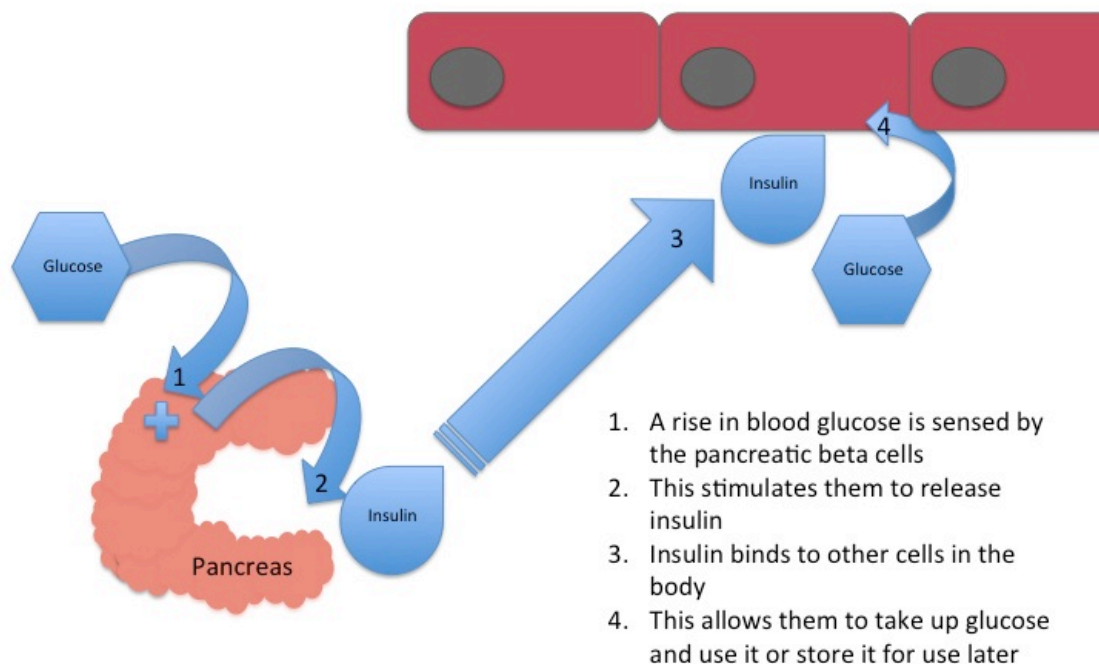


Diabetes Mellitus In Cats

What is Diabetes Mellitus and why does it occur?

Diabetes mellitus describes a state in which the body is either not able to produce enough insulin or not able to respond appropriately to the insulin that is produced (or a combination of both). In a non-diabetic, insulin is produced from specialized cells, called beta cells, within the pancreas. These cells are adapted to respond to the amount of glucose within the blood and release insulin whenever the glucose is elevated. Insulin allows other cells to take up the glucose and use it for energy or store it for use later (Figure 1).

Figure 1: The normal response to increased blood glucose



There are different forms of diabetes described in people, namely type 1 and type 2 diabetes. Type 1 diabetes is caused by the immune system attacking the pancreatic beta cells and destroying them: This form of diabetes is rare in cats. Type 2 diabetes is caused by a combination of decreased insulin production and insulin resistance (cells within the body not responding appropriately to the insulin levels). It isn't known which of these problems occurs first, but the pancreas no longer produces an appropriate amount of insulin in response to elevated blood glucose levels, and the cells are no longer able to respond appropriately to the insulin and take up glucose and process it in a normal manner. This leads to a high blood glucose level, which in turn causes a

condition known as 'glucose toxicity'; this further decreases the function of the pancreatic beta-cells further worsening the problem. In addition, there are some conditions which can stop the cells within the body being able to respond to insulin or that alter the production of insulin by the pancreas (or both); these conditions include over production of steroid hormones by the adrenal glands (a condition known as hyperadrenocorticism), and over production of a hormone called growth hormone from a pituitary (part of the brain) tumor (Figure 2). When these conditions occur they can block the bodies response to insulin and the production of insulin by the pancreas and therefore result in diabetes mellitus as a consequence of the underlying disease process (this is known as secondary diabetes mellitus).



Figure 2a: A cat with Hyperadrenocorticism. She presented with clinical signs of Diabetes, but also a rotund abdomen and very thin skin (which developed a tear-seen in image)



Figure 2b: A cat with Acromegaly. He presented with unstable Diabetes, but also had enlarged organs and enlargement of his skull, which lead to a prominent jawline.

