Reducing sepsis deaths: A systems approach to early detection and management

An interdisciplinary sepsis initiative eases the sepsis burden on patients, families, and the healthcare system.

By Hildy Schell-Chaple, PhD(c), RN, CCRN, CCNS, FAAN, and Melissa Lee, MS, RN, CNS-BC

MARTHA JOHNS *is admitted to the acute-care medical unit for monitoring and I.V. antibiotics to treat community-acquired pneumonia. Since her admission, her respiratory rate has ranged from 10 to 24 breaths/minute. Her white blood cell count remains elevated at 16,000 cells/mcL and her temperature is 96.6° F (35.9° C). When she becomes confused, the nurse increases her supplemental oxygen flow from 2 to 6 L/minute gradually over 2 hours to keep her pulse oximetry reading (SpO_2) above 92%.*

≈

David Chao was admitted to the acute-care surgical unit 2 days ago after ventral hernia repair. His vital signs have been stable and within normal ranges. But during the afternoon assessment, the nurse notes his heart rate has increased to 110 beats/minute (bpm) and his respiratory rate has risen slightly to 22 breaths/minute. He reports he hasn't had to use the urinal since early in the morning.

If you care for medical-surgical patients, you're probably familiar with scenarios like these. When a patient's assessment findings change as they did for Mrs. Johns and Mr. Chao, ask yourself, "Could this clinical change represent sepsis development or a deterioration related to severe sepsis?"

At hospitals across the country, sepsis education is increasing, and more clinicians are using a systems approach for early sepsis identification and timely evidence-based interventions for patients with suspected or known sepsis, severe sepsis, or septic shock. These sweeping changes stem largely from the work of the Surviving Sepsis Campaign (SSC) and hospitals' commitment to reduce unacceptably high sepsis-related deaths. A collaboration of expert clinicians from critical-care professional organizations, SSC aims to reduce sepsis-related deaths worldwide through awareness building, clinician education, development of diagnostic and management guidelines, and performance-improvement programs.

This article presents an overview of sepsis, reviews current recommendations from SSC's updated guidelines for managing severe sepsis and septic shock, and describes one hospital's approach to early detection and management to reducing sepsis-related deaths.

CNE
1.3 contact hours

LEARNING OBJECTIVES

1. Describe the continuum of sepsis manifestations.
2. Discuss how to manage sepsis.
3. Identify the key elements of a sepsis initiative.

The author and planners of this CNE activity have disclosed no relevant financial relationships with any commercial companies pertaining to this activity. See the last page of the article to learn how to earn CNE credit.

Expiration: 7/1/17

Understanding sepsis terminology

Sepsis is a clinical syndrome with a continuum of increasingly severe manifestations. The term refers to the body's response to an infection that has moved beyond localized tissue to become *systemic inflammatory response syndrome* (SIRS). In SIRS,

signs and symptoms result from systemic activation of the immune response to an infection or an injury (such as trauma or acute pancreatitis). SIRS manifestations include tachycardia, tachypnea or hyperventilation, body-temperature changes, and leukocytosis or leukopenia.

Unless identified and treated early, sepsis can progress to *severe sepsis*, which causes signs and symptoms of organ dysfunction or tissue hypoperfusion. *Septic shock*, at the far end of the sepsis continuum, is severe sepsis accompanied by persistent hypotension after fluid resuscitation. (See *Sepsis terms and definitions*.)

Sepsis terms and definitions

Led by the Society of Critical Care Medicine, international professional organizations have standardized and refined sepsis terminology and definitions through consensus conferences over the past 20 years. This chart shows the latest definitions and diagnostic criteria for sepsis and related conditions.

