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MEDICATIONS

- Antibiotics
    - **Amoxicillin**
        - Indications: Bactericidal aminopenicillin with the same spectrum as ampicillin used to treat a wide range of infections, including…
            - Bacterial UTIs: 11-15 mg/kg PO q8-12hrs
            - Lyme disease: 20 mg/kg PO q8hr x30 days
            - Systemic infections: 11-22 mg/kg PO q8hrs
        - Precautions:
            - Give with food to reduce risk of GI upset
            - Do not give to rabbits, guinea pigs, chinchillas, hamsters, rodents, or other pocket pets
    - **Amoxicillin/Clavulanate** (Clavamox, Augmentin)
        - Indications: Potentiated aminopenicillin used empirically for bacterial UTIs, skin and soft tissue infections, respiratory disease with bacterial component or infections susceptible to amoxi/clav
        - Dose: 13.75-25 mg/kg PO q8-12hrs
        - Precautions:
            - Give with food to reduce risk of GI upset
            - Do not give to rabbits, guinea pigs, chinchillas, hamsters, rodents, or other pocket pets
    - **Ampicillin**
        - Indications: Aminopenicillin used for…
            - Empiric therapy for sepsis or susceptible systemic infections
                - Dose: 20-40 mg/kg IV q6-8hrs typically in combination with aminoglycoside of fluoroquinolone for gram-negative coverage
            - Leptospirosis if Doxycycline not an option due to vomiting or other adverse reactions
                - Dose: 20mg/kg IV q6hrs
        - Precautions:
            - Incompatible in IV line with buprenorphine, ketamine, midazolam; questionable compatibility with butorphanol, insulin, lidocaine, and metoclopramide
            - Do not administer to rabbits, guinea pigs, chinchillas, or hamsters
    - **Ampicillin-Sulbactam** (Unasyn)
        - Indications: Potentiated aminopenicillin used for…
            - Empiric therapy in critical patients:

            - Dose: 20-30 mg/kg IV q6-8hrs; typically in combination with aminoglycoside or fluoroquinolone for gram negative coverage
        - Patients unable to take oral medications with infections susceptible to amoxicillin-clavulanate
            - Dose: 22 mg/kg SC, IV, or IM q8hrs
        - Presurgical and intraoperative prophylaxis for colorectal procedures
            - Dose: 22mg/kg IV ~1hr prior to incision; repeated q2hrs intra-operatively
    - Precautions:
        - Methicillin-resistant staphylococci are resistant to ampicillin/sulbactam.
        - Administration with LRS should be done with caution-- may reduce ampicillin concentration
        - Incompatible in IV line with diazepam and midazolam; questionable compatibility with buprenorphine, butorphanol, fentanyl, furosemide, insulin, lidocaine, metoclopramide, morphine,and KCl
- **Azithromycin**
    - Indications: macrolide antibiotic typically used for…
        - Felines:
            - Upper respiratory infections
                - Dose: 5-10 mg/kg PO q24hr for 5 days, then every 72 hours for up to 6 to 8 weeks if response to therapy is positive
            - Bartonellosis, Cryptosporidiosis, and Toxoplasmosis
                - Dose: 10 mg/kg PO q24hr x 3 wks (Bartonella) to 4 wks (Toxo)
    - Precautions:
        - Not effective for treating *Chlamydophila felis* or *Mycloplasma haemofelis* infection in cats
        - Use with caution in patients with impaired hepatic function
- **Cefazolin**
    - Indications: First-Generation Cephalosporin, good coverage for gram-positive pathogens, used for…
        - Surgical prophylaxis for orthopedic, soft tissue, or colonic (w/metronidazole) procedures
            - Dose: 20-22 mg/kg IV slowly (over 3-5 min) within 1 hr of incision, followed by 20-22 mg/kg IV slowly q90-120min until wound closure
        - Susceptible infections

            - Dose: 15-35 mg/kg q6-8hrs IV slowly, IM (large muscle only), or SC.
                - Average starting dose: 20mg/kg q8hrs
        - Dose should be adjusted for renal insufficiency
            - Consider: 20mg/kg q12hr IV slowly, IM (large muscle only), or SC
    - Precautions: do not use in small mammals (eg, hamsters, guinea pigs, etc)
- **Cefovecin** (Convenia)
    - Indications: Third-Generation Cephalosporin used for…
        - Skin and soft tissue infections, UTIs, periodontal and gingival infections
            - Dose: 8mg/kg subcutaneously once, may be repeated one time; typically repeated at 7-10 days, depending upon bacteria targeted
        - Lyme Disease
            - Dose: 8mg/kg SC, second dose in 14 days
    - Precautions: Do not use in small herbivores (eg, guinea pigs, rabbits, hamsters)
- **Cefpodoxime** (Simplicef)
    - Indications: third-generation cephalosporin typically used for skin infections and potentially bacterial UTIs
    - Dose:
        - Canine: 5-10 mg/kg PO q24hr
        - Feline: 5 mg/kg PO q12hr or 10 mg/kg PO q24hr
- **Cephalexin**
    - Indications: first-generation cephalosporin used for…
        - Skin infections
            - Dose: 22-30 mg/kg PO q12hr
        - Bacterial urinary tract infections
            - Dose: 12-30 mg/kg PO q12hr
    - Precautions:
        - Consider dose reduction in patients with renal disease
        - Rarely used and typically not recommended in small mammal species (eg, hamsters, guinea pigs, rabbits, etc) as serious adverse GI effects can occur
- **Clindamycin**
    - Indications: Lincosamide antibiotic with broad-spectrum coverage against many anaerobes, gram-positive aerobic cocci, and *Toxoplasma* spp. Used for…
        - Osteomyelitis
            - Dose: 11-33 mg/kg PO q12hr x28 days
        - Skin infections

        - Superficial pyoderma dose: 5.5-10 mg/kg PO q12hr or 11mg/kg PO q24hrs
        - Deep pyoderma dose: 11 mg/kg PO q12-24hrs
    - Systemic infections
        - Dose: 10-15 mg/kg IV q12hr
        - Dilute to ≤18mg/mL, give as intermittent IV infusion over ~30-60 min. Max rate: 30 mg/min
        - Requires an additional antibiotic (eg., aminoglycoside, fluoroquinolone) for gram-negative bacteria
- Precautions
    - Contraindicated in hindgut fermenters (eg, horses, rodents, ruminant, and lagomorphs)
    - Use with caution in patients with liver or renal dysfunction; reduce dose if severe
- **Doxycycline**
- Indications: Tetracycline antibiotic used for…
    - Susceptible bacterial infections, acute respiratory infections
        - Dose: 5-10 mg/kg PO q12-24hr x7-10 days
    - Canines:
        - Canine heartworm disease - see treatment protocol from American Heartworm Society
        - Leptospirosis, Anaplasmosis, Rickettsial diseases:
            - Dose: 5 mg/kg PO or IV q12hr x2 weeks
        - Lyme disease
            - Dose: 10 mg/kg PO q12-24hr x30 days
        - Ehrlichiosis
            - Dose: 10 mg/kg PO q24hr x28 days
    - Felines:
        - Ehrlichiosis or Anaplasmosis
            - Dose: 5-10 mg/kg PO q12hr x21 days
        - Bartonellosis
            - Dose: 10mg/kg PO q12-24hr
        - Mycoplasma felis URIs
            - Dose: 10mg/kg PO q24hr x14 days
        - Mycoplasma haemofelis (feline infectious anemia)
            - Dose: 10mg/kg PO q24hr or 5mg/kg q12hr x14-28 days
        - Clinical Toxoplasma gondii
            - Dose: 5-10 mg/kg PO q12hr x28 days
        - Chlamydial infections
            - Dose: 10mg/kg PO q24hr for minimum 21-28 days
- Precautions: use caution with oral administration in cats-- follow with 6mL of water or use compounded slurry. Do NOT dry pill.

- **Enrofloxacin** (Baytril)
  - Indications: Fluoroquinolone antibiotic used for…
    - Canines
      - Susceptible infections
        - 5-20 mg/kg PO q24hr
      - Lower UTIs (reserve for resistant UTIs)
        - Dose: 10-20mg/kg PO q24hr
      - Pyelonephritis
        - Dose: 20 mg/kg PO q24hr
    - Felines - susceptible infections
      - Dose: 5 mg/kg PO q24hrs or 2.5mg/kg q12hr
      - Injectable (22.7mg/mL) can be used extra-label at 5 mg/kg (or less) per day IM; IV use not recommended, some clinics give IV if diluted and with caution
  - Precautions:
    - Minimize use in young, growing animals (esp large breed dogs) whenever possible due to potential for cartilage development abnormalities
    - Avoid higher doses (> 5mg/kg/day) in cats-- may cause blindness
    - Many potential drug interactions
- **Marbofloxacin** (Zeniquin)
  - Indications: Fluoroquinolone antibiotic typically used for urinary tract, skin, and soft tissue infections or *Pseudomonas* spp otitis
  - Dose: 2.75-5.5 mg/kg PO q24hr
  - Precautions: can cause cartilage abnormalities in young or growing animals
- **Metronidazole** (Flagyl)
  - Indications: anaerobic antibacterial and antiprotozoal agent used for…
    - Adjunct therapy for inflammatory GI conditions
      - Dose: 10-15 mg/kg PO q12hr
    - Anaerobic infections, reduce bacterial translocation associated with acute GI conditions
      - Dose: 10-15 mg/kg q8-12hrs
      - Severe infection/sepsis dose: 15 mg/kg IV q12hr
    - Hepatic encephalopathy
      - Dose: 7.5 mg/kg PO q8-12hrs
    - Surgical prophylaxis (colorectal surgery, usually used in conjunction with cefazolin)
      - Dose: 15mg/kg IV over 30-60 min, ~1hr prior to surgery
  - Precautions:
    - IV doses should be given slowly
    - Neurotoxicity can occur at high doses

- Anti-inflammatories
    - **Carprofen** (Rimadyl)
        - Non-steroidal anti-inflammatory drug (NSAID)
        - Dose:
            - Canines: 4.4mg/kg q24hr or 2.2mg/kg q12hr, SC or PO
            - Felines: not typically used-- higher risk for renal adverse effects; extreme caution advised
        - Precautions:
            - Contraindicated in dogs with bleeding disorders
            - Use with caution in geriatric patients or those with pre-existing chronic diseases
            - Can cause rare idiosyncratic hepatic failure-- monitor liver enzymes
            - Increased risk for GI adverse effects when used concomitantly with corticosteroids or other NSAIDs
            - Monitor for adverse GI effects, can cause GI ulceration
    - **Firocoxib** (Previcox)
        - Oral COX-2 inhibitor (NSAID)
        - Indication: Adjunctive treatment for TCC of the urinary bladder in Dogs
            - Dose: 5 mg/kg PO q24hr
        - Precautions:
            - Not recommended in felines
            - Monitor for adverse GI effects
    - **Meloxicam** (Metacam)
        - COX-2 preferential NSAID
        - Indications:
            - Canines: pain, inflammation, and OA
                - Dose: 0.2 mg/kg as initial dose, then 0.1 mg/kg q24hr; SC or PO
            - Felines: short term control of pain and inflammation (labeled dose; FDA-approved)
                - Dose: 0.3 mg/kg as one-time SC injection - currently not typically recommended for longer term use due to risk of acute renal failure
        - Precautions:
            - GI adverse effects possible
            - Renal adverse effects possible, especially in cats
            - Rare idiosyncratic hepatotoxicity in dogs
    - **Robenacoxib** (Onsior)
        - Coxib-class NSAID
        - Post-op pain and inflammation
            - Canine dose: 2 mg/kg SC or PO q24hr for maximum of 3 days

- Feline dose: maximum 3 days (6 days in UK)
    - Injectable: 2 mg/kg SC q24hr
    - Oral:
        - For 5.5-13.2lb (2.5-6kg): 1 tab PO q24hr
        - For 13.3-26.4lb (6.1-12kg): 2 tabs PO q24hr
- Chronic pain and inflammation (eg, osteoarthritis)
    - Canine dose: 1-2 mg/kg PO q24hr adjusted to lowest effective dose
    - Feline dose: 1-2.4mg/kg PO q24hr
        - UK label information says safe for up to 6 days
        - One study found to be well-tolerated for 28 days, even in cats with evidence of concurrent CKD

Opioids

- **Buprenorphine** (Buprenex, Simbadol)
    - Indications: partial opioid agonist used for analgesia for mild to moderate pain
        - Simbadol - FDA approved long-acting buprenorphine approved for use in cats
    - DEA C-III controlled substance
    - Dose:
        - Canine: 0.005-0.03 mg/kg IV, IM, or SC q6-12hrs
        - Feline:
            - 0.01-0.03 mg/kg IV, IM, or buccal/OTM (oral-transmucosal) q6-8hr
            - Simbadol (1.8 mg/mL): 0.24mg/kg SC q24hr for up to 3 days
        - Can be used in combination with other drugs for pre-medication for anesthetic procedures or for sedation (see sedation section)
        - Can be used as CRI (see CRI section)
    - Precautions:
        - Incompatible with diazepam
        - Can rarely cause respiratory depression
        - Longer onset than other opiates
- **Codeine**
    - Indications: opioid used for analgesia and cough in dogs and cats
    - DEA C-II for codeine-only products, C-III for codeine combinations
    - Dose
        - Canine
            - Antitussive: 1-2 mg/kg PO q6-12hr
            - Analgesic
                - Alone: 1-3 mg/kg PO q4-6hr, can go up to 4 mg/kg for severe pain

                - With acetaminophen: dose per the acetaminophen component at 10-15 mg/kg (of acetaminophen) PO q8hr
            - Feline - do NOT use combination product containing acetaminophen in cats
                - Analgesic: 0.5-2 mg/kg PO q6-8hr
        - Precautions
            - Many formulations are combined with acetaminophen-- do NOT use these products in cats or ferrets
            - Adverse effects: sedation, constipation, respiratory depression at high doses; CNS stimulation in cats
    - **Fentanyl** (CRI dose in CRI section)
        - Indications: opiate analgesic with both injectable and transdermal formulations used for control of post-op and severe pain
        - DEA C-II controlled substance
        - Injectable - give bolus, then continue as CRI (see CRI section below for doses)
        - Transdermal Patch (Duragesic)
            - Dose
                - Small dogs (<5kg) and cats: 12 mcg/hr size patch
                - Dogs 5-10kg, large cats: 25 mcg/hr size patch
                - Dogs 10-20kg: 50 mcg/hr size patch
                - Dogs 20-30kg: 75 mcg/hr size patch
                - Dogs >30kg: 100 mcg/hr size patch
            - Patch Location
                - Dog: thorax, inguinal area, metatarsal-carpal areas, base of tail, or dorsal or lateral cervical area.
                - Cat: lateral thorax, inguinal area, metatarsal/-carpal areas, or base of tail. Cervical area not recommended.
        - Precautions
            - Patches should be handled with caution and disposed of properly
            - See Plumb's formulary for patch application instructions and handling precautions
            - Dose-related respiratory, CNS, and circulatory depression
            - Potent opioid-- monitor patients closely and use with caution
    - **Hydromorphone** (Diluadid)
        - Indications: injectable opioid used for sedation, analgesia, and pre-anesthesia
        - DEA C-II controlled substance
        - Dose
            - Canines:
                - 0.05-0.2 mg/kg IV, IM, or SC q2-4hr

            - CRI: loading dose 0.05-0.1 mg/kg IV, then 0.01-0.05 mg/kg/hr IV
        - Felines:
            - 0.05-0.1 mg/kg IV, IM, or SC q2-6hr
            - CRI: loading dose 0.025 mg/kg IV, then 0.01-0.05 mg/kg/hr IV
    - Precautions
        - Nausea, vomiting, panting, defecation, vocalization, and sedation are common side effects in dogs. Nausea is common in cats.
            - Typically administered in conjunction with or after administration of Maropitant (Cerenia)
            - Give IV injections slowly to reduce risk and severity
        - CNS depression, respiratory depression, and bradycardia possible in dogs. Ataxia, hyperesthesia, hyperthermia, tranquilization, and behavioral changes possible in cats.
- **Methadone** (Dolophine)
    - Indications: narcotic agonist alternative to morphine used for opioid preanesthetic and analgesic
    - DEA C-II controlled substance
    - Dose
        - Dog
            - 0.1-1 mg/kg IV, SC, or IM q4-8hr
            - CRI: loading dose 0.1-0.2 mg/kg IV, then 0.12 mg/kg/hr IV CRI; can combine with ketamine and/or lidocaine
            - Multiple combination sedation or premedication protocols
        - Feline
            - 0.05-0.5 mg/kg IV, SC, or IM q4-6hr
            - CRI: loading dose 0.1-0.2 mg/kg IV, then 0.12 mg/kg/hr IV CRI
            - Can be used in combination sedation and preanesthesia protocols
    - Precautions
        - Respiratory depression can occur at high doses
- **Tramadol** (Ultram)
    - Indications: synthetic mu receptor opioid agonist and reuptake inhibitor of serotonin and norepinephrine used for treatment of pain, most effective if used in combination with NSAID or other analgesic drugs
    - DEA C-IV controlled substance
    - Dose
        - Canines: 4-10 mg/kg q6-8hr
        - Felines: 1-2 mg/kg PO q12hr
    - Precautions
        - Sedation most likely adverse effect

- Can cause Serotonin syndrome if used in conjunction with SSRIs or MAOIs
- Efficacy as a single agent is questionable

- Other Pain Medications
  - **Amantadine**
    - Indications: antiviral drug that has NMDA antagonist properties, which can be useful for adjunctive chronic pain control in combination with NSAIDs, opioids, or gabapentin
    - Dose: 2-5 mg/kg PO q24hr
      - q12hr dosing may be more effective
      - Start at low end of dosing range and increase slowly PRN
    - Precautions
      - Limited information on potential adverse events due to limited use/experience in vet med - may cause GI upset and agitation
      - Overdoses can be serious - fairly narrow therapeutic index
        - Behavioral effects possible at 15mg/kg
        - Toxic dose 30 mg/kg in cats
  - **Gabapentin** (Neurontin)
    - Indications: anticonvulsant and neuropathic pain analgesic useful for adjunctive therapy for seizures, reducing fear response in cats during exams and handling, and treatment of pain in dogs and cats
    - Dose
      - Canines
        - 10-20 mg/kg PO q8hr
        - Can go up to 30 mg/kg PO q8hr or can give q6hr
      - Felines
        - Adjunctive therapy for seizures: 5-20 mg/kg PO q6-12hr
        - Adjunctive analgesic: 3-10mg/kg PO q8-12hr
        - Fear and anxiety reduction (i.e., during vet visits, grooming, etc.): 50-100 mg/cat PO
    - Precautions
      - Most common adverse effects are drowsiness/sedation and ataxia
      - Some oral liquid formulations contain xylitol, which is toxic to dogs-- avoid these formulations in canines
- CRIs - (appropriate solutions for dilution are indicated in parentheses after the drug)
  - Vasopressors (0.9% NaCl or D5W)
    - **Dobutamine**
      - Indications: treatment of hypotension in cardiac related cases
        - If a severely decompensated heart failure patient is unable to take oral medications and has signs of severe low cardiac output heart failure, dobutamine is recommended
      - Adrenergic-positive inotrope with primarily beta-1 effects.

- Improves cardiac output primarily by increasing the force of contraction with minimal effects on increasing heart rate
- **Dose 5-10 mcg/kg/min**
- Administered IV, onset of action is 1–2 min, but peak effect may take 10 min
- Blood pressure and ECG should be monitored during dobutamine infusion
    - Can cause marked increase in heart rate or blood pressure
    - Can cause arrhythmias at high doses

■ **Dopamine**

- Indications: hypotension that is refractory to fluid/volume resuscitation (sepsis, anesthesia, etc.)
    - Hypotension due to volume/blood loss - make sure you have given sufficient fluids or blood products before starting
    - Intraoperative hypotension - try reducing anesthetic depth or administering fluid bolus(es) before starting
- Alpha- and Beta-1 adrenergic agonist, catecholamine
- **Dose 5-20 mcg/kg/min**
- Monitor blood pressure closely and repeatedly
- Do not stop suddenly - can cause marked hypotension

■ **Norepinephrine**

- Indications: **first line vasopressor for sepsis-induced hypotension;**
    - Anesthetic inhalant induced hypotension
    - Hypotension/shock that is unresponsive or persistent after adequate volume replacement
- Catecholamine, neurotransmitter in the sympathetic nervous system, vasoconstriction, increase in myocardial contractility, heart rate, AV conduction
- **Dose 0.5-1 mcg/kg/min**
- Monitor blood pressure closely and repeatedly (ideally MAP >65 mmHg)

■ **Vasopressin**

- Indications: alternative for epinephrine during CPR; used in conjunction with catecholamines for persistent hypotension/shock
- **Dose 0.001-0.004 U/kg/min**
- *** A bolus of Vasopressin must be given prior to starting the CRI
    - Vasopressin bolus 0.4 Units/kg
- Monitor urine output and USG following administration

○ **Propofol**

■ Indications: short/long term sedation, induction/maintenance of anesthesia, status epilepticus

        - Anesthetic
        - Dose
            - Canine - 0.1-0.6 mg/kg/min titrated to effect (start with bolus first of 1-4 mg/kg IV to evaluate response/if CRI needed for status epilepticus)
            - Feline - 0.1-0.4 mg/kg/min titrated to effect (start with bolus first of 1-4 mg/kg IV to evaluate response/if CRI needed for status epilepticus)
        - Can cause significant respiratory and cardiac depression
        - must monitor closely after administration (be prepared to intubate!)
        - some clinicians believe anything on a propofol CRI should be intubated and ventilated - check with your ECC at your hospital
    - **Metoclopramide** (crystalloid of your choice)
        - Indications: antiemetic and promotility
        - Dose**:** 1-2 mg/kg/day - generally added to crystalloids
        - *** A bolus of Metoclopramide must be given prior to starting the CRI
            - Metoclopramide bolus 0.4-0.5 mg/kg SQ
        - Only use in cases where a foreign body has been ruled out - if used with foreign body present, can increase chance of perforation/peritonitis. Do not use with GI hemorrhage
    - **Procainamide** (0.9% NaCl or D5W)
        - Indications: antiarrhythmic for VPCs/V-tach
            - Use when lidocaine has failed or otherwise indicated (toxins)
        - Dose**:** 25-50 mcg/kg/min
        - *** A bolus of Procainamide must be given prior to starting the CRI
            - Bolus (ranges anywhere from 2-8 mg/kg, I generally do 4-6 mg/kg) procainamide slowly to effect, repeat up to twice prior to starting CRI
        - Monitor with continuous ECG
    - **Furosemide** (0.9% NaCl or D5W)
        - Indications: mainstay diuretic for CHF (congestive heart failure)
        - Dose**:** 0.1-0.9 mg/kg/hr (I generally do 0.5 mg/kg/hr)
        - *** A bolus of Furosemide must be given prior to starting the CRI
            - Furosemide bolus 1-2 mg/kg
        - Monitor electrolytes, BUN/Creatinine
    - **Fentanyl** (0.9% NaCl or D5W)
        - Indications: opioid pain control, best administered as CRI due to very short duration of action
        - Dose**:** 2-5 mcg/kg/hr
        - *** A bolus of Fentanyl (or other opioid) must be given prior to starting the CRI
            - Fentanyl bolus of 3-5 mcg/kg
        - Monitor respiratory rate and body temperature

- **Lidocaine** (0.9% NaCl or D5W)
  - Indications
    - Local anesthetic
    - Cardiac arrhythmias (VPCs, V-tach)
    - Analgesia at low-dose CRI
    - Free-radical scavenger
  - Canine
    - Dose: 50-80 mcg/kg/min
    - *** A bolus of Lidocaine must be given prior to starting the CRI
      - Bolus 2mg/kg Lidocaine slowly, repeat up to 4 times prior to starting CRI
      - If no response after 4th bolus, lidocaine CRI may not work
  - Feline
    - Dose: 10-20 mcg/kg/min
    - *** A bolus of Lidocaine must be given prior to starting the CRI
      - Bolus 0.25mg/kg Lidocaine slowly, repeat up to 2 times prior to starting CRI
      - If no response after 2nd bolus, lidocaine CRI may not work
      - Watch for signs of lidocaine toxicity (seizures, bradycardia, hypotension)
  - From VIN Veterinary Drug Handbook: “Most common reason for lack of efficacy as antiarrhythmic is administration of a dose that is too low or that is administered too slowly; start with IV bolus followed by CRI (target endpoint = conversion of arrhythmia); if conversion of arrhythmia is deemed critical, don't assume ineffective until patient either converts, seizures or vomits”
- **FLK** (0.9% NaCl or NormR)
  - Fentanyl 2-5 mg/kg/hr
  - Lidocaine 10-20 ug/kg/min
  - Ketamine 2-4 ug/kg/min
  - *** A bolus of Fentanyl, lidocaine, and ketamine must be given prior to starting the CRI
    - Fentanyl bolus 4 mcg/kg
    - Lidocaine bolus 1 mg/kg
    - Ketamine bolus 0.25 mg/kg

