



Forth Valley Diabetes Team  
Insulin Pump Workbook  
Medtronic 780G

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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 Guardian 4 sensor readings and an algorithm which is called Smartguard. 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.

Medtronic 780G 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 should be placed 3 inches away from your CGM sensor site, ideally wear on the same side of the body with your pump screen facing out.

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.

### 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 glucose and ketone levels 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 infusion set and cartridges
- Insulin vial
- 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 insulin vial.
- Background insulin pen (if going away for more than 12 hours)
- Treatment for hypoglycaemia
- Emergency contact numbers

## Insulin Pump Settings

Your pump requires to be programmed with a basal rate of insulin which will deliver insulin in the background across a 24 hour period however once Smartguard is switched on the algorithm will no longer work from these manual set basal rates. The algorithm works by auto calculating basal rates and correction factors. When delivering a bolus for food, your pump will calculate the required bolus based on your insulin to carbohydrate ratio (ICR), target level and active insulin time (AIT) which are programmed into your pump. A target of 5.5, 6.1 or 6.7 can be programmed into your pump however a default target of 5.5 is recommended to achieve more time in range. The algorithm is designed for a short active insulin time of 2-3 hours.

### Setting your Basal Rates

The basal rate is the rate at which your insulin pump delivers background insulin automatically. The pump will only work from these programmed basal rates when you are not in automation. The first basal rate always starts at midnight and you will start with 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 for .....g of carbohydrate.

## Calculating your insulin sensitivity factor (correction factor)

A correction dose is how much 1 unit of insulin will reduce your blood glucose level by. Your insulin sensitivity factor will be required for any periods not in Smartguard.

### 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 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 by .....mmol/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 every .....g 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.
  - Timing of meal bolus – 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

Hybrid closed loop systems give additional protection against hypoglycaemia over injections by reducing or suspending insulin delivery in response to falling glucose levels. People using hybrid closed loop systems require less rapid acting carbohydrate to treat hypoglycaemia than those using injections because of this feature of the system. Often half of the previous hypo treatment can be enough.

When treating hypoglycaemia, a useful tool to guide how much rapid acting carbohydrate you might need is to look at the information on your pump. 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.

| <b>Food</b>                               | <b>5-10g CHO is found in:</b> |
|---|-------------------------------|
| 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                           |

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.

## 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 glucose levels are managed differently with an insulin pump. With injections or pumps there are several reasons why your 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 to 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 cartridge empty or is your pump suspended?

If your 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

You can ask the pump to administer a manual correction bolus in addition to the automatic correction boluses if blood glucose is high but you cannot override the pump decision in automode i.e. if the pump does not recommend giving any insulin at that time, this is because the system has calculated that the insulin already given will be sufficient and that any additional insulin will lead to hypoglycaemia.

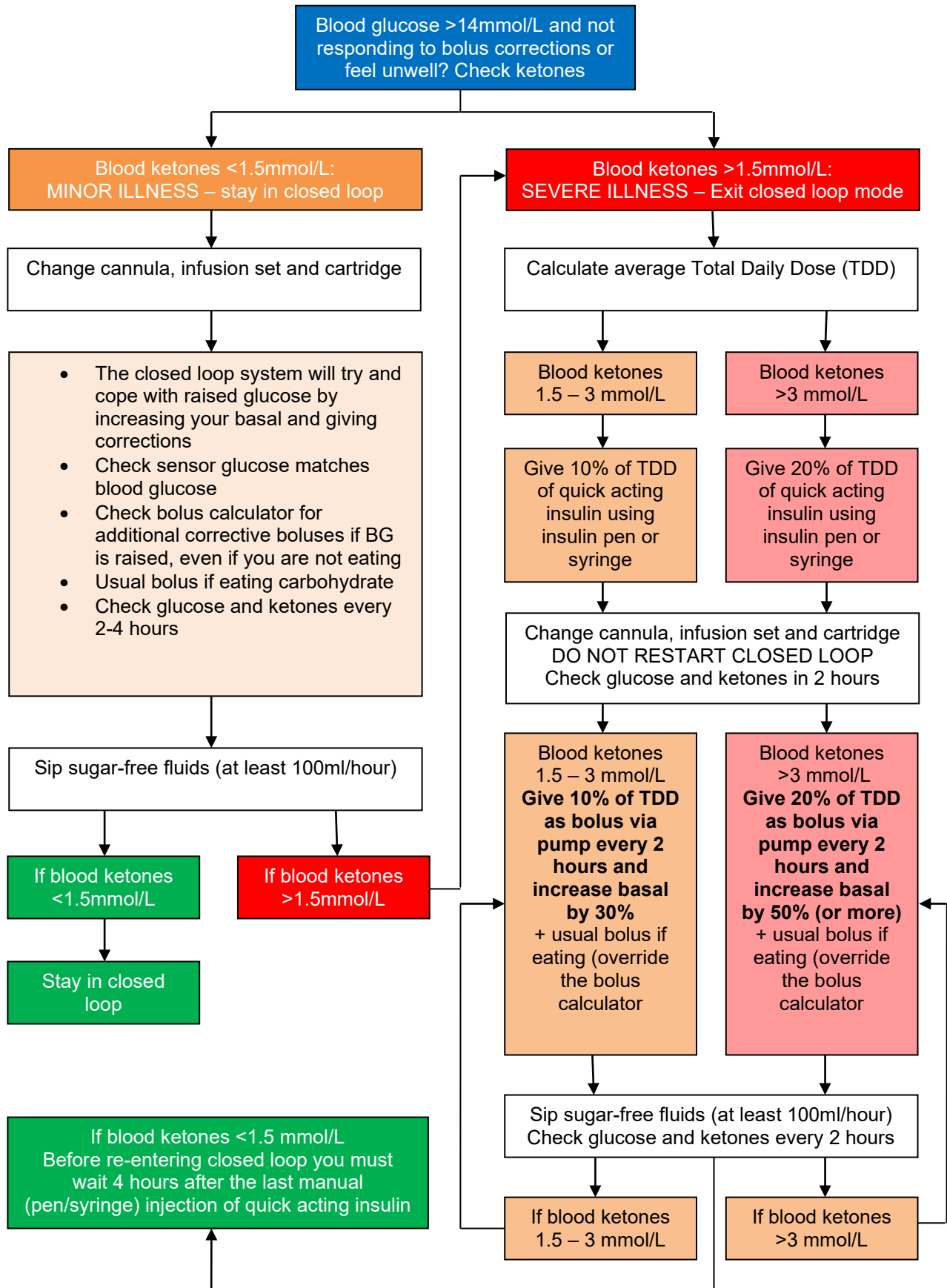
**If your ketone levels are above 1.5mmol/L then you must come out of Smartguard and use your pump in manual mode. See over page.**

#### **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

There is no extended bolus feature in Smartguard. Basal insulin will increase in response to increasing glucose levels so will help manage delayed post meal glucose rises for high fat and high protein meals.

For large carbohydrate meals above 60g (slowly absorbed meals often higher in fat/protein) you can choose to split your bolus however the second bolus should be given within 1 hour of eating otherwise rising glucose levels will trigger auto corrections and increase in basal insulin which could result in hypoglycaemia. Consider entering up to a maximum of 60g via the bolus calculator and then covering the remaining carbohydrates with a second bolus 1hour later if required.

## Exercise and Physical Activity



**Temporary Target** – Temporary target will temporarily increase the target to 8.3mmol/L. For planned exercise or an increase in physical activity which you know is likely to increase the risk of hypoglycaemia, it is recommended that you switch on exercise mode 1 – 2 hours before starting exercise. The pump will not deliver auto corrections whilst the temporary target is switched on.

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 the pump 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 factor. Your pump will upload automatically to a platform called Carelink therefore up to date pump settings can also be found on your Carelink 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 grams 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

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](http://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 may also wish to use the temporary target to reduce the risk of hypoglycaemia during the procedure. This would require to be switched on 1-2 hours before the procedure.
- Ensure that your pump has a new battery, a full cartridge, 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 supplier:

- Faulty pump/sensor
- Issues with insulin pump supplies or delivery
- Technical difficulties connecting to Carelink

MEDTRONIC [www.medtronic-diabetes.com/en-gb](http://www.medtronic-diabetes.com/en-gb)

Tel: 01923 205 167

### 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](mailto:fv.diabetespumpserv@nhs.scot)

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

[www.forthvalley/diabetes](http://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.