



Forth Valley Diabetes Team

Insulin Pump Workbook

Ypsopump

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Insulin Pump Therapy

In multiple injection therapy, long acting insulin is used as background (basal) insulin and fast acting (bolus) insulin is used for food.

An insulin pump uses only fast acting insulin to supply the body with insulin continuously. This is made possible by different basal rates and bolus variations delivered by the pump over a 24 hour period.

Hybrid Closed Loop Pump

A hybrid closed-loop system automatically regulates insulin delivery according to your glucose levels, reducing insulin when you are at risk of going low and delivering more insulin when you are at risk of going high. This is based on continuous glucose monitoring (CGM) readings which link with the CamAPS FX app on your phone to form a hybrid closed loop system with your pump. When you eat a meal or snack containing carbohydrate, you need to give a bolus dose of insulin by letting the insulin pump know your carbohydrate intake prior to eating.

Wearing an Insulin Pump

An insulin pump delivers insulin through a small plastic cannula which is a tube inserted under the skin.

Ypsopump is a 'tethered' pump which delivers insulin through a tube which runs from the pump to the cannula inserted under the skin.

Inserting the cannula is similar to taking an insulin injection. After insertion the needle is removed and the plastic cannula remains beneath the skin for 2-3 days before it is changed.

A cannula can be attached to:

- Stomach
- Buttock
- Thighs

It is best to avoid:

- Waistbands
- Skin folds
- Scar tissue / lumpy areas
- Areas of lipohypertrophy (fatty lumps)
- Tattoos

Comfort & Tube Safety

- Consider where car seat belts would lie
- Tuck the tubing into clothing as this protects it from catching on objects such as door handles.
- There are various carrying systems available which help the pump to be worn comfortably and discreetly. See www.mylife-diabetescare.com

Other things to consider when changing your infusion set

- Wash your hands before changing your set
- If you use body lotion avoid putting on the area that you wish to use
- Use different sites as lipohypertrophy can develop on a pump too
- If you need to shave or wax the area do so 12 hours before you will insert a set to prevent inserting it into sensitive skin.
- If possible change the set prior to a meal so you are giving a food bolus soon after.
- You must check your glucose levels 1-2 hours after inserting a new set so that you know it is working correctly. This means that changing just before bed is not a good idea!

Change the cannula:

- At appropriate time intervals, i.e. every 2-3 days
- If the site is uncomfortable or itchy or the site is red and inflamed
- If there is blood in the infusion set
- If you have high blood glucose and ketones and have given a correction dose by pen

Try to check your cannula site morning and evening to ensure that there are no problems. This will only take a few seconds.

If you have problems with itchy red cannula sites try spraying with Cavilon 3M 'no sting' barrier spray prior to inserting your cannula. This is an alcohol-free liquid barrier film that dries quickly to form a breathable, transparent coating on the skin and is available on prescription from your GP.

Emergency Kit

When you wear an insulin pump, you must be prepared at all times with a backup system that will allow you to give insulin if something goes wrong with your pump.

It is recommended that you should carry the following items when going out:

- Blood glucose meter, finger pricking device and strips.
- Blood ketone meter and test strips
- Spare cannula and infusion set
- Spare filled reservoir or pumpcart
- Spare battery
- Mealtime insulin pen and needle (in date). Don't leave the needle attached to the pen or the insulin can crystallise and block the needle. Alternatively you can use a disposable syringe and take insulin from your filled reservoir.
- Background insulin pen (if going away for more than 12 hours)
- Treatment for hypoglycaemia
- Emergency contact numbers

Insulin Pump Settings

Before your pump starts working in auto mode (CamAPS) which will automatically adjust insulin delivery, you will require to programme the insulin pump with settings which the pump will work from until auto mode is switched on (Usually around 7 days after starting on the pump). The pump settings also need to be there for times when the pump is not working in auto mode.

Setting your Basal Rates

The basal rate is the rate at which your insulin pump delivers background insulin automatically. The first basal rate always starts at midnight. Other rates can be set depending on your insulin requirements however you will start on one basal rate over the 24 hour period initially.

