Federating Distributed Clinical Data for the Prediction of Adverse Hypotensive Events

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Summary

The ability to predict arterial hypotensive events - where a patient's arterial blood pressure is abnormally low - would be a major benefit to the fields of primary and secondary health-care. A wealth of data exists around the world, that provide information on the major health indicators of patients in hospitals (blood pressure, temperature, heart-rate, etc.) It is believed that if enough of this data is drawn together and analysed in a systematic way, then a system can be built that will trigger an alarm predicting the onset of a hypotensive event. This is the basis for the Avert-IT project (http://www.avert-it.org), an EU-funded collaborative project involving the construction of a hypotension alarm system, using techniques of data federation to bring together the relevant data for study and development of such a system.

Abstract

In the current environment, it has been estimated that if health-care professionals could have earlier warning about hypotensive events, and therefore administer earlier and less-aggressive treatments, the cost saving would be estimated at an average of €1600 /patient/day across the EU25 [1]. As such, the Avert-IT project aims to build an alarm system which allows healthcare professionals to be made aware of the onset of hypotensive events over a feasible time-scale (around half an hour). The various steps involved in the development of the system include:

- The collection of data from the various distributed sources around Europe, contributing to the project (including the UK, Spain, Italy, Germany, Lithuania and Sweden)
- The construction of a system that "learns" to recognise significant patterns in the variable indicator fields, through the use of a *Bayesian Belief Network (BBN)*
- The design and construction of a production interface that triggers an alarm based on the detection of such events.

The definition of a hypotensive event varies between different centres - a study conducted between the partners involved in Avert-IT showed a variation in using the systolic and (mean) blood pressures and central perfusion pressure (CPP = Mean Blood Pressure – Mean Intracranial Pressure) values [Table 1]. Depending on whether the threshold set and the duration of an event met the specific criteria, a hypotensive event would or would not be recorded. This research in itself was a goal of the Avert-IT project [2]. With the abundance of different definitions, there must be a set of pre-agreed criteria between the partners for training the BBN system. However, the wide range of definitions also allows a greater set of values to be drawn upon to train the system using different initial conditions, therefore allowing a greater number of comparative results to be drawn.

However, before this analysis can be run, the data must be collated using techniques familiar to the field of e-Science. In the first instance the design of a secure portal has been undertaken, in a similar manner to other e-Health projects run at NeSC [3,4], which bring together the data from the Avert-IT partner centres. This paper describes the challenges in implementing this portal - with particular emphasis on schema integration and fine-grained security - and how it feeds into the second step of data analysis.

References

[1] Avert-IT project proposal - Advanced Arterial Hypotension Adverse Event prediction through a Novel Bayesian Neural Network (http://wiki.avert-it.org/wordpress)

[2] Event Definition Analysis Preliminary Results, Rob Donald (http://wiki.avert-it.org/wordpress)

[3] Virtual Organisations for Trials and Epidemiological Studies (VOTES) - http://www.nesc.ac.uk/hub/projects/votes

[4] Grid-Enabled Microarray Experiment Profile Search (GEMEPS) - http://www.nesc.ac.uk/hub/projects/gemeps

Tables

[1] Hypotensive definition by centre, Rob Donald, from reference [2].

	Uppsala	Glasgow	Kaunas	Heidelberg	Monza	Barcelona
Measure & Threshold	BPs < 100	BPm < 70	BPs/BPm < 90/50 AND BPm < 70	CPP < 50	BPs < 90	BPs < 90
Event Hold Down	2	5	5	5	5	5
Clear Hold Down	BPs >100;5m	BPm > 70;5m	BPm > 70;5m	CPP > 60;5m	BPs > 90;10m	BPs > 90;15m