Term	Definition	Diagnostic criteria
Sepsis	Suspected or documented infection plus signs of SIRS	• Clinical suspicion or positive microbiologic confirmation of infection • Two or more criteria for SIRS (see below)
Systemic inflammatory response syndrome (SIRS)	Group of signs and symptoms resulting from systemic activation of the immune response to infection or injury	• Two or more of the following: • temperature > 100.9° F (38.3° C) or < 96.8° F (36° C) • heart rate > 90 beats/minute • respiratory rate > 20 breaths/minute or $Paco_2$ < 32 mm Hg • WBC count > 12,000 or < 4,000 cells/mcL • normal WBC with > 10% bands on differential
Severe sepsis	Sepsis plus signs of organ dysfunction or tissue hypoperfusion	• Sepsis • Organ dysfunction or signs of tissue hypoperfusion: • hypotension (systolic pressure < 90 mm Hg or decrease of 40 mm Hg from baseline; MAP < 70 mm Hg • blood lactate level > 2 mmol/L • altered mental status • hypoxemia (Spo_2 < 90% or Pao_2/Fio_2 ratio < 250) • low urine output (< 0.5 mL/kg/hour) • coagulopathy (platelets < 100,000/mcL; INR > 1.5) • bilirubin level > 2 mg/dL
Septic shock	Severe sepsis plus associated hypotension after fluid resuscitation	• Severe sepsis • Hypotension necessitating vasopressors after initial fluid resuscitation

Fio_2 = fraction of inspired oxygen. INR = International Normalized Ratio. MAP = mean arterial pressure. Pao_2 = partial pressure of oxygen in arterial blood. $Paco_2$ = partial pressure of carbon dioxide in arterial blood. Spo_2 = oxygen saturation measured by pulse oximetry. WBC = white blood cell.

Managing severe sepsis and septic shock

Because early sepsis identification allows prompt diagnosis and management, the 2012 SSC guidelines recommend hospitals implement a performance-improvement program for sepsis, including a routine patient-screening process for severe sepsis. The guideline for managing severe sepsis and septic shock specifies two care bundles. The first bundle should be completed within 3 hours of severe sepsis presentation; the second bundle, within 6 hours. (*Note:* The Institute for Healthcare Improvement calls the first bundle the severe sepsis 3-hour resuscitation bundle; the second bundle, the 6-hour septic shock bundle.)

3-hour bundle

Within the first 3 hours, healthcare providers should:

- obtain blood lactate levels to identify possible tissue hypoperfusion related to severe sepsis and to evaluate resuscitation interventions. A byproduct of anaerobic metabolism, lactate occurs in sepsis when oxygen demand exceeds oxygen delivery to tissues.
- perform appropriate diagnostic tests (including blood cultures) before giving antibiotics, to aid prompt diagnosis. Barriers to this recommendation include challenging vascular access, variations in access to phlebotomy services or nurse phlebotomy skills, and competing patient-care priorities related to sepsis management. At the University of California, San Francisco, Medical Center (UCSFMC), we found that using a blood culture algorithm with a timeline and escalation options reduces the median time for obtaining blood cultures.
- administer broad-spectrum antibiotics within 1 hour of recognizing severe sepsis or septic shock. To prevent administration delays, standard broad-spectrum antibiotics recommended by the UCSFMC pharmacy are stocked in medication stations on all inpatient units.
- administer crystalloid I.V. fluids totaling 30 mL/kg (2,400 mL for an 80-kg patient) when the patient has hypotension or a lactate level of 4 mmol/L or higher. At UCSFMC, we've encountered

such challenges as the time providers take to weigh the risks and benefits of administering fluids to patients with cardiac insufficiency, as well as comorbidities that raise concern for harmful effects of fluid overload.

6-hour bundle

The second bundle typically relates to the patient's transition to a higher level of care. Healthcare providers should administer vasopressors if hypotension persists after the initial 30 mL/kg fluid resuscitation. The goal is to achieve a target mean arterial pressure (MAP) of 65 mm Hg or higher. SCC guidelines recommend remeasuring lactate levels to evaluate the effects of fluid or vasopressor resuscitation (or both), as well as measuring central venous pressure (CVP) and central venous oxygen saturation ($ScvO_2$) in patients with septic shock to guide further interventions.

Be aware that CVP and $ScvO_2$ measurements require an invasive central venous catheter. Also, the usefulness of CVP and $ScvO_2$ monitoring is controversial; studies are underway to evaluate their clinical efficacy. Results of these studies will provide evidence addressing the controversial points and update the evidence-based recommendations in SSC guidelines.

