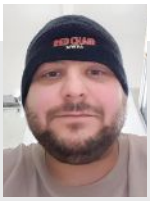
TIME IS OF THE ESSENCE
Timely identification of critical patients and stabilization for transfer to an emergency facility are essential to ensure positive outcomes.

Goldfish Studio/shutterstock.com

EMERGENCY MEDICINE/CRITICAL CARE

Stabilizing the Critically Ill Patient



MEET THE AUTHOR

***Karl R. Alon**, AS, RVT, VTS (ECC)*
Carrington College
San Jose, Calif.

Karl has been a veterinary technician for almost 14 years, during which he has worked exclusively in veterinary emergency medicine, both in extended-hour general practices offering emergency care and state-of-the-art multispecialty referral practices. Karl obtained his RVT certification in 2013, after working as an unlicensed veterinary assistant for 6 years, and his VTS certification in 2017. His areas of interest include acid-base derangements, electrolyte abnormalities, trauma, and technician training. He is currently a veterinary technician instructor. He has lectured many times at local continuing education events in California, as well as large international veterinary conferences such as IVECCS.

Critically ill patients may present to a general practice at any time and require rapid identification and treatment to be stabilized. Often, these patients are difficult to identify, as some animals are stoic and do not show illness, pain, or weakness until their condition nearly consumes them. The ability to rapidly identify critically ill patients comes from knowledge of physical and physiological markers as well as a complete patient history. These markers help guide the veterinary team to a cause and help the veterinarian choose appropriate treatment options, including the decision to transfer the patient if necessary.

IDENTIFYING THE CRITICALLY ILL PATIENT

Whenever a patient presents to a veterinary professional, it is the responsibility of that team member to perform basic triage at a minimum. Triage, a French word meaning "to choose, pick out, or separate from others," is the skill of assessing the patient on presentation and determining if it is at much higher risk for immediate death than other patients that may have arrived earlier.

Initial Observation and Assessment

Although triage takes time to learn and master, certain signs affecting the respiratory, cardiovascular, and neurologic systems are readily identifiable. Initial triage, based on gross visualization of the patient, takes these signs into account. The vital signs and physical markers

listed in **BOX 1** are also of immediate value in identifying critically ill patients.

Patients that present in respiratory distress often have abdominal respiratory effort and may present with their head and neck stretched out. Cardiovascular patients are often collapsed and have a dull to obtunded mentation; pale gums; and poor, thready pulses. Neurologic patients can present like both respiratory and cardiovascular patients, often with dull mentation or in status epilepticus (actively seizing). A patient that presents laterally recumbent with a dull to nonresponsive mentation should be considered the most critical and requires immediate intervention, including a brief history from the owner and immediate clinician attention.

BOX 1

Physical Markers of Critical Illness[1,2]

- **Mentation:** May range from quiet and not acting as usual (per owner), to dull, depressed, obtunded, stuporous, or comatose.
- **Heart rate:** Typically elevated in both dogs and cats at the beginning of most critical illnesses (may also be stress related from being in the hospital). May drop and become bradycardic as disease progresses.
- **Respiratory rate:** Typically elevated in both dogs and cats at the beginning of most critical illnesses (may also be stress related from being in the hospital). Respiratory rhythm may become abnormal with certain diseases. Knowing normal versus abnormal is often enough to identify a critically ill patient.
- **Temperature:** May vary depending on disease process. Often elevated (hyperthermia) due to true fever (often pathogen related), physical or environmental factors (e.g., brachycephaly, heatstroke), or inflammation. Can be low (hypothermia) due to metabolic diseases, environmental factors, or cardiac disease.
- **Capillary refill time:** Can be prolonged (>2 seconds) or extremely rapid (<1 second); either may represent a disease process affecting the circulatory system.
- **Mucous membrane color:** Can range from pink (normal, healthy) to deep/brick red (often associated with systemic disease and inflammation), pale (anemia, shock), yellow (icterus), blue (cyanosis), or muddy brown (shock).

