Extremely low blood pressure in the Intensive Care Unit: earlier detection may save lives

In the Intensive Care Unit (ICU) peoples’ lives hang in the balance. Extremely low blood pressure – called hypotension, if untreated, can lead to the rapid failure of vital organs. Building on its strength in patient monitoring in the ICU, Philips is researching techniques of early detection of hypotension which may enable life-saving intervention. Thereby, Philips aims to contribute to helping people pass through the ICU and back to a healthy life.

In some ICUs, over 25% of patients experience hypotension making it one of the most frequent and dangerous conditions experienced in the ICU. Typical causes of rapid onset hypotension in ICUs include undetected bleeding, acute heart failure and septic shock. Due to the fact that it results in decreased blood flow through the body’s tissues, if left untreated, it can result in the rapid failure of vital organs like the brain and kidney. Most existing patient monitoring systems only alert ICU staff once the blood pressure has already fallen below a certain very low level, at which point rapid intervention is required to prevent significant organ damage. Early detection, diagnosis and treatment of these so-called ‘decompensations’ is therefore critical.

“Hypotension is a serious condition in the ICU” says Mohammed Saeed, MD PhD, Fellow in Cardiovascular Medicine from University of Michigan Health Systems. “An early alert that the patient’s condition is deteriorating could mean the difference between life and death or prevent a prolonged ICU hospitalization”

Philips Research experimental Hemodynamic Instability Indicator
Philips Research has developed prototype software that aims at continually assessing the risk of developing hypotension and at aiding timely intervention. Using vital signs such as heart rate and blood pressure readings from the existing patient monitoring equipment, together with other patient data and laboratory test results, the system generates a color-coded Hemodynamic Instability Indicator value for each patient. The prototype system displays this value together with the patient’s bed location, on the experimental ICU central nursing station system.

“As the leading provider of patient monitoring and informatics systems across the globe, Philips is very committed to helping our customers improve outcomes for their patients” says Joe Frassica M.D., CMO Philips Patient Care and Clinical Informatics. “By investigating such early warning technologies Philips hopes to be able to expand the safety net provided by our patient monitoring and help more patients to safely traverse times of critical illness and return to their daily lives.”

Machine learning
Based on a patient’s heart rate and blood pressure readings, the experimental software calculates a Vital Signs Instability Index using machine learning algorithms that Philips Research has developed using known outcome data from over 41,000 ICU patients in twenty-five different hospitals. This index is then combined with other information, such
as the patient’s lab test results, age and medical history, to present the patient’s overall risk of hypotension in the form of a Hemodynamic Instability Indicator score.

With goal to reduce hypotension and its consequences in the ICU, Philips Research aimed at developing algorithms that could detect hypotension hours earlier than current patient monitoring systems. Experimental results obtained using known-outcome patient data have already demonstrated that Philips Research’s algorithms detected at least one third of the hypotension events around 3 hours before the patient’s hypotension was actually noticed, while generating few false alarms (specificity 97%). Time that Philips hopes could make a difference to some patients in ICU.

The Philips’ experimental Hemodynamic Instability Indicator system will undergo clinical evaluation in hospitals during 2012.

The Intensive Care Unit Setting

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