Study analyzes EHRs to find causes that predict sepsis

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Computer algorithms were used to analyze 29 clinical variables in UPMC's electronic health record systems, and were able to recognize patients with sepsis within six hours of arrival.

But it took a lot of learning to reach this stage and be able to spot the signs of sepsis and the hidden subtypes of sepsis, say researchers at Pitt Health Sciences, part of University of Pittsburgh Medical Center.

"For over a decade there have been no major breakthroughs in the treatment of sepsis; the largest improvements we've seen involve the enforcing of 'one size fits all' protocols," says study lead author Christopher Seymour, MD, an associate professor in Pitt's department of critical care medicine. But these protocols ignore that sepsis patients are not all the same."

In fact, use of algorithms have found four distinct sepsis types:

- Alpha: the most common type (33 percent), comprising patients with the fewest abnormal laboratory test results, least organ dysfunction and lowest in-hospital death rate at 2 percent.
- Beta: older patients comprising 27 percent with the most chronic illnesses and kidney dysfunction.
- Gamma: similar frequency to beta but with elevated levels of inflammation and primarily pulmonary dysfunction.
- Delta: the least common at 13 percent, but the most deadly type, often with liver dysfunction and shock, and the highest in-hospital death rate at 32 percent.

Having analyzed the clinical variables of 20,000 patients, researchers then studied the electronic health records of 43,000 other UPMC sepsis patients and the four findings held. The findings held again when the team studied rich clinical data and immune response biomarkers from about 500 pneumonia patients enrolled at 28 hospitals across the nation.

The next step was to apply their findings to recently completed international clinical trials that tested promising therapies, but results were unremarkable.

Sepsis recognition can be tricky, says Derek Angus, MD, senior author of the study and an associate professor in Pitts' department of critical care medicine. Most doctors are not confused about a classic case of sepsis, but those are only a very small portion of all cases, meaning that in most other cases the recognition of sepsis is known only when it has become obvious and is too late to make the first correct treatment moves, Angus notes.

In an "early goal-directed therapy (EGDT)," an aggressive resuscitation protocol that includes placing a catheter to monitor blood pressure and oxygen levels, delivery of drugs fluids and blood transfusions was found to have no benefit following a five-year $8.4 million study. But when Seymour's team-reexamined the results, they found that EGDT was beneficial for patients with the Alpha type of sepsis, but EGDT resulted in worse outcomes for those with the Delta subtype.

"Intuitively, this makes sense as you would not give all breast cancer patients the same treatment," Angus explains. "Some breast cancers are more invasive and must be treated aggressively. Some are positive or negative for different biomarkers and respond to different medications. The next step is to do the same for sepsis that we have for cancer—to find therapies that apply to the specific types of sepsis and then new clinical trials to test them."

That's why it is imperative that patients have their vitals and labs captured upon arrival at the hospital, Seymour says. Sepsis requires the presence of organ disruption and six organs can be effected by the disease. Consequently, early treatment intervention should be done within 6 hours of suspected sepsis as the time window for capturing data at hospital presentation is 6 hours.

Capturing the vitals and labs early, with additional information available in the electronic health record, quickly helps physicians at the bedside to wrap their minds around the patient's physiology. But now, physicians have another powerful tool at their disposal—machine learning technology.

Machine learning can find patterns that doctors cannot—much more than the three to four variables that doctors usually use. Data in the EHR can help doctors select variables to consider and then run machine learning models in collaboration with biostatisticians and computer scientists, says Seymour.

"We rely on doctors to find sepsis and quickly get patients on antibiotics, and we have machine learning and the EHR to parse out the type of sepsis," he adds.