Gastrointestinal Drugs

- **Cisapride**
  - Indications: oral GI pro-motility agent used for GI stasis, esophageal reflux, esophagitis, and constipation or megacolon
  - Dose
    - Canines: 0.1-0.5 mg/kg PO q8-12hr, may be titrated up to 1 mg/kg q8hr if tolerated and required

            - Felines: 2.5 mg per cat PO q12hr 15-30min before food, can be titrated up to 7.5 mg per cat PO q8hr in large cats
        - Precautions
            - Patients with hepatic insufficiency may need dosage interval extended
            - Vomiting, diarrhea, and abdominal discomfort possible
            - Possible drug reactions-- see formulary
            - Contraindications: GI perforation or obstruction, hemorrhage
    - **Famotidine** (Pepcid)
        - Indications: H2-receptor antagonist used to reduce gastric acid production and increasing gastric pH
        - Dose: 1 mg/kg PO, SC, or IV q12hr
        - Precautions
            - Bradycardia possible with rapid IV infusion
            - Once daily dosing recommended in patients with severe renal dysfunction
    - **Lactulose**
        - Indications: osmotic laxative used to reduce blood ammonia levels and for constipation
        - Dose
            - Hepatic encephalopathy: 1-3 mL per 10kg PO q6-8hr
            - Retention enema for acute hepatic encephalopathy: 1-10 mL per 10 kg used to create 30% lactulose solution (3 parts lactulose to 7 parts warm water). Administer solution as retention enema for 30 min.
            - Constipation
                - Canines: 0.25-0.5 mL/kg PO q6-8hr
                - Felines: 0.5 mL/kg PO q8-12hr
        - Precautions: dehydration and electrolyte abnormalities possible with excessive doses or long term use
    - **Maropitant** (Cerenia)
        - Indication: Neurokinin (NK-1) Receptor Agonist Antiemetic used for the treatment of peripherally or centrally mediated emesis. May also provide visceral analgesia.
        - Dose
            - Injectable (canine and feline): 1 mg/kg SC or IV (over 1-2 min) q24hr up to 5 consecutive days
            - Tablets (canine):
                - Acute vomiting: 2 mg/kg PO q24hr

Dog body weight		Number of Tablets		
Pounds	Kilograms	16 mg	24 mg	60 mg
2.2 – 8.8	1.0 – 4	½		
8.9 – 17.6	4.1 – 8	1		
17.7 – 26.4	8.1 – 12		1	
26.5 – 52.8	12.1 – 24		2	
52.9 – 66	24.1 – 30			1
66.1 – 132	30.1 – 60			2

- Motion sickness: 8 mg/kg PO q24hr on empty stomach or with small meal

Dog body weight		Number of Tablets			
Pounds	Kilograms	16 mg	24 mg	60 mg	160 mg
2.2	1	½			
2.3 – 3.3	1.1 – 1.5		½		
3.4 – 4.4	1.6 – 2	1			
4.5 – 6.6	2.1 – 3		1		
6.7 – 8.8	3.1 – 4	2			
8.9 – 13.2	4.1 – 6		2		
13.3 – 16.5	6.1 – 7.5			1	
16.6 – 22	7.6 – 10				½
22.1 – 33	10.1 – 15			2	
33.1 – 44	15.1 – 20				1
44.1 – 66	20.1 – 30				1½
66.1 – 88	30.1 – 40				2
88.1 – 132	40.1 – 60				3

- Tablets (feline): 1 mg/kg PO q24hr

- Precautions
  - Typically well tolerated
  - Use with caution in patients where GI obstruction has not been ruled out

- **Metoclopramide** (Reglan)
  - Indications: GI prokinetic agent used as antiemetic and to stimulate upper GI motility
  - Dose
    - Canines: 0.2-0.5 mg/kg q6-8hr PO, SC, IV, or IM; doses as high as 1 mg/kg may be required for severe emesis
      - Can be used as CRI (see CRI section below for dosing)
    - Felines
      - Antiemetic: 0.1-1 mg/kg IM or SC
      - Gastric prokinetic: 0.4 mg/kg SC q8hr
  - Precautions
    - Contraindications: GI hemorrhage, obstruction, or perforation

                - Use with caution in patients with seizure disorders or pheochromocytoma
                - Possible adverse effects (typically well tolerated)
                    - Changes in mentation and behavior (restlessness, vocalization, hyperactivity, drowsiness, depression, aggression).
                    - Cats may become disoriented or excited.
                    - Tremors possible in patients with renal insufficiency.
                    - Constipation possible
    - **Misoprostol** (Cytotec)
        - Indications: prostaglandin E1 analog used in dogs for treating and preventing gastric ulcers, especially associated with NSAIDs
        - Dose (canines): 1-3 micrograms/kg PO q6-12hr
        - Precautions
            - Possible side effects: diarrhea, abdominal discomfort, vomiting, and flatulence
            - Contraindications: pregnancy and nursing mothers
            - Pregnant women should avoid handling as it can cause miscarraige.
    - **Omeprazole** (Prilosec)
        - Indications: proton pump inhibitor used for GI ulcers and erosions
        - Dose
            - Canines: 0.5-2 mg/kg PO q12-24hr
            - Felines: 0.5-1 mg/kg PO q12-24hr
        - Precautions
            - Typically well tolerated
            - May need to adjust dose in patients with hepatic or renal disease
    - **Ondansetron** (Zofran)
        - Indications: serotonin type 3 receptor antagonist used for the prevention and treatment of vomiting
        - Dose
            - Canine: 0.5-1 mg/kg PO or IV (slowly over 5-15 min) q8-12hr
            - Feline: 0.1-1 mg/kg PO, SC, IM, or IV (slowly) q6-12hr
        - Precautions: typically well tolerated
    - **Pantoprazole** (Protonix)
        - Indications: proton pump inhibitor used for treating and preventing gastric-acid related diseases
        - Dose: 0.7-1 mg/kg IV over 15min q24hr
        - Precautions: typically well tolerated
    - **Probiotics** (Fortiflora, Prostora, Propectalin, Proviable, etc)
        - Indications: oral probiotics used for treatment and prevention of diarrhea in dogs and cats
        - Dose: each product typically has dosing instructions on package

        - Precautions: give 1-2 hours apart from any antibiotics
    - **Sucralfate** (Carafate)
        - Indications: GI mucosal protectant used for prevention and treatment of GI ulcers and esophagitis
        - Dose:
            - 1g tablets: ¼ (toy-breed dogs and cats) to 1 (large dogs) tablet PO q6-12hr
            - Crush tablet and dissolve in water to create slurry
        - Precautions
            - Typically well tolerated - constipation possible
            - Should be administered on an empty stomach
            - Dissolve tablets in water before administering
            - Can impair the oral absorption of many medications-- should be separated from any other medication by at least 2 hrs
    - **Tylosin** (Tylan)
        - Indications: macrolide antibiotic used for diarrhea and inflammation of the intestinal tract (i.e., inflammatory bowel disease, idiopathic antibiotic responsive diarrhea, etc)
        - Dose: 10-40 mg/kg PO q8-12hr
        - Precautions
            - Powder is extremely bitter
            - Typically well tolerated, can cause mild GI upset
- Antiparasitics
    - See Companion Animal Parasite Council Recommendations at capcvet.org for further information on individual drugs and parasites
    - **Fenbendazole** (Panacur, Safe-Guard)
        - Indications: roundworms, hookworms, whipworms, tapeworms (Taenia pisiformis), Giardia, *Strongyloides* spp, and lungworms
            - Ineffective against Dipylidium caninum
        - Dose: 50 mg/kg PO q24hr, duration of treatment and redosing recommendations depend upon targeted parasite
        - Precautions: best given with food. Typically well tolerated.
    - **Ivermectin** (Ivomec, Heartgard)
        - Indications: avermectin drug used as a heartworm preventative in dogs and to treat a variety of ectoparasites (demodecosis, sarcoptic mange, cheyletiellosis)
        - Dose: see formulary for treatment protocols
        - Precautions
            - Caution in breeds prone to *MDR1* mutation-- higher risk for CNS toxicity
            - Extreme caution or avoid use with other drugs affecting P-glycoprotein

            - Use with caution in heartworm positive patients: risk of shock-like reaction from dying microfilaria
    - **Praziquantel** (Droncit, Drontal, Drontal Plus)
        - Indications: Tapeworms
            - Dogs: *Dipylidium caninum*, *Taenia pisiformis*, *Echinococcus granulosis*, and *Echinococcus multilocularis*
            - Cats: *Dipylidium caninum* and *Taenia taeniaeformis*
        - Dose: see label for dosing instructions for Droncit/Drontal Plus or injectable formulation
        - Precautions: typically well-tolerated
    - **Pyrantel pamoate** (Strongid)
        - Indications: ascarids (*Toxocara canis*, *Toxacaris leonina*), hookworms (*Ancylostoma caninum*, *Uncinaria stenocephala*), and stomach worm (*Physaloptera*) in dogs; safe for use in cats
        - Dose:
            - Dogs weighing <5lb: 10mg/kg PO
            - Dogs weighing >5lb: 5 mg/kg PO
        - Dosing protocols:
            - Hookworm or roundworms: repeat dose in 7-10 days
            - Puppies should routinely be treated at 2, 4, 6, and 8 weeks of age to prevent environmental contamination
            - See formulary or capcvet.org for additional parasite-specific dosing recommendations
        - Precautions: typically well-tolerated
    - **Sulfadimethoxine** (Albon)
        - Indications: sulfonamide antimicrobial agent used to treat coccidiosis in dogs and cats
        - Dose:
            - Label dose: 55 mg/kg PO on day 1, then 27.5 mg/kg PO q24hr; duration of treatment depends upon clinical response but 3-5 days is typically adequate
            - Extra-label: 50-60mg/kg PO q24hr x5-20 days
        - Precautions
            - Contraindications: severe renal or hepatic impairment, Dobermans, and sulfa hypersensitivity
            - Caution: renal or hepatic disease, urinary obstruction
            - Multiple potential adverse effects (crystalluria, KCS, bone marrow suppression, hypersensitivity reactions, focal retinitis, fever, vomiting, non-septic polyarthritis, etc)

SEDATION PROTOCOLS

- Sedation protocols (these are protocols that have worked for me in the past)
    - **Canine**
        - Alfaxalone 2-3 mg/kg + 2-3 mcg/kg dexmedetomidine + butorphanol 0.2 mg/kg or buprenorphine/methadone/hydromorphone IV/IM
        - Butorphanol 0.2 mg/kg + midazolam 0.2-0.5 mg/kg IV/IM
        - Dexmedetomidine 3-10 mcg/kg + butorphanol 0.2 mg/kg IV/IM
        - Dexmedetomidine 3-10 mcg/kg + buprenorphine/methadone/hydromorphone IV/IM
        - Dexmedetomidine 3-10 mcg/kg + ketamine 1 mg/kg + buprenorphine/methadone/hydromorphone IV/IM
    - **Feline**
        - Alfaxolone 5 mg/kg + butorphanol 0.2 mg/kg or buprenorphine/methadone/hydromorphone IM
        - Alfaxolone 1-3 mg/kg + dexmedetomidine 3-5 mcg/kg + butorphanol 0.2 mg/kg or buprenorphine/methadone/hydromorphone IM
        - Butorphanol 0.2 mg/kg + midazolam 0.1-0.5 mg/kg + ketamine 1-5 mg/kg IM
        - Dexmedetomidine 3-5 mcg/kg + butorphanol 0.2 mg/kg + ketamine 1-5 mg/kg IM

CPR

- **Steps**
    - 1) Begin chest compressions - 100-120 compressions/minute
    - 2) Ventilate - intubate in lateral recumbency while continuing compressions - give 1 breath every 6 seconds (10 breaths/minute)
    - 3) Initiate monitoring - ECG, ETCO2
        - If ETCO2 >15 mmHg - good compressions
    - 4) Obtain vascular access
        - Asystole/pulseless electrical activity (PEA)
            - Low dose epinephrine and/or vasopressin every other BLS cycle
            - Atropine every other BLS cycle (every other from epinephrine)
            - If no response, give high dose epinephrine
        - Ventricular fibrillation (VF)/pulseless ventricular tachycardia (VT)
            - Charge defibrillator, clear and give 1 shock
                - Monophasic - 4-6 J/kg
                - Biphasic - 2-4 J/kg
            - If prolonged VF/VT

                - Lidocaine
                - Low dose epinephrine and/or vasopressin every other BLS cycle
                - Increase defibrillator dose by 50%
            - Don't be afraid to do a cut down to get IV access
            - If unable to get IV access, can give epinephrine/vasopressin/atropine IT diluted with saline
            - Doses
                - Epinephrine - 0.01 mg/kg IV
                - Vasopressin - 0.8 U/kg IV
                - Atropine - 0.04 mg/kg IV
    - 5) Administer reversals if indicated
        - Opioids - naloxone
        - Alpha2 agonists - atipamezole
        - Benzodiazepines - flumazenil
    - One full cycle = 2 minutes - change person performing compressions every cycle/2 minutes
- **OK, you got your patient back. Now what?**
    - Ventilate for patient if not breathing on their own adequately until they are able to
        - Manual ventilation vs ventilator
        - Monitor ETCO2 - keep between 35-40
    - Stabilize hemodynamically
        - Resolve hypotension
        - Monitor lactate until normalized
    - Protect brain/nervous system
        - Concerns
            - Hypoxic injury
            - Ischemic injury
            - Reperfusion injury
        - Therapies
            - Address any seizure activity (see seizure section)
            - Reduce intracranial edema with mannitol or hypertonic saline
                - Mannitol - 0.5-1 g/kg through a filter over 20 minutes
                    - Do not give if patient is hypotensive
                - Hypertonic saline - 3-5 mL/kg over 20 minutes
                    - Monitor sodium q4-6 hours later
    - Prognosis - grave; better if anesthetic related

Fluid Therapy

- **Goals**
    - Supplement normal ongoing losses (maintenance)

    - Replace concurrent losses (vomiting, diarrhea, etc.)
    - Correct water/electrolyte deficits
- **Common Isotonic Crystalloid Solutions**

Solution	***LRS***	***Plasmalyte A; Norm R***	***0.9% NaCl***
Na	130	140	154
K	4	5	0
Ca	3	0	0
Mg	0	3	0
Cl	109	98	154
Gluconate	0	23	0
Lactate	28	0	0
Acetate	0	27	0
Osmolarity	270	294	310

- **Fluid Rates**
    - Maintenance
        - Dogs - 60 mL/kg/day
        - Cats - 45 mL/kg/day
        - Pediatrics - 90 mL/kg/day
        - Body weight (kgs) x 2-4 mL/kg/hr
    - Dehydration
        - Body weight (kgs) x % dehydration x 1000 = mLs of deficit
        - Estimating dehydration
            - <5% - no clinical signs
            - 5-8% - tacky MM, +/- prolonged CRT
            - 8-10% - tacky MM, prolonged skin tent, prolonged CRT, hemoconcentration

                - 10-12% - tacky MM, marked skin tenting, hemoconcentration, sunken eyes in orbit
                - >12% - above signs + shock
            - Creating a fluid plan in the dehydrated patient
                - Maintenance + dehydration fluid replacement + ongoing losses
                    - Ongoing losses = 3-4 mL/kg/vomit/diarrhea
                        - I tend to bolus anywhere from 5-15 mL/kg with severe ongoing losses (large bouts of diarrhea, large bouts of vomiting/regurgitation, etc).
    - Shock boluses/hypotension
        - Signs of hypovolemia - prolonged CRT, cold distal extremities, absent to minimal pedal pulses, weak/thready femoral pulses, tachycardia
            - Hypotension - MAP <60, systolic <90
        - Shock volume
            - Dogs - 90 mL/kg; quarter shock 22.5 mL/kg
            - Cats - 60 mL/kg; quarter shock 15 mL/kg
        - Synthetic colloids/hypertonic crystalloids
            - Colloids
                - Indicated with hypovolemia, especially with hypoproteinemia, but only after appropriate crystalloid rehydration has been pursued
                - Should not replace crystalloid therapy
                - Recent controversy about whether to use at all, concern for potential kidney damage/AKI
                - Hetastarch/Vetstarch - 5-10 mLs/kg bolus
            - Hypertonic saline
                - Can consider for rapid intravascular compartment expansion in patient with normal hydration
                - Contraindications - dehydration, hypernatremia
                - 4-7 mL/kg over 20 minutes
                - Recheck electrolytes (sodium) 4-6 hours after administration
- **Monitoring**
    - Monitor body weight q8-24hrs if significant rehydration going on to monitor for under/over/normal hydration
- **Concerns/complications with fluid therapy**
    - Volume overload - fast CRT, injected MM, bounding pulses, distended jugular vein
    - Pulmonary edema - increased respiratory rate/effort
    - Too rapid sodium shifts → CNS signs (seizures, obtunded mentation, intracranial edema)
    - Phlebitis
- **Supplementation**

- Potassium

Patient's K+ (mEq/L)	Amount of K+ to add per liter
3.5 – 4	20 mEq
3.0 – 3.5	30 mEq
2.5 – 3.0	40 mEq
2 – 2.5	60 mEq
<2	80 mEq

    - NEVER BOLUS → can cause cardiac arrest
    - Remember, you cannot go higher than 60 mEq in a peripheral catheter - if you need to supplement 80, you must have a central catheter
    - Can always supplement orally
    - If patient is eating/drinking well, potassium should be close to normal
    - Monitor Q6-24 hours depending on severity of hypokalemia and amount of supplementation occurring
    - If patient has continued hypokalemia despite supplementation, check a magnesium and supplement as needed - should be on P-Lyte or NormR

Transfusions

- **Indications**
    - Decreased RBCs
        - Start transfusion if clinical for anemia (tachycardic, hypotensive, tachypnea, pale mucous membranes, prolonged CRT) or if PCV <12-15% depending on patient history and status; also consider transfusion if patient's PCV has decreased a significant percentage (15-20%) in a short period of time
    - Decreased clotting factors
        - PT/PTT are prolonged, clinical evidence of bleeding
    - Decreased albumin
        - Evidence of hypoalbuminemia (edema, ascites, hypotension) or consider if albumin <2 (depending on patient status)
            - Canine albumin usually has to specially ordered, rare to have available
    - Decreased platelets
        - Evidence of bleeding/petechiae/ecchymosis/bruising
- **What product do you need?**
    - For RBCs - fresh or stored whole blood, pRBCs

    - For clotting factors - fresh whole blood, fresh plasma (within 24 hours), fresh frozen plasma (FFP)
    - For platelets - fresh whole blood, fresh plasma (within 6 hours), platelet rich plasma
- **Blood transfusion**
    - Type dogs and cats
        - Dogs - ~12 types; most common DEA 1; DEA 1:1 negative universal donor
        - Cats - A, B, AB; most common A
    - Crossmatch
        - If first time transfusion in a dog and have same blood type, do not necessarily have to crossmatch; if has received a blood transfusion in the past, always crossmatch
        - Always crossmatch with cats
- **Transfusion administration**
    - Ideally, give over 4 hour time period; if animal is actively bleeding severely or is so anemic he/she is in critical condition, may need to give over a faster time period
    - Give through blood administration set (should include filter)
    - Amount to give
        - Whole blood
            - K x weight in kgs(required PCV - recipient PCV)/PCV of donated blood
            - K - 90 for dogs, 66 for cats
        - pRBC - 10 mL/kg (goal is to increase PCV by 10%)
        - FFP - 10-20 mL/kg
    - Rate to give over - variable methods:
        - Start with a low rate (1 mL/hr) and then increase every 15 minutes until final rate reached; OR
        - Start with 25% of the calculated final dose for the first 30 minutes to one hour of the transfusion; increase incrementally until reaching final rate
    - Monitor temperature, HR, RR, MM, and CRT closely - initially every 5-10 minutes; after first hour can monitor every 15-30 minutes as long as patient tolerating without issue
    - Some people pre-medicate with diphenhydramine (2 mg/kg IM) - others wait for evidence of transfusion reaction, then administer
    - If body temperature increased by >1 degree, concern for transfusion reaction
        - Slow rate of transfusion; if temperature continues to rise, consider discontinuing the transfusion
        - Administer diphenhydramine 2 mg/kg IM if not pre-medicated with it
    - If patient develops vomiting, diarrhea, or collapse - concern for anaphylactic reaction - stop the transfusion
        - +/- dexamethasone SP

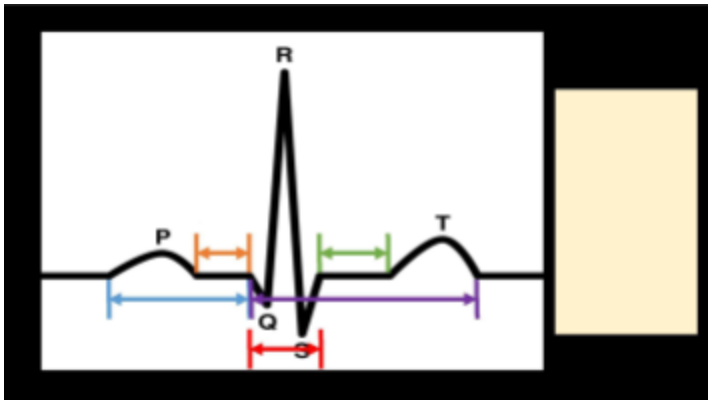
        - +/- epinephrine

Respiratory/Cardiac

- **Generalized Distress**
    - Intubate if the patient is not breathing!
    - Administer oxygen (flow by, oxygen cage, etc.)
    - Assess effort and sounds
        - Complete airway obstruction - absent sounds, excessive abdominal effort
        - Upper airway disease - stridor (inspiratory vs expiratory), stertor, cough
            - Possible causes - laryngeal paralysis, collapsing trachea, trauma, inflammation, mass/neoplasia, brachycephalic, etc.
        - Lower airway disease - inspiratory and expiratory difficulties, wheezing, coughing
            - Possible causes - asthma/bronchitis
        - Parenchymal disease - increased effort +/- abdominal component, coughing, crackles
            - Possible causes - cardiogenic/noncardiogenic pulmonary edema, infectious (pneumonia, etc.), inflammatory (ARDS), neoplasia, hemorrhage, PTE
        - Pleural disease - dull/decreased lung sounds, shallow/rapid breathing
            - Possible causes - pleural effusion (see pleural effusion section), pneumothorax
        - Chest wall disease - visible flail chest, palpable pain/crepitus
        - Other trauma - absent or abnormal lung sounds, auscultatable GI sounds in the chest, absent GI sounds in the abdomen, etc.
    - Treatment
        - Upper airway
            - Relieve the obstruction via sedation, intubation, tracheostomy, etc.
                - Butorphanol 0.2 mg/kg IV
                - Midazolam 0.1-0.5 mg/kg IV
            - Consider dexamethasone SP 0.1-0.2 mg/kg IV for inflammation
        - Lower airway
            - Bronchodilators
                - Terbutaline 0.01 mg/kg IM/SQ
                - Albuterol 1-2 puffs pRN
                - Aminophylline 4-8 mg/kg IV slow infusion 30-60 minutes
        - Pleural disease
            - Thoracocentesis (see thoracocentesis section)
            - Consider chest tube placement if repeat thoracocentesis needed

- Determine underlying cause via diagnostics (fluid analysis/cytology, radiographs, bloodwork, CT, etc.) and treat underlying cause accordingly
- Parenchymal disease
  - Treat underlying cause accordingly
- Chest wall disease
  - See thoracic trauma in polytrauma section

- **Arrhythmias/Electrocardiogram**
  - Electrocardiogram
    - Electrocardiogram is best used for evaluation of heart rate and rhythm/conduction pattern
      - Use of ECG for chamber enlargement is relatively inaccurate (roughly 50-60% sensitivity)
    - **Standard Calibration of ECG**
      - Paper speed : 50 mm/s (interval between 2 fine lines = 20 msec), 25 mm/s (interval between 2 fine lines = 40 msec)
      - Sensitivity: 10 mm/mV (interval between 2 fine lines = 0.1 mV), 5 mm/mV (2 fine lines = 0.2 mV)
    - **Generation of the ECG:**
      - P wave: Atrial depolarization
      - PR interval: Conduction from SA node through AV node to the ventricle
      - QRS complex: Ventricular depolarization
      - T-wave: Ventricular repolarization
      - QT interval: Complete de-and re-polarization
      - PR interval - blue
      - PR segment - orange
      - QT interval- purple
      - ST segment- green
      - QRS width- red



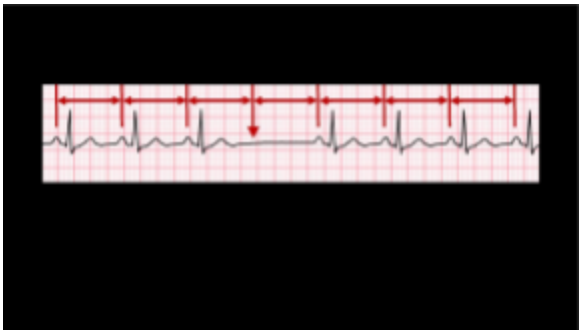
    - **Normal ECG Measurements**
      - Dog PR 60-130 ms, QRS <70 ms, QT 150-240 ms, P duration 40 ms (50 ms giants), P amplitude 0.4 mV, R amplitude >0.5 mV, T amplitude <0.05 -1 mV
      - Cat PR 50-90 ms, QRS <40 ms, QT 160-220 ms, P duration <35 ms, P amplitude <0.2 mV, R amplitude <0.9 mV, T amplitude <0.03mV
    - Arrhythmia – anything other than sinus arrhythmia; Rhythms that originate outside the sinus node, Rate too fast, Rate too slow

        - **FOUR QUESTIONS TO ASK BEFORE INTERPRETING EVERY ECG!**
            - What is the heart rate and the mean electrical axis?
            - Is the rhythm regular or irregular?
            - Is the rhythm supraventricular or ventricular?
            - What is the relationship between the P waves and the QRS complexes? (Is there a P wave for every QRS and vice versa)
        - **HEART RATE CALCULATION**
            - Bic pen method – great for average heart rate; the bic pen (WITH CAP ON) IS 15 CM (eg. 3 seconds in 50 mm/s; 6 secs in 25 mm/s). Count the number of complexes that occur in the span of the bic pen and multiply accordingly (10 for 25 mm/s, 20 for 50 mm/s).
            - Instantaneous rate – great for paroxysmal bursts of tachycardia;
                - 50 mm/s = 3000 mm/60s (there are 3000 tiny boxes in a minute so HR = 3000 divided by the number of tiny boxes in between two complexes; 25 mm/s = 1500 mm/30s (HR = 1500 divided by the number of tiny boxes in between two complexes)
    - **SITES OF NORMAL AUTOMATICITY** (where impulses can be generated)
        - SA Node - Depolarizes at a rate faster than other automatic sites and so normally functions as the PRIMARY pacemaker, rate > 60 bpm in dogs
        - AV Node – will take over sinus rate if low enough; usual rate at 40-60 bpm in dogs
        - Purkinje fibers – rate of 20-40 bpm in dogs
    - **Supraventricular versus Ventricular**
        - Narrow QRS complexes are usually supraventricular, wide (>70 ms) are usually ventricular in origin
    - **ARRHYTHMIAS**
        - <u>Respiratory Sinus Arrhythmia</u> (THIS CAN BE NORMAL IN CATS AND DOGS)
            - Slow HR with expiration, faster HR with inhalation
            - Cause: Alterations in autonomic tone varies impulse origin in the sinus node resulting in variations of p to p intervals (SEE PICTURE)
            - Can be dependent on respiration OR Vagal tone
            - Not present before 4 weeks of age
            - Common to SEE variations in p wave amplitude on beat to beat basis (this is known as wandering pacemaker)

    - **HOW TO DIFFERENTIATE PATHOLOGIC (SSS, AV Block) FROM PHYSIOLOGIC (HIGH VAGAL TONE/DRUG INDUCED) SINUS ARREST**

- Atropine response test (Give 0.04 mg/kg IM/SC, assess ECG every 5 minutes thereafter
  - Positive result (meaning the cause is physiologic) = sinus tachycardia (> 160 bpm)
- Sinus Node Dysfunction (with clinical signs this is known as Sick Sinus Syndrome)
  - Breed predispositions : Miniature schnauzer, Westies, Dachshund, Cocker Spaniel
  - Clinical signs: lethargy, decreased appetite, SYNCOPE (occurs at > 6 seconds of sinus arrest)
  - Treatment: Surgery (Pacemaker implantation), Medical (in order to increase heart rate) ex. Terbutaline, Theophylline, Propantheline bromide Hyoscyamine

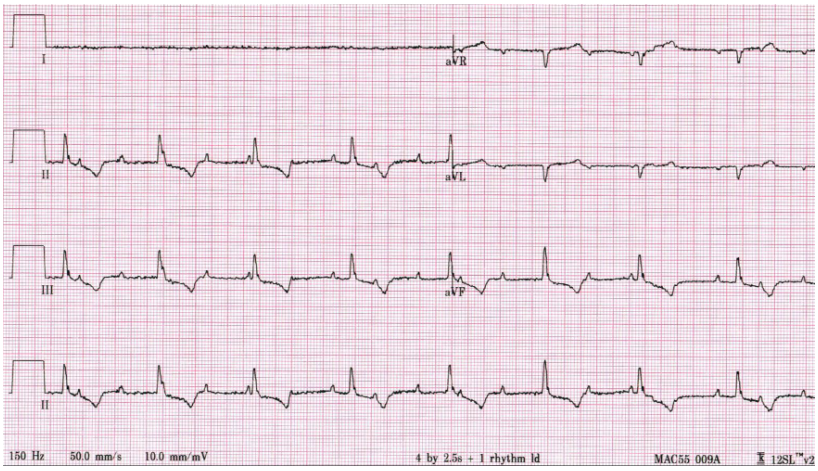
- **HOW TO DIFFERENTIATE ESCAPE BEAT FROM PREMATURE BEAT**
  - Escape beat : late onset depolarization (ventricular = wide; junctional = narrow)
  - Premature beat: early onset depolarization (APC = narrow; VPC = wide)
- **ABNORMAL IMPULSE CONDUCTION**
  - Sinoatrial Block – In the SA node the impulses don't exit the node, commonly secondary to high vagal tone.



  - Bradyarrhythmias that may require a pacemaker : Sick Sinus Syndrome, Persistent atrial standstill, High grade second degree AV Block, third degree AV block.
    - KEY POINTS TO REMEMBER ABOUT PACEMAKERS: They don't require to be turned off for humane euthanasia (ECG after injection can be deceiving)
    - ***YOU MUST REMOVE THE PACEMAKER GENERATOR VIA DISSECTION FROM THE PATIENT BEFORE CREMATION**** If not then you risk blowing up your local crematorium (not cool).
  - **Persistent Atrial Standstill**: NO P WAVES, BRADYCARDIA

    - Secondary to atrial cardiomyopathy

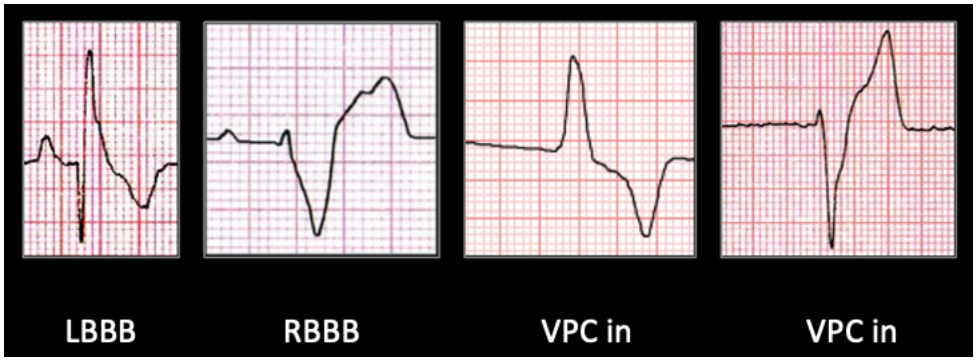
        - Atrium not able to respond to impulses from SA node
    - The ecg is made up of junctional escape beats (40-60 bpm)
    - Breed predisposed for English Springer Spaniels
    - Treatment = Pacemaker implantation
    - Must differentiate from transient atrial standstill (aka sinoventricular rhythm) (NO p waves, normal HR, appears junctional QRS complexes, can be due to digoxin toxicity or hyperkalemia)
- **Atrioventricular Block**
    - **First degree AV Block** – Prolonged PR interval
        - Usually physiologic secondary to high vagal tone or drug induced
    - **Second degree AV Block**
        - Mobitz Type 1 (Wenckebach)
            - Usually physiologic secondary to high vagal tone or drug induced
            - Prolonged PR interval followed by p wave without QRS complex
        - Mobitz Type 2
            - Can be pathologic or physiologic
            - Can progress to 3rd degree AV Block
            - Normal PR interval followed by P wave without QRS complex
            - HIGH GRADE - Multiple p waves without QRS Complexes but association between P and QRS is apparent.
- **Third degree AV Block** (see picture) – always pathologic, AV dissociation



    - No association between the P wave and QRS waves
    - Cause: usually degenerative, but can also be caused by neoplasia, infectious diseases, cardiomyopathy, rarely thyroid disease
    - Cats can be asymptomatic

- Can result in sudden death, secondary organ failure due to poor circulation, syncope, and secondary CHF
- Patient should have full blood panel, SNAP 4DX +/- NCSU tick panel, thoracic radiographs, abdominal ultrasound, echocardiogram, and atropine response test.

○ **Bundle Branch Blocks**- The rhythms originate from the SA node, pass through the AV node normally, but undergo conduction delay in the ventricle. These DO NOT compromise hemodynamics therefore no treatment is needed.
  ■ How to differentiate wide QRS complexes from being ventricular in origin versus bundle branch block (SA in origin)
    - The presence of a P-wave in front of wide QRS complex = BBB
    - The absence of a p-wave = ventricular in origin



○ **ENLARGEMENTS PATTERNS** in lead II (remember this isn't 100% sensitive)
  ■ Enlarged R wave can suggest left ventricular enlargement
  ■ Deep S wave can suggest right ventricular enlargement
  ■ Alternating R wave amplitude with each beat – Electrical alternans
    - This is created by swinging of the long axis of the heart inside the chest. Can occur with pericardial effusion but NOT ALWAYS.
  ■ Deep Q wave can be normal in deep chested dogs

○ **ANTIARRHYTHMIC THERAPY**
  ■ Goals of therapy are rate control and rhythm control.
  ■ Vaughan Williams Classification Scheme (only readily available drugs included in this list)
  ■ Class 1a
    - Quinidine – useful for conversion of atrial fibrillation in horses to sinus rhythm. Not successful in dogs and cats.
    - Procainamide – useful for ventricular tachycardia (usually my #1 or #2 choice) and AV nodal independent SVT.
      ○ Procainamide is dosed in dogs at 2 mg/kg, slow IV bolus, to a maximum cumulative dose of 25 mg/kg over 10–15 min, continuing if needed as a CRI at 25–40 mcg/kg/min or at 10–20 mg/kg, tid-qid, IM or SC. The oral (regular) formulation is dosed at 4–6 mg/kg, PO, every 2–4 hr (maintenance dose every 4 hr), and the sustained-release formulation at 10–20 mg/kg, PO, tid.
  ■ Class 1b

- Lidocaine – useful for ventricular tachycardia (>160-180 hemodynamically significant V tach). Also has been proven to convert dogs out of vagally induced atrial fibrillation/SVT.
    - The typical clinical approach in dogs is to administer 2 mg/kg, IV boluses over ~1 min to effect (slowing the ventricular arrhythmia or conversion to sinus rhythm) or to a cumulative dose of 8 mg/kg over ~30 min. Given the very short half-life, repeat boluses or a CRI (25–75 mcg/kg/min) is needed to maintain rhythm control. Lidocaine is rarely indicated in cats, because clinically significant or life-threatening ventricular arrhythmias are rare in this species. The dosage in cats is 0.1–0.4 mg/kg, IV bolus over ~1 min, then increase to a total dose of 0.25–1 mg/kg, IV slowly, if no response. This can be followed by a CRI (10–20 mcg/kg/min). Lidocaine has few undesirable effects. Toxicity is manifest in dogs primarily as GI and CNS signs. Drowsiness or agitation may progress to muscle twitching and convulsions at higher plasma concentrations. Hypotension may develop if the IV bolus is given too rapidly. In cats, which are more susceptible to toxicity, cardiac suppression and CNS excitation may be seen.
- Mexilitine - oral analogue of lidocaine used to treat ventricular arrhythmias in dogs. It is rarely used as monotherapy for ventricular arrhythmias. It is most often an adjunctive treatment in severe, chronic ventricular arrhythmias not well controlled by sotalol alone or in dogs that do not tolerate sotalol. It should be administered at its lowest effective dose with food to limit toxicity. Common adverse effects include anorexia, vomiting, tremors, and hepatic toxicity. Hepatic enzymes should be evaluated before treatment and periodically (approximately every 6 mo) during chronic treatment as well as any time GI disturbances develop during treatment.
    - The dosage in dogs is 4–6 mg/kg, PO, TID.

■ Class II – Beta Blockers
- β-adrenergic blockers are used for a variety of indications in veterinary medicine, including control of inappropriate or undesirable sinus tachycardia, treatment of ventricular and supraventricular arrhythmias, management of chronic hypertension in dogs and cats, and palliation of adverse effects of uncontrolled hyperthyroidism in cats and pheochromocytoma in dogs.
- Propanolol – non-selective (B1 and B2), half life in dogs (1.5-2h)
    - The dosage in dogs is 0.2–1 mg/kg, PO, tid (titrate dose to effect) and in cats is 0.4–1.2 mg/kg (2.5–5 mg/cat), PO, tid. Use of propranolol should be avoided in dogs and cats with evidence of primary respiratory disease (eg, asthma).
- Atenolol – selective B1, half life in dogs (5-6h), cats (3.5h)

        - Dogs is 0.2–1 mg/kg, PO, bid, and in cats 1–2.5 mg/kg, PO, bid, or 6.25–12.5 mg/cat, PO, bid.
        - In both dogs and cats, titrating up gradually is required, especially if atenolol is initiated in the face of active or stable CHF or in DCM. In general, dogs and cats without CHF and normal systolic function can tolerate higher initial and target dosages. **Abrupt discontinuation should be avoided; if cessation is indicated, titrating down gradually is recommended (this applies to all beta blockers).** If CHF develops in an animal receiving atenolol, the dosage may need to be reduced and the drug eventually discontinued, but unless the CHF is life-threatening, abrupt cessation should still be avoided. Potential adverse effects are dose related and more likely if underlying systolic function is present. Adverse effects include myocardial depression, bradycardia (sinus and AV block), and hypotension.
    - Esmolol – selective B1, this drug is great because of its ultra short duration of action. I've used it in cases to assess if a beta blocker would be helpful in slowing down SVT or V tach or just tachycardia in general. Half Life = 8 minutes. It only comes in IV formulations.
- Class III – K Channel Blockers
    - Sotalol – non-selective, reaches peak plasma concentration, most commonly used long term treatment for hemodynamically significant ventricular arrhythmias in dogs and cats. It is often used as monotherapy for this indication but can be combined with mexiletine if rhythm control is suboptimal with sotalol alone. It has some efficacy in treatment of atrial fibrillation (rate control), but it is not as efficacious as other agents and is not commonly used for this indication. Sotalol is safe and well tolerated and is often used in combination with other drugs commonly used to treat heart disease and heart failure, including ACE inhibitors, furosemide, spironolactone, and pimobendan. Because it has β-blocking effects, it should not be combined with other β-blockers (eg, atenolol) or other negative inotropes (eg, diltiazem). In addition, it should not be combined with another class III agent (eg, amiodarone).
        - The dosage in dogs and cats is 1–2.5 mg/kg, PO, bid. It should be used with caution and at the lower end of the dosage range in patients with CHF or DCM or when combined with mexiletine. In this situation, titrating up (dosage increases every 10–14 days) to a higher target dose may be attempted if lower doses are not efficacious. Dogs and cats with normal systolic function can tolerate higher initial and target doses.
        - Possible adverse effects include negative inotropy, bradyarrhythmia (sinus and AV block), and proarrhythmia.

- Amiodarone – a drug that spans the confines of just one drug class. Its predominant electrophysiologic effect is to prolong the refractory period of atrial and ventricular myocardium and the AV junction. In addition, it has class I effects (sodium channel–blocking properties), some class II effects (β- and α-receptor blockade), and some class IV effects (calcium channel blockade). Amiodarone is used to treat life-threatening ventricular arrhythmias (rhythm control) and atrial fibrillation (rate control) in dogs refractory to other, more common treatments. In some cases, it is used because of its effectiveness in treatment of both ventricular and supraventricular arrhythmias. **It is rarely used as a first-line drug.**
    - Long half life in dogs of 3.2 days
    - Because it has β-blocking effects it should not be combined with other β-blockers(eg, atenolol) or other negative inotropes (eg, diltiazem). In addition, it should not be combined with another class III agent (eg, sotalol).
    - Use as Nexterone if giving IV since IV amiodarone can cause anaphylaxis reaction (due to polysorbate 80)
    - Adverse effects seem to be related to dose and duration of treatment and include significant increases in liver enzymes, GI signs, thyroid dysfunction, blood dyscrasias (neutropenia), and proarrhythmia. The liver effects seem to be the most common adverse effect encountered clinically and are typically reversible after cessation of therapy.
    - The oral dosage in dogs is 8–10 mg/kg, PO, once to twice daily for 7–10 days, and then decreased to 4–6 mg/kg/day for longterm treatment; the parenteral dosage in dogs is 2–5 mg/kg, IV, infused over 30–60 min.

- Class IV – Calcium channel blockers
    - Diltiazem
        - Typically indicated for treatment of **atrial fibrillation (rate control) and other supraventricular arrhythmias in dogs and cats.** Another historical indication is for treatment of feline hypertrophic cardiomyopathy. However, limited practicality in combination with its unconfirmed efficacy for feline hypertrophic cardiomyopathy has caused diltiazem to fall into disfavor for this indication. Diltiazem has no effect on ventricular arrhythmias.
        - Dosage
            - Parenteral: 0.05–0.2 mg/kg, IV, over 5 min, which can be repeated to a cumulative dose of 0.3 mg/kg, after which the dog should be reassessed or an oral formulation initiated
            - Dogs, oral dose:
                - Standard oral formulation: 0.5–2 mg/kg, PO, TID

                - Sustained-release formulation: 1–4 mg/kg, PO, BID
            - Cats, oral dose:
                - Standard oral formulation: 7.5 mg/cat, PO, TID
                - Sustained-release formulation: 30–60 mg/cat, PO, once to twice daily.
            - Initial doses should be at the lower end of the dose range and titrated up to a clinically effective dose.
            - Blood pressure and heart rate and rhythm should be monitored during IV administration.
            - Dogs and cats without CHF and with normal systolic function can tolerate higher initial and target dosages.
            - The sustained-release formulation cannot be made into suspensions but can be reformulated into lower-dose capsules.
        - Possible adverse effects include systemic hypotension, negative inotropy and bradycardia (sinus or AV block), and exacerbation of CHF. GI signs are the common noncardiac adverse effect and are more common in cats, especially with sustained-release preparations.
        - DO NOT USE CONCURRENTLY WITH A BETA BLOCKER
    - Amlodipine has minimal effects on cardiac calcium transport. Primary mechanism of action is on the vascular smooth muscle. Save this puppy for treating systemic hypertension.
- The antiarrhythmic drug that knows no class
    - Digoxin - decrease sinus discharge rate, depress AV node conduction, prolongs AV nodal refractoriness, depresses atrial automaticity, enhances intraatrial conduction velocity.
        - Weak positive inotrope
        - Toxicity more common in hypokalemic state
        - Half life : 14-56 hr in dogs, 23-43hrs in cats
        - Can take 5-7 days before reaching peak plasma concentration
        - Side effects include GI upset, lethargy, anorexia, AV block, bundle branch block, proarrhythmic
            - If side effects apparent, consider testing Digoxin plasma levels to rule out toxicity
        - It is administered to a dose of 0.005-0.01 mg/kg/12 hours PO route or 0.22mg/m2/12 hours by PO route in dogs of more than 20 kg.
        - Useful for atrial fibrillation (some literature supports Digoxin with diltiazem in combination is better to slow heart rate of dogs in atrial fibrillation than diltiazem alone) and supraventricular arrhythmias.
- **Injectables for Ventricular Tachycardia**

            - Lidocaine IV, Procainamide, Magnesium, Esmolol, Amiodarone
        - **Orals for V Tach**
            - Sotalol, Mexilitine, Atenolol, Procainamide
        - **Injectables for Atrial Fibrillation** (rarely needed unless patient is unstable)
            - Diltiazem, Esmolol
        - **Orals for A Fib**
            - Diltiazem, Digoxin, Atenolol
- **Congestive Heart Failure (CHF)**
    - Can occur secondary to any underlying heart disease; MMVD by far most common in dogs
    - Common history
        - Canines: typically have history of heart murmur on routine physical exam (not always), coughing, weakness or exercise intolerance, abdominal distention, collapsing/fainting episodes (syncope), orthopneic position
        - Felines: may or may not have history of heart murmur or cardiac arrhythmia on routine physical exams; labored breathing, open mouth breathing, coughing
    - Clinical signs - tachypnea, dyspnea, orthopneic position, +/- heart murmur (dog should have a heart murmur, cat not necessarily), crackles, cyanosis
    - Diagnostics
        - Thoracic radiographs - cardiomegaly, pulmonary venous distention (not always present), pulmonary edema (generally perihilar/caudodorsal interstitial). +/- elevation mainstem bronchi
        - Baseline CBC/CHEM ideal - at minimum obtain kidney values and electrolytes
        - USG to check kidney function (if able)
        - BP
        - SpO2 if able/not stressing patient out too much
        - Ideally echocardiogram when patient is stable enough and if available
    - Treatments
        - Oxygen! (Flow-by, O2 cage, nasal cannula, etc.)
        - Sedate as needed - butorphanol 0.2 mg/kg IV/IM
        - When in doubt, give a 2 mg/kg dose of furosemide IV or IM - if not heart failure, a single dose is unlikely to cause any serious issue (like contributing to underlying kidney disease)
        - Continuing diuretic therapy
            - Furosemide boluses 2-4 mg/kg IV PRN (generally q2-6 hrs depending on patient status)
            - Furosemide CR @ 0.5-1 mg/kg/hr
                - I generally choose this if the patient is severely dyspneic and needs minimal handling

            - Reduce/Discontinue once resp rate and effort have improved and switch to boluses/oral medications
        - Positive inotrope
            - Pimobendan (dogs) - 0.5 mg/kg PO daily, divided into q12hr dosing (0.2-0.3 mg/kg PO q12hrs)
                - My criticalist taught me to start this in canine patients even when in severe distress (“shove it down their gasping throats,” she said!)
    - Monitoring
        - Monitor RR/RE q1hrs
        - Monitor SpO2 q4-6 hrs if patient will tolerate it
        - Monitor kidney values and electrolytes q6-24hrs depending on patient status
        - +/- recheck radiographs
    - Prognosis - variable
        - First time CHF generally respond well to therapies
        - Long term prognosis guarded
        - Always strongly recommend consult with cardiologist once stable enough
- **Pleural Effusion**
    - Fluid accumulation in the pleural space that is abnormal (normal to have 2-3 mLs fluid as lubricant for the lungs)
    - Generally more common in cats thats dogs
    - Possible causes - congestive heart failure, neoplasia, FIP (cats), chylothorax, infectious/pyothorax, hemorrhage/coagulopathies, inflammatory, idiopathic etc
    - History - labored breathing, abdominal component, open mouth breathing (cat), exercise intolerance, coughing, lethargy
    - Clinical sign - tachypnea, increased effort, abdominal effort, shallow breathing, open mouth breathing, cyanosis, dyspnea, muffled heart and lung sounds (ventral)
    - Diagnostics
        - Thoracic radiographs
        - US
        - Thoracocentesis - see centesis section; submit fluid for fluid analysis and cytology
        - ProBNP
            - Used to differentiate between cardiac vs noncardiac effusion
            - Can be run on both serum or pleural effusion
            - Cardiac effusion leads to much higher levels of NT-proBNP
            - Available only for cats at this time
    - Treatment
        - Thoracentesis - both diagnostic and therapeutic; consider chest tube placement if recurrent taps needed
        - Oxygen support as needed

        - Furosemide if cardiac related (See CHF section)
        - Further treatment dependent on underlying cause
    - Prognosis - variable; depends on underlying cause
- **Pneumonia**
    - Inflammation of the lungs → fluid accumulates in alveoli
    - Potential causes - aspiration, infectious causes (bacterial, viral, fungal, parasitic, protozoal), chemical or smoke inhalation
    - History - coughing, difficulty breathing, labored breathing, hyporexia/anorexia, nasal discharge
        - Remember to ask about recent travel!
    - Clinical signs - tachypnea, cyanosis, dyspnea, coughing, crackles, fever
    - Diagnostics
        - CBC - leukocytosis, neutrophilia +/- left shift, lymphopenia, +/- anemia
        - Radiographs - alveolar pattern (ventral), +/- bronchiolar, interstitial, or mixed; aspiration - usually right middle, right cranial and caudal portion left cranial lobes affected
        - SpO2
        - BAL - consider for cytology and culture
        - Serology/testing for infectious agents as indicated
    - Treatment
        - Oxygen as needed
        - IVF therapy
        - Nebulization and coupage
        - Antibiotic therapy
            - Go to: Unasyn 22-30 mg/kg IV q8hrs + enrofloxacin 10 mg/kg IV q24hrs
            - Other options - 2nd/3rd gen cephalosporin + fluoroquinolone or aminoglycoside
    - Prognosis - good to variable, depending on the underlying cause and concurrent conditions
- **Collapsing Trachea**
    - Narrowing of the diameter of the tracheal lumen - due to weakness of the tracheal rings, redundant tracheal membrane, or combination
    - Exact cause unknown; potential exacerbating causes - obesity, smoke/pollutant/allergen/irritant inhalation, CHF, excitement, etc.
    - Potential history - coughing when excited/active, “goose honk” cough, collapse, cyanosis, respiratory distress; small breed dogs usually
    - Clinical signs - stertor/stridor, cyanosis, tachypnea
    - Diagnostics
        - Radiographs - need to be taken both expiratory/inspiratory to catch dynamic movement of trachea
        - Fluoroscopy
        - Bronchoscopy gold standard diagnostic