Patient History

When a patient presents with signs of illness that do not fall under the listed markers of critical illness, a complete and thorough history should be obtained from the owner. Often, taking the history can be accomplished while the patient's vitals are being obtained, allowing the veterinary professional to listen to the owner's concerns while simultaneously obtaining physical, objective data that may assist in completing the "whole story."

Including the owner in the discovery of any physical disease identifiers is an important, and often valuable, part of discussing the patient's presenting complaint. For example, if a patient's breathing or gum color is abnormal, the veterinary nurse can ask the owner if they have noticed this type of derangement before. Such information can help differentiate patients that may be scared/nervous in the hospital (elevated heart rate, respiratory rate, etc.) from patients that may be ill and needing intervention. In addition, while the patient's vital signs may not be immediately alarming, the veterinary professional may garner information during the patient history that could raise concern, such as the pet not eating for multiple days, or having vomiting or diarrhea.

Once the physical markers of critical illness (**BOX 1**) have been assessed, both the veterinary nurse and the clinician performing the patient examination will have more details with which to work in identifying the patient's potential health conditions. The clinician may be able to narrow the differential diagnosis and can have a more detailed conversation with the owner, indicating which parameters are of concern and requesting authorization of further tests, such as those listed in **BOX 2**. These tests, which provide more objective, numeric results, may yield a much more specific answer.

PRIMARY INTERVENTIONAL THERAPIES

Oxygen Therapy

The stabilization of critically ill patients can be challenging and requires a full collaborative effort by the veterinary team. Oxygen therapy should be the first

step. Oxygen therapy is always beneficial for critically ill patients because it increases the fraction of inspired oxygen (FiO_2), thereby increasing the amount of oxygen that is available for cells to use and thus helping prevent anaerobic respiration and the progression of shock.[3] Lack of oxygen distribution to tissues is the definition of shock.[1]

Anaerobic respiration—a metabolic process that occurs in the absence of oxygen molecules—produces much less adenosine 5′-triphosphate (ATP) than does aerobic respiration. ATP is the primary energy source for cells,[4] and as the availability of ATP decreases, cells start to shut down and die. Should enough cells die, tissue becomes nonviable and begins to necrose, compounding the critical condition until the patient starts to develop organ dysfunction.

Oxygen therapy can be administered successfully in multiple ways. Flow-by oxygen uses the oxygen flow of an anesthetic machine with the hose placed to the patient's face. Although it is not the most accurate form of administering oxygen, flow-by is effective and should be used until a more appropriate method is available. When administering flow-by oxygen, it can be beneficial to attempt to use an oxygen mask—for example, creating a cone around the patient's muzzle/face—thereby facilitating a more direct flow of oxygen to the patient. However, some patients will not tolerate a mask and should not be stressed by placing one.

An oxygen chamber can be extremely useful for stressed or aggressive patients by allowing the veterinary team to control the FiO_2 without handling the patient. The patient is placed inside a sealed chamber, which is then filled with a higher-than-normal FiO_2 (commonly 40%, doubling the normal atmospheric FiO_2 of 20.9%; however, a higher FiO_2 can be used if necessary). Often, adjunct therapy such as intramuscular sedation goes hand in hand with oxygen chamber therapy.

Catheter Placement

After oxygen therapy, the placement of a catheter for immediate systemic access should be the next step in the stabilization of critical patients. Intravenous (IV) catheter placement is the most common and direct route. IV catheterization is also the most rapid way to administer fluids and medications.[5] When placing IV catheters in critically ill patients, it is extremely important to shave the entire insertion site of all hair all the way around the limb to limit the risk of infection at the site. Catheters should be checked frequently and should be replaced at the first sign of phlebitis, inflammation, or extravasation.

