# Diabetes Mellitus

Here are the Take-Homes for Pet Diabetes:

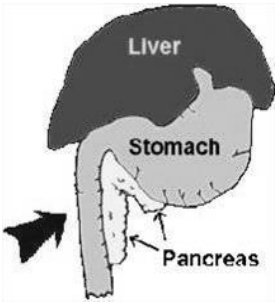
- *Diabetes mellitus is caused by a deficiency of insulin. You will probably have to give insulin injections to correct the deficiency. (Don't worry. It's easier than you think.)*
- *The main symptoms of diabetes mellitus are excessive urination, excessive thirst, excessive appetite, and weight loss. Treatment should control these symptoms. Watching for these symptoms is the best way to know how your pet is doing.*
- *The starting insulin dose is going to be based on averages and will be tweaked based on trial and error, depending on both test results and control of the symptoms.*
- *Using too little insulin is a problem in the long term, but too much insulin is potentially an emergency in the short term. Be sure you know how to recognize hypoglycemia and what to do about it.*

**What is Diabetes Mellitus?**

In order to understand the problems involved in diabetes mellitus it is necessary to understand something of the normal body's sugar metabolism.

The cells of the body require fuel in the form of fat or sugar to conduct their daily activities. Some tissues can use either sugar or fat depending on circumstances, and some tissues (such as the brain and nervous system) depend almost exclusively on sugar as fuel. Diabetes mellitus mostly involves the metabolism of sugar (in particular, a sugar known as glucose), so we will focus on the sugar part of the situation. Glucose comes from the diet in the form of starches and sugars that we eat.

Tissues cannot absorb glucose without a hormone known as insulin. Insulin is produced by the pancreas as part of the body's natural blood sugar regulation. Insulin can be considered to be a key that unlocks the door, allowing sugar in the bloodstream to enter the body's cells. Once inside the tissues, glucose can be burned for fuel or stored, but without insulin, the sugar stays in the bloodstream and cannot be used by the body.




The pancreas is nestled along the stomach and small intestine. It secretes digestive enzymes into the small intestine but it also secretes hormones into the bloodstream to regulate blood sugar.

In a diabetic animal, there isn't enough insulin. In fact, there may be no insulin at all. Remember that insulin was the key to unlocking the cell so that glucose could be brought inside. With no insulin, glucose cannot get in. Not only is glucose not being taken in and stored, but it is left floating around in the bloodstream in extremely high amounts. The body's tissues are starving and the bloodstream has plenty of glucose to feed them, but without insulin, the glucose is unavailable.

**So What Symptoms Result from this?**

Because there is no way to remove glucose from the bloodstream, blood sugar levels are astronomically high. Normally, the kidney is able to conserve the bloodstream's glucose but its mechanisms are overwhelmed and glucose spills into the urine in high amounts. If we continue our food delivery analogy, all the undeliverable food must be dumped. In the body, glucose dumping happens in the kidney with extra glucose dumping in the urine. This process involves the use of a lot of water with the ultimate result being a lot of urine being produced to process all that glucose to dump. This translates into excessive thirst and urination.

The tissues of the body are unable to access any of the glucose they need for fuel and are basically starving. Fat is mobilized and muscle is broken down to help feed the tissues but it does not do much good without insulin to bring fuel inside the cells. The patient shows excessive appetite because his body is in a state of starvation. Because the body is rapidly breaking itself down, weight loss is also a classic sign.

All the sugar in the urine provides a desirable growth medium for bacteria, and urinary tract infection is a common finding in diabetes mellitus.

In diabetic dogs (but not cats), a specific type of cataract rapidly develops in the eye when high amounts of glucose enter the lens. Glucose normally feeds the lens, but the amounts of glucose coming into a lens in the diabetic state are much higher. Excess glucose is converted to another sugar called sorbitol, which in turn attracts water. The excess water disrupts the clarity of the lens, creating a diabetic cataract, which leads to blindness in almost all diabetic dogs.

**Is it like Human Disease? Will We Need to Give Insulin Shots?**

*Dogs: Diabetes is most likely permanent and yes on the insulin shots.*

*Cats: Diabetes might not be permanent. Yes on the insulin shots if you want a chance at remission.*

Diabetes mellitus is a classical disease in humans and most of us have heard some of the terms used to describe it. In humans, diabetes is broken down into two forms: Type I and Type II. These are also referred to as juvenile-onset and adult-onset diabetes or insulin-dependent and non-insulin-dependent diabetes. In short, Type I is the type where the pancreas produces no insulin at all, and Type II is the type where the pancreas produces some but not enough. Many pet owners wonder if dogs and cats have similar categories for their diseases.

Virtually all dogs have insulin-dependent diabetes and must be treated with insulin. There is no way around it. Their condition is similar to the Type I diabetic human in many ways.