- Therapy
    - Oxygen as needed; intubate if severe distress/respiratory arrest imminent
    - Sedation - butorphanol, acepromazine, midazolam
    - Dexamethasone SP if inflammation suspected/contributing
    - Bronchodilators - theophylline, terbutaline, albuterol
    - Antitussive - hydrocodone
    - Surgical intervention/stent placement if collapse worse than 50%, patient is not responding to medical management
        - Considered a salvage procedure
- Prognosis - variable; no cure, will likely continue to worsen over time

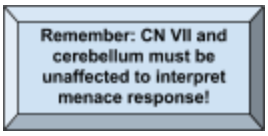
Neuro

- **Exam**
    - Mentation/behavior
        - Mentation - level of consciousness
            - Normal - alert
            - Obtunded - lethargic, dull, less responsive to normal stimuli
            - Stuporous - asleep, but may be aroused by strong stimulation; only aroused when stimulated
            - Comatose - unconscious; no cerebral response to noxious stimuli
            - Demented - inappropriate response to normal stimuli
        - Behavior - animals may be alert with normal consciousness but exhibit abnormal behavior - aggression, tail chasing, fly biting, etc.
    - Gait and posture
        - How is the animal walking?
            - Ataxia
                - Sensory or vestibular deficits
            - Paresis - decrease in voluntary movement
                - Monoparesis - one leg paresis
                - Paraparesis - pelvic limb paresis
                - Hemiparesis - same side thoracic limb and pelvic limb paresis
                - Tetraparesis - all limbs paresis
            - Weakness
            - Paralysis
            - Non-ambulatory
        - Is there any involuntary movement?
            - Tremors
            - Myclonus
            - Fasciculations
        - Posture/attitude
            - Head tilt

- Decerebrate rigidity - comatose, all limbs extended
- Decerebellate rigidity - not comatose, extended thoracic limbs
- Opisthotonus - rigid extension of head and neck
- Schiff-Sherington - paraplegic, forelimbs hypertonic, seen with severe injury T3-L7

- Cranial nerves (CN)
  - I - Olfactory Nerve
    - Function: smell
    - No reliable and easy test can be performed to evaluate. Can clinically observe response to odor/food.
  - II - Optic Nerve
    - Function: carry image from retina to visual cortex
    - Evaluated by: maze test, menace response, pupillary light reflexes
  - III - Oculomotor Nerve
    - Function: pupil constriction, eye movements
    - Evaluated by: pupillary light reflexes, evaluating for strabismus and nystagmus
  - IV - Trochlear Nerve
    - Function: eyeball position
    - Evaluated by: inducing physiologic nystagmus
  - V - Trigeminal Nerve
    - Function: sensation for most of the head, innervation to masticatory muscles
    - Branches: ophthalmic, maxillary, and mandibular
    - Evaluated by
      - Masticatory muscle symmetry and size (mandibular branch)
      - Palpebral reflexes
        - Medial canthus of eye: ophthalmic branch
        - Lateral canthus of eye: maxillary branch
      - Corneal reflex (ophthalmic branch)
  - VI - Abducens Nerve
    - Function: eyeball position
    - Evaluated by: inducing physiologic nystagmus
  - VII - Facial Nerve
    - Function: facial symmetry; movement of muzzle, eyelids, ears, and external nares
    - Evaluated by: menace response, palpebral reflexes, assessing facial symmetry
  - VIII - Vestibulocochlear Nerve
    - Function: hearing (cochlear) and vestibular function
    - Evaluated by:

        - Cochlear part only able to be objectively assessed with electrodiagnostic testing (BAER)
        - Vestibular part: observe for head tilt and abnormal nystagmus
    - IX - Glossopharyngeal Nerve
        - Function: pharyngeal function
        - Evaluated by: assessing swallowing, gag reflex, patient history (presence of dysphagia/choking while eating or drinking)
    - X - Vagus Nerve
        - Function: pharyngeal and laryngeal function
        - Evaluated by: assessing swallowing, gag reflex, patient history (owner reports dyspnea, snoring, or voice change; presence of dysphagia/choking while eating or drinking)
    - XI - Accessory Nerve
        - Function: laryngeal function
        - No reliable and easy test can be performed to evaluate
    - XII - Hypoglossal Nerve
        - Function: tongue innervation
        - Evaluated by: observing symmetry and function of tongue
- Cranial Nerve Assessment Tests
    - Menace Response - Optic Nerve (CN II) and Visual Pathways
        - Patient must have cognitive function (i.e., able to register the menacing gesture) as well as facial nerve (CN VII) and cerebellar function to obtain normal response
            - Not a true reflex as it involves cerebellum
        - Evaluation of entire visual pathway (retinas, optic nerves, optic chiasm, optic tracts, optic radiations, occipital cortices)
            - Presence of appropriate menace response indicates integrity of visual pathway
            - Absence of appropriate response indicates dysfunction along visual pathways



    - Pupillary Light Reflexes (PLRs)
        - Afferent (sensory) path: retinas, optic nerves, optic chiasm
            - Menace response should be evaluated first
        - Efferent (motor) path: oculomotor nerve (CNN III)
        - Pupils should be examined for size at rest, symmetry, as well as presence of PLRs
            - Dilated pupils are normal for patients in hospital setting, especially if stressed or painful
        - PLRs:
            - Use strong light source to evaluate pupil constriction
            - Evaluate direct and consensual reflexes

        - If menace is present, but pupil is not responsive to bright light→ CN III ipsilaterally is affected
        - If menace absent, PLR present→ lesion is above optic chiasm
- Eye Position and Movement
    - Evaluate for presence of strabismus (fixed abnormal eye position)
    - Induce physiological nystagmus
        - Move head (or entire patient if small) horizontally from side to side→ should see coordinated conjugate eye movements
        - Involves eye muscles, CN III, CN IV, CN VI, medial longitudinal fasciculus (MLF), and CN VIII
            - MLF = transmits info from vestibular apparatus and CN VIII to CN III, IV, and VI
    - Dysfunction of CN III: eye on affected side appears immobile when inducing physiological nystagmus
- Masticatory Muscle Assessment
    - Evaluate for symmetry and size
    - Innervated by mandibular branch of trigeminal (CN V)
    - Masticatory muscles can atrophy with chronic illness
- Palpebral Reflexes
    - Touch medial canthus and lateral canthus→ observe for blink
    - Afferent (sensory): trigeminal nerve (CN V)
        - Medial canthus: ophthalmic branch
        - Lateral canthus: maxillary branch
    - Efferent (motor): facial nerve (CN VII)
- Auriculo-palpebral reflexes
    - Touch base of inner pinnae→ observe for blink, twitching of ear, or shaking of head
    - Afferent (sensory): mandibular branch of CN V
- Corneal Reflex
    - Touch center of cornea with moist cotton swab→ observe for retraction of globe +/- blink
    - Afferent (sensory): ophthalmic branch of CN V
    - Efferent (motor): CN VI +/- VII
- Trigeminofacial Reflex/Vibrissae Response
    - Touch area of maxillary whiskers/upper lip→ observe for blink, lip pull, or turning head away
    - Afferent (sensory): CN V
- Stimulating Nasal Septum
    - Helps to determine if information from afferent CN V is getting to cerebral cortex
    - Gentle, blunt stimulation of nasal mucosa on medial nasal septum→ observe for pulling head away (cortical response)

- Postural reactions
    - CPs
    - Hopping
    - Placing
    - Wheelbarrowing
    - Extensor postural thrust
- Muscle size
    - Evaluate size, symmetry, and tone
- Spinal reflexes
    - Patellar
    - Pelvic limb withdrawal
    - Perineal
    - Panniculus
- Palpation/pain evaluation
- Specific lesion localization
    - Above foramen magnum
        - Seizures
        - Mentation changes
        - CNN deficits
        - Head tilt
        - Postural deficits on contralateral side
    - Spinal cord segments
        - C1-C5
        - C6-T2
        - T2-L3
        - L4-S3

- **Spinal Pain/T3-L3 Myelopathy**
    - Possible causes - soft tissue injury, IVDD, vascular/FCE, infectious, inflammatory, neoplasia, other trauma
    - Common history - jumping up/down off furniture and crying out, decreased activity, hesitancy or inability to use the stairs, holding head low, crying out in pain, hunched posture, other trauma etc.
    - Clinical signs - hunched posture, palpable spinal pain, stiff gait (especially in pelvic limbs), +/- tetra vs paresis, ataxia, delayed or absent CPs in the affected limbs
    - Diagnostics
        - Radiographs - may see narrowed/wedged disc spaces or mineralized discs, spondylosis, other evidence of trauma, bony neoplasia, etc.; pets with severe hip arthritis can sometimes also have loss of normal neuro reflexes in pelvic limbs
        - CHEM/NSAID panel - prior to prescribing anti-inflammatories
    - Treatment options
        - Pain management and strict rest

                - Strict cage rest for 2-8 weeks depending on severity of signs
                - Medications - anti-inflammatory (steroids vs NSAIDs) + opioid or gabapentin +/- methocarbamol
                - Recheck in 2 weeks, sooner if any concern of loss of motor
            - Acupuncture/rehabilitation/physical therapy if available in your area/client interested
            - Pursue surgical intervention if motor is lost
    - Prognosis - good to excellent with strict rest and pain management
- **Acutely Down**
    - Common history - see above, plus unable to use/move back legs
    - Clinical signs - loss of cutaneous trunci reflex somewhere in T3-L3 region, spinal pain severe paresis to paralysis of the pelvic limbs, absent CPs pelvic limbs, minimal to absent motor
        - If motor is absent, check for superficial pain. If absent, check for deep pain. Remember to differentiate between pain response and withdrawal.
    - Diagnostics
        - Myelogram
        - Ideally CT or MRI (generally CT better for disc extrusion, MRI better for other causes) in preparation for surgery
    - Treatment options
        - If losing motor function or motor is lost, surgery is recommended.
        - If surgery is not an option, can try strict rest and medications (see above in back pain) and other modalities but warn owner about strong potential for permanent paralysis
        - Acupuncture/physical therapy if surgery cannot be pursued
    - Prognosis - varied
        - If losing deep pain and surgery is not pursued within 48 hours, prognosis is extremely poor for return to function
        - Good prognosis if surgery pursued after motor is lost but before superficial pain is lost
        - Always warn owners that neurologic status could be worse after surgery
- **Seizures**
    - Increased abnormal electrical activity in the brain
    - Potential causes - epilepsy (idiopathic), neoplasia, inflammatory, infectious, vascular, trauma, toxin, metabolic, congenital
    - Common history - visualized seizure activity, behavior changes at home (post-ictal vs intracranial disease)
    - Stages
        - Pre-ictal/prodrome - animals may or may not have one
            - Behavioral changes (anxious, clingy, fearful, aggressive, etc.)
        - Ictus - actual seizure event
        - Post-ictal - recovery period after the seizure

            - Blindness (generally temporary), behavior changes (see above), confusion, pacing, ataxia, etc.
    - Clinical signs
        - Generalized seizures - loss of consciousness, paddling/tremoring or rigid extension/flexion of limbs, salivating, +/- urination/defecation, vocalization
        - Focal/partial seizures - abnormal twitching or movement of face (lips, muzzle, ears, eyelids) or limbs, +/- loss or change of consciousness
    - Diagnostics
        - CBC/CHEM/UA - rule out toxic/metabolic and other causes of seizures; will likely be normal in cases of epilepsy
            - If hypoglycemic, consider insulin:glucose ratio to rule in/out insulinoma
        - Bile acids
        - Thoracic radiographs to screen for neoplastic process
        - If able, MRI +/- CSF analysis with neurologist
    - Treatment options
        - If pet has only had one seizure and has a normal neurologic exam +/- normal diagnostics (if owner willing to do), then no medication necessary at that time
        - Medications warranted if pet is having 2+ seizures in a 6 week period or if cluster seizures (2+ seizures in a 24 hr period) are occurring, seizures are lasting >5 minutes, post-ictal period is prolonged/patient not recovering normally
        - Stop active seizures with benzodiazepine
            - Diazepam 0.5-2 mg/kg IV or rectal if IV access cannot be gained; 0.5 mg/kg intranasal if IV access cannot be gained
            - Midazolam 0.3-0.5 mg/kg IV/IM
            - Quick dose for both - guess weight in kgs and move decimal point over (both concentrations of drug 5 mg/mL, dose 0.5 mg/kg)
                - Example - 10 kg dog will get 1 mL of diazepam/midazolam IV
                - Example - 24 kg dog will get 2.4 mLs of diazepam/midazolam IV
        - Long acting anti-convulsants
            - Phenobarbital
                - Dogs
                    - If continued seizure activity - 2-8 mg/kg IV q4-6hrs
                    - Load to a total dose of 16-20 mg/kg
                        - Example 4 mg/kg IV q4-6hrs for 4 doses
                    - Oral dose to go home with - 1-2.5 mg/kg PO q12hrs
                    - Recommend owners check phenobarbital levels 2-4 weeks after with PDVM

                - Advise owners of need to monitor liver values and phenobarbital levels for life
            - Cats
                - 3 mg/kg IV
                - Load to 16-20 mg/kg IV
                - PO dose 1-3 mg/kg PO q12hrs
        - Keppra (Levetiracetam)
            - Dogs
                - 60 mg/kg IV once over 15 minutes
                - Oral doses
                    - 20 mg/kg PO q8hrs
                    - 30 mg/kg PO q12hrs if XR
                        - XR comes in 500/750/1000 mg capsules, so XR may not be option for smaller pets
            - Cats
                - 20 mg/kg IV q8hrs
                - PO dose 20 mg/kg PO q8-12hrs
        - Zonisamide and KBr are not really used in an emergency setting but can be considered in adjunct to phenobarbital/Keppra for improved control at home
- Status
    - Benzodiazepines
        - Diazepam CRI - 0.1-2 mg/kg/hr IV until seizures stop
            - Make with 0.9% NaCl or D5W
            - Once seizures stop, reduce dose by 50% q 4-6 hrs x2 before discontinuing
        - Midazolam CRI - 0.05 - 0.5 mg/kg/hr IV (Cats 0.2 mg/kg/hr IV)
    - Propofol
        - Canine - start with bolus first of 1-4 mg/kg IV to evaluate response/if CRI needed for status epilepticus - give bolus to effect.
            - If seizures recur after 1-2 injections, consider switching to a propofol CRI - 0.1-0.6 mg/kg/min titrated to effect
        - Feline - start with bolus first of 1-4 mg/kg IV to evaluate response/if CRI needed for status epilepticus- give bolus to effect
            - If seizures recur after 1-2 injections, consider switching to a propofol CRI - 0.1-0.4 mg/kg/min titrated to effect
    - If cannot get status under control after loading on phenobarbital and/or Keppra and using the above CRIs, prognosis is extremely poor - refer to neurologist or consider euthanasia

Ophtho

- **Conjunctivitis**
  - Inflammation of the conjunctiva
  - Possible causes
    - Dogs - generally noninfectious - environmental allergens, trauma, etc.
    - Cats - generally infectious - herpes, calicivirus, etc.
  - History - red eyes, rubbing at eyes, eyes appear swollen, eye discharge
  - Clinical signs - blepharospasm, chemosis, hyperemia, ocular discharge (may be clear or purulent), pruritis, etc.
  - Diagnostics (in this order)
    - Schirmer tear test
    - Tonometry
    - Fluorescein stain - look for positive uptake indicating corneal abrasion
  - Treatment
    - Cats - topical erythromycin, oxytetracycline, or chloramphenicol
      - Do NOT use Neo/Poly/Bac in cats - the polymyxin and neomycin have been reported to cause anaphylaxis in some cats
    - Dogs - Neo/Poly/Bac with dex/hydrocortisone
    - E-collar
  - Prognosis - good
- **Corneal Ulcers**
  - Trauma to the cornea
  - History - squinting, pawing/rubbing at eye
  - Clinical signs - blepharospasm, hyperemic/inflamed conjunctiva, epiphora, +/- visible corneal defect
  - Diagnostics
    - Fluorescein stain - look for positive uptake indicating corneal abrasion
    - Consider Schirmer tear test to rule out KCS - do before stain
  - Treatment
    - Topical antibiotic - neo/poly/bac, neo/poly/gram, erythromycin, etc
    - Avoid steroids!
    - Consider oral NSAID/opioids/gabapentin if significant discomfort
    - E-collar
    - Recheck in 7-10 days
  - Prognosis - simple ulcers generally good
- **Glaucoma**
  - Reduced drainage of aqueous humor leading to elevated intraocular pressure (IOP)
  - Primary vs secondary
    - Primary - hereditary or breed related (more common in purebred dogs - Asian breeds, spaniels, etc.)

        - Secondary - develops secondary to obstruction of aqueous humor outflow/circulation
            - Anterior lens luxation, uveitis, hyphema
            - Neoplasia, iris melanosis
            - Intraocular surgery
            - Trauma
    - History - rubbing at eyes, acting painful, acute blindness, difficulty navigating/bumping into things
    - Clinical signs - blepharospasm, corneal edema, mydriasis, ocular discharge, episcleral injection, +/- loss of vision in the affected eye
    - Diagnostics
        - Tonometry
            - Always perform on both eyes for comparison
            - Normal values
                - Dog - 10-20 mmHg (can go up to 24 with stress/rebound tonometry)
                - Cat - 10-20 mmHg (can go up to 24 with stress/rebound tonometry)
            - If >50, needs intervention immediately to try and save vision
    - Treatment
        - If >50 mmHg
            - Dogs - use prostaglandin analogue (latanprost, etc.) in the affected eye - give every 10-15 minutes for 2-3 doses
            - If IOP remains elevated, then give mannitol (1-2 g/lg IV) slowly over 20 minutes. Can repeat 1 hour later if no improvement; remember to slowly reintroduce water intake
            - For cats, follow mannitol protocol, then refer
        - E-collar
        - Refer to ophthalmologist ASAP!!!
- **Globe Trauma/Prolapsed Globe**
    - Acute expulsion of the globe from the orbit
    - Usually occurs from trauma
    - May occur from very minimal trauma in brachycephalic breeds due to anatomy
    - Clinical signs - globe is anterior to eyelids/orbit; PLRs/menace may or may not be intact; associated evidence of trauma (hemorrhage, bruising, corneal ulceration, skull fractures etc.)
    - Diagnostics
        - Pre-anesthetic bloodwork ideal
        - Skull radiographs if indicated on physical exam
    - Treatment
        - Requires immediate surgical intervention - either replacement of globe or enucleation
            - If >2 ocular muscles torn, recommend enucleation

        - Lube eye until surgery can be pursued and put hard e-collar on
        - Perform under general anesthesia
        - Reduction/globe replacement and tarsorrhaphy
            - Manipulate the eyelids anteriorly and away from the globe - grasp the eyelids close to the dorsal/ventral margins
                - Strabismus hooks
                - Towel clamps
                - Allis forceps
                - Preplaced horizontal mattress sutures
            - Manipulate eyelids over globe while putting gentle pressure on the cornea/globe to replace it back into the orbit
            - Consider lateral canthotomy if severe swelling/globe cannot be replaced
            - Perform temporary tarsorrhaphy to close central and lateral palpebral fissure
                - Horizontal mattress sutures 3-0 to 5-0 nonabsorbable suture - use stents to prevent sutures from pulling through eyelids or putting too much pressure on skin/avoid tissue necrosis
                - Pass suture into the free edge of the eyelid margin through the meibomian gland so suture will not rub on cornea
                - Leave opening medially to apply topical medication
        - Enucleation
            - Pursue if severe trauma or avulsion of optic nerve
            - Remember to remove the eyelid margins, third eyelid, and conjunctiva to remove/avoid future complications from residual adnexal tissues
        - Medications
            - Oral NSAIDs (carprofen, meloxicam, etc.)
            - Analgesics (codeine, gabapentin, tramadol, etc.)
            - Oral antibiotics if severe soft tissue injury from trauma or trauma from bite wounds
            - Topical antibiotics and artificial tear ointment q8hrs for 10-14 days
        - E-collar always!!!!
        - Recheck 5-7 days after initial procedure; ideally leave tarsorrhaphy for 10-14 days
    - Potential complications/warn owers
        - Loss of vision/damage to the optic nerve (despite surgical intervention)
        - Development of KCS
        - Permanent corneal disease/damage
        - Glaucoma
        - Deviation of globe from normal position
        - Need for second surgery

- Prognosis
  - Favorable indicators
    - Vision present at time of procedure
    - No damage to extraocular muscles
    - <2 extraocular muscles affected
    - No/minimal intraocular hemorrhage
    - Brachycephalic
  - Poor prognostic indicators
    - Proptosis in mesocephalic/dolichocephalic breeds or cats
    - Optic nerve damage
    - Non-visual
    - Moderate to severe intraocular hemorrhage
    - >2 extraocular muscles affected
    - Concurrent facial fractures

Gastrointestinal

- **Vomiting**
  - One of the most common clinical signs in animals
  - Potential causes (everything! lol)
    - GI
      - Dietary indiscretion, food allergy
      - Obstruction
      - IBD
      - Pancreatitis
      - Poor/delayed gastric motility
      - Parasites
      - Infectious causes (parvo, panleukopenia, bacterial, etc.)
      - Neoplasia
    - Non-GI
      - Toxins
      - Endocrine (Addison's, diabetes mellitus, DKA, etc.)
      - Vestibular disease
      - Other CNS disorders
      - Pyometra
      - CHF
  - Hematemesis
    - Causes
      - GI ulceration
        - Foreign body, IBD, neoplasia
        - Toxins, drugs, uremia secondary to liver or kidney failure, infectious, Addison's
      - Coagulopathies

            - Swallowing blood from elsewhere
    - History
        - Determine whether vomiting vs regurgitation
        - Determine acute vs chronic
    - Clinical signs - active vomiting, dehydration, abdominal discomfort or pain, nausea, ptyalism, potential palpable foreign body/intussusception/neoplasia/pyometra etc.
    - Diagnostics
        - Bloodwork
            - PCV/TS or blood gas versus CBC/CHEM
                - Metabolic alkalosis concerning for pyloric outflow obstruction
            - Spec fPL or cPL if concern for pancreatitis
            - Consider baseline cortisol or ACTH stim if concern for Addisons'
            - Consider GI panel if chronic signs
        - Radiographs - look for foreign body vs obstructive pattern vs linear/plication pattern vs neoplasia vs evidence of effusion/peritonitis
        - US - focal GI US good to rule in/out obstruction if radiographs are suggestive but not clear cut; otherwise excellent modality to rule in/out other causes of vomiting (masses, GI thickening, pancreatitis, concern for diffuse neoplasia, delayed motility/gastric emptying, etc.)
        - Fecal - look for GI parasites
        - Consider ParvoSnap test if unclear/unknown/incomplete vaccine history
    - Treatment
        - IV fluid therapy - correct dehydration and any electrolyte imbalances
        - Antiemetics - maropitant (1 mg/kg IV/SQ), ondansetron (0.5-1 mg/kg IV/SQ), metoclopramide (0.5 mg/kg SQ, CRI @ 2 mg/kg/day)
            - If any concern about foreign body, do not administer maropitant or metoclopramide
        - If concern for GI ulceration
            - Antacids (pick one or the other)
                - Famotidine 0.5-1 mg/kg PO q12hrs
                - Omeprazole 0.5-1 mg/kg PO q12-24 hrs
            - Sucralfate
                - 0.25-1 gram slurry PO q8hrs
        - Bland diet
    - Monitoring
        - BP for hypotension
        - Electrolytes q6-24hrs as indicated
        - Repeat imaging as indicated
    - Prognosis - variable; generally good unless significant underlying disease process
- **Diarrhea**

- Acute vs chronic (2-4+ weeks)
- Potential causes
  - Dietary indiscretion/change in diet/new treats
  - Infectious (parasitic, parvovirus, panleukopenia, salmonella, clostridium species, etc.)
  - Foreign bodies/obstruction
  - Inflammatory Bowel Disease
  - Neoplasia
  - Drugs/toxins (antibiotics, NSAIDs, steroids, chemotherapy, etc.)
  - Stress
- History - change in stool consistency to be looser (may be soft or liquid) +/- blood present, +/- vomiting, lethargy, weight loss, etc.
- Clinical signs - dehydration, change in stool consistency on rectal, abnormal abdominal palpation
- Diagnostics
  - Fecal - look for parasites, bacterial overgrowth, etc
  - CBC - hemoconcentration, elevated white blood cell count, anemia (if chronic/hemorrhage), +/- left shift
  - CHEM - hypoproteinemia, pre-renal azotemia, hepatopathy, electrolyte derangements
  - Radiographs - may show fluid filled intestines, not overtly diagnostic, helpful to rule out foreign body
  - US - look for changes in GI wall layer thickness, changes in motility, etc.
  - Biopsies via endoscopy or surgical biopsies ideal for diagnosis of chronic GI disease (IBD vs LSA vs other)
  - Consider baseline cortisol or ACTH stim if concern for Addisons'
  - Consider GI panel if chronic signs
- Treatment
  - Fluid therapy - if mild consider outpatient, if significantly dehydrated or hypovolemic, consider hospitalization and IV fluid therapy
  - Antibiotics
    - Metronidazole 10 mg/kg IV/PO q12hrs for 5-7 days
    - If concern for GI translocation, add unasyn 30 mg/kg IV q8hrs
  - Probiotics
  - Antiemetics if vomiting/nausea
  - Deworming if indicated
  - Bland therapy
- Prognosis - variable but generally good

- **HGE/AHDS**
  - Hemorrhage Gastroenteritis or Acute Hemorrhagic Diarrhea Syndrome
  - Most common in dogs; most common in small breed dogs
  - Unknown etiology - sometimes associated with dietary indiscretion, Costridium exposure, etc.

