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# An Electronic Tool for the Evaluation and Treatment of Sepsis in the ICU: A Randomized Controlled Trial

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## Abstract

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**Objective—**To determine whether addition of an electronic sepsis evaluation and management tool to electronic sepsis alerting improves compliance with treatment guidelines and clinical outcomes in septic intensive care unit patients.

**Design—**A pragmatic randomized trial.

**Setting—**Medical and surgical intensive care units of an academic, tertiary care medical center

**Patients—**Four hundred and seven patients admitted during a 4-month period to the medical or surgical intensive care unit with a diagnosis of sepsis established at the time of admission or in response to an electronic sepsis alert.

**Interventions—**Patients were randomized to usual care or the availability of an electronic tool capable of importing, synthesizing, and displaying sepsis-related data from the medical record, using logic rules to offer individualized evaluations of sepsis severity and response to therapy, informing users about evidence-based guidelines, and facilitating rapid order entry.

**Measurements and Main Results—**There was no difference between the electronic tool (218 patients) and usual care (189 patients) with regard to the primary outcome of time to completion of all indicated Surviving Sepsis Campaign 6 hour Sepsis Resuscitation Bundle elements (Hazard Ratio 1.98, 95% Confidence Interval 0.75 – 5.20, p=0.159) or time to completion of each element individually. ICU mortality, ICU-free days, and ventilator-free days did not differ between intervention and control. Providers used the tool to enter orders in only 28% of available cases.

**Conclusions—**A comprehensive electronic sepsis evaluation and management tool is feasible and safe but did not influence guideline compliance or clinical outcomes, perhaps due to low utilization.

### Keywords

Sepsis; Resuscitation; Early Goal Directed Therapy; Protocol; Electronic; Alert

## INTRODUCTION

Sepsis is a common and lethal illness frequently managed in the intensive care unit (ICU) (1–3). Early resuscitation (4, 5) and prompt antibiotic administration (6–8) improve mortality. To aid clinicians in consistent implementation of these interventions, the Surviving Sepsis Campaign (SSC) outlined in 2005 a 6-hr Sepsis Resuscitation Bundle incorporating rapid sepsis recognition, early cultures and antibiotics, and goal-directed fluid administration and hemodynamic support (9, 10). Implementation of SSC 6-hr Resuscitation Bundle elements using a written protocol has been shown to improve compliance with recommendations (11–13) and mortality (14). However, in the absence of ongoing feedback to clinicians, even after intensive education in sepsis detection and management, compliance with guidelines remains low (15). The use of electronic tools to address this challenge interests physicians and hospitals. Electronic tools have been successfully employed in the ICU for ventilator weaning (16) and identification of ARDS (17). One prior study in sepsis has evaluated a computerized translation of a written protocol for early resuscitation (18). With recent advances in information technology, a single electronic tool can now couple real-time monitoring of the medical record to identify patients with potential sepsis (19) with

decision-support to guide clinicians through severity evaluation, provide education about sepsis guidelines generally and identify interventions indicated in a specific patient, facilitate rapid entry of sepsis-management orders, and monitor the patient's response to interventions throughout the ICU course. We hypothesized that, in adult ICU patients with sepsis, implementation of such an electronic evaluation and management tool would improve compliance with sepsis treatment guidelines and clinical outcomes.

## MATERIALS AND METHODS

### Definitions and Terms

**Sepsis—**The co-occurrence of suspected infection and two or more of the systemic inflammatory response syndrome (SIRS) criteria: 1. Temperature > 38 or < 36 degrees Celsius. 2. Heart rate > 90 beats/min. 3. Respiratory Rate > 20 breaths/min or PaCO2 < 32mm Hg. 4. White Blood Cell count (WBC) > 12,000 cells/mm3 or < 4,000 cells/mm3, or > 10% immature (band) forms.

**Modified SIRS Criteria—**Two or more SIRS criteria met within a rolling 24 hour window, with at least one being abnormal temperature or WBC count.