Scenarios continued

When the nurse reassesses Mrs. Johns, he notes signs of severe sepsis and suspects her condition is worsening. He obtains a blood lactate level per the protocol and notifies the physician of the change in her condition and her lactate level of 5.3 mmol/L. The new assessment and lab findings trigger activation of the Code Sepsis system, leading to prompt blood culture sampling, broad-spectrum antibiotics, and an I.V. fluid bolus of 30 mL/kg. The nurse closely monitors the patient's hemodynamic and respiratory response and obtains a follow-up lactate level.

2012 SSC guidelines recommend hospitals implement a performance-improvement program for sepsis.

When obtaining new vital signs for Mr. Chao, the nurse finds a heart rate of 130 bpm and blood pressure of 88/60 mm Hg. After the patient complains of new abdominal pain, she notifies the physician and communicates her concern that he might have severe sepsis. Per protocol, she obtains a blood lactate sample; the lab calls to report a critical level of 4.8 mmol/L. After activating the Code Sepsis system, she obtains blood cultures and begins an I.V. fluid bolus of 1.5 L, as ordered. When Mr. Chao's blood pressure remains low, he is transferred to the intensive care unit (ICU), where he's started on antibiotics and receives an additional fluid bolus. Also, a norepinephrine infusion is started, titrated to keep his MAP above 65 mm Hg.

In both of these cases of patients with known infections who are receiving treatment, the nurse adeptly detected a decline in the patient's condition along the sepsis continuum.

UCSFMC sepsis initiative

The sepsis initiative at UCSFMC launched in January 2012 with the goal of reducing sepsis-related deaths. It uses a systems approach to ensure early detection and timely management of severe sepsis and septic shock. The following sections describe the actions of the interprofessional team in educating clinicians, designing and testing a sepsis screening tool and electronic alert system, and improving systems to promote rapid management of patients with severe sepsis and septic shock.

Interprofessional team

We started the initiative by convening an interprofessional sepsis committee consisting of clinical and advance practice nurses, physicians, pharmacists, and representatives from the laboratory and quality and safety program. The emergency department (ED), medical-surgical ICU, progressive care unit, and medical acute-care unit were chosen as pilot units because they frequently have sepsis cases. Physician and nurse champions from those units worked closely with the sepsis committee to determine screening criteria and operational definitions, design sepsis screening tools, plan education for pilot-unit clinicians, and outline the sepsis management bundle in concordance with SSC guidelines. The champions served as unit- and discipline-based resources, participated in design and testing of new tools, and represented peer feedback in the performance-improvement process.

Clinician education

To raise sepsis awareness and provide education on sepsis diagnosis and treatment, UCSFMC offered clinicians several educational opportunities:

- nursing grand rounds
- nursing stories from the bedside session dedicated to sepsis education and case studies coinciding with World Sepsis Day
- case-based, high-fidelity, hands-on simulation sessions with interprofessional participation
- online educational modules and educational staff development at staff meetings
- unit-based newsletter articles and educational posters and flyers.

Sepsis screening

One of our goals was to implement an electronic surveillance system for early sepsis detection that would continually evaluate patients for signs of sepsis as new data populated the medical record. While

this system was being built and tested, a paper screening system was designed and implemented on the inpatient pilot units. Nurses completed the paper screening at least once each shift and with clinical changes, as needed.

Electronic surveillance and alerts

The ED moved forward with sepsis surveillance and electronic alerts. The electronic surveillance system included decision-support algorithms to activate the Code Sepsis response system and aid completion of sepsis bundle interventions. Screening systems were validated through review of completed screening tools and charts.

After a year of design and testing by unit champions, inpatient pilot units began electronic sepsis surveillance using the electronic medical record (EMR). To design the inpatient system, we built on our experience with ED surveillance and alerts. The electronic surveillance system evaluates clinical documentation, including laboratory results, and triggers a pop-up window alert if data meet configured sepsis criteria. Healthcare providers (including physicians, nurses, and physician assistants) and pharmacists receive activated electronic alerts when they open the EMR.