Peripheral IV access in a critically ill patient is often difficult and may even prove impossible. When choosing to place a peripheral catheter, the patient's size, need, and hydration status are all factors in choosing the catheter size. Smaller patients may require a smaller-bore catheter to fit their vessels, as may dehydrated patients. In severely dehydrated patients the

BOX 2

Physiological Findings Associated With Critical Illness[1,2]

- **Biochemical markers:** Typical concern arises from increased values, most commonly renal and hepatic in origin.
- **Complete blood count (CBC):** Both increased and decreased erythrocyte, leukocyte, and/or thrombocyte values can be indicators of concerning disease.
- **Lactate:** Increased lactate is a good indicator of lack of oxygen delivery to tissue. A lactatometer may be used to measure lactate immediately and with little blood. In conjunction with other values (i.e., glucose, packed cell volume/total solids), lactate can assist the clinician in identifying patients that may need immediate intervention and may be sicker than initially considered, including patients that may be in shock.
- **Blood glucose:** Both increased and decreased blood glucose values can be indicators of critical illness. Low blood glucose (hypoglycemia) can lead to seizure-like episodes and activity and must be addressed immediately. Seizures are uncommon with high blood glucose (hyperglycemia).
- **Packed cell volume/total solids (PCV/TS):** The PCV gives the clinician insight into the patient's red blood cell count. Both low and high PCV are important. The TS allows identification of patients that may be dehydrated or hypovolemic.
- **Blood gases and electrolytes:** These values are often obtained in conjunction with biochemistry and the CBC. Blood gas measurement gives an excellent picture of whether gas exchange in the lungs is adequate, as well as at a vascular level. Increases and decreases in electrolytes give insight into the function of numerous body systems.

Aside from the physical difficulty of placing IO catheters, risks involved include bone fractures, extravasation of fluids into the surrounding tissue, and infection (IO catheters should never be placed through infected skin).

peripheral vasculature may collapse, making larger catheters more difficult to place even in larger patients. Smaller-bore catheters placed in such patients must be monitored closely. Larger patients receiving a larger volume of fluids at a higher rate through a smaller-bore catheter can experience a catheter "blow" due to the inability of the catheter to bear the stress of the patient's needs.

Placement of a jugular catheter can also be considered in critical patients. Although more technically challenging than a peripheral catheter, jugular catheterization provides the veterinary team with immediate venous access, allowing the administration of drug therapy. Like other IV catheters, jugular catheters are not benign, posing risks that include exsanguination and thrombosis, depending on the patient's possible disease process.

In lieu of IV therapy, the second most rapid form of infusion is intraosseous (IO) catheterization.[6] Both IV and IO catheterization can prove extremely difficult in critically ill patients, requiring an elevated level of technical skill. IO catheterization also requires a certain level of physical strength (IO catheters may be placed with a specialized electric drill, decreasing the need for physical strength but requiring knowledge of the tool's operation and use). IO catheters are most commonly placed in neonates.

Locations for placement of IO catheters vary. In dogs and cats, the most common sites are the greater tubercle of the humerus and the trochanteric fossa of the femur. In larger dogs, the flat medial surface of the proximal tibia, the tibial tuberosity, the wing of the ileum, and the ischium can also be used.[7] Aside from the physical difficulty of placing IO catheters, risks involved include bone fractures, extravasation of fluids into the surrounding tissue, and infection (IO catheters should never be placed through infected skin).

If both IV and IO access are unachievable, the patient should be considered for rapid transfer to a critical care facility. Without the ability to provide systemic intervention, there is often little else that can be done to assist the patient. Subcutaneous therapy in critically ill patients is often ineffective, as these patients have poor peripheral blood flow, which means that many drugs (including isotonic crystalloids) will be poorly absorbed from the subcutaneous layer, offering little help in correcting systemic derangements.[5] Rapid transfer to a critical care facility will be the best care offered in this scenario, ensuring the patient receives the therapy it requires as quickly as possible.