**Listening Application—**An electronic tool that monitors patient data in real-time, evaluates data against diagnostic and alerting rules to identify patients who newly meet modified SIRS criteria, and communicates with the alerting system to notify providers (19).

**Alerting System—**An electronic tool that receives information from the listening application on patients who have met modified SIRS criteria, notifies providers of the finding, and solicits an assessment to determine if the patient clinically meets criteria for sepsis (19).

**Integrated Sepsis Assessment and Management Tool—**A software program within the electronic medical record (EMR) designed to import, synthesize, and display sepsis-related data from different portions of the record, use logic rules to offer an up-to-date, individualized evaluation of sepsis severity and response to therapy, inform users about evidence-based guidelines, and facilitate rapid order entry.

**Clinical Provider—**ICU resident physician or nurse practitioner primarily responsible for patient management and order entry.

### Screening and Enrollment

From April 1st to July 31st of 2012, we conducted a pragmatic, open-label, parallel-group randomized trial in the medical and surgical intensive care units of Vanderbilt University Hospital. This study was approved by the Institutional Review Board with waiver of informed consent.

All patients admitted to a study ICU and assessed by their clinical provider as having sepsis were enrolled (Figure 1). Patients assessed as septic via an automatic prompt offered at ICU admission were enrolled immediately. For all patients without sepsis at ICU admission,

electronic monitoring was employed to facilitate early detection of sepsis development (Supplemental Digital Content: Figure S1. Schematic of the Listening, Alerting, and Provider Assessment systems). A previously-established listening application screened real-time data from the nursing documentation, electronic health record, and lab system for modified SIRS criteria (19). If modified SIRS criteria developed in an ICU patient who had not previously been assessed by a clinical provider as septic, an alerting system notified the clinical provider via text page and a flag appeared next to the patient's name on the clinical provider's electronic patient list. Using this flag, clinical providers recorded a revised sepsis assessment. If an assessment was not recorded within one hour, a reminder was sent. No management recommendations were given by the listening application or alerting system. If patients were assessed not to be septic, further alerts were suppressed for 48 hours, and then electronic monitoring resumed. If patients were assessed as septic they were enrolled in the study and no further alerts were delivered for that hospitalization. Study enrollment occurred at the time the first prompt to which the clinical provider confirmed the presence of sepsis was offered. Patients were excluded if they were never assessed as septic by their clinical provider or had been previously enrolled during the same hospitalization. Patients with orders limiting resuscitation were not excluded.

### Randomization and Masking

All ICU patients assessed by a provider as septic were randomized by a computerized algorithm without use of permuted blocks or stratification to usual care (control) or the availability of an integrated, electronic sepsis assessment and management tool (intervention). Clinical providers were aware of group assignment. Separate study personnel remained blinded until the completion of data collection.

### Intervention

In the intervention group, when a provider's assessment confirmed the presence of sepsis, the integrated sepsis assessment and management tool (Supplemental Digital Content: Video 1. Overview of the electronic sepsis tool) opened automatically and remained available to all providers throughout the ICU admission. The tool resided directly within the EMR and contained a divided display. Half presented graphs of current value, trend, and goal range for temperature, heart rate, mean arterial pressure, central venous pressure, white blood cell count, hemoglobin, platelet count, prothrombin time, lactate, and Richmond Agitation and Sedation Score. The other half contained a set of tabs dedicated to evaluation of the patient condition and management. The assessment tab offered providers an evaluation of sepsis severity using an algorithm in which sepsis was defined as previous confirmation of sepsis by a clinical provider in response to a prompt, severe sepsis was sepsis plus mean arterial pressure ≤ 60 mmHg or a lactate above the laboratory upper limit of normal, and septic shock was sepsis plus vasopressor use or either mean arterial pressure ≤ 60 mmHg or a lactate ≥ 4 mmol/L despite an order for ≥ 1,000 mLs of IV crystalloid. The provider could agree with or modify the severity assessment which would then propagate into the management tabs allowing the tool to highlight interventions recommended for that specific patient. The management tabs were displayed in a workflow modeled on the SSC 6-hr Resuscitation Bundle beginning with a diagnostics panel addressing basic labs, cultures, and imaging for source control, followed by a therapeutics panel addressing antibiotics and goal-

