Development of a task-based reminder system for critical care environments.

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Abstract. *Objective*. Reminder systems, which incorporate practice guidelines, are increasingly used as an extension of Electronic Patient Record (EPR) systems to provide decision support to the EPR system's users. Automated knowledge acquisition tools, such as Knowledge Base Editors (KBEs) may facilitate the guideline development process by helping domain experts formulate and structure domain knowledge for use in knowledge base systems, such as reminder systems. Based on a model of the task domain, KBEs can be classified into several categories, such as symbol-level KBEs and task-based KBEs. Symbol-level KBEs represent domain knowledge as the necessary computational symbols and procedures, needed to perform an action (e.g., IF-Then rules), whereas task-based KBEs describe the actions that are needed to achieve a goal, independent of the computational mechanism that is used to model the requisite actions (e.g., the terms and relations that are needed to report drug contraindications).

The drawback of symbol-level KBEs is that its users (domain experts) can be forced to translate their knowledge into a form that might be unnatural, since many symbol-level entities in reality are implementation details. Also, utilizing the task-based architecture allows the separation of the knowledge that describes the actions (reviewing knowledge) from the medical entities and their relations, needed by the reviewing process (medical knowledge), which is thought to simplify system maintenance as well as the knowledge acquisition process. However, acquiring these task specifications from a domain expert may also result in a very low production of knowledge, because domain experts (and humans in general) do not use the rather abstract notion of general tasks, but usually think in examples or instances of tasks. This is especially true in clinical care and emergency care environments. In these environments, there is wide variety of variables and the rules are often physician or institution-specific.

This abstract discusses the subject of developing a reminder system that operates in an Intensive Care Unit (ICU), using automated knowledge acquisition techniques. To validate our ideas, we have developed a task-based KBE that enables ICU physicians to describe domain knowledge at different levels and transfer this knowledge to a reminder system that is incorporated into the EPR system, operating at the ICU clinical environment.

Methods. The KBE is a graphical knowledge acquisition tool that enables physicians to formulate guidelines and transfer them to the knowledge base of the reminder system, integrated into the EPR system of our ICU.

Each guideline is defined by a number of general properties (e.g., name, author and literature references), an expression that consists of logical propositions (combined with boolean operators, such as AND, OR and NOT) and a message that is send (by the reminder system) to the users of the EPR system, when the expression evaluates to true. Physicians construct the expression by selecting and combining medical terms from an ontology, such as drugs, treatments and diseases.

Guidelines are grouped into categories, according to the guideline's purpose. When a single category contains a number of guidelines, a panel of ICU physicians analyses them and extracts a number of features, defining a task specification. Examples of such features are a set of pertinent event classes that will execute the task (e.g., 'starting a drug'), the required actions (e.g., 'get all known contraindications of the started drug' and 'determine if one of those contraindication is present in the EPR') and the message, send to the user by the reminder system (e.g., 'finding B is a contraindication of drug A'). The task specification is then implemented into the KBE, after which physicians are able to enter the terms and relations of the defined task structure (e.g., drugs and their contraindications). As a result, whenever domain knowledge is added, a physician only has to update the database, containing the medical knowledge. The knowledge base that contains the reviewing knowledge (which is usually a far more complex structure) remains unaltered.

Results. A present, the physicians have entered 75 different guidelines into the reminder system's knowledge base by means of the knowledge base editor. The contents of the guidelines varies from relatively simple, such as 'a patient, admitted outside normal working hours, is usually marked as an emergency' to more complex, such as the detection of drug contraindications and side effects or reporting the absence of certain monitoring requirements. From these guidelines, we have extracted and implemented various task specifications, such as a contraindication task, which warns against drug contraindications, a monitoring task that embodies the notion that a certain pertinent event (e.g., prescribing drug or establishing a diagnoses) may require certain observations (e.g., a laboratory test) and a preparation task that warns when a minimum-workup requirement is not found in the EPR.

Conclusion. Although the KBE and the reminder system are in practical use only for a few months now, the first results are promising. Physicians are able to enter guidelines without assistance of a knowledge engineer. Also, when they have entered enough instances of a task, they are able to extract and describe a task's general features. We believe that this bottom-up strategy, combined with automated knowledge acquisition tools enables medical specialists themselves to improve the quality of the knowledge base, the EPR, and hopefully, of the care in critical care environments such as ICUs.

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