Fluid Resuscitative Therapy

IV fluids are one of the most common therapies offered

BOX 3

Dehydration and Maintenance Fluid Calculations

Dehydration deficit[8]
Body weight (kg) × % dehydration as a decimal = liters of fluid required to correct dehydration

Maintenance Fluid Requirement (Dog)[9]
Body weight $(kg)^{0.75} \times 132$ = 24-hour fluid requirement in mL

Maintenance Fluid Requirement (Cat)[9]
Body weight $(kg)^{0.75} \times 80$ = 24-hour fluid requirement in mL

at veterinary practices and can provide great assistance to a wide range of patients. They are not, however, without risk and should be used with the same care and understanding as any other medication. A complete discussion of fluid therapy is beyond the scope of this article; interested readers are encouraged to consult the **RECOMMENDED READINGS** for more details.

The most common types of IV fluids contain balanced electrolytes, mimicking physiologic conditions. However, many different types of fluids exist within 2 main categories: crystalloids, which can contain different ratios of buffer solutions and electrolytes, and colloids, both synthetic and natural, with larger molecules that allow them to stay in the patient's vasculature for longer periods of time than crystalloids.

When discussing fluid resuscitative therapy for critically ill veterinary patients, it is important to understand why fluids are being given as well as the positive and negative effects they may have on the patient's wellbeing. Fluids are typically given to patients that have one of the following fluid disturbances:

1. Decrease in volume (e.g., dehydration, blood loss).

Fluid loss from the vasculature resulting in dehydration can have myriad causes, but all dehydrated patients require IV fluids or blood products to help replace this loss. Often, these patients are not physically altered and require further assessment to determine their degree of dehydration; however, patients that are critically ill due to dehydration frequently have prolonged skin turgor, dry and tacky gums, and potentially sunken eyes. These subjective clinical signs can help the veterinary nurse and the clinician make a gross assessment of hydration status. Objective measurements (i.e., packed cell volume/total solids [PCV/TS]) can help confirm dehydration.

Critically ill dehydrated patients may benefit from a rapid bolus infusion of fluids, followed by a slower infusion of fluids until the dehydration and, potentially, the underlying disease process are corrected. The veterinarian can calculate, using the equations in **BOX 3**, the amount of fluid necessary to correct the hydration deficit, typically over 24 hours, followed by the patient's maintenance rate of fluids while hospitalized.

Patients that are hypovolemic due to blood loss are often critical and require immediate fluid therapy with crystalloids to help maintain normal physiologic functions. Although these fluids contain electrolytes, they do not replace the cellular blood components, and these patients often require blood product transfusion at a critical care facility.

2. Change in composition (e.g., hypokalemia).

TABLE 1 lists some commonly available fluids that can be used when blood work reveals a change in body fluid composition. Such patients are usually also dehydrated, and specific changes usually depend on the initial reason for dehydration. For example, hypokalemia is often associated with loss of potassium during fluid loss from gastrointestinal (GI) disturbances (e.g., vomiting, diarrhea). In these patients, the clinician can choose a fluid that will provide potassium as well as help replace overall fluid loss.

3. Change in distribution (e.g., pleural effusion).[9]

These disturbances are typically noticed on physical examination, although some may not be definitively recognized until diagnostic tests are performed. These patients are not dehydrated, as they have the appropriate amount of fluid in their body, but they are hypovolemic because the fluid is within body cavities and not in the vasculature where it belongs. Changes in fluid distribution almost always have an underlying disease process as the cause.

Providing these patients with IV fluids is imperative, as is the removal of the displaced fluid. However, without treatment of the underlying cause, IV fluids often also become maldistributed, exacerbating the patient's illness. These patients are often critical and require transfer to a critical care facility.

