

# Diabetes Mellitus – Feline

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## Definition

In feline *diabetes mellitus*, hyperglycemia occurs because of inadequate insulin secretion from pancreatic beta cells. Peripheral insulin resistance secondary to genotype, obesity, physical inactivity, disease, or drugs is often a contributing factor.

## Key Diagnostic Tools and Measures

Persistent hyperglycemia is indicative of diabetes mellitus. Concurrent clinical signs of polyuria, polydipsia, and a history of weight loss are common and support a diagnosis of diabetes. Glucosuria and ketonemia help confirm the diagnosis; however not all cats are ketonuric or ketonemic. If blood glucose concentration is only moderately elevated (200–300 mg/dL; 12–17 mmol/L), persistent hyperglycemia should be documented on two to three successive blood samples taken at least 4 hours apart over 1 to 2 days to rule out stress-induced hyperglycemia. Fructosamine concentrations of  $\geq 400$  to 500  $\mu\text{mol/L}$  are supportive of diabetes, while those greater than 500  $\mu\text{mol/L}$  are highly associated with diabetes.

## Pathophysiology

More than 80% of cats are thought to have type 2 diabetes mellitus which results from beta cell failure that occurs secondary to prolonged demand for increased insulin secretion as a result of peripheral insulin resistance. Eventually this damages beta cells and insulin secretion fails. The remaining cases are associated with other specific types of diabetes, such as pancreatic carcinoma, pancreatitis, acromegaly or hyperadrenocorticism, which either destroy beta cells directly or cause marked insulin resistance. Once blood glucose increases, it further suppresses insulin secretion and damages beta cells (termed glucotoxicity). Most cats are insulin dependent at the time of diagnosis; however depending on the underlying cause and duration of diabetes and management, 20% to 90% of diabetic cats can achieve non-insulin dependence (termed remission),

## Signalment

Cats with diabetes are typically older, with a peak onset between 10 and 13 years. Cats that are overweight or obese, neutered, male, and domestic breed are at increased risk. In the US, Maine Coon, domestic long-haired, Russian Blue, and Siamese are over-represented, whereas Burmese cats are four times more likely to be diabetic in Australia, New Zealand, and the UK compared with domestic cats.

## Key Nutrient Modifications

Diets low in soluble carbohydrate<sup>a</sup> (CHO) (<20% on a dry matter [DM] basis; <15% metabolizable energy) are considered superior for the management of diabetes and have proven efficacious in managing feline diabetes. 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 and blood glucose fluctuations after a meal are minimized. Recently diagnosed diabetic cats usually do well on a low-CHO high protein diet. Cats require protein ( $\geq 30\%$  DM and  $>85\%$  digestible) of high biologic value (egg, meat, liver). Achieving diabetic remission is an advantage in these cats and is an important goal in any cat that has been diabetic for less than one year. The probability of remission is low in cats that have been diabetic for more than one year.

## 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
Carbohydrate	0–20	0–5	n/a	n/a
Fat	10–35	3–7	9	2.3

Modified intake of these nutrients may help address metabolic alterations induced by disease states. The recommended dietary composition is shown as percent of dietary dry matter (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 management goals in feline diabetes are to avoid insulin-induced hypoglycemia and to optimize the chance of achieving remission by minimizing hyperglycemia. 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. The postprandial period of cats is very long and blood glucose remains elevated for more than 14 hours after a meal containing 50% to 100% of daily energy requirements.

Feeding low-CHO foods are associated with increased rates of remission in newly-diagnosed diabetic cats compared with feeding high-fiber foods. Because remission has such great advantages for the client and cat, diabetic management should be initially directed at maximizing the probability of remission. Therefore, low-CHO food should be fed in newly-diagnosed diabetics and to all diabetic cats in remission. Relapse of diabetes has occurred in cats when changed to a higher-CHO diet. However glucose control is not significantly different in cats that remain insulin-dependent when a high-fiber, high-CHO diet rather than a low-CHO diet is fed, although insulin dose is usually lower in those fed low-CHO foods. Dietary management of the co-morbidities must also be considered when selecting diets for the diabetic patient.

Overweight and obesity are associated with insulin resistance therefore maintaining or achieving an ideal body weight is important in facilitating remission in diabetic cats. Overweight and obese cats should be fed restricted amounts of a diet with a low caloric density (fat) with the least amount of CHO (NFE) as possible (<20% DM).<sup>\*</sup> The energy intake needs to be restricted so that 1% to 2% loss of body weight occurs per week although more commonly 0.3-0.5%/wk is achieved.