Establishing an initial basal rate

In general less insulin is required when using an insulin pump because of the way the insulin is delivered. This can be 20- 30% less than your total daily insulin dose.

Calculating your basal rate:

1. On average, how many units of quick acting/meal time insulin are you injecting in 24 hours?
e.g. 18 units
2. How many units of background insulin are you injecting in 24 hours?
e.g. 22 units
3. Add both together to give your pre pump total daily dose
e.g. 40 units
4. Take 25% off pre pump total daily dose. This is now your total daily pump dose
e.g. 75% of 40 units = 30 units
5. Divide your total daily pump dose by 2 to give your total basal rate in 24 hours
e.g. $30 \div 2 = 15$
6. Divide by 24 to give an hourly basal rate
e.g. $15 \div 24 = 0.625$ units per hour (round down to 0.6 units per hour)

Calculating your insulin to carbohydrate ratio

You should already have an insulin to carbohydrate ratio (ICR). This may need to be altered when you move onto pump therapy. This is a general guide for working out your ICR although your diabetes team may decide to continue your current ICR when you commence pump therapy:

Working out your ICR:

1. Calculate your total daily pump dose (as documented on previous page)
e.g. 30 units
2. Divide this into 400
e.g. $400 \div 30 = 13.3$ round this to 13

For example this would mean you will need approx 1 unit of insulin for every 13g carbohydrate.

My starting insulin to carbohydrate ratio:

I need to take 1 unit of insulin forg of carbohydrate.

Calculating your insulin sensitivity factor (correction dose)

A correction dose is how much 1 unit of insulin will reduce your blood glucose level by.

Working out your correction dose:

This is a general guide and may need to be adjusted

1. Calculate your total daily pump dose
e.g. 30 units
2. Divide this into 130
e.g. $130 \div 30 = 4$

This means that 1 unit of insulin will reduce your blood glucose level by approximately 4mmol.

A more accurate way of working out your correction dose is to use your continuous glucose monitor (CGM). When your blood glucose is above target, but is relatively stable, and you have no active insulin on board, take a bolus of 1 unit and see how much this drops your blood glucose by. This will indicate what your correction dose/insulin sensitivity factor will be.

My correction dose is: 1 unit of insulin will reduce my blood glucose bymmol/l.

Calculating insulin pump settings

Calculate pre-pump total daily dose (TDD) =
(This includes both basal and bolus insulin)

Adjustment for pump therapy (-25%):
..... (TDD) x 0.75 = ○ adjusted pump TDD

Anticipated basal 50% of adjusted pump TDD (basal of 40-50% assumes CHO intake 100-200g per day)

Adjusted pump TDD ÷ 2 =

÷24 (hr) = hourly basal rate

Insulin to CHO ratio = $400 \div \text{adjusted pump TDD} = \dots\dots\dots$

Therefore 1 unit of insulin is required for everyg of CHO

Insulin sensitivity = $130 \div \text{adjusted pump TDD} = \dots\dots\dots$

Therefore 1 unit of insulin will reduce your blood glucose by mmol/l

Hypoglycaemia

Hypoglycaemia (blood glucose of less than 4mmol/L) can occur when using an insulin pump for the same reasons as when injecting insulin by pen.

The three most common causes of hypos are:

- Too much insulin.
- Over-estimation of carbohydrate content of food/not finishing meal.
- More physical activity than planned.

Causes Specific to Insulin Pump Therapy:

- Infusing insulin through “lumpy sites” (lipohypertrophy).
- Tubing primed while still attached to your body.
- Related to your bolus dose of insulin:
 - Miscalculation of a bolus
 - Over correction of an elevated blood glucose level e.g manual corrections or incorrect ISF setting.
 - Timing of meal bolus – once in automode, a delayed meal bolus will likely result in the pump giving an auto correction and therefore if you then bolus the full amount for your meal it can result in hypoglycaemia

Treatment of hypoglycaemia

Before your pump is working in auto mode, hypos should be treated with the ‘Rule of 15’ just like you did on injections.

The table below shows some examples of 15g treatments:

Food	15g CHO is found in:
Glucose/dextrose tablets	4-5
Pure fruit juice	150 ml
Cola/lemonade-type fizzy drink (not diet)	150 ml
Jelly Babies	3
Jelly Beans	10
Fruit Pastilles	6

Unlike when you were on injections, when you are using a pump you do not need to give an additional carbohydrate snack when your blood glucose is back above

4mmols/L. If you do eat then you should enter this carbohydrate into your pump and take the insulin for it.

Once your pump is working in auto mode, most people find they need less hypo treatment than they needed when using injections or standard insulin pump therapy. Often half of the previous hypo treatment can be enough as the automated insulin delivery system will have delivered very little or no insulin in the time leading up to the hypo.

When treating hypoglycaemia, a really useful tool to guide how much rapid acting carbohydrate you might need is to look at the information on your CamAPS FX app (turn your phone on its side). If there has been a slow steady fall in glucose without a lot of insulin delivery in the preceding 4 hours (i.e. insulin on board from boluses or basal from the algorithm) then you should treat with 4-5g at a time e.g. one jelly baby or soft mint. Frequently this is all that is required for overnight hypoglycaemia as most often there will not have been any recent boluses.

If, however, the glucose is falling rapidly (steeply) and/or you can see that you have a lot of insulin on board then you should treat with 8-10g.

Over treating hypoglycaemia when using this system, will result in increased insulin delivery after the hypo in response to the resulting hyperglycaemia, potentially increasing the risk of further episodes of hypoglycaemia.

The table below gives examples of hypo treatments containing 5-10g of carbohydrate.

Food	5-10g CHO is found in:
Glucose/dextrose tablets	2-3
Pure fruit juice	50-100 ml
Cola/lemonade-type fizzy drink (not diet)	50-100 ml
Jelly Babies	1-2
Jelly Beans	3-6
Fruit Pastilles	2-4

Illness and Diabetic Ketoacidosis (DKA)

When you are ill, your body becomes more resistant to the insulin you are taking so you may require more. In addition, you will produce stress hormones that will cause your glucose levels to rise.

Managing High Blood Glucose Levels when using an Insulin Pump

High blood glucose levels are managed differently with an insulin pump. With injections or pumps there are several reasons why your blood glucose levels can rise such as illness, missed insulin, stress or anxiety. Other things to consider when you are using a pump are: -

- Have you eaten carbohydrate foods and have forgotten a bolus?
- Has your infusion set been in place for longer than 2-3 days?
- Is the infusion site sore or red?
- Is there any air in the tubing?
- Is the reservoir empty or is your pump suspended?

If your blood glucose levels are 14 mmols/L (in pregnancy 10mmol/L) or above you should do the following: -

- Check your cannula site to ensure that it is ok
- Check for ketones in your blood

If your pump is in auto mode, you can consider using the “Boost function” if you notice your glucose levels are running higher than usual when you are unwell. The boost function makes the algorithm deliver about 35% more insulin if you are running high but will stop “boosting” when it predicts glucose levels will reach your target.

