EMERGENCY MEDICINE/CRITICAL CARE

Treatment of Sepsis

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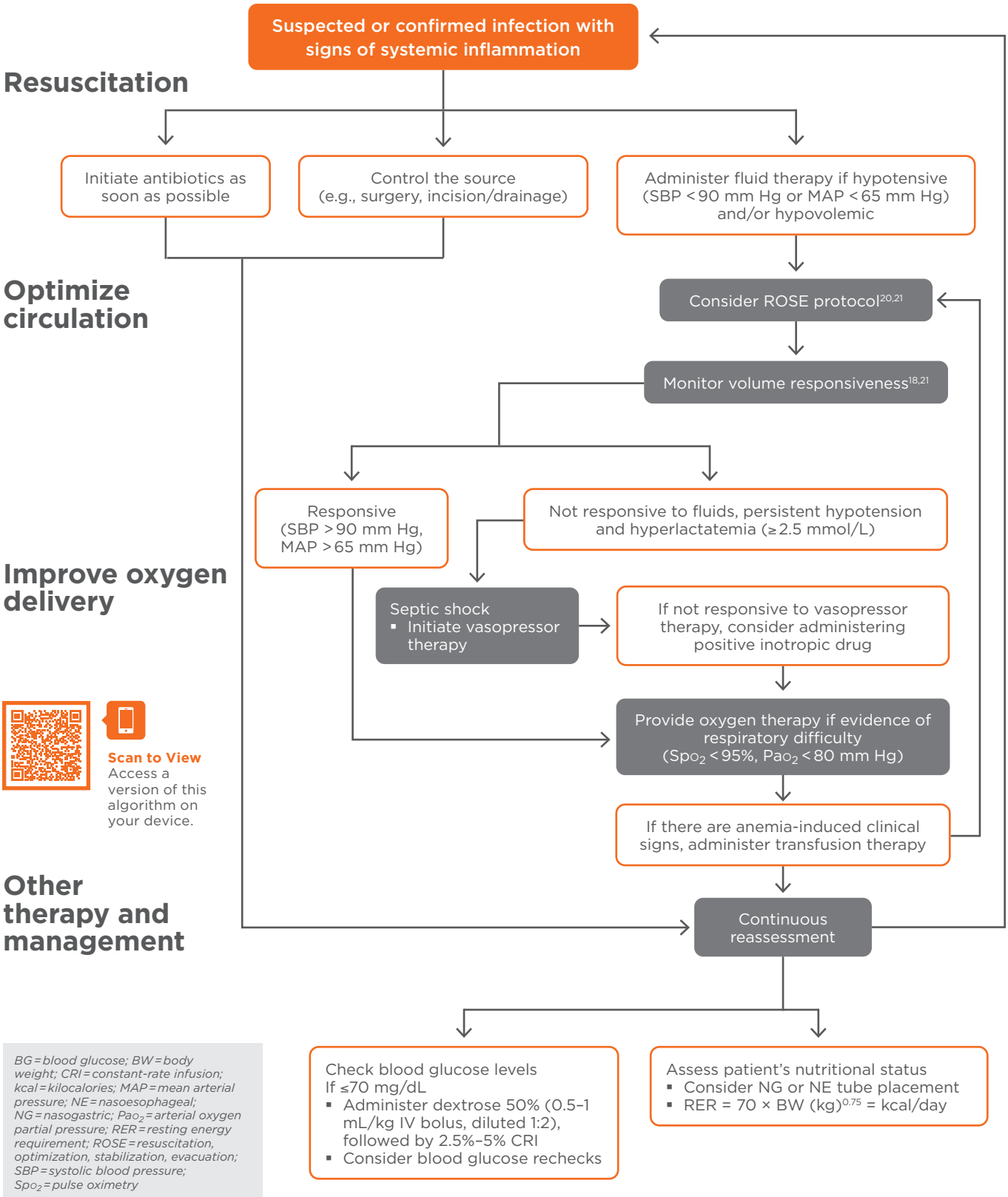
Sepsis is a leading cause of death in veterinary patients.[1,2] It is defined as a life-threatening organ dysfunction caused by a dysregulated host response to infection.[3,4] Untreated patients progress to septic shock, a subset of sepsis in which underlying circulatory, cellular, and metabolic functions are severely compromised, leading to high mortality rates.[1,2,5] Persistent hypotension and hyperlactatemia are the hallmarks of septic shock.[6,7]

In dogs and cats, sepsis is diagnosed by using the SIRS (systemic inflammatory response syndrome) criteria in a patient that has a diagnosed or suspected underlying infection.[4,8-10] However, the specificity of this diagnostic approach is low, favoring delayed diagnosis and treatment and therefore resulting in poorer outcomes.[8-11] Other scoring systems have been proved to be more accurate in diagnosing sepsis in humans, but similar findings are lacking in dogs and cats.[12,13] The elevated costs of treatment, the necessity for well-trained healthcare personnel, and the emergence of multidrug-resistant bacteria also contribute to the observed high mortality rates of sepsis in small animals.