Links within electronic alerts promote use of the lactate protocol, which was developed to allow a nurse-driven order for a lactate laboratory test based on specified sepsis criteria. Also, a standardized electronic sepsis order set was developed and made accessible to all providers, to promote timely ordering of management bundle elements. (See *Designing an electronic surveillance and alert system*.)

Code Sepsis response system

We implemented a Code Sepsis response system to bring trained resources to the inpatient pilot units and thus reduce delays in sepsis detection and management. Nurses activate a Code Sepsis through hyperlinks in the electronic alerts or through the pager system. Code Sepsis team members who respond to manage patients meeting severe sepsis or septic shock criteria include the rapid response team (RRT) nurse and respiratory therapist, a critical care nurse practitioner (NP), and a pharmacist providing remote consultation. The NP serves as the Code Sepsis team leader and ensures that sepsis management bundle elements are implemented in a timely manner as indicated.

Designing an electronic surveillance and alert system

With the growing use of electronic medical records, electronic sepsis surveillance systems increasingly are becoming a vital part of comprehensive sepsis prevention and care programs. Many workflow assessments are crucial to successful design of an electronic surveillance and alert system. When designing ours, we asked ourselves these crucial questions:

- Which clinical criteria should we include in the system configuration? For example, should two signs or three signs of systemic inflammatory response syndrome trigger the alert? Should the criteria differ by level of care or diagnostic populations?
- How much information should be included in alerts? Is a simple alert preferred over a complex alert that presents a lot of data and clinician guidance on actions to take?
- Who should receive the alerts? Should each discipline see the same alert information? Or should the alert be tailored to the discipline's clinical focus?
- Where and when in the clinician workflow should the alert display?
- How often and over what timeframe should the electronic system review clinical signs?
- Once the alert is displayed, what lockout timeframes should be used for subsequent surveillance alerts to clinicians? Once the sepsis bundle is completed, how long should the alert be suppressed?

We built alert parameters tailored to the level of care areas, with the same set of surveillance criteria for acute- and progressive-care units. Critical care patients have a slightly different set of criteria, considering the impact of such critical therapies as mechanical ventilation, renal replacement therapy, and targeted temperature management. Alert screens include embedded links for additional decision support to resources outlining definitions of sepsis terminology and management bundle elements.

Challenges

To determine if a patient has a sepsis condition, electronic alerts prompt UCSFMC nurses to answer a question to determine if clinical changes relate to an infection. Our nurses found this question challenging to answer, as most of their patients were at risk for infection but had many other medical or surgical conditions that could explain the clinical change. We gathered their feedback on ways to improve the system. For instance, we asked, "Looking back on the last patient you cared for, what would a new or worsening infection look like clinically? Would you see increased sputum production or wound drainage?" ED staff suggested changing this question to "Do you *suspect* this patient has a new or worsening infection?" Nurses also were challenged to determine if this was a new change, so we provided a look-back timeframe of 6 hours as a reference.

Process and outcome monitoring

The Department of Patient Safety and Quality at the University of California, San Francisco, Medical Center (UCSFMC) reviews compliance with the sepsis screening and management bundle element process measures, as well as outcomes for severe sepsis and septic shock patients. Based on ongoing review, improvement interventions are designed, implemented, and evaluated to optimize performance.

Input from frontline clinicians is essential to the success of practice changes and improved patient outcomes. Outcomes are reported internally to all clinical team members and shared with external organizations. As our compliance with sepsis screening and management-bundle implementation improves, sepsis-associated deaths continue to decline.

As previously described, after we identified challenges in drawing blood cultures within the suggested period, we developed a blood culture algorithm that includes a timeline and escalation options. This contributed to a reduced median time for obtaining cultures in ICU patients with severe sepsis.

