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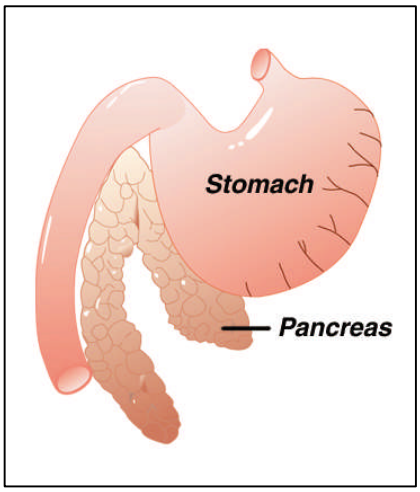
DIABETES MELLITUS IN DOGS

What is diabetes mellitus?

There are two forms of diabetes in dogs: diabetes insipidus and diabetes mellitus. Diabetes insipidus is a very rare disorder that results in failure to regulate body water content. Your dog has been diagnosed with the more common type of diabetes, diabetes mellitus. Diabetes mellitus is frequently diagnosed in dogs five years of age or older. This is also known as Type II or adult-onset diabetes. There is a congenital form that occurs in puppies called Type I or juvenile diabetes, but this is rare in dogs.



Diabetes mellitus is a disease of the pancreas. This is a small but vital organ that is located near the stomach. It has two significant populations of cells. One group of cells produces the enzymes necessary for proper digestion. The other group, called beta-cells, produces the hormone insulin. Simply put, diabetes mellitus is a failure of the pancreas to regulate blood sugar.

Some people with diabetes take insulin shots, and others take oral medication. Is this true for dogs?

In humans, two types of diabetes mellitus have been discovered. Both types are similar in that there is a failure to regulate blood sugar, but the basic mechanisms of disease differ somewhat between the two groups.

Type I or Insulin Dependent Diabetes Mellitus, results from total or near-complete destruction of the beta-cells. This is the most common type of diabetes in dogs. As the name implies, dogs with this type of diabetes require insulin injections to stabilize blood sugar.

Type II or Non-Insulin Dependent Diabetes Mellitus, is different because some insulin-producing cells remain. However, the amount produced is insufficient, there is a delayed response in secreting it, and the tissues of the dog's body are relatively resistant to it. Type II most commonly occurs in older obese dogs. People with this form may be treated with an oral drug that stimulates the remaining functional cells to produce or release insulin in an adequate amount to normalize blood sugar. Unfortunately, dogs do not respond well to these oral medications.

Why is insulin so important?

The role of insulin is much like that of a gatekeeper: it stands at the surface of body cells and opens the door, allowing glucose to leave the blood stream and pass inside the cells. Glucose is a vital substance that provides much of the energy needed for life, and it must work *inside* the cells. Without an adequate

amount of insulin, glucose is unable to get into the cells. It accumulates in the blood, setting in motion a series of events that can ultimately prove fatal.

When insulin is deficient, the cells become starved for a source of energy. In response to this, the body starts breaking down stores of fat and protein to use as alternative energy sources. As a consequence, the dog eats more; thus, we have weight loss in a dog with a ravenous appetite. The body tries to eliminate the excess glucose by excreting it in the urine. However, glucose (blood sugar) attracts water resulting in the production of a large amount of urine. To avoid dehydration, the dog drinks more and more water. Thus, we have the four classical signs of diabetes:

1. ***Weight loss***
2. ***Increased water consumption***
3. ***Increased appetite***
4. ***Increased urination***

How is diabetes mellitus diagnosed?

The diagnosis of diabetes mellitus is based on three criteria: the four classical clinical signs, the presence of a persistently high level of glucose in the blood stream, and the presence of glucose in the urine.

The normal level of glucose in the blood is 80-120 mg/dl (4.4-6.6 mmol/L). It may rise to 250-300 mg/dl (13.6-16.5 mmol/L) following a meal. However, diabetes is the only common disease that will cause the blood glucose level to rise above 400 mg/dl (22 mmol/L). Some diabetic dogs will have a glucose level as high as 800 mg/dl (44 mmol/L), although most will be in the range of 400-600 mg/dl (22-33 mmol/L).

To keep the body from losing glucose, the kidneys do not allow glucose to be filtered out of the blood stream until an excessive level is reached. This means that dogs with a normal blood glucose level will not have glucose in the urine. Diabetic dogs, however, have excessive amounts of glucose in the blood, so it will be present in the urine.

What are the implications for me and my dog?

For the diabetic dog, one reality exists: blood glucose cannot be normalized without treatment. Although the dog can go a day or so without treatment and not have a crisis, treatment should be looked upon as part of the dog's daily routine. Treatment almost always requires some dietary changes and administration of insulin.

