

Codman Awards

Improving Care of the Sepsis Patient

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Christiana Care Health System (Christiana Care), a large health care provider in the mid-Atlantic region, serves Delaware and portions of seven counties in Pennsylvania, Maryland, and New Jersey. A 1,100-bed tertiary care facility, Christiana Care is composed of two teaching hospitals, which admit nearly 56,000 patients each year and receive more than 149,000 patient visits in the emergency departments (EDs).

Severe sepsis occurs in an estimated 750,000 patients in noncoronary intensive care units (ICUs) in the United States; nearly 40% of these patients die of the condition.¹ In 2004, Christiana Care's annual mortality rate for this population was as high as 61.7%. Trauma systems have demonstrated improved outcomes when patients have been adequately resuscitated within 60 minutes (the "golden hour") of injury. Similar findings have been observed in patients with acute coronary or cerebral ischemia. Christiana Care recognized that timely intervention is equally essential for sepsis patients and committed to improving sepsis care in a similar manner. The Surviving Sepsis Campaign² provided a major opportunity to initiate a systemwide culture change to significantly reduce mortality. The organization committed to improving the care of all sepsis patients—not only those in the ED but throughout the health care system. The 2004 Surviving Sepsis Campaign guidelines³ were used as the foundation for an independent initiative to reduce the organization's mortality rate by at least 25%. The initiative was also spurred by a landmark study showing the efficacy of early goal-directed therapy.⁴

Article-at-a-Glance

Background: In 2004, Christiana Care Health System (Christiana Care), a 1,100-bed tertiary care facility, used the Surviving Sepsis Campaign guidelines as the foundation for an independent initiative to reduce the mortality rate by at least 25%.

Methods: In 2004, an interdisciplinary sepsis team developed a process for rapidly recognizing at-risk patients; evaluating a patient's clinical status; and providing appropriate, timely therapy in three major areas of sepsis care; recognition of the sepsis patient, resuscitation priorities, and intensive care management. The Sepsis Alert program, which did not require additional staffing, was developed and implemented in 10 months. The Sepsis Alert packet included a care management guideline, a treatment algorithm, an emergency department treatment order set, and multiple adjuncts to streamline patient identification and management.

Results: Introduction of sepsis resuscitation and critical care management standards led to a 49.4% decrease in mortality rates ($p < .0001$), a 34.0% decrease in average length of hospital stay ($p < .0002$), and a 188.2% increase in the proportion of patients discharged to home ($p < .0001$) when the historic control group is compared with the postimplementation group from January 2005 through December 2007.

Discussion: An integrated leadership team, using existing resources, transformed frontline clinical practice by providers from multiple disciplines to reduce mortality in the population of patients with sepsis.

Methods

ESTABLISHING THE SEPSIS ALERT PROGRAM

The program began in February 2004 with the presentation of strong scientific evidence to Christiana Care's executive leadership, who quickly supported the initiative. Next, key clinical champions were identified to participate in an interdisciplinary sepsis team. The team conducted an intensive review of evidence-based practice and then began to develop a process for rapidly recognizing at-risk patients, evaluating a patient's clinical status, and providing appropriate therapy in a timely fashion. The team identified three major areas of sepsis care: recognition of the sepsis patient, resuscitation priorities, and ICU management. Using these three areas as a foundation, the team began to build a comprehensive program to reduce Christiana Care's sepsis-related mortality. The program, now referred to as *Sepsis Alert*, would facilitate care for all adult patients with newly diagnosed sepsis throughout the health care system (pediatric patients continued to receive care at the local children's hospital).

No additional staffing was required for this initiative; however, additional data collection responsibilities and research opportunities did increase the work load of key team members after the Sepsis Alert program was implemented. Costs associated with instructional materials and care management packets were absorbed by Christiana Care's department of performance improvement. Over time, the initial interdisciplinary development team was modified to oversee the program and to monitor outcomes data.

IMPLEMENTATION

The inception and implementation of the Sepsis Alert program took place during a 10-month period. Because of the relationship between sepsis and systemic inflammatory response syndrome (SIRS), the SIRS criteria recommended by the Surviving Sepsis Campaign were used to identify patients with possible sepsis. This strategy required the development and implementation of an intensive educational program that focused on early identification of patients with SIRS and targeted the health care providers in the EDs and ICUs. Both triage and ICU nurses must recognize these patients and initiate a primary evaluation of their condition, including a complete blood count, blood cultures, and serum lactate concentration.

