

RULE OF TWENTY MONITORING OF THE CRITICAL PATIENT

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The following list, called the "Rule of Twenty," is a guideline for case management of the critically ill small animal patient. Consideration of each aspect of the Rule of Twenty on a daily basis ensures that major organ systems are not overlooked. The list also provides a means to integrate and relate changes in different organ systems functions with one another.

1. Fluid balance The treatment of hypovolemic and septic shock requires the placement of large-bore intravenous catheters in peripheral and central veins. Reassess the patient's perfusion parameters (heart rate, capillary refill time, blood pressure, urine output) on a continual basis to direct further fluid therapy. Synthetic colloid fluids (hydroxyethyl starch or hemoglobin based oxygen carriers, if available) can also be administered in the initial resuscitation from shock. In critically ill patients, fluid loss can be measured in the form of urine, vomit, diarrhea, body cavity effusions, and wound exudates. Additionally, insensible losses (those that cannot be readily measured from sweat, panting, and cellular metabolism) constitute 20-30 mL/kg/day. Measurement of fluid "ins and outs" in conjunction with the patient's hematocrit, albumin, and colloid oncotic pressure can help guide fluid therapy.

2. Blood pressure

Maintenance of normal blood pressure is necessary for adequate oxygen delivery to meet cellular energy demands. Blood pressure can be measured using direct arterial catheterization, or through indirect means such as Doppler plethymography or oscillometric methods. The systolic pressure should remain at or greater than 90-100 mm Hg at all times. The diastolic pressure is very important, too, as it constitutes two thirds of the mean arterial pressure; it must be greater than 40 mm Hg for coronary artery perfusion. The mean arterial pressure should be greater than 60 mm Hg for adequate tissue perfusion. If fluid resuscitation and pain management are not adequate in restoring blood pressure to normal, vasoactive drugs including positive inotropes and pressors may be necessary to control blood pressure.

3. Heart rate, rhythm, contractility, and pulse quality

Cardiac dysrhythmias should be controlled whenever possible. Treatment of bradycardia should be directed at treating the underlying cause. Perform passive rewarming if the patient is hypothermic. Correct any underlying electrolyte abnormalities such as hyperkalemia and hypo- and hypermagnesemia. Treat ventricular dysrhythmias such as multifocal premature ventricular contractions (PVCs), sustained ventricular tachycardia ≥ 160 beats per minute, and R on T phenomenon, or if runs of ventricular tachycardia cause a drop in blood pressure.

4. Albumin

Albumin can decrease as a result of loss from the gastrointestinal tract, urinary system, and wound exudates, or into body cavity effusions. Serum albumin contributes 80% of the colloid oncotic pressure of blood, in addition to its important roles as a free radical scavenger at sites of inflammation and as a drug and hormone carrier. Albumin levels ≤ 2.0 g/dL have been associated with an increase in morbidity and mortality in human and veterinary patients. Administer fresh frozen plasma (20 mL/kg) or concentrated human albumin (2 mL/kg of 25% solution) to maintain serum albumin 2.0 g/dL. Additional oncotic support can be in the form of synthetic colloids, as indicated.

5. Oncotic pressure

Colloid oncotic pressure within the intravascular and interstitial spaces contributes to fluid flux. Oncotic pressure can be measured with a colloid osmometer. Normal oncotic pressure is 15 mm Hg. In cases of sepsis and SIRS, increased vascular permeability increases the tendency for leakage of fluids into the interstitial spaces. Colloids that can be administered until the source of albumin loss resolves include the synthetic colloids hydroxyethyl starch, concentrated human albumin (25% albumin, 2 mL/kg), canine albumin (3 – 6 mL/kg of the 16% solution) and plasma (20 mL/kg).

6. Oxygenation and ventilation

* From Purvis D, Kirby R. Systemic inflammatory response syndrome: septic shock. *Vet Clin North Amer Small Anim Pract* 24(6):1225-1247, 1994.

Kirby R: Septic shock. In Bonagura JD, editor: *Kirk's current veterinary therapy XII*. Philadelphia, 1995, WB Saunders.

Oxygenation and ventilation can be evaluated by arterial blood gas analysis or by the noninvasive means of pulse oximetry and capnometry (see sections on Pulse Oximetry and Capnometry). Administer supplemental oxygen as flow-by, nasal or nasopharyngeal catheter, oxygen hood, or oxygen cage. Supplemental oxygen should be humidified, and delivered at 50-100 mL/kg/minute. If oxygenation and ventilation are so impaired that the PaO₂ remains ≤ 60 mm Hg with the patient on supplemental oxygen, a PaCO₂ ≤ 60 mm Hg, or severe respiratory fatigue, develops, and mechanical ventilation should be considered.