As for you, the owner, there are two implications: financial commitment and personal commitment.

When your dog is well regulated, the maintenance costs are minimal. The special diet, insulin, and syringes are not expensive. However, the financial commitment is significant during the initial regulation process and if complications arise.

Initially, your dog will be hospitalized for a few days to deal with the immediate crisis and to begin the regulation process. The "immediate crisis" is only great if your dog is so sick that it has quit eating and drinking for several days. Dogs in this state, called *ketoacidosis*, may require a week or more of hospitalization with quite a bit of laboratory testing. Otherwise, the initial hospitalization may be only for a day or two for basic tests and to begin treatment. At that point, your dog goes home for you to administer medication. At first, return visits are required every 3-7 days to monitor progress. It may take a month or more to achieve good regulation.

The financial commitment may again be significant if complications arise. We will work with you to try and achieve consistent regulation, but some dogs are difficult to keep regulated. It is important that you pay close attention to our instructions related to administration of medication, diet, and home monitoring. Another complication that can arise is *hypoglycemia*, or low blood sugar, which can be fatal. This may occur due to inconsistencies in treatment. This will be explained in subsequent paragraphs.

Your personal commitment to treating your dog is very important in maintaining regulation and preventing crises. Most diabetic dogs require insulin injections once or twice daily. They must be fed the same food in the same amount on the same schedule every day. If you are out of town, your dog must receive proper treatment while you are gone. These factors should be considered carefully when your pet has been diagnosed with diabetes mellitus.

What is involved in treatment?

Consistency is vital to proper management of the diabetic dog. Your dog needs consistent administration of medication, consistent feeding, and a stable, stress-free lifestyle. To best achieve this, it is preferred that your dog live indoors most of the time. Although that is not essential, indoor living removes many uncontrollable variables that can disrupt regulation.

The first step in treatment is to alter your dog's diet. Diabetes mellitus is known as a "fiber-responsive disease". Diets high in fiber are preferred because they are generally lower in sugar and slower to be digested. This means that the dog does not have to process a large amount of sugar at one time. Additionally, the fiber may help stimulate insulin secretion in Type II diabetes. The preferred diets are Prescription Diet Canine w/d™ and CNM OM™. If your dog is overweight, Prescription Diet r/d™ or CNM OM™ is fed until the proper weight is achieved, then your dog is switched to one of the others.

Your dog's feeding routine is also important. Some dogs prefer to eat several times per day. This means that food is left in the bowl at all times for free choice feeding. However, this is not the best way to feed a diabetic dog. The preferred way is to feed twice daily, just before each insulin injection. If your dog is currently eating on a free choice basis, it is important to try and make the change. If a two-meals-per-day feeding routine will not work for you, it is still important to find some way to accurately measure the amount of food that is consumed.

The foundation for regulating blood glucose is the administration of insulin by injection. Many people are initially fearful of giving insulin injections. If this is your initial reaction, consider these points:

A. Insulin does not cause pain when it is injected.

B. The injections are made with very tiny needles that your dog hardly feels.

C. The injections are given just under the skin in areas in which it is almost impossible to cause damage to any vital organ.

Please do not decide whether to treat your dog with insulin until we have demonstrated the injection technique. You will be pleasantly surprised at how easy it is and how well your dog tolerates the injections.

The injection technique is as follows:

Insulin Information. Insulin comes in an airtight bottle that is labeled with the insulin type and the concentration. It is important to make sure you match the insulin concentration with the proper insulin needles. Most dogs receive U-100 insulin. Make sure that the insulin needles you use are designed for your pet's insulin.

Before using the insulin, mix the contents. Be sure to roll it gently between your hands, not shake it. The reason for this is to prevent foam formation, which will make accurate measuring difficult. Some types of insulin used in dogs have a strong tendency to settle out of suspension. If it is not shaken properly, it will not mix well and dosing will be inaccurate. Therefore, the trick is to shake it vigorously enough to mix it without creating foam. When you have finished mixing the insulin, turn the bottle upside down to see if any white powder adheres to the bottom of the bottle. If so, more shaking is needed.

Insulin is a hormone that will lose its effectiveness if exposed to direct sunlight or high temperatures. It should be kept in the refrigerator, but it should not be frozen. If you have any question about your pet's insulin and how it was stored, we recommend replacing it instead of risking using ineffective insulin. Insulin is safe as long as it is used as directed, but it should be kept out of the reach of children.

Drawing up the Insulin. Have the needle and syringe, insulin bottle, and dog ready. Then, follow these steps:

1. Remove the guard from the needle, and draw back the plunger to the appropriate dose level.
2. Carefully insert the needle into the insulin bottle.
3. Inject air into the bottle. This prevents a vacuum from forming within the bottle.
4. Withdraw the correct amount of insulin into the syringe.

