



# Diabetes with Ketoacidosis

## Basics

### OVERVIEW

- A true medical emergency; condition secondary to absolute or relative insulin deficiency, characterized by increased levels of glucose (sugar) in the blood (known as “hyperglycemia”), high levels of ketones in the blood (known as “ketonemia”), metabolic acidosis (a condition in which levels of acid are increased in the blood), dehydration, and electrolyte depletion
- “Diabetes” refers to diabetes mellitus (“sugar diabetes”)
- “Diabetes with ketoacidosis” or “diabetic ketoacidosis” is a condition in which levels of acid are increased in the blood due to the presence of ketone bodies secondary to diabetes

### SIGNALMENT/DESCRIPTION OF PET

#### Species

- Dogs
- Cats

#### Breed Predispositions

- Dogs—miniature poodle and dachshund
- Cats—none

#### Mean Age and Range

- Dogs—mean age, 8.4 years
- Cats—median age, 11 years (range, 1–19 years of age)

#### Predominant Sex

- Dogs—females 1.5 times more likely to develop ketoacidosis than males
- Cats—males 2 times more likely to develop ketoacidosis than females

### SIGNS/OBSERVED CHANGES IN THE PET

- Increased urination (known as “polyuria”)
- Increased thirst (known as “polydipsia”) or absence or lack of thirst (known as “adipsia”)
- Diminished activity
- Lack of appetite (known as “anorexia”)
- Weakness
- Vomiting

- Sluggishness (lethargy) and depression
- Muscle wasting and weight loss
- Unkempt hair coat
- Rapid breathing (known as “tachypnea”)
- Dehydration
- Thin body condition
- Decreased or low body temperature (known as “hypothermia”)
- Dandruff
- Thickened bowel loops
- Enlarged liver (known as “hepatomegaly”)
- Ketone odor on breath
- Yellowish discoloration to the gums and other tissues of the body (known as “jaundice” or “icterus”)

## CAUSES

- Insulin-dependent diabetes mellitus
- Infection (such as infection of the skin, respiratory tract, urinary tract, prostate gland, kidneys, uterus, or lungs [pneumonia])
- Coexistent disease (such as heart failure, inflammation of the pancreas [known as “pancreatitis”], kidney failure, asthma, cancer)
- Unknown cause (so-called “idiopathic disease”)
- Lack of appropriate dosing of medications to treat diabetes mellitus (such as not giving insulin injections on routine schedule)
- Stress
- Surgery

## RISK FACTORS

- Any condition that leads to an absolute or relative insulin deficiency
- History of administration of steroids or  $\beta$ -blockers in the treatment of various diseases
- Female dog (known as a “bitch”) in heat or estrus

## Treatment

### HEALTH CARE

- If the pet is bright, alert, and well hydrated, intensive care and intravenous fluid administration are not required; start administration of insulin, offer food, and supply constant access to water; monitor closely for signs of illness (such as lack of appetite [anorexia], lethargy, vomiting)
- Treatment of “sick” diabetic ketoacidotic dog or cat requires inpatient intensive care; this is a life-threatening emergency; goals are to correct the depletion of water and electrolytes, reverse the high levels of ketones and acids in the blood (ketonemia and acidosis), and increase the rate of glucose use by insulin-dependent tissues
- Fluids—necessary to ensure adequate blood volume being pumped by the heart (known as “cardiac output”) and blood flow to the tissues and to maintain blood volume; also helps to reduce blood glucose concentration

### DIET

- A low-fat, high-fiber, high-complex-carbohydrate diet is recommended, once the pet is stabilized

## Medications and Treatment

- Medications presented in this section are intended to provide general information about possible treatment. The treatment for a particular condition may evolve as medical advances are made; therefore, the medications should not be considered as all inclusive

### INSULIN

- Regular insulin is the insulin of choice in the initial treatment of a pet with diabetic ketoacidosis; needed to decrease levels of glucose (sugar) in the blood
- Check blood glucose every 1–3 hours to monitor response of blood glucose to insulin

- Monitor urine glucose and ketones daily
- Start administering longer-acting insulin when the pet is eating, drinking, and no longer receiving intravenous (IV) fluids and levels of ketones are diminished greatly

## **POTASSIUM SUPPLEMENTATION**

- Total body potassium is depleted and treatment (such as fluids and insulin) will further lower serum potassium; potassium supplementation is always necessary
- If possible, check potassium concentration before initiating insulin therapy, to guide supplementation dosage; if serum potassium concentration is extremely low, insulin therapy may need to be delayed (hours) until it increases
- Low levels of potassium in the blood that do not respond to treatment (known as “refractory hypokalemia”) may indicate magnesium depletion, requiring magnesium replacement (using magnesium chloride or magnesium sulfate) as a continuous-rate infusion
- If potassium concentration is unknown, add potassium (40 mEq/L) to the intravenous (IV) fluids; administer intravenous potassium carefully

## **DEXTROSE SUPPLEMENTATION**

- Must give insulin, regardless of the blood glucose concentration, to correct the ketoacidotic state
- Whenever blood glucose is less than 200–250 mg/dl, 50% dextrose should be added to the fluids to produce a 2.5% dextrose solution (increase to 5% dextrose if needed); discontinue dextrose once glucose is maintained above 250 mg/dl
- Do not stop insulin therapy

## **BICARBONATE SUPPLEMENTATION**

- May be considered if the pet's venous blood pH is less than 7.0 or if the total carbon dioxide (CO<sub>2</sub>) is less than 11 mEq/L on blood tests (indicates that the pet's blood is very acidic)

## **PHOSPHORUS SUPPLEMENTATION**

- Pretreatment serum phosphorus usually is normal; however, treatment of ketoacidosis reduces phosphorus, so phosphorus supplementation may be necessary; serum phosphorus concentrations should be checked every 12–24 hours once phosphorus supplementation is initiated

# **Follow-Up Care**

## **PATIENT MONITORING**

- Attitude, hydration, urine output, body weight, and status of heart and lungs should be monitored
- Blood glucose (sugar) levels should be checked every 1–3 hours initially; every 6 hours once stable
- Electrolytes (such as potassium, sodium, chloride) should be checked every 4–8 hours initially; every 24 hours once stable
- Acid–base status should be checked every 8–12 hours initially; every 24 hours once stable

## **PREVENTIONS AND AVOIDANCE**

- Appropriate insulin administration

## **POSSIBLE COMPLICATIONS**

- Low levels of potassium in the blood (hypokalemia)
- Low levels of glucose (sugar) in the blood (hypoglycemia)
- Low levels of phosphorus in the blood (hypophosphatemia)
- Buildup of fluid in the brain (known as “cerebral edema”)
- Buildup of fluid in the lungs (known as “pulmonary edema”)
- Kidney failure
- Heart failure

## **EXPECTED COURSE AND PROGNOSIS**

- Guarded

## Key Points

- Diabetic ketoacidosis is a true medical emergency
- Serious medical condition requiring lifelong insulin administration in most affected pets

## Notes

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