

Pathophysiology of Ketoacidosis

- Hyperglycemia and accelerated ketogenesis occur when there is an absolute or relative deficiency of insulin, and relative excess of glucagon, cortisol, growth hormone, epinephrine
- Nitroprusside reaction:
 - Used for detection and semiquantification of plasma, serum and urinary ketones
 - Detects acetone and acetoacetate
 - (when measuring serum ketones, an additive metabolizes B-OHB to acetoacetate in a known/ 1:1 manner, and this value is reported)
- When insulin therapy is instituted, B-OHB is metabolized to acetoacetate
 - Subjective urine ketone tests may 'worsen' in the initial 2-3 days
 - Ketosis may persist 3-4 days after instituting treatment due to decreased clearance of acetone
 - Never base insulin doses on presence or degree of ketosis (use blood glucose concentration)

Diagnosis

- Usually indicate anorexia, depression, weakness, vomiting: 1-3d
- Complete workup usually for a 'sick' diabetic dog or cat
 - TxR, AxR, AUS, CBC, chem, UA
- Extreme levels of hyperglycemia tend to occur only when extracellular fluid volume and blood pressure have decreased to the point of causing impaired urine flow
- Metabolic acidosis: due to ketone bodies and possible concurrent disease
- Anion gap: increased
- Hyponatremia
 - 'real': renal or gastric losses
 - 'fictitious': dilution from osmotic draw of intravascular hyperglycemia
- Hyperkalemia
 - Acidemia, insulin deficiency and plasma hyperosmolarity cause a shift of K from intracellular to extracellular
- Hypokalemia
 - Usually due to depletion of whole-body potassium stores
 - Losses occur with vomiting and osmotic diuresis
 - May be unmasked by rehydration, continued urinary losses, correction of acidosis, and increased cellular uptake
- Hypophosphatemia
 - Increased urinary phosphorus wasting
- Increased ALT/ALP
 - Commonly increased due to hepatic lipidosis

- Hypovolemia or coexisting pancreatitis can also cause (reversible) increases
- Azotemia
 - Renal or prerenal
- Neutrophilia
 - Mature: common due to the stress of the primary disorders
 - Bands and toxic changes: search for an inflammatory focus

Treatment

- IVF
- Dextrose supplementation, as dictated by patient blood glucose
- Potassium supplementation
 - If concurrent hypophosphatemia, supplement 1/3 of the potassium in the form of KPhos
- If severe hypokalemia, 1.0mEq/kg/hr potassium can be 'safely' supplemented (author's experience): recommended to perform ECG and urine output monitoring
- At least q12h electrolyte monitoring
- IVF discontinued when chem and hydration are normal, and when the dog/cat is able to drink/eat without vomiting
- Phos dose: 0.01-0.03mmol/kg/hr, repeat serum phos assessment q6h and d/c supplementation when serum phos is 2.5mg/dL
- NaHCO₃ supplementation: controversial! Use when:
 - pH <7.1
 - HCO₃ <10-12 mEq/L
 - NaCO₃ (mEq) = base deficit (mEq) x 0.3 x kg
 - D/c treatment when pH >7.2, HCO₃ > 10-12 mEq/L
- Insulin therapy: cornerstone of management for 'sick' DKA/HHS patients
 - Regular crystalline (IV, IM, SC) when patient is depressed, dehydrated, anorexic or vomiting
 - Correct hypovolemia prior to use
 - Do not exceed 75-100mg/dL/hr decrease in blood glucose
 - Transition to long acting insulin when:
 - Euhydrated
 - BG <250mg/dL
 - Serum and urine ketones are minimal to absent
 - Patient eating

Complications

- Hypoglycemia
- Hypokalemia
- Cerebral edema
- Metabolic alkalosis
- Paradoxical cerebrospinal fluid acidosis

Questions

1. Of the three ketone bodies, which is/are measured by the nitroprusside reaction?
2. NaHCO₃ use is controversial, though use typically is recommended at pH _____. Discontinuation of therapy is recommended when the pH is _____.
3. What are the criteria for transition from regular to long acting insulin?

Answers

1. Of the three ketone bodies, which is/are measured by the nitroprusside reaction?
 - a. Acetone
 - b. Acetoacetate
2. NaHCO₃ use is controversial, though use typically is recommended at pH <7.1. Discontinuation of therapy is recommended when the pH is >7.2.
3. What are the criteria for transition from regular to long acting insulin?
 - a. Euhydrated
 - b. BG <250mg/dL
 - c. Serum and urine ketones are minimal to absent
 - d. Patient eating