

# UNDERSTANDING INSULIN PUMPS

Information for people with  
type 1 diabetes

The quotes that appear throughout this booklet are from adults and children who attended a Diabetes Victoria pump information session in April 2009. We thank them for allowing us to share their experiences.

## Contents

Introduction	2
What are insulin pumps?	4
What are the benefits of pump therapy?	5
How does an insulin pump work?	6
Insulin pump therapy and blood glucose monitoring	11
How do I choose an insulin pump?	14
Pump features to consider	15
What are the costs?	17
What are the challenges of pump therapy?	20
What about...? Food, carbohydrates, sleeping etc.	25
Important things to remember about pump therapy	36
When is pump therapy not recommended?	38
How do I get started on an insulin pump?	39
How can I get more information?	40
Acknowledgements	43
References	44

## Introduction

This information booklet is for people with type 1 diabetes considering insulin pump therapy.

Here you will find answers to the most common questions about pump therapy. However, you will need to do more of your own research and speak with your diabetes care team before you decide if a pump is suitable for you.

Insulin pumps are small electronic devices which can make life with type 1 diabetes more flexible. In recent years, the use of insulin pumps by people with type 1 diabetes in Australia has become increasingly popular. Currently, over 10 per cent of people (approximately 10,000) with type 1 diabetes in Australia are using insulin pumps instead of multiple daily injections (MDI) to deliver their daily insulin requirements.

### Insulin pumps are able to do three things:

- continuously deliver small doses of rapid-acting insulin to meet your basal (background) needs
- allow you to deliver a surge of insulin for the carbohydrates you eat. This is called a meal bolus
- allow you to deliver extra insulin to correct high blood glucose levels (BGLs). This is called a correction bolus.

Research has shown that insulin pump therapy can reduce the frequency of severe hypoglycaemia as well as improve quality of life. Using a pump may also improve suboptimal blood glucose control.

It is important that you have realistic expectations about pump therapy. It is not a cure for type 1 diabetes but a way of delivering insulin that may offer increased flexibility, improved glucose levels and improved quality of life. Pump therapy requires motivation, regular blood glucose checking, the ability to learn pump technology and the willingness to keep in regular contact with your diabetes educator or endocrinologist for review and adjustment of pump rates.

***“I decided to wear a pump because it took away the guess work. At times I couldn’t remember if I had injected or when I had. The pump records everything, it’s a genius.”***

**Diane, 38 years, pumping for two and a half years.**



## Insulin pumps

An insulin pump is a small battery-operated electronic device about the size of a pager or small mobile phone. The rapid acting insulin is delivered via an infusion set which is inserted under the skin (subcutaneously). The device delivers insulin in two ways:

- 1 basal (sometimes called background) – delivering small amounts of insulin continuously in order to maintain cell function (replacing the need for long acting insulin)
- 2 bolus – delivering a dose of insulin on demand to account for the carbohydrates in meals or to correct high BGLs.

An insulin pump is worn 24 hours a day but can be taken off for up to two hours when required (e.g. for swimming, contact sport or showering). Some people choose to take the pump off and go back to injections for short periods (e.g. for a trip to the beach).



## What are the benefits of pump therapy?

Insulin pump therapy can help you to better manage your diabetes. The major advantage of insulin pump therapy is that insulin is absorbed more efficiently and more predictably under the skin.

### Using an insulin pump may:

- reduce large fluctuations in BGLs
- improve blood glucose (diabetes) levels
- increase your flexibility in the quantity and timing of meals
- decrease your risk of hypoglycaemia during exercise while maintaining optimal BGLs
- improve your quality of life.

### Pump therapy may especially be of assistance if any of the following applies to you:

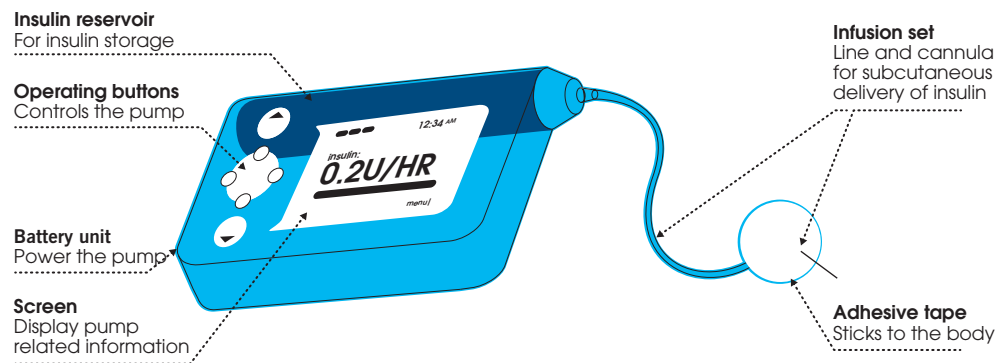
- hypoglycaemia unawareness (inability to detect 'hypos')
- severe and frequent hypoglycaemia
- frequent night time hypoglycaemia
- gastroparesis (delayed emptying of the stomach)
- an unpredictable lifestyle or daily routine (e.g. working nightshifts)
- extreme insulin sensitivity
- dawn phenomenon (rising blood glucose early in the morning)
- planning for, and during, pregnancy.

## How does an insulin pump work?

An insulin pump can provide all the insulin requirements of a person with type 1 diabetes.

The pump contains a reservoir or cartridge filled with insulin. A micro-computer built into the pump allows you to program the pump to deliver a dose of insulin according to your needs. A small motor inside the pump controls the delivery of insulin. Insulin is delivered from the reservoir/cartridge through flexible tubing fitted with a small Teflon® (or metal) cannula that is inserted subcutaneously (under the skin) and held in place with special adhesive tape. Together, the tubing and cannula are called an infusion set. The cannula is easily inserted and removed by you; it is not surgically implanted. An introducer needle allows the cannula to be inserted under the skin. The needle is then removed leaving behind the cannula only. For those who do not want to insert the needles manually, there are disposable and reusable devices to assist with cannula insertion.

The cannula must be changed every two to three days. Metal cannulas may need to be changed every one to two days. The most common site to place infusion sets is in the abdomen (easy to access) but they can also be placed in the upper buttock, upper outer thigh, hip or upper arm.



## What type of insulin is used in a pump?

An insulin pump delivers rapid-acting insulin such as NovoRapid® and Humalog®. It delivers the insulin in two ways (basal and bolus), therefore replacing the need for long-acting insulin (Lantus®, Levemir® or Protophane®).