SECONDARY INTERVENTIONAL THERAPIES

If systemic access is obtained, the veterinarian will determine what intervention will provide the most benefit to the patient with the least risk. Although a definitive diagnosis may not be available or even possible during triage, the information gathered by the veterinary nurse at this stage (e.g., recognizing the presence of a heart murmur) may help guide the veterinarian toward a tentative diagnosis that will allow them to make informed decisions about interventional therapies such as drugs for stabilization and

TABLE 1 Composition of Common Veterinary Crystalloid Fluids[8]

FLUID TYPE	COMPONENT						BUFFER(S)
	PH	SODIUM (MEQ/L)	CHLORIDE (MEQ/L)	POTASSIUM (MEQ/L)	MAGNESIUM (MEQ/L)	CALCIUM (MEQ/L)	
0.9% Saline	5.5	154	154	0	0	0	None
Plasmalyte A	7.4	140	98	5	3	0	Acetate (27 mEq/L) Gluconate (23 mEq/L)
Plasmalyte 56	5	40	40	13	3	0	None
Normosol-R	7.4	140	98	5	3	0	Acetate (27 mEq/L) Gluconate (23 mEq/L)
Normosol-M	5	40	40	13	3	363	Acetate (16 mEq/L)
Lactated Ringer's solution	6.5	130	109	4	0	2.7	Lactate (28 mEq/L)

intervention. Transfer to a critical care facility may be considered for stabilized patients.

Analgesic Therapy

In general, the use of analgesic therapy is imperative in ill patients to benefit their health and wellbeing. In the past, analgesic therapy was often withheld from critically ill patients out of concern for the patient's mentation or cardiovascular stability. Research into pain in both human and veterinary medicine has since shown that pain has a negative impact on patient healing and physiologic parameters and that pain management provides positive relief.[10] Although pain management is often indicated in critically ill patients, determining which type of pain medication to administer can still be difficult.

The current understanding of pain is that it is a symptom of a disease process, not its own ailment. Typically, pain is broken down into 4 different types: acute, chronic, cancer, and neuropathic.[11] Cats and dogs experiencing pain may express it in several ways, ranging from more subtle body language (e.g., lethargy, hiding) to more overt, apparently aggressive behavior (e.g., biting, scratching, hissing, growling). If pain is suspected, analgesic therapy must be used to help differentiate which of the patient's signs are pain related and which are related to illness.

Analgesic therapy for the critically ill patient most commonly uses drugs that interact with μ-opioid receptors in the body, known as μ-opioid agonists. Pure μ agonists are members of the opioid family and are excellent options for pain management in critically ill patients for multiple reasons, the primary reason being that they are completely reversable in the event of an adverse reaction. However, these drugs require additional licensing and security, and general practitioners may not desire to keep them on the premises. Other controlled substances, such as ketamine and buprenorphine, although not pure μ agonists, may provide adequate pain relief until the patient is able to be transferred to a facility that carries drugs of higher potency. Unfortunately, butorphanol has been determined to be an inadequate form of pain management for anything more than mild discomfort and should not be considered for critically ill patients except in the instance of required sedation.[1]

Antibiotic Therapy

Antibiotics are considered when a bacterial infection seems likely to be the cause of, or contributing to, the patient's critically ill state. Patients in which sepsis is suspected should have antibiotic therapy started immediately (i.e., within 1 hour).[12] However, use of antibiotics is not appropriate in every patient that is considered critical, and appropriate antimicrobial stewardship must be employed.

Antimicrobial stewardship, which is geared toward improving antibiotic prescription and use to effectively treat infections, protect patients from harm, and combat antibiotic resistance,[13] generally contraindicates the use of antibiotic therapy in any patient without

clinical signs or laboratory findings indicating bacterial infection. In addition, the potential side effects (e.g., GI upset) may make the patient feel worse instead of better. As with all drug therapies, clinicians must weigh the risks of antibiotics against the benefits to the patient.

Antiemetic Therapy

Antiemetic therapy can be extremely beneficial in improving how a patient feels and reacts to other treatments. In dogs especially, the GI tract tends to be the organ most initially affected by shock,[10] leading to a slowdown in peristalsis and an increase in nausea. Providing antiemetic medication helps reduce nausea, which helps patients start to eat on their own again and restart the peristaltic waves of the GI tract. In cats, antiemetic therapy helps prevent car sickness while the patient is transferred to a critical care facility.[14]

If antibiotics are administered, providing antiemetic therapy before, or combined with, antibiotic therapy helps reduce the risk of GI side effects and additional fluid losses through vomiting.