Cats with mild to moderate signs of hypoglycemia, such as weakness, trembling, and wobbliness, that are still able to eat, should immediately be 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 applied to the gums and owners should seek veterinary attention immediately.

■ **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 with a fat and protein content (high or low) suitable for the co-morbidities.

■ **Tips for Increasing Palatability** – Transition the diet change from the

<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.

regular diet to the suitable diabetic diet over 5 to 14 days; a longer period may be needed 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 heat canned food. Add warm chicken or beef broth (+/- sodium) 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 are <20% CHO, 40% to 60% protein, and 10% to 35% fat on a DM basis. Cats should be fed to maintain or achieve an ideal body weight. Canned foods are generally more palatable, contain more water and fat, and less CHO than kibble, and facilitate weight loss in some overweight and obese cats.

## 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 are fed, and that the food is obtained from a reliable source for quality control and product consistency.
- Cats can become non-insulin dependent (remission), hence close monitoring is essential. It is essential to continue feeding a low-CHO diabetes diet to cats in remission to minimize demand on beta cells to secrete insulin.
- 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 diet, high-CHO, low-fiber “intestinal” diet. If signs are severe such as seizure or coma, glucose syrup designed for human diabetic patients can be applied to the gums, and owners should seek veterinary attention immediately.

## Common Comorbidities

In lowering the CHO fraction, the dietary protein, fat, fiber, or some combination thereof must increase to account for the difference. Low CHO diets with varying levels of fat, protein, and fiber are useful in providing a multitude of dietary options depending upon the comorbidities for each case. Underweight diabetic cats should be fed CHO (<20%DM), protein (~55% DM), low fiber (1% DM), high fat (20–30% DM) and energy density (4–5 kcal/g DM metabolizable energy [ME]) diets. Overweight and obese cats can be managed by restricting the total amount of energy (as fat) fed. Insulin sensitivity should improve with the loss in body fat. Overweight and obese diabetic cats are best managed with CHO (<20% DM) diets with moderate fiber (10–15% DM) and low fat (~10% DM) and caloric density (3–3.5 kcal/g DM ME). Feeding canned

diets may be more satiating than dry food for some cats due to the water content although canned foods generally contain more fat than the comparable dry version.

In cats with renal insufficiency (IRIS 2), try a low-CHO diet (<15% DM) because azotemia improves in many cats with improved glycemic control. If azotemia worsens, these cats may do better on a CHO (30–40% DM) diet with 35–40% DM protein and <1% DM phosphorus. Cats with advanced renal disease (IRIS 3 or 4) with systemic signs associated with azotemia are better managed with a restricted protein diet (CHO <30% DM, protein ~30% DM, fat ~30% DM, and <1% DM phosphorus) with phosphate binding agents to further control plasma phosphate concentrations in conjunction with acarbose to reduce glucose absorption from the gastrointestinal tract. Home-made diets that control the CHO, protein and restrict phosphorous are also an option for some clients.

Other common conditions in diabetic cats include pancreatitis or cancer (adenocarcinoma) (can still be fed low-CHO, high-protein diabetic foods); bacterial cystitis and urinary tract infections; hyperlipidemias (change to a lower-fat, low-CHO diabetic food); endocrinopathies (hyperadrenocorticism, acromegaly, hyperthyroidism); drug-induced conditions (glucocorticoids, progestins); and stress-induced hyperglycemia associated with illness (manage these cats as diabetics until resolved).

## Interacting Medical Management Strategies

Corticosteroids predispose to diabetes, and repeated long-acting injections of corticosteroid are particularly important to avoid in diabetic cats, or cats in remission. Similarly progestins, such as megestrol acetate, decrease insulin sensitivity and predispose to diabetes.

## Monitoring

Blood glucose concentrations need to be monitored to determine the level of glycemic control and appropriate insulin dosage. Blood glucose is best monitored at home using a portable glucose meter, preferably one calibrated for feline blood. Where this is not possible, home monitoring of urinary glucose and ketone concentrations is helpful. 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 while avoiding hypoglycemia. Monitor body weight and adjust energy intake to achieve an ideal weight.

See **Algorithm - Nutritional Management of Feline Diabetes Mellitus** on page 34.