

# Diabetes Mellitus – Canine

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## Definition

*Diabetes mellitus* is caused by absolute or relative deficiency of insulin. This results in altered carbohydrate, fat, and protein metabolism, which manifests as hyperglycemia, hyperlipidemia, polyuria, lethargy, weight loss, polyphagia, poor hair coat, and reduced immunity.

## Key Diagnostic Tools and Measures

Diagnosis of diabetes mellitus is based on hyperglycemia and glucosuria with compatible clinical signs. Measurement of canine pancreatic lipase immunoreactivity (cPLI) may aid in the identification of concurrent pancreatitis. Canine trypsin-like immunoreactivity (cTLI) may identify concurrent exocrine pancreatic destruction. Continued monitoring of body condition, glycemia, and serum triglyceride concentration is recommended.

## Pathophysiology

Type 1 and other specific types of diabetes have been reported in dogs; the relative frequency varies with geographic location and particularly with neutering rates in female dogs. In North America, approximately 50% of dogs have type 1 diabetes mellitus caused by immune destruction of pancreatic beta cells. In approximately 30%, diabetes is due to extensive pancreatic damage from chronic pancreatitis. Canine diabetes also occurs secondary to corticosteroid therapy, hyperadrenocorticism, or progesterone-induced acromegaly. In intact bitches, a form analogous to human gestational diabetes can occur during diestrus or pregnancy and is common in countries with low neutering rates, such as Sweden.

## Signalment

Most diabetic dogs are over 5 years of age with the highest prevalence occurring between 8 and 12 years of age. Intact females are at increased risk, especially if they are also overweight. Mixed-breed dogs have increased risk compared with most pure breeds. The following breeds are at increased risk: Australian terrier, standard schnauzer, Samoyed, miniature schnauzer, fox terrier, keeshond, bichon frise, Finnish spitz, cairn terrier, miniature poodle, Siberian husky, and toy poodle.

## Key Nutrient Modifications

Total carbohydrate content of the diet is the major determinant of the glycemic response of typical commercial dog foods, and so a moderately carbohydrate-restricted diet (<30% metabolizable energy [ME]) is recommended; and meals should have consistent carbohydrate content. The guaranteed analysis statement on pet foods does not provide information on the carbohydrate content of the food, and so this must be inferred (see **Appendix III**). Low glycemic index carbohydrate sources are likely preferable; recommended sources include sorghum and barley. Rice is unlikely to be an optimal carbohydrate source. Diets with corn syrup should be excluded.

Although several studies indicate that high-fiber diets, compared with low-fiber diets, might be associated with improved glycemic control, there has been no clear demonstration of clinical benefit for diabetic dogs of feeding a high-fiber formulation compared with feeding a typical adult maintenance diet with moderate-fiber content (30–40 g/1000 kcal). Dietary fat restriction (<30% ME) is recommended for diabetic dogs with concurrent chronic pancreatitis or persistent hypertriglyceridemia. Nutrient requirements for concurrent diseases usually have priority over those for diabetes mellitus.

## Recommended Ranges of Key Nutrients

Nutrient	% DM	g/100 kcal	% DM	g/100 kcal
	Recommended dietary level		Minimum dietary requirement*	
Protein	25–50	6–10	18	5.1
Fat	8–12 <sup>#</sup>	3–5 <sup>#</sup>	5	1.4
Carbohydrate	0–40	0–8	n/a	n/a
Crude Fiber	5–15	2–4	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 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

<sup>#</sup>Dietary fat restriction is recommended for diabetic dogs with concurrent chronic pancreatitis or persistent hypertriglyceridemia. Dietary fat restriction should not be routinely recommended for diabetic dogs with thin body condition.

## Therapeutic Feeding Principles

Exogenous insulin therapy is the mainstay of clinical management of diabetes mellitus in dogs, and the primary goals are long-term resolution of all clinical signs and avoidance of insulin-induced hypoglycemia. A successfully managed diabetic dog will have no polyphagia, lethargy, or polydipsia, and will be able to maintain body weight. A typical management regimen includes twice-daily insulin dosages and consistent meals, which should be highly palatable so that food intake is predictable.

Commercial dog foods usually result in postprandial elevation of plasma glucose for less than 90 minutes following consumption by dogs and meals should be timed so that maximal exogenous insulin activity occurs during the postprandial period. Thus, dogs should be fed within 2 hours of administration of lente or NPH insulin or within 6 hours of protamine zinc insulin. When a twice-daily insulin dosing regimen is used, a feasible compromise is to feed the dog immediately following the insulin injection.