Before injecting your dog with the insulin, check that there are no air bubbles in the syringe. If you get an air bubble, draw twice as much insulin into the syringe as you need. Then withdraw the needle from the insulin bottle and tap the barrel of the syringe with your fingernail to make the air bubble rise to the nozzle of the syringe. Gently and slowly expel the air bubble by moving the plunger upward.

When this has been done, check that you have the correct amount of insulin in the syringe. The correct dose of insulin can be assured if you measure from the needle end, or "0" on the syringe barrel, to the end of the plunger nearest the needle.

Injecting the Insulin. The steps to follow for injecting insulin are:

1. Hold the syringe in your right hand (switch hands if you are left-handed).
2. Have someone hold your dog while you pick up a fold of skin from somewhere along your dog's back in the "scruff" region with your free hand. Try to pick up a different spot each day.
3. Quickly push the very sharp, very thin needle through your dog's skin. This should be easy and painless. However, take care to push the needle through only one layer of skin and not into your finger or through two layers of skin. The latter will result in injecting the insulin onto your dog's

haircoat or onto the floor. The needle should be directed parallel to the backbone or angled slightly downward.

4. To inject the insulin, place your thumb on the plunger and push it all the way into the syringe barrel.

5. Withdraw the needle from your dog's skin. Immediately place the needle guard over the needle and discard the needle and syringe.

6. Stroke your dog to reward it for sitting quietly.

7. Be aware that some communities have strict rules about disposal of medical waste material so don't throw the needle and syringe into the trash until you know if this is permissible. If it is not, we can dispose of them for you.

It is neither necessary nor desirable to swab the skin with alcohol to "sterilize" it. There are four reasons:

1. Due to the nature of the thick hair coat and the type of bacteria that live near the skin of dogs, brief swabbing with alcohol or any other antiseptic is not effective.

2. Because a small amount of alcohol can be carried through the skin by the needle, it may actually carry bacteria with it into the skin.

3. The sting caused by the alcohol can make your dog dislike the injections.

4. If you have accidentally injected the insulin on the surface of the skin, you will not know it. If you do not use alcohol and the skin or hair is wet following an injection, the injection was not done properly.

5. Although the above procedures may at first seem complicated and somewhat overwhelming, they will very quickly become second nature. Your dog will soon learn that once or twice each day it has to sit still for a few minutes. In most cases, a reward of stroking results in a fully cooperative dog that eventually may not even need to be held.

Is continual or periodic monitoring needed?

It is necessary that your dog's progress be checked on a regular basis. Monitoring is a joint project on which owners and veterinarians must work together.

Home Monitoring

Your part consists of two types of monitoring. First, you need to be constantly aware of your dog's appetite, weight, water consumption, and urine output. You should be feeding a consistent amount of food each day, which will allow you to be aware of days that your dog does not eat all of it or is unusually hungry after the feeding. You should weigh your dog at least monthly. It is best to use the same scales each time.

You should develop a way to measure water consumption. The average dog should drink no more than 7 1/2 oz. (225 ml) of water per 10 pounds (4.5 kg) of body weight per 24 hours. Since this is highly variable from one dog to another, keeping a record of your dog's water consumption for a few weeks will allow you to establish what is normal for your dog. Another way to measure water consumption is based on the number of times it drinks each day. When properly regulated, it should drink no more than six times per day. If this is exceeded, you should take steps to make an actual measurement.

Any significant change in your dog's food intake, weight, water intake, or urine output is an indicator that the diabetes is not well controlled. We should see your dog at that time for blood testing.

The second method of home monitoring is to determine the presence of glucose in the urine. If your dog is properly regulated, there should be no glucose present in the urine.

There are several ways to detect glucose in urine. You may purchase urine glucose test strips in any pharmacy. They are designed for use in humans with diabetes, but they also work in the dog. A fresh urine sample should be collected and tested with the test strip. If glucose is detected, the test should be repeated the next two days. If it is present each time, we should see your dog for a blood test.

You should keep a small container to catch urine as the dog voids. The test requires only a small amount of urine. Because the female dog usually squats to urinate, a shallow pan or dish may be placed under the hindquarters when she begins to urinate. For male dogs, urine can be collected as soon as the dog lifts the leg to void. Male dogs often urinate small amounts in several different places and often on vertical objects, such as bushes and trees.

Monitoring of Blood

There are two blood tests that can be used to monitor your dog. One of these should be performed about every 3-4 months if your dog seems to be well regulated. Testing should also be done at any time the clinical signs of diabetes are present or if glucose is detected in the urine for two consecutive days.