Diuretic Therapy

Diuretics are defined as drugs that promote the formation of urine by the kidneys. As such, these drugs are uniquely adapted to assist the body in removing excess fluid in the form of urine. The use of diuretics in critically ill patients should be reserved for patients that have cardiac disease and present in cardiogenic shock caused by an increase in fluid that their cardiovascular system cannot handle.

Although use of diuretics is limited in critical patients, it is imperative for those patients that require it. Furosemide, the most commonly used injectable diuretic, may be given both IM and IV to help patients with respiratory distress caused by pulmonary edema secondary to cardiac disease. Although often difficult to assess immediately without diagnostic radiographs, these patients may be identified on auscultation as having a heart murmur, crackles in the lungs, or, often, both simultaneously. These patients often present with severe dyspnea and have difficulty breathing and therefore require the use of an adjunct sedative such as butorphanol to reduce their levels of stress. Such patients are critical but sometimes require a "recovery" period before transfer to a critical care facility. Depending on the comfort level of the general practitioner, the use of diuretic therapy, sedative therapy, and oxygen therapy for a short period may reduce the risk of mortality and increase the safety of the patient during transport.

The use of diuretics in critically ill patients should be reserved for patients that have cardiac disease and present in cardiogenic shock caused by an increase in fluid that their cardiovascular system cannot handle.

DIAGNOSTIC TESTS

Diagnostic tests should be run only if they do not interfere with the patient receiving the therapy it requires in a timely manner. Although beneficial, they are not always required before transferring a patient to a critical care facility.

Point-of-Care Blood Work

If point-of-care testing is available, obtaining a small sample of blood from the patient during the placement of the IV catheter may facilitate blood work before transfer. With time often being of the essence in these situations, it is equally beneficial, if the staff can obtain a blood sample, to send that sample to the critical care facility with the patient. If blood work is run before transfer, it is imperative that the results be sent with the patient or directly to the critical care facility via email, fax, or any other method that will ensure their arrival.

Common point-of-care diagnostic tests include measurement of blood lactate, glucose, and PCV/TS; an i-STAT analyzer may be useful. Results of these tests provide an immense amount of information pertaining to the patient's health and require only minute samples of blood.

Radiographs

Radiographs are often extremely important and provide

invaluable information to the clinician that can help in arriving at a definitive diagnosis. However, as with point-of-care blood work, radiography of the critically ill patient should only be considered when it is safe for the patient and does not delay treatment.

Additionally, as with blood work results, any radiographs obtained must be sent to the critical care facility to which the patient is transferred. If the practice uses radiographic film, the developed film should be sent with the patient to limit the need for additional radiographs when the patient arrives. Digital radiographs may be downloaded to a CD to go with the patient, or they can be emailed to the critical care facility while the patient is en route.

TRANSFERRING THE CRITICALLY ILL PATIENT

There is always a risk when transferring a critically ill patient from one veterinary facility to another that the patient will decompensate rapidly during transit. Before the patient is transferred, the veterinarian at the presenting facility should contact the critical care facility that they intend to transfer the patient to and speak to the clinician at the site. The transferring clinician or veterinary nurse should then speak to the owners and offer them a realistic idea of what to expect when they arrive at the critical care facility. This includes possible wait times, as well as the potential cost. If the owner agrees to the transfer and believes it is the best chance for their pet, the patient should be transferred to the critical care facility with any notes, records, test results, and paperwork that contains any information about what was performed at the veterinary hospital where the pet initially presented.

Transporting the patient should be done with the utmost care and whatever precautionary measures can be taken. Typically, the owners transport the patient in their own vehicle. Some practices send a veterinary nurse to monitor the pet during transit.

