VET 433A Shock

Shock: Inadequate cellular energy production

- Oxygen delivery does not equate to oxygen consumption

Pathophysiology of shock

1. Inadequate blood flow to cells
    a. Oxygen delivery
2. Lack of substrate
    a. Glucose delivery
3. Cellular dysfunction
    a. Mitochondrial issues

Shock classification based on physical exam findings

1. Mention
2. Mucous membrane color
3. Capillary Refill Time
4. Heart Rate
5. Pulse Quality
6. Peripheral Temperature

Vasoconstrictive Shock

1. Obtundation
2. Pale Mucous Membranes
3. Slow CRT
4. Tachycardia (cats may have bradycardia)
5. Poor Pulse Quality
6. Cold extremities

Types

Shock	Hypovolemic Shock	Obstructive Shock	Cardiogenic Shock
Mechanism	Decreased preload Decreased Stroke Volume Decreased Cardiac Output Decreased delivery of O_2	Decreased venous return	Decreased preload, contractility, or increased afterload Decreased stroke volume or altered HR Decreased Cardiac Output Decreased oxygen delivery
Causes	Intravascular Volume Loss Whole blood loss (external or internal hemorrhage) Plasma Loss	Pericardial effusion Gastric dilation and volvulus Space occupying lesions	3rd degree AV block Sick Sinus Syndrome DMVD DCM

	-GI (malabsorption, liver failure) Isotonic Loss -GI (vomiting and diarrhea) -Extra-gastrointestinal -Renal, burns, 3rd space loss		*Do NOT treat with IVF

Vasodilatory Shock

1. Obtundation
2. Hyperemic mucous membranes
3. Rapid CRT
4. Tachycardia
5. Bounding pulse quality
6. Warm Extremities

Types

Distributive shock

Mechanism

- Decreased systemic vascular resistance
- Decreased venous return
- Decreased cardiac output
- Decreased delivery of O_2

Causes

- Decreased systemic vascular resistance
- Inflammatory mediators
- Sepsis/SIRS
    - Infectious (septic peritonitis)
    - Sterile (pancreatitis, extensive burns)
- Anaphylactic reactions
    - Bee stings

Summary

Shock	Mentation	HR	Pulse	MM Color	CRT	Temp
Hypovolemic	Obtunded	Increased	Decreased	Pale	Increased	Decreased
Obstructive	Obtunded	Increased	Decreased	Pale	Increased	Decreased
Cardiogenic	Obtunded	Variable	Decreased	Pale	Increased	Decreased
Distributive	Obtunded	Increased	Increased	Hyperemic	Decreased	Increased

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Metabolic Shock

- Alterations in cellular metabolism
- Hypoglycemic or hypoxemic shock
  - Severe hypoglycemia (neonates/sepsis)
  - Hypoxemia (anemia, dyshemoglobinemia, lung disease)
- Substrates available but cannot be used (cytopathic shock)
  - Uncoupling of oxidative phosphorylation (cyanide toxicity)

Shock Therapy

- Initial Treatment
  - Supplemental O_2 administration
  - Obtain Vascular access
    - Large bore and short IVC
    - Intraosseous access can also be utilized
  - Cats: Active warming
  - Frequent reassessment every 5-10 minutes
- Fluid Resuscitation
  - Increase preload

Fluid Type	**Crystalloids**	**Crystalloids**	**Colloids**
Examples	Isotonic 0.9% NaCl Plasmalyte 148 Normosol-R Lactated Ringer's	Hypertonic 7.2% NaCl (Hypertonic Saline) *1232 mEq/L Na^+	Hetastarch Hextend Tetrastarch
Total Shock Dose	Dogs: 80-90 ml/kg IV Cats: 40-60 ml/kg IV	Dogs: 4-6 ml/kg IV Cats: 2-3 ml/kg IV	Dogs: 10-20 ml/kg IV Cats: 5-10 ml/kg IV
Rate	5-15 minutes Initial bolus: ¼ to 1/2 dose IV then reassess	5 minutes	5-15 minutes Initial bolus: ¼ to 1/2 dose IV then reassess
Pros	Cheap Effective	Cheap Effective Small Volumes Vasodilation Improved microcirculatory function Improved myocardial contractility	Smaller volumes Remain in intravascular space
Cons	Redistribute to interstitium	Cellular dehydration	Expensive

	Edema with low oncotic pressure LRS: Transiently worse hyperlactatemia	Blood volume only increases by a small amount Needs to be followed with isotonic crystalloid	May cause coagulopathy and AKI Limit 20ml/kg/day hetastarch or 50ml/kg/day vetstarch
Additional Info		Use for head trauma with concurrent shock Giant breed dogs Active hemorrhage “low volume resuscitation” NEVER use hypotonic solutions for shock resuscitation (D5W, sterile water, 0.45% NaCl)	Natural colloids (Fresh) Frozen Plasma > Fresh whole blood > packed RBC Dose 10-20 ml/kg IV to reverse secondary coagulopathy Rate Depends on patient status *lower oncotic pressure than synthetic colloids and a possibility for an adverse reaction

Resuscitation Endpoints

- Normalization of clinical perfusion parameters
    - Normal HR and pulse quality
- Improved blood pressure (MAP > 65 mmHg)
- Clearance of plasma lactate (<2.5 mmol/L)
- Increase of venous oxygen
- Normal urine output (>0.5 ml/kg/hr)