The majority of cats diagnosed with diabetes mellitus have Type 2 diabetes, although secondary diabetes mellitus is also seen. There are certain risk factors that have been identified which increase the likelihood of developing type 2 diabetes. These include genetics (Burmese cats are at a 5 times higher risk of developing diabetes compared to other breeds of cat, and male cats have a higher risk than female cats do), obesity, indoor lifestyle and certain medications (such as corticosteroids or some hormones ie: megestrol acetate or ovarid). These risk factors can dramatically increase the chance of a cat developing diabetes, for example, it is known that a 50% gain in weight (ie: an averaged sized cat (which would typically weight 4kg) that is overweight and weighs 6kg) decreases the response to insulin by 50%-this means that the pancreas has to work twice as hard to control the circulating blood glucose levels, simply because the cat is overweight. In obese people, early diagnosis of type 2 diabetes can negate the immediate need for insulin injections. Unfortunately this is not the case in cats-by the time they show clinical signs of the problem (ie: drinking and urinating more-see Table 1) they are already suffering from glucose toxicity and therefore, they require insulin (at least initially) to decrease the glucose and allow any remaining beta cell function to recover.

Table 1: Clinical Signs in Cats with Diabetes Mellitus

Increased drinking
Increased urinating
Weight loss
Increased appetite
Poor hair coat (often dull, but sticky)
Lethargy
Occasionally (10%) of cases will develop neurological changes typically walking on their hocks and having problems jumping

