

# DIABETES MELLITUS

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## UNDERSTANDING DIABETES

There are two diseases called diabetes in dogs and cats: diabetes insipidus and diabetes mellitus. Diabetes insipidus is a very rare disorder that results in failure of the kidney to regulate body water content. Diabetes mellitus, or sugar diabetes, is much more common and is a failure in regulation of blood sugar content.

## INSULIN AND GLUCOSE

Glucose (blood sugar) is a vital substance that provides much of the energy needed for life. In order to be utilized by the body, it must first be able to get inside the body's cells. Insulin is the hormone that makes this possible. The role of insulin is much like that of a gatekeeper. It stands at the surface of body cells and opens the door, thus allowing glucose to leave the blood stream and pass into the cells. When the gatekeeper is not there or is asleep at the post, glucose is unable to get into the cells. It accumulates in the blood, setting into motion a series of events that can ultimately prove fatal if nothing is done to treat the problem.

The excess glucose that accumulates in the blood spills out of the body through the kidneys in the urine taking excessive amounts of water with it. This is seen as increased urine production (polyuria). The dehydration that results from increased urine loss causes the patient to be abnormally thirsty (polydipsia). Furthermore, the excess glucose being lost is, essentially, energy and calories. The increased loss of calories causes weight loss. Finally, because the body's cells aren't getting sugar, they are in effect being starved. The apparent starvation perceived by the body causes the patient to have a ravenous appetite (polyphagia). These are the classic signs of diabetes mellitus: weight loss, ravenous appetite, increased water consumption, and increased urination.

As the cells continue to be starved for a source of energy, the body starts breaking down stores of fat and protein to use as alternative energy sources. This is very dangerous because this type of metabolism can result in fatal disease processes called as ketoacidosis. Ketoacidosis is a severe

derangement of blood pH caused by ketones which are an acid byproduct of fat metabolism. Another complication of diabetes is a form of liver failure called hepatic lipidosis which is caused by infiltration of the liver by fats.

## TYPES OF DIABETES

*Type I diabetes mellitus* or *insulin-dependent diabetes mellitus* (IDDM) occurs when the *beta cells* in the pancreas fail to produce adequate amounts of insulin. The lack of insulin prevents cells the glucose in the blood from being pulled into the body's cells. Consequently, blood levels of glucose increase. The only treatment for this problem is to give the patient insulin from some other source (injections). This is the most common type of diabetes that we see in dogs. About half of cats with diabetes have this form.

*Type II diabetes mellitus* or *non-insulin dependent diabetes mellitus* (NIDDM) occurs when the pancreatic beta cells are producing enough insulin, but the body's cells are incapable of responding to the insulin. Again, this results in an inability of the cells to remove glucose from the blood, and, again, glucose accumulates in the blood. Patients with this type of diabetes may sometimes be treated with insulin and sometimes with medications called oral hypoglycemics. This type of diabetes is seen in about half of diabetic cats.

## DIAGNOSING DIABETES

The diagnosis of diabetes mellitus is based on three criteria: the finding at least two of the four classical clinical signs, the presence of a persistently high level of glucose in the blood stream (hyperglycemia), and the presence of glucose in the urine (glucosuria).

The normal level of glucose in the blood is 80-145 mg/dl. It may rise to 250-300 mg/dl following a meal or when the pet is very excited (such as a trip to the vet). However, diabetes is the only disease that will cause the blood glucose level to rise persistently above 400 mg/dl. Some diabetic pets will have a glucose level in excess of 800 mg/dl, although most will be in the range of 400-600 mg/dl.

To keep the body from losing its needed glucose, the kidneys do not allow glucose to be filtered out of the blood stream until a threshold

level is reached, usually around 180 mg/dl. This means that pets with a normal or mildly elevated blood glucose level will not have glucose in the urine. Diabetic pets, however, have consistently excessive amounts of glucose in the blood well above the threshold, so it will be present in the urine.

## WHAT IT MEANS TO BE DIABETIC

For the diabetic pet, one reality exists: diabetes requires treatment if the patient is to live. Diabetic pets can live a wonderful quality of life, but some commitments, both personal and financial, are needed from the owner. Although most pets can occasionally go a couple of days without medication, treatment should be looked upon as a permanent part of the pet's daily routine.

Your personal commitment to treating your pet is very important in maintaining regulation and preventing crises. Most diabetic pets require insulin injections twice per day, every day at about 12-hour intervals. If you are out of town, your pet must receive proper treatment while you are gone. Although it is not difficult to learn to do, you will need to learn to give shots—for some this can be quite an emotional strain until you are comfortable with the process.

Once your pet is well regulated, the maintenance costs are minimal. Medications, supplies, and occasional tests are not generally expensive. However, the financial commitment can be significant during the initial regulation process depending on whether your pet responds to treatment quickly or slowly. Expenses can also add up quickly during complications which sometimes occur, such as hypoglycemia, ketoacidosis, or hepatic lipidosis.