7. Glucose

Glucose is a necessary fuel source for red blood cells and neuronal tissues, and serum glucose should be maintained within normal reference ranges. Glucose supplementation can be administered as 2.5-5% solutions in crystalloid fluids, or in parenteral and enteral nutrition products.

8. Acid-base and electrolyte and lactate status

Arterial and venous pH can be measured by performing blood gas analyses. Decrease in tissue perfusion, impaired oxygen delivery, and decreased oxygen extraction in the various forms of shock can lead to anaerobic metabolism and metabolic acidosis. In most cases, improving tissue perfusion and oxygen delivery with crystalloid and colloid fluids, supplemental oxygen, and inotropic drugs will help normalize metabolic acidosis. Serial measurements of serum lactate (normal, ≤ 2.5 mmol/L) can be used as a guide to evaluate the tissue response to fluid resuscitative efforts.

Serum electrolytes often become severely deranged in shock states. Serum potassium, magnesium, sodium, chloride, and total and ionized calcium should be maintained within normal reference ranges. If metabolic acidosis is severe, sodium bicarbonate may be required.

9. Coagulation

Cage-side coagulation monitors are available for daily measurement of activated clotting time (ACT), prothrombin time (PT), activated partial thromboplastin time (APTT), and platelet counts.

10. Mentation

Monitor the patient for changes in mental status, including stupor, coma, decreased ability to swallow and protect the airway, and seizures. Elevation of the patient's head can help to protect the airway and decrease the risk of increased intracranial pressure. Serum glucose should be maintained within normal levels to prevent hypoglycemia-induced seizures.

11. Red blood cell and hemoglobin concentration

One of the major components of oxygen delivery is the binding to hemoglobin. Packed cell volume must be kept above 20-30% for adequate cellular oxygen delivery. Oxygen-carrying capacity and hemoglobin levels can be increased with administration of RBC component therapy.

12. Renal function

Monitoring of renal function includes daily measurement of BUN, creatinine, and urine output. Normal urine output in a hydrated euvolemic patient is 1-2 mL/kg/hour. Fluid ins and outs should be measured in cases of suspected oliguria or anuria.

13. White blood cell count, immune function, antibiotic dose and selection

The patient's white blood cell count may be elevated, normal, or decreased, depending on the type of shock. The decision to administer antibiotics should be made on a daily basis.

14. Gastrointestinal motility and integrity

Impaired gastrointestinal motility and vomiting should aggressively be treated with antiemetics and promotility drugs, histamine-receptor blockers or proton-pump inhibitors. If the gastrointestinal barrier function is diminished due to poor perfusion, infection, or inflammation, administer broad-spectrum antibiotics such to prevent gastrointestinal bacterial translocation.

15. Drug doses and metabolism

The course of drug therapy should be reviewed daily and the patient should be monitored for potential drug interactions.

16. Nutrition

Nutrition is of utmost importance in any critically ill patient. Enteral nutrition is preferred, whenever possible, because enterocytes undergo atrophy without luminal nutrient stimulation. A variety of enteral feeding tubes can be placed, depending on what portion of the gut is functional, to provide enteral nutrition in an inappetent patient. If enteral nutrition is impossible because of protracted vomiting or gastrointestinal resection, glucose, lipid, and amino acid products are available that can be administered parenterally to meet nutrient needs until the gastrointestinal tract is functioning and the patient can be transitioned to enteral nutrition.

17. Analgesia and pain control

In any animal determined to be in pain, analgesic drugs should be administered to control pain and discomfort at all times. Opioids are cardiovascularly friendly, and their effects can easily be reversed with naloxone if adverse effects such as hypotension and hypoventilation occur.

18. Nursing care and patient mobilization

If the patient is nonambulatory, rotate the animal from side to side every 4 to 6 hours to prevent lung atelectasis. Passive range-of-motion exercises and deep muscle massage should be performed to increase tissue perfusion, decrease dependent edema, and prevent disuse atrophy. Animals should be kept completely dry on soft, padded bedding to prevent the development of decubital ulcers.

19. Wound care/bandage care

All bandages, wound sites, and catheter sites should be checked daily for the presence of swelling, erythema, and pain. Soiled bandages should be changed to prevent strike-through and contamination of the underlying catheter or wound.

20. TLC (tender loving care)

Hospitalization can be a stressful experience for patient and client alike. Allowing brief visits and walks outside in the fresh air can improve a patient's temperament and decrease stress. The preemptive use of analgesic drugs on a regular schedule (not PRN) should be used to prevent pain before it occurs. Pain decreases the patient's ability to sleep. Lack of sleep can promote further stress and impaired wound healing.