In an effort to prevent alert fatigue and optimize the impact of early sepsis detection, nurses and other providers gave feedback to help us determine how the alerts were acknowledged and what lockout timeframes were safe. Behind-the-scenes work on physician, pharmacist, and nursing alerts and how they interacted after one clinician interfaced with an alert involved significant fine-tuning to ensure appropriate communication among team members. We stressed the importance of maintaining clinical assessment for sepsis and notification of concerns based on that assessment, rather than relying on the alert system alone. We also emphasized that the electronic alert is an adjunctive tool, not a replacement for critical thinking. (See *Process and outcome monitoring*.)

Facilitating factors

The system changes we implemented to promote sepsis screening and timely management were crucial to improving patient outcomes. To promote early sepsis detection, we developed a protocol that allows the nurse to order and draw a blood lactate sample based on a patient's presentation of SIRS and the nurse's assessment of a suspected new or worsening infection. Protocol training included the rationale and procedure for sending blood samples to the laboratory for rapid analysis and developing a critical value at or above which the laboratory would contact the nurse. This allows nurses caring for patients with suspected severe sepsis to gather more data in a timely manner and to contact the provider with more comprehensive data to guide the next interventions. Also, our pharmacists developed a reference to guide the ordering of first-dose broad-spectrum antibiotics to promote appropriate pathogen coverage. These medications were added to the floor stock of all medication stations on all units.

RRT nurses and respiratory therapists

UCSFMC nurses can call on respiratory therapists and RRT nurses when they suspect sepsis. The latter provide ongoing education to unit nurses and other providers on the medical and surgical teams regarding early signs of new and worsening sepsis and appropriate interventions. Most important, they serve as a resource for unit nurses, who already are multitasking and may have other patients to care for. They expedite the process of obtaining laboratory samples, cultures, I.V. access, and reducing barriers to timely administration of antibiotics, fluids, and vasopressors.

Moving forward

At UCSFMC, plans for continuous process improvement include:

- optimizing and implementing the electronic sepsis surveillance program throughout all inpatient units
- developing a dashboard that displays outcomes of our sepsis initiative
- continually identifying opportunities for improving the care of sepsis patients by engaging with frontline clinicians, patients, and families.

We've learned that the keys to success in improving patient outcomes include use of a systems approach by the collaborative interdisciplinary team to engage frontline clinicians, evaluate workflow impacts, and promote the shared goal of improving care in the effort to reduce the burden of sepsis on patients, families, and the healthcare system. ✭

Selected references

Aitken LM, Williams G, Harvey M, et al. Nursing considerations to complement the Surviving Sepsis Campaign guidelines. *Crit Care Med.* 2011;39(7):1800-18.

Dellinger RP, Levy MM, Rhodes A, et al. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock, 2012. *Crit Care Med.* 2013; 41(2):580-637.

Kleinpell R, Schorr CA. Targeting sepsis as a performance improvement metric: role of the nurse. *AACN Adv Crit Care.* 2014;25(2):179-86.

Levy MM, Artigas A, Phillips GS, et al. Outcomes of the Surviving Sepsis Campaign in intensive care units in the USA and Europe: a prospective cohort study. *Lancet Infect Dis.* 2012;12(12):919-24.

Schorr CA, Zanotti S, Dellinger RP. Severe sepsis and septic shock: management and performance improvement. *Virulence.* 2014;5(1):190-9.

The ProCESS investigators. A randomized trial of protocol-based care for early septic shock. *New Engl J Med.* 2014;370(18):1683-93.

The authors work at the University of California, San Francisco, Medical Center. Hildy Schell-Chaple is a clinical nurse specialist in adult critical care and an associate clinical professor in the department of physiological nursing at the School of Nursing. Melissa Lee is a clinical nurse specialist in adult acute care.

Note: All names in scenarios are fictitious.

POST-TEST • Reducing sepsis deaths

Earn contact hour credit online at www.AmericanNurseToday.com/ContinuingEducation.aspx

CNE

CNE: 1.3 contact hours

Instructions

To take the post-test for this article and earn contact hour credit, please go to the blue link above. Simply use your Visa or MasterCard to pay the processing fee. (ANA members $15; nonmembers $20.) Once you've successfully passed the post-test and completed the evaluation form, you'll be able to print out your certificate *immediately*.