- History - bloody diarrhea/hematochezia, lethargy, vomiting, collapse, anorexia; usually within a relatively short time frame (<12 hours)
- Clinical signs - hematochezia/bloody diarrhea on rectal, severe dehydration, tachycardia, abdominal discomfort, absent to weak pedal pulses, cool extremities, other evidence of hypovolemic shock
- Diagnostics
  - See diarrhea section
  - Mainstay - PCV >60% (often >65%)
  - May see evidence of significant hypovolemic shock/sepsis - hyperlactatemia, hypoglycemia, metabolic acidosis
- Therapy
  - Aggressive IV fluid therapy
    - Boluses ideally until hypotension resolved
    - Replace deficits over 12 hour period
    - Consider vasopressor therapy if has received shock volume of fluids and hypotension continues
    - Supplement hypokalemia as needed
  - Antiemetics - maropitant, ondansetron
  - Antacids - pantoprazole, famotidine
  - Antibiotics
    - Metronidazole 10 mg/kg IV/PO q12hrs for 5-7 days
    - If concern for GI translocation/sepsis, add unasyn 30 mg/kg IV q8hrs
  - Probiotics when eating
  - Bland diet
- Prognosis - variable; generally good with early intervention; poor with concurrent sepsis

- **Pancreatitis**
  - Inflammation of the pancreas; occurs when pancreatic proenzymes are activated and then released into the pancreas which leads to autodigestion
  - Potential causes - many times unknown/idiopathic; can be associated with high fat meal/dietary indiscretion, obesity, concurrent endocrinopathies, etc.
  - Clinical signs - anorexia, vomiting, abdominal pain (can be severe), diarrhea, fever, lethargy, dehydration
  - Potential concurrent complications
    - Ileus - mild to severe
    - Hepatopathy
    - Coagulpathies/DIC
    - Pancreatic abscess
  - Diagnostics
    - CBC - normal to inflammatory; in cases with severe pancreatitis - thrombocytopenia (DIC), left shift, anemia

        - CHEM - elevated amylase/lipase, +/- elevated liver enzymes, hypo/hyperglycemia, hypoalbuminemia
        - Snap cPL/fPL - can be helpful in indicating pancreatitis
        - Spec cPL/fPL - test of choice to to identify pancreatitis
        - US - can also identify pancreatitis, plus concurrent issues (ileus, pyloric foreign body, neoplasia, etc.)
        - Radiographs - can see loss of serosal detail in right cranial quadrant but is subjective and not always present
    - Treatment
        - Supportive care - no magic fix - always remind owners of this
        - Fluid therapy - correct dehydration, electrolytes, any acidosis
        - Antiemetics - maropitant, ondansetron
        - Prokinetics - metoclopramide, cisapride
        - Pain control - opioids (these may contribute to ileus), gabapentin if able to take oral medications
        - Begin nutritional support if it has been 2 days or more without eating (NG tube, e-tube, PEG tube, etc.)
        - Consider antibiotics if concern for pancreatic abscess/infection
    - Monitoring
        - BPs
        - EPOCs
        - Can do serial spec cPL to monitor levels
        - Can do serial USs
        - If concern for development of DIC, PT/PTT and CBCs to monitor platelets
    - Prognosis - variable; can be very mild and treated as an outpatient or very severe and requiring several days of hospitalization (longest I've seen is 4 weeks but the pet went home!)
- **Parvoviral Enteritis**
    - History/Signalment: typically young dogs (6 wks to 6 mo), with poor vaccination history; can occur in unvaccinated dogs of any age
    - Incubation period 2-14 days, typically show clinical signs 4-7 days post-exposure
    - Transmission: shed in feces
        - Active viral shedding typically present for ~2 wks, but can rarely persist for ~1yr
        - Can remain infectious in contaminated ground/soil for >5 months
    - Clinical signs/PE: vomiting, diarrhea (often bloody, mucoid, and/or watery), anorexia, lethargy, abdominal pain, dehydration
    - Diagnostics
        - Bloodwork
            - CBC: leukopenia, lymphopenia, neutropenia, anemia, and thrombocytopenia common; panleukopenia and severe neutropenia occur in severe cases

            - Serum Chemistry: hypoproteinemia, hypoalbuminemia, and hypoglycemia are common
            - Electrolytes: hypokalemia, hypochloremia, and hypo- or hypernatremia are common
            - Coags (if indicated): DIC can occur
        - In-house fecal ELISA test (Witness Parvo, Idexx SNAP)
- Treatment
    - Inpatient Hospitalization - Standard of Care, recommend first
        - Isolation: CPV is highly contagious and hardy
            - Resistant to some disinfectants-- use appropriate commercial product or dilute bleach
        - Monitoring
            - Electrolytes and blood glucose multiple times daily
            - Serum protein at least q24hr
            - Vital parameters, body weight, mentation, and hydration status frequently
        - IV fluid therapy
            - +/- shock bolus
            - Balanced electrolyte solution to correct dehydration and replace ongoing losses, which can be severe
            - +/- KCl for hypokalemia
            - +/- dextrose for hypoglycemia
            - +/- colloids
        - IV antibiotics
            - Enrofloxacin (5-10 mg/kg q12-24hr) in combo with ampicillin (20-40 mg/kg q6-8hr), cefazolin (22 mg/kg q8hr), or ampicillin-sulbactam (30 mg/kg q8hr)
                - If using enrofloxacin in young pet, always warn owners of potential to affect cartilage/growth plates - unlikely if using within dosage range
            - +/- Metronidazole (10-15 mg/kg q12hr)
        - Antiemetics (Maropitant, ondansetron, and/or metoclopramide)
        - Analgesia for visceral pain (buprenorphine, fentanyl, lidocaine, etc)
        - Nutritional therapy - consider placing naso-esophageal tube as early enteral nutrition is beneficial
        - +/- plasma or blood transfusion if indicated
    - Outpatient - Colorado State University Protocol (http://csu-cvmbs.colostate.edu/documents/parvo-outpatient-protocol-faq-companion-animal-studies.pdf)
        - Survival rates ~75-80% (compared to 90% for Standard of Care/hospitalization protocol)
        - Initial stabilization should be provided first

        - Assess electrolyte panel, blood glucose, and PCV/TP at a minimum
        - IV catheter and IV fluids
            - Isotonic crystalloid boluses over 15-20 min for IV fluid resuscitation (table in Protocol Guidelines to determine volume loss to be replaced)
            - Correct hypoglycemia: Dextrose 25% 1-2 ml/kg
    - Outpatient Treatment Protocol:
        - Norm-R 120 mg/kg/day, divided and given q8hr (40 ml/kg/dose) as maintenance
            - Fluid replacement amount should be added to maintenance SC fluid doses (there is table in Protocol Guidelines to determine hydration status)
                - Keep in mind ongoing losses from regurgitation, vomiting, and diarrhea
            - Do not add additives (dextrose or KCl) to SC fluids
        - Convenia 8 mg/kg SC once
        - Cerenia 1mg/kg SC q24hr (if eating, can switch to 2mg/kg PO q24hr)
        - Syringe feed small amounts of Hill's a/d q6hr (1ml/kg PO), as tolerated
        - If painful: buprenorphine 0.02 mg/kg SC q6-12hr
        - Adjunctive anti-nausea: ondansetron 0.5 mg/kg SC q8-12hr
        - Karo/simple syrup supplementation: 1-5 mL bucally q2-6hrs PRN for hypoglycemia-- important in small breeds
        - Potassium supplementation (if K+ <3.4 mEq/L): Tumil-K 0.5-1 tsp per 10lb PO q4-6 hr
        - Recommend once daily BG check and PE by veterinarian
- Prognosis: varies and depends on duration of illness, level of medical care provided, concurrent illnesses, complicating factors, vaccination history, and age of patient

Endocrine

- **Insulin Overdose/Hypoglycemia**
    - Occurs with accidental insulin overdose or when animals have not eaten/vomits
    - Clinical signs - weakness, dull mentation, ataxia, seizures
    - Treatment
        - Owners can put karo syrup or honey on gums while coming to the hospital
        - Can give oral dextrose until IV access is gained

        - Stop all insulin administration until hyperglycemia returns
        - Give dextrose via bolus and then in IVF @ 5%
        - Offer food when pet able to eat
        - Monitor BGs q2-4hrs depending on clinical signs
    - Prognosis - good with appropriate intervention
    - If you have concurrent refractory hypoglycemia despite dextrose supplementation - concern for insulinoma - pull insulin:glucose ratio with BG is <40
- **Diabetic Ketoacidosis (DKA)**
    - Occur in either previously undiagnosed diabetics or poorly regulated diabetics due absolute lack or severe deficiency of insulin
    - Concurrent/inciting issues that can contribute to DKA include pancreatitis, cholangiohpatitis, Cushing's (hyperadrenocorticism), bacterial infections, other inflammatory and infectious conditions, hypothyroidism, renal failure, excessive sex hormones, glucagon-secreting tumors, pheochromocytoma
    - Clinical signs - can present as very ill (vomiting, diarrhea, severe dehydration, laterally recumbent, anorexia) or more consistent with diabetics (PU/PD) or may appear healthy
    - Diagnostics
        - CBC: +/- leukocytosis/neutrophilia, +/- anemia
        - CHEM: **hyperglycemia,** +/- pre-renal vs renal azotemia, +/- elevated liver values if concurrent Cushing's, +/- electrolyte derangements
        - Urinalysis: **glucosuria, ketonuria,** +/- UTI, +/- low specific gravity
        - Blood gas: **acidosis**
        - Serum ketones can be checked as well as urine ketones
        - Abdominal ultrasound - evaluate pancreas for pancreatitis, kidneys for pyelonephritis, ileus, rule out foreign body, etc.
    - Treatment
        - Rehydration/fluid therapy
            - <u>Incredibly important in DKAs</u>
            - Used to recommend 0.9% NaCl but now recommend P-Lyte or NormR (LRS less appropriate because lower amount of potassium/magnesium)
            - Correct hypotension with fluid boluses
            - Correct dehydration over 24 hours
                - Pets need a least 1.5-2x maintenance, however best to calculate fluid deficit and correct
            - Will likely need to supplement potassium and phosphorous
                - Losses through vomiting, anorexia, and through urine
                - K+ and Phos are driven lower when insulin instituted
                - Usually range of 20-40 mEq KCl
                    - Can do 20 mEq KCl and 20 mEq KPHos for example (adjust accordingly)

            - Check potassium scale in fluid therapy section if needed
    - Acid/base status will generally improve with fluid therapy
        - In rare cases, will need to supplement bicarb - talk to your criticalist!
- Insulin CRI
    - When to start? Prior literature recommended waiting at least 6 hours to start CRI to allow for rehydration. Newer reports indicate that there is no major difference in waiting versus starting sooner. (For me, I generally wait 4-6 hours before starting the CRI so I can correct any hypotension). If you have an IMED or ECC specialist at your hospital, discuss with them what they prefer/recommend
    - DOG:
        - Insulin CRI - 2.2 U/kg units regular insulin in 250 ml of 0.9% saline, adjust as follows:
            - If BG >250, insulin CRI at 10 ml/hour, no dextrose in IV fluids
            - If BG = 200-250, insulin CRI at 7 ml hour, 2.5% dextrose in IV fluids
            - If BG = 100-199, insulin CRI at 5 ml/hour, 2.5% dextrose in IV fluids
            - If BG <100, D/C insulin, 5% dextrose in IV fluids
        - - Notify DVM if BG is > 250 for more than 6 hours (DVM to increase insulin CRI by 25%)
        - - If BG is <100, stop insulin CRI until BG > 80, restart insulin CRI with 25% reduction from prior rate.
        - - Once dextrose is added to fluids, do not remove it until patient is eating adequately.
        - - Discontinue insulin CRI based on nutritional status of patient and BG level. If glycemic control is achieved and patient is eating, CRI may be discontinued and intermittent long acting insulin therapy initiated even if the ketone level is still positive (moderate to slight)
    - CAT:
        - Insulin CRI - 1.1 U/kg units regular insulin in 250 ml of 0.9% saline, adjust as follows:
            - If BG >250, insulin CRI at 5 ml/hour, no dextrose in IV fluids
            - If BG = 200-250, insulin CRI at 4 ml hour, 2.5% dextrose in IV fluids
            - If BG = 150-199, insulin CRI at 3 ml/hour, 2.5% dextrose in IV fluids

                - If BG = 100-149, insulin CRI at 2 ml/hour, 2.5% dextrose in IV fluids
                - If BG <100, D/C insulin, 5% dextrose in IV fluids
            - - Notify DVM if BG is > 250 for more than 6 hours (DVM to increase insulin CRI by 25%)
            - - If BG is <100, stop insulin CRI until BG >100, restart insulin CRI with 25% reduction from prior rate.
            - - Once dextrose is added to fluids, do not remove it until patient is eating adequately.
            - - Discontinue insulin CRI based on nutritional status of patient and BG level. If glycemic control is achieved and patient is eating, CRI may be discontinued and intermittent long acting insulin therapy initiated even if the ketone level is still positive (moderate to slight)
        - One patient is eating, can switch to appropriate long acting insulin
    - Broad spectrum antibiotics if warranted
        - Patients many times have concurrent infections (UTI, pneumonia, etc)
        - Ampicillin, unasyn, enrofloxacin, etc.
        - Metronidazole or/and probiotic for diarrhea
    - Gastroprotectants
        - Maropitant, ondansetron, metoclopramide (if foreign body ruled out)
        - Famotidine or pantoprazole for antacid (keep in mind pantoprazole can contribute to diarrhea in some cases)
    - Pain management
        - If pancreatitis/concurrent abdominal discomfort present, can use available opioids - keep in mind, opioids can contribute to ongoing nausea and ileus which may contribute to anorexia in the animal
- Monitoring
    - Check acid/base/potassium/electrolytes q12hrs (more frequently in severely debilitated patients)
    - Check phosphorous and magnesium q24hrs
    - Check ketones q24hrs
    - Blood pressure PRN
- Prognosis
    - Variable
    - Prepare owners that their pet could be in the hospital easily for 3-5 days or longer, and that treatment can become very expensive (in Virginia we average about $4000 per DKA). Also owners needed to be prepared for the long term care of a diabetic.

- **Addison's Disease/Hypoadrenocorticism**
    - Primary vs Secondary

        - Primary - destruction of the adrenal cortex leading to lack of appropriate levels of glucocorticoids and mineralcorticoids
            - Characterized by hyperkalemia and hyponatremia because mineralcorticoids help regulate sodium, potassium, and water homeostasis
            - Most common type of in dogs (immune mediated)
        - Secondary - decreased ACTH production from either destructive lesion of the pituitary or iatrogenic causes (steroid cream) leading to deficiency in glucocorticoid but not mineralcorticoid
            - “Atypical” Addisonian’s
    - Clinical signs
        - “The Great Pretender” - can really present any way it wants to
        - Usually in young to middle aged females
        - Vomiting, diarrhea, anorexia, lethargy, weight loss
        - Dehydration, collapse, hypovolemic shock, PU/PD, bradycardia
    - Diagnostics
        - CBC - no stress leukogram; non-regenerative anemia can be present but masked by dehydration; +/- lymphocytosis
        - CHEM
            - Hyperkalemia, hyponatremia, hypochloremia (occurs due to decreased aldosterone)
                - Normal Na/K = 27:1-40:1
                - Addison’s Na/K= <27:1
            - Elevated BUN
                - Can be from dehydration (pre-renal) or from GI hemorrhage (commonly seen)
            - Hypercalcemia (pathophys unknown)
            - Liver changes
                - Hypoalbuminemia
                - Hypocholesterolemia
                - Elevated liver enzymes
                - Microhepatica
                - Hypoglycemia - occurs secondary to lack of glucocorticoids
        - Fecal - rule out whipworms as other potential cause of clinical signs
        - Baseline cortisol - great way to rule in/out concerns about Addison’s, inexpensive for owners
            - Snap test - if <0.5 concerning for Addison’s, run ACTH stim; if >2, then likely not Addison’s
        - ACTH stimulation test
            - Will help confirm diagnosis of Addison’s but will not differentiate which type

                - Serum cortisol concentrations are measured before and one hour after administration of 5ug/kg cosyntropin (Cortrosyn) intravenously
                - It is OK to give Dexamethasone while doing ACTH stim, will not affect the results
    - Treatment
        - Fluid therapy
            - Correct hypovolemia
            - Classically treated with 0.9% NaCl, however more recent suggestions recommend LRS, NormR or P-lyte to avoid raising sodium too quickly
            - Serum potassium should correct quickly with fluid therapy. However if it does not, recommend giving calcium gluconate to protect the heart and dextrose/insulin to help drive potassium intracellularly (see urethral obstruction section for doses)
            - Correct hypoglycemia with dextrose boluses and 2.5%-5% in IVF (remember not to bolus dextrose!)
        - Monitor electrolytes/BG q4-6 hours until everything has normalized
        - Steroids!
            - Dexamethasone SP - will not affect ACTH stim
                - 0.1 mg/kg IV q24hrs
            - Can transition to oral steroids once patient is able to take oral medications
                - Prednisone 0.5-1mg/kg/day, divided BID. Start with 1 mg/kg/day and then decrease to 0.5 mg/kg/day after 24-48 hours.
                    - Keep in mind that if prednisone is given before a baseline cortisol or ACTH stim has been performed, those tests **cannot** be performed for a minimum of 12-hours due to cross-reactivity of the prednisone/prednisolone with cortisol on the assay.
        - Mineralocorticoids
            - Desoxycorticosterone pivalate (DOCP): 2.2 mg/kg IM q25 -28 days
                - Can be given safely while waiting for ACTH stim to return
            - Florinef (fludrocortisone): 0.02 mg/kg PO divided BID
    - Prognosis - good with early intervention and appropriate long term management

Immune-mediated

- **IMHA/ITP**
    - Most common immune-mediated blood disorders in dogs

        - IMHA - immune-mediated hemolytic anemia - most common cause of anemia in dogs
        - ITP - immune-mediated thrombocytopenia
        - Evan's syndrome - both IMHA and ITP
    - Typically affects young to middle aged animals
    - Common breeds: Cocker Spaniels, English Springer Spaniels, Poodles, Old English Sheepdogs
    - Primary vs secondary
        - Primary (more common in dogs)
            - Idiopathic or autoimmune
        - Secondary (more common in cats)
            - Infectious/parasitic
                - FeLV, hemobartonellosis (mycoplasmosis)
                - Erlichiosis, babesiosis, diroflariasis
            - Immune-related
                - Lupus
                - Transfusion reactions
            - Medications
                - TMS
                - Penicillins
                - Cephalosporins
                - Levamisole (dogs), methimazole (cats)
            - Neoplasia
                - Lymphosarcoma, hemangiosarcoma
            - Toxins
                - Onion, garlic
                - Tylenol
                - Zinc
                - Propylene glycol
            - Vaccine reaction
    - Pathophys - antibody-mediated cytotoxic (Type II) destruction of circulating red blood cells (RBCs)
    - Clinical signs
        - Anemia - Lethargy, weakness, pale gums, hyporexia/anorexia, icterus, heart murmur (secondary to anemia), splenomegaly
        - Thrombocytopenia - hemorrhage from any orifice, hyphema, petechiae/ecchymosis/bruising
    - Diagnostics
        - CBC
            - Regenerative or non-regenerative anemia - usually regenerative, however if early in disease process, can appear as non-regenerative

            - Regenerative anemia - macrocytic, hypochromic erythrocytes with increased polychromasia
        - Reticulocytosis
        - +/- spherocytes
        - +/- thrombocytopenia - r/o consumption vs destruction (ITP)
    - CHEM - elevated T. bili, +/- hepatopathy
    - Slide agglutination - should be macro/micro positive
    - PT/PTT - rule out coagulopathy (should be normal with IMHA/ITP)
    - Coombs test - honestly have not done this in practice yet
    - Infectious testing
        - Tick testing - 4Dx, tick titers/PCR, etc
        - FelV for cats
    - Imaging to rule in/out neoplasia (x-rays, abdominal ultrasound, etc.)
    - Bone marrow - recommended if multiple lines affected/not responding to supportive care
- Treatment
    - pRBC transfusion
        - Recommended if PCV <20% or if patient is clinical for anemia (tachycardia,
    - Glucocorticoids
        - Dexamethasone 0.2-0.3 mg/kg IV q24hrs
        - Prednisone 2 mg/kg PO 24 hours or split q12hrs
    - Immunosuppressive medication
        - Cyclosporine 3-10 mg/kg (aim for 5 mg/kg) PO q12hrs
        - Azathioprine 2 mg/kg PO q24-48 hours
    - Antibiotics
        - Cover for tick borne disease with doxycycline 5 mg/kg q12 or 10 mg/kg q24s IV/PO
    - Vincristine can be used for thrombocytopenia to help release platelets from the bone marrow into peripheral circulation
    - Fluid therapy
    - Consider IVIG if not responding to therapies
- Monitoring
    - PCV/TS q8-24 hours
    - Slide agglutination q24hrs
    - Platelet estimate q24 hrs if thrombocytopenic
    - T. Bili q24hrs if IMHA
    - BP PRN
- Prognosis - variable
    - Without treatment, almost always fatal
    - Can be well managed for years, but owners need to be prepared for potential lifelong medications and relapses
    - Most published studies have long-term survival rates of around 50%

Repro

- **Dystocia**
    - Normal stages of parturition
        - Stage I labor - uterine contractions start, but not visible externally; cervix begins to dilate
            - Common signs (canine): behavior changes (panting, pacing, nesting, shivering, hiding), anorexia, and vomiting. Clear, watery vaginal discharge may occur. Rectal temp drop of >1°F.
            - Common signs (feline): behavior changes (restless, purring, scratching the nesting box, pacing, excessive grooming). Rectal temp drop of >1°F.
            - Typical timeframe: 6-24 hrs in length
        - Stage II labor - fetuses start moving through birth canal
            - Common signs: abdominal contractions
            - Typical timeframe: pups or kittens usually delivered q30-60 min, but up to 3 hrs between can be normal. Entire stage can last up to 24hrs, but is typically shorter
        - Stage III labor - passage of fetal membranes, can occur concurrently with Stage II; retained fetal membranes are rare
    - When is it considered a dystocia?
        - Prolonged gestation
            - Canine: >72 days post breeding, >65 days post ovulation, or 12-24hrs post progesterone drop to <2 ng/mL)
            - Feline: >68 days post-mating
        - No fetus delivered for >24hrs after onset of stage I labor
        - Stage II abdominal contractions with no birth in 30-60 min or >3-4 hrs between delivery of subsequent fetuses
        - Fetal membrane visible for 15 minutes or longer or presence of immobile fetus in birth canal
        - Excessive or abnormal vaginal discharge (green, black, hemorrhagic, or purulent)
        - More than 24 hours of labor to deliver entire litter
        - Weak or infrequent labor contractions, crying or biting at flank or vulva
    - Causes
        - Maternal: primary uterine inertia (failure to initiate parturition at term; typically only 1-2 pups), secondary uterine inertia (contractions stop after parturition has started; typically large litters or bitches/queens in poor body condition), brachycephalic breeds, dolichocephalic cats, conformational issues (obesity, historical pelvic trauma, congenital abnormalities), fear or pain

        - Neonatal: abnormalities in presentation, position, posture, size, or due to the presence of developmental defects
    - Diagnosis
        - Patient may appear healthy and stable or critically ill
        - Digital vaginal exam
            - Feel for fetus or signs of obstruction
            - Ferguson reflex - apply pressure on dorsal vaginal vault to induce contractions
                - Can restart labor
                - Diagnostic test: no contractions = uterine inertia; medical therapy may not be successful
        - Ultrasound - best tool to assess fetal distress and viability
            - Normal fetal heart rates: >180-220bpm
                - Fetal distress: 160-180bpm
                - Immediate emergency, take to c-section: <160bpm
        - Abdominal radiographs - assess number of remaining fetuses
        - Progesterone assay
            - Progesterone level of 2.0 ng/mL is necessary to support pregnancy
    - Treatment
        - Manipulate Manually
            - Position bitch in standing position
            - Use a liberal amount of lubricant and gauze sponges to manipulate fetus
            - Gentle traction in ventral and posterior direction, do not pull on jaw or extremities, may help to turn fetus side to side
        - Medical Management
            - Appropriate for mild cases, when birth canal is not obstructed, bitch or queen is not systemically ill, and there are no other apparent issues that would prohibit vaginal delivery
            - Place IV catheter, start IV fluids if dehydrated
            - +/- admin Dextrose 25% IV if hypoglycemia present
            - Admin Calcium gluconate - affects the strength of uterine contractions
                - Calcium gluconate 10% 0.5-1.5 mL/kg slowly IV
                    - Monitor heart rate and rhythm
            - Admin Oxytocin - induces and enhances uterine contractions, milk ejection
                - Dose: 0.25-2.0 IU IM or SC (max 4 IU)
                - Can repeat in 30-60 min for two total doses
            - Intermittently perform vaginal exams and feathering
            - If a fetus is delivered, wait an hour to see if another will be delivered. If no fetus is delivered, perform c-section.