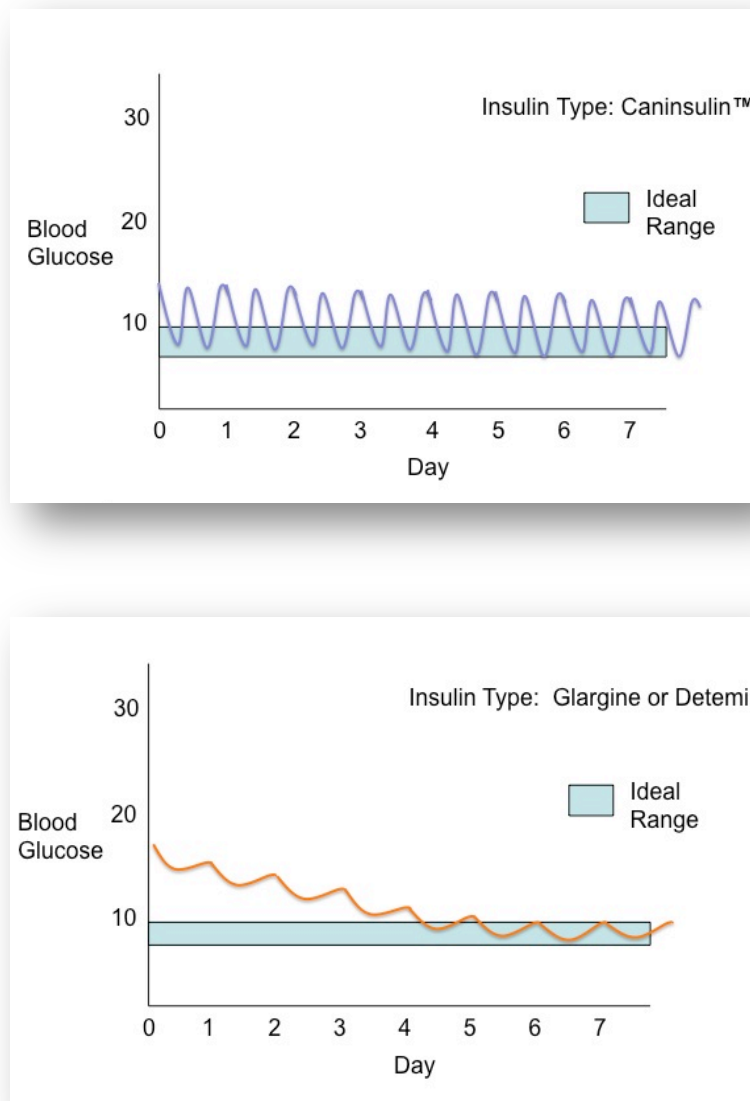


Management of Diabetes Mellitus

The aim of therapy for DM is to eliminate the signs of disease so that the cat can have a good quality of life. The mainstay of treatment is insulin administration; the effects of injectable insulin are far superior to those of any oral medications at decreasing glucose toxicity and increasing the chance of diabetic remission (return to a state in which injectable insulin is no longer required). There are several types of insulin available. However, in the UK there is only one veterinary licensed insulin available, this is known as Caninsulin™. This insulin has an intermediate level of duration (typically around 12 hours) and therefore needs to be given by subcutaneous (under the skin) injection twice daily, at approximately 12 hour intervals. Whilst this can be quite daunting at first, it is generally very well tolerated by cats, and injecting under the skin is actually very easy once you have the knack of it. Insulin is a protein that is easily denatured (loses its effects) therefore it is important that it is stored appropriately, Caninsulin™ should be kept upright (contact with the rubber stopper in the bottle can destroy the effectiveness of the insulin) and that it is kept refrigerated. In addition to insulin, it has been shown that cats with diabetes mellitus respond best to a low carbohydrate, high protein diet (this may not be appropriate if your cat has other problems such as renal insufficiency, and is therefore only available on prescription). Feeding a low carb diet decreases the rise in blood glucose after eating, and therefore helps keep glucose within a stable range. Studies have shown that by feeding such a diet and administering insulin twice daily, many cats can become 'transient diabetics' (ie: be weaned off insulin). In order to achieve this it is imperative that the cat is closely monitored, and ideally has at home monitoring (see later). Not all cats will stabilize on twice daily Caninsulin™ injections, this maybe because there is another condition which is leading to insulin resistance; any other disease process can participate in this, the most common of which include urinary tract infections (present in approximately 16% of diabetic cats despite no overt signs of cystitis), pancreatitis, acromegaly or hyperadrenocorticism; or because the cat makes antibodies to the insulin (Caninsulin™ is a porcine (pig) product and whilst it is similar to feline insulin it does have some slight differences which occasionally cats can make antibodies to). Alternative insulins are available. The most commonly used are synthetic (man-made) ultra-long acting human insulins. These products have been developed to slowly lower blood glucose and keep it lowered for prolonged periods of time. Their structure is slightly different to naturally occurring insulins, and the monitoring is different, in that although they are very long acting, twice daily administration is still

advised, to allow an accumulation of the insulin. **These insulins accumulate over 5-7 days and therefore the dose should not be increased more than once per week.** Once the insulin level is stable the aim is to maintain the blood glucose within or near to the normal range. This decreases glucose toxicity and is thought to improve the probability of a cat becoming a transient diabetic-in fact studies using these insulins (Glargine or Detemir) along with diabetic (low carb) diet, have shown very good responses in cats, with the majority of cases becoming transient diabetics (Figure 3).

Figure 3: Blood glucose curves demonstrating a 'good response' to different types of insulin



Monitoring of blood glucose is imperative. Cats which are receiving too much insulin can have one of two responses; they can develop hypoglycaemia (low blood glucose), which can be fatal if severe/not treated, as the body requires glucose to circulate to the cells in order for those cells to have an energy substrate in order to stay alive; alternatively, if the blood glucose drops rapidly or too low, the body can react by

producing 'stress hormones' such as adrenaline, noradrenaline and corticosteroids, these hormones block the effect of insulin and the glucose will bounce back to a high level and remain there until the stress hormones levels decrease (which can take up to three days in a cat), this will make the cat appear as if it is not responding to insulin on a spot check, when in fact it has responded previously and developed a short term insulin resistance as a result of too much insulin. As a diabetic cat is stabilized it is therefore important to monitor the effect of the insulin dose to see at what level the individual cats blood glucose is controlled and remains within or just above the normal range throughout the day. This varies between cats, depending on the individuals residual pancreatic reserve, and the amount of insulin resistance, and can vary with time as the effects of glucose toxicity decrease. Unfortunately, prolonged elevations in glucose are life threatening and can lead to the development of acidosis (the bodies pH is normally closely controlled around 7.4, if it becomes too acid the cells can no longer work normally), imbalances in the breakdown and storage of fat, protein and various metabolites and ultimately can prove fatal. Therefore, diabetic cats should be monitored to ensure that the blood glucose is neither too high nor too low. The most effective way of doing this is to monitor the cats' blood glucose at home. If the idea of injecting insulin seemed daunting at first this probably sounds like an impossible task! However, it isn't. Studies have shown that 'at home' monitoring better reflects the cats' response to insulin than monitoring within a veterinary practice, where cats' are stressed and therefore their blood glucose will vary. Whilst in some cases, in practice monitoring is useful (particularly in the initial stages), once the cat is on a regular regime at home monitoring can be irreplaceable. Humans generally monitor their own blood glucose using a small hand-held measuring device called a glucometer. Either human manufactured glucometers or specialized veterinary glucometers can be used to monitor cats. Whilst the veterinary devices are more expensive they have been made specifically for cats/dogs and therefore are potentially more accurate and use less blood. Whilst the human machines aren't quite as accurate, it is the general trend and ensuring that the blood glucose hasn't dropped too low that is most important and for both of these applications, using a human glucometer is preferable to not measuring at all. At home glucose monitoring can be achieved in the majority of cats, (see appendix) demonstrates how to do this and what to do if you have a low blood glucose reading. Other ways of monitoring a cats response to insulin include monitoring fructosamine levels and using implantable glucose monitors. Fructosamine is a protein that becomes elevated with prolonged elevations in blood glucose and can give your vet an idea of the average blood glucose over the preceding 3-6 weeks. This is useful in the diagnosis of diabetes mellitus, but is less useful in monitoring the response to insulin. Alternatively, implantable glucose monitors can be used to document the cats response to insulin over a 2-3 day period (Figure 4), these can be very useful in cats that are hard to stabilize but require specialized equipment and need calibrated by measuring the blood glucose 3 times each day. They can be used in the veterinary clinic, or home environment provided the owner can measure the blood glucose and calibrate the device.



