PATIENT TLC
SIRS and sepsis affects critically ill patients. These syndromes require early recognition, prompt emergency treatment, and diligent nursing care.

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CONTINUING EDUCATION

EMERGENCY MEDICINE/CRITICAL CARE

Recognizing, Treating, and Monitoring Systemic Inflammatory Response Syndrome and Sepsis

MEET THE AUTHOR

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Systemic inflammatory response syndrome (SIRS) and sepsis are complex clinical syndromes that are often related and can be fatal. Sepsis is common in both human and veterinary emergency and critical care settings and has high mortality rates (40% to 70%).[1,2] Patients affected by SIRS and sepsis are at risk for developing multiple organ dysfunction syndrome and/or septic shock (**BOX 1**).

PATHOPHYSIOLOGY

The body's normal response to pathologic inflammation balances the activation of proinflammatory mediators (e.g., platelet activating factor, tumor necrosis factor, cytokine interleukin [IL]-6) with activation of anti-inflammatory mediators (e.g., IL-10, IL-13, transforming growth factor β).[2] The proinflammatory response is part of normal immune function and is intended to protect the host from disease by eradicating damaged tissue.[5]

During SIRS, the proinflammatory and anti-inflammatory mediators become unbalanced and excessive activation of inflammation leads to damage to normal tissue.[2,5] Homeostasis is disrupted, with consequences that include those listed in **TABLE 1**. While SIRS is most commonly associated with sepsis, other disease states can cause a systemic inflammatory response (**FIGURE 1** and **BOX 1**).[2]

In sepsis, the systemic inflammation is in response to a documented bacterial, fungal, protozoal, parasitic, or viral infection (**FIGURE 1**).[5] The infectious agent is

TABLE 1 Consequences of Homeostatic Disruption in SIRS and Sepsis[1,2]

	CONSEQUENCES	
SYSTEM AFFECTED	**SIRS**	**SEPSIS**
Thermoregulation	Fever	Fever
Loss of vascular tone	Vasodilation, hypotension, poor cardiac contractility	Vasodilation, distributive shock
Endothelium	Vascular leakage	Vascular fluid shifts, bacterial translocation (e.g., GI tract), impaired oxygen delivery to tissue
Coagulation	Hypercoagulable state	Procoagulant state; increased risk of disseminated intravascular coagulopathy

GI=gastrointestinal; SIRS=systemic inflammatory response syndrome.

recognized by pathogen-associated molecular patterns and microbial-associated molecular patterns, which stimulate the immune response, leading to a massive cytokine release and macrophage activation, further propagating the inflammatory cascade.[1,2] This excessive inflammatory response results from disproportionate activation of proinflammatory mediators and/or lack of regulatory counterparts. Neutrophils respond to the cytokine release by producing reactive oxygen series and nitrous oxide, damaging tissue by altering systemic vascular resistance.[1,2] Vasomotor tone is lost due to the overproduction of nitrous oxide, which causes systemic vasodilation and leads to a distributive shock state.[1]

In both SIRS and sepsis, endothelial injury occurs from microcirculatory derangements that increase vascular permeability. The inflammatory response is dysregulated by cytokine release, which upregulates tissue factor levels to initiate the coagulation cascade. The normal coagulation cascade involves activation of the platelet plug and anticoagulant pathways to maintain hemostasis; these processes are inhibited due to downregulation (decreased levels) of antithrombin.[1,2] This leads to the hemostatic balance favoring a procoagulant state.

