National Healthcare Group

Adding years of healthy life

Fundamentals in Insulin Therapy for Type 2 Diabetes (FITT2)



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GLOSSARY

It is recommended that you familiarise yourself with all the terms in this glossary (in alphabetical order) as these terms will be used throughout this guidebook.

Apidra®	Insulin glulisine, a rapid-acting insulin for bolus coverage
Basal Insulin	Background insulin coverage to control blood glucose throughout the day and night, even when fasting. This usually refers to intermediate- or long-acting insulin
BG	Blood glucose or blood sugar
Bolus Insulin	Refers to short- or rapid-acting insulin to cover mealtime glucose rise from carbohydrate consumption (meal bolus) and to correct for high BG levels (correction bolus)
Carbohydrate (carb) counting	Carbohydrates which include sugars and starches, are one of the main nutrients found in food and drinks. Carbs affect your BG more than other nutrients and is usually counted in grams (g) or by carb portions
Diabetes Mellitus (diabetes / DM)	A metabolic disease that is characterised by either decreased insulin sensitivity or the inability of the pancreas to produce insulin, causing high BG
DKA	Diabetic ketoacidosis: A serious complication of DM that occurs when the body produces high levels of blood acids called ketones. This usually occurs when BG has been too high for too long and is life-threatening
HbA1c	Glycated haemoglobin, the average BG level over a 2-3 month period
Hyperglycaemia	High BG
Hypoglycaemia (Hypo)	Low BG of less than 4.0 mmol/L
Insulatard®	Isophane insulin, an intermediate-acting insulin for basal coverage
Lantus®	Insulin glargine, a long-acting insulin for basal coverage
Levemir®	Insulin detemir, a long-acting insulin for basal coverage

Lipodystrophy	Small lump or dent in the skin that forms when a person repeatedly injects insulin into the same spot and / or with insulin needle re-use
MDI	Multiple daily insulin injections – these are insulin injections taken several times a day and includes 2 different types of insulin (long-acting or basal insulin and rapid-acting or bolus insulin)
NovoRapid®	Insulin aspart, a rapid-acting insulin for bolus coverage
Type 1 Diabetes Mellitus (T1DM, type 1 diabetes)	A metabolic disorder that occurs because of little or no insulin production from beta cells in the pancreas, causing high BG
Type 2 Diabetes Mellitus (T2DM, type 2 diabetes)	A metabolic disorder that occurs because of the body's resistance to insulin causing high BG

WELCOME MESSAGE

We know that it can be challenging when people with type 2 diabetes are offered insulin treatment by their healthcare team. This book is hence specially created for people with type 2 diabetes journeying with insulin. You may be someone who has just been offered insulin treatment and have some queries, someone keen and ready to start but not quite sure how, or someone who has been on insulin for a while and maybe preparing to travel.

We have put together a set of information about type 2 diabetes treatment surrounding insulin. These include commonly asked questions, key facts and information relevant to the local context. We hope to guide you through your journey and support you wherever possible.

It takes time to understand why you need insulin. You are not alone! This book will guide you through some of these concepts. Always feel free to check back with your healthcare team to clarify any potential gaps and doubts that this book does not cover.

Sincerely,
NHG Diabetes School



CHAPTER 1:
TYPE 2 DIABETES: AN OVERVIEW

Learning Objectives:

1. Understand type 2 diabetes and the concept of insulin resistance
2. Know the natural progression of type 2 diabetes
3. Understand the reasons and benefits of starting insulin therapy

1.1 Type 2 diabetes: a condition of insulin resistance

Insulin is produced by the pancreas in the body. Diabetes happens when the body is not able to maintain normal blood glucose (BG) levels through effective insulin production and action.

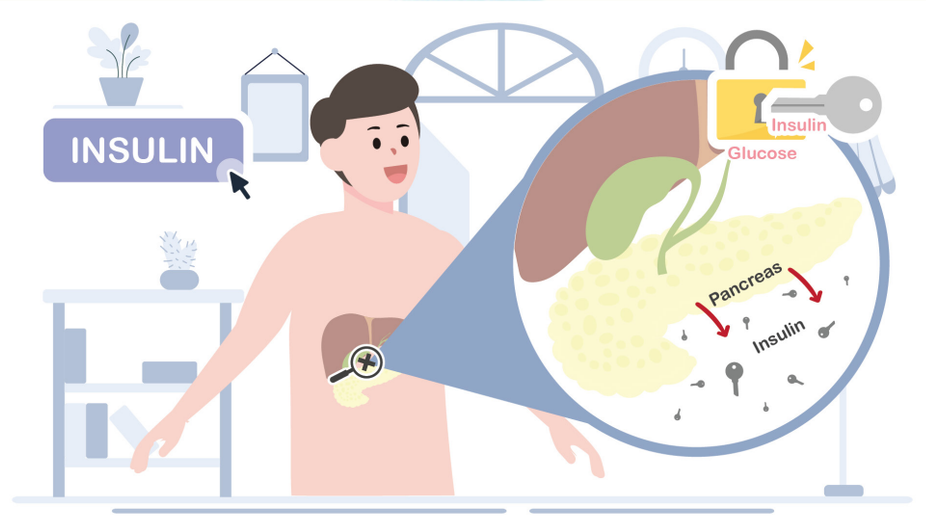


Figure 1.1: Insulin production and action

Type 2 diabetes is the most common form of diabetes. It is a condition where BG levels rise to unhealthy levels due to the body's inability to make use of insulin effectively to take glucose into the body's cells. This is also known as **insulin resistance.**

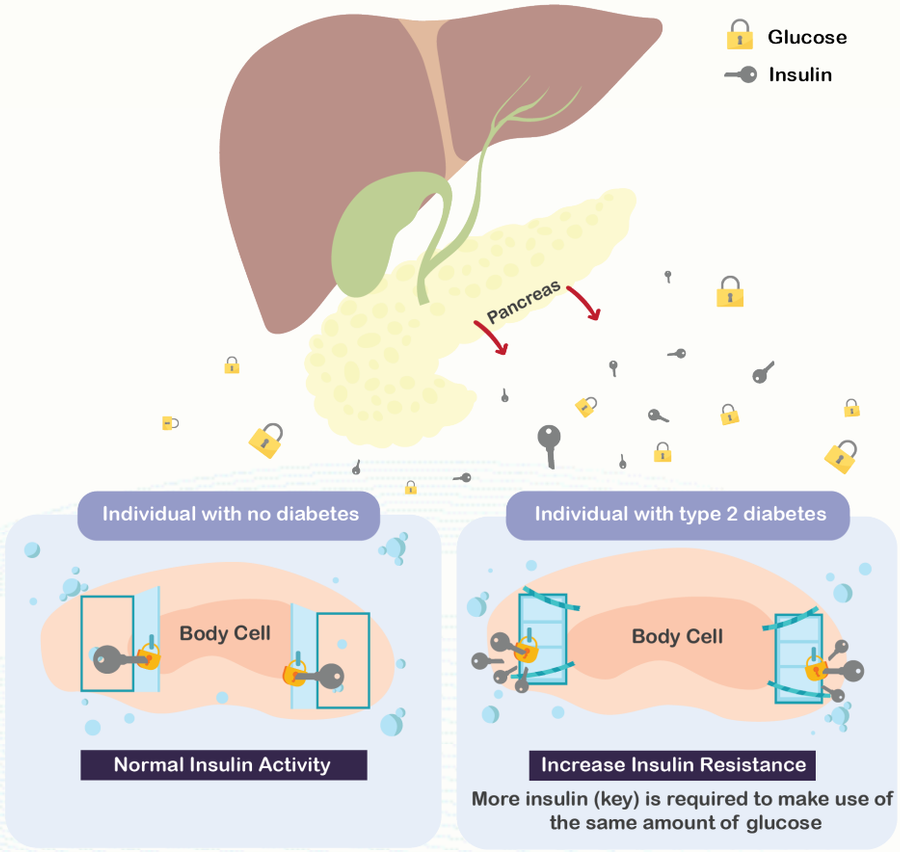


Figure 1.2: Comparison between an individual with no diabetