

# Diabetes Mellitus and Crystal-Related Cystitis – Feline

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## Definition

In feline *diabetes mellitus* blood glucose concentrations cannot be maintained in the normal range as a result of low insulin secretion from pancreatic beta cells with and without peripheral insulin resistance. Cats with *lower urinary tract disease* exhibit hematuria, stranguria, pollakiuria without an identifiable cause. For more on diabetes in cats, see pages 30–31; for more on lower urinary tract disease in cats, see pages 90–91.

## Key Diagnostic Tools and Measures

Hyperglycemia on three to four successive blood glucose measurements taken at least 4 hours apart over 2 days is indicative of diabetes mellitus. Concurrent clinical signs of polyuria, polydipsia, and history of weight loss are common. Cats are rarely ketonuric but may have glucosuria and ketonemia. Fructosamine concentrations between 400 and 500  $\mu\text{mol/L}$  are supportive of diabetes while concentrations greater 500  $\mu\text{mol/L}$  are highly associated with diabetes. Clinical signs of stranguria and pollakiuria with a positive urinalysis (pH, specific gravity, presence of blood, crystals, bacteria) are indicative of feline lower urinary tract disease (FLUTD).

## Pathophysiology

More than 80% of cats with diabetes are thought to have Type II diabetes mellitus, which is a relative insulin deficiency because the amount of insulin actually secreted may be increased, decreased, or normal, but is always inadequate relative to serum glucose levels. FLUTD is a syndrome of clinical signs with a multitude of etiologies. The causes of the cystitis (idiopathic, bacteria, crystals) appear to be different in cats of different ages. Cats with calcium oxalate-related cystitis should be checked for hypercalcemia.

## Signalment

Diabetes affects cats of any age and gender but is diagnosed more commonly in neutered male cats older than 6 years of age (usually between 10 and 13 years) with no particular breed predilection. FLUTD in cats less than 10 years of age is most often idiopathic; in cats under 1 and over 10 years of age it is likely to be bacterial cystitis. In cats with crystal-related cystitis, 90% of cases are due to struvite or calcium oxalate.

## Key Nutrient Modifications

Diets low in soluble carbohydrate<sup>a</sup> (CHO) (<20% on a dry matter [DM] basis) are considered superior for the management of DM. Grains suggested to have a lower glycemic index in the cat include corn, sorghum, oats, and barley. By limiting dietary carbohydrates, blood glucose is maintained primarily from hepatic gluconeogenesis, which releases glucose into the circulation at a slow and steady rate. Blood glucose fluctuations after a low CHO meal are minimized. In lowering the CHO fraction, the content of protein, fat, fiber, or some combination thereof must increase to account for the difference. Diabetic cats with struvite crystal-related cystitis require lower-magnesium, urine-acidifying canned diets. Diabetics with calcium oxalate-related cystitis require potassium citrate in addition to a canned diet. There are no dietary changes for idiopathic and bacterial-related FLUTD.

<sup>a</sup> Soluble CHO (mostly starch) is measured and reported as Nitrogen Free Extract (NFE) whereas CHO as fiber is reported as Crude Fiber.

## Recommended Ranges of Key Nutrients

Nutrient	% DM	g/100 kcal	% DM	g/100 kcal
	Recommended dietary level		Minimum dietary requirement*	
Protein	40–60	10–17	26	6.5
Fat	15–30	3.5–6	9	2.3
Carbohydrate	10–35	3–7	n/a	n/a

Modified intake of these nutrients may help address metabolic alterations induced by disease states. The recommended dietary composition is shown as percent of dietary DM and as g or mg per 100 kcal metabolizable energy. All other essential nutrients should meet normal requirements adjusted for life stage, lifestyle, and energy intake.

\*Nutrient requirement for adult animals as determined by the Association of American Feed Control Officials

## Therapeutic Feeding Principles

The goals of management in feline diabetes are to avoid insulin-induced hypoglycemia and hyperglycemic episodes and to optimize the chance of achieving diabetic remission. It is generally recommended that diabetic cats be fed twice daily at the time of the insulin injections, although it is acceptable to provide smaller meals more frequently.