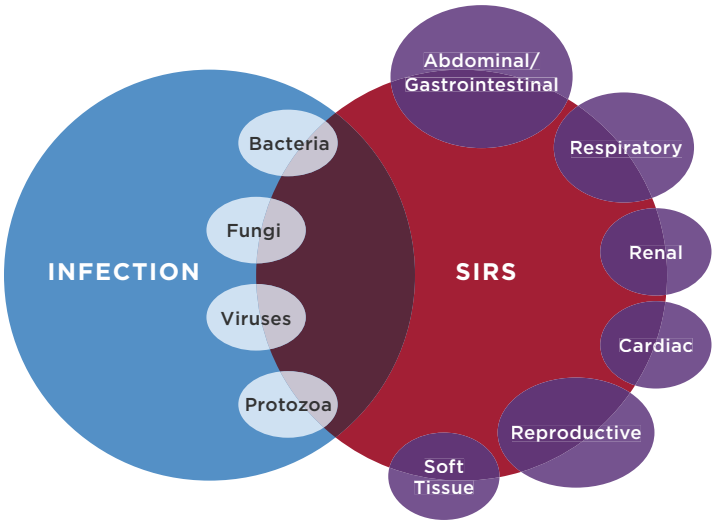

FIGURE 1. Systemic inflammatory response syndrome (SIRS) and sepsis are dysregulated inflammatory states that affect the whole body. The cause of SIRS may be an infectious or noninfectious insult; when the cause is an infectious agent, the specific inflammatory response is described as sepsis. Most infections do not lead to sepsis. Bacteria are the most common cause of sepsis, but any type of infectious agent can be involved. Noninfectious conditions affecting a variety of organ systems (e.g., abdominal/gastrointestinal, lungs, urinary tract, heart, reproductive organs) can be implicated in SIRS.

CAUSES AND CLINICAL SIGNS

In veterinary patients, the most common cause of SIRS/sepsis is bacterial infectious peritonitis secondary to leakage of gastrointestinal (GI) contents into the abdominal cavity.[1]

In both SIRS and sepsis, disruption of homeostasis causes organ dysfunction. Patients presenting with SIRS and/or sepsis often have a nonspecific medical history. Clinical signs include lethargy, weakness, hyporexia or anorexia, abdominal discomfort or abnormal posturing (e.g., prayer position), vomiting, diarrhea, increased respiratory rate and/or effort, fever, erythema, swelling of extremities and/or joints (possible

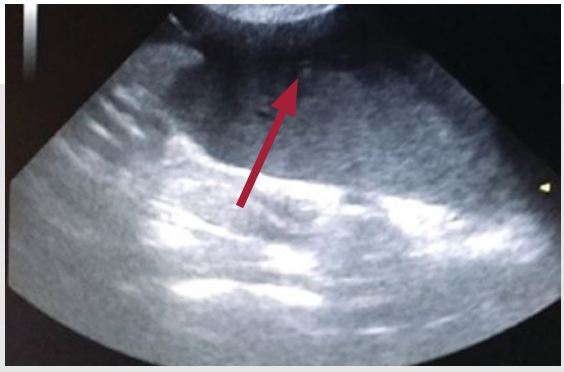

FIGURE 2. Point-of-care ultrasound showing free abdominal fluid (arrow).

limping), infected-looking and/or odorous wounds, changes in heart rate, change in respiration, injected mucous membrane color, rapid capillary refill time, and altered level of consciousness (change in mentation).[1,2]

DIAGNOSTIC CRITERIA

Studies in both human and veterinary medicine are ongoing to identify reliable and specific biomarkers of inflammation and infection to assess inflammatory response.[2]

Four criteria have been proposed for the diagnosis of SIRS in canine and feline patients (**TABLE 2**).[1,2] Cats and dogs exhibiting 2 of these 4 diagnostic criteria are considered to have SIRS.[1,2] These criteria are statistically sensitive and specific for the diagnosis of SIRS, but not sepsis. Diagnosis of sepsis should focus on the diagnostic criteria associated with septic peritonitis (**TABLE 3**).

BOX 1

Initiating Causes of SIRS[1,2,6]

- Abdominal disease (e.g., penetrating trauma, pancreatic abscess, hepatic abscess, peritonitis)
- Gastrointestinal disease (e.g., ulceration/perforation from long-term NSAID use, foreign body, gallbladder rupture, parvovirus)
- Surgical site dehiscence
- Cardiac disease (e.g., endocarditis)
- Pulmonary/pleural space disease (e.g., pneumonia, lung abscess, pyothorax)
- Renal disease (e.g., pyelonephritis, cystitis, renal abscess, uroabdomen)
- Reproductive disease (e.g., pyometra, mastitis, prostatitis)
- Soft tissue injuries (e.g., traumatic wounds, burns, osteomyelitis, infectious joint effusions)

