

Sepsis: Noninvasive Assessment

Mary Beth Flynn Makic, PhD, RN, CCNS, CCRN-K, FAAN, FNAP, FCNS

SEPSIS CONTINUES TO BE a leading cause of morbidity and mortality with more than 1.7 million cases identified annually and an estimated one in three patients who die during hospitalization with sepsis.^{1,2} Sepsis is a life-threatening condition caused by dysregulated patient response to infection that leads to organ dysfunction.² The most common types of infections found to be associated with sepsis include pulmonary, urinary tract, skin, and intestinal infections.² Advanced age and chronic illnesses also increase the patient's risk of infection and lead to sepsis. Patients requiring surgical interventions may be at increased risk of infection, especially surgical site infections or urinary tract infections, which may compound the patient's risk for sepsis.^{1,2}

Current sepsis guidelines evaluate the patient for changes in temperature ($>38^{\circ}\text{C}$ or $<36^{\circ}\text{C}$), tachycardia (heart rate > 90 beats/min), tachypnea (respiratory rate > 22 breaths/min), hypotension (systolic blood pressure ≤ 100 mm Hg) changes in mental status, and serum lactate > 2 mmol/L.^{1,3,4} Early recognition and treatment of patients with sepsis remains essential to improving outcomes. Interventions focus on identifying and treating the source of the infection and supporting the patient's tissue perfusion through fluid resuscitation. Both invasive and noninvasive assessments can be used to evaluate tissue perfusion and often less invasive techniques are often overlooked.⁵ Incorporating noninvasive assessment techniques can assist the perianesthesia nurse in gathering data to evaluate the patient's response to treatment.

Mental Status Changes

Fluctuations in mental status are often subtle yet can be a significant clinical assessment parameter alerting the perianesthesia nurse to possible hypoperfusion state. The patient's mental status can range from anxiety to inattention and disorganized thinking to difficulty in arousal. Although numerous factors need to be evaluated as to the possible cause of the patient's change in mentation (eg, electrolyte abnormalities, sleep deprivation, pain, sedation, adverse drug interactions, fever, hypoglycemia), sepsis-associated microcirculatory changes alter brain perfusion leading to dysfunction manifesting as mental status changes.^{5,6} Several clinical assessment tools are available to evaluate mental status to include delirium assessment (ie, Confusion Assessment Method for the Intensive Care Unit), Glasgow Coma Scale, and simply the patient's orientation to person, place, and time. In addition, engaging family to notify the nurse of subtle changes in mentation is important as family may notice alternations in thought patterns sooner. Current evidence suggests that patients with sepsis, who are hemodynamically stable, can manifest early with signs of mental status changes suggesting brain hypoperfusion.^{6,7} Thus, serial neurologic examinations by the nurse and trending subtle changes are increasingly important to evaluate changes in perfusion and the patient's response to interventions that may not be evident by blood pressure assessment alone.^{3,5,6}

Capillary Refill Time

Capillary refill time (CRT) measures the time required for color to return to baseline after application of blanching pressure to either the tip of the finger or knee. Studies dating back 70 years have described CRT as an indicator of hypoperfused states.^{5,8} This assessment is easy to do and provides data as to the adequacy of regional and global perfusion during sepsis and resuscitation

Mary Beth Flynn Makic, PhD, RN, CCNS, CCRN-K, FAAN, FNAP, FCNS, College of Nursing, University of Colorado, Aurora, CO.

Conflict of interest: None to report.

Address correspondence to Mary Beth Flynn Makic, College of Nursing, University of Colorado, 13120 E 19th Avenue, Aurora, CO 80045; e-mail address: marybeth.makic@cuanschutz.edu.

© 2019 by American Society of PeriAnesthesia Nurses

1089-9472/\$36.00

<https://doi.org/10.1016/j.jopan.2019.05.003>

phases of care.^{5,6,9} Normal CRT is less than 4.5 seconds in adults; thus CRT >5 seconds correlates to hypoperfused states and worse patient outcomes.^{5,6,9} Serial monitoring of CRT responsiveness can be helpful in the noninvasive evaluation of the effectiveness of resuscitation.^{5,6} Although CRT is easy to conduct in the care of the critically ill patient, this assessment tool is not without limitations. The primary constraints focus on the consistency of the site for the assessment. Perianesthesia nurses should communicate and document CRT performed on the distal finger or the knee and be consistent with the site used for sequential assessments. Compression firmness and time, ranging from 5 to 15 seconds, may limit reproducibility in the assessment. Lastly, CRT has not been well studied on individuals with dark skin tones. Despite these limitations, evidence suggests that the ease of this assessment and correlations of CRT to effectiveness of resuscitation efforts may be appreciated before normalization of lactate levels are achieved.^{5,6,10} Incorporating CRT as an assessment parameter can provide insight into the patient's perfusion status independent of changes in systemic hemodynamic assessment.⁹ Although CRT is not an end point for evaluating effectiveness of treatment efforts, this assessment tool used with other clinical parameters of peripheral perfusion may improve resuscitation efforts for the septic patient.^{5,10}