directed resuscitation including fluid boluses, CVP, vasopressors, serial lactate measurements, inotrope use, and blood transfusion, and concluded by a supportive care panel addressing lung-protective ventilation, adrenal insufficiency, glucose control, and venous thromboembolic and stress ulcer prophylaxis. Each management tab contained evidence-based information and "single-click" order entry enabling providers to place related orders while reviewing the guidelines. The tool was integrated with electronic order entry from all parts of the hospital so that providers could see via a color-coded system not only which orders were recommended but which orders had already been completed in the ICU or prior to ICU admission. The tool could be minimized at any time to review the medical record and could be closed and reopened any time throughout the admission. Technical aspects of the sepsis tool's development, architecture, and user interface have been published previously (20–23, 19) and are summarized in the online supplement (Supplemental Digital Content: eMethods).

## Data Collection

Patients were followed for 28 days or until hospital discharge, whichever occurred first. Demographic and baseline characteristics, vital signs and laboratory results, and clinical outcomes were collected by study personnel blinded to group assignment. The date and time at which each of the SSC 6-hr Resuscitation Bundle elements was completed underwent automated, electronic documentation in the EMR as a part of routine clinical care. These data were prospectively abstracted into a database by blinded study personnel. Listening application, alerting system, and tool usage data were collected automatically in a separate database. Retrospective review of the medical record by study physicians used all available information to adjudicate whether each patient had been septic at the time of enrollment.

The primary endpoint was time from enrollment until completion of all indicated elements of the SSC 6-hr Resuscitation Bundle – blood cultures drawn, broad spectrum antibiotics ordered, CVP measured, intravenous fluid bolus administered if indicated, vasopressors administered if indicated, and lactate measured. Lactate clearance is used in place of venous oxygen saturation in our ICUs (24). Time to completion for each element was calculated as time from enrollment until the time that each bundle element was electronically documented as completed in the EMR. Secondary endpoints included time to completion of each individual SSC 6-hr Resuscitation Bundle element, ICU mortality, days alive and free from mechanical ventilation (VFDs), days alive and out of the ICU (ICU-free days), and days alive and free from vasopressor administration (vasopressor-free days), all to study day 28.

## Statistical Analysis

Based on prior data from the same setting (19), planned enrollment of 400 patients provided 80 percent statistical power to detect a one hour decrease in the primary endpoint of time to completion of all SCC 6-hr Resuscitation Bundle elements with a Type I error rate of 0.05. Demographics and baseline characteristics were summarized by median and inter-quartile range (IQR) or mean and standard deviation for continuous variables and as numbers and percentages for categorical variables across intervention and control groups. To analyze the time to completion of all SSC 6-hr Resuscitation Bundle elements and each element individually, the cumulative event probabilities were estimated and compared using Kaplan-

Meier method with log rank testing and Cox proportional-hazards regression. A logistic regression model with pre-specified covariates was fit to assess what factors impacted the use of the tool to enter orders. All analyses were performed using the statistics software R version 3.0.1.

### Role of the Funding Source

The National Institutes of Health, National Center for Research Resources, and National Science Foundation provided financial support for this study but were not involved in its design, data collection, analysis, interpretation, or reporting. M.W.S. had full access to all the data and had final responsibility for the decision to submit for publication.

## RESULTS

### Enrollment and Baseline Characteristics

Of 1,843 ICU admissions during the study period, 407 were identified by providers as having sepsis and were enrolled (Figure 1). The 218 patients randomized to the integrated sepsis assessment and management tool and the 189 patients randomized to control had similar baseline characteristics and pre-randomization management (Table 1). Patients averaged 56 years of age, were predominantly male and Caucasian, and were most frequently admitted from the emergency department and cared for in the MICU. A pulmonary source of sepsis was most common and one fifth of patients were mechanically ventilated at enrollment.

