data including numerical results of measurements (continuous and discrete variables), medical signals and images, text or medical guidelines. The classification analysis is a task of multivariate statistical analysis with the aim to construct objective classification rules able to assign individual observations to groups (Hastie et al., 2001). Because the classification methods are based on automatic learning the classification rule over a training data set, the term machine learning is used as a synonym for classification analysis, particularly in the context of computer science. Standard classification rules are proposed to solve