Most cats have "non-insulin-dependent diabetes" at least to start. This suggests that some cats can get away without insulin injections and, indeed, some cats may qualify for oral options or temporary treatment with insulin. For cats, diabetes can resolve if we can re-activate the pancreas promptly.

Not all diabetic cats are similar to humans with Type II diabetes. Some diabetic cats, perhaps as many as 25 percent, have more severe hormone issues, such as acromegaly or Cushing's disease, that make them not only insulin dependent but difficult to regulate.

**Treatment: Giving Insulin by Injection**

Since deficiency of insulin is the problem, it's not surprising that giving insulin is the solution. You will need to learn to give injections, which is daunting to some owners at first, but almost everyone quickly becomes an expert.

First, an insulin type and dose need to be selected. There are several types of insulins and it is not possible to know exactly how much insulin your individual pet will require; trial and error is needed. Your veterinarian will make a guess based on what works for other cats and dogs and what has been reported in the literature. Most pets require injections twice a day, approximately 12 hours apart, in conjunction with a meal.

Insulin has traditionally been given by syringe in a shot, but insulin pens are proving more and more popular. The syringe method involves buying a box of syringes and a bottle of insulin, drawing up a measured amount of insulin, and giving a shot. The pen involves applying a needle tip to the pen, dialing a dose on the pen, sticking the tip into the pet's skin, and pressing a button on the pen. Most people feel the pen method is much easier to perform but it may be difficult to find needle tips that are long enough for pet use as pet skin is much thicker than human skin. Some insulins are available from the neighborhood pharmacy and some are available only through veterinary offices and veterinary pharmacies. Your veterinarian will either provide you with supplies or will give you the necessary prescriptions. If you are using syringes be sure the syringes and insulin concentration match. Insulin syringes are marked in insulin units (either U-100 syringes for 100 unit/cc insulins or U-40 syringes for 40 unit/cc insulins). Whenever you receive more supplies, always double-check these numbers.

The various insulin formulations have different storage requirements. Check with your veterinarian for the proper storage of your pet's prescribed insulin.

**Diet and Feeding**

Regulation can generally be worked out on whatever diet the pet is eating but there are some diets and feeding strategies that are helpful. For dogs, high-fiber/low-fat diets are preferred as they slow the absorption of sugars in the diet and help maintain a more regulated blood sugar level. Fiber also seems to make the body's tissues more sensitive to insulin which also helps with regulation. Rewards are often employed to facilitate the insulin injection experience but these calories can add up and interfere with regulation so be sure your veterinarian is aware of all food items. Diabetic dogs are best fed in two meals, approximately 12 hours apart. After they have been seen to eat their food, their insulin dose can be given.

For cats the strategy is different. First, cats seem to do best fed in multiple small meals daily so they should be allowed access to food at all times. Second, the high protein/low carbohydrate diets seem to be the most conducive to regulation. There are specific prescription diets, both canned and dry, for diabetic cats.

**What about Glucose Testing?**

Never alter the insulin dose recommended by your doctor. To determine whether dose adjustments (or even a different type of insulin would be more appropriate), the pet will need a "glucose curve" where sugar levels are tracked over 10-24 hours. This kind of testing tells the doctor how long the insulin

injection is lasting as well as what the lowest and highest glucose levels of the day are. It is important to find out when your pet's curve is due. Often in the beginning it takes several dose selections and several cures before the right dose id determined.

As an alternative to a glucose curve, a continuous glucose monitor (CGM) can be obtained by a prescription form a human pharmacy. The Frestyle Libre device is a human glucose monitoring system that can be adapted to dogs and cats easily. For pets, a spot is shaved, usually on the shoulder or flank, and a round glucose sensor is implanted such that the sensor monitors tissue glucose levels. The provided scanner can wirelessly communicate with the sensor. In this way, glucoses can be checked simply by scanning the pet and no blood collection is needed. The sensor must be replaced every two weeks (generally done at the vet's office as shaving the skin is involved). The kit and sensors can be obtained from most human pharmacies. Your veterinarian must prescribe the system for you.

- If your pet is very active, the sensor can be dislodged and, in that situation, a new one must be implanted. A dislodged sensor cannot be re-implanted. Wearing a pet sweater or using some bandage material helps prevent this problem.
- Tissue glucose levels lag behind blood glucose levels by about 15 minutes. This is unlikely to come into play but could in event of a low blood sugar episode.

**Hypoglycemia**

The most serious problem to watch for is hypoglycemia (low blood sugar). This results from a mismatch in food consumption and insulin dose. If the dose is too high, you can get hypoglycemia. If the pet doesn't eat, you can get hypoglycemia. Your pet may look simply tired, weak, or sleepy. If she is roused, she will seem drunk or may not be able to fully come to alertness. This can be an emergency and can progress to seizures, so it is good to know what to do at home to prevent disaster.