        - Surgery - Cesarean section
            - Most anesthesia protocols recommend short-acting induction agents (i.e., propofol, alfaxalone) and limiting sedatives until fetuses are out
                - Contraindicated: ketamine, xylazine, medetomidine, and acepromazine
                - Adequate pain control is necessary
                    - If opioid used: Naloxone can be used if neonate shows signs of respiratory depression after delivery
            - OVH if medically indicated or breeder requests
            - Decreasing neonatal loss: rapid dystocia diagnosis and treatment, IV fluids and pre-oxygenate bitch prior to surgery, limiting anesthesia time, and PRN neonatal resuscitation
- **Neonates**
    - Neonatal Reflexes
        - Suckle reflex: place finger in mouth of neonate
        - Rooting reflex: cup hand around muzzle of neonate
        - Eliciting squeal: rub over lumbar region
        - Righting reflex: place onto back, should make efforts to right self
        - Pinching toes should stimulate neonate to bob its head
    - Neonatal/Fetal Resuscitation
        - Oxygen is most important - flow-by vs positive pressure ventilation w/mask
        - Wipe nasal passages, use bulb syringe to clean secretions out of nasal passages and oral cavity
        - Stimulate neonate by rubbing gently with clean, warm towel
            - Thoracic wall, rectal, nasal, genital, and periumbilical stimulation
            - Acupuncture point (stimulate respiration): insert 25g needle at nasal philtrum, twist in clockwise direction
        - Keep neonate warm
        - Drug therapy (if prolonged or unsuccessful resuscitation)
            - Dextrose 50% - one drop transbucally
                - Helps w/respiratory and cardiac muscle contractions
            - Epinephrine - one drop transbucally or via IV or IO catheter
                - If bradycardic despite O_2 and dextrose therapy
            - Naloxone - one drop transbucally
                - To reverse opioid-induced respiratory depression
            - NOT recommended:
                - Atropine - ineffective due to neonatal physiology and hypoxic myocardium
                - Doxapram - only appropriate to reverse effects of barbiturates (phenobarbital, etc), otherwise not

recommended as it increases O_2 demand in already hypoxic patient

- Congenital Defects
  - Cleft palate
  - Atresia ani
  - Open fontanel
  - Urogenital abnormalities

Toxicities

- Always recommend owners call ASPCA animal poison control - (888) 426-4435 - advise owners there is a $75 fee when they call
- Doses to know:
  - Apomorphine 0.03-0.05 mg/kg IV to induce vomiting in dogs; dexmedetomidine 7 mcg/kg IM in cats (works about ⅔ of the time for me)
  - Maropitant 1 mg/kg SQ/IV after vomiting has resolved
- **Marijuana**
  - Pathophys - Cannabinoids interact with cannabinoid receptors in the nervous and immune systems, leading to CNS alterations
    - More significant toxicosis occurs with ingestion of edibles/plant versus more mild toxicosis with second hand smoke
  - Clinical signs
    - Quiet to dull mentation, ataxia, hyperesthesia, bradycardia (sometimes tachycardia), hypothermia, vomiting, ptyalism, dribbling urine, mydriasis (sometimes miosis), tremors; rarely seizures
    - In severe cases - obtunded to comatose
  - Diagnostics
    - Diagnosis generally made off of history (if owners will admit to it) and clinical signs
    - Can try a urine drug test, but not necessarily accurate - rare to have false positives but common to have false negatives
  - Treatment
    - If seizures present
      - Midazolam/diazepam, Keppra, phenobarbital, propofol (see seizure section)
    - Generally inducing vomiting is not an option since CNS too effected and risk of aspiration pneumonia high
    - If can safely administer activated charcoal, can consider this 1-5 gram/kg, only if patient can safely swallow
    - IV fluids
    - Heat support as needed
    - Antiemetics - maropitant

        - IV lipids in severe cases (comatose, unknown amount of ingestion occurred)
            - 1.5 mL/kg bolus followed by 0.25 mL/kg/min x 30-60 min
            - Check serum for hyperlipemia before repeating
    - Many times owners cannot afford/not interested in hospitalization
        - Recommend SQ fluids, maropitant, and keeping the pet somewhere quiet, dark, and warm until clinical signs resolve
    - Edibles
        - THC content can have extreme variation amongst edibles
        - Many times if a chocolate edible, the chocolate and marijuana will help counteract each other somewhat
        - The only time I have ever had to give lipids is with small patients who ingested high concentration edibles
    - Prognosis - good; warn owners it could take 1-3 days for clinical signs to completely resolve, but should be seeing progressive improvement
- **Chocolate**
    - Most common food toxicity in dogs
    - Toxic component - methylxanthines (theobromine and caffeine)
    - Clinical signs - occur within 1-4 hours of ingestion
        - GI signs - vomiting and diarrhea
        - Cardiac - tachycardia
        - Neuro - hyperexcitability/anxiety/restlessness, weakness, ataxia, seizures, coma
    - When do signs occur (dose of methylxanthine)
        - GI - 20 mg/kg
        - Arrhythmias - 40-50 mg/kg
        - Seizures - 50-60 mg/kg
        - VIN has a chocolate toxicity calculator, as does Merck which can be helpful in determining treatment moving forward
    - Treatment
        - Induce vomiting - may not be necessary if pet has vomited a large amount of chocolate prior to coming in
        - Activated charcoal (per ASPCA toxicologists, some are still recommended charcoal while some are moving away from it)
            - Usually 0.5-1 gram/kg; first dose with sorbitol, following doses without. Normally do not need more than 2-4 doses total
        - Seizures can be controlled with diazepam/midazolam
        - Fluid therapy
        - Monitor ECG/BP, treat arrhythmias accordingly
        - Treatment is usually anywhere from 12-24 hours
    - Prognosis is good
- **Xylitol**
    - Sweetener - seen in baked goods, sugar free gum, vitamins

- Pathophysiology
  - Increased serum insulin → hypoglycemia
  - Mechanism for hepatotoxicity unknown
  - >0.1 g/kg → hypoglycemia
  - >0.5 g/kg → hepatotoxicity
  - 1 piece of gum can have 1-2 grams of xylitol
  - Rapidly absorbed - peak concentration ~30 minutes after ingestion
- Clinical signs
  - Vomiting, hypoglycemia (dull mentation, tremors, head bobbing, difficulty walking, seizures)
- Diagnostics
  - Chemistry
    - Hypoglycemia
      - Hypoglycemia
      - Hypokalemia
      - Hypophosphatemia → can see hyperphosphatemia with liver failure
    - Hepatotoxicity
      - Elevated liver enzymes
        - Profound elevation ALT, mild to moderate elevation ALP
      - Hyperphosphatemia
      - Thrombocytopenia
      - Prolonged PT/PTT
- Treatment
  - Emesis if just occurred and patient asymptomatic
  - Hospitalize for 72 hours on IVF
  - Monitor BG frequently q1-4hrs
  - Treat hypoglycemia with dextrose boluses (50% dextrose, 1 mL/kg, diluted 1:1 with saline) and adding dextrose to IVF
    - If going higher than 7.5% in IVF, will need central line
  - Feed small meals frequently
  - Recheck chemistry at 24, 48, and 72 hours
  - Treat elevated liver values with hepatoprotectants (per ASPCA, generally do N-acetylcysteine or Denamarin)
    - N-acetylcysteine (140–280 mg/kg loading dose IV, PO; followed by 70 mg/kg qid), vitamin K1 (1.25–2.5 mg/kg PO bid), plasma, SAMe (20 mg/kg/day PO), vitamin E (100–400 IU bid PO) and silymarin (20–50 mg/kg/day PO)
      - If giving N-acetylcysteine PO, dilute to 5% solution - decreases chance of mucosal irritation and ulceration
  - If ALT >1000, check PT/PTT. If PT/PTT prolonged, consider FFP transfusion

- Prognosis
    - Uncomplicated hypoglycemia, mild elevated liver enzymes - good with treatment/supportive care
    - Hepatotoxicity, coagulopathy - guarded to poor

- **Rodenticide**
    - Anticoagulant
        - Short acting (Coumarin compounds, warfarin)
        - Long acting (brodifacoum, bromadiolone, chlorophacinone, difethialone, diphacinone, pindone)
        - MOA - inhibit vitamin-K dependent coagulation factors (II, VII, IX, X) by blocking vitamin-K becoming its active form
            - Generally don't see signs of poisoning until 5-7 days after ingestion because of half lives of coagulation factors
        - Clinical signs
            - GI signs (vomiting, lethargy) can occur the day of ingestion
            - Coagulopathy signs (3-7 days after ingestion) - hemorrhage, weakness/exercise intolerance, bruising, pale mucous membranes, cough/dyspnea, painful abdomen, swollen joints/lameness
        - Diagnostics
            - PT (prothrombin time)
                - Tests extrinsic and intrinsic pathways
                - Elevated with deficiency of factor VII
                - If <72 hours post ingestion, animal will not be clinical but PT will be prolonged
            - PIVKA (Protein Induced by Vitamin K Absence or Antagonists)
                - Will be prolonged
                - Detects a build up of nonfunctional clotting factor precursors
                - Most sensitive test for determining deficiency of the vitamin K-dependent coagulation factors
        - Treatment
            - If ingestion recent, induce vomiting
            - If animal clinical, stabilize as needed
                - FFP transfusion
                - pRBC or whole blood transfusion may be necessary
            - Vitamin K1
                - 2.5 mg/kg BID or 3-5 mg/kg/day split up into BID or TID administration
                - Give with fatty meal to help absorption
                - Length of treatment
                    - Warfarin - 14 days
                    - Bromadiolone - 21 days

            - Brodifacoum and others - 30 days
        - Check PT 48 hours after last dose of vitamin K1
    - Prognosis good with early intervention, variable if animal is clinical
- Bromethalin
    - MOA - uncouples oxidative phosphorylation (Krebs Cycle) → leads to depletion of ATP → inhibits the Na/K ATPase → intramyelinic edema develops → causes decreased nerve impulse conduction
    - Clinical signs
        - Can have GI signs - vomiting
        - CNS signs - tremors, seizures, hyperesthesia, ataxia, forelimb extensor rigidity, CNS depression, paresis, paralysis, coma, death
        - Occur within 24 hours to two weeks post ingestion
    - Diagnostics
        - Difficult to diagnose, usually based on history (known or potential exposure) or on post mortem
    - Treatment
        - Aggressive decontamination
            - Induce vomiting
            - Activated charcoal with sorbitol, 1-3 grams/kg, dose every 4-8 hours for 72 hours ideally
        - If severely affected, can consider mannitol, furosemide, and corticosteroids to try and reduce reduce cerebral edema
    - Prognosis - good with early intervention, poor if CNS signs are occurring
- Cholecalciferol (Vitamin D3)
    - MOA - conversion of cholecalciferol into calcitriol → absorption of calcium from the GI tract/bone/kidneys → profound hypercalcemia. This causes acute renal failure, arrhythmias and in some cases heart failure, mineralization of tissues
    - Clinical signs
        - Vomiting, diarrhea, hyporexia, polyuria, polydipsia, arrhythmias, lethargy, weakness
        - Usually occur 18-36 hours after ingestion
    - Diagnostics
        - Chemistry: hyperphosphatemia (often occurs before calcium elevates), hypercalcemia, azotemia
        - ECG: bradycardia, shortening of Q-T interval
    - Treatment
        - Aggressive decontamination ASAP post ingestion (hypercalcemia can occur within one hour of ingestion)
        - Get baseline calcium and kidney values, then monitor every 12-24 hours for 72 hours.
            - If calcium is normal for 96 hours, no further treatment is necessary.

- IVF @ 2x maintenance using 0.9% saline
- Pamidronate
    - Inhibits osteoclastic bone resorption
    - 1.3-2 mg/kg diluted in saline IV over 2 hours
    - Generally lowers calcium to normal over 48 hours
    - May need to be repeated in 5-7 days
    - Do not use with salmon calcitonin
- Can consider glucocorticoids and furosemide for calciuretic effects
- Salmon calcitonin
    - Inhibits osteoclastic activity
    - 4-6U/kg SQ q2-3 hrs until calcium normalizes

■ Prognosis - good with early intervention, animals with severe clinical signs have a guarded prognosis

- **Snail Bait/Metaldehyde**
    - Seen in snail/slug bait
    - Any dose > 2 mg/kg requires treatment
    - Clinical signs (“shake n’ bake”)
        - Anxiety, tachycardia, tremors, nystagmus, hypersalivation, seizures, mydriasis, panting, diarrhea, death secondary to respiratory failure
    - Diagnostics
        - Monitor liver values initially and then 72 hours after exposure
        - Monitor anion gap in hospital for metabolic acidosis
    - Treatment
        - Activated charcoal if mentally appropriate enough
        - Warm water enemas
        - Tremors - methocarbamol
            - 44 mg/kg IV to effect. Administer half the dose and monitor the pet. Pause until pet starts to relax, then administer to effect. Further doses may be necessary and should be given as needed. Do not exceed total cumulative dose of 330 mg/kg/day
        - Seizures - control initially with benzodiazepines but be prepared to start propofol CRI
            - May need isoflurane anesthesia, may need barbiturate anesthesia
            - Sedation may be necessary for 24 hours
    - Prognosis - with prompt and aggressive control, prognosis is good
- **Moldy Foods/Mycotoxins**
    - Mycotoxins produced by fungi, found on a variety of common foods and decaying organic material
    - Clinical signs
        - Usually occur within 30 minutes of ingestion
        - Restlessness, panting, pytalism, +/- vomiting, tremors (mild initially and then progress to severe), +/- seizures, hyperthermia secondary to muscle activity, tachycardia, +/- diarrhea

- Diagnostics
  - No specific test for which mycotoxin when in the clinic
  - Can see evidence of dehydration, metabolic acidosis, and elevated CK/AST secondary to prolonged muscle activity
- Treatment
  - If early enough and animal is not showing CNS signs, induce vomiting
  - Treat seizures as needed (see seizure section for doses of medications)
    - Benzodiazepines
    - Keppra loading dose, then q8hrs
    - Phenobarbital 4-16 mg/kg IV PRN
    - Propofol bolus or CRI
  - IV fluids for diuresis
  - Control tremors with methocarbamol
    - 44-50 mg/kg IV to effect. Administer half the dose and monitor the pet. Pause until pet starts to relax, then administer to effect. Further doses may be necessary and should be given as needed. Do not exceed total cumulative dose of 330 mg/kg/day
    - Minor tremors can be treated with oral dose
  - Lipid therapy
    - Give 1.5 mL/kg as a slow IV bolus over 2-5 min, followed by 0.25 mL/kg/min IV CRI over 30-60 minutes
  - Cooling measures for hyperthermia
    - Fluids, ice packs on jugular/femoral vessels
  - Monitor blood pressure, heart rate and rhythm, body temperature, and neurologic status.
  - Monitor urine for myoglobinuria
  - Monitor for DIC/coagulopathies in patients with severe/prolonged signs or with severe hyperthermia
- Prognosis - variable, depends on amount of moldy food ingested, severity of signs, what time intervention is instituted
  - Severe tremors and seizures generally resolve within 24-72 hours
  - Residual muscle tremors and/or ataxia may persist for days to weeks following acute severe toxicosis.

- **Grapes/Raisins**
  - Ingestion of grapes, raisins, sultanas, and Zante currants can cause acute renal failure in dogs
  - Pathophysiology is unknown
  - Toxicosis
    - 0.7 oz/kg of grapes and 0.11 oz/kg of raisins is known to cause ARF
    - However any amount of ingestion should warrant treatment as some patients have been seen to develop ARF without reaching those doses
  - Clinical signs
    - Can be asymptomatic with both recent or longer ingestion

        - Usually will begin within several hours of ingestion
        - **Vomiting**, anorexia, nausea, diarrhea, abdominal discomfort, lethargy
        - 1-5 days after ingestion - PU/PD, ataxia, peripheral edema
        - Renal failure - oliguria, anuria, +/- hypertension
    - Diagnostic
        - Chemistry
            - Baseline kidney values
                - Creat will rise shortly after ingestion if toxicosis is going to occur; BUN will rise ~24hrs later
            - +/- hypo or hyperkalemia, elevated ALT/ALP
        - Urinalysis
            - +/- Isothenuria, proteinuria, hematuria, crystalluria, casts
    - Treatment
        - Induce vomiting with apomorphine if recent ingestion
        - Activated charcoal 1-3 g/kg PO
            - For large ingestions, consider a second dose 8-12 hrs after the initial dose
        - Fluid therapy
            - Correct dehydration over 12-24 hours
                - Body weight (kg) x estimated % dehydration = fluid deficit (L) + maintenance rate
            - Then match ins and outs
            - Ideally patient on IVF and monitored for minimum of 48 hours - if normal kidney values at 48 hour mark, can wean IVF and then discharge
        - Gastroprotectants
            - Maropitant, ondansetron, metoclopramide
            - Famotidine or pantoprazole for antacid (keep in mind pantoprazole can contribute to diarrhea in some cases)
        - Monitor kidney values q12-24 hrs
        - Monitor urine output
        - Monitor weight q8-12hrs - weight gain with lack of urination concerning for oliguria/anuria
        - Monitor BP for hypo and hypertension
    - Prognosis - generally good; poor if AKI/ARF develops
- **Acetaminophen**
    - Toxicity - itself has low toxicity, however forms toxic metabolites that lead to RBC injury and hepatotoxicity
        - Methemoglobinemia
            - Cyanosis, chocolate brown color blood
            - Heinz body formation and Heinz body hemolytic anemia
        - Hepatotoxicosis
        - KCS

            - Rare in cats, uncommon in dogs
            - MOA unknown
    - Toxic doses
        - Cats - 10-40 mg/kg for methemoglobinemia; cats usually pass away from this before hepatotoxicity can develop
        - Dogs
            - >75-100 mg/kg for hepatotoxicosis
            - >200 mg/kg for methemoglobinemia
            - >30 mg/kg KCS
    - Clinical signs
        - Cats
            - Methemoglobinemia - 1-4 hours after exposure; last 12-48 hours (or until death) - respiratory distress (tachypnea, dyspnea), cyanosis, +/- facial/peripheral edema
            - Hepatoxicity 24-48 hours after exposure - vomiting, anorexia, icterus
            - Renal injury - rare but can be seen 24-48 hours after evidence of hepatotoxicity
            - KCS - tear production decrease in 48-72 hours post
        - Dogs
            - Hepatoxicity 12-24 hours after exposure - vomiting, anorexia, icterus
                - If severe, hypoglycemia, coagulopathies, and hepatic encephalopathy can occur
            - Methemoglobinemia - 1-4 hours after exposure; last 12-48 hours (or until death) - respiratory distress (tachypnea, dyspnea), cyanosis, +/- facial/peripheral edema
            - KCS - tear production decrease in 48-72 hours post exposure
    - Diagnostics
        - CBC: anemia, Heinz bodies
        - CHEM: elevated ALT, ALP, AST, T. Bili, globulins; azotemia/elevated BUN, hypoglycemia
        - Urinalysis: bilirubinuria, casts, glucosuria, hemoglobinuria
        - Blood gas: hypoxemia, hypercapnia
        - Ocular: decreased or zero on Schirmer TT
    - Treatment
        - Administer oxygen to any patients with dyspnea or hypoxia
        - If severe anemia, administer blood product as available and indicated
        - Induce emesis if recent ingestion
        - Activated charcoal 1-3 g/kgs PO; consider second dose 8-12 hours after first dose for large ingestions
        - Hepatic injury

                - N-Acetylcysteine - 140 mg/kg PO/IV loading dose, then 70 mg/kg PO/IV q6hrs x 5-7 treatments
                    - If giving PO, dilute to 5% solution - decreases chance of mucosal irritation and ulceration
                - SAM-e - 40 mg/kg PO, then 20 mg/kg PO q24hrs for 9 days
                - Ascorbic acid - 30 mg/kg PO q6hrs
            - Methemoglobinemia
                - Methylene blue - 1.5 mg/kg IV q2-3hrs x2-3 treatments
                    - Can worsen methemoglobinemia if not titrated carefully
                    - See clinical improvement within 1-3 hours
                - N-Acetylcysteine - 140-280 mg/kg PO/IV loading dose, then 70-100 mg/kg PO/IV 4-8hrs x 3 treatments
                    - PO - 200 mg/kg q2hrs x3 doses, then 100 mg/kg PO once
                - Silymarin - 30 mg/kg PO within 4 hours of ingestion in cats; no evidence helps in dogs
            - Fluid therapy - 1.5-2x maintenance
            - Lube eyes as needed
    - Monitoring
        - HCT/PCV
        - Methemoglobin levels
        - Liver enzymes
        - Tear production
    - Prognosis - varied; much more guarded in cats
        - Methemoglobinemia - resolved 5-7 days
        - Hepatopathy - peak at 72 hours, then gradually decrease over days to weeks
        - Tear production - 1-2 weeks until resolution
- **NSAIDs**
    - Toxicosis
        - Decreased GI perfusion → GI ulceration/perforation
        - Renal tubular hypoxia secondary to decreased renal blood flow → acute kidney injury/acute renal failure
        - CNS signs - pathophy unknown
        - Hepatic injury seen more with chronic NSAID use
    - Known toxic doses
        - Carprofen
            - GI - dogs >20 mg/kg, cats, >4 mg/kg
            - Renal - dogs >40 mg/kg, cats 8 mg/kg
            - CNS - dogs >400 mg/kg
        - Deracoxib
            - GI - dogs >15 mg/kg, cats >4 mg/kg
            - Renal - dogs >30 mg/kg, cats >8 mg/kg
        - Ibuprofen

                - GI - dogs >25 mg/kg, cats >10 mg/kg
                - Renal - dogs >150-175 mg/kg, cats unknown
                - CNS - dogs >400 mg/kg
            - Meloxicam
                - GI - dogs >1 mg/kg, cats above therapeutic dose (0.05-0.1 mg/kg PO)
                - Renal - dogs >2 mg/kg, cats >1.5x therapeutic dose
            - Naproxen
                - GI - dogs >5 mg/kg, cats any dose
                - Renal - dogs >10 mg/kg, cats unknown
    - Clinical signs
        - GI
            - Vomiting/diarrhea - 2-6 hours after ingestion
            - Anorexia, hematemesis, hematochezia, melena, hemorrhage/GI ulceration - 12-96 hours post ingestion
            - GI perforation - collapse, hypovolemia, peritonitis
        - Renal
            - PU/PD, isosthenuria - 12-24 hours post ingestion
        - CNS
            - Ataxia, seizures, mentation changes, comatose
            - Only occurs in massive overdoses
    - Diagnostics
        - CBC - +/- hemoconcentration from dehydration, +/- regenerative anemia from blood loss
        - CHEM - elevated Creat and BUN, low albumin from GI protein loss
        - UA - isosthenuria, glucosuria, hematuria, casts
        - Blood gas - metabolic acidosis
    - Treatment
        - Induce vomiting
        - Activated charcoal - 1-2/g/kg w/ sorbitol
            - Can repeat 6-12 hours later in drugs with long half lives (Naproxen)
            - Do not use if evidence of GI bleeding - delays healing
        - Fluid therapy - 1.5-2x maintenance
            - Monitor ins/outs
        - Prevent gastric injury
            - Sucralfate 0.5-1 gram PO q8hrs
            - Acid reducers - use one or the other
                - PPIs
                    - Omeprazole/pantoprazole - 1 mg/kg PO q24hrs
                - H2 antagonists
                    - Famotidine - 0.5 mg/kg PO/SC/IM/IV q12hrs
                    - Cimetidine - 5 mg/kg PO/SC q8hrs

