Design and Optimization of Medical Decision Support Services

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I. Introduction

Over the past years, medical treatment has made enormous progress, resulting in new medical data about the patient's conditions and an increase in the complexity of medical protocols. Information technology and communication technology for processing automatically large amounts of data and implement distributed applications have been introduced on a large scale in industry but were not widely adopted in health care. Today, in Intensive Care Units (ICUs), physicians and nurses are still performing time-consuming manual data analysis for making the most optimal medical decision for each individual patient. Moreover, current ICU platforms are not offering an infrastructure for infection surveillance, decision support, data-driven guidance and modeling of critical illness. Due to the lack of an integrated management platform detecting infections at early stages or following the daily patient's evolution is a complex task.

The provisioning of a decision support system would enable the discovery of patterns in health data which might be important for the fight against nosocomial (hospital-acquired) infections and prevent incorrect diagnosis, unnecessary prescriptions, improper use of antibiotics and overuse of antibiotics. Typical examples of desired services for ICU include antibiotic management services for automated dose adjustments or monitoring of antibiotic prescriptions and patient outcome calculator services. As described in this article, these services can assist in the daily patient workflow by giving immediate alerts and turn current raw patient data into new medical knowledge that can be used to improve medical decisions in Intensive Care in an early stage.

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II. Design and optimizations

The aim of this research is to design and develop an optimal decision support and management system for Intensive Care, integrating patient's data and while allowing a more accurate and efficient data collection process, supporting the physicians in their daily decision making. Important topics of the provisioning of decision support though computerized medical services in health care were studied by building a web services platform, plugging in real life medical decision support services, and modeling the service while measuring the impact of data-, service- and platform layer on the overall service performance:

- A service platform, able to combine and integrate collected patient data and integrate new services that perform analysis of antimicrobial consumption and therapy, was designed [1]. This service execution platform is being implemented with inclusion of messaging support to alert physicians of infection outbreaks. As illustrated in figure 1, the platform also offers generic services for data retrieval, task scheduling, medical services, event handling, interaction with a bedside client. The platform is

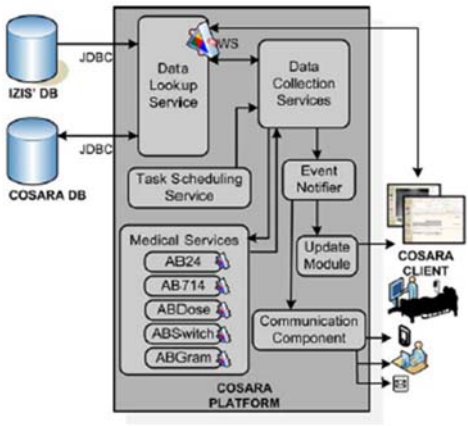

Figure 1. Overview of the core platform services

based on the principles of service-orientation, wherein all components are implemented as web services. New medical services can be plugged in easily into this platform.

- Each medical service encapsulates a certain clinical guideline that is a plan for measurements or decisions in case of certain patient's conditions or alarming values [2]. Prototypes of services for antibiotic management and outcome prediction (for example SOFA score or organ failure) have been implemented as web services. The choice of the level of service granularity is a trade-off between performance and service reusability [3]. Often the service is a composition of existing services. An evaluation of service composition tools and workflow engines [4] for medical support was performed.

- The modeling of performance, load and response times in the service creation and scheduling of tasks is done in order to predict service behavior. Therefore measurements in data access layer, processing and communication handling are done, in order to model, predict, and optimize future service execution.

III. Evaluation of Services for ICU

The services have been applied to the Intensive Care Unit of Ghent University hospital. Several iteration cycles are performed to evaluate and validate the results of automated services, allowing a profound evaluation of services. Services to identify patients with prolonged antibiotic therapy (AB24/714), who receive inappropriate drug doses (ABDose) and who can switch in antibiotic therapy (ABSwitch) were deployed on the platform. Direct clinical benefit resulting from the automation of the surveillance of infections and antibiotic consumption monitoring was noticed.

IV. Conclusions

By deploying a medical decision platform in the ICU, many labor and time-consuming tasks, that had to be done by nurses and physicians, are now performed by computer-based services. The focus of our research is on the system design of medical decision support for ICU and on service optimization through modeling and prediction of the real-time performance of these decision support services.

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