### Main Outcomes

There was no significant difference between the integrated sepsis assessment and management tool and control with regard to the primary outcome of time to completion of all indicated SSC 6-hr Resuscitation Bundle elements or the secondary outcome of time to completion of each element individually (Figure 2). There was no difference between the groups in ICU mortality, ICU-free days, ventilator-free days, or Vasopressor-free days (Table 2). Sensitivity analyses showed no difference in the primary outcome between intervention and control in the subgroups with sepsis at ICU admission (Hazard Ratio 1.60, 95% Confidence Interval 0.45 – 5.67, p=0.462) or sepsis recognized after ICU admission in response to an alert (Hazard Ratio 2.53, 95% Confidence Interval 0.52 – 12.16, p=0.231). In a prospectively-planned per-protocol analysis, patients for whom one or more orders were placed using the tool were more likely to have blood cultures and lactate drawn in the first 6 hours than patients for whom the tool was not used to place orders (Figure 3) but there was no difference in ICU mortality (14.3% versus 14.9%, p=0.905), ICU-free days (17.9±1.4 versus 19.0±0.5, p=0.473), VFDs (22.3±1.3 versus 23.0±0.5, p=0.576), or vasopressor-free days (22.2±1.3 versus 22.6±0.5, p=0.789).

### Tool Utilization

Of the patients enrolled, 60% were identified as septic at ICU admission. In these, the median time from electronic prompt to provider's completed assessment was 46 [interquartile (IQR) 20–125] minutes compared to 59 [interquartile (IQR) 16–200] minutes for those assessed as septic later in response to an alert from the listening application

(p=0.982). Of 218 patients randomized to the intervention arm, the tool was opened by providers in 126 cases (57.8%). The tool was re-opened after closure 51 times in the care of 17 patients (7.8%). The tool was used to enter orders in 62 cases (28.4%) yielding 473 individual orders for 37 unique actions including 104 (38.1%) for hematologic or metabolic laboratory studies, 62 (22.7%) for cultures, 31 (11.4%) for lactate measurement, 29 (10.6%) for antibiotic administration, 16 (5.9%) for imaging studies, and the remainder for fluid administration, vasopressors, steroids, glucose control, sedation, prophylaxis, and intravenous access. Orders were entered via the tool for 67.3% of SICU patients versus 36.5% of MICU patients (p=0.001) and a multivariable analysis confirmed that surgical ICU was the only baseline factor associated with utilization of the tool to enter orders (Odds Ratio 4.65, 95% CI 2.06–11.0, p<0.001) (Supplemental Digital Content: Table S1. Multivariable regression for use of tool to enter orders). The tool was employed by 87 unique providers, primarily resident physicians (63.5% of MICU utilizations versus 7.7% of SICU utilizations, p<0.001) and nurse practitioners (35.1% of MICU utilization versus 90.4% of SICU utilization, p<0.001). Over the course of the study, each provider accessed the tool on a median of 2 occasions (range 1 to 21).

## DISCUSSION

This pragmatic randomized trial of an integrated, electronic sepsis evaluation and management tool in two ICUs at a single center did not demonstrate a significant difference in the primary outcome of time until completion of all indicated SSC 6-hr Resuscitation Bundle elements. There are several potential explanations for this lack of effect.

Utilization of the tool was low. Providers opened the tool in less than 60% of available cases and placed orders through the tool in less than 30%. Prior studies of computerized clinical decision support systems (CDSS) have identified characteristics predictive of CDSS success which may be relevant to understanding our tool's unexpectedly low utilization (25–27). Two systemic reviews (25, 26) suggest that successful CDSSs provide decision support automatically rather than relying on clinician initiative, deliver decision support at the time and location of decision making, and provide actionable recommendations rather than simply assessment. Our sepsis tool opened automatically at enrollment but, once closed, relied on providers to re-access rather than prompting with changes in patient status. The tool resided in the EMR and became available immediately after identification of sepsis by the ICU team. However, the capacity of the tool to generate orders directly from the EMR interface was novel and providers may have been more comfortable entering orders through the established computerized physician order entry system. Though our tool went beyond evaluation to provide patient-specific recommendations, impact may have been limited by the manner in which recommendations were delivered. Color-coding the recommended elements of the SSC 6-hr Resuscitation Bundle relied on the provider to actively select highlighted orders. Collating recommended orders into a discrete bundle and perhaps even employing an opt-out approach where recommended orders occurred unless providers actively disagreed may have been more effective. Other potential strengths of our tool's design (integration with EMR and order entry, minimal clinician data entry, justification of recommendations with evidence, and on-site development in a CDSS-friendly environment via iterative refinement with support of ICU leaders) (25–27) may have been outweighed

from the user's perspective by shortcomings in either usability or content. Although system speed, clinician time savings, and clarity of user interface (25) were not barriers in pilot testing, rotations in ICU resident staffing meant each provider interacted with the tool an average of only two times during the four month study. The suggestion that the time and energy costs of learning new software may have disincentivized use is supported by the observation that the nurse practitioners, who worked continuously in the ICUs throughout the study period, were the highest utilizers of the tool. "Information overload" is particularly challenging to CDSSs targeting disease management and the amount of content presented in our tool may have overwhelmed users. Similarly, the abundance of electronic reminders in routine use in our ICUs (drug interaction checks, sedation goals, anticoagulation monitoring, insulin advisors, imaging advisors, etc.) coupled with the sepsis alerts may have precipitated "alert fatigue" encouraging providers to navigate around the electronic sepsis tool reflexively. Bypass of the tool by providers might have been minimized by providing periodic performance feedback, requiring documentation of reasoning when tool was not used or recommendations were not followed, or even electronically forcing use in the intervention arm (28). Provider acceptance of protocolized care may have influenced tool utilization. Use was higher in the surgical ICU and among nurse practitioners, provider groups that in our institution have greater preexisting familiarity with protocolized care. Finally, although the tool was available to all providers during the patient's ICU stay, only residents and nurse practitioners received the sepsis alert page. Given that attending physicians at our institution play a supervisory role in which they are encouraged to defer order entry, initial evaluation, and initial management to trainees whenever appropriate, we feel that including attending physicians on the sepsis alerts would not have changed our findings.

Restriction of the tool to ICUs in an academic center may have further diminished its utility. In contrast to studies in which sepsis management interventions were initiated in the emergency department (11–13, 29) or hospital floor (30), the majority of patients in our study received elements of the SSC 6-hr Resuscitation Bundle prior to enrollment. The performance of blood cultures, fluid resuscitation, and vasopressor administration before ICU admission in more than half of cases in which they were indicated may have limited the additive value of the tool. Additionally, our ICUs are staffed 24 hours a day by physicians and nurses who, because of the high incidence of sepsis in this environment, are experienced in the early recognition and guidelines-based management of septic patients. The implementation of an electronic sepsis tool in an emergency department, hospital ward, or less resource-intensive ICU may demonstrate substantially different results. Moreover, bundle compliance in the control arm may have been augmented by provider awareness of the study (Hawthorne effect) and contamination of "usual care" by exposure to the electronic tool when providers were caring for patients in the intervention and control arms concurrently (patient-level rather than cluster randomization).

Low severity of illness may have influenced the outcome of the trial. While the study was limited to patients requiring ICU admission, we included septic patients without organ dysfunction. The mean APACHE II score of 20 and overall ICU mortality of 15% are lower than prior studies of sepsis bundle implementation (4, 12–14, 31) and some of the SSC 6-hr

Resuscitation Bundle elements may not have been indicated in the subgroup of less severely ill patients.

