ICU MANAGEMENT & PRACTICE

## New algorithm reduces testing for ICU patients

Enrolling seriously ill patients in intensive care units for clinical trials is often a big challenge for investigators. This is one reason why there is a dearth of evidence-based guidelines in critical medicine. For instance, ICU doctors often face a dilemma when it comes to ordering lab tests for specific patients.

While ICU doctors are aware that every blood test they order could yield critical information, labs may also increase costs and risks for patients. A new machine learning algrorithm, developed by Princeton University researchers, may provide a solution to this problem. The new algorithm aims to both reduce the frequency of tests and improve the timing of critical treatments.

The algorithm uses a "reward function" that encourages a test order based on how informative the test is at a given time. According to researchers, there is greater reward in administering a test if there is a higher probability that a patient's state is markedly different from the last measurement, and if the test result is likely to suggest a clinical intervention such as initiating antibiotics or assisting breathing through mechanical ventilation. At the same time, the function adds a penalty for the test's monetary cost and risk to the patient. Depending on the situation, a clinician could decide to prioritise one of these components over others, the researchers noted.

The lab ordering system was developed using a large data set. The researchers worked with the MIMIC III database, which includes detailed records of 58,000 critical care admissions at Beth Israel Deaconess Medical Center in Boston. For the study, the researchers selected a subset of 6,060 records of adults who stayed in the ICU for between one and 20 days and had measurements for common vital signs and lab tests.

The study focused on four blood tests measuring lactate, creatinine, blood urea nitrogen and white blood cells. These indicators are used to diagnose two dangerous problems for ICU patients: kidney failure or a systemic infection called sepsis.

"Since one of our goals was to think about whether we could reduce the number of lab tests, we started looking at the [blood test] panels that are most ordered," said Li-Fang Cheng, an electrical engineering graduate student. Cheng is co-lead author of the study along with Niranjani Prasad, a graduate student in computer science.

To test the utility of the lab testing policy they developed, the researchers compared the reward function values that would have resulted from applying their policy to the testing regimens that were actually used for the 6,060 patients in the training data set, who were admitted to the ICU between 2001 and 2012. They also compared these values to those that would have resulted from randomised lab testing policies.

For each test and reward component, the policy generated by the machine learning algorithm would have led to improved reward values compared to the actual policies used in the hospital. In most cases the algorithm also outperformed random policies. However, lactate testing was a notable exception; this could be explained by the relatively low frequency of lactate test orders, leading to a high degree of variance in the informativeness of the test.

Overall, the results showed that the algorithm would have helped inform clinicians to intervene sometimes hours sooner when a patient's condition began to deteriorate.

"There is a scarcity of evidence-based guidelines in critical care regarding the appropriate frequency of laboratory measurements," said Shamim Nemati, an assistant professor of biomedical informatics at Emory University who was not involved in the study. "Data-driven approaches such as the one proposed by Cheng and co-authors, when combined with a deeper insight into clinical workflow, have the potential to reduce charting burden and cost of excessive testing, and improve situational awareness and outcomes."

The study authors are collaborating with data scientists on Penn Medicine's Predictive Healthcare Team to introduce this policy in the clinic within the next few years. "Having access to machine learning, artificial intelligence and statistical modelling with large amounts of data," notes Penn Senior Data Scientist Corey Chivers, will help clinicians "make better decisions, and ultimately improve patient outcomes."

Source: Princeton University, Engineering School
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