Provider accreditation

The American Nurses Association's Center for Continuing Education and Professional Development is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation. ANCC Provider Number 0023.

Contact hours: 1.3

ANA's Center for Continuing Education and Professional Development is approved by the California Board of Registered Nursing, Provider Number CEP6178 for 1.58 contact hours.

Post-test passing score is 75%. Expiration: 7/1/17

ANA Center for Continuing Education and Professional Development's accredited provider status refers only to CNE activities and does not imply that there is real or implied endorsement of any product, service, or company referred to in this activity nor of any company subsidizing costs related to the activity. The planners and author of this CNE activity have disclosed no relevant financial relationships with any commercial companies pertaining to this CNE.

Purpose/goal

To provide nurses with information on how they can best identify and care for patients with sepsis.

Learning Objectives

1. Describe the continuum of sepsis manifestations.
2. Discuss how to manage sepsis.
3. Identify the key elements of a sepsis initiative.

Please mark the correct answer online.

1. A group of signs and symptoms resulting from activation of the immune response to an infection is called:

a. systemic inflammatory response syndrome (SIRS).
b. moderate sepsis.
c. severe sepsis.
d. septic shock.

2. Your patient has a bilirubin of 3 mg/dL, a pulse oximetry reading of 80%, and a low urine output, but he doesn't require vasopressors to treat hypotension. Which form of sepsis does he have?

a. SIRS
b. Moderate sepsis
c. Severe sepsis
d. Septic shock

3. A patient who still has hypotension after initial fluid resuscitation most likely has which form of sepsis?

a. SIRS
b. Moderate sepsis
c. Severe sepsis
d. Septic shock

4. Which of the following signs in your patient indicate SIRS?

a. Respiratory rate 18 breaths/minute, white blood cell (WBC) count 8,000 cells/mcL
b. Heart rate 100 beats/minute, temperature 99.0° F (37.2° C)
c. Normal WBC count with 15% bands on differential, heart rate 110 beats/minute
d. Temperature 99.0° F (37.2° C), respiratory rate 16 breaths/minute

5. Which statement about lactate and lactate levels is correct?

a. Lactate is a byproduct of aerobic metabolism.
b. Lactate levels aren't helpful in evaluating resuscitation interventions.
c. Lactate is a byproduct of anaerobic metabolism.
d. Lactate levels help identify possible tissue hyperperfusion.

6. Which of the following blood lactate levels should concern you?

a. 3.0 mmol/L
b. 1.5 mmol/L
c. 1.0 mmol/L
d. 1.25 mmol/L

7. The 3-hour sepsis bundle requires administration of broad-spectrum antibiotics how soon after recognition of severe sepsis or septic shock?

a. 30 minutes
b. 60 minutes
c. 90 minutes
d. 120 minutes

8. Your patient with sepsis has a blood pressure of 88/54 mm Hg and a lactate level of 4 mmol/L; he weighs 70 kg (154.3 lb). Which volume of crystalloid I.V. fluids should you expect the physician to order?

a. 1,200 mL
b. 1,800 mL
c. 2,100 mL
d. 3,000 mL

9. If a patient with sepsis requires a vasopressor, it's usually administered to keep the mean arterial pressure (MAP) at:

a. 55 mm Hg or higher.
b. 60 mm Hg or higher.
c. 65 mm Hg or higher.
d. 70 mm Hg or higher.

10. Which of the following is NOT a question that should be asked when designing an electronic surveillance system?

a. How can we ensure there are no lockout timeframes?
b. Which clinical criteria should be included?
c. Who should receive the alerts?
d. How should the electronic system review clinical signs?

11. To promote sepsis screening and timely management, it's helpful to have a protocol that:

a. allows the nurse to draw a blood lactate sample based on the patient's presentation.
b. avoids using an algorithm to determine when to draw blood cultures.
c. involves only nurses and pharmacists, to keep the protocol uncomplicated.
d. focuses on relying solely on the electronic alert system for determining sepsis.