Despite extensive research efforts, sepsis treatment remains primarily supportive.[3,14] It is well established, particularly in humans, that early and optimal treatment including antimicrobial and fluid therapy, coupled with close patient monitoring, significantly improves survival.[15-19] While fluid therapy and antimicrobials serve as cornerstones in sepsis treatment, myriad other drugs and approaches are often required.[3]

This algorithm for the treatment of sepsis in dogs and cats is aimed at management. It is important to note that the management of sepsis may vary based on individual patient factors and the specific clinical scenario. A companion checklist to be used alongside this algorithm has also been provided (see **BOX 1**).

BOX 1
Scan the QR code or turn to page 93 to access a checklist that is intended to be used in the clinic as a companion to this algorithm. It features additional details, clinical considerations, and space to record individual patient data.



Scan to View
Access a version of this algorithm on your device.

BG = blood glucose; BW = body weight; CRI = constant-rate infusion; kcal = kilocalories; MAP = mean arterial pressure; NE = nasoesophageal; NG = nasogastric; Pao_2 = arterial oxygen partial pressure; RER = resting energy requirement; ROSE = resuscitation, optimization, stabilization, evacuation; SBP = systolic blood pressure; Spo_2 = pulse oximetry

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CLINIC RESOURCE

Sepsis Examination and Treatment Checklist

1 Diagnosis

Systemic Inflammatory Response Syndrome (SIRS)

Diagnostic criteria	Dogs (2/4 changes required)	Cats (3/4 changes required)
Temperature	<38.1 °C (100.6 °F) or >39.2 °C (102.6 °F)	<37.8 °C (100 °F) or >40 °C (104 °F)
Heart rate (beats/min)	>120	<140 or >225
Respiratory rate (breaths/min)	>20	>40
White blood cells (×10^3/µL); % bands	<6 or >16; >3%	<5 or >19; >5%

Infection?

- ☐ Suspected
- ☐ Documented (source: _____)

Time of presentation: _____

2 Resuscitation

Early antibiotics

- ☐ Cultures: blood (×2), urine, site specific
- ☐ Broad-spectrum antibiotics (IV; **see step 5**)

Drug(s): _____

Time: _____

Fluid therapy

Balanced crystalloid bolus(es) (5–20 mL/kg over 5–15 min)

- ☐ Lactated Ringer's solution
- ☐ Normosol-R, Plasma-Lyte A or PhyLyte

Source control

- ☐ Surgery, incision/drainage, other

Monitor

- ☐ ABCs
- ☐ Airway protection
- ☐ IV access
- ☐ Blood pressure
- ☐ SpO_2
- ☐ ECG
- ☐ POCUS

Laboratory tests

- ☐ CBC
- ☐ Serum biochemistry profile
- ☐ Urinalysis
- ☐ Effusion
  - ☐ Cytology
  - ☐ Lactate
  - ☐ Glucose
- ☐ Coagulation
- ☐ Blood typing

3 Optimize circulation

Assess volume status

- ☐ Euvolemic
- ☐ Hypovolemic
  - ☐ Mental status
  - ☐ CRT
  - ☐ Pulse quality
  - ☐ SBP/MAP
  - ☐ Lactate
  - ☐ CVC_d[1-3]
- ☐ Hypervolemic (edema/cavitary effusion)

→ Yes →

Monitor volume responsiveness

- ☐ Post–fluid resuscitation improvement?
  - ☐ Mental status
  - ☐ MM color
  - ☐ CRT
  - ☐ Pulse rate
  - ☐ SBP/MAP
  - ☐ POCUS[1-3]

→ No →

Septic shock

- ☐ MAP ≤65 mm Hg
- ☐ Hyperlactatemia (>2.5 mmol/L)

Vasopressors*

- ☐ **1.** Norepinephrine (0.05–1 µg/kg/min IV) *or* dopamine** (5–20 µg/kg/min IV) ± vasopressin
- ☐ **2.** Vasopressin (0.5–5 mU/kg/min IV)
- ☐ **3.** Epinephrine*** (0.05–1 µg/kg/min IV)

**Dilute as recommended*
***If norepinephrine is unavailable*
****Use as sole agent if unresponsive to other vasopressors*

4 Improve oxygen delivery

Bedside echocardiography

Hypodynamic heart?