## TREATMENT

The key to successful treatment is consistency. Your pet needs consistent administration of medication, consistent feeding and diet, and a stable, stress-free lifestyle. Generally, diabetic pets should be adapted to indoor life. Although this is not essential, indoor living removes many uncontrollable variables that can disrupt regulation.

## *Insulin*

The first step in treatment is to use a drug to decrease blood glucose levels. Although many people are initially uncomfortable with the thought of giving injections, this is actually often better to do than giving oral medications. This is because many pets do not take tablets well (if at all), the vast majority will respond to insulin injections while a high percentage of pets will not respond to oral hypoglycemics, and sticking a needle into a pet is technically easier than opening the mouth to force-medicate.

If your initial reaction to giving injections is one of fear, consider that insulin does not cause pain when it is injected, the injections are made with very tiny needles that are hardly felt, and the needles are very short so injuring deep organ structures would be very difficult. Please do not decide not to treat your pet with insulin because of fear or distaste for the procedure until we have demonstrated the injection technique. You may be pleasantly surprised how easy it is.

## *Oral Hypoglycemics*

Oral hypoglycemics are consideration for cats with NIDDM as an alternative to insulin injections. Unfortunately, no practical tests exist to know if your pet is truly non-insulin dependent or not. However, pets that have been diabetic for very long or have had complications from diabetes are unlikely to respond to these medications and insulin should be considered. If oral hypoglycemics are chosen for your pet, we usually allow about one month to see if a response will occur. If no response is seen within that time, we will need to switch to insulin therapy.

One disadvantage to treating with tablets is that some pets only have a temporary response. The tablets function by stimulating the existing beta cells to produce more insulin, thus overwhelming the cells with insulin so that they have no choice but to respond. However, many diabetic pets have a gradual decline over time in the number of functioning beta cells. Essentially, what is happening is that some type II diabetics are progressing to a type I diabetic state. This means that a time will come when the tablets are no longer effective because there will simply be no beta cells to stimulate. This may occur after only a few

months or it may be after many years; variability is great from patient to patient.

### **Diet**

A second step in treatment is to alter your pet's diet. Diets that are high in fiber are preferred for dogs because they are generally lower in sugar and slower to be digested. This means that the pet does not have to process a large amount of sugar at one time. For cats we often prefer a high protein diet. This is because cats are obligate carnivores and are very good at using protein to make glucose instead of having to get in sugar form so their diets can afford to be low carbohydrate.

Your pet's feeding routine is also important. Because every diabetic is at risk for developing hypoglycemia, food should always be available. However, this does not mean that feeding should be completely unregulated. Obesity is a common problem in free-choice feeding. Obese pets are more likely to become diabetic and more likely to have complications when they are already diabetic. If your pet is overweight, a reducing-type diet is fed until the proper weight is achieved, then your pet is switched to a maintenance food. Regulating and monitoring diets in pets can sometimes be difficult but it is well worth the effort in diabetic pets.

## **MONITORING**

### **Home Monitoring**

Monitoring at home is at least as important, if not more so, as hospital monitoring. To do this, you need to be constantly aware of your pet's appetite, weight, water consumption, and urine output. If you are feeding a constant amount of food each day, you will be aware of days that your pet does not eat as much or if he is unusually hungry after the feeding. You should weigh your pet at least twice monthly. It is best to use the same scales each time.

If possible, you should develop a way to measure water consumption. Even well controlled diabetics may exceed this criterion, but you can establish what is normal for your own pet. Keep a written record for several weeks, and then determine an average daily consumption. Another way to measure water consumption is based on the number of times it drinks each day. When properly regulated, your pet should drink no more than four

times per day. Since this is not very accurate, if this is exceeded, you should take steps to make an actual measurement.

Urine output should also be noted if possible. In dogs this may be a bit tricky, but in cats this can be measured by determining the amount of litter that is scooped out of the litter box. This is a little less accurate if you have more than one cat that uses the litter box, but it can still be meaningful. The best way to measure litter is to use clumping litter and scoop it into a sellable container, such as a baby diaper disposal can. After a few weeks you will be able to know what is the normal fill rate for your pet. Too rapid a filling rate will indicate that your cat's urine production has increased.

### **Hospital Monitoring**

Veterinarians have two tools, glucose curves and fructosamine levels, with which to monitor glucose levels and adequacy of diabetes control. In the seemingly well-controlled patient, monitoring fructosamine is an adequate means of periodic monitoring. This gives us an idea of glucose levels at home in, hopefully, a stress-free environment. It has the advantages of being less expensive and more convenient than glucose curves because it can be done as a single random blood sample drawn on an outpatient basis. Fructosamine tests should be performed every 4 to 6 months for patients exhibiting adequate control.

Only when the patient is initially being regulated or when fructosamine levels are unexpectedly abnormal is it necessary to do a glucose curve. This usually involves brief hospitalization for the purpose of glucose testing every 2 hours for a 12 to 24 hour period. Should a glucose curve be necessary follow the following procedure.

