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Diabetic ketoacidosis

DKA, ketoacidotic diabetes mellitus (KADM)

Affected Animals:

Dogs and cats.

Overview:

Diabetic ketoacidosis, or DKA, is one of the most serious metabolic disorders seen in both human and veterinary medicine. A severe complication of diabetes mellitus, DKA is characterized by an elevated concentration of blood sugar, the presence of substances called ketones in the urine, and reduced concentrations of bicarbonate in the blood. Some dogs with DKA will be affected mildly, but the majority will be seriously ill and may have severe complications such as neurological problems due to brain swelling, acute kidney failure, pancreatitis, and anemia. DKA will lead to death in many cases, but aggressive diagnostics and treatment can be life saving.

DKA often develops in dogs with diabetes that had previously been unrecognized or untreated. Thus, it is essential to identify diabetes mellitus or the development of additional symptoms in a dog that is known to be diabetic to prevent DKA from occurring.

Clinical Signs:

Clinical signs include polyuria, polydipsia, polyphagia, weight loss, lethargy, anorexia, and vomiting. Complications may include anemia, electrolyte abnormalities, neurological disorders, and acute renal failure.

Symptoms:

Symptoms include increased thirst, appetite, and frequency of urination; weight loss; tiredness; vomiting; loss of appetite; and symptoms related to any of a large number of disorders that can accompany or trigger DKA.

Description:

Diabetic ketoacidosis is probably the most serious complication that can develop in association with diabetes mellitus. Used for energy production in most body tissues, ketones, also called ketone bodies, normally form when fatty acids are released from fatty tissue and are transported to the liver. The liver then makes ketones from the fatty acids. Excessive production of ketones can occur in uncontrolled diabetes mellitus, and as they accumulate, ketosis, and eventually acidosis, develop. The four major factors that contribute to ketone formation in DKA are insulin deficiency, fasting, dehydration, and increased levels of "stress" hormones such as epinephrine, cortisol, glucagon, and growth hormone.

DKA occurs more commonly in animals with previously undiagnosed diabetes mellitus,

but it can also be seen in dogs with established diabetes that are not receiving enough insulin. In these dogs, there may be an associated inflammatory or infectious disease. Other canines may develop conditions associated with insulin resistance such as hypothyroidism or Cushing's disease. Dogs may be only mildly affected by DKA, or they may be close to death at the time of diagnosis. DKA develops at an unpredictable rate, and some diabetic dogs may be able to live fairly normal lives for several months with no treatment at all. However, once DKA develops, most dogs become seriously ill within one week.

The aggressiveness of treatment depends on how sick the dog is. While dogs with mild DKA may be successfully treated with intravenous fluids and insulin, dogs with severe manifestations of disease will need more significant intervention. Fluid therapy, potassium, bicarbonate, and phosphorus supplementation can be vitally important. Any accompanying disorders must be identified and treated specifically where possible to enhance resolution of DKA.

Complications during DKA treatment are common, and can include the development of hypoglycemia, neurological signs due to brain cell swelling, and severe electrolyte abnormalities. Anemia due to red blood cell breakdown can occur if the serum phosphorus concentration drops too low. Acute kidney failure also is possible.

DKA is one of the most serious metabolic disorders seen in both human and veterinary medicine. Many patients will die from it. However, the majority of patients can pull through a crisis successfully with aggressive diagnostics and treatment.

Diagnosis:

The diagnosis of DKA is based on the clinical signs and the presence of elevated serum glucose concentrations and ketones in the urine, and reduced serum bicarbonate concentrations within the blood stream. Mild DKA is present when dogs with high serum glucose concentrations and ketones in the urine appear healthy, or have only mild clinical signs, or have mild decreases in serum bicarbonate concentration. These dogs do not require extremely aggressive treatment, and should be distinguished from dogs with severe DKA. Dogs with severe DKA have high serum glucose concentrations, ketones in the urine, extreme reductions in serum bicarbonate concentration, and often show severe signs of illness.

In addition to the serum glucose concentrations and urinalysis results, other key diagnostic procedures include measurement of venous total carbon dioxide, blood gas evaluation, and analysis of electrolytes and serum kidney values. In addition to a routine urinalysis, a urine culture should be performed on any dog with DKA, as urinary tract infections are very common complicating factors for this condition. A complete blood count, serum liver and pancreatic enzyme measurements, and cholesterol and triglyceride levels should also be obtained. X-rays of the chest and abdomen, and ideally an abdominal ultrasound, should also be used to investigate underlying or associated factors, as well as other abnormalities that might require specific treatment.

Prognosis:

The prognosis for DKA is guarded. As many as five to 10 percent of humans with DKA die from this condition. Death rates for dogs may be as high as 30 to 40 percent in some environments.

Transmission or Cause:

DKA usually occurs in either dogs with diabetes that has been present but unrecognized and untreated for a long time, or in previously diagnosed diabetic dogs that have become ill with another problem or that are taking inadequate amounts of insulin.

Treatment:

Relatively healthy dogs with DKA can be treated with potent but regular short-acting crystalline insulin injections to help get the serum glucose levels back under control. It may take a few days for serum glucose and urine ketone levels to fall, but aggressive treatment may not be needed as long as the dog's condition is basically stable.

Treatment of sick diabetic dogs needs to be more aggressive. Paramount to the treatment of DKA is the gradual replacement of fluid deficits, as well as the maintenance of normal fluid balance. Many dogs will seem substantially better after being treated by intravenous fluids alone. Phosphate supplementation may also be needed, since serum phosphorus concentrations can drop to dangerously low levels during the treatment of DKA leading to serious complications such as a red blood cell breakdown that results in anemia. Bicarbonate is given to help correct acid-base disturbances. Insulin also is vital in the treatment of DKA. In some situations, fluids need to be replaced quickly, while the glucose levels will need gradual adjustment.

Until safer serum glucose concentrations are obtained, most dogs with DKA are treated first with regular crystalline insulin, the most potent and shortest acting form of insulin, which may be given intravenously or on an hourly basis in the muscle. If the dog is not eating on its own, dextrose may be added to the fluids to keep the serum glucose level from dropping too low after insulin is started.

Concurrent illnesses must be identified and treated specifically where possible. Pancreatitis is extremely common in DKA, but there is no specific treatment for this disorder. Bacterial infections need to be identified and treated in a timely manner. Antibiotics usually are given even if a bacterial infection has not been confirmed, due to the problems that infections cause in DKA. Acute kidney failure may also accompany DKA, and needs to be treated aggressively with fluids. Drugs may be needed to stimulate urine production if it appears inadequate.

Complications during treatment of DKA that occur most frequently include the development of hypoglycemia, central nervous system signs, electrolyte abnormalities, and anemia. The best way to prevent these side effects is to aim for gradual correction of the multiple abnormalities associated with DKA. Excessively rapid correction of glucose concentrations and electrolyte abnormalities often leads to brain cell swelling and neurological signs. Electrolyte concentrations need to be monitored very carefully during the treatment of DKA, as frequent adjustments of fluid type and rate, and the amount of potassium supplementation, are often needed. Also, close attention must be paid to the serum phosphorus concentration, as supplementation with phosphorus is often needed to prevent the development of severely low serum phosphorus concentrations and the anemia that can result from this.

Once the dog is stabilized and eating and drinking on its own, longer-acting insulin types can be initiated. In addition, the supportive measures, such as fluid therapy and medications, can be tapered, as long as no other complicating issues surface and improvement continues. Eventually, the animal should be able to go home with an insulin regime designed for at home use, as well as any other treatments necessary to address additional disorders that might be present.

Prevention:

There is no specific method for preventing DKA, but careful treatment and monitoring of diabetic dogs is essential. Recognition of the common signs of diabetes mellitus in a dog--increased thirst and urination, increased appetite, and weight loss--also is important so the diagnosis of uncomplicated diabetes mellitus can be made, and appropriate treatment can be started before DKA develops. The feeding of high fat foods, which can trigger pancreatitis and then lead to DKA, should be avoided. In diabetic dogs, steroids such as prednisone should be used very carefully, if at all, because of the risk of insulin resistance and the frequent association of steroid administration with the development of DKA.