



## DIABETES MELLITUS

### What is diabetes mellitus?

There are two forms of diabetes in dogs: diabetes insipidus (drinking diabetes) and diabetes mellitus (sugar diabetes). Diabetes insipidus is a very rare disorder that results in failure to regulate body water content. Your dog has the more common type of diabetes: diabetes mellitus. This is a fairly common disorder and is most often seen in dogs 5 years of age or older. There is a congenital form that occurs in puppies, but this is not common. 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 called insulin. Simply put, diabetes mellitus is a failure of the pancreas to regulate blood sugar.

### **Some people with diabetes have to have daily injections of insulin 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.

1. Type I, or Insulin Dependent Diabetes Mellitus, results from total or near-complete destruction of the beta-cells of the pancreas. This is the only type of diabetes known in dogs. As the name implies, dogs with this type of diabetes require insulin injections to stabilise blood sugar.
2. Type II, or Non-Insulin Dependent Diabetes Mellitus, is different because some insulin-producing cells remain. However, the amount produced is insufficient and there is a delayed response in secreting it. 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 normalise blood sugar. Because Type II diabetes is rare in dogs, generally oral medications are not appropriate for treating diabetic dogs.

### 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 which 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, the excess blood sugar attracts water; thus, urine glucose takes with it large quantities of the body's fluids, 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:

### CLASSICAL SIGNS OF DIABETES MELLITUS

- Weight loss**
- Ravenous appetite**
- Increased water consumption**
- 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 blood glucose and the presence of glucose in the urine.

The normal level of glucose in the blood is 4.4-6.6 mmol/l. It may rise to 10 mmol/l following a large meal. However, diabetes is the only common disease that will cause the blood glucose level to rise above 22 mmol/l. Some diabetic dogs will have a glucose level as high as 44 mmol/l, although most will be in the range of 22-33 mmol/l.

To prevent glucose loss from the body the kidneys only allow it to pass out in the urine when very high levels of glucose are circulating in the blood. 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 normalised without treatment. Although the dog can go a day or so without treatment and not get into a crisis, treatment should be looked upon as part of the dog's daily routine. Treatment almost always requires administration of insulin and some modification of the diet.

For 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 very expensive. However, the financial commitment is significant during the initial regulation process and if complications arise.

Initially, your dog may be hospitalised for a few days to deal with the immediate crisis and to begin the regulation process. The "immediate crisis" is only great if the dog is so sick that it has stopped eating and drinking for several days. Dogs in this state, called ketoacidosis, may require a week or more of hospitalisation with a number of laboratory tests. Otherwise, the initial hospitalisation may be only for a day or two in order to start stabilisation. At that point, your dog goes home for you to administer medication. At first, return visits are required frequently 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 a few dogs are difficult to keep regulated. It is important that you pay close attention to our instructions related to administration of medication, to diet, and to home monitoring. Another complication that can arise is hypoglycemia, or low blood sugar. If severe, this 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 even 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 before deciding to commence treatment.

## **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. Generally most dogs are healthier and happier if they receive insulin injections twice daily.

The first step in treatment is to review your dog's diet. Diets that are high in fibre 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. The preferred diets are on prescription but will be supplied by the veterinary surgeon. If your dog is overweight, a special weight reducing diet may be first prescribed and then once the proper weight is achieved, another diet will be introduced.

Your dog's feeding routine is also important. The best way to feed a diabetic dog is to feed at insulin injection times and 6-8 hours later. If your dog is currently eating on a free choice basis, please try to make the change. However, if your dog will not change or if you have several dogs that eat in a free choice fashion, you may find that this change is not practical.

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

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

2. The injections are made with very tiny needles that your dog hardly feels. The injected volumes are minute.
3. 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.

The injection technique is as follows:

**About Insulin.** Insulin comes in an airtight bottle that is labelled with the insulin type and the concentration. Shake the bottle to mix the contents. Some of the 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 not be accurate. Therefore, the trick is to shake it vigorously enough to mix it without creating foam. Since bubbles can be removed (as described later), it is more important to mix it well than to worry about foam formation.

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. It is not ruined if left out of the refrigerator for a day or two, although this is not advisable. 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 syringe and needle, 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 finger 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. Pick up a fold of skin (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.
4. Draw back on the needle plunger and make sure no blood enters the syringe. If it does then the needle is in a vein. This rarely happens but we do not want to inject into a vein. So if you see blood, remove the syringe and start again in a different spot.
5. To inject the insulin, place your thumb on the plunger and push it all the way into the syringe barrel.
6. Withdraw the needle from your dog's skin. Immediately place the needle guard over the needle and store the needle and syringe back in the fridge. The needle and syringe can be reused many times over.
7. Stroke your dog to reward it for sitting quietly.
8. Be aware that some communities have strict rules about disposal of medical waste material so don't throw the needle/syringe into the rubbish 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 "sterilise" 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 very 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.

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 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 veterinary surgeon must work together.

### Home Monitoring

Your part consists of two forms 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 constant 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 once 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 approximately 300 mL of water per 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 only a trace amount present in the urine.

There are several ways to detect glucose in urine. We will supply you with urine glucose test strips. A fresh urine sample should be collected in the morning **before** there insulin dose and tested with the test strip. Your insulin dose should then be adjusted accordingly.

URINE GLUCOSE CONCENTRATION	ACTION
Negative	Reduce dose 10% or 0.1IU/kg
0.1-1 % trace or +	Keep dose the same
>2% brown colours	Increase dose 10% or 0.1iu/kg

If it is high for several days in a row then we should see your dog for a blood test.

Please telephone and discuss. You should keep a small container to catch urine as the dog voids. We can supply these. A large amount of urine is not needed to test for urine glucose; it is not necessary to catch the entire 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 most often urinate on vertical objects, such as bushes and trees.

### Monitoring of Blood Glucose

Determining the level of glucose in the blood is the most accurate means of monitoring. This should be done about every 3-4 months if your dog seems to be well regulated. It should also be done at any time the clinical signs of diabetes are present or if appreciable amounts of glucose are detected in the urine for several days.

1) one method is blood fructosamine levels which reflect the last 3 months of glucose levels.

2) blood glucose measurements

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 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 4-8 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 surgery immediately. If you cannot get it there 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 without giving it insulin.
3. A blood sample will be taken immediately, 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. In this way the tests are likely to be more accurate.

### **Does hypoglycaemia (low blood sugar) occur in dogs?**

Hypoglycaemia means low blood sugar. If it is below 2.2 mmol/l, it can be life-threatening. Hypoglycaemia 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. If your dog does not eat, you need to call your veterinarian. 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 hypoglycaemic 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 notice it, telephone and we will organise blood tests.

If your dog is slow to recover from this period of lethargy, you can try feeding a **glucose** solution. This should bring about an improvement. If not repeat it after 15 minutes. A teaspoonful of sugar in a little water can be used in an emergency.

If there is still no response, contact us immediately for further instructions.

If severe hypoglycaemia occurs, a dog will have seizures or lose consciousness. This can only be reversed with intravenous administration of glucose. Please telephone immediately, be it day or night. **THIS IS AN EMERGENCY.**

### **SUMMARY OF INSTRUCTIONS**

Read and reread this material so that you understand the basics of proper regulation and how to recognise and treat hypoglycaemia.

Make sure you have sufficient supplies of insulin and syringes. These will either have been supplied by the practice or on prescription from your local chemist.

Give the first injection of insulin of \_\_\_\_\_ units at about \_\_\_\_\_ AM and \_\_\_\_\_ PM and feed \_\_\_\_\_ of \_\_\_\_\_ at the time of injections and \_\_\_\_\_.