Feed your pet and give insulin on schedule. If these are due while you are still at home, do them there. If they will not be due until after arrival at the hospital, we will give them here. Be sure to bring your pet's food and insulin with you.

1. If the situation is a routine glucose curve and not an emergency be sure that the insulin has been given on the usual schedule for at least 72 hours. This means no missed doses and no doses given more than 1 hour before or after the scheduled time. If any doses are missed or

given very far off schedule, the curve will be meaningless.

2. The morning of the glucose curve ensure that the insulin is given *on schedule*. Depending on the time the dose is normally given, this means you may need to give the insulin before you bring your pet in or we may need to give the insulin after you have come in. Either way the dose must be given at the correct time or the curve will be meaningless.
3. Bring your pet to the hospital as early in the morning as possible.
4. A blood sample will be taken immediately, and every 2 hours thereafter.
5. Call late in the afternoon to find out whether or not your pet will need to stay overnight for a full 24-hour curve or when he/she can go home.

## HYPOGLYCEMIA

Hypoglycemia means low blood sugar. Glucose levels below 40 mg/dl can be life-threatening.

### **Causes Of Hypoglycemia**

*Insulin dose is too high.* Although most pets will require the same dose of insulin for long periods of time, it is possible for the pet's insulin requirements to change. Changes can also occur just from day-to-day fluctuations in body chemistry. Although it is not practical to do in pets, this is why human diabetics monitor their insulin frequently.

*Too much insulin is given.* This can occur if insulin was not properly measured in the syringe, or if the insulin is not mixed properly prior to drawing into the syringe.

*Two doses were given.* This can occur if you give it, then forget that you gave it, and give it again. Or if, unbeknownst to each other, two people in the house give it. Or if you "miss" with the needle and repeat the dose not realizing that you didn't really "miss" with the needle.

*Spontaneous remission of the diabetes.* This occurs in about 20% of diabetic pets. They can be diabetic and on insulin for many months, then suddenly no longer be diabetic. Since this is not predictable and can happen quite suddenly, a hypoglycemic crisis ("insulin shock") is may be the

first indication. This occurs most commonly in cats.

### **When Hypoglycemia Is Most Likely To Occur**

The most likely time that a pet will become hypoglycemic is the time of peak insulin effect (4 to 7 hours after an insulin injection). When the blood glucose is only mildly low, the pet may be tired, dull, and unresponsive. Within a few hours, the blood glucose will rise, and your pet will return to normal. Since many pets sleep a lot during the day, this important sign is easily missed. Watch for it as it may be the first sign of impending problems. Signs of moderate hypoglycemia can include sudden incoordination, ataxia (walking like he's drunk), or falling. If severe hypoglycemia occurs, a pet can have seizures (either tetanic-like or convulsive-type) or lose consciousness. Prolonged seizures can result in irreversible brain damage or death.

### **What To Do When Hypoglycemia Occurs**

*In the event that a hypoglycemic event occurs, **do not panic!*** Bear in mind ALL diabetics will likely experience hypoglycemia at some point in their lives. The important thing to remember is not to panic. For mild signs of hypoglycemia, sometimes just offering a pet fresh palatable food is effective. For moderate signs, it is helpful to give a small amount of white corn syrup or honey followed by a meal of fresh palatable food. If your pet responds well to these therapies, continue observation and call this office at the first available opportunity for advice. Rushing in to an emergency clinic in the middle of the night is not usually necessary in these instances.

If these therapies are ineffective with no response within 15 minutes, repeat the corn syrup or the honey and try a different food. If there is still no response or if response is poor or brief call this office or an emergency clinic for instructions, then plan to take your pet into the hospital for further assistance.

In the event of serious signs, such as seizures or loss of consciousness, if active seizures are not present, carefully with a blunt spoon or similar device, apply syrup or honey to the gums. Then proceed as quickly and as safely as possible to the nearest veterinary office or emergency clinic. If active seizures are present, do not try to apply syrup

or honey; just go to the nearest veterinary office or emergency clinic.

- Never, ever put your fingers in the mouth of a seizing animal as severe bites or even digit amputation may result.
- Never, ever try to pour anything down the throat of a seizing or unconscious animal as this may cause choking which could even be fatal.

## **SPONTANEOUS REMISSION**

This is a poorly understood phenomenon that only happens in some cats, rarely in dogs. Unfortunately, it can happen rather suddenly so a hypoglycemic crisis may be created when the normal amount of insulin is given. When spontaneous remission occurs, the cat may be normal for a few weeks or for many months. However, diabetes will almost always return. One speculation as to the cause of spontaneous remission is that the cat may initially be non-insulin-dependent, have a temporary remission, and then become insulin-dependent. Should your cat go into spontaneous remission, simply stopping therapy is usually all that is required but you should stay alert for any recurrence of signs of diabetes, then contact us should those signs recur.