Determining the level of glucose in the blood is the most commonly used blood test. Timing is important when the blood glucose is determined. Since eating will elevate the blood sugar for several hours, it is best to test the blood at least 6 hours after eating.

When testing the blood we want to know the highest and lowest glucose readings for the day. The highest blood sugar reading should occur just before an injection of insulin is given. The lowest should occur at the time of peak insulin effect. This is usually 5-8 hours after an insulin injection, but it should have been determined during the initial regulation process. Therefore, the proper procedure is as follows:

1. Feed your dog its normal morning meal then bring it to the hospital immediately. If you cannot get it to the hospital within 30 minutes, do not feed it. In that situation, bring its food with you.

2. Bring your dog to the hospital early in the morning before giving it insulin.

3. A blood sample will be taken immediately and then we will give insulin and feed your dog if it did not eat at home.

4. A second blood sample will be taken at the time of peak insulin effect.

If your dog gets excited or very nervous when riding in the car or being in the hospital, the glucose readings may be falsely elevated. If this occurs, it is best to admit your dog to the hospital the morning (or afternoon) before testing so it can settle down for testing the next day. Otherwise, the tests give us limited information.

The alternative test is called a fructosamine test. This test is an average of the blood glucose levels for the last two weeks. It is less influenced by stress and inconsistencies in diet and exercise. For some dogs, this is the preferred test. It does not require fasting and can be performed at any time of the day.

Does hypoglycemia occur in dogs?

Hypoglycemia means low blood sugar. If it is below 40 mg/dl, it can be life threatening. Hypoglycemia occurs under two conditions:

1. ***If the insulin dose is too high.*** Although most dogs will require the same dose of insulin for long periods of time, it is possible for the dog's insulin requirements to change. However, the most common causes for change are a reduction in food intake and an increase in exercise or activity. The reason for feeding before the insulin injection is for the purpose of knowing when the appetite changes. *If your dog does not eat, skip that dose of insulin*. If only half of the food is eaten just give a half dose of insulin. *Always remember that it is better for the blood sugar to be too high than too low.*

2. ***If too much insulin is given***. This can occur because the insulin was not properly measured in the syringe or because two doses were given. You may forget that you gave it and repeat it, or two people in the family may each give a dose. A chart to record insulin administration will help to prevent the dog being treated twice.

The most likely time that a dog will become hypoglycemic is the time of peak insulin effect (5-8 hours after an insulin injection). When the blood glucose is only mildly low, the dog will be very tired and unresponsive. You may call it and get no response. Within a few hours, the blood glucose will rise, and your dog will return to normal. Since many dogs sleep a lot during the day, this important sign is easily missed. Watch for it. It is the first sign of impending problems. If you see it, please bring your dog in for blood testing.

If your dog is slow to recover from this period of lethargy, you should give it corn syrup (1 tablespoon by mouth). If there is no response in 15 minutes, repeat the corn syrup. If there is still no response, contact us immediately for further instructions.

If severe hypoglycemia occurs, a dog will have seizures or lose consciousness. Ultimately, untreated hypoglycemia will lead to coma and death. This is an emergency that can only be reversed with intravenous administration of glucose. If it occurs during office hours, come in immediately. If it occurs at night or on the weekend, call our emergency phone number for instructions.

SUMMARY OF INSTRUCTIONS

1. Read and reread this material so that you understand the specifics of proper regulation and how to recognize and treat hypoglycemia.

2. Purchase the supplies for treatment. Your prescription will specify the type of insulin and syringes. If you will be using urine glucose tests strips, they should be purchased at a pharmacy.

3. Give the first injection of insulin of _____units at about _____ AM/PM.

4. Return for a glucose curve, no later than 8:00 a.m., on _____. Feed your dog that morning and immediately bring it to the hospital. Do not give insulin, but bring it with you. (If it will take more than 30minutes to drive to the hospital, call for instructions on feeding.)

5. Following regulation in the hospital, measure the urine glucose two consecutive days, then twice weekly for the next two weeks. If glucose is not detected, measure the glucose two consecutive days every other week.

6. If you are unable to test the urine for glucose, return to our hospital in 2-4 days for a blood glucose test. This should be done about 5-8 hours after an injection of insulin. If two injections are given each day, be sure the test is done *before* the evening injection.

7. Return to our hospital for a blood glucose test in 1 month. This should be done about 5-8 hours after an injection of insulin. If two injections are given each day, be sure the test is done *before* the evening injection.

8. Return to our hospital for a blood glucose test in one month. Since this test is the fructosamine level, the time of day is not important and fasting is not necessary.

This client information sheet is based on material written by Ernest E. Ward Jr., DVM.