Skin Mottling

Skin mottling is defined as patchy skin discoloration typically around the knees, anterior leg, and elbows. It has a distinct patchy pattern and is caused by small-vessel vasoconstriction indicating poor microperfusion of the skin.^{5,6} Skin mottling can be easily evaluated and thus used as an indicator of peripheral perfusion. To assist with consistency of skin mottling assessment, the perianesthesia nurse is encouraged to use the skin mottling score (SMS). The SMS was developed and validated by Ait-Oufella et al¹¹ to quantify the extent of mottling on the leg when positioned at heart level.^{9,11} The SMS ranges from 0 (no mottling) to 5 (extremely severe mottling). Mottling is assessed from the center of the knee and subsequent extension of the patchy skin

Box 1. Skin Mottling Score

Score	Mottling (With Leg at Heart Level)
0	No mottling
1	Modest, coin size, mottling observed on the knee
2	Moderate mottling but does not extend beyond the superior edge of the kneecap
3	Mild mottling extending to the middle thigh
4	Severe mottling progressing to the fold of the groin
5	Extreme mottling that goes beyond the fold of the groin

discoloration on the leg (Box 1). As the mottling extends, this clinical finding correlates with other perfusion indicators such as elevated lactate levels.¹¹ The presence of mottling was also reported to be independent of mean arterial pressure, cardiac output, and vasopressor infusion.^{6,10,11} Limitations of this assessment tool include difficulty to assess changes in dark skin-toned persons or individuals with cirrhosis. Assessment of mottling is a simple yet highly reliable parameter to evaluate peripheral perfusion status in a patient with sepsis.

Implications for Practice

Identifying sepsis early is critical to establishing life-saving interventions to reduce the morbidity and mortality of this syndrome. Too often we depend on standard assessment variables such as changes in blood pressure, heart rate, urine output, respiratory rate, to alert the clinician to possible clinical problems. Although it is vitally important to trend changes in these standard parameters, often once the blood pressure drops, the patient's sepsis syndrome may be significantly advanced.^{3,10} Incorporating several noninvasive assessment parameters into the care of the patient at risk of developing sepsis can facilitate earlier identification of poor perfusion states and facilitate evaluation of resuscitation interventions. Assessing for subtle changes in mental status, CRT, and determining an SMS are clinically relevant noninvasive assessments the perianesthesia nurse can implement in the

care of the patient with sepsis. Adding these assessments to standard hemodynamic monitoring parameters and resuscitation evaluation tools, such as lactate, can facilitate a

more clear picture of the patient's overall perfusion status to guide clinical interventions and care decisions.

References

1. Health Research & Educational Trust (June 2018). *Sepsis and Septic Shock Change Package: 2018 Update*. Chicago, IL: Health Research & Educational Trust. Available at: <http://www.hret-hiin.org/>. Accessed April 29, 2019.
2. Centers for Disease Control and Prevention. Sepsis Data and Reports. August 23, 2016. Available at: <https://www.cdc.gov/sepsis/datareports/index.html>. Accessed April 29, 2019.
3. Singer M, Deutschman CS, Seymour CW, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). *JAMA*. 2016;315:801-810.
4. Levy, M., Evans, L., Rhodes, A. The Surviving Sepsis Campaign Bundle: 2018 Update. *Crit Care Med*; 46: 997-1000
5. Huber W, Zanner R, Schneider G, et al. Assessment of regional perfusion and organ function: less and non-invasive techniques. *Front Med*. 2019;6:50.
6. Pastelnicu R, Evans L. Monitoring of the physical exam in sepsis. *Curr Opin Crit Care*. 2017;23:232-236.
7. Taccone F, Su F, Pierrakos C, et al. Cerebral microcirculation is impaired during sepsis: an experimental study. *Crit Care*. 2010;14:R140.
8. Naumann D, Lima A. Could resuscitation be based on microcirculation data? *Intensive Care Med*. 2018;44: 947-949.
9. Bridges E. Assessing patients during septic shock resuscitation. *AJN*. 2017;117:34-40.
10. Dubin A, Henriquez E, Hernandez G. Monitoring peripheral perfusion and microcirculation. *Curr Opin Crit Care*. 2018;24:173-180.
11. Ait-Oufella H, Lemoinne S, Boelle P, et al. Mottling score predicts survival in septic shock. *Intensive Care Med*. 2011;37: 801-807.