

# HEALTH INFORMATICS TOOL TOWARD SEPSIS SCREENING

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## **Background**

Sepsis is a syndrome without, at present, a validated criterion standard diagnosis test.<sup>1</sup> Sepsis can rapidly progress to septic shock, multiple organ dysfunction syndromes (MODS), and death.<sup>2</sup> Mortality of intensive care unit (ICU) patients with severe sepsis or septic shock is as high as 30 percent to 40 percent, even with comprehensive treatment.<sup>3</sup> Prompt management of sepsis can decrease the risk of complications, organ failure, and mortality. Initial clinical presentation of sepsis can be nonspecific and obscured by underlying morbidity of a patient, which makes sepsis challenging to detect until the condition becomes deteriorated. The clinical decision support (CDS) system for sepsis can play a critical role in improving sepsis management and outcomes. Many healthcare institutions have been increasingly leveraging clinical data captured in electronic health records (EHRs) and CDS systems to alert clinicians to the possible presence of sepsis and other clinical deteriorations.<sup>4</sup> However, the significant challenge is creating a CDS tool that is intuitive, user-friendly, and has effective protocols for alarms, alerts, and decision-making pathways.<sup>5</sup>

In 2011, Ochsner Health System launched EHRs at all its facilities and had actively engaged CDS in clinical settings. In October 2015, the Centers for Medicare and Medicaid Services (CMS) enacted a national quality measure (NQF #0500) for reporting on sepsis called the Severe Sepsis and Septic Shock Early Management Bundle (SEP-1).<sup>6</sup> Medicare included the SEP-1 quality measure in the Medicare Hospital Compare reports, a publicly available database rating on a hospital, based on each CMS captured measure.<sup>7</sup> Ochsner developed the sepsis order set that contains recommended treatment guidelines based on the SEP-1 measure. However, Ochsner faced low usage of the sepsis order set; hence, the compliance rate of SEP-1 measure was lower than Louisiana average and national average. Ochsner aimed to improve patient care quality, increase performance metrics, and standardize sepsis treatment by promoting adherence to SEP-1. In January 2018, the Ochsner informatics team launched the sepsis screening tool to improve adherence to standard treatment by raising awareness of the providers, encouraging sepsis order sets usage, and increasing compliance to SEP-1. This study's objectives were to determine the association between the sepsis screening tool, the use of sepsis order set, the compliance with SEP-1, and the primary outcomes. The primary outcomes were 1) time zero to antibiotics; 2) inpatient length of stay; and 3) survival at discharge.

## **Materials and Methods**

### *Study Design and Population*

This retrospective study was conducted at a tertiary academic hospital (Ochsner Medical Center,

New Orleans, Louisiana). Data were extracted directly from EHR. The population was adult patients admitted through the emergency department that had a diagnosis of sepsis or septic shock during admission from July 1, 2017, to July 31, 2018. The diagnoses of sepsis/septic shock based on the International Classification of Disease (ICD)-10. The exclusion criteria were a) referral patients from outside facilities; b) who had antibiotics started before arrival at the emergency department; and c) transferred patients to outside facilities. The time that a patient arrived at the emergency department was the time zero. In January 2018, the sepsis screening tool was launched and incorporated into the EHR at the triage station. The sepsis screening tool contained clinical history and screening criteria based on SIRS criteria (**Figure 1**). If there were positive at least two out of three criteria, a patient would be considered to have sepsis, an automatic alert in the provider's EHR would be triggered, and that patient would be brought in to have prompt evaluation and intervention by the emergency team. The physician could use the sepsis order set, which was incorporated in the EHR but does not have a direct link from the sepsis screening tool. The sepsis order set contains a package of treatments including antibiotics recommendation, laboratory testing orders, and other recommended standard management based on SEP-1.

This study collected patients' data during the six months before and six months after the launch of the sepsis screening tool, which would be called the pre-intervention and post-intervention group, respectively. The compliance with each element of the SEP-1 measure at three hours and six hours was collected based on the eligibility of a patient's conditions that met the criteria for the intervention. The perfect care was achieved when a patient received all required elements according to the protocol at three hours (3H perfect care) and six hours (6H perfect care). The total perfect care was the group of patients who completed both three- and six-hour requirements. Total perfect care represented the compliance to the SEP-1 measure and was used for reporting to CMS Hospital Compare.

First, we compared the pre-intervention and post-intervention group to assess the association between the sepsis screening tool and the usage of sepsis order set, the sepsis screening tool, and the compliance of the SEP-1 measure, and the sepsis screening tool and the primary outcomes. Second, we regrouped the whole population to be the group that used the sepsis order set and that which did not use the sepsis order set. Then, we assessed the association between the sepsis order set and total perfect care, and the association between the sepsis order set and the primary outcomes. Last, we regrouped the whole population into the group that achieved total perfect care and did not achieve total perfect care. We then assessed the association between total perfect care and the primary outcomes.

This study was approved by the University of Tennessee Institutional Review Board as meeting the criteria for exempt status for nonhuman subjects research status; 18-05810-NHRS.

### *Statistical Analyses*

The chi-square statistic was used to assess the association between the categorical variables for the sepsis screening tool and the order set usage, the sepsis screening tool, and total perfect care, and the order set usage and total perfect care. An independent t-test was used to assess the association between time zero to antibiotics and a) the sepsis screening tool; b) the order set usage; and c) total perfect care. The negative binomial regression statistic was used to assess the association between the inpatient length of stay and a) the sepsis screening tool; b) the order set usage; and c) total perfect care. The logistic regression statistic was used to assess the association between the survival at discharge and a) the sepsis screening tool; b) the order set usage; and c) total perfect care. All analyses were performed using SPSS version 26 (IBM Corp., Armonk, NY). The p-value of less than 0.05 was considered to be statistically significant.

## Results

The final population for analysis was 632 (**Figure 2**). The collected data comparing the pre-intervention group and post-intervention group is shown in **Table 1**. Our results showed that the usage of the sepsis order set increased significantly in the post-intervention group ( $p = 0.001$ ). We found that the post-intervention group was 1.8 times more likely to use the order set than the pre-intervention group. The average time zero to antibiotics in the post-intervention group was 17.7 minutes lower than the pre-intervention group. However, there was no significant association between the pre-intervention and post-intervention groups and primary outcomes or total perfect care.

The association between using the sepsis order set and the primary outcomes (**Table 2**) showed that the average time zero to antibiotics in the order set usage group was 54 minutes shorter than the group that did not use the order set ( $p = 0.001$ ). The average length of stay in the group that used the order set was 1.8 days shorter than the group that did not use the order set ( $p = 0.002$ ). There was a non-significant trend toward improvement of survival in the group that used the order set.

We found that the number of total perfect care increased significantly in the group that the order set was used with the p-value  $<0.001$  (**Table 3**). The group that achieved total perfect care had 102.4 minutes shorter average time zero to antibiotics ( $p < 0.001$ ), 1.5 days shorter average length of stay ( $p = 0.004$ ), and better survival at discharge ( $p < 0.001$ , 95% CI 0.02 – 0.206, OR 0.064) than the group that did not achieve total perfect care.

## Discussion

Our findings confirmed that the sepsis screening tool improved adherence to standard treatment. The sepsis screening tool raised awareness of the emergency department personnel by showing that the usage of the sepsis order set significantly increased in the post-intervention group ( $p = 0.001$ ). The post-intervention group was 1.8 times more likely to use the sepsis order set than the pre-intervention group, despite no direct link within the sepsis screening tool. Even though the sepsis screening tool did not improve primary outcomes, the post-intervention group received

antibiotics 17.7 minutes earlier than the pre-intervention group.

Our study found that the usage of the sepsis order set improved the adherence to the treatment guidelines and reduced time to antibiotics and length of stay. The utilization of the sepsis order set streamlined and standardized the sepsis management, which resulted in a shorter time to antibiotics by 54 minutes ( $p = 0.001$ ) and shorter length of stay by 1.8 days ( $p = 0.002$ ). However, there was no significant difference in survival between the group that used the order set and the group that did not use it. Our results showed a significant association between sepsis order set usage and total perfect care ( $p < 0.001$ ), which indicated that the order set usage increased the compliance with SEP-1 measure.

National Quality Forum (NQF) stated that an absolute reduction in mortality over 20 percent was reported with the compliance rate of 52 percent of the sepsis management bundle.<sup>8</sup> The survival benefit of the compliance of SEP-1 remains unclear. The association between SEP-1 measure and mortality was evaluated in a multicenter retrospective study<sup>9</sup>. Rhee et al. reported that the crude mortality rates were higher in sepsis cases that failed to comply with SEP-1 measure when comparing with sepsis cases that passed, but the difference was not significant after adjusting for clinical characteristics and severity of illness.<sup>10</sup> Rhee's study concluded that detailed adjustment was necessary to properly interpret associations between SEP-1 compliance and mortality.<sup>11</sup>

Our results showed that the compliance of SEP-1, by achieving total perfect care, significantly improved all primary outcomes. The group that achieved total perfect care had significantly shortened the average time to antibiotics by 102.4 minutes ( $p < 0.001$ ), shortened length of stay by 1.5 days ( $p = 0.004$ ), and improved survival at discharge ( $p < 0.001$ , 95% CI 0.02 – 0.206, OR 0.064). Even though our results showed strong association between the compliance of SEP-1 and primary outcomes, more study is needed to confirm these findings because we did not adjust for clinical characteristics and severity of illnesses.

Our study had some limitations. The first limitation was the data lacked the details of clinical characteristics and severity of illness of the studied group. The second limitation was the nature of a retrospective review with the data extracted directly from the EHR, which might be confounded by the incompleteness of the data. The third limitation of our study was that the number of studied populations might not be enough to detect significant differences. The last limitation was the confounding effect of partial treatments on the outcome of the study. Many patients underwent parts of the bundle elements but did not complete the required interventions per SEP-1 measure in which the benefit of partial treatments could become confounding factors of this study.

## **Conclusion**

Performance metrics could drive change in clinical behavior, improve quality of care, and may

decrease mortality in patients with severe sepsis and septic shock<sup>12</sup> Our study showed that the sepsis screening tool raised awareness of emergency department providers and improved adherence to standard treatment. Furthermore, our study confirmed that adherence to the standard treatment guidelines improved the treatment outcomes. Even though the overall compliance of the SEP-1 measure in this study was 46 percent, our study demonstrated the benefits of the sepsis screening tool, the benefits of the sepsis order set, and the benefits of compliance of SEP-1 measure. More study is needed to confirm the association between compliance of SEP-1 measure and patient-related outcomes.

### **Author Biographies**

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