                - Ranitidine 0.5-2 m/kg PO/IV/IM q8-12hrs
            - Misoprostol 1-3 mcg/kg PO q8hrs
                - Must wear gloves, can cause spontaneous abortion
                - **I tend to use this in the hospital but do not usually send home with clients due to safety reasons
                - Don't use if evidence of clinical bleeding already occurring
        - CNS signs
            - Seizures - diazepam/midazolam 0.5-2 mg/kg IV to effect (generally do 0.5 mg/kg)
            - Comatose - heat support PRN, recumbent care, lube eyes, etc.
    - Monitoring
        - Monitor kidney values q12-24hrs for 48-72 hours (longer if massive ingestion occurred)
        - Monitor electrolytes q8-24 hrs
        - Monitor ins/outs and weight
        - Keep pet in the hospital for minimum of 48 hours → if kidney values remain normal, can wean off of fluids and recheck at 72 hours; if kidney values elevated, keep in hospital until normalize or plateau
    - Prognosis - variable
        - Good with early intervention and aggressive care
        - Patients that develop kidney injury will require post-monitoring and potential continued care (SQ fluids, antacids, renal diets) for weeks to months
        - Poor prognosis with anuria/oliguria
- **Lilies**
    - Easter lily (*Lilium longiflorum*), tiger lily (*L. tigrinum*), rubrum lily (*L. speciosum*), Japanese show lily (*L. lancifolium*), stargazer lily (*L. auratum*), some species of the day lily (*Hemerocallis)*
    - Pathophysiology - proximal tubular necrosis leading to acute renal failure
    - Clinical signs
        - Vomiting, anorexia, lethargy, hypothermia, dehydration, oral ulcers, uremic breath, enlarged/painful kidneys, variation in urine production
    - Diagnostics
        - CBC - sometimes hemoconconcentation, +/- stress leukogram
        - Chemistry
            - Severe azotemia (creatinine severely elevated compared to BUN)
            - Hyperkalemia
            - Hyperphosphatemia
        - UA - isosthenuria, glucosuria, proteinuria
        - Imaging - enlarged kidneys
    - Treatment
        - Attempt to induce emesis if recent ingestion
        - Charcoal with sorbitol

        - IV fluids for minimum 48 hours
        - Antacids, gastroprotectants, antiemetics
        - Treat hyperkalemia with insulin/dextrose (see urethral obstruction section for doses/administration)
        - If anuria/oliguria develops
            - Furosemide 2 mg/kg IV PRN
            - Try mannitol (0.25-0.5 g/kg IV over 20 minutes) if furosemide not working; can repeat dose 1 hour later if not working
        - Monitor body weight frequently (at least every 8-12hours)
        - Ideally place u-cath to monitor ins/outs - ideally making 1-2 mL/kg/hr
        - Monitor BUN/Creat/electrolytes q12-24 hours
        - Dialysis if above treatments not working
    - Prognosis - good with early intervention (<6 hours from ingestion), guarded to poor if renal failure develops
- **ADHD Medications**
    - Sympathomimetic drugs
        - Amphetamine, dextroamphetamine (Adderall, Dexedrine)
        - Benzphetamine (Didrex, Regimex)
        - Diethylpropion (Tenuate, Tepanil)
        - Ephedrine, Ma Huang
        - Lisdexamfetamine (Vyvanse)
        - Methamphetamine (Desoxyn)
        - Methylphenidate (Daytrana, Ritalin, Aptensio, Metadate, Methylin, Concerta)
        - Pemoline (Cylert)
        - Phendimetrazine (Adphen, Alphazine, Bontril, Cam-Metrazone, Di-Metrex, Melfiat, Metra, Phenazine, Plegine, SPRX, Statobex, X-Trozine)
        - Phentermine (Adipex-P, Fastin, Ionamin, Lomaira, Obestin, Oby-Trim, Ona-Mast, Pre-Sate, Qsymia, Suprenza, Tora, Wilpo
        - Pseudoephedrine (Silfedrine, Sudafed)
    - Toxicity
        - Stimulate epinephrine, norepinephrine, and dopamine receptors, leading to cardiovascular and CNS stimulation
        - Hyperthermia common feature; prolonged hyperthermia can lead to multiorgan failure and DIC
        - Usually reach drug peaks between 1-3 hours after ingestion, and then gradually release smaller levels over 12-24 hours
    - Clinical signs
        - See signs between 15-60 minutes of ingestion
        - Agitation, restlessness, hyperactivity, panting, tachycardia, hyperthermia, head bobbing, pacing, circling, vomiting

        - Behavioral changes (aggression), ataxia, tremors, hyperesthesia, seizures, mydriasis, sudden death
        - Severe cases - rhabdomyolysis, multiorgan failure, DIC
    - Diagnosis
        - CBC/CHEM - generally remain unchanged unless severe toxicities - hypoglycemia, electrolyte derangements, acidosis
            - Organ failure - azotemia, hepatopathy, thrombocytopenia
        - Urine drug test
            - Generally produce positive results - amphetamine, benzphetamine, dextroamphetamine, ephedrine (Ma Huang), lisdexamfetamine, methamphetamine, phentermine, and pseudoephedrine
            - Can produce false positives for amphetamine - fluoxetine, labetalol, metformin, promethazine, phenylpropanolamine, ranitidine, and trazodone
        - BP - hypertension
        - PT/PTT - prolonged in severe cases with prolonged hyperthermia/DIC
    - Treatment
        - Seizures
            - Phenobarbital 2-20mg/kg IV PRN
            - Keppra 20-60mg/KG IV q8hrs/PRN
            - AVOID benzodiazepines
        - Cooling measures for extreme hyperthermia
        - If ingestion extremely recent and patient asymptomatic, can induce vomiting
        - Activated charcoal 1-5 g/kg PO once if patient able to consume it safely
        - IVF therapy 1.5-2x maintenance
        - For agitation, tachycardia, hyperthermia, hypertension - acepromazine 0.05 mg/kg IV to start, then titrate up as needed, careful not to exceed 1 mg/kg in that episode of controlling agitation
        - Tremors - methocarbamol 50-220 mg/kg IV slowly to effect
        - Tachycardia (persistent past acepromazine administration) - propranolol 0.02-0.06mg/kg IV to effect
        - Amphetamine-induced hyperthermia, serotonin syndrome - cyproheptadine 1.1 mg/kg PO/rectal q6hrs
    - Monitoring
        - BP, ECG, body temperature, CNS status
        - Platelets/PT/PTT in patients with prolonged hyperthermia
    - Prognosis - variable; good with early intervention
- **Albuterol**
    - Binds to beta-2 receptors on smooth muscle
    - Dogs usually exposed by puncturing/chewing inhalers, but potentially ingestion of oral forms as well

- Clinical signs
    - Restlessness, agitation, hyperactivity, tachycardia, tachypnea, tremors, weakness
- Diagnostics
    - Electrolytes - hypokalemia
    - ECG - tachycardia, VPCs, V-tach
- Treatment
    - Fluid therapy
    - Propranolol - beta blocker - 0.02 mg/kg IV slowly. Titrate to effect while watching ECG to maximum of 1 mg/kg
    - Supplement potassium PRN
    - Agitation - diazepam 0.5 mg/kg or low dose acepromazine - 0.005-0.01 mg/kg IV
- Monitoring
    - Monitor vitals, ECG, and potassium closely over initial 12 hours, then as long as signs persist
- Prognosis - good with intervention

- **Bufo toads**
    - Found in Southwest US, California, Hawaii, Texas, and Florida
    - Toxicity
        - Toxicity occurs via ingestion/mouthing of the toad or drinking of water where the toad has been in
        - Bufagenins and bufotoxins - cardioactive glycoside (like digitalis) → cardiac arrhythmias
        - Bufotenines - CNS and GI changes
    - Clinical signs
        - GI signs - immediately to 15 minutes post ingestion
            - Hypersalivation, vomiting, retching, diarrhea
        - Cardiac signs - 15 minutes to 4 hours post ingestion
            - Syncope, collapse, tachycardia, bradycardia, other arrhythmias
        - CNS - 15-20 minutes post ingestion
            - Ataxia, tremors, seizures, nystagmus, hyperexcitability, coma
    - Diagnostics
        - CBC/CHEM - nonspecific changes
        - ECG - severe ventricular arrhythmias
        - BP - +/- hypotension
    - Treatment
        - Oral lavage - wash mouth with water at home and at hospital - not in patients who are seizuring or comatose
        - Emesis if patient ingested any parts of the road
        - Fluid therapy
            - Treat hypotension with fluid boluses
        - Cooling measures for hyperthermia

        - Arrhythmias
            - Atropine 0.02-0.04 mg/kg IV/SC/IM for bradycardia, heart block, SA node changes - do NOT use if patient tachycardic
            - Propranolol 0.02 mg/kg IV slowly to effect (do not exceed 1 mg/kg) for sinus tachcardia and supraventricular rachyarrhythmias
            - Lidocaine 2 mg/kg IV bolus, can repeat 2-3x - if response, start CRI @ 50-80 mcg/kg/min. If no response, do not start CRI
        - Seizures
            - Diazepam/midazolam 0.5 mg/kg IV PRN
            - Phenobarbital 2-20 mg/kg IV PRN
        - Antiemetics
            - Maropitant, ondansetron
    - Monitoring
        - Continuous ECG monitoring
        - Vitals - HR/Temp
        - Electrolytes for hypokalemia Q4-6 hours for first 12 hours
        - Baseline kidney values, then recheck 72 hours later
    - Prognosis - variable

Miscellaneous

- **Heat Stroke**
    - Significant elevation in body temperature (>106F) secondary to environmental temperature, strenuous exercise, or severe tremors/seizures; animal cannot dissipate heat effectively to cool itself (reminder, animals use evaporation and conduction as main ways for heat dissipation)
    - Pathophysiology
        - Marked elevated temperature leads to coagulopathies, inflammatory conditions, and tissue dysregulation leading to multiorgan disruption/failure
        - Anything above 109F leads to alteration at the cellular level (normal cell membrane stability and enzyme activity are disrupted)
        - Common systems affected:
            - Cardiovascular → systemic hypoperfusion, cardiac arrhythmias
            - Renal → AKI
            - Coagulation → thrombocytopenia, DIC
            - Respiratory → acute lung injury/ARDS
            - GI → bleeding/hemorrhage, ischemia, bacterial translocation
            - CNS → intracranial hemorrhage/edema/hypoperfusion → altered mental status, seizures, coma, etc.
            - Musculoskeletal → rhabdomyolysis
    - History

        - Commonly animal exposed to sun/increased temperatures (especially in beginning of summer when animal has not had time to acclimate)
        - Pet locked in hot car
        - Strenuous exercise
        - Animals that are obese, brachycephalic, have concurrent cardiovascular or respiratory issues are at higher risk
    - Clinical Signs
        - Elevated temperature >105
            - ***Keep in mind that some owners begin active cooling prior to presentation which may bring this down to normal by the time your pet gets to the clinic
            - If active cooling has not occurred prior to coming in, and the pet is hypothermic on presentation, prognosis is poor
        - Collapse/recumbency
        - Evidence of hemorrhage - petechiae, hematochezia, etc
        - Tachycardia, tachypnea
        - Shock, dehydration
    - Diagnostics
        - CBC - hemoconcentration, thrombocytopenia, leukocytosis or leukopenia
        - CHEM - azotemia, elevated liver values (ALT, ALP, GGT, T. Bili), elevated AST/CK, hypoglycemia, +/- hyperkalemia and other electrolyte derangements
        - PT/PTT - marked prolongation
        - BP - hypotension
        - ECG - arrhythmias
        - US - may see evidence of free fluid/hemorrhage secondary to coagulopathy
    - Treatment
        - Begin active cooling if hyperthermic - cool water on body, alcohol on foot pads/other areas of thin air, shave thick haired pets, +/- ice packs on jugular/femoral vessels (some controversy) - stop once temperature is 103 to prevent hypothermia
        - Oxygen therapy as indicated
        - IV fluids - bolus PRN
        - Dextrose support (boluses diluted 1:1 with saline, then in IVF @ 2.5-5%)
        - Reduce intracranial edema
            - Hypertonic saline (4 mL/kg IV over 20 minutes) vs mannitol (0.5-1 gram/kg IV over 20 minutes)
        - Antibiotics - broad spectrum (ideally unasyn + enrofloxacin)
        - Gastroprotectants (H2 blocker/PPI, anti-nausea medications, sucralfate if mentation allows oral medications)
        - Treat any arrhythmias as indicated
        - FFP if PT/PTT prolonged

        - Vasopressors for refractory hypotension
        - Recommend placing a central line (PICC/sampling, jugular catheter etc) for sampling since will likely need frequent monitoring (see below)
        - Recommend placing urinary catheter to monitor ins/outs (also these patients tend to be recumbent so this will help with sanitation)
    - Monitoring
        - Closely monitor BG, electrolytes, lactate
            - BGs q1-4 hrs
            - Blood gas/electrolytes q4-6 hrs
        - BP q30 minutes-4 hrs
        - PT/PTT q8-12hrs or 2 hours post FFP transfusion
        - Continuous ECG to monitor HR/rhythm
        - Recheck CBC/CHEM q24hrs
    - Prognosis - variable
        - Generally about 50/50
        - Negative prognostic indicators
            - Hypothermia at time of admission
            - Hypoglycemia or prolonged PT/PTT at time of admission
            - Development of DIC within 24 hours
            - Development of ARF, hypothermia, or coma
            - Seizure activity
- **Polytrauma**
    - Multiple systems suffering injuries that are immediately or quickly life threatening
    - Causes - vehicular trauma, falls, gunshot, etc.
    - Start with basic triage - ABCs, signs of shock, vitals, mentation, ambulation
        - Oxygen support as needed (flow by, O2 cage, nasal canula)
        - IV access and IV fluid therapy for hypotension
        - Pain management
    - When patient is stable, begin basic diagnostics
        - CBC/CHEM
        - Blood Gas
        - BP
        - SpO2
        - Radiographs - if any concern over spinal trauma, perform laterals first and interpret before flipping patient into VD/DV to minimize potential spinal trauma
            - Ideally full body screen - thoracic radiographs, spinal radiographs, abdominal radiographs, pelvic radiographs, +/- any other distal orthopedic/musculoskeletal areas of concern
    - Traumatic brain injury/head trauma
        - Clinical signs - anisocoria, mydriatic or miotic pupils, mentally altered to comatose, absent or delayed cranial nerve responses
        - Do neuro exam and Glasgow Coma Score

        - Cushing's Reflex
            - How the body responds to increased intracranial pressure (ICP) and decreased cerebral blood flow
            - Leads to hypertension, reflex bradycardia, and neuro changes
            - If untreated, brain herniation will occur
        - Treatment
            - Oxygen support in patients who are hypoxic
            - Reduce intracranial pressure with either mannitol or hypertonic saline
                - Mannitol - 0.5-1 g/kg through a filter over 20 minutes
                    - Do not give if patient is hypotensive
                    - Monitor kidney values
                - Hypertonic saline - 3-5 mL/kg over 20 minutes
                    - Monitor sodium q4-6 hours later
            - Keep head elevated 30 degrees
            - Provide pain management - ideally fentanyl (can be titrated) or low dose (minimal side effects) buprenorphine so as to minimize opioid induced sedation when evaluating neurologic status
            - Seizures - treat as they occur (see seizure section)
            - Serial neurologic exams (every 4-6 hours initially, then farther spaced as neuro exam improves)
    - Thoracic trauma
        - Thoracic radiographs - contusions, fractures, pneumothorax, etc.
        - Thoracic ultrasound - can see glide sign with pneumothorax, evaluate for free fluid
        - Common types
            - Pulmonary contusions
                - Clinical signs - tachypnea, dyspnea, pale/muddy/cyanotic mucous membranes
                - Can take up to 48 hours to develop/worsen
                - Mild (no intervention necessary) to severe - oxygen support and time
            - Rib fractures
                - Clinical signs - palpable discomfort, crepitus, flail chest
                - Generally do not require intervention
                - Flail chest
                    - Complete fracture $\geq$ 2 consecutive ribs → paradoxical movement of the segment
                    - Surgical intervention not always necessary
                    - Stabilize with systemic pain injection +/- local anesthetic; then place light chest wrap to limit movement

            - Pursue surgery if there is open penetration into thoracic cavity or pneumothorax/hemothorax that is not resolving
        - Pneumothorax
            - Clinical signs - tachypnea, dyspnea, dull lung sounds dorsally
            - Thoracocentesis (see centesis/tube section) +/- chest tube placement
            - Surgical intervention if evidence of penetrating trauma/open chest wounds
        - Diaphragmatic hernia
            - Rupture of diaphragm leads to abdominal contents entering the thoracic cavity
            - Clinical signs - tachypnea, dyspnea, changes in heart/lung sounds, etc.
            - Consult surgeon regarding when to pursue surgery
    - Abdominal trauma
        - FAST US - look for evidence of free fluid
        - Abdominocentesis if evidence - see centesis/fluid analysis section for details
        - If concern for urinary trauma, place urinary catheter to help monitor ins/outs and stabilize urinary system
    - Musculoskeletal trauma
        - Stabilize fractures as indicated
        - Clip/clean wounds
        - Antibiotics for any contaminated wounds
    - High-Rise Syndrome
        - Occurs when cat/dog falls from height greater than second story
        - Common triad of injuries - pneumothorax, epistaxis, and hard palate fracture (+/- other traumatic injuries)
- **Urethral Obstructions**
    - Common history: straining to urinate, frequenting litter box with no production, vocalizing, decreased appetite, vomiting; potential history of inappropriate urination/hematuria in hours/days prior
    - Uncomplicated
        - Presents: firm, palpable painful bladder, unable to be expressed; vitals acceptable
        - Get baseline electrolytes/kidney values
        - Recommend opioid pain injection ASAP (use whatever your clinic has; butorphanol is not appropriate pain control)
        - Place IVC, begin fluid therapy (anywhere from maintenance to 2x maintenance depending on hydration status/azotemia)
        - Sedation/anesthesia

- Ketamine/valium
- Alfaxolone
- Propofol - for me, I generally do opioid and then propofol to effect, then unblock. Rarely do I need additional sedation or anesthesia
- Epidural
- Consider general anesthesia if difficult unblocking/not responding well to sedation

■ Unblocking
- Attempt to pass open ended tom-cat or slippery sam gently; use sterile saline to gently displace/retropulse any grit/stones/plugs
- Once unblocked, obtain urine sample and run UA (UMIC ideal)
- If difficulty unblocking, consider emptying bladder via cystocentesis - recommend butterfly catheter
- Lavage bladder copiously - the more hemorrhagic/gritty the urine is, the more you should lavage - 10-20 mLs sterile saline in, then express or re-suction out
- Place indwelling u-cath - red rubber (3.5 or 5 Fr), slippery sam, or mila catheter
- Suture catheter to prepuce; tape u-cath to tail

○ Complicated
■ Presents: obtunded, bradycardic, firm palpable painful bladder unable to be expressed, etc.
■ Place on ECG → if hyperkalemic, will see tall T waves and wide QRS complexes and P waves
- Treat with calcium gluconate: 1 mL diluted 1:1 with saline
- Give slowly to effect while watching ECG

■ For hyperkalemia
- Fluid bolus can help decrease K+
- For profound hyperkalemia, use insulin/dextrose
  - 1U regular insulin IM, followed immediately by 3-4 mLs 50% dextrose (diluted 1:1 with saline) bolus, and then add 2.5-5% dextrose to IVF for next 6 hours
  - Check BG frequently (q1-2hrs) for hypoglycemia
  - If normoglycemic at end of 6 hours, D/C dextrose, monitor BG for 2-4 hours after

■ Sedation/anesthesia
- Opioid +
  - Ketamine/valium
  - Alfaxolone
  - Propofol
- Consider general anesthesia

○ Continued care
■ Urine output (UOP) q4hrs - note total volume and mL/kg/hr

            - Ideally making 1-2 mL/kg/hr
        - Make sure you are matching ins and outs
            - Normal to have a post-obstructive diuresis
        - Buprenorphine (0.01-0.02 mg/kg OTM q8hrs) and prazosin (0.5 mg PO q8-12hrs)
        - E-collar always
        - Appropriate antibiotics pending urinalysis findings
        - Diet change pending urinalysis findings
        - If non-azotemic, consider robenacoxib (2 mg/kg SQ q24hrs or oral 1 tablet PO q24hrs) for anti-inflammatory effects
        - If azotemic, monitor kidney values q12-24hrs
        - If hyperkalemic, monitor K+ q4-24 hours depending on severity
        - Clean UCS q6hrs, change system q4hrs
        - Leave u-cath in for 24-48 hours (some places recommend 48 regardless, others 24 and only longer if urine significantly hematuric/gritty)
        - Consider pulling u-cath when urine quality normal, non-azotemic, etc.
        - If third offense, recommend PU surgery
- **Wounds**
    - Types
        - Clean - atraumatic (aka aseptic surgical incision)
        - Clean-contaminated - minimal contamination, easily remedied (aka enterotomy, cystotomy)
        - Contaminated - recent wound from trauma with bacterial contamination (aka bite wounds, vehicular trauma, GI perforation, etc.)
        - Infected - older wound, obviously infected
    - Phases of healing
        - Inflammation (days 0-5)
        - Debridement (occurs basically at the same time as inflammation)
        - Repair/proliferation aka granulation tissue and epithelialization (starts day 3-5, lasts 2-4 weeks)
        - Maturation - wound contraction and remodeling (days 17-20 post injury, can last years)
    - Basic wound care
        - Assess response to antibiotics (or need for antibiotics)
        - Debride and lavage with sterile technique
        - Assess for primary closure
        - Protect wounds as necessary (e-collar, bandages, etc.)
    - Cleaning wounds
        - Chlorhexidine or betadine scrub on healthy skin around the wound
        - Lavage the wound itself with sterile saline, LRS, or dilute chlorhexidine solution
        - Use 60 mL syringe with 18-g catheter
    - Antibiotic usage

        - Always culture if you can!
        - Superficial infection - cefazolin or cephalexin
        - Deeper infection - Clavamox
        - Severe infections - beta lactam + either fluoroquinolone or aminoglycoside
        - Give antibiotics for minimum 7 days - if not improving recommend (re)culture
    - Bandages
        - Wet-to-dry bandages - generally sterile saline, although there are a variety of moist wound dressing products out there
            - Change every 1-3 days depending on contamination of wound, or if there is strike-thru
        - Honey bandages
            - Manuka honey
            - Change every 24 hours or if there is strike-thru
        - Consider placing a tie-over bandage over large wounds that cannot be closed
            - Place individual suture loops around wound in normal skin
            - Apply appropriate wound dressing, then padding (lap sponges, gauze, etc), then drape material
            - Use umbilical tape and lace through the various suture loops over the drape to secure the bandage and padding down
            - Change every 1-3 days depending on contamination of wound, or if there is strike-thru
        - Remind clients that any bandage needs to stay dry!
    - Bite wounds
        - Type of injury: shearing, tensile, compressive - leads to avulsion of skin and underlying tissue, crushing injuries, punctures, fractures
        - All bite wounds should be considered contaminated
        - Keep in mind, multiple bite wounds/infected bite wounds can lead to sepsis and/or SIRS
        - If there are bite wounds over the thorax or abdomen with any chance of penetration into the cavities, then surgical exploration should ideally be pursued
        - Debride all necrotic tissue
        - Lavage copiously
        - Drains
            - Some people use them, some people do not
            - Can be gravity dependent (penrose, etc.) or closed suction (JP, etc.)
            - Should exit through separate stab incision in the sterile field
            - Remove in 3-5 days, depending on amount of production occurring

        - Consider delayed primary closure if there is not enough viable tissue to close
        - Clavamox ideal antibiotic, otherwise penicillin + aminoglycoside or 2nd-gen cephalosporin + fluoroquinolone
        - Wounds should be monitored closely for evidence of necrosis
        - Always warn owners about the potential for the wound to “declare” itself within the first few days after the initial assault, and the potential for the wound to need a revision
- **Allergic Reactions**
    - Acute local hypersensitivity reaction
    - Can be caused by vaccines, insect stings, environmental allergens, food, other medications/drugs; many times no history of exposure to any stimuli
    - Clinical Signs - erythema, pruritus, urticaria (hives); common to see on the periocular areas, muzzle/face, ears; can see hives along any part of the body
    - Diagnostics
        - Lactate - hyperlactatemia can indicate ongoing anaphylactic reaction
        - PCV/TS - hemoconcentration can indicate ongoing anaphylactic reaction
    - Treatment
        - Diphenhydramine HCl
            - 2 mg/kg IM at the hospital
            - Owner continues 2 mg/kg PO q8hrs for 2 days
        - Corticosteroids
            - Dex/Dex SP 0.2-0.25 mg/kg IV
    - Advise owners to monitor for recurrence or worsening of signs within the first 24 hours and to have the pet reevaluated if these occur
- **Anaphylaxis**
    - Acute systemic hypersensitivity reaction
    - Can be caused by vaccines, insect stings, environmental allergens, food, other medications/drugs; many times no history of exposure to any stimuli
    - Clinical Signs - erythema, pruritus, urticaria (hives), vomiting, diarrhea, respiratory distress, arrhythmias, collapse, CNS changes, evidence of coagulopathy, prolonged CRT, poor to absent pedal pulses, weak femoral pulses, ocular changes
    - Diagnostics
        - BP - many times hypotensive, require crystalloid fluid boluses
        - ECG - look for arrhythmias
        - SpO2 - look for hypoxemia
        - Lactate - hyperlactatemia
        - PCV/TS - hemoconcentration; sometimes low total solids secondary to fluid losses/acute vasculitis
        - CBC - hemoconcentration, leukocytosis or leukopenia, thrombocytopenia; can also be unchanged
        - CHEM - elevated ALT, +/- hypoglycemia

