

Introduction

- Performing a blood glucose curve is a vital step in achieving accurate stabilization of a diabetic patient.
- A blood glucose curve should be performed in all diabetic animals around 1-3 weeks after the start of treatment and at any stage where stabilization is in question.
- It can be useful in determining the reason for poor stabilization.

Principles

- In order to be of value a blood glucose curve should portray as closely as possible the blood glucose concentrations experienced by the patient in a normal day.
- The normal management regime should be followed during the time of sampling for the blood glucose curve.
- Meals and insulin injection must be given at the normal times and exercise programmes should match those of the home environment.

💡 To monitor owner technique it might be advisable to get the owner to give the insulin injection before admission.

- In reality most animals undergoing a day long blood glucose monitoring are hospitalized which immediately creates problems.
- The novel environment of the veterinary surgery inevitably will trigger a stress response and release of stress hormones may have an insulin-antagonizing effect.
- Blood glucose readings may therefore be higher than normal. Dogs may be hospitalized for 24-48 h before the test to acclimatize to the environment but this may increase stress in some animals.
- Repeated venipuncture for collection of blood samples may also increase stress and for this reason the placement of an indwelling venous catheter for the duration of the study is advocated.
- Catheter placement increases the volume of blood that needs to be withdrawn during the course of the study and this can be significant in very small animals.

If a glucometer is available this may be a useful alternative for measuring blood glucose as it requires only a single drop of blood at each measurement.

- If using a glucometer at least one sample should be checked in the laboratory to confirm the accuracy of the glucometer.
- If any alterations in regime are made then the glucose curve must be repeated after a period of adjustment to the new regime to confirm adequate stabilization.
- For details on how to obtain results for a blood glucose curve see the technique

- To produce a blood glucose curve, serial blood glucose concentrations are plotted against time on a graph.

It is much easier to read a graphical display of results than to interpret a table of values.

- First draw a horizontal time axis with ticks for every hour and a vertical blood glucose concentration axis marked off in mmol/l.
- It helps to mark lines for the normal range of blood glucose concentrations
- Now mark onto the graph the points relating to the results of the blood glucose measurements that you have made and join the points to form a curve. Finally add to the curve the times of important events during the day for example meals, insulin injection, exercise

If you have made urine glucose measurements during the day mark the times these were taken onto the graph too.

Interpreting the graph

The basic question to be answered is insulin effective and does the effect persist for long enough.

Is the insulin effective in lowering blood glucose?

- Look at the baseline glucose concentration before insulin injection to see that blood glucose concentrations fall after insulin administration
- If there is no change in blood glucose concentration the insulin is ineffective either because it is not reaching the blood stream (poor handling or administration technique) or there is antagonism to its action.

💡 Before assuming insulin resistance in a case with a flat glucose curve, always rule out the possibility of poor administration technique as a cause of the problem.

- Poor technique can be confirmed by repeating the curve following veterinary administration of the same insulin dose from a new bottle.
- In a well controlled diabetic the maximum blood glucose concentration will be within the normal blood glucose concentration range.
- This is rarely achieved in the diabetic patient and the peak blood glucose concentration is often between 15 and 20 mmol/l.
- This is acceptable provided that high blood glucose concentrations are not sustained and the patient appears clinically stable.

What is the rate of onset of action?

- Insulin effects should be seen within 4 h of injection.
- A delay in the drop in blood glucose concentrations after insulin injection may indicate poor absorption of insulin.

When is the peak effect of insulin occurring?

- The peak insulin effect occurs at the time of the lowest blood glucose concentration (*blood glucose nadir*)
- Knowing the timing of peak and trough blood glucose concentrations in any particular case can be useful in the management of insulin dose based on urine glucose readings.
- Measuring urine glucose concentrations at the time of peak and trough blood glucose allows a crude assessment of high and low blood glucose is, ie is it above or below the renal threshold?

It is not advisable for glucose nadir to occur at a time when the patient is not supervised as this is the major risk time for development of hypoglycemia.

Is blood glucose nadir sufficiently low?

- It is important to know how low blood glucose concentrations are falling
- The blood glucose nadir is directly affected by the insulin dose.

Ideally the lowest blood glucose concentration should be within the normal range lines (5-9 mmol/l).

- If it is above this the insulin dose is probably too low and blood glucose is never being normalized.
- If the glucose nadir is not sufficiently low increase the dose of insulin.
- If the blood glucose concentration is falling below the normal range there is a risk of the patient developing hypoglycemia at this time.
- This may be clinically significant or could result in the release of antagonistic hormones and the Somogyi overswing
- Always reduce the dose of insulin if blood glucose concentrations fall below 4.4 mmol/l.
- If blood glucose nadir is too low reduce insulin dose by 50%.

Night time glucose nadirs are higher than day time ones in patients receiving twice daily insulin so 24 h glucose concentration monitoring is not necessary.

- If blood glucose concentrations fall below 3 mmol/l then take samples and measure blood glucose every 30 min until they begin to rise.

Differential

- The differential is the difference between blood glucose concentration at the nadir and the peak (before the next insulin injection).
- If this is flat (2.8-5 mmol/l) and blood glucose concentrations are too high, then the insulin is having insufficient effect and the total dose should be increased.

- The glucose nadir should be adjusted, if necessary, using altered insulin dose and the patient allowed to stabilize on the new regime for at least 4 days before repeating the blood glucose curve.

Duration of effect of insulin

- Once the glucose nadir is adequate then the duration of insulin effect can be examined.
- The duration of the insulin effect is the time on the graph between glucose injection and the time at which blood glucose concentrations start to rise again.
- A duration of action of 22-24 h on once daily injections is adequate.
- A shorter duration of action may be due to rapid metabolism of insulin.
- Twice daily injections are required if duration of action is less than 10-14 h.
- If action is <8 h and blood glucose concentrations are falling consider Somogyi overswing effect.
- If blood glucose returns from the nadir to 70% of the baseline and >12 mmol/l by 12 h twice daily injections are required.
- Alternatively, if the duration of insulin action is too short, change to a longer acting insulin preparation.