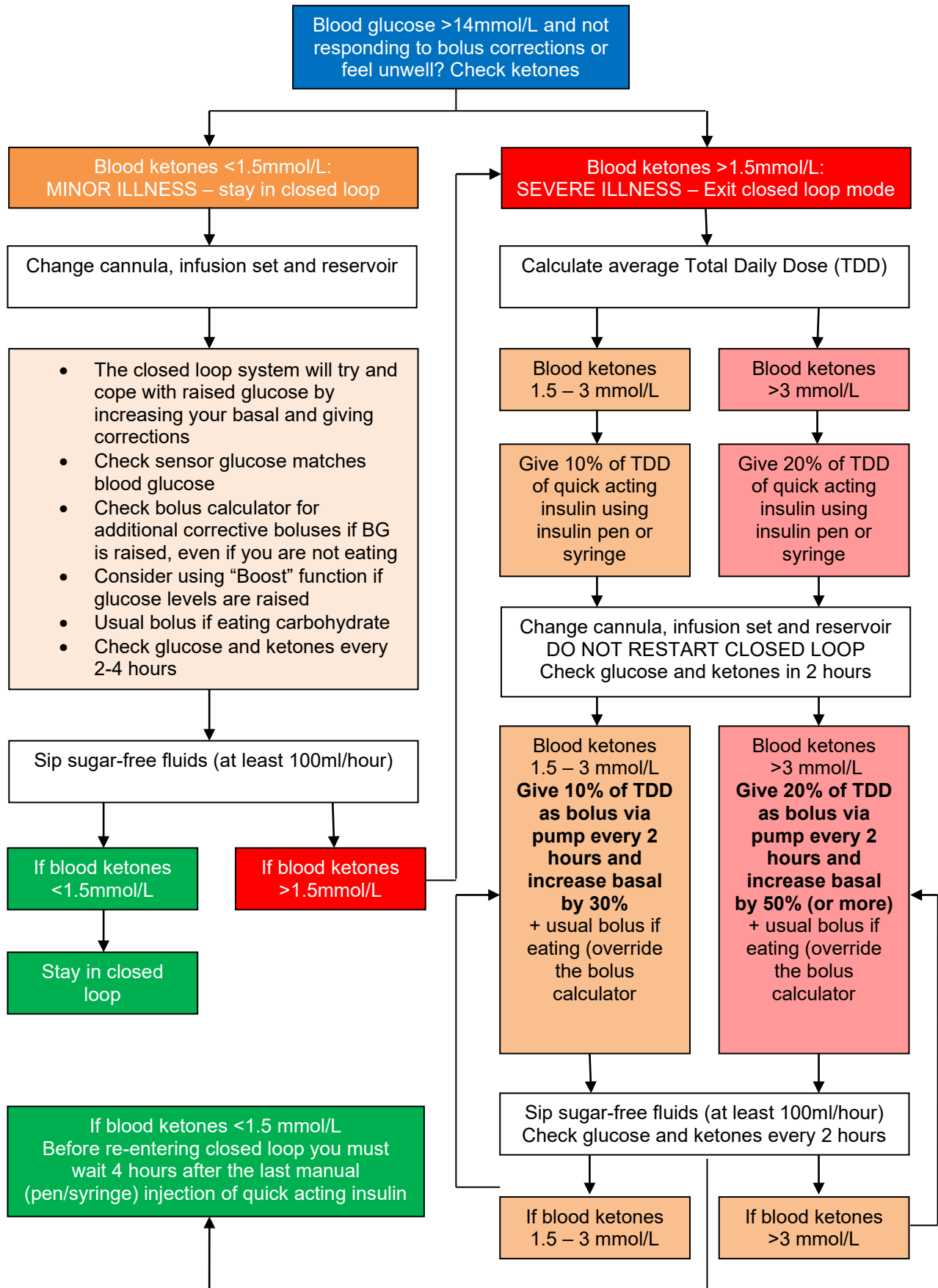
However if your ketone levels are above 1.5mmol/L then you must **stop auto mode**. See over page.

IMPORTANT:

If you have been trying to address hyperglycaemia for more than 4 hours with no improvement contact diabetes team.

If you are vomiting and are unable to keep fluids down, or unable to control your blood glucose or ketones you must contact your GP/Accident and Emergency Dept/NHS 24

Hyperglycaemia and Sick day rules



Delivering a Meal Bolus



Timing of boluses for food is very important, however recommendations are slightly different for a hybrid closed loop system compared with injections. It is even more important to bolus in advance of a meal. If you bolus during or after a meal, there will be a higher chance that you experience post meal hypoglycaemia. This is because the system will have already responded to the rising blood glucose levels by increasing insulin delivery and, with a bolus in addition, you may receive more insulin than is required for the food you have eaten.

We recommend that you try to bolus 10-15 minutes before meals. If you bolus much more in advance than this the result can be hyperglycaemia after meals as the system will reduce basal insulin delivery in response to falling glucose levels (the opposite of the scenario above).

If a mealtime bolus is missed or delayed:

- 30 – 60 mins after the meal has started give half the bolus dose
- More than 60 mins from the start of the meal – avoid giving the meal time bolus but ask the pump to deliver a manual correction bolus instead
- In both instances the boost function can be used to help correct the high.

For large carb meals or where you previously split the bolus consider entering a maximum of 60g via the bolus calculator or the initial (first dose) bolus you usually did, 10-15 minutes before and then leaving Cam APS to manage the rest over a few hours. If post meal glucose levels are consistently high then you could try:

- Giving the insulin for the rest of the carbs via a second bolus (using the bolus calculator) during or at the end of the meal OR
- Enter the remaining carbs in the 'add meal' function to inform the algorithm that additional 'x' grams of carbs are being consumed. Choose 'Meal or snack'. This announces to the system that extra carbs are being eaten. CamAPS FX will adjust to cover the carbs but only when glucose rises.
- For slowly absorbed meals – often higher fat, protein and / or very low GI meals – consider splitting the bolus, but this time add the remaining (2nd) amount of carbs in the 'add meal' function AND choose 'slowly absorbed meal'. CamAPS FX will deliver additional insulin, if required, every 30 minutes for the next 3-4 hours in response to rising glucose levels.

Exercise and Physical Activity



Ease off – the ease off function makes the algorithm less aggressive by temporarily raising the personal glucose target (PGT) and reducing basal insulin delivery. In ease off mode insulin delivery stops if glucose is less than 7 mmol/L. Ease off can be particularly useful for exercise.

For planned exercise or an increase in physical activity which you know is likely to increase the risk of hypoglycaemia, we recommend switching on ease off mode anywhere up to 1-2 hours before, for the duration of the exercise and potentially up to a few hours afterwards.

For cardiovascular exercise (e.g. running or cycling) that is high intensity over a long period of time, the ease off function alone might not be enough to prevent hypoglycaemia.

If delivering a bolus within 2 hours of planned exercise, consider reducing the bolus. The amount you reduce by will depend on the nature and duration of the planned exercise.

You should avoid 'carb loading' prior to exercise as you may have done on injections. A rise in glucose will cause Control IQ to increase insulin, increasing the risk of hypoglycaemia during the activity. A gradual and consistent intake of carbohydrate may be necessary, guided by your sensor glucose readings e.g. 10g every 20mins if glucose levels are falling.

Conversion Back on to Insulin Injections

In an emergency situation it may be necessary for you to convert back onto insulin injections.

In case you are unable to recall information from your pump it is recommended that you should always keep a record of your up to date pump settings – you will need your total amount of basal insulin, your insulin to carbohydrate ratio and your correction dose. Your pump will upload to a platform called Glooko and if you have this set up, then up to date pump settings can also be found on your Glooko reports.

How to calculate your starting background dose

Take your total daily dose of basal insulin and add 20% to this amount.

If you take Lantus: take this total amount of insulin

If you take Levemir: divide this amount by two and take that amount twice a day.

How to calculate your food doses

Using your insulin to carbohydrate ratio – take the grammes of carbohydrate you are eating and divide by the amount of your ratio.

Eg;

Insulin to carbohydrate ratio is 1:20g

Carbs in meal is 80g so $80/20 = 4$ units of insulin.

If you need to add on a correction:

Insulin sensitivity factor is 1:2mmols/L

Blood glucose is 10.3 and target is 6mmols – difference in 4.3mmols/l

$4.3/2 = 2$ units

Travel with an Insulin Pump



FAQ's

What preparations do I have to make prior to travelling?

When going on trips, be sure to take extra pump batteries, insulin, pump supplies and an insulin syringe or insulin pen for injections just in case. See the section "Conversion Back On to Insulin Injections" if your insulin pump stops functioning. You should also take your blood testing and ketone monitoring equipment. A good rule of thumb is to take double the amount of supplies that you think you would need.

I'm going on a long haul flight; do I have to make any changes to my pump settings?

Travel across time zones means that you will need to change the clock on your insulin pump when you arrive. You need to make sure your pump knows when you are waking up and going to sleep. Remember to change it back once you are home.

Is there anything else I should do?

- You will need a travel letter from your diabetes team confirming that you use an insulin pump.
- Insulin pumps **must not** be passed through an airport baggage scanner or body scanner and should always remain connected to you.

Holidays



Extremes of temperature can affect blood glucose levels. If insulin becomes too hot or cold it can stop working, which means that your blood glucose levels will rise very quickly. Heat can also make your insulin work more quickly causing unexpected low blood glucose levels.

FAQ's

Are there any special precautions I need to take?

- If you are wearing your pump on the beach, you will need to keep it out of direct sunlight. When sunbathing put a heavy towel over your pump and tubing and keep it in the shade.
- Try wrapping your insulin pump and the line in a FRIO insulin cool wallet. These are water-activated cool bags that will keep your insulin cool for 24 hours. FRIO insulin cool wallets are available from www.medicalshop.co.uk, freephone 0800 731 6959
- If you are wearing a swimwear think about where you insert your cannula. When it's hot, the tape on your cannula may not stick as well, especially if your skin is sweaty. You may need to put a second piece of tape over the cannula site. Opsite or Tegaderm can be either bought from a chemist or obtained on prescription from your GP.
- Try spraying unscented antiperspirant onto the site before inserting a new cannula. This can help the tape to stick better.
- Disconnect your pump if you have a sauna. This stops the pump being affected by the intense heat.
- In very cold weather try and keep the infusion set tubing inside your clothing. The tubing is very thin and the insulin inside could easily freeze.
- For winter sports you can wear your pump in a sports harness, which is similar to a tiny rucksack. This still needs to be worn under clothing to prevent the insulin from freezing.

Hospital Admission

FAQ's

What happens if I have to go into hospital, is there anything I have to do?

Here are some simple guidelines to follow.

- If your admission is planned, inform your Diabetes Team as soon as you know the date for admission. If it is to a different hospital ask them to contact the appropriate team.
- It is easier but not essential if your procedure can be done first thing in the morning.
- The appropriate medical team will advise you about eating and drinking and if you will have to fast. Remind them you have diabetes and ask them to inform the diabetes team that you are in hospital.
- You may be able to wear your insulin pump throughout the procedure if this is performed under local anaesthetic. It is advisable that you have a venflon (a small cannula) inserted into your hand/arm as a precautionary measure. You can use the "Ease off" function and/or increase your personal glucose target to reduce the risk of hypoglycaemia.
- Ensure that your pump has new batteries, a full reservoir, new infusion set and that you have a spare set of each.
- Scanners, e.g. CT scanners, MRI scanners can affect your insulin pump and sensor accuracy. The pump must, therefore be removed prior to medical scanning for the duration of the procedure and then reconnected.
- If the procedure is carried out under general or spinal anaesthetic intravenous insulin should be commenced and your insulin pump discontinued.
- Make a note of your basal rates in case these are lost from your pump.
- Once you are well enough to manage your pump yourself you can restart your insulin pump.
- When you change back from intravenous insulin onto your insulin pump, the insulin pump and IV insulin should run together for 1 hour before the intravenous infusion is discontinued.

Useful Contacts

If you are experiencing the following issues please contact your insulin pump/Dexcom supplier:

- Faulty pump
- Issues with insulin pump/Dexcom supplies or delivery
- Technical difficulties downloading your pump at home

Ypsopump www.mylife-diabetescare.com/en-gb Tel: 0344 856 7820
Dexcom www.dexcom.com/en-gb Tel: 0800 031 5761
Tech Support 0800 031 5763

Urgent Advice:

- Within working hours 9am – 4pm Monday - Friday, please phone 01324 566929
- Out of hours speak to NHS 24 on 111.

Non Urgent Advice:

- Please email fv.diabetespumpserv@nhs.scot

Downloading your pump:

Glooko - Proconnect code - ukforthadu

You may find the answer to your question on our website:

www.forthvalley/diabetes

Non Diabetes Related:

If you have a problem, not related to your Diabetes, please get in touch with your GP or NHS 24 on 111.