It is not yet clear which food profile (high fiber vs. low carbohydrate) provides optimal glycemic control. Feeding low-carbohydrate foods is associated with a reversion rate of clinical diabetes to a non-insulin-dependent state by threefold compared with feeding high-fiber foods. Reversion has occurred, however, when feeding the high-fiber option and glucose control is not significantly different in cats that remain insulin dependent. Dietary management of the comorbidities must also be considered when selecting diets for the diabetic patient.

Diabetic cats with crystal-related cystitis should be fed canned diabetic diets. Cats with calcium oxalate-related cystitis may do better on a high-fiber (less acidifying), low-oxalate (less acidifying), low-carbohydrate diabetic food with 40 to 75 mg potassium citrate per kg BW added to each BID meal. Cats with struvite-related FLUTD should be fed a lower-magnesium, low-carbohydrate urine-acidifying canned diet.

■ **Treats** – Maintaining a constant and low-CHO intake is important, and high-CHO treats should be avoided. Suitable examples include portions of the cat's usual low-CHO diet or home-cooked meat or fish treats for struvite-related cystitis. Meat treats may not be suitable for calcium oxalate-related cystitis as they may lower urine pH.

■ **Tips for Increasing Palatability** – Transition from the regular diet to the suitable diabetic diet should be done over 5 to 14 days or longer for cats that are more resistant to change. The palatability of food generally increases with increased temperature, water, and nutrients (fat, protein, and salt). Warm (microwave) food or lightly warm canned food. Add warm chicken or beef broth (low salt) or add water or oil from canned fishes (sardine, tuna, mackerel) if appropriate to enhance taste.

■ **Diet Recommendations** – Nutrient ranges of low-CHO diets recommended for diabetic cats with struvite-related cystitis are <20% CHO, 30% to 60% protein, and 10% to 25% fat with <0.08% magnesium (Mg) (DM basis) or <20 mg Mg per 100 kcal basis. Cats should be fed to maintain or achieve an ideal body weight. Canned foods are generally more palatable and contain more water, fat, and less CHO than kibble. Consider a specifically designed home-made diet with potassium citrate to meet multiple dietary needs if commercial products are unsuccessful.

## Client Education Points

- Feed meals at the time of insulin injection at 12-hour intervals. It is recommended that only food products designed for a diabetic cat be fed, and that the food is obtained from a reliable source for quality control and product consistency.
- Cats can become non-insulin-dependent, hence close monitoring is essential.
- Cats with mild to moderate signs of hypoglycemia such as weakness, trembling, and wobbliness that are still able to eat should be immediately fed a palatable highly digestible, high-CHO, low-fiber “intestinal” diet. If signs are severe, such as seizure or coma, glucose syrup designed for human diabetic patients can be rubbed into the gums, and owners should seek veterinary attention immediately.
- Monitor for clinical signs of FLUTD.

## Common Comorbidities

Comorbidities are very common in diabetic cats with FLUTD. Cats that are also overweight or obese should be fed a high-fiber, low-CHO food. Insulin sensitivity may return as adiposity decreases. Cats that also have pancreatitis or cancer (adenocarcinoma) can still be fed a low-CHO, high-protein diabetic foods. For renal insufficiency, change the diet to a

lower-protein, low-CHO diabetic food. For hyperlipidemias, change to a lower-fat, low-CHO diabetic food. Other common comorbidities include endocrinopathies (hyperadrenocorticism, acromegaly) and drug-induced conditions (glucocorticoids, progestins). For stress hyperglycemia associated with illness, manage as a diabetic until resolved.

## Interacting Medical Management Strategies

Monitor urine sediment and pH. If calcium oxalate crystals are present and pH is too low, add urine alkalinizer (potassium citrate) for calcium oxalate-related cystitis. If struvite crystals are present and pH is too high, add a urine acidifier for struvite-related cystitis.

## Monitoring

Blood and urinary glucose and ketone concentrations need to be monitored to determine the level of glycemic control. Exogenous insulin is administered with a low-CHO, high-protein diet (preferably) to control blood glucose concentrations, and is adjusted accordingly to maintain as close to a normal blood glucose concentration as possible. Monitor body weight and adjust energy intake to achieve an ideal weight. On urinalysis, sediment should be crystal free, with a pH <6.5 for struvite prevention or pH 6.6-7.5 for calcium oxalate prevention.

## Algorithm – Nutritional Management of Feline Diabetes Mellitus and Crystal-Related Cystitis