Figure 4: Placement of an implantable blood glucose monitor in a cat with unstable Diabetes mellitus, allowing recording of blood glucose every 5mins for up to 3 days. This device is generally well tolerated by cats and can provide useful information regarding the response to insulin injections.

Images courtesy of Sara-Ann Dickson BSc VN

Appendix: Home Monitoring of the Cat with Diabetes Mellitus

Things to consider

- Home monitoring negates the stress caused by taking cats into the vets surgery
 - Aside from the obvious financial and social benefits, it has been shown that cat blood glucose curves in the hospital can be quite different from those in the home environment
- Allows frequent measurements and can be used in emergency situations (ie: blood sugar too low)
- 95% of cats tolerate ear vein monitoring

Ear Vein

- The ear vein is a tiny vessel running around the edge of the cats ear
- It is accessible from either side of the pinna (ear flap)



Shopping List

- **A Glucometer**
- **A box of glucometer test strips**
 - These need to match the meter you bought. Prices vary and often the cheaper glucometers charge a lot more for the test strips!
- **A bag/packet of lancets**
 - These are tiny pins you use to prick the cat's ear.
 - The glucometer will come with a lancet pen. This is a little spring-loaded device that shoots the pin out and into the skin. You can set the depth so as to prick them only as deep as necessary to draw the small amount of blood you need. Personally I find these quite cumbersome and use just the lancet without the pen. The lancets are single use only and should be discarded in your sharps bin.
- **A tube of Vaseline**
 - Putting a little vaseline on the ear before pricking it means that the blood forms a "bleb" rather than running along the surface of the skin

Taking a Measurement

- First time don't expect to get this right-it takes practice; hopefully you will have a reading after 4 or 5 goes.
- Wait until your cat is comfortable (preferable sleeping quietly)
- Only have one go-if you fail come back another day!

Taking a Measurement

1. Load up the Glucometer
so it is ready for use (these do turn off automatically so make sure everything else is ready)

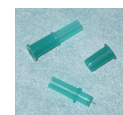


2. Locate the vein

If you are having difficulty with this ask your vet to clip the hair over it.

Taking a Measurement

3. Take out a Lancet used to prick the vein-note how much smaller than a needle

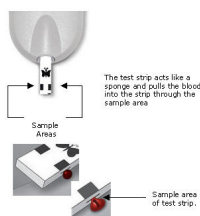


4. Apply Vaseline over the vein and **prick with the lancet**, put **pressure** on either side until a "bleb" appears-the size required will depend on your glucometer

Taking a Measurement

5. Place the glucometer test strip against the blood until its countdown commences

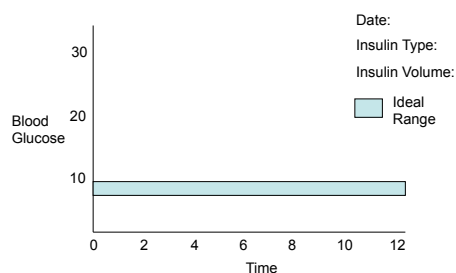
6. Record the result



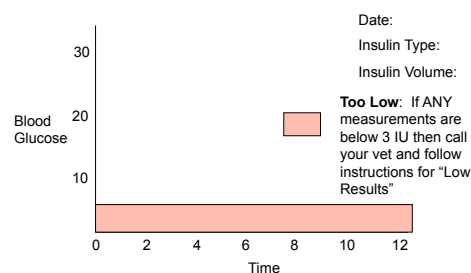
Once you have it cracked!

- Initially try occasional tests until you are confident of the procedure.
- Now you are ready to try a curve!!!
 - Wait until a day when you are at home
 - Try and obtain a reading just before insulin (time 0) and then every 2-3 hours up until the next dose, 12 hours later
 - Graph your results or record as a table and send to your vet for interpretation

Blood Glucose Curve



Blood Glucose Curve



Low Results

- If you obtain a low reading and your cat appears normal, offer your cat some food, if your cat eats recheck the blood glucose in 30 mins and 60 mins to ensure it has increased. Let your vet know the results immediately
- If your cat is dull/quiet or seizures/loses consciousness, immediately rub honey or sugary solution onto the gums (don't squirt into the mouth as the cat may inhale it) or if you have "glucogel" administer this-contact your vet immediately