DIAGNOSTIC TESTS

Ultrasonography and Abdominal Fluid Sampling

Diagnostics should start with a point-of-care ultrasound (POCUS) to assess for the presence of free fluid in the peritoneal cavity (**FIGURE 2**). POCUS imaging can be performed cageside, is minimally invasive, and provides rapid diagnostic results. If free fluid is identified in the peritoneum, a sample should be collected via abdominocentesis following the 4-quadrant technique. This technique involves restraining the patient in left lateral recumbency, clipping and aseptically preparing the site (6-inch circumference from the umbilicus), and, wearing sterile gloves, inserting four 20- to 18-gauge needles around the umbilicus in the locations shown in **FIGURE 3**.[1] A syringe is used to collect the fluid from the needles and instill it in a red top tube and a lavender top tube (EDTA; BD Vacutainer, bd.com) for microscopic evaluation. In-house cytology can identify the presence of intracellular bacteria, which confirms septic peritonitis (**FIGURE 4**).[1,2,6] If enough abdominal fluid is collected, a sample should be submitted to an outside laboratory service for culture and sensitivity testing.

Lactate and Glucose Measurement

Blood Lactate Concentration

Blood lactate concentration alone is a well-known biomarker of tissue perfusion and prognostic indicator.[1,2] Lactate elevation >2.5 mmol/L is reflective of severe cellular oxygen deficiency.[1,6] Serial measurements of lactate can help in evaluating tissue and oxygen perfusion status.

TABLE 2 SIRS Criteria[2]

CRITERIA	DOGS	CATS
Temperature (°F)	<100 or >104	<100 or >104
Heart rate (beats/min)	>140	<140 or >220
Respiratory rate (breaths/min)	>40	>40
WBC count (WBC x 10^3/µL)	<6 or >19	<5 or >19

WBC=white blood cell; SIRS=systemic inflammatory response syndrome.

GLOSSARY

Distributive shock Ineffective or inappropriate circulation and distribution of blood volume leads to a maldistribution of blood flow,[3] in which vasodilation creates peripheral blood pooling.

Homeostasis A physiologic state of equilibrium.

Hypovolemia Loss of intravascular blood volume.

Multiple organ dysfunction syndrome Clinical syndrome in which physiologic derangements of two or more major organ systems arise from a life-threatening disease process(es) in which normal homeostasis cannot be maintained.[2]

Sepsis Clinical manifestation of life-threatening organ dysfunction caused by a dysregulated host response to infection.[4] Can develop secondary to SIRS.

Septic shock Clinical subset of sepsis in which underlying circulatory and cellular/metabolic abnormalities are profound enough to substantially increase mortality. Results if sepsis is not addressed/corrected.[4]

Systemic inflammatory response syndrome (SIRS) Clinical manifestation of widespread inflammatory response to an infectious or noninfectious insult.[2] Infectious insults can result in sepsis.

Vasodilation Expansion of blood vessels that makes the normal blood volume insufficient, causing blood to be displaced away from the heart and central circulation.

Abdominal Fluid Lactate and Glucose Levels

Septic peritonitis can be diagnosed by comparing abdominal lactate and glucose levels to peripheral lactate and glucose levels (**TABLE 3**).[1,2,6]

A difference of >2.0 mmol/L between peripheral blood lactate and abdominal fluid lactate (with peripheral blood lactate being *lower*) confirms septic peritonitis.[1,2,6] This difference occurs because lactate is a byproduct of anaerobic metabolism and the abdominal cavity is an anaerobic environment; lactate levels will therefore be higher in abdominal fluid than in peripheral blood.[1,3,6]

A difference of >20 mg/dL between peripheral blood glucose and abdominal fluid glucose (with peripheral blood glucose being *higher*) also confirms septic peritonitis. This difference occurs because glucose is an organism's primary energy source; when there are bacteria in the free abdominal fluid, they will consume the available glucose to have energy to proliferate, causing glucose levels to be lower in the abdominal fluid than in peripheral blood.[1,3,6]

Other Diagnostic Tests

Other diagnostic tests that should be included as part of a SIRS/sepsis patient workup are complete blood count (CBC), serum biochemistry panel, clotting times, and blood culture. A CBC will show an elevated white blood cell count in the presence of infection and/or inflammation, as well as thrombocytopenia, indicating a disruption of the coagulation cascade (primary hemostasis). A biochemistry panel will show the severity of renal and hepatic system involvement and hypoglycemia. Clotting times will be prolonged if there is a disruption in the coagulation cascade (secondary hemostasis).

Blood culture allows for specific identification of the infectious pathogen and ensures that antimicrobial therapy is tailored to the patient.[4,8] While human medicine considers blood culture as part of the standard of care for sepsis or suspected sepsis, collection of blood samples for culture is less routinely performed in veterinary medicine. However, studies show that about 50% of critically ill patients have a positive blood culture result.[2]

FIGURE 3. Abdominocentesis using the 4-quadrant technique. The circles indicate locations for needle insertion.

TABLE 3 Septic Peritonitis Criteria[1,2,6]

CRITERIA	PERIPHERAL BLOOD	ABDOMINAL FLUID
Fluid cytology	N/A	Bacteria present
Lactate level	Lower (e.g., 3.4 mmol/L)	Higher (e.g., 12.8 mmol/L)
Glucose level	Higher (e.g., 61 mg/dL)	Lower (e.g., 41 mg/dL)

Blood samples for culture should be collected before starting antimicrobial therapy; however, their collection should not delay or prohibit the administration of antibiotics. If blood samples cannot be collected within 1 hour of the diagnosis of sepsis, they should be forgone.

TREATMENT

Patients with SIRS or sepsis require immediate stabilization and treatment. It is recommended that treatment be centered on fluid resuscitation, antimicrobial therapy, infectious source control, and overall supportive care (e.g., pain control, nutrition).[4] This "bundle of care" is based on the most recent Surviving Sepsis Campaign guidelines (**BOX 3**).

Fluid Resuscitation

Aggressive fluid resuscitation is necessary to restore circulatory status (e.g., provide cardiovascular support, maintain adequate tissue oxygen delivery and perfusion) and maintain hemodynamic stability.[1,2] Septic patients typically have a combination of vasodilation, hypovolemia, dehydration, myocardial dysfunction, and hypotension.[1] As such, the fluid resuscitation options include isotonic crystalloids, hypertonic crystalloids, synthetic colloids, and vasopressor therapy. It is recommended to initiate fluid resuscitation within 3 hours of suspected or confirmed sepsis diagnosis, and to guide fluid resuscitation to target mean arterial pressure (MAP) of >65 mm Hg and normalize blood lactate levels.[4]

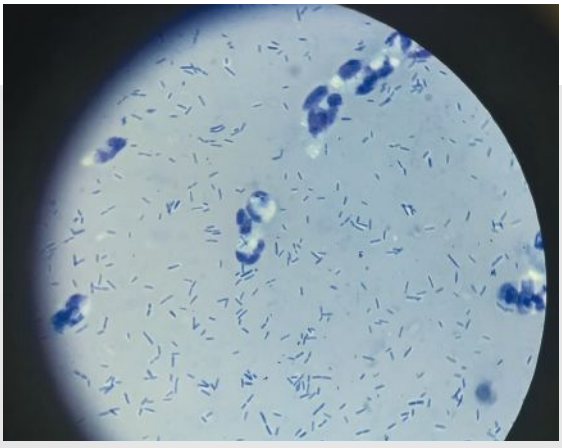

FIGURE 4. Rod bacteria in a sample of abdominal fluid (40×).

Crystalloids

Intravenous (IV) isotonic crystalloids are the mainstay of fluid resuscitation, as their composition is the most similar to that of extracellular fluid. The shock volume of crystalloid solutions is equal to an animal's blood volume; it varies slightly depending on the reference source and species. In dogs, the shock dose of IV crystalloids is 60 to 90 mL/kg. In cats, it is 45 to 60 mL/kg.[1,2]

BOX 3

Surviving Sepsis

The Surviving Sepsis Campaign (SSC) is a global initiative that was launched in 2004 to form consensus guidelines for best practices to reduce the morbidity and mortality of sepsis and sepsis-related clinical syndromes. The guidelines are updated and published every 4 years. The most recent guidelines were published in 2016.

