

# A NEW APPROACH TO MANAGING SEPSIS: DON'T DIAGNOSE IT - PREDICT IT

---

**PRINCIPALS:** Sandra Hendren, M.S., Omar Danner, M.D

**BACKGROUND:** Sepsis is a toxic response to infection that kills 258,000 Americans each year. It is a medical emergency that requires early detection and treatment for best outcomes. It is the most expensive reason for hospitalization. In 2011 (the most recent published data), the US spent \$20.3 billion dollars on hospital care for patients with sepsis. This means we are spending \$55,616,438 on sepsis care in US hospitals every day.<sup>1</sup>

In response to this national problem, the Surviving Sepsis Campaign was established in 2002, with updated/revised criteria in 2008 and 2012. This campaign delineates protocols for the diagnosis and management of sepsis. These criteria are known as SIRS, acronym for "systemic inflammatory response syndrome".

**PROJECT OBJECTIVES:** While SIRS guidelines are current best practice for diagnosing and managing sepsis, there are several issues inherent in its use. First, SIRS guidelines are nonspecific to the physiological inflammatory process. Second, an accurate diagnosis of sepsis relies on lab test results which often delays treatment beyond the 3-hour "early goal directed therapy" window for best outcomes. Without initiation of treatment in the first 3 hours, mortality and morbidity from sepsis increases significantly.

This study attempted to answer the questions "Can we predict sepsis instead of diagnosing it? Can we do so earlier and more accurately than using SIRS guidelines? More specifically, can we predict sepsis when a patient walks in the emergency room door instead of diagnosing it hours later based upon lab tests?" Such capability would enable earlier intervention and treatment, resulting in better patient outcomes and reduced healthcare costs for sepsis.

**METHODS:** Input data were SIRS indicators, age, vital signs, and lab results for 109,812 patient visits to the emergency room of a large, public, academic hospital in 2014. 1,857 emergency room patients, 1.7% of the total, had been diagnosed with sepsis, severe sepsis, or septic shock.

A supervised machine learning approach based on stepwise logistic regression with balancing was used to determine the primary predictors of sepsis. The resulting algorithm, trained on a 60% random data sample of the 2014 data, was validated against a holdout test and validate dataset of 20% each of the 2014 patient visits. Further validation of the algorithm was achieved by using it to predict sepsis in an out-of-sample dataset of 53,313 emergency room patients in 2015.

**RESULTS:** Three attributes, based only on vital signs and data gathered during triage (i.e., before lab tests were ordered) were found to be the primary predictors of sepsis with 76% sensitivity. (Sensitivity is a measure of the ability to correctly predict sepsis. It is the percentage of true positives, i.e., the number of predicted positives/number of actual

---

<sup>1</sup> Pfuntner et al. Costs for Hospital Stays in the United States. HCUP Statistical Brief #168.

## A NEW APPROACH TO MANAGING SEPSIS: DON'T DIAGNOSE IT - PREDICT IT

---

positives in the study population.) SIRS guidelines on the same population resulted in 33% sensitivity, less than half that of the algorithm.

Of particular note, the 76% sensitivity can be achieved in triage - in the first minutes of patient presentation to the emergency room - instead of 1+ hours later based on lab results when it is already too late for best treatment. This capability is game-changing since early identification and aggressive treatment of sepsis have been shown to markedly decrease mortality and morbidity in patients and their progression from a diagnosis of 'sepsis' to 'severe sepsis' and 'septic shock'.

**CONCLUSIONS:** An alternative to expert-opinion-driven SIRS guidelines and sepsis diagnosis is available, viable, and potentially superior, in an era of data-driven healthcare. If this algorithm were used by hospitals across the U.S. it could save approximately 100,000 American lives and more than \$2B in healthcare costs per year.

Note: The full study has been published in *The American Journal of Surgery*, Jan. 5, 2017.  
[http://www.americanjournalofsurgery.com/article/S0002-9610\(17\)30025-9/fulltext](http://www.americanjournalofsurgery.com/article/S0002-9610(17)30025-9/fulltext)