In addition to the above weaknesses, our study has several major strengths. Prior investigations have examined sepsis detection via electronic listening applications (19, 30) and implementation of sepsis management bundles via written protocols (11–13, 29, 31) or computerized translation of a written protocol (18). However, this is the first trial of a comprehensive electronic tool with sepsis detection, alerting, severity assessment, and management functions. Our study confirms that development and implementation of such a comprehensive tool for a complex disease like sepsis is feasible and safe. The finding that patients for whom the tool was used to enter orders experienced higher compliance with early sepsis treatment metrics suggests that, if utilized more consistently, the tool itself may have been capable of improving guideline adherence. Future studies of comprehensive electronic sepsis tools should target more severely ill patients in lower provider-intensity settings, immediately after sepsis presentation. Integration into the EMR should occur where providers enter orders, not where they review data. The appeal of a tool that is comprehensive and educational must be carefully weighed against the advantages of simplicity, speed, and ease of use. Finally, attention and resources may need to be shifted from the underlying algorithms to the user interface, and from development to implementation.

Since the completion of this study, the SSC has released new sepsis resuscitation guidelines and restructured sepsis bundles emphasizing performance of lactate, blood culture, antibiotics, and fluid bolus elements in the first three hours and vasopressors, central venous pressure measurement, and lactate re-measurement in the first six hours (32). Even more recently, two large multicenter trials comparing early goal-directed resuscitation with usual care failed to confirm the difference in outcome on which the early sepsis resuscitation guidelines themselves are based (33, 34). These potentially major changes in understanding early sepsis resuscitation do not undermine the potential utility of an electronic sepsis evaluation and management tool. As evidence for best practices in critical care medicine evolves, translation into routine clinical practice frequently lags on the scale of years to decades (35). In contrast, the clinical logic algorithms and evidence-based education structured into an electronic tool can be updated rapidly with minimal effort by a small number of individuals. With the proliferation of electronic medical records and the recent passage of the Health Information Technology for Economic and Clinical Health Act linking incentive payment to implementation of clinical decision support tools (36), interest in developing sophisticated electronic disease management tools for use in the ICU environment can be expected to increase. Our study emphasizes that the success of future electronic tools depends not only on addressing the technical challenges of managing increasingly large data inputs, integrating multiple complex software platforms, and providing up-to-date, evidence-driven recommendations for an individual patient at any specific moment in the clinical course, but on ensuring that providers use the tool once its built.

## CONCLUSIONS

Developing and instituting a comprehensive electronic sepsis evaluation and management tool is feasible and safe. Addition of an electronic sepsis evaluation and management tool to electronic sepsis alerting in the ICU did not change guideline compliance or clinical outcomes, possibly due to low utilization.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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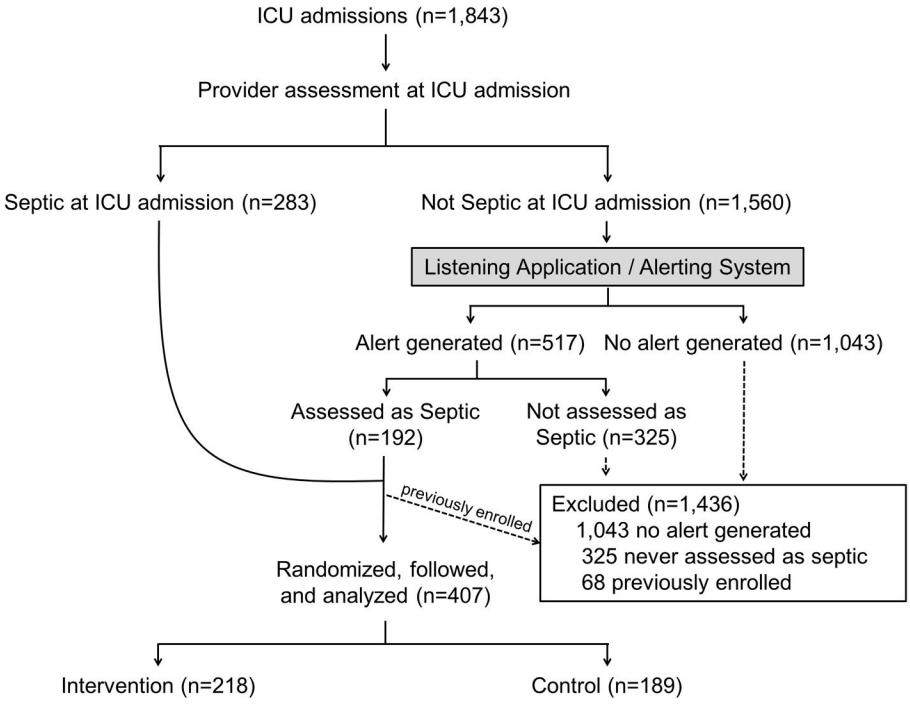