The Sepsis Alert program's overarching principle is the

collaboration of all members of the health care team to initiate antibiotics and the early goal-directed management of sepsis. To foster this collaboration, the interdisciplinary team created a Sepsis Alert packet, which includes a care management guideline, a treatment algorithm, an ED treatment order set, and multiple adjuncts to streamline patient identification and management. These documents incorporate strategies specific to sepsis care, including:

- Early and appropriate antibiotic administration
- Rapid fluid resuscitation
- Early central venous catheter placement
- Vasopressor administration
- Venous oxygen saturation (SvO₂) measurement and analysis
- Assessment for activated protein C administration

A first-dose Sepsis Alert kit was also created, which contains single-dose vials of antibiotics and corticosteroids with administration guidelines. To eliminate guesswork in selecting the proper drug for any particular circumstance, the team created the following resources*:

- An antibiotic selection chart, with antibiotics—both for primary therapy and alternates for penicillin/cephalosporin allergy—listed for a variety of infections (community-acquired pneumonia, health care-associated pneumonia, febrile neutropenia, intra-abdominal, and meningitis). The chart was designed and placed on the back of the ED treatment order set found in the Sepsis Alert packet.
- A broad versus narrow antibiotic spectrum poster, which enables nurses to prioritize the order of antibiotic administration to maximize clinical effectiveness.

Sepsis Alert packets, which also included a treatment protocol (Figure 1, page 189) and an education poster, were located in the EDs, in adult ICUs, and in key locations throughout Christiana Care.

To provide the same care to hospitalized inpatients with severe sepsis, the Rapid Response Team (RRT) was integrated into the Sepsis Alert program. The RRT, which is composed of an experienced ICU nurse, a respiratory therapist, a senior medical resident, and an intensivist, brings the components of the Sepsis Alert program, including the packet and medication kit, to the patient's bedside.

* The antibiotic selection chart, broad versus narrow antibiotic spectrum poster, and education poster are available by e-mail request from the authors.

PERFORMANCE IMPROVEMENT
ACTIVITIES

The Sepsis Alert program's effectiveness is continually monitored and assessed. Performance improvement meetings are held monthly to review individual cases, assess compliance with the care management guideline and treatment protocol, and review outcomes data. Christiana Care's adaptation of the Plan-Do-Check-Act (PDCA) model for rapid-cycle continuous improvement is used by clinical staff. An inherent goal of the Sepsis Alert program is for staff to consistently use the treatment protocol as a guidepost as they explore diagnosis and treatment options for individual patients.

At least four major revisions were made to the Sepsis Alert protocol as new information became available. Information presented at the performance improvement meetings is used as the basis for feedback given to staff; the program cannot effectively maintain its goals without ongoing education for physicians, nurses, pharmacists, and other health care providers. As more outcomes data are compiled, the need for additional staff education is ascertained. Nursing grand rounds, in-service seminars, and external conferences have been used as forums for disseminating information and for discussing possible means for refining the Sepsis Alert tools. Through the distribution of videos, posters, and internal newsletter articles, staff members can continue to become better educated about their roles in providing optimal care. The Sepsis Alert program is now described in presentations to all incoming residents, and all ED nurses are now required to participate in an annual Web-based seminar. A patient education brochure, *For Your Information, Sepsis: What You Should Know*, became available in October 2006.