Evidence-based medicine provided by the SSC supports the implementation of a treatment care bundle concept.[4] A "bundle of care" refers to a group of therapies that, when initiated together, produce better results than if initiated alone.[2] Establishing a bundle of care has been shown in human studies to improve patient outcomes (decrease morbidity and mortality) and helps to prioritize and standardize sepsis treatment protocols.[4] For instance, the treatment modalities discussed in this article would ideally be implemented within 6 hours from the diagnosis of SIRS/sepsis.[4]

Administration of IV antibiotic therapy should be initiated as soon as possible (within 1 hour) after suspicion or confirmation of sepsis.[4]

When delivering shock doses of crystalloids, it is generally recommended to start with aliquots, such as one-quarter or one-third the full shock dose, and then reassess the patient. Ideally, shock doses of IV crystalloids should be administered rapidly, over 10 to 15 minutes; it is often necessary to implement a pressure bag rather than the typical fluid pump.

Hypertonic crystalloids have a higher osmolality than normal extracellular fluid.[9] The use of hypertonic solutions allows rapid, small-volume resuscitation for septic patients, as their cardiovascular effect is transient (typically 30 minutes), which can provide enough time for other therapies (e.g., isotonic crystalloid) to take full effect.[2,9] The most commonly used hypertonic crystalloid solution is 7% to 7.5% NaCl. Hypertonic saline is dosed at 3 to 5 mL/kg and given IV over 10 to 15 minutes.[2,6]

Colloids

Synthetic colloid solutions contain large molecules suspended in crystalloid solutions. These large molecules do not cross the blood vessel barrier as readily as smaller ones, thus better sustaining intravascular volume.[9] The most commonly available synthetic colloids are derivatives of hydroxyethyl starches. The use of colloid solutions has recently been called into question, as studies in human medicine have shown a correlation between hydroxyethyl starch use and development of acute kidney injury and coagulopathy.[2] While the Surviving Sepsis Campaign currently recommends colloid use in human patients, the effect in veterinary patients is currently unknown.

BOX 4

Antimicrobial Therapy[2,4]

- **Ampicillin:** 22–40 mg/kg IV q6–8h
- **Ampicillin-sulbactam:** 22–30 mg/kg IV q6–8h
- **Enrofloxacin:** 10–20 mg/kg IV q24h
- **Cefazolin:** 15–35 mg/kg IV q8h
- **Metronidazole:** 15 mg/kg IV q12h

Vasopressor Therapy

If target fluid resuscitation parameters cannot be achieved with crystalloids alone, vasopressor therapy is recommended, with norepinephrine as the first choice.[2,4] Norepinephrine is an α-receptor agonist, which makes it a potent constrictor of arteries and veins.[2,10] Norepinephrine redirects blood flow from the peripheral circulation to the central circulation, causing MAP to increase.[1,6]

Norepinephrine is administered IV as a constant-rate infusion (CRI) and requires more aggressive monitoring of patient perfusion parameters (e.g., heart rate, blood pressure). The dose of norepinephrine ranges from 0.1 to 2 µg/kg/min.[2] Norepinephrine dosing is typically started at the lower end of the range and slowly titrated up based on the patient's response. Alternative vasopressor agents include dopamine, dobutamine, and vasopressin.

Antimicrobial Therapy

Administration of IV antibiotic therapy should be initiated as soon as possible (within 1 hour) after suspicion or confirmation of sepsis.[4] Multiple human studies have shown a correlation with the rapidity of antibiotic administration and mortality rates; each hour antibiotics are delayed is associated with a measurable increase in patient mortality.[4] Antimicrobial therapy should be initiated with a broad-spectrum bactericidal protocol, then narrowed based on pathogen identification.[2,4] Suggested dosages of broad-spectrum antibiotics are summarized in **BOX 4**.

Infectious Source Control

Diagnosing the source of infection is critical to patient outcome because stabilization requires source control. Identifying the source of infection involves either medical or surgical intervention. The source should be eliminated as soon as practically possible.

If surgery is required to address the source of infection (e.g., repair of gastric perforation, placement of a chest tube, wound debridement), specific anesthetic considerations are necessary. Patients with sepsis or septic shock are considered high-risk anesthetic candidates and should be stabilized as much as possible before surgery. Preemptive use of antiemetics decreases the chance of regurgitation and subsequent aspiration pneumonia. Preanesthetic agents considered to be relatively safe include opioids (e.g. fentanyl) and benzodiazepines (e.g. diazepam, midazolam).[1]

Ketamine and alfaxalone are preferred as induction agents owing to their cardiopulmonary-sparing effects; propofol and etomidate should be avoided.[1] Sevoflurane is preferred to isoflurane based on its more desirable effects on the pulmonary and immune systems.[1] Depending on the severity of sepsis, the patient may need to be anesthetically ventilated in addition to diligent anesthetic monitoring.[1]