If your pet appears wobbly or drunken, the blood sugar level may have dropped too low. This occurs after an insulin overdose. First, try to get your pet to eat. If the pet will not eat, administer light Karo syrup, honey, or even sugar water at a dose of one tablespoon per 5 pounds. If no improvement occurs, immediately see your veterinarian for emergency treatment. When your pet is more stable, a glucose curve or CGM will be needed to determine why this happened and what a more appropriate insulin dose might be.

It is best to make sure that your pet has recently eaten before giving the scheduled insulin dose.

<u>Bring your pet in for a re-check exam and testing if you note any of the following:</u>

- the pet seems to feel ill.
- the pet is losing weight.
- the pet has a ravenous appetite or loses its appetite.
- the pet seems to be drinking or urinating excessively.
- the pet becomes disoriented or groggy.

## Insulin Administration

Insulin is the injectable medication you use to control your diabetic pet's blood sugar. When insulin therapy is first started, the optimal dose for your pet will be unknown and will have to be determined by trial and error.

Most pets will need insulin injections twice a day, though occasionally a patient is found where a single dose is long-acting and once-a-day insulin works out. A dose will be selected based on what research has shown to be a good starting point and after a week or two, a glucose "curve" will be needed to map out the blood sugar levels over the day. The curve will show if the insulin is lasting long enough and if the dose should be raised, lowered, or kept the same. A glucose curve can be performed in the hospital or by using a continuous glucose monitor at home.

Be sure you understand how much insulin you are supposed to give your pet.

Do not change your pet's insulin dose without veterinary guidance.

## Storing Insulin

The insulin bottles should be kept in the refrigerator. It is best to keep them on a shelf and not in the door of the fridge.

- Do not use insulin that is past its expiration date.
- It is a good idea to change to a fresh bottle every 6 to 8 weeks. That being said, the standard in veterinary medicine is to keep it longer; 4-6 months as long as the insulin is refrigerated and not discolored. Please consult with your veterinarian about what will work best for you and your pet.
- Do not use insulin that has been frozen. Insulin is not normally frozen but accidents happen, especially in smaller refrigerators.
- Do not expose insulin to direct light or heat.

## Syringes for Use with Vials

Human and veterinary insulins are made at different concentrations and thus each requires its own type of syringe for proper dosing. Insulin syringes are extremely small in diameter so that injection will not be painful. It is a rare patient that objects to insulin shots per se, but some dogs resent being held still. It is crucial that the injection goes into the dog rather than into the fur of the dog. The best area for injection is around the shoulders but, if possible, the area of the injection should be changed up with each injection from right to left for best insulin absorption.

Always be sure you have the correct syringes for your insulin.

Used syringes should be placed inside a thick plastic container, such as a liquid laundry detergent bottle or similar receptacle. If the needle is enclosed in such a container, the entire container can be closed up and disposed of in the regular trash at home. Specific containers can be purchased for needle

disposal or the used syringes can be returned to your veterinary hospital for disposal if you prefer. Some states, such as California, have specific regulations for disposing of sharps.

**How to Give the Injections**

Insulin is drawn into the syringe after holding the bottle upside down.

First, feed your pet. The blood sugar of a dog or cat that has not eaten a normal meal but receives insulin may drop to a dangerously low level. If your pet is not eating, this could indicate a need for a checkup with your veterinarian. After the pet has eaten, you are ready to give the injection.

Before drawing up the insulin, it is important to be sure that the insulin is properly mixed as some of it will settle on the bottom of the vial. The manufacturer of Vetsulin recommends simply shaking the bottle until the contents are uniformly milky. The manufacturer of Prozinc recommends either rolling the bottle in the palms of your hands or turning the bottle over several times to gently mix the contents. The only product that should be shaken to mix is Vetsulin.

When drawing up the insulin, always hold the bottle vertically to avoid unnecessary bubbles in the syringe. Since insulin is being given under the skin, bubbles are not an enormous problem as it would be with an intravenous injection but we still want to minimize bubbles. If you get bubbles in the syringe, flick the syringe with your fingers until the bubbles rise to the top, and then simply push the air out of the syringe with the plunger.

After you have the insulin dose ready in the syringe, it is time to get your pet. Be sure you can trust your pet to hold reasonably still for the shot or have an additional person to assist in holding.

Lift up a fold of skin, ideally along the side of the body. This will create a small space for the needle. Insert the needle into this space and inject the insulin. Withdraw the syringe and needle when you are finished.

Giving injections and becoming comfortable with needles may seem intimidating at first but you will most likely be surprised at how easy it quickly becomes. Managing a diabetic pet is definitely a project but can be a very rewarding one. If you have any questions or problems, remember your veterinarian's office is available for demonstrations or to answer your questions as they come up.