Sepsis Alert Treatment Protocol

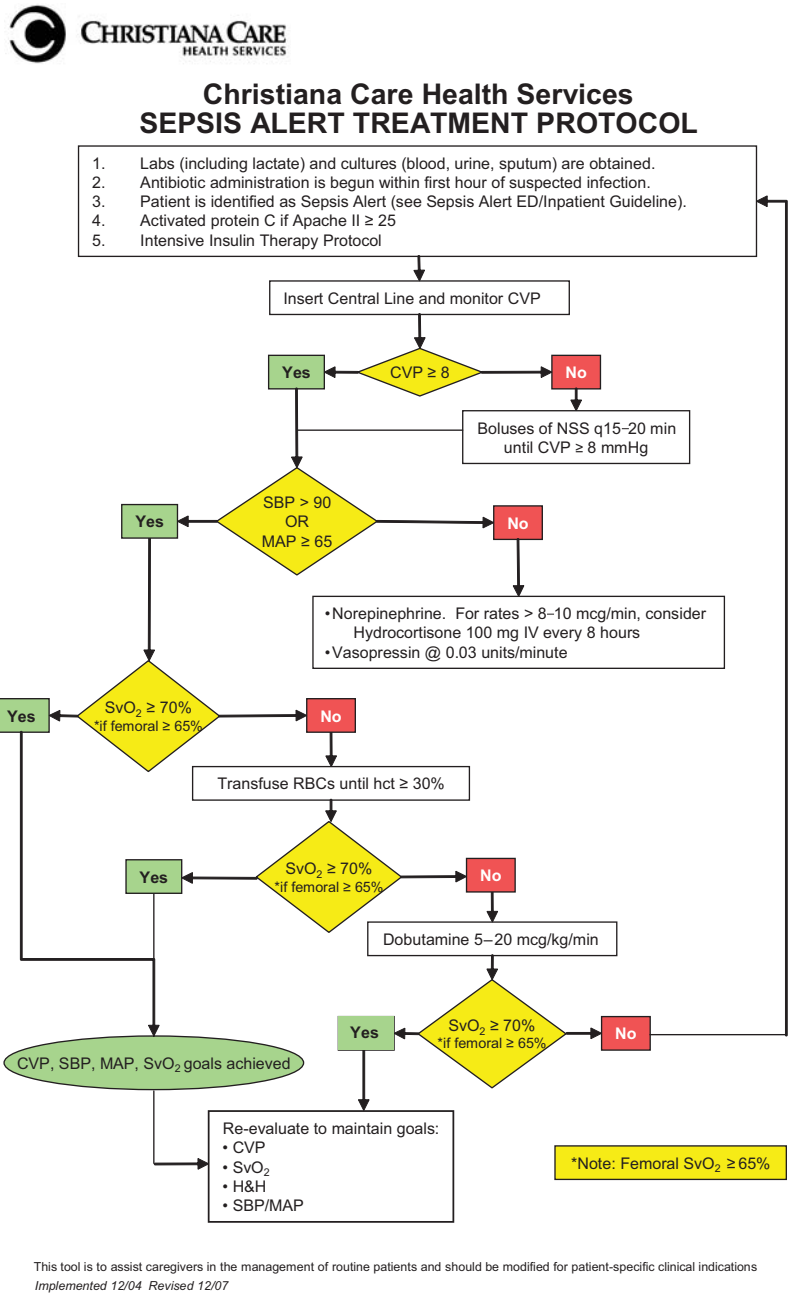


Figure 1. Sepsis Alert packets, which included this treatment protocol, were located in the emergency departments, adult intensive care units, and key locations throughout Christiana Care. ED, emergency department; CVP, central venous pressure; NSS, normal saline solution; SBP, systolic blood pressure; MAP, mean arterial pressure; SvO₂, venous oxygen saturation; RBC, red blood cell; hct, hematocrit; H&H, hemoglobin and hematocrit; IV, intravenous.

STATISTICAL ANALYSIS

The primary outcome indicator is mortality in adult patients who receive the diagnosis of sepsis on admission to or during their stay at Christiana Care. Secondary measurements include ICU and hospital lengths of stay, functional outcome (as measured by discharge disposition), and organ dysfunction.

The historic control group was made up of adult patients who were discharged or who died between October 1, 2003, and September 30, 2004, with severe sepsis and septic shock (primary or secondary ICD-9-CM [*International Classification of Diseases, Ninth Revision, Clinical Modification*] diagnostic code of 995.92 [systemic inflammatory response syndrome due to infection process with organ dysfunction]) who received vasopressor therapy during hospitalization.

A Sepsis Alert Collection Tool (SACT) was created to track an individual patient's diagnostic tests, procedures, medications, and supportive care. It was modified in 2006 to measure compliance with the severe sepsis resuscitation bundle, defined by the Institute for Healthcare Improvement.⁵ To achieve success in completing the severe sepsis resuscitation bundle, the care team must carry out all seven steps within six hours of the patient's identification as a candidate for Sepsis Alert.

Sepsis Alert patients were identified for review on the basis of ED and ICU logbook entries, RRT records, physician rounds, and chart audits. Clinical outcome information was obtained through chart review and the hospital's information system. During the first two years (2005–2006) following the Sepsis Alert program implementation, 100% of patients meeting the Sepsis Alert definition were included in the analysis. Beginning in 2007, a stratified random sample of patients was used because of sustained protocol compliance rates and resource limitations. The project was approved by the Christiana Care Institutional Review Board.

DATA DISSEMINATION

Physicians, nurses, and pharmacists—all instrumental to the program's success—receive ongoing feedback and education. Sepsis Alert outcome data are actively shared throughout the organization, including with executive leadership. Formal reports, an internal biweekly magazine, conference presentations, and section meetings are all used

to inform and educate the entire Christiana Care community.

