REPRESENTING AND PROCESSING VARIOUS KNOWLEDGE TYPES IN AN ANAESTHESIA INFORMATION SYSTEM

C. Greiner, H. Knublauch, M. Sedlmayr, T. Rose
Research Institute for Applied Knowledge Processing (FAW) at the University of Ulm, Germany

Introduction

The information overload caused by the continuous stream and quantity of patient data delivered by traditional monitoring devices, and the inherent complexity of the anaesthesia process lead to slips, omissions and mistakes by medical staff that might result in critical incidents. "Intelligent" monitoring devices should assist in operating rooms in order to reduce the number of these - mostly preventable - critical situations.
The project "Anaesthesia Information System (ANIS)" aims at the development of a knowledge-based assistance system that provides context-sensitive information to clinical personnel. The system's task is to deliver information about the patient's state by means of an integrated graphical display that reduces data overload and focuses the personnel's attention on the most important parameters for a given situation.

Methods

Clinical decision-making is based on various types and sources of knowledge, like raw data about patients, information about the current state of the treatment process, medical knowledge and general problem-solving knowledge. Computerized support of the clinical decision making process must reflect these elements. Yet, to provide credible and reliable assistance for medical staff, any medical information system has to generate recommendations in a transparent and explainable way based on accepted clinical guidelines.
The ANIS system is designed to give advice on subsequent steps in the anaesthesia process taking these various knowledge sources and additional information entered by clinicians into account. To do so, a model of expertise for anaesthesia is being developed to model and represent the domain knowledge for anaesthesia. It includes concepts like *observables*, defining the incoming patient data, *parameters*, describing an abstract mental image of the current situation – including information on the current step in the anaesthesia process – and *scenarios* specifying temporal relationships between the parameters and the transitions between their values.
Using this domain knowledge, that is created, edited, and maintained by experienced anaesthetists using an integrated knowledge editor, the task of transforming patient data into context-sensitive information is implemented by a set of modular problem-solving methods, that accomplish tasks like data validation, data abstraction, context recognition and analysis, as well as the simulation of effective drug doses using pharmacokinetic models. The results of this reasoning process are displayed on an integrated graphical user interface in a suitable way.

Results

The approach for acquiring and utilizing medical knowledge, based on an explicit model of expertise, leads to a system that is able to recognize the current situation and to display context-sensitive information on a graphical user interface applying intuitive interaction and display metaphors. On request, these information include an assessment of the patient's risks, guidance for the anaesthesia process and specialized information from a detailed online manual. Furthermore, the system can be used to simplify the generation of anaesthesia protocols and accounts.

Conclusions and further work

The presented framework for an anaesthesia information system is based on an explicit model of expertise that will allow to use, maintain and extend the system in a credible and explainable manner. The prototype system is currently being extended to handle more elaborate cases and exceptions. Future research will aim at the refinement of the knowledge acquisition and representation methods, including consistency checking and intelligent visualization of the relationships of the various knowledge types involved. The system is continuously tested and evaluated using simulated and recorded patient data. Clinical trials will be conducted in parallel.

Acknowledgements

The authors would like to acknowledge C. Backhaus, B. Claßen and W. Friesdorf for helpful discussion and continued support. The project is supported by the German Ministry of Research and Science (Grant no.: 01EI9621/8).