If mild signs of hypoglycemia develop, the owner should feed a meal of the dog's usual food or high-carbohydrate treats. Hand-feeding might be necessary to encourage the dog to eat. If the dog is unwilling or unable to eat, syrup containing a high glucose concentration can be administered orally. Suitable syrups are marketed for use by human diabetics and should be kept in reserve by all owners of diabetic dogs. When the dog recovers, a meal of the dog's usual food should be fed immediately, and then the owner should contact their veterinarian before the next insulin injection is due. Half the usual dose of insulin should be administered when a diabetic dog does not eat the accompanying meal.

■ **Treats** – Feeding consistent meals at fixed times each day is an important aspect of management; owner compliance should be encouraged. If treats are fed, they should be consumed during the expected period of maximal exogenous insulin activity. Treats containing high sugar or fat should be avoided.

■ **Tips for Increasing Palatability** – The majority of diabetic dogs will readily consume meals twice daily following the insulin injections if the meals are highly palatable and contain half the daily caloric requirement. For finicky eaters, the meal should be fed at the time of insulin administration and remain available until the expected end of the period of maximal exogenous insulin activity. Diabetic dogs are more likely to readily accept a diet that has a formulation similar to the diet they were consuming before diagnosis of diabetes. Foods with high sugar or fat content should not be used to improve the palatability of food prescribed for diabetic dogs. An example of a suitable alternative is warm low-fat chicken broth.

■ **Diet Recommendations** – Diets formulated for canine adult maintenance

with moderate dietary fiber and carbohydrate content will be suitable for most diabetic dogs. A fat-restricted diet should be considered for diabetic dogs with concurrent chronic pancreatitis or persistent hypertriglyceridemia. High-fiber, restricted-fat diets should not be routinely recommended for diabetic dogs with thin body condition. Most well-managed diabetic dogs require a similar amount of food per day as healthy non-diabetic dogs of similar age, gender, and lifestyle. Diabetic dogs with reduced exocrine pancreatic function have increased caloric requirement compared with healthy dogs.

### Client Education Points

- Feeding consistent meals at fixed times each day is crucial to successful management of diabetes in dogs. Ideally, every meal should contain the same ingredients and calorie content.
- Timing of meals must be matched with timing of insulin injections.
- The importance of avoiding an insulin overdose cannot be over-emphasized. If some insulin is spilt during injection the owner should never give more at that time, even if it appears that the dog has received no insulin. If the owner is ever uncertain, the safest option is to withhold the injection, as the consequences of missing a single dose are negligible.
- Owners must be aware of the nutritional strategies for management of hypoglycemia as described earlier.
- Owners should seek prompt veterinary advice whenever a diabetic dog shows inappetence or anorexia because there is an increased risk of hypoglycemia if insulin is administered when the dog does not eat.

### Common Comorbidities

Urinary tract infection, pancreatitis, hyperadrenocorticism, dermatitis, otitis externa, and exocrine pancreatic insufficiency are common conditions occurring in dogs with diabetes mellitus, as well as diestrus, pyometra, and

obesity in intact diabetic females.

### Interacting Medical Management Strategies

Exercise can be associated with increased risk of hypoglycemia in insulin-treated diabetic dogs. This can be managed with reduced insulin dose and/or increased feeding prior to exercise. Management strategies must be individualized for each dog.

### Monitoring

One of the key clinical signs of untreated diabetes mellitus is loss of body weight and condition, despite polyphagia. With institution of appropriate medical and nutritional therapy, weight loss is usually arrested before optimal glycemic control is achieved. It is, therefore, important to monitor both body weight and body condition at each re-assessment. Glycemic monitoring is used to evaluate response to the insulin and dietary regimen. Fasting serum triglyceride concentration can be monitored to identify persistent hypertriglyceridemia, and to monitor the response to feeding a fat-restricted diet. Exogenous insulin therapy will result in resolution of hypertriglyceridemia in some diabetic dogs, while others require dietary fat restriction in addition to insulin therapy. Dietary fat restriction <30% ME should be recommended for all diabetic dogs with fasting serum triglyceride concentration >500 mg/dL because of the association with pancreatitis. For diabetic dogs with good glycemic control, dietary fat restriction <30% ME is recommended if fasting serum triglyceride concentration is >400 mg/dL. It is expected that fasting triglyceride levels will decrease in response to dietary fat restriction. Therefore if fasting serum triglyceride concentration is >400 mg/dL when the dog is being fed a diet with <30% ME fat, further restriction of dietary fat to <20% ME is recommended. If body weight loss continues despite adequate glycemic control, it is recommended that serum cTLI concentration be assayed to evaluate exocrine pancreatic function.

## Algorithm – Nutritional Management of Canine Diabetes Mellitus