- ☐ LV dimensions and volume
- ☐ Fractional shortening (≤20% to 35%)
- ☐ LV ejection fraction (≤40%)

→ Yes →

Positive inotrope

- ☐ Dogs: Dobutamine (5–20 µg/kg/min CRI)
- ☐ Cats: Dobutamine (≤5 µg/kg/min)

If in respiratory distress (Spo_2 <95%, Pao_2 <80 mm Hg), administer oxygen therapy

- ☐ Flow-by oxygen
- ☐ Oxygen cage
- ☐ Nasal cannula (unilateral/bilateral)
- ☐ High-flow oxygen
- ☐ Positive-pressure ventilation

→

Persistent hemodynamic instability ± hypoxemia?

Lung-protective ventilation

- ☐ Low tidal volume (6–8 mL/kg)
- ☐ Minimal PEEP of 5 mm Hg
- ☐ Permissive hypercapnia (Pao_2 ≤60 mm Hg)

If MAP is <65 mm Hg, perform bedside ECG

Ventricular tachycardia?

- ☐ **1.** Lidocaine IV bolus (maximum of 3 boluses) Bolus: 2 mg/kg (dogs) *or* 0.25–0.5 mg/kg (cats)
- ☐ **2.** If responsive, administer lidocaine CRI (50–70 µg/kg/min IV)

→

Requires electrolyte/acid–base correction?

- ☐ Ca^{+2}
- ☐ K^+
- ☐ Mg^{+2}
- ☐ H^+/HCO_3^-

If there are anemia-induced clinical signs, administer transfusion therapy

- ☐ pRBCs (10–20 mL/kg), fresh bags preferable

5 Other therapy and management

Imaging

- ☐ Radiography (chest, abdomen, other)
- ☐ Abdominal ultrasonography
- ☐ Computed tomography (region:_____)

Additional medication

- ☐ Adequate analgesia (if needed)
- ☐ Antiemetics and/or prokinetics
- ☐ Other patient-specific drugs

If in refractory shock/CIRCI[4]

- ☐ Hydrocortisone (0.3–0.5 mg/kg/hr IV or CRI *or* 2–4 mg/kg IV q6h)
- ☐ Dexamethasone-SP (0.1 mg/kg IV once followed by 0.05 mg/kg IV q12–24h)

Empiric IV broad-spectrum antibiotic protocols[a]

- **Ampicillin/sulbactam + enrofloxacin:** 50 mg/kg q6–8h ampicillin/sulbactam + 5 mg/kg (cats) *or* 20 mg/kg (dogs) q24h enrofloxacin
- **Ceftazidime:** 50 mg/kg q6–8h *or* 4.4 mg/kg once followed by 4.1 mg/kg/h
- **Cefotaxime:** 50 mg/kg q6–8h *or* 3.2 mg/kg once followed by 5 mg/kg/h
- **Clindamycin + enrofloxacin:** 10 mg/kg q8–12h clindamycin + 5 mg/kg (cats) *or* 20 mg/kg (dogs) q24h enrofloxacin
- **Ampicillin/sulbactam + amikacin:** 50 mg/kg q6–8h ampicillin/sulbactam + 15 mg/kg q24h amikacin
- **Clindamycin + amikacin:** 10 mg/kg q6–8h clindamycin + 15 mg/kg q24h amikacin
- **Meropenem[b]:** 12 mg/kg q8h
- **Vancomycin[b]:** 15 mg/kg q6h

[a]De-escalate antimicrobial therapy according to culture results.
[b]Administer after culture results and/or pharmacist recommendation.

Definitions:
ABCs = airway, breathing, and circulation; CBC = complete blood count; CIRCI = critical illness–related corticosteroid insufficiency; CRI = constant-rate infusion; CRT = capillary refill time; CVC_d = caudal vena cava diameter; ECG = electrocardiography; LV = left ventricle; MAP = mean arterial pressure; MM = mucous membrane; $Paco_2$ = arterial partial pressure of carbon dioxide; PEEP = positive end-expiratory pressure; POCUS = point-of-care ultrasound; pRBCs = packed red blood cells; SBP = systolic blood pressure; Spo_2 = pulse oximetry.

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