## How does a pump deliver my daily insulin requirements?

An insulin pump delivers insulin continuously (basal) and on demand (bolus) to account for carbohydrates in meals or high BGLs.

### Basal

The basal insulin is the insulin that your body needs continuously for normal metabolism. It maintains stable blood glucose in the absence of food. The pump delivers insulin automatically and continuously (at individually-set intervals; commonly this is every three minutes), 24 hours a day. The rate of delivery (basal rate) is programmed in units per hour and adjusted according to your needs. This rate is initially calculated by your diabetes educator or endocrinologist. In time, with the support of your diabetes care team, you will learn to make adjustments to your own rates according to the patterns and trends of your BGLs.

### Bolus

A *bolus* is a dose of insulin that is delivered on demand. Pump users manually activate the pump to give a meal bolus to match the amount of carbohydrate in the food about to be eaten. The amount of insulin delivered as a meal bolus is calculated using an insulin-to-carbohydrate ratio initially set by your diabetes educator or endocrinologist based on your individual needs.

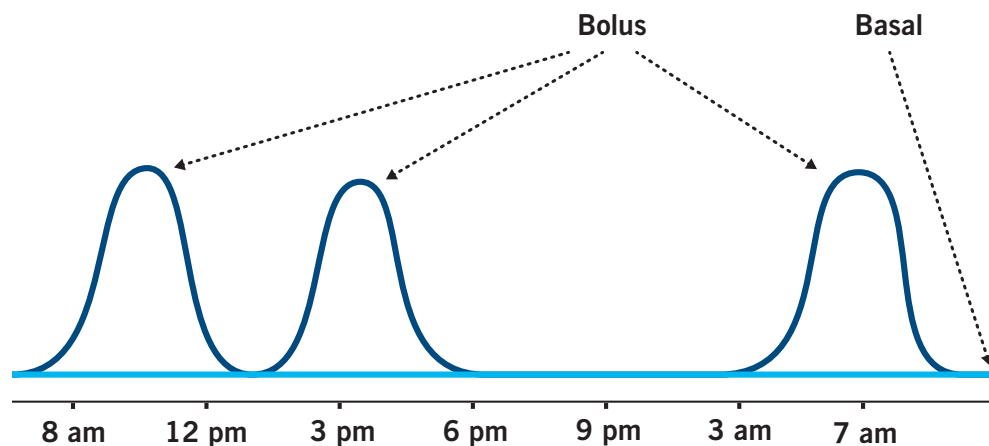
Insulin pump makes and models vary in how they are operated but you typically program into the pump the amount of carbohydrate you intend to eat and the pump calculates the amount of insulin you need based on the programmed insulin-to-carbohydrate ratio.

You can manually enter a dose of insulin that you have calculated but this is not the ideal way to use a pump.

Some pumps come with a meter that allows you to set a fixed insulin dose to deliver at meal times. Again this is not the ideal way to give a bolus but in some cases it can be useful.

The right amount of insulin delivered as a bolus dose should return the blood glucose to the target range within two to three hours of eating. (See the section titled 'What about...?' on page 25 for more information on meal boluses.)

**Correction bolus:** delivered to correct a high blood glucose reading. This is calculated according to your insulin sensitivity or correction factor set by your diabetes educator or endocrinologist.



Approximately half of your daily dose of insulin is spread across 24 hours (basal rate), so the hourly rate of insulin given is very small. The remainder of your daily dose is given as bolus doses at meal and snack times and to correct high BGLs. These bolus doses can be smaller than those given with injections because the insulin is more reliably absorbed.

### 'Smart pumps'

Most pumps will calculate the insulin dose for each meal or snack based on the insulin to carbohydrate ratio programmed into the pump. This ratio is calculated with your diabetes educator or endocrinologist. You need to know the carbohydrate content of the meal or snack you intend to eat so that you can enter the amount of carbohydrate into the pump. The pump will calculate the insulin dose required for the meal. 'Smart pumps' can also add a correctional bolus of insulin at this time if your pre-meal BGL is out of the target range.

Although it is possible to rely on a 'smart pump' to calculate the insulin dose required, it is important that the pump user understands the basis of the calculation so that the dose recommended by the pump can be verified.

### Disconnecting from the pump

Insulin pumps use only rapid-acting insulin. This insulin starts working within 10 to 15 minutes of delivery, peaks within one to three hours and ceases working after three to five hours. A lack of insulin can lead to the rapid development of ketones and diabetic ketoacidosis (DKA) which is a life-threatening condition.

For this reason, **it is important to never disconnect from the pump for more than two hours without using an alternative method of insulin delivery** (e.g. insulin injections) and to regularly check that the pump is delivering insulin. **Prompt attention to rising BGLs is essential in order to prevent DKA.**

## Insulin pump therapy and blood glucose monitoring

**It is vital that people using insulin pumps monitor their blood glucose at least four times a day, preferably six times a day.**

Insulin pumps use only very rapid-acting insulin that lasts a relatively short period of time in the blood stream. For this reason you need to do regular blood checks so that you are aware of any possible problem with insulin delivery.

Whilst insulin pumps now have sophisticated features and are an efficient means of delivering insulin, they cannot do the thinking for you. A pump is only as good as its operator so you do need to put in the effort to achieve results. In the future, it is hoped that blood glucose sensors will 'talk' to the pump and automatically adjust insulin doses as required.

### Insulin pumps and continuous glucose monitoring systems

There have been significant advances in the development of continuous glucose monitoring systems (CGMS) in recent times. CGMS is a means of measuring glucose levels continuously in order to gain insight into patterns and trends in glucose levels throughout the day and night. A CGMS sensor is worn separately to the pump, inserted under the skin, and measures the level of glucose in the interstitial fluid (fluid in the tissue). The sensor is disposable and changed according to manufacturer recommendations.

### What about HbA1c?

HbA1c is a measure of long-term BGLs. Research investigating the efficacy of insulin pump therapy in relation to blood glucose levels suggests that it can improve HbA1c, especially in those with an elevated HbA1c and in those who have been unable to reduce their HbA1c with MDI (multiple daily injections).

For people who have BGLs and an HbA1c within the target range on MDI, insulin pump therapy may make little difference to their HbA1c. Pump therapy may help to reduce the frequency and severity of hypoglycaemia (hypos) and hyperglycaemia (high blood glucose) because insulin is delivered continuously and in small doses.



***“My new best friend! I have been able to exercise more, eat when I want to, enjoy meals more and experience a lot more freedom with having diabetes. Now I feel I have a future as some of the complications cloud has lifted.”***

Karen, 59 years, pumping for one year.

**Currently there are two types of CGMS products available in Australia:**

- 1 One type of CGMS product includes a sensor and a separate unit of similar appearance to a normal blood glucose meter (worn separately in a similar fashion to a pump). This type does not communicate with the pump and, therefore, can be used by people who do not have an insulin pump (those on MDI) or who use an insulin pump that does not include continuous sensing.

The trends in glucose levels are displayed on the CGMS unit's screen. Products that provide this service include the Minimed Guardian® REAL-Time System produced by Medtronic and the Dexcom® Gen4 CGM System distributed by Australasian Medical and Scientific Ltd. (AMSL).

- 2 The other type of CGMS product combines CGMS with an insulin pump. A sensor and an attached transmitter are worn separately to the pump and transmit glucose levels to the insulin pump (not a separate unit) via radio frequency. The MiniMed Paradigm™ VEO® System and the Minimed 640G™ System have the capacity to halt insulin delivery from the pump for two hours when your glucose falls below a pre-set limit. These pumps can also be programmed to alarm if the blood glucose is rising or falling rapidly. The Dexcom® CGM System is compatible with the Animas Vibe insulin infusion pump (distributed by AMSL) and can be set to alarm with rapidly changing glucose levels but will not halt the flow of insulin.

Currently, the CGMS is not capable of automatically triggering the pump to increase or decrease delivery of insulin based on glucose levels. The cost of the sensor and transmitter is not included in the price of the insulin pump and must be purchased separately. Some private health funds may provide a rebate for the transmitter under ancillary cover. Please consult the pump company for more information.

Whilst CGMS sensor readings provide excellent information regarding glucose trends and patterns, they are an indication only and should never be used to calculate a dose of insulin. Normal blood glucose checks must still be done, both to calibrate the device and prior to administering a dose of insulin.

The blood check results are used to calibrate the sensor to help maintain accuracy. Sensors need to be changed every five to seven days.

**Note**

As yet, none of the disposable glucose sensors on the transmitter devices which are used for continuous blood glucose monitoring are available on the National Diabetes Services Scheme (NDSS), **so the cost of the sensors must be wholly met by the consumer.**





## How do I choose an insulin pump?

There are a variety of insulin pumps by different manufacturers on the market. All pumps work in the same basic manner but will vary in their specific functions and features. Your diabetes educator can support you in the process of choosing an insulin pump and help you to work out which one is best for you. If you do not have a diabetes educator you can access one in the following ways:

- contact your nearest hospital
- ask your doctor or endocrinologist to refer you to a credentialed diabetes educator and/or a dietitian who is experienced in insulin pump therapy
- contact the Australian Diabetes Educators Association (ADEA) [www.adea.com.au](http://www.adea.com.au).

Currently there are three brands of insulin pumps available in Australia (photos of the pumps and company contact details can be found on page 42). This booklet does not discuss the individual pump models. If you would like more information about individual pumps and their features, visit the websites listed at the end of this booklet. Pump companies will also send out information packs for potential purchasers.

Pump technology is constantly changing. Be sure to thoroughly research the various pumps you are interested in and make an informed choice. If you have any questions about pump functions speak to your diabetes educator, or the relevant pump company representatives who will be able to help you.

## Pump features to consider

### Calculating insulin

Pumps calculate the amount of insulin required to cover the carbohydrate eaten (using rates set by your diabetes educator or endocrinologist). Pumps also calculate the insulin dose required to correct any high BGL that you enter in the pump that is outside your target range.

### Tracking active insulin

Pumps have a feature that prevents you from 'stacking' or giving too much insulin. When you enter your BGL and carbohydrate intake, the pump will calculate the dose required after considering the insulin still active or 'on board' from a previous bolus. This may assist with avoiding hypos.

### Bolus types

Pumps can be programmed to deliver a meal bolus in different ways. A meal bolus may be delivered, for example, over a period of two hours rather than all at once. These different bolus types can make eating a variety of foods and eating out much easier. See the section titled 'What about...?' on page 25 for more information.

### Insulin delivery

Pumps vary in the increments of the basal rate and bolus dose that can be delivered. If you have a very small total daily dose of insulin or are very insulin sensitive (e.g. small children) then small delivery doses will be important.

### Insulin reservoir/cartridge size

The reservoir/cartridge size varies between pumps, so depending on your daily dose of insulin some pumps will be more suitable than others.

### Infusion sets

Not all infusion sets are suitable for everybody. Some people with very little subcutaneous fat will need a different type of infusion set to those with more. Some people have skin sensitivities so will require a set with little tape in contact with the skin.

### Insertion devices

Some infusion sets have an insertion device that assists you to insert the cannula with its introducer needle. This can make infusion set changes much easier, especially for children.

Pump features to consider (continued)

### **Computer software**

All pumps have software that allows you to upload pump activity into a program that can analyse the data. The program can save the data in a format that makes it suitable for sharing electronically with diabetes health professionals.

### **Food database**

Pumps with a food database allow you to store the carbohydrate content of a large range of foods that you commonly eat for easy reference.

### **Water resistance**

Some pumps are splash resistant and others are waterproof to certain depth specifications. See the manufacturer's website for individual water resistance specifications.

### **Continuous glucose monitoring systems**

Some pumps are CGMS-ready, and can display real-time glucose information on the monitor. Some can even automatically halt insulin delivery for a couple of hours if the system detects that your glucose level has fallen below a pre-set threshold and you do not respond. CGM can be useful especially at night when you are asleep.

### **Insulin pump cost**

The cost of an insulin pump ranges from \$8950 to \$9500, depending on the brand.

### **Who pays?**

In many cases private health insurance funds will rebate the full costs of the pump. However, the level of cover required will vary from fund to fund so it's a good idea to shop around.

## **Contacting private health insurers:**

### **Private Health Insurance Prostheses List - List C**

When taking out private health insurance make sure you take an option that includes prostheses on List C of the Private Health Insurance - Prostheses List. You do not need extras or ancillary cover to claim a pump. Your insurance must include cover for medical admissions.