**Figure 1. Enrollment and Randomization**

Of 475 patients assessed as septic, 68 had been enrolled in the study previously in the hospitalization and were excluded. The remaining 407 were randomized, followed, and included in the analysis.

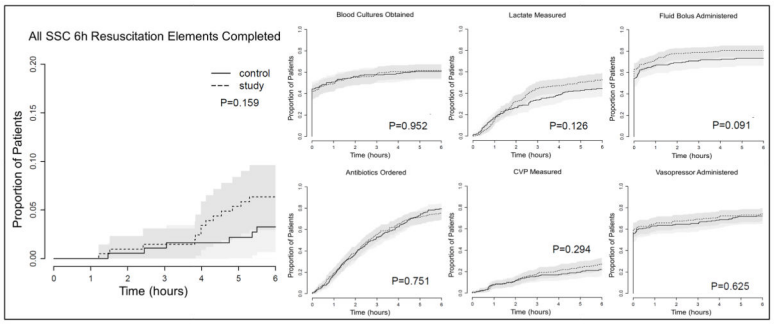


**Figure 2. Completion of Surviving Sepsis Campaign 6 hour Sepsis Resuscitation Bundle Elements for Patients Randomized to the Electronic Tool (study intervention) versus Usual Care (control)**

Proportion of patients for whom indicated bundle elements were completed over the 6 hours after enrollment. Lactate measurement, CVP measurement, and antibiotic administration were considered indicated in all patients during their first 6 hours in the ICU. Blood cultures were considered indicated in all patients but deemed completed at enrollment if obtained in the 6 hours prior to enrollment. Fluid bolus administration and vasopressor administration were considered indicated only in patients who met the hemodynamic criteria for each intervention as specified in the SSC 6-hr Resuscitation Bundle. There was no difference between the electronic tool and usual care with regard to time to completion of the SSC 6-hr Resuscitation Bundle elements.

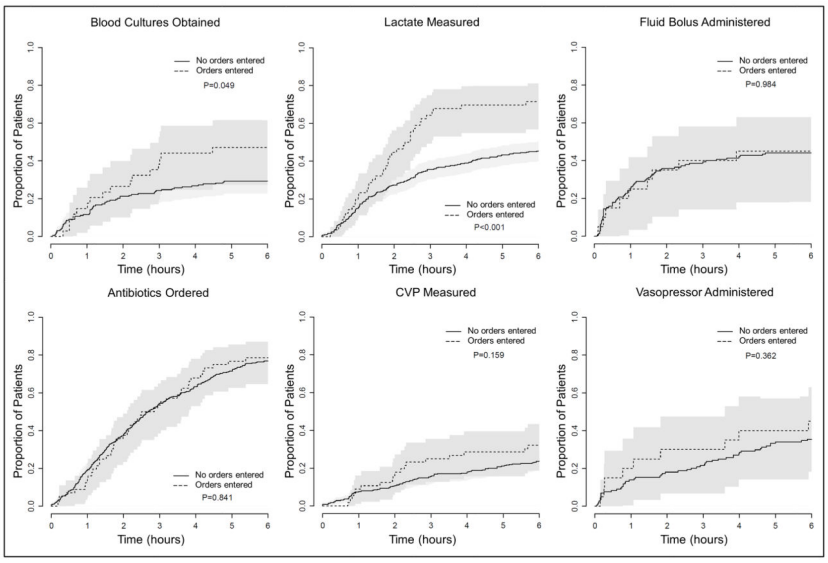


**Figure 3. Completion of Surviving Sepsis Campaign 6 hour Sepsis Resuscitation Bundle Elements by Use of Electronic Tool for Order Entry**