Pain Management

Unidentified, untreated pain leads to greater morbidity and mortality; therefore, evaluation of patient pain is important, and analgesics should be considered in any patient experiencing pain.[2,3,8] Additionally, untreated pain masks clinical signs, contrary to the common belief that analgesics mask clinical signs.[1,6]

Sepsis/SIRS can be painful disease processes, and therefore pain assessment and control need to be part of the treatment and nursing care. The use of a standardized, objective pain scoring system can help document pain assessment and minimize subjective differences between staff members. Various scales exist, and different practices may find different ones suitable to their staff and patients. In the author's experience, Colorado State University's canine[a] and feline[b] acute pain scales are effective tools.

Opioids are the most effective class of analgesics and are often the first-line drugs used to provide pain relief. Opioids limit the perception of pain by affecting different receptors within the brain, spinal cord, and peripheral nerves.[1,6]

Nutrition

Nutrition is often overlooked as part of care for septic patients. However, nutritional support is necessary for recovery from all disease processes and should be instituted for every patient. Enteral nutrition is preferred as the most physiologically appropriate method of feeding, and early initiation helps maintain GI mucosa, prevent bacterial translocation from the gut, maintain glycemic control, and increase wound healing and the immune response.[1,4,6]

For septic patients, enteral nutrition is most readily provided via feeding tubes (e.g., nasoesophageal, nasogastric, esophagostomy). Pharmacologic support to protect the GI system and relieve GI discomfort in patients with septic peritonitis includes the use of antiemetics (e.g., maropitant, ondansetron), gastroprotectants (e.g., famotidine, pantoprazole), and prokinetics (e.g., metoclopramide).

BOX 5

Kirby's Rule of 20[2,3,8]

- Fluid balance
- Albumin/oncotic pull
- Mentation/level of consciousness
- Heart rate/contractility/rhythm
- Blood pressure/perfusion
- Oxygenation and ventilation
- Body temperature
- Electrolytes and acid–base
- Glucose
- Renal function
- Gastrointestinal motility and integrity
- Nutrition
- Immune status (antibiotics)
- Drug dosage and metabolism
- Pain control
- Wound care and bandages
- Nursing care
- Tender loving care
- Coagulation
- Red blood cells and hemoglobin

[a] csu-cvmbs.colostate.edu/documents/anesthesia-pain-management-pain-score-canine.pdf
[b] csu-cvmbs.colostate.edu/documents/anesthesia-pain-management-pain-score-feline.pdf

NURSING CARE

The importance of the veterinary nurse's role in caring for these critically ill patients cannot be overstated. SIRS/sepsis patients require intensive, dedicated nursing care and close monitoring during the recognition, stabilization, and hospitalization periods. Kirby's Rule of 20 (**BOX 5**), a checklist of 20 vital parameters that should be evaluated daily in critically ill patients, helps ensure monitoring of essential parameters. Septic patients require multiple fluid types and drugs to be administered, and knowledge of pharmacology, drug/fluid interactions, and medical math calculations is required.

Patient Handling

Special care is paramount when handling patients with either suspected or confirmed sepsis. Proper handling includes wearing examination gloves during every patient interaction, changing gloves frequently, and performing frequent handwashing.[8] Examination gloves should also be worn during any "tube" handling (peripheral IV catheter, central IV catheter, arterial catheter, feeding tube, urinary catheter, chest tube, Jackson-Pratt drain). When medications are administered or patients are disconnected from or reconnected to fluid lines, ports should be disinfected with a 70% isopropyl alcohol swab.

Patient Monitoring

Patient monitoring includes assessment of vital signs every 2 to 10 minutes during initial stabilization and every 1 to 4 hours during hospitalization. It is common for SIRS/sepsis patients to require continuous electrocardiography monitoring and frequent blood pressure measurement. For patients with respiratory system compromise, oxygen therapy and monitoring of additional respiratory parameters (e.g., respiratory effort, SpO_2, arterial blood gas) may be indicated. A line on the treatment sheet for recording a Modified Glasgow Coma Scale score (**glasgowcomascale.org**) can be used to evaluate neurologic status.

