Hypoglycemia

Common causes of hypoglycemia in dogs and cats include puppy/kitten hypoglycemia, sepsis, xylitol toxicity, liver dysfunction, insulinoma, and exogenous insulin overdose. The brain is reliant on a constant stream of blood glucose for its energy needs. When low blood sugar occurs, neuroglycopenia (hypoglycemia of the central nervous system develops). Clinical signs of neuroglycopenia include altered mentation or dullness, sleepiness, weakness, ataxia, blindness or altered vision and seizures. Prolonged neuroglycopenia can lead to permanent brain injury and neurologic signs that persist beyond the resolution of the hypoglycemia. Other clinical signs may include pacing, restlessness, shaking, trembling, vomiting, anorexia, panting, diarrhea or urination.

Regardless of the etiology of the hypoglycemia, emergency medical treatment is the similar. Administration of 0.5-1 ml/kg of 50% dextrose (diluted 1:2 to 1:4 should be administered) should be administered to patients with hypoglycemia that present with the above signs. Additional dextrose containing fluids (2.5-5%) should be administered until the underlying cause can be determined and the patient is capable of maintaining euglycemia on their own.

Insulinoma’s are insulin secreting tumors of the pancreas. Diagnosis is made by documenting a high insulin level during a period of hypoglycemia. Patients with insulin secreting tumors (such as an insulinoma) require special considerations. While a bolus of dextrose is still indicated for management of life threatening side effects of hypoglycemia (such as seizures), a rebound hypoglycemia may occur after dextrose supplementation due to increased insulin release. Therefore, routine administration of dextrose boluses in the absence of clinical signs should not be performed. For these patients, administration of anti-insulin medications such as steroids and diazoxide will increase blood sugar without the risk of rebound hypoglycemia. Surgery may ultimately be required to remove the tumor.

Hypoadrenocorticism – Addison’s disease

Hypoadrenocorticism is an uncommon endocrinopathy that commonly affects middle aged female dogs although any age, sex or breed may be affected. Classical hypoadrenocorticism results from a mineralocorticoid deficiency leading to severe electrolyte derangements. While an atypical form may also occur from the result of glucocorticoid deficiency only, it is unlikely to present as an emergency and therefore will not be discussed here.
Patients affected with hypoadrenocorticism often have vague clinical histories and clinical signs may include anorexia, vomiting, diarrhea, weight loss, and lethargy. These signs may be intermittent or chronic and mild or severe. Other clinical signs include tremoring, shaking, weakness, PU/PD, bradycardia and hypotension. As mentioned above, there is a sex predilection for females and most dogs are middle aged (mean age of 4-5 years) at the time of diagnosis. A variety of breed predilections have been reported including the Portugese Water Dog, Great Dane, West Highland White Terrier, Standard Poodle, Wheaton Terrier and Rottweiler. However, mixed breed dogs are affected more than any other dog breed. Cats are rarely affected.

Common clinicopathologic abnormalities include lack of a stress leukogram, hypoglycemia, pre-renal azotemia, hypernatremia and hyperkalemia. A sodium/potassium ratio <27 is suggestive and a Na/K ratio less than 23 is highly suggestive of hypoadrenocorticism. An ACTH stimulation test is required for definitive diagnosis, however. Differential diagnoses for a low Na/K ratio include severe whipworm infestation, kidney failure, ascites and chylothorax.

Treatment of a hypoadrenocortical crisis involves aggressive fluid resuscitation, correction of hypoglycemia and electrolyte abnormalities, and glucocorticoid and mineralocorticoid supplementation. Fluid resuscitation typically involves the administration of isotonic crystalloids (0.9% saline or balanced buffered solutions may be used). Large volumes of crystalloids may be required to restore perfusion and correct hypotension. Hypoglycemia may be corrected as discussed above. Electrolyte abnormalities will resolve with administration of crystalloids and mineralocorticoid supplementation. Fluid resuscitation is the single most important treatment in the emergency management of these patients. Once fluid resuscitation has commenced, supplementation of glucocorticoids in the form of Dexamethasone SP, hydrocortisone or prednisone may occur. It is important to note that only DexSP should be administered if an ACTH stimulation test is yet to be completely as other glucocorticoids will affect the results. While hydrocortisone is likely the best injectable glucocorticoid for use in this situation, it is not readily available and is expensive. Mineralocorticoid supplementation can occur in the form of DOCP (Percorten) or Fludrocrorosine (Florinef).

**Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic Syndrome (HHS)**

Diabetes mellitus is a disorder characterized by a relative or absolute insulin deficiency. Insulin has many effects on body function with the main effect being to decrease blood glucose. The net effect of insulin is storage of carbohydrate, proteins and fat. It also had numerous effects on electrolytes, enzymes and growth. Various hormones also exist to counter the effects of insulin. These include glucagon, epinephrine, growth hormone and cortisol. These counterregulatory hormones antagonize the effects of insulin and increase blood glucose by increasing glycogenolysis, gluconeogenesis and lipolysis. These hormones are very important in the development of DKA.

The development of DKA occurs from an absolute or relative deficiency of insulin resulting in increased gluconeogenesis, accelerated glycogenolysis, and impaired glucose use by tissues. Despite increased blood glucose the cells become starved for energy shifting to the use of free fatty acids as an energy source. The progression from an unregulated but compensated diabetic to DKA is due to an increase in
counterregulatory hormones. These “stress” hormones are thought to be due to a secondary or coexisting disease process. An increase in these counterregulatory hormones causes of a vicious cycle of elevated blood glucose with cellular “starvation” and eventually DKA or HHS ensues. Common coexisting disease processes include pancreatitis, urinary tract infections, hyperadrenocorticism, neoplasia, pneumonia, pyelonephritis and chronic kidney disease. Hyperglycemic Hyperosmolar Syndrome (HHS) is a form of diabetic crisis marked by severe hyperglycemia (>600 mg/dl), minimal or absent urine ketones, and serum osmolality >350 mOsm/Kg. The development of HHS occurs similarly to DKA but it is believed that small amounts of insulin and hepatic glucagon resistance inhibit lipolysis, thereby preventing ketogenesis.

Clinical Presentation

Diabetes occurs most commonly in middle aged to older animals, although younger animals may also be affected. There is no sex predilection and dogs and cats can both be affected. Common clinical signs include PU/PD, weight loss (despite a ravenous appetite), weakness and lethargy. When animals become sick with DKA they often will develop anorexia, vomiting or diarrhea. Confirmation of a diabetic crisis can be made with routine bloodwork. Persistent hyperglycemia with glucosuria is indicative of diabetes mellitus. A blood gas and serum or urine ketones should also be performed to confirm ketosis +/- acidosis. Additional diagnostics should be performed to assess for comorbidities and include a CBC, serum chemistry, urinalysis, urine culture, thoracic radiographs and abdominal ultrasound.

Treatment:

The goals of therapy for a DKA are to restore intravascular volume, correct electrolyte disturbances, correct dehydration, correct acid-base imbalance, decrease blood glucose, rid the body of detectable ketones and treat any underlying or coexisting disease.

Fluid therapy is the cornerstone of DKA treatment. NaCl 0.9% has traditionally been advocated due to the presence of hyponatremia in many of these patients. This may worsen acidosis, however as 0.9% NaCl is an acidifying fluid. Balanced buffered solutions including LRS, Norm-R or plasmalyte may contribute to the management of acidosis and hypokalemia (also very common). Ultimately, the type of isotonic crystalloid is not as important as remembering to use one! Fluid therapy increases renal perfusion and urine excretion which will decrease blood glucose, ketones, and counter regulatory hormones. It also restores intravascular volume and dehydration deficits. It is important not to initiate insulin therapy until volume and dehydration deficits have been restored and this will worsen hypovolemia and may lead to cardiovascular collapse.

Electrolyte disturbances are very common in diabetic emergencies and most commonly include hyponatremia, hypokalemia, hypophosphatemia or hyperphosphatemia and hypomagnesemia. Hypokalemia is a common and potentially life threatening electrolyte derangement. Patients with normal blood potassium levels may actually be whole body depleted in potassium and insulin administration will worsen hypokalemia. As such, potassium supplementation should be administered to all patients with DKA with normal or low potassium levels.
Once hypovolemia, dehydration, acid-base and electrolyte derangements have been corrected, insulin therapy should be started. Insulin therapy is more important in DKA than it is in HHS as insulin is required for reduction of ketones. Regular insulin should be administered to patients with DKA or HHS. This can be administered either via insulin CRI or intermittent intramuscular administration.