Proportion of patients for whom indicated bundle elements were completed over the 6 hours after enrollment for the subgroups of patients for whom the tool was used to enter orders versus patients for whom it was not used to enter orders. Lactate measurement, CVP measurement, and antibiotic administration were considered indicated in all patients during their first 6 hours in the ICU. Blood cultures were considered indicated in all patients but deemed completed at enrollment if obtained in the 6 hours prior to enrollment. Fluid bolus administration and vasopressor administration were considered indicated only in patients who met the hemodynamic criteria for each intervention as specified in the SSC 6-hr Resuscitation Bundle. Graphs in this figure display patients for whom the resuscitation bundle element was indicated during the 6 hours after enrollment and exclude patients for whom the element was completed before enrollment or not indicated. Patients for whom the tool was used to enter orders were more likely to have blood cultures obtained and lactate measured.

## Table 1

Baseline Characteristics

| Characteristic | Control (n=189) | Electronic Tool (n=218) |
|---|---|---|
| Age (yr) | 57±17 | 55±16 |
| Male | 55.0% (104) | 54.6% (119) |
| Race | | |
| Caucasian | 76.7% (145) | 73.9% (161) |
| African American | 15.9% (30) | 18.3% (40) |
| Asian | 1.6% (3) | 1.8% (4) |
| Unknown | 5.8% (11) | 6.0% (13) |
| Route of Admission | | |
| Emergency Department | 45.5% (86) | 46.8% (102) |
| Transfer from another hospital | 12.7% (24) | 16.5% (36) |
| Floor transfer | 25.4% (49) | 20.2% (44) |
| PACU/Recovery room | 8.5% (16) | 10.6% (23) |
| Other | 7.4% (14) | 6.0% (13) |
| MICU | 71.4% (135) | 70.6% (154) |
| Sepsis acknowledged at admission | 65.1% (123) | 54.6% (119) |
| If not at present at admission, time to development (hrs) | 1.8 [0.5–29.3] | 2.2 [0.5–49.6] |
| Time from sepsis prompt to positive assessment (min) | 48.5 [16.5–152.0] | 47.5 [18.0–154.0] |
| Sepsis confirmed on review | 88.4% (167) | 84.4% (184) |
| Source of Sepsis | | |
| Pulmonary | 30.2% (57) | 22.5% (49) |
| Urinary | 14.3% (27) | 14.7% (32) |
| Abdominal | 22.2% (42) | 21.1% (46) |
| Skin and soft tissue | 7.4% (14) | 7.3% (16) |
| Bacteremia | 16.4% (31) | 16.1% (35) |
| Other | 9.5% (18) | 18.3% (40) |
| Fluid in 6 hours pre-enrollment (mL) | 858±983 | 777±800 |
| Vasopressors in 6 hours pre-enrollment | 6.3% (12) | 10.1% (22) |
| Mechanically Ventilated | 20.7% (39) | 21.6% (47) |
| APACHE II score | 20.6±8.5 | 20.2±8.6 |

Data given as mean ± SD, median [25th – 75th percentile], or percentage (number)

**Table 2**

Clinical Outcomes

| | Control (n=189) | Electronic Tool (n=218) | *p* |
|---|---|---|---|
| ICU mortality | 15.9% (30) | 13.8% (30) | p=0.549 |
| ICU-free days to day 28 | 18.7±0.7 | 18.9±0.7 | p=0.901 |
| Ventilator-free days to day 28 | 23.0±0.7 | 23.0±0.7 | p=0.940 |
| Vasopressor-free days to day 28 | 22.4±0.8 | 22.5±0.7 | p=0.909 |