        - PT/PTT - can be prolonged/out of range
        - FAST US - gallbladder edema (halo or double rim effect around the gallbladder); +/- pleural, pericardial, and/or peritoneal effusion
    - Treatment
        - Aggressive fluid therapy; carefully match losses (especially with GI losses)
        - Oxygen as needed
        - Diphenhydramine 2 mg/kg IM q8hrs
        - Dex/Dex SP 0.2-0.25 mg/kg IV
        - Famotidine 0.5 mg/kg IV q12hrs
        - Maropitant or ondansetron
        - Bronchodilators (albuterol, terbutaline) for severe respiratory distress
        - Epinephrine - if giving IV, give slowly and titrate to effect
        - FFP if coagulopathic
        - Metronidazole 10 mg/kg IV q12 hrs if having diarrhea
    - Monitoring
        - HR, RR, RE, MM, CRT, mentation every 30 minutes until stable, then every 1-4 hours
        - BP very 30 minutes until stable, then every 1-4 hours
        - Continuous ECG
        - SpO2
        - EPOC (blood gas, lactate, PCV/TS, electrolytes) - q12-24 hrs, consider more frequently (q4-6hrs) if patient critical
        - Monitor BGs if hypoglycemic
        - Recumbent care as needed
    - Prognosis - variable
- **Snake Envenomation**
    - In America, most commonly see Crotalid species (rattlesnakes, Copperhead, water moccasins)
    - Clinical signs depend on
        - Size/age of victim, amount of venom, location of bite, type of venom, time between bite and start of medical therapy
        - Typically, local and systemic signs develop within 30 minutes to 2 hours but onset of signs may be delayed for up to 8 hours in some cases
        - Most common to see bites on face and forelimbs
        - Severe local pain and swelling, edema, erythema, ecchymosis, bruising, lethargy, weakness, +/- hypotension, +/- arrhythmias, +/- vomiting, +/- evidence of hemorrhage/bleeding other than bite site, +/- puncture marks
        - Rattlesnake and water moccasin bites generally have more severe pain and swelling compared to copperhead bites
        - Mojave rattlesnake causes neurotoxicity
        - Neurotoxicity more common in cats than dogs
    - Diagnostics

        - CBC - anemia or hemoconcentration, thrombocytopenia, leukocytosis
        - Blood smear - echinocytes
        - Chemistry - may be normal, or may see azotemia, elevated CK, ALT, AST, hyperbilirubinemia
        - UA - may be normal, may see hematuria, hemoglobinuria, myoglobinuria
        - PT/PTT - may be normal or may be prolonged
        - BP - hypotension common
        - ECG - arrhythmias can occur (V-tach or VPCs most common)
    - Treatment
        - **Antivenin** - only proven therapy
            - Administered IV
            - Most effective when administered in the first 4 hours
            - Various types out there, your hospital should hopefully have in stock what is needed for your area
                - Most are given over an hour but refer to your specific product
            - Monitor for anaphylaxis
                - If occurs, stop transfusion, give diphenhydramine, restart transfusion over slower rate
            - Keep cost in mind, can be cost prohibitive for some clients
        - Opioid based pain medications
            - Generally start with methadone/hydro injection, then continue either intermittent injections vs fentanyl CRI depending on pain level
        - Fluid therapy
            - Many times hypotensive, will likely require bolus(es), keep IVF on 1.5-2x maintenance
        - Wounds do not need to be debrided, antibiotics are only necessary if secondary infection occurrs (not common)
        - Monitor BPs, ECGs
        - Recheck platelet/PT/PTT q12hrs
        - Corticosteroids, NSAIDs, and heparin are contraindicated
        - Go home with oral opioids (tramadol, codeine)
    - Prognosis - generally good
        - With copperhead bites, generally do very well. Many times we do not need to administer antivenin and only do so based on if the location of the bite is severe, or if the patient already has changes on bloodwork. I can't think of a single copperhead bite in the past 4 years I've been in Virginia that did not go home
        - Rattlesnake bites require early intervention with antivenin to have a more favorable prognosis. Anecdotally from when I worked in California, I would say the prognosis was closer to 70/30
- **Porcupines**

- Sedation/Anesthesia
    - Sedate with butorphanol or dexmedetomidine (depending on cardiac status, age, etc.) for superficial quills (i.e., ones that are not in the mouth)
    - For bad quill cases, anesthetize fully (typically with propofol induction) and intubate.
- Tips for quill removal:
    - Pull straight out with a good pair of hemostats.
    - Quills that are wet will often break, so don't rush; just keep good traction on the quill.
    - Put a little bit of water in the dish with the quills as it keeps them from sticking to everything you have.
- Warn owner that you likely won't get them all and that the dog may need to come back for further quill removal.
    - Usually by the time they reach the office some have already broken off and migrated under the skin.
    - Those that are readily palpable can be extracted with some local anesthetic and a small cut down, but they can be elusive

Common Emergency Surgeries

- **Gastric Dilatation and Volvulus (GDV)**
    - Exact cause unknown
    - Most common in large breed/deep chested dogs
    - Clinical Signs: non-productive retching or attempts to vomit, distended/rounded abdomen, abdominal pain, restlessness, ptyalism, collapse, weakness, tachycardia,
    - Diagnostics
        - Abdominal radiographs - right lateral - “double bubble” or “Popeye’s arm”
        - Lactate - <4 better prognosis, >4 worse prognosis; if lactate decreased by 4 at recheck after surgery, better prognosis
        - CBC - normal to inflammatory leukogram, hemoconcentration; in severe cases can see thrombocytopenia
        - CHEM - azotemia, elevated liver values, protein changes
        - Blood gas - metabolic acidosis, hyperlactatemia
        - PT/PTT - can be prolonged in cases with DIC
        - Thoracic radiographs - recommend doing prior to anesthesia to evaluate for cardiomegaly and neoplastic processes
        - ECG - cardiac arrhythmias
    - Treatment
        - Immediate stabilization
            - Fluid therapy
                - Place 2 peripheral IV catheters (avoid saphenous/caudal venous placement)

        - Give ¼ shock boluses every 15-20 minutes as needed
    - Pain management - opioids
    - Gatroprotectants - maropitant, pantoprazole or famotidine
    - Gastric decompression (do one or the other)
        - Orogastric tube
            - Sedation - opioid and benzodiazepine; opioid and alfaxolone
            - Measure orogastric tube from end of xiphoid to tip of nose
            - Use mouth gag (2 inch roll of tape, etc.)
            - Lube the end and pass into the esophagus
            - Gentle rotate to attempt to enter the stomach - NEVER force or could cause perforation
            - Lavage with water to remove stomach contents
        - Trocharization
            - Sterilely prep right lateral abdomen where tympany is noted
            - Use 14-18g needle/catheter and insert into stomach, removing air/fluid
- Surgery
    - Gastropexy +/- splenectomy +/- gastric resection
- Post-op care
    - Monitor for arrhythmias - most commonly VPCs/V-tsch
        - Treat with lidocaine bolus, then lidocaine CRI if responsive
    - Monitor perfusion parameters, electrolytes, lactate, acid base status
- Prognosis - variable
    - Reported ~15-25% mortality rate
    - Gastric necrosis/resection higher mortality rate
    - Persistent hyperlactatemia higher mortality rate

- **Hemoabdomen**
    - Generally characterized as traumatic vs spontaneous/non-traumatic
        - Traumatic
            - Vehicular trauma and other blunt force trauma, bleeding from organ biopsy sites, failure of surgical hemostasis
            - For traumatic hemoabdomens, generally respond well to initial stabilization; rare for surgical intervention to be necessary - pursued in those cases that are not responsive to large volume resuscitation and where continued intra-abdominal bleeding is occurring
            - Any penetrating abdominal trauma should have surgery, regardless of whether hemorrhage has continued or resolved
        - Non-traumatic/spontaneous

                - Most common is ruptured intra-abdominal masses (spleen, liver)
                - Tearing of short gastric vessels with GDV, anaphylaxis, secondary to rodenticide or other toxin
                - If history fits with spontaneous/noplasia, remember ⅔ rule (more recent literature supports that this may be closer to 50/50)
    - History - intermittent/progressive weakness vs acute weakness, pale gums, labored breathing, collapse, distended abdomen
    - Clinical Signs - tachycardia, tachypnea, hypothermia, weak to absent distal pulses, pale/white mucous membranes, prolonged CRT, abdominal distension, palpable fluid wave, palpable abdominal mass, etc.
    - Diagnostics
        - PCV/TS
            - Protein tends to be <6 with acute hemorrhage
            - If abdominal > peripheral, consistent with hemoabdomen
            - If >10% difference between abdominal/peripheral or if peripheral PCV <20%, then will likely need pRBC transfusion for stabilization
        - CBC - regenerative vs non-regenerative anemia, +/- thrombocytopenia (generally from consumption)
        - PT/PTT - can be mildly elevated with hemorrhage; will be markedly prolonged with vitamin K antagonist
        - Lactate - elevated, indication of poor systemic perfusion
        - FAST US: confirm abdominal effusion, many times can see large cavitated mass; make sure to evaluate for pericardial/pleural effusion
        - Abdominocentesis - frank, non-clotting blood
        - ECG - can see ventricular arrhythmias
        - Thoracic radiographs - rule out metastasis
    - Treatment
        - Different places have different preferences - some prefer attempted stabilization and then surgery several hours later vs more immediate stabilization and then immediate surgery - ask your surgeon's preference
        - Initial perfusion stabilization
            - IVC
            - Fluid boluses as needed
            - pRBC/whole blood transfusion if not responsive to crystalloid resuscitation
                - Can consider autotransfusion if no blood products on hand
            - Can place abdominal wrap - questionable about how much stabilization it provides
            - Consider Yunnan Baiyao - Chinese herbal supplement with hemostatic properties
        - Surgery to remove bleeding mass if indicated
    - Prognosis - varied - depends on underlying cause and state of instability on presentation

- **Pyometra**
    - Accumulation of purulent material in the female reproductive tract
    - Common in middle aged intact female dogs, usually seen a few weeks after being in heat
    - Exact pathophys unknown, known to be due to factors of hormones and infectious processes
    - Clinical signs - “open” vs “closed”
        - Open - purulent vaginal discharge, lethargy, inappetence, vomiting, diarrhea, PU, PD
        - Closed - lethargy, inappetence, vomiting, diarrhea, PU, PD, abdominal pain/discomfort, signs of sepsis/shock
    - Diagnostics
        - AFAST: fluid-filled structures in caudal abdomen - looks like multiple bladders
        - CBC - white cell count - can be elevated (severely at times, usually neutrophilia) vs normal; in severe infection, can see panleukopenia
        - CHEM - normal to azotemia, low albumin, elevated globulins, elevated ALP, etc.
    - Treatment
        - Recommend immediate stabilization, followed by surgery
            - Fluid therapy - bolus as needed
            - Gastroprotectants (maropitant, antacid, etc)
            - Broad spectrum antibiotics - unasyn + enrofloxacin
        - Surgery - OVH
            - Ideally obtain uterine culture if can/finances allow for it/owner approves
        - For open pyometra - can attempt to treat medically (oral/IV antibiotics), however OVH should be pursued ASAP
    - Prognosis - variable; good with early intervention; guarded to poor if sepsis/SIRS has begun
- **GI Obstruction/Foreign Body**
    - Types/categories
        - Partial or complete
        - Small or large intestine
        - Mechanical or functional
    - Potential causes - foreign bodies (FBs), neoplasia, intussusception, etc
    - History - anorexia, vomiting, diarrhea, painful abdomen, regurgitation, weight loss etc.
    - Clinical signs - dehydration, painful abdominal palpation, palpable abdominal abnormalities (fluid filled loops, foreign body, mass, etc.), ptyalism, diarrhea on rectal, etc.
        - ***Always check under tongue for potential string/linear FBs
    - Diagnostics

        - CBC - hemoconcentration, +/- anemia if history/evidence of GI bleed, leukocytosis, leukopenia - intestinal perforation and septic abdomen
        - CHEM - hypochloremia, hypokalemia, hyponatremia, +/- azotemia, elevated ALT/ALP, elevated amylase/lipase
        - Radiographs
            - Foreign objects, mass(es), signs of obstruction
                - Fluid/air dilated intestines
                - Two populations of “large” intestines
                - Linear FB - plication/bunching
                - Pneumoperitoneum - intestinal perforation
        - US - can be very helpful to rule in/out obstruction if radiographs are suggestive but inconclusive
    - Treatment
        - Begin IVF therapy to rehydrate - sometime partial obstructions can pass with fluid therapy
        - Gastroprotectants
        - If concern for perforation/sepsis, begin broad spectrum antibiotics - unasyn + enrofloxacin, etc.
        - Surgery
            - Gastrotomy, enterotomy, RNA, etc.
    - Prognosis -variable

Centesis/Tube Placement/Fluid Analysis

- **Abdominocentesis**
    - Indication
        - Removal of unexplained abdominal fluid
        - Removal of previously diagnosed fluid build up leading to compromise of the respiratory and/or GI systems
    - Risks
        - Infection, bleeding, damage to internal organs, electrolyte derangements and/or hypotension secondary to fluid shifts
    - Clinical signs
        - Abdominal distention, palpable fluid wave, abdominal discomfort, difficulty breathing, weakness, lethargy, collapse
    - Diagnostics/Fluid Analysis
        - Ideally US for at least four quadrant FAST scan
        - Save fluid samples in EDTA (purple-top) and red-top tubes
        - Can obtain culture PRN
        - In-House Cytology of Fluid
            - Types of effusions
                - Pure transudate
                    - Color - transparent, yellow/straw

        - Low cellularity/protein
        - Cell types - rare monocytes, mesothelial cells
        - Common causes - low albumin, liver disease, portal hypertension
    - Modified transudate
        - Color - transparent, yellow, red
        - Low to medium cellularity/protein
        - Cell types - variable (monocytes, lymphocytes)
        - Common causes - CHF, vasculitis, portal hypertension, diaphragmatic hernia
    - Exudate
        - Color - yellow, red, viscous
        - High protein/cellularity
        - Cell types - polymorphonuclear neutrophils (can be degenerative)
        - Common causes - bacterial or fungal, neoplasia, pancreatitis, FIP
    - Chyle
        - Color - white, pink, cloudy
        - High protein/variable cellularity
        - Triglycerides
            - Abdominal effusion >1.1 mmol/L
            - Abdominal effusion level higher than peripheral serum level
        - Cell types - mature lymphocytes, polymorphonuclear neutrophils, macrophages
        - Common causes - lymphatic obstruction, idiopathic, trauma, CHF
    - Septic
        - Intracellular bacteria - consistent with septic abdomen
        - Elevated lactate (see below)
        - Decreased BG (see below)
    - Bile
        - Color - green, orange, yellow
        - Cell types - macrophages; can also see pigmentation that is green, gold, or black/brown
        - Abdominal bilirubin >2x serum bilirubin diagnostic for bile peritonitis
- PCV
    - >10% to be considered hemorrhagic
    - If abdominal PCV higher than peripheral PCV, active hemorrhage occurring, intervention necessary

        - TP
            - See types of effusions above
        - Blood glucose
            - If the abdominal fluid glucose is more than 1.1 mmol/L less than the concurrent peripheral blood glucose concentration (without IV dextrose supplementation), concerning for sepsis
        - Lactate
            - If the abdominal fluid lactate is 1.5 mmol/L higher than the concurrent peripheral blood lactate, concerning for sepsis
        - Potassium
            - >1.4x the serum level strongly suspicious for uroabdomen
        - Creatinine
            - >2x serum level strongly suspicious for uroabdomen
    - Procedure/Technique(s) (in order of ideal to less ideal)
        - For all techniques, patient should be placed in right lateral recumbency, and the abdomen sterilely prepped around the umbilicus (ideally at least 3cm caudal, cranial, and left/right lateral)
        - Perform with 20-22 guage needle and 3-6 mL syringe
        - Place needle perpendicular to skin and advance through the skin (this is the part that hurts, so do it quickly!) - once through the skin and into the SQ/abdominal wall, begin aspirating - fluid should accumulate once needle has penetrated through
        - US guided
            - Use probe to find anechoic region (fluid) and visualize needle into placement of fluid
        - Four quadrant
            - Advance a needle into each quadrant
                - Diaphragmatico-hepatic - just caudal to xiphoid process
                - Spleno-renal- left flank region
                - Cysto-colic - on the midline over the urinary bladder/caudal to umbilicus
                - Hepato-renal - right flank (most dependent) region
        - Blind
            - Perform in dependent region ~2-3cm caudal to umbilicus and ~2-3cm off of midline in dependent region
- **Thoracocentesis**
    - Indication - accumulation of fluid or air in the thoracic space
    - Risks - pneumothorax, hemorrhage, trauma to lungs
    - Common causes
        - Trauma - hemothorax or pneumothorax
        - Infection (penetrating bite wounds, migrating foreign body) - pyothorax, pneumothorax
        - Cardiac/heart failure - hydrothorax

        - Neoplasia - hydrothorax, pneumothorax, hemothorax
        - Hypoalbuminemia - hydrothorax
        - Coagulopathy - hemothorax
        - Idiopathic - chylothorax, hydrothorax
    - Clinical signs
        - Tachypnea, dyspnea, cyanosis, increased respiratory effort +/- abdominal component, lethargy, exercise intolerance, decreased lung and/or heart sounds
    - Diagnostics
        - Ultrasound ideal but not required
        - See abdominocentesis section above for types of effusions for cytologic/fluid analysis
        - Thoracic radiographs - recommend performing AFTER thoracocentesis has been performed
        - CT - ideal
    - Procedure
        - Can be placed in sternal or lateral recumbency (I far prefer sternal)
        - Mild sedation may be necessary/helpful (butorphanol, midazolam, alfaxolone, etc.)
        - Surgically prep the lateral thorax (either both sides or side fluid is accumulating on)
        - Use 14-20 gauge catheter (ideally 1.5inch or longer)
        - Insert cranial to the edge of the ribs at the 6-10 intercostal space (usually 7-8 intercostal spaces); advance until there is a flash of fluid in the hub; remove the stylet and place extension set with three way stop cock and 20-60cc syringe
        - Obtain samples of fluid and place in red top and purple top, then remove remaining fluid and quantify - if concern for pneumothorax is high (chronic fluid build-up) recommend not removing all fluid
        - May need to “hop” intercostal spaces to find new pocket of fluid to be aspirated
        - Monitor for worsening respiratory status following procedure - could indicate pneumothorax vs recurrent fluid build-up
- **Pericardiocentesis**
    - Indication - abnormal accumulation of fluid in the pericardial sac
    - Risks - pneumothorax, trauma to the heart, hemorrhage, spontaneous death/cardiac arrest
    - Common causes
        - Dogs - hemangiosarcoma (HSA), heart based tumor, idiopathic, infectious, coagulopathy (rodenticide)
        - Cats - CHF, lymphoma, FIP, PPDH
    - Clinical signs - collapse, pale gums, muffled heart signs, lethargy, difficulty breathing

        - ***if concerned about a hemoabdomen, always FAST the heart too if you have an US
    - Diagnostics
        - Echocardiogram is ideal but not always feasible
        - FAST US - confirm pericardial effusion, +/- visualize mass (right atrium - HSA, between aorta/main pulmonary artery - heart based)
            - ***Just because not obvious mass noted does not mean mass is not present
            - ***Large fibrin clot can look similar to mass
        - ECG - possible ventricular arrhythmias, small QRS complexes, electrical alternans
        - Thoracic radiographs - globoid cardiac silhouette
        - CBC - PCV to assess anemia, platelet count to look for severe thrombocytopenia
        - PT/PTT - ideal to rule out coagulopathy
        - ***Many times on ER these guys come in crashing and you have to tap them before any of the above diagnostics can be performed - always advise owners on potential risks of doing procedure without diagnostics
    - Procedure
        - Ideally stabilize with O2 and fluid bolus prior to procedure (since will be removing hopefully large volume of body)
        - Mild sedation may be necessary/helpful (butorphanol, midazolam, alfaxolone, etc.; avoid acepromazine and alpha-2 agonists)
        - Can be placed in sternal or lateral recumbency (I far prefer sternal)
        - Place on ECG during procedure
        - Surgically prep the **right** side of the thorax between 2nd-8th ribs
        - Apex of heart beat can be palpated between 4th-5th ribs - or can use US guided to help
        - Do local lidocaine block at selected location prior to inserting catheter
        - Recommend making small nick through skin at site of lidocaine block to facilitate catheter insertion
        - Insert catheter with stylet and advance slowly into the thoracic cavity until there is a flash of fluid in the hub
            - Sometimes you can feel a soft pop when perforating the pericardium (I've gotten in the habit where when I'm performing these I actually close my eyes when inserting the catheter and do it by feel - I can almost always feel the pop through the pericardium when I do this)
        - Once pericardium has been penetrated, advance catheter/stylet 2-3 mm further
        - Remove stylet and attach collection system (three way stock cock, extension set, and 20-60cc syringe) and remove fluid - obtain samples and then quantify

        - If needle has advanced into the heart, will get clotting blood
        - If you feel a scratching sensation, is likely the catheter is in contact with the heart (may also see VPCs on the ECG) - remove catheter a small amount until this does not occur anymore
        - Sometimes pericardium tears and fluid is released into the pleural space - this is fine!
        - Patient generally feels significantly better almost immediately after pericardiocentesis - pink MM, BP normalizes, HR normalizes, respiratory distress resolves
        - Monitor for recurrence of effusion (can happen within minutes so keep close eye on patient for first 12-24 hours)
- **Nasal Cannula**
    - Indication
        - Animal requiring oxygen supplementation that is not receiving adequate oxygenation in O2 cage or animal is too large for O2 cage
    - Risks
        - Hemorrhage
        - Do not place in animals with severe thrombocytopenia/coagulopathies or in bad head trauma cases
    - Procedure
        - Place a few drops of proparacaine or lidocaine into nostril
        - Use appropriate sized red rubber (5-12)
        - Pre-measure tube to level of medial canthus or second premolar
        - Lubricate end with water soluble jelly
        - Insert tube into nare in a ventromedial direction
        - Place suture at base of nostrils close to nare and anchor tube in place. Place additional sutures or staples alongside the side of the face or along the bridge of the nose to secure the tube
        - Secure end of tube to hard e-collar and attach to oxygen
- **Nasogastric Tube**
    - Indication
        - Provide nutrition
        - Aspirate gastric contents secondary to ileus, gastritis, pancreatitis, etc.
    - Risks
        - Hemorrhage
        - Placement into the trachea instead of the esophagus
        - Trauma/puncture of the mainstem bronchi/lungs
        - Do not use in patients with active vomiting or are comatose/lack gag reflex
    - Procedure
        - Measure from nasal planum to 3-4 inches past the last rib
        - Place a few drops of proparacaine or lidocaine into nostril
        - Lubricate end with water soluble jelly

        - Insert tube into nare in a ventromedial direction
        - Gently continue to pass tube - once hitting oropharynx, patient many times will cough - watch for swallowing as tube enters esophagus
        - Advance tube to premeasured mark
        - Take a lateral radiograph to confirm location; also recommend administered a few mLs of sterile saline into tube -if causes coughing, tube is in the trachea and not the esophagus
        - Secure with sutures at opening of nare and along dorsal midline bridge of nose
        - Place hard e-collar; secure end of tube on either e-collar or bandage around the neck
- **Chest Tube**
    - Indication
        - Requiring multiple thoracocentesis within first few hours of presentation
        - Unable to achieve negative pressure
    - Risks - see thoracocentesis
    - Procedure - classic
        - Perform with either sedation/local anesthesia vs general anesthesia
        - Chest tube ~same size as mainstem bronchus
        - Prep entire lateral thorax
        - Have an assistant grab the skin at the level of the shoulder blade and pull cranially
        - Using lidocaine, block skin down pleura at 7th-9th intercostal space
        - Make stab incision slightly larger than the tube
        - Use hemostats to bluntly dissect down to intercostal, then push hemostats into the thorax
        - Place chest tube in cranioventral direction using stylet to guide the tube - usually about 4-6 inches
        - Place clamp and/or three way stop cock
        - Release skin - creates SQ tunnel
        - Secure tube to periosteum of ribs - simple interrupted sutures to close SQ space around tube; finger trap to secure tube to patient
        - Place TAO and then place bandage covering (stockinettes are handy)
        - Either use three-way stop cock for intermittent aspirations or use continuous suction system
    - Procedure - mila chest tube
        - There’s a great video on youtube, watch it!
        - Perform with sedation/local anesthesia
        - Prep entire lateral thorax
        - Place the over-the-needle plastic catheter at the 7th or 8th intercostal space
        - Once entered the pleural space, remove the needle and leave the plastic catheter in place

- Pass guidewire through plastic catheter and into pleural space, ~8-12 inches
- Once wire in place, carefully remove plastic catheter, making sure to hold guidewire in place
- Advance chest tube over guidewire until it enters the pleural space to point of marked hub
- Remove guidewire and attach syringe at end of chest tube
- Secure chest tube to chest with sutures