Developing and Deploying Clinical Models for the Early Detection of Clinical Complications in Neurological Intensive Care Units

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Abstract

We propose a translational informatics infrastructure that allows physicians to discover new ways to predict patient complications in neurological intensive care units (ICUs) and use these findings at the bedside. This infrastructure leverages a state-of-art stream computing platform for the real-time analysis of physiological data. It integrates data mining systems for knowledge discovery. We evaluate the use of this infrastructure on the early detection of Delayed Cerebral Ischemia (DCI) events in neurological ICU patients.

Background

During rounds of critically-ill patients each morning a physician may be confronted with more than 200 variables [1]. Clinical information systems capture physiological variables and device parameters online at least every minute [2]. These physiological data samples are usually stored within the memory of the patient monitors for 72-96 hours and then discarded. ICU patient records typically consist of paper notes, prepared manually, that represent 30 or 60 minutes summaries of the enormous quantity of physiological data available. These summaries tend to be disjointed from other important data points captured in general medical records (e.g., laboratory test results, general hospital records). Physicians are required to integrate all these pieces of information manually to develop adequate representations of the state of their patients, and drive the appropriate treatment plan.

Subtle yet clinically meaningful correlations are often buried within several multi-modal data streams, across long periods of time. The high dimension of this data and the time critical situations physicians are confronted results in constant information overload [3]. There is a lack of infrastructure support for the exploration and detection of such meaningful events in these data and as a result, medical care delivered in ICUs tends to be reactive. Physicians often react to significant events that have already occurred and impacted the patient. Detecting the signature of such events several hours or days earlier would allow proactive interventions before the complication negatively impacts the patient [4].

Approach

We have established a research partnership with between IBM and Columbia University for the development of an infrastructure in a neurological ICU to enable detection of early signs of physiological derangement. This system serves as an infrastructure for translational informatics by serving both as an exploration platform for development and testing of clinical models and as a real-time analytical platform instantiating the developed clinical models for the detection of complications resulting in earlier proactive care. It relies on a stream computing platform already in use in neonatal ICUs [5], capable of turning physiological data into meaningful events. The system is also tightly integrated with data mining components for the development of clinical models.

Evaluation

In this presentation, we present and evaluate the capabilities of this system with a research study for the early detection of DCI events in neurological ICU patients. We show how this infrastructure is being used for the discovery of clinical models capable of detecting DCI events several hours before the current medical practices. We illustrate how this infrastructure may be integrated at bedside in a real ICU environment for DCI event detection.

References

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