

Diabetes Mellitus

What is the pancreas and what is insulin?

The pancreas is an organ located adjacent to the small intestine in the right anterior (front) part of the abdomen. The pancreas has both *endocrine* and *exocrine* function. Among the most important functions of the pancreas is to make insulin, a hormone that helps to regulate blood glucose (sugar) levels. As blood glucose levels climb (after a meal for example), the pancreas makes more insulin. This helps to keep the glucose levels from becoming too high. As glucose levels decline, insulin production also declines. In this way, blood glucose levels are kept within a limited appropriate range.

- The *exocrine* function of the pancreas is to make digestive enzymes that are secreted into the intestines to aid in the digestion of fats and proteins
- The *endocrine* function of the pancreas is to make hormones (including insulin) that regulate various metabolic functions in the body

What is diabetes mellitus (DM)?

DM is due to inadequate insulin production or inadequate cellular response to insulin. This results in a marked increase in blood glucose and causes a multitude of clinical signs and laboratory changes. Without treatment, DM is progressive and can quickly become fatal.

What causes DM?

Dogs typically develop DM as a result of inadequate insulin production. This is usually associated with 'burn-out' of the endocrine pancreas or chronic pancreatic inflammation (*pancreatitis*). Cats may develop DM for similar reasons or inadequate response to insulin.

- *Insulin-dependent* or *Type 1* diabetes is associated with inadequate insulin production
- *Non insulin-dependent* or *Type 2* diabetes is associated with poor response to insulin; this form of diabetes can be associated with obesity

What clinical signs does DM cause?

DM usually develops acutely and clinical signs are typically very obvious. In the initial stages of DM, most animals still appear healthy and active. If left untreated, however, animals can become very sick and will eventually die.

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Common signs include:

- ❖ Polydipsia
- ❖ Polyphagia
- ❖ Polyuria
- ❖ Weight loss

Less common clinical signs include:

- ❖ Blindness
- ❖ Vomiting
- ❖ Decreased appetite
- ❖ Malaise

- *Polyuria (PU)* is the increased urination that results from direct effects of elevated glucose on the kidney's ability to concentrate urine
- *Polydipsia (PD)* is the increased drinking that results from the polyuria of DM
- *Polyphagia (PP)* is the increased appetite commonly seen in DM

What laboratory changes does DM cause?

DM can potentially cause many changes on laboratory tests. Depending on the severity and duration of disease, the changes may be mild or extreme. Ultimately, laboratory tests are required to confirm the diagnosis of DM, evaluate for secondary changes, and check for other primary diseases.

Common laboratory changes include:

- ❖ Glucosuria
- ❖ Hyperlipidemia/ lipemia
- ❖ Increased liver enzymes
- ❖ Hyperglycemia
- ❖ Urinary infection
- ❖ Leukocytosis

- *Glucosuria* is the presence of glucose (sugar) in the urine; this is a hallmark of DM
- *Hyperglycemia* is the elevation of blood glucose that is present in DM
- *Lipemia* is the gross increase of fats in the blood, making the serum look milky or white; *hyperlipidemia* is the increase in cholesterol and triglycerides that causes lipemia
- *Leukocytosis* is an increase in white blood cells; this can be seen associated with infection or stress of illness

What testing is recommended for DM patients?

In evaluating patients with DM, there are many things that need to be considered. First, there are tests that are used to confirm the diagnosis of DM; secondly, there are tests that are important in evaluating for severity of disease and secondary internal changes; finally, there are tests used to evaluate for other underlying or causative conditions. Depending on presentation, history, previous lab work, and timing of the visit, various tests may be recommended.

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Patients evaluated for DM may need the following tests:

- ❖ Chemistry profile
- ❖ Urinalysis
- ❖ Complete Blood Count (CBC)
- ❖ Urine culture
- ❖ Abdominal ultrasound
- ❖ Blood Pressure

- *Abdominal ultrasound* is a non-invasive test that uses sound waves to create images of internal organs and structures
- *Blood pressure* can be elevated in patients with DM

What treatment options are available for DM?

DM is a treatable condition and both dogs and cats can do very well with appropriate medical therapy. Insulin injections are required in all canines and all but a few feline patients. There are a number of different types of insulin available. We recommend glargine insulin (Lantus®) for cats, and lente insulin (Vetsulin®) for dogs. Insulin is generally given twice daily except in rare instances. While it may take some time to get used to giving the injections, both pets and owners generally do great! Dietary therapy is important with both cats and dogs. For dogs, this generally means a high-fiber, low-fat diet for controlled release of sugars. For cats, low-carbohydrate, high-protein/fat diets are recommended. Rarely, certain cats can be managed with oral medications and diet alone.

What sort of long-term monitoring is recommended for DM patients?

The initial goal for managing any diabetic patient is to get the glucose levels controlled by making certain the insulin dose is appropriate. Most animals will be started on a conservative insulin dose. This dose will be increased slowly (over days to weeks) until glucose levels seem appropriate. During this time, patients are visiting the hospital for random or *nadir* blood glucose levels. Occasionally patients require longer *glucose curves* to determine the appropriate insulin needs. Once glucose levels are controlled, *fructosamine* levels can be monitored along with periodic chemistry panels, CBCs and urinalyses (depending on the status of the disease). While many animals remain controlled on a given dose, certain patients require increased dosages over time while others still (cats in particular) may be cured of their illness. At-home urine glucose and ketone monitoring may be recommended. At-home blood glucose monitoring is challenging and can adversely affect the owner/pet relationship. For these reasons, it is generally not recommended. Monitoring is often patient specific and unique recommendations may be made.

- The *nadir* is the lowest glucose after insulin injection; for most patients this is about six hours after dosing

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- A *glucose curve* is the measurement of multiple glucose levels (every two to four hours) over a period of time (typically eight to 24 hours)
- *Fructosamine* is a blood test that reflects long term (three weeks) glucose control

What complications can arise in DM patients?

It is important to monitor for certain complications in DM patients. DM adversely affects the immune system, making patients more prone to infection, especially of the urinary tract. Patients that are on insulin are at risk of insulin over-dosage. This causes *hypoglycemia*. Hypoglycemia can cause extreme lethargy, weakness, imbalance, stupor, seizures, coma, and death. If any of these signs are noted, it is recommended to feed a meal or apply honey or corn syrup (Karo® syrup) to the gums and tongue to help increase blood sugar levels. Dogs with DM are prone to cataract formation. In all but the best controlled patients, cataract formation and subsequent blindness is possible. Cats do not experience this problem. In dogs that do develop cataracts, surgery can be performed to restore vision. Ketoacidosis is an abnormal metabolic state that develops when DM patients are poorly regulated, not yet on insulin, or have other illnesses. While unusual in patients that are on insulin therapy, it often requires hospital care. Finally, there is a slight increased risk for *hypertension* in DM patients.

- *Hypoglycemia* is low blood sugar
- *Hypertension* is elevated blood pressure

What is the prognosis with DM?

The prognosis for DM patients is generally excellent. While vigilant at-home care and regular follow-up is required, most diabetic patients live for many years after the time of diagnosis. Severity and duration of disease as well as whether secondary or other conditions are present may affect the prognosis in rare cases.