Results

Introduction of sepsis resuscitation and critical care management standards led to a 49.4% decrease in mortality rates ($p \leq .0001$), a 34.0% decrease in average length of hospital stay ($p \leq .0002$), and a 188.2% increase in the proportion of patients discharged to home ($p \leq .0001$) when the historic control group is compared with the postimplementation group from January 2005 through December 2007. In addition, the incidence of sepsis-related organ dysfunction declined—by 62.9% ($p \leq .001$) for acute respiratory distress syndrome (ARDS) and 22.8% ($p \leq .10$) for acute renal insufficiency/failure. A comparative methodology and multivariable analysis, which corrected for confounders, including age, gender, and triage severity score (a proxy for severity of disease and comorbidities), revealed that the Sepsis Alert program was an independent predictor of decreased mortality. Regular monitoring and sharing of results led to 100% compliance with fluid resuscitation guidelines, 93% compliance with recommendations for timely antibiotic administration, and a 40% decrease in the time to initiate resuscitation when comparing the initial six months, January through June 2005, with the most recent 6 months, July through December 2007. In addition, early central venous catheterization placement improved by more than 20 minutes.

The initial overall score for the severe sepsis resuscitation bundle was 28.6% for October through December 2005. Opportunities for improved compliance were identified, and these results were shared with ED staff, the RRT, and other staff involved in the Sepsis Alert program. Since that time, appropriate vasopressor use has increased to 73.8% (a 30% increase), and SvO₂ compliance has improved by 52% (from 37.5% to 57.0%). The overall score for the severe sepsis resuscitation bundle increased to 68.0% ($p \leq .06$) for July through December 2007.

Discussion

In Christiana Care's Sepsis Alert program, an integrated leadership team, using existing resources, transformed frontline clinical practice by providers from multiple disciplines to reduce mortality in the population of patients with sepsis. In contrast, Rivers and colleagues,⁴ for exam-

In-Hospital Mortality Rate, 2005–2007

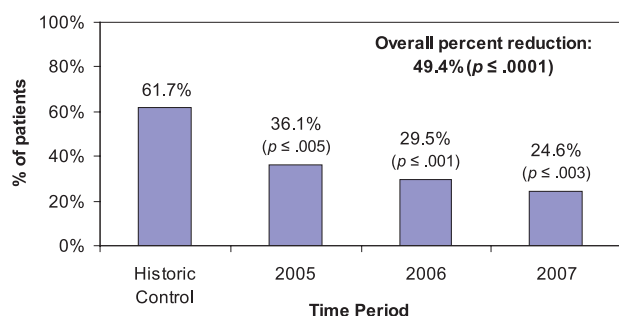


Figure 2. The in-hospital mortality rate for patients with severe sepsis has been reduced by 49.4% for 2005–2007 as compared with historic controls.

ple, reported on work only in the ED and required extra dedicated resources. Institution of the program has yielded significant reductions in mortality rates, hospital length of stay, and organ dysfunction (ARDS and acute renal insufficiency/failure) in severe sepsis. The proportion of patients discharged to home has dramatically increased. The overall number of severe sepsis and septic shock patients is believed to be declining because of early identification of patients with SIRS and possible infection who have received aggressive treatment, thereby averting deterioration into the continuum to septic shock.

Given this initiative's clinical nature, the retrospective nature of the historic control is somewhat limiting. The postimplementation group consisted of the Sepsis Alert population, 75% of whom required vasoactive pressors; the others were included on the basis of high serum lactate measurements. Mortality rates through December 2007 decreased from 61.7% to 31.3% ($p \leq .0001$). If only those patients receiving vasoactive pressors in the postimplementation group are compared with the historic control, mortality rates decreased from 61.7% to 33.2% ($p \leq .001$). It is encouraging that after implementation, mortality further declined from 36.1% in 2005 to 29.5% in 2006 and to 24.6% in 2007 (Figure 2, above) as feedback was provided to clinical staff and the protocol was refined.

Three major challenges remain for the Sepsis Alert program's continued success: maintaining currency with new diagnostic and treatment recommendations, educating health care providers on an ongoing basis, and tracking the protocol's compliance and effectiveness. As with most

areas of health care, guidelines for care of the patient with sepsis are always evolving. Downturns in algorithm compliance have been observed whenever the intervals between educational updates exceed two or three months. The tracking of protocol compliance and outcomes remains resource-intensive. After two years of 100% case review, the team began to employ a population sampling method by using The Joint Commission guidelines on sample size,⁶ a strategy that will allow continued monitoring of reliable data within the resource constraints available for chart reviews.

The ultimate challenge of bringing critical care directly to the patient's bedside requires the continuous education of health care providers who do not traditionally work in an intensive care environment. Incorporating technology with fixed and mobile virtual ICUs, decision support, and point-of-care testing augments the process. **J**

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