Urinary catheters require care every 6 to 8 hours to prevent a secondary infection. Feeding tubes require daily maintenance to ensure patency. In patients with disseminated intravascular coagulation, blood component therapy with fresh frozen plasma may be indicated and require a transfusion with frequent monitoring. Postoperative patients may have wound drains that need to be quantified and maintained.

Pain scoring should be included on the treatment sheet to ensure pain is being regularly evaluated and the pain management plan adjusted accordingly.

Patient Comfort

Lastly, veterinary nurses should ensure patient comfort. Providing soft/plush kennel bedding, physical therapy for recumbent patients, supportive walks for weak patients, and appropriate lighting to allow for rest; bundling treatment orders together (once stabilized); facilitating owner visits; and providing loving care are important in caring for these patients.

CONCLUSION

SIRS and sepsis patients represent some of the most severely critically ill veterinary patients. Being able to understand the pathophysiology of the clinical syndrome, recognize clinical signs, perform diagnostic testing, and implement emergent treatment therapies is crucial to identifying SIRS/sepsis and caring for these patients. Following evidence-based medicine and implementing patient care bundles can greatly reduce patient morbidity and mortality, and providing supportive, diligent nursing care is essential in promoting a positive outcome. **TVN**

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CONTINUING EDUCATION

Recognizing, Treating, and Monitoring Systemic Inflammatory Response Syndrome and Sepsis

TOPIC OVERVIEW

Systemic inflammatory response syndrome and sepsis are interrelated, life-threatening emergencies that affect critically ill patients. Each disease is a clinical syndrome that requires early recognition, prompt emergency treatment, and diligent nursing care and monitoring to give the patient the best chance of a positive outcome.

LEARNING OBJECTIVES

After reading this article, participants should be able to define systemic inflammatory response syndrome (SIRS) and sepsis; understand their pathophysiology; recognize the clinical signs, causes, and diagnostic criteria; and learn what treatment interventions and nursing care should be provided to a SIRS/septic patient.

The article you have read has been submitted for **RACE approval for 1 hour of continuing education credit** and will be opened for enrollment when approval has been received. To receive credit, take the approved test online for free at **vetfolio.com/journal-ce**. Free registration on **VetFolio.com** is required. Questions and answers online may differ from those below. Tests are valid for 2 years from the date of approval.

1. **The cause of SIRS can be infectious or noninfectious.**
   True
   False

2. **Which of the following is not a major homeostatic change of sepsis?**
   a. Dysregulated coagulation system
   b. Dysregulated inflammatory system
   c. Endothelial cell injury
   d. Increased vasomotor tone

3. **Which of the following is not a common clinical sign for SIRS/sepsis?**
   a. Vomiting/diarrhea
   b. Lethargy
   c. Hyporexia
   d. Hypothermia

4. **What is the most common cause of sepsis in veterinary patients?**
   a. Pancreatitis
   b. Pyometra
   c. Peritonitis
   d. Pyelonephritis

5. **Which of the following is not a diagnostic criterion for SIRS?**
   a. Tachycardia
   b. Hypoventilation
   c. Elevated white blood cell count
   d. Fever

6. **What are the 2 most important diagnostic tests for septic peritonitis?**
   a. Lactate and blood pressure measurement
   b. Lactate and glucose measurement
   c. Glucose and ECG measurement
   d. Blood pressure measurement and POCUS assessment

7. **Which of the following is the first-choice vasopressor agent?**
   a. Dobutamine
   b. Dopamine
   c. Norepinephrine
   d. Vasopressin

8. **According to the Surviving Sepsis Campaign guidelines, antimicrobial therapy should be administered within _____ of diagnosis of sepsis.**
   a. 1 hour
   b. 2 hours
   c. 4 hours
   d. 6 hours

9. **Which of the following statements is false regarding treatment care bundles?**
   a. The use of treatment care bundles has been shown to improve patient outcomes.
   b. "Treatment care bundle" refers to a group of therapies that, when initiated together, produce better results than when used alone.
   c. Treatment care bundles group treatment costs.
   d. Using treatment care bundles helps prioritize and standardize treatment protocols.

10. **What is the mortality rate for SIRS/sepsis?**
    a. 20% to 50%
    b. 40% to 70%
    c. 60% to 90%
    d. 80% to 90%