### **The billing code for your chosen pump**

It is useful to know the specific billing code of the insulin pump. The pump company or sometimes the health professional assisting you with fitting your pump should be able to provide the billing code.

### **When calling your private health insurer**

It may prove helpful when phoning your private health insurer to ask to speak directly to the team that assesses prosthetics.

## **Waiting periods when starting on a pump and pump upgrades**

It is important to confirm your eligibility for insulin pump benefits with your health fund. It is necessary that you meet any requirements set by your private health insurer regarding qualifying periods before you can claim a rebate on an insulin pump. If you are purchasing private health insurance for the first time in order to claim a pump, be aware that private health insurers have a waiting period. This is usually 12 months, but can be as long as five years as is the case with HCF.

Some people upgrade their pumps after a number of years (usually four or five years) to a new pump. Each private health insurer has specific criteria to qualify for a pump upgrade. You will need to check carefully with your private health insurer with regards to upgrading to a new pump from your current pump. Health funds will not upgrade your pump simply because a newer model is available. Your pump must be out of warranty and faulty.

To ensure that you will not experience any out of pocket expenses when you are fitted with a pump, it is advisable that you check with your private health insurer about your level of cover and the rebate they will provide.

## Loan pumps

Most pump companies will loan pumps for trial purposes to people considering going on a pump while the individual meets all private health insurance qualifying periods.

## Diabetes educators

If you see a diabetes educator in private practice to get your pump fitted, rather than through a service in a public hospital, you may be required to pay an out of pocket fee for the diabetes educator consultations.

## Type 1 Diabetes Insulin Pump Grant Program for people under 18

Since 1 November 2008, a person under the age of 18 has been able to apply for an insulin pump subsidy through the Type 1 Diabetes Insulin Pump Grant Program. The Type 1 Diabetes Insulin Pump Program (IPP) is an Australian Government program designed to provide subsidies for insulin pumps for people under 18 years of age. The subsidy is means tested.

The program is a collaboration between the Juvenile Diabetes Research Foundation, Diabetes Australia and the Australian Government. The government allocated \$5.5 million over four years to the Program.

For the latest information about the program including applying for a subsidy, go to [www.jdrf.org.au/pumps](http://www.jdrf.org.au/pumps)

## Pump consumable costs and the National Diabetes Services Scheme (NDSS)

Insulin pump consumables (infusion sets and reservoirs/cartridges) are subsidised by the NDSS for eligible consumers only. Under the NDSS, the cost of an infusion set is currently about \$1.60. The cost of an insulin reservoir/cartridge is about \$1 per unit. Batteries and other pump accessories are not subsidised by the NDSS.

### To access insulin pump consumables under the NDSS you must:

- already be an NDSS registrant
- meet the additional criteria set out for insulin pump consumables.

People with type 1 diabetes who do not meet the eligibility criteria for subsidised consumables (or people with type 2 diabetes) can still use pump therapy but will be responsible for the ongoing costs. For people not eligible, pump consumables (i.e. the reservoirs/cartridges and infusion sets) will cost approximately \$270 per month.

For frequently asked questions, eligibility criteria, assessment forms and order forms visit: [www.ndss.com.au](http://www.ndss.com.au)

***“I wanted to improve my diabetes control so I started pumping. I now have the freedom to eat, not eat and do things spontaneously. My control has improved and I feel almost normal.”***

Kris, age 58, pumping for one and a half years.

## What are the challenges of pump therapy?

### Expense

Using an insulin pump with its disposable infusion sets, cartridges and batteries is more costly than using insulin pens or syringes. Private health insurance will cover the cost of the pump but the consumables must be purchased. This cost will vary according to the brand of pump and the supplies required but will probably amount to approximately \$20–\$30 a month if you qualify for NDSS subsidised pump consumables.

### Insulin dose adjustment

Life on an insulin pump can take some getting used to. It may take some time to get your insulin dose regulated on the pump. Initially you can expect lots of ups and downs in your BGLs while you and your diabetes care team intensively monitor and make the necessary adjustments. In the first week or so you need to contact your diabetes educator every one to two days to make adjustments to your rates. As your BGLs stabilise, and you become more comfortable with your pump, the contact will be less frequent.

### Being connected

Being connected to a piece of equipment 24 hours a day is probably the issue that most concerns people when they are considering insulin pump therapy. There is no doubt that life with a pump provides greater flexibility in day-to-day living, eating and exercising, but getting used to wearing it around the clock can take some time.

Modern pumps are small and compact, which means that they are easy to disguise. You can conceal them in pockets, bras, on belts, clips or in carry cases. Many come in bright colours or have interchangeable covers like a mobile phone. Infusion sets have quick-release connections so the pump can be easily detached from the cannula for showering or swimming. It does not take long before most pump users forget that they are attached.

*“I’ve been on a pump for four and a half years. It’s much more flexible – I can get tighter control with fewer hypos. Negatives – doorknobs (I’m serious).”*

Daniel, age 29, pumping for four and a half years.

### Skills required

Although insulin pumps are quite user-friendly in terms of programming and daily use, they still require a certain level of skill to program and make changes to basal rates, set bolus doses, alarms and so on. You also have to learn to change cartridges and infusion sets.

You will have at least one intensive training session with your diabetes educator when you are fitted with your pump, but there is also a lot of ‘on-the-job training’ as you get to know your pump in the first few weeks.

You will need to keep records and stay in frequent contact with your diabetes educator in the beginning to safely adjust insulin rates and learn the skills needed.



## A special note about kids and teens

For children and teenagers operating the pump themselves, emotional maturity is essential. Pumping requires a lot of motivation and diligence. The child or teenager needs to be able and prepared to:

- check BGLs eight to 10 times a day initially
- check BGLs at least four times a day once BGLs stabilise
- count the carbohydrate content of the foods they eat.

Body image is also an important consideration. A pump is worn 24 hours a day and is a visible sign of type 1 diabetes. Consider this when thinking about a pump at a time when body image is important, especially during adolescence.

If you are a parent of a child with type 1 diabetes, you also have the responsibility to ensure that you are committed to pump therapy. You need to understand that although the benefits of pump therapy are immense, the level of commitment is high.

You need to know as much about the pump as if it were your own and you need to be prepared to problem solve should an issue arise at school or at social activities.

Regular discussion and supervision of your child remains essential.

***“I couldn’t be happier with my pump. It has given me so much freedom. I now have the freedom to eat when I want and still keep good BGLs. I even wore it swimming whilst on holidays. But, it’s not a free ride . . . I’m learning all the time and continue to improve my control.”***

Brian, age 53, pumping for 14 months.

## Technical problems

Even the most reliable equipment encounters technical problems at times. Insulin pumps and their in-built micro-computers are very reliable but problems can arise. Infusion sets can become blocked, computers can fail, screens and pump bodies can be damaged. Pumps do have some alarms and safety features to alert the user to possible problems. It’s a good idea to record your rates somewhere e.g. diary, iPhone. Regularly downloading your pump data allows easy access to the last programmed rates in case of pump failure.

Technical assistance is available from individual pump companies 24 hours a day. In case of any problems or pump failure it is important to have available insulin pens or syringes and a supply of in-date long-acting insulin in your refrigerator, as well as a written back-up plan.

## Skin problems

One of the most common problems associated with insulin pump use is skin irritation. Infusion sets feature hypoallergenic adhesive tape that is designed to minimise skin irritation. Those with sensitive skin may still experience itching, rashes or minor inflammation. There are many different brands of infusion sets on the market and you may need to experiment to find a brand that suits your skin. You can also consider using a skin barrier to minimise contact between your skin and the tape of the infusion set.

## Skin infections are another potential problem.

Skin infections will not normally occur as long as you:

- wash your hands
- clean your skin appropriately
- use a proper technique when changing infusion sets
- change the set on a regular basis.

### More rapid development of ketones

Ketones are chemicals produced when the body breaks down stored fat for energy because there is not enough insulin in the blood. Insulin pumps do not use long-acting insulin, so any interruption in insulin delivery for more than a few hours can lead to ketosis.

Ketosis is a state characterised by elevated levels of ketones in the blood. If not treated promptly, ketosis can lead to diabetic ketoacidosis (DKA); a life-threatening condition that requires emergency treatment in hospital. For this reason, pump users need to check their BGLs at least four times a day. Ketones must be checked when BGLs are 15mmol/L or more at the first sign of illness.

If this situation should arise, always make urgent contact with your diabetes care team. Always have in-date ketone test strips (either blood or urine) available for use.

*“I’ve only been on an insulin pump for four weeks but have already seen small improvements in my daily BGL averages. There seems to be more stuff to carry around, but not doing injections is great! Looking forward to much greater improvements and actually looking forward to my next HbA1c check-up!”*

Mark, age 35, pumping for one month.

### What about...?

#### Food and carbohydrate counting

Insulin pump therapy can offer many benefits relating to the dietary management of type 1 diabetes. An insulin pump offers:

- more flexibility about the timing of meals and snacks
- more flexibility about the amount of carbohydrate eaten
- ability to eat to appetite.

For pump therapy to be effective it is necessary to count carbohydrate intake in order to either calculate and ‘dial-up’ the required bolus dose of insulin, or program the amount of carbohydrate into the pump so that the pump can calculate and deliver the correct bolus dose at meal and snack times.

Meal bolus doses are calculated according to the amount of carbohydrate to be eaten, your insulin to carbohydrate ratio and your BGL at the time.

#### Example

Sarah’s insulin to carbohydrate ratio is 1.0 unit of insulin for 10 grams of carbohydrate. If Sarah was to eat 50 grams of carbohydrates, she must ‘dial-up’ 5.0 units of insulin. If Sarah was using a ‘smart pump’, she would enter this amount of carbohydrate in the pump and the pump would calculate and deliver 5.0 units of insulin. This, of course, is in addition to the basal insulin delivered to Sarah continuously.

Pumps can be programmed to deliver meal bolus insulin in a variety of ways to:

- cope with meals that are spread over long periods of time
- cope with foods which have a lower glycaemic index or are higher in fat, which affects glucose absorption.

A pump can deliver, for example, a 5-unit bolus with a small amount of insulin delivered initially and the remainder spread over a two hour period.



***“Since I started on my insulin pump, I have had better control over my BGLs and have been able to eat more freely. I don’t have to eat at exact times anymore or eat a set amount of carbohydrates. I would not like to go back to having needles.”***

Renee, age 12, pumping for six months.

## **Carbohydrate counting is important!**

It is important that you consult with a dietitian experienced in teaching carbohydrate counting prior to starting on a pump. Further consultations are important to reinforce and practice carbohydrate counting as well as emphasise healthy eating.

A carbohydrate counting guide is a very useful resource for this purpose as it lists carbohydrate values for a large range of foods. An example is *The Fat, Fibre and Carbohydrate Counter: The Essential Guide to Healthy Eating 2009*, Murdoch Books, Sydney. There are calorie counting apps for iphones as well as websites such as CalorieKing.

Some people find that they gain weight after starting pump therapy because they are more likely to eat things they would not have previously eaten, due to the ease of ‘dialing-up’ an insulin dose. This reinforces the need to see an accredited practicing dietitian experienced in carbohydrate counting for individualised dietary advice.

Finding a dietitian who has some knowledge about insulin pumps would be advantageous.

## **How to access a dietitian**

### **Dietitians Association of Australia**

Phone: 1800 812 942 Website: [www.daa.asn.au](http://www.daa.asn.au)

### **Diabetes Australia in your state**

Phone: 1300 136 588

## Places to wear the pump

Some people are comfortable with wearing the pump on their belt. The pump may come with a leather carry case or clip, which holds the device and gives the appearance of a pager or small mobile phone.

Others simply carry the pump in a pocket. Some women prefer to wear the pump in their bra or attached to a garter on the leg. Each of the pump suppliers has accessories and there are now also many websites selling pump accessories.

The cannula, which is inserted under the skin, is often placed in the abdominal area but can also be placed in the upper buttock, upper and outer thigh, hip or upper arm.

## Swimming

Swimming is a very healthy activity for people with diabetes including those using a pump. Some pumps are waterproof and tested to an international standard while others are watertight. This means it is possible to swim, shower and surf without taking your pump off if you so choose. If you participate regularly in water sports it is advisable to check the individual product specifications regarding waterproof status before choosing your pump.

If you do swim with your waterproof pump you should check for any cracks or loose cartridge or battery covers and so on. If you do not check these things the pump may not be covered under the warranty, as they may be deemed 'user error'. When wearing the pump during water-based activities you need to be sure it is attached securely. If a pump becomes disconnected in the water it might be difficult to recover and generally health funds will not cover a replacement pump during the warranty period.

Most infusion sets are fitted with a quick-release connection, which allows the pump to be disconnected without removing the cannula from under the skin. This means that it is possible to quickly disconnect from your pump to take a shower, bath or swim. Pump users can safely disconnect from their pump for up to two hours but should monitor BGLs and replace missed basal insulin if necessary.

Diabetes specialists or diabetes educators can advise on the replacement of basal insulin during periods of not using the pump. An insulin pump should not be worn in a spa or sauna as the heat can affect the pump and the insulin.

## Sleeping

One of the questions most commonly asked about pump therapy is 'Where do I put the pump when I go to sleep?'

**Some common places people leave their pumps are:**

- under their pillow or in their bed
- clipped to their pyjamas or in a pyjama pocket
- specially designed waist bands.

## Sex

Some people find that the pump can be worn during sexual activity without causing problems, but for many the pump may get in the way. Pumps can be easily disconnected using the quick-release connection whenever required (for no longer than two hours), but of course it is important to remember to reconnect. The pump can be put in 'suspend' or 'stop' mode and it will alarm regularly to remind you to reconnect.





## Exercise

Regular physical activity is recommended as part of the diabetes management plan. Physical activity can be much easier with a pump because it is possible to temporarily reduce the basal rate of insulin before, during and after the period of exercise to help prevent hypos.

During a long bushwalk or bike ride, for example, it is possible to reduce the basal insulin to 30 per cent of normal in order to reduce the risk of hypos. After exercise, a recovery period with a reduced basal rate is usually needed. It is recommended that you remove the pump during vigorous contact sports. Missed basal insulin can be given as a small bolus if required. The pump should not be removed for longer than two hours or you will risk developing ketones and feeling unwell.

***“I had hypo unawareness and major hypos often due to exercise. A pump has required a lot more blood tests, but has provided a lot more flexibility in terms of my activities. I can fix bad BGLs more quickly and I can sleep without waking up with a horrendously high BGL.”***

Dave, age 42, pumping for eight years.

## School

It is important that all teachers and staff caring for the student be informed of the student’s insulin pump and that this detail be recorded in the student’s type 1 diabetes school management plan and kept on file.

Using a pump may make participating in school sports and managing BGLs during times of sickness easier because basal rates can be adjusted to prevent hypos and hyperglycaemia.

### Important information

**It is essential that parents or guardians provide the school with an emergency kit. This should include:**

- hypo food (quick-acting carbohydrates such as jelly beans)
- emergency contact numbers
- spare pump batteries
- back-up insulin with spare syringe or pen
- spare pump consumables
- alcohol wipes or disinfectant
- glucagon.

It is strongly recommended that the emergency kit be kept in the school sickbay and be available on school excursions.



## Travel

When going on trips it is important to remember to take extra supplies of:

- pump batteries
- pump consumables
- insulin (including long-acting) and insulin pens or syringes in case the pump fails
- glucose/ketone meter
- blood and ketone test strips.

You may consider carrying a spare pump. Pump companies will loan you a spare pump (it may carry a cost) but you will need to contact them a few weeks beforehand.

It is highly recommended that you carry a letter from your doctor in case you get inspected at airport security.

Some pumps may be affected if scanned by a 'wand', but walking through metal detectors at airport security will not affect the pump.

## Going through security

It is important to note you do not need to disconnect your pump when going through customs and/or airport security. The pump may or may not trigger the alarm as all airport security systems are different. It is always advisable to notify airport security of your pump.

Remember to pack your extra supplies in your carry-on luggage in case your checked-in luggage goes missing. Insulin must be packed in carry-on luggage as the temperature of the cargo hold may cause insulin to freeze.

Insulin pumps are not usually covered by travel insurance so you will need to enquire with your provider if you want it covered.

Insulin pumps have clocks as a built-in feature. For international travel it is recommended that the new time zone be entered once the final destination has been reached – NOT whilst in transit in case there are any delays or other problems along the way. Bolus doses are given as you usually would according to the carbohydrate content in your meals and snacks served whilst in transit. Do not forget to put your clock back to local time when you return home.

## Travel and Diabetes information sheet

[www.ndss.com.au](http://www.ndss.com.au)

### Travelling overseas with PBs medicine

<http://www.humanservices.gov.au/customer/services/medicare/travelling-overseas-with-pbs-medicine>

### Advice on travel / insurance

[www.smarttraveller.gov.au/](http://www.smarttraveller.gov.au/)

## Pregnancy

Ideally, pump therapy should be initiated at least three months prior to conception. This allows time to optimise control and become proficient in the operation of the pump. Of course, if you are already pregnant it is still possible to commence pump therapy and you should discuss this with your diabetes care team. Some hospitals and pump companies may loan you a pump so that you may trial pump therapy before you commit to a purchase.

### The advantages of using an insulin pump during pregnancy include:

- tighter diabetes control with less frequent hypoglycaemia
- ability to fine-tune the changing insulin requirements that occur during pregnancy
- easier management of morning sickness
- lower likelihood of the baby developing macrosomia (large birth weight)
- more convenience and flexibility during labour because insulin delivery rates are able to be changed according to your needs
- variable rates allow more flexibility whilst breastfeeding.

## Hospitalisation

In the event that you are admitted to hospital, you will need to inform hospital staff of your diabetes and that you use an insulin pump.

Given that pumps are not commonly used in Australia, it is important that you keep in mind that some hospitals may not be experienced in dealing with pumps. Hospital staff may try to remove your pump during a surgical procedure, for example, if they are not comfortable with you wearing a pump under general anaesthetic. If it is necessary to remove your pump, an alternative routine of insulin delivery needs to be arranged and administered immediately. If you are too unwell to operate your pump then you may have to go back on injections until you are able to take back control.

### Important information

An insulin pump should not be worn during an X-ray, CT or MRI scan.

## Other medications and illnesses

Just like anybody with diabetes, pump users should always advise their doctors or diabetes educator of any other illnesses they have or medications that they take. Some medications will influence insulin requirements and make it necessary to temporarily adjust basal insulin rates.

## Sick days

During periods of illness, your insulin requirements may change. A pump can make sick days easier to manage because there is greater flexibility with adjusting insulin doses and delivery rates. A sick day management plan should be prepared in advance with your diabetes educator or endocrinologist and put into action during illness. Your diabetes educator can support and guide you through sick day management so it is important to make contact if you do not have experience in managing sick days yourself.

## After hours contact numbers are essential

You will need to check BGLs and blood or urine ketones regularly and adjust insulin rates accordingly. The pump's basal rate can be temporarily adjusted to deliver more or less insulin during periods of illness if necessary.

It is important to remember that your risk of DKA is increased on a pump because there is no long-acting insulin available. Children and pregnant women are at an increased risk of developing DKA during illness so the guidance of their diabetes care team is extremely important.

## Identification

It is advisable that people with type 1 diabetes wear medical identification so that treatment for hypoglycaemia or ketoacidosis can be given quickly if needed. If you are a pump user, identification is particularly useful to alert health care providers to your method of insulin delivery. In the case of extreme hypoglycaemia it would be important for the pump to be suspended or disconnected to prevent further lowering of your BGLs.

***“I started using the pump to get better control and prevent hypos. This was achieved and I discovered a new freedom to be able to live life normally. Researching the pump prior to starting eliminated all negatives. I’m extremely grateful for it and my diabetes educator who introduced me to it.”***

Robert, age 62, pumping for three years.

## Important things to remember about pump therapy

Using an insulin pump means you no longer have to give yourself injections, although there may be the odd time when you need insulin via injection. There are other things, however, which you will need to be willing to do.

- Check your BGL at least 8–10 times a day when you start using a pump. When BGLs are stabilised, a minimum of four checks a day (before each meal) are needed so that you can program your pump to deliver the appropriate amount of insulin you need according to your BGLs.
- Learn to:
  - count carbohydrates and get lots of practice, preferably well before you start on a pump
  - adjust your insulin rates according to BGL patterns and trends
  - adjust your insulin doses or rates according to activity levels, ketones or sick days.
- Respond quickly when BGLs show hyperglycaemia (high BGL) and/or if ketones are present in the blood. Long acting insulin is not used in a pump so if there are any technical problems with the pump or the infusion set, BGLs can rise very quickly, increasing your risk of DKA.

Download your pump regularly to share data with your healthcare team.

- Regularly monitor your pump. Also monitor:
  - tubing for air bubbles. Air bubbles themselves cause no harm, however the risk is that you would miss out on some of your insulin dose
  - the insertion site for any problems. Redness or itchiness around the site, for example, may indicate the need to change your cannula.
- Learn and accept responsibility for pump use, troubleshooting and self-care behaviours.
- Remember that your pump settings, basal rates, insulin sensitivity factor (correction factor) and insulin to carbohydrate ratios will change over time with weight loss or weight gain, different activity levels and age. You should keep in frequent contact with your diabetes educator at first and at regular, intermittent intervals. Make sure you have follow-up appointments and 6-12 monthly reviews with your diabetes care team.
- Always keep a backup of in-date long-acting insulin and have extra syringes or pens at home for insulin delivery in case of pump failure.

***“I was experiencing severe hypos whilst attempting to become pregnant. Starting on my pump refocused me on regular BGL testing and the ease with which I could make adjustments to insulin delivery improved my BGL control enormously – and made keeping excellent HbA1c during my pregnancy very achievable!”***

Anne, age 40, pumping for two years.

## When is pump therapy not recommended?

Pump therapy is not recommended for people who:

- are not performing or are not willing to perform frequent blood glucose checks
- are not willing or able to calculate the amount of carbohydrate in meals and snacks
- are not able to detect air bubbles in the infusion line (vision impaired)
- are not able to hear the alarms (hearing impaired), although most modern pumps have a vibration alarm as well as an audible alarm
- are not able to press the buttons on a pump (e.g. severe arthritis)
- are not able to manage possible problems which may arise, including site infections and blocked lines
- are not willing or able to keep in regular contact with their diabetes educator or have regular reviews by their endocrinologist
- are in any way unable to manage the pump functions.



## How do I get started on an insulin pump?

Once you have discussed pump therapy with your diabetes care team and you have chosen a pump, you will need to receive pump education. This education must be provided by a team consisting of at least a credentialed diabetes nurse educator and an endocrinologist or specialist physician.

Many major public hospitals offer insulin pump training. There are also diabetes educators who work privately providing training in some private hospitals. This education must be provided in consultation with your diabetes specialist.

**Pump training will usually cover topics such as:**

- pump functions
- alerts and alarms
- dose calculation (including working out your insulin to carbohydrate ratio and correction factor)
- changing basal and bolus doses
- line changing, filling the insulin cartridge/reservoir
- carbohydrate counting
- sick day guidelines and emergency contact
- when to monitor
- exercise
- 'holidays' from the pump
- hypoglycaemia
- hyperglycaemia and ketone checking
- insulin doses if pump fails
- problem solving
- pump downloading.

## How can I get more information?

- Discuss pump therapy with your diabetes specialist or diabetes educator.
- Contact Diabetes Australia in your state (1300 136 588) for information about local hospitals with insulin pump clinics.
- Contact Australian insulin pump suppliers (see page 42).

### Useful websites

[www.diabetesaustralia.com.au](http://www.diabetesaustralia.com.au)

For general information on insulin pumps.

[www.jdrf.org.au/pumps](http://www.jdrf.org.au/pumps)

For information on the Type 1 Diabetes Insulin Pump Grant Program such as eligibility criteria, subsidy estimates or to submit an application.

[www.ndss.com.au](http://www.ndss.com.au)

Download an NDSS Assessment form for access to subsidised insulin pump consumables and an order form for pump consumables.

[www.diabetesnet.com](http://www.diabetesnet.com)

This site provides diabetes information, research findings, product information, books on diabetes and lots of pump therapy information including a pump comparison table (note that not all the pumps shown are available in Australia).

[www.insulin-pumpers.org](http://www.insulin-pumpers.org)

Insulin Pumpers® provides information and support for adults and children with diabetes and their families interested in insulin pump therapy. There is a special section devoted to children with diabetes and stories about how an insulin pump has changed their lives.

[www.childrenwithdiabetes.com](http://www.childrenwithdiabetes.com)

An online community for kids, families and adults with diabetes with a section on insulin pumps.

[www.diabeteskidsandteens.com.au](http://www.diabeteskidsandteens.com.au)

A website for kids and teens with type 1 diabetes. Here you can find information and a comparison table on various types of insulin delivery devices, and links to information and support about pumps.

[www.diabetes.org](http://www.diabetes.org)

This is the American Diabetes Association's official site and provides lots of useful information on pumps, including links to pump resources. Not all pumps shown are available in Australia.

[www.d1.org.au](http://www.d1.org.au)

The Type 1 Diabetes Network provides information, support and a voice for people living with type 1 diabetes. There is a popular website with a section about pumps, as well as a forum and monthly newsletter, Yada Yada.

### Useful books

***Insulin Pump Therapy Demystified: An essential guide for anyone pumping insulin***

Gabrielle Kaplan-Meyer 2003 Marlowe & Company New York.

***Pumping Insulin***

(4<sup>th</sup> ed) John Walsh & Ruth Roberts 2006 Torrey Pines Press San Diego.

***Smart Pumping: A Practical Approach to the Insulin Pump***

Howard Wolpert (Ed) 2002 American Diabetes Association.

***The Fat, Fibre and Carbohydrate Counter The Essential Guide to Healthy Eating 2009***

Murdoch Books Sydney.

## Useful journal article

Elizabeth A. Doyle, Stuart A. Weinzimer, Amy T. Steffen, Jo Ann H. Ahern, Miranda Vincent, and William V. Tamborlane: A Randomized, Prospective Trial Comparing the Efficacy of Continuous Subcutaneous Insulin Infusion with Multiple Daily Injections Using Insulin Glargine. Diabetes Care 27: 1554-1558.

## Pump companies

### Medtronic

Phone: 1800 777 808

[www.medtronic-diabetes.com.au](http://www.medtronic-diabetes.com.au)



### Animas

Australasian Medical and Scientific

Phone: 1300 851 056

[www.amsl.com.au](http://www.amsl.com.au)



### Roche Diagnostics

Accu-Chek Pump Hotline

Phone: 1800 633 457

[www.accu-chek.com.au](http://www.accu-chek.com.au)



## Acknowledgements

This booklet has been proudly produced by Diabetes Victoria.

Diabetes Victoria is the leading charity and peak consumer body representing people with diabetes in Victoria and providing vital support and information to the community about diabetes.

We would like to acknowledge the assistance of the following people for their valuable editorial comments and reviewing the clinical accuracy of the content:

- Karen Rocca, Project Co-ordinator, NDSS National Development Programs, Diabetes Australia
- Cheryl Steele, RN-CDE, Western Hospital
- Victoria Stevenson, RN-CDE, Austin Health.

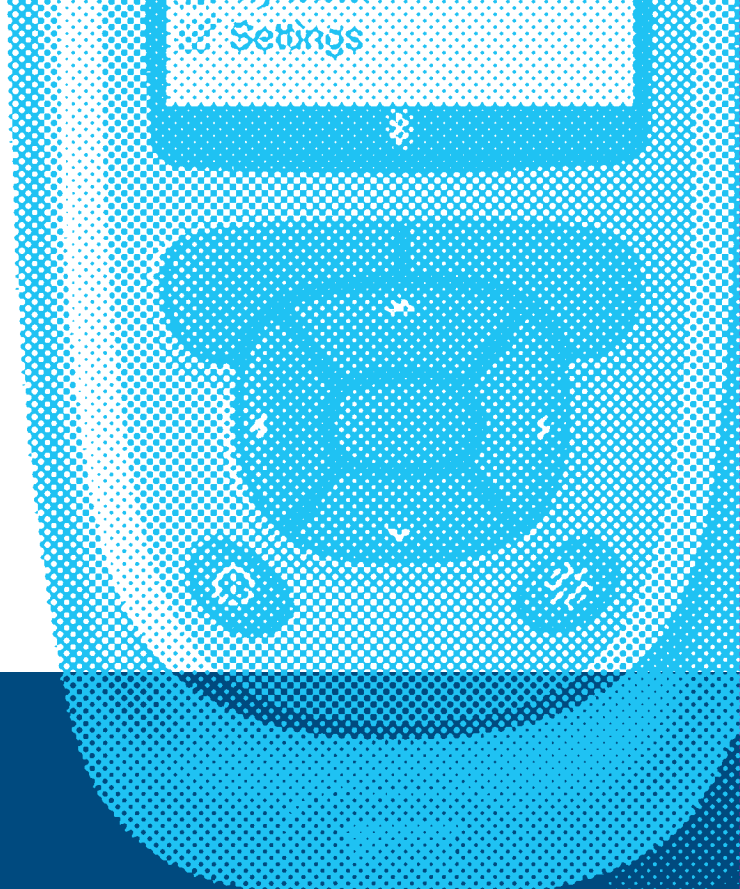
## References

- 1 Hirsch IB, Bode BW, Garg S, Lane WS, Sussman A, Hu P, Santiago OM, Kolaczynski JW (2005) Continuous subcutaneous insulin infusion (CSII) of insulin aspart versus multiple daily injection of insulin aspart/insulin glargine in type 1 diabetic patients previously treated with CSII. *Diabetes Care* 28:533-538.
- 2 Retnakaran R, Hochman J, DeVries JH, Hanaire-Broutin H, Heine RJ, Melki V, Zinman B (2004) Continuous subcutaneous insulin infusion versus multiple daily injections: the impact of baseline A1c. *Diabetes Care* 27:2590-2596.
- 3 Nicolucci A, Maione A, Franciosi M, Amoretti R, Busetto E, Capani F, Bruttomesso D, Di Bartolo P, Girelli A, Leonetti F, Morviducci L, Ponzi P, Vitacolonna E (2008) Quality of life and treatment satisfaction in adults with Type 1 diabetes: a comparison between continuous subcutaneous insulin infusion and multiple daily injections. *Diabetic Medicine* 25:213-220.
- 4 Pickup JC, Renard E (2008) Long-acting insulin analogs versus insulin pump therapy for the treatment of type 1 and type 2 diabetes. *Diabetes Care* 31 Suppl 2:S140-145.

**ndss**  
national diabetes services scheme

This booklet has been printed and distributed with funding provided through the National Diabetes Services Scheme (NDSS). The NDSS is an initiative of the Australian Government administered by Diabetes Australia.





570 Elizabeth Street  
Melbourne Victoria 3000  
infoline 1300 136 588  
† 03 9667 1777  
f 03 9667 1778  
[www.diabetesvic.org.au](http://www.diabetesvic.org.au)  
[mail@diabetesvic.org.au](mailto:mail@diabetesvic.org.au)