CONCLUSION

The ability to identify critically ill patients at presentation can be challenging and should be a priority of staff training and education. The skills required to appropriately stabilize and transfer these patients in a safe and timely manner are invaluable. These patients require a collaborative effort ranging from triage and primary interventions to clear communication with both the owner and the receiving facility when the patient is transferred. When all of these steps are successful, the likelihood of the patient's survival increases. TVN

Recommended Reading

- Battaglia AM, Steele AM. *Small Animal Emergency and Critical Care for Veterinary Technicians.* St. Louis, MO: Elsevier; 2020.
- Creedon JM, Davis H. *Advanced Monitoring and Procedures for Small Animal Emergency and Critical Care.* Hoboken, NJ: Wiley-Blackwell; 2012.
- Kirby R, Linklater A. *Monitoring and Intervention for the Critically Ill Small Animal: The Rule of 20.* Ames, IA: Wiley-Blackwell; 2017.

References

1. de Laforcade A, Silverstein DC. Shock. In: Silverstein DC, Hopper K, eds. *Small Animal Critical Care Medicine*. St. Louis, MO: Elsevier Saunders; 2015:26-30.
2. Newfield AL. Triage and initial assessment of the emergency patient. In: Norkus CL, ed. *Veterinary Technician's Manual for Small Animal Emergency and Critical Care*. Hoboken, NJ: Wiley; 2019:3-16.
3. Reineke EL. Evaluation and triage of the critically ill patient. In: Silverstein DC, Hopper K, eds. *Small Animal Critical Care Medicine*. St. Louis, MO: Elsevier Saunders; 2015:1-5.
4. Rudloff E. Assessment of hydration. In: Silverstein DC, Hopper K, eds. *Small Animal Critical Care Medicine*. St. Louis, MO: Elsevier Saunders; 2015:307-310.
5. Balakrishnan A, Silverstein DC. Shock fluids and fluid challenge. In: Silverstein DC, Hopper K, eds. *Small Animal Critical Care Medicine*. St. Louis, MO: Elsevier Saunders; 2015:321-326.
6. Trent KB. Venous access. In: Norkus CL, ed. *Veterinary Technician's Manual for Small Animal Emergency and Critical Care*. Hoboken, NJ: Wiley; 2019:35-44.
7. Lange J, Boysen SR, Bentley A, Atilla A. Intraosseous catheter flow rates and ease of placement at various sites in canine cadavers. *Front Vet Sci*. 2019;6:312.
8. Hughston L. The basics of fluid therapy for small animal veterinary technicians. Today's Veterinary Nurse. Published 2016. Accessed August 2021. todaysveterinarynurse.com/articles/the-basics-of-fluid-therapy-for-small-animal-veterinary-technicians
9. Davis H, Jensen T, Johnson A, et al. 2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats. American Animal Hospital Association. Accessed January 31, 2021. aaha.org/globalassets/02-guidelines/fluid-therapy/fluidtherapy_guidlines_toolkit.pdf
10. Arenth JM, Norkus CL. Shock and initial stabilization. In: Norkus CL, ed. *Veterinary Technician's Manual for Small Animal Emergency and Critical Care*. Hoboken, NJ: Wiley; 2019:17-34.
11. Allweiler S. Types of pain. The Merck Veterinary Manual. Updated February 2020. Accessed August 2021. merckvetmanual.com/special-pet-topics/pain-management/types-of-pain
12. Montealegre-Golcher F. Surviving sepsis in veterinary medicine. Illinois State Veterinary Medical Association. Published 2018. Accessed December 10, 2020. isvma.org/wp-content/uploads/2018/10/SurvivingsepsisinVeterinary-Medicine.pdf
13. Centers for Disease Control and Prevention. Core Elements of Antibiotic Stewardship. Accessed April 13, 2021. cdc.gov/antibiotic-use/core-elements/index.html
14. Coates JR. Motion sickness in animals. The Merck Veterinary Manual. Updated March 2021. Accessed August 2021. merckvetmanual.com/nervous-system/motion-sickness/motion-sickness-in-animals