

## Metabolic and Endocrine Emergencies

### **Addisonian Crisis**

Addison's disease can mimic gastroenteritis and kidney failure

#### Physical Exam Findings

- Can range from quiet and sick but ambulatory to obtunded and recumbent in hypovolemic shock
- Signs of hypovolemic shock
  - Pale MM
  - Poor mentation
  - Delayed CRT
  - HR may be absolutely or relatively low for shock
  - Poor Pulses
  - Cool extremities
- Abdominal pain is common, melena or hematochezia variably present on rectal exam

#### Treatment

- IVC – ideally cephalic vein
- Immediate shock fluid therapy – rapid infusion of IVF
  - Fluid choice = isotonic crystalloid fluid
  - Dose based on estimated canine blood volume (80-90 mL/kg)
    - Give at least ¼ of this dose (minimum of 20 mL/kg)
  - Give at a rate that could guarantee the entire shock volume could be administered in an hour
    - Ex: if you choose 20mL/kg it must be given in no more than 20 min

#### Lab Findings

- Electrolytes
  - Hyponatremia, hyperkalemia
  - Na:K will be < 28 and usually <23
  - Mechanism for hyponatremia: lack of aldosterone is associated with the generation of hyponatremia coupled with the lack of cortisol and its disinhibition of ADH secretion. This leads to increased ADH secretion, increased water retention, dilution of sodium molecules present in the ECF, and a low plasma sodium concentration.
- Hypoglycemia – common
- Hypercalcemia – common
- Azotemia – common

## Treating Hyperkalemia

- IVF therapy – resuscitation, deficit replacement, improved GFR
- Calcium IV (calcium gluconate, chloride, or other)
  - Does not change plasma  $[K^+]$  only acts as a cardioprotectant
- Dextrose (+/- insulin) – drives  $K^+$  into cells dropping plasma  $[K^+]$ 
  - Insulin should not be given until normoglycemia is achieved
- Sodium bicarbonate may drive  $K^+$  into cells and drop plasma  $[K^+]$
- Glucocorticoids (ideally after ACTH stim); DOCP

## Supportive Care

- Isotonic crystalloid fluid therapy to replace deficits
  - After treating hypovolemic shock, replace hydration deficit
  - Maintenance + anticipated abnormal ongoing losses
- Anti-emetics, GI protectants
- Analgesia if needed – not NSAIDS
- Frequent monitoring – ECG, electrolytes, BG, blood pressure

## Take-Home Message

- Vague history, often with GI/poor appetite component
- Presentation off crisis is hypovolemic shock, often with discordantly low HR
- IVF resuscitation for shock, treat high  $K^+$  and low BG
- Expect low Na : K ration < 28; often azotemic
- Definitive ACTH stim test
- Treat supportively; expect 2+ days of hospitalization
- Steroids once ACTH stim test is complete if there is a strong suspicion of disease

## **Hypoglycemia**

\*Low plasma glucose concentration – seizures are the most common ER sign

### Causes

1. Insulin excess
  - a. Iatrogenic – client or veterinary treatment for DM
  - b. Insulinoma
  - c. Paraneoplastic (insulin-like factor)
  - d. Xylitol intoxication (dogs)
2. Excessive glucose utilization
  - a. Sepsis

- b. Excessive muscle activity (uncommon)
- 3. Impaired glucose production - often reflects low glycogen stores
  - a. Liver failure
  - b. Sepsis
  - c. Hypoadrenocorticism
  - d. Neonates, young teacup breed dogs

### History and Clinical Signs

- Since there are a variety of causes, the historical findings vary
- ER-related clinical signs
  - Seizures (inadequate glucose to neurons – “neuroglycopenia”)
  - Shock (obtundation, tachycardia – other parameters variable)
  - Weakness, collapse, lethargy

### Measure Blood Glucose

- Prompt measurement is key! Lab errors can occur if the sample sits out too long
- High PCV can lead to artifactual hypoglycemia in whole blood measurement

### Treating Hypoglycemia

- IV dextrose administration
  - 0.25-0.5 g/kg dextrose IV (0.5-1mL of a 50% solution)
  - If actively seizing, administer a benzodiazepine (midazolam, diazepam)
  - Once clinical signs resolve, IVF with 2.5 – 5% dextrose added
- Oral corn syrup or dextrose may help but it takes ~30 min to work, this is NOT appropriate for an in-hospital emergency
- Caution with dextrose and insulinomas – normoglycemia worsens insulin release

### **Diabetic Ketoacidosis**

- The most common emergency complication of diabetes mellitus
  - Due to a combination of DM and another problem – you need to find the other problem and fix it to resolve the ketoacidosis
- Combination of hyperglycemia BG >300 and a high AG metabolic acidosis not fully accounted for by lactate
- Main treatments
  - Fluid therapy
  - Insulin

### Pathophysiology

- Inadequate insulin or insulin resistance AND another primary condition
  - Increased pro-inflammatory cytokines
  - Increased counter-regulatory (diabetogenic) hormones
    - Glucagon, cortisol, epinephrine, growth hormone
- Low insulin and high glucagon
  - Ketoacids produced by the liver
    - B-hydroxybutyrate, acetoacetate, acetone
    - Dissociate at physiologic pH
    - Acidosis

### Clinical Signs

- Malaise, poor appetite
- Vomiting
- Diarrhea
  - Shock when severe
- Systemic effects: cardiovascular, renal, and CNS
- Acidemia causes much of the illness

### Priorities

1. IVF Therapy
  - a. Early and ample, stabilize the animal!
  - b. 80-90 mL/kg in dogs
  - c. ~50 mL/kg in cats
  - d. Balanced isotonic crystalloid
  - e. Buffered
  - f. Provide some  $K^+$
  - g. P-lyte and Norm-R provided  $Mg^{2+}$
  - h. Supplement  $PO_4$  as needed
2. Insulin therapy
  - a. Stop ketogenesis
3. Vigilant monitoring and support
  - a. Potassium, phosphorous, magnesium, Acid-base, BG
4. Diagnose and treat the second problem

### Hyponatremia of Hyperglycemia

- For every 100mg/dL the BG is elevated plasma  $[Na^+]$  drops by 1.6-2.4 mEq/L
- Ex: BG 600 = 500 (five 100 mg/dL units greater than usual)
  - If the  $[Na^+]$  is 134 it will correct to....
  - (5 units x 2 mEq/L/unit = 10 mEq/L) and  $134 + 10 = 144$  mEq/L which is WNL

## Hypokalemia and Hypophosphatemia

- Hypokalemia clinical signs
  - Weakness – cervical ventroflexion
  - Less common: arrhythmia
- Hypophosphatemia
  - If  $< 1.0$  mg/dL HEMOLYSIS
  - Supplementation is key!

## Insulin Therapy

- Should you delay insulin treatment?
  - Slightly torn opinions and the American Diabetes Association does not specify
  - Ideally  $[K^+] > 3.3$  mEq/L when starting insulin
  - Studies have shown a quicker resolution of DKA (19h) and no negative effects with earlier insulin administration
- Can be administered IM vs Constant Rate Infusion (IV)

Add 2.2 U/kg regular insulin  
to 250mL bag 0.9% NaCl. Then...

Blood Glucose Concentration, mg/dL	Other fluid composition:	Rate of insulin CRI, mL/hr
>250	No additives	10
200-250	2.5% dextrose	7
150-200	2.5% dextrose	5
100-150	5% dextrose	5
<100	5% dextrose	0 (Stop insulin)

### \*Bicarbonate therapy

- Not indicated for mild to moderate acidemia in DKA
  - $pH > 7.1$
- May consider if  $pH < 7.1$  or  $7.0$  or plasma  $[HCO_3^-] < 11-12$  mEq/L

## Overall Management of DKA

- Patients sick mostly from acidemia +/- concurrent illness
- Fluids are top treatment priority – Norm-R / P-lyte
- Insulin stops ketogenesis: give early and give enough
- Vigilant monitoring is key
  - Electrolytes, blood gases, physical status
- Bicarbonate therapy is rarely indicated
- Common concurrent illnesses

- Dogs: pancreatitis, hyperadrenocorticism, UTI / pyelonephritis, gastroenteritis
- Cat: pancreatitis, GI disease, hepatic lipidosis, pyelonephritis

## **Hypocalcemia**

### Overview

- Clinically evident hypocalcemia is uncommon
- When seen in patients it is most often appreciated in lactating dogs with a high milk production
- Clinical signs
  - Facial rubbing, agitation, eventually tremors
- Treatment
  - Calcium supplementation and if it is due to lactation, weaning puppies and improving the diet are key

### Causes

1. Eclampsia (“puerperal tetany” or “puerperal hypocalcemia”)
2. Chronic kidney disease
3. Pancreatitis (uncommon)
4. Iatrogenic
  - a. Blood transfusion (EDTA chelates calcium), bicarbonate therapy

### Clinical Signs

Normal ionized calcium: 1.15-1.45 mmol/L \*species variation

- None if mild
  - Clinical signs do not typically show until  $iCa^{2+}$  is  $<0.8$  mmol/L
- Moderate
  - Facial rubbing, muscle tremors “tetany”
- Severe
  - Seizures, obtundation, cardiac arrhythmia / death

### ER Room Treatment

- Administer calcium
  - IV Calcium choices
    - 10% calcium gluconate 0.5-1.5 mL/kg over 10-20 min
      - 23% CaGluc solutions are also available
    - 10% Ca Chloride 0.2-0.5 mL/kg over 10-20 min
  - Monitor ECG for bradyarrhythmia

- Slow or stop Ca infusion if noted

### Note on Eclampsia

- Post-partum hypocalcemia
- Associated with greatest lactation demand just prior to weaning
- Smaller breed dogs with larger puppies (or more puppies)
- Treat for hypocalcemia in-clinic, then educate client
  - Switch puppies to milk replacer
  - Allow bitch free access to high quality puppy food
  - Often supplement with calcium carbonate (Tums)

### **Hypercalcemia**

#### Causes "HARD IONS"

- Hyperparathyroidism
- Addison's disease
- Renal failure (especially acute)
- Hypervitaminosis D – cholecalciferol rodenticides!
- Idiopathic (especially cats)
- Osteoclastic disease (granulomatous disease)
- Neoplasia
- Spurious

#### Clinical Signs

- PU/PD
- Poor appetite
- +/- vomiting
- Often found during a workup for the primary underlying problem (ie. General lymphadenopathy)

#### ER Treatment

- Indicated when  $iCa^{2+} > 1.6-1.8$  mmol/L,  $tCa^{2+} \times Phos > 60-70$ , or pet is azotemic
- Fluid therapy (0.9% NaCl) – rehydrate and diurese
- Furosemide – helps eliminate  $Ca^{2+}$  in urine
- Glucocorticoids – try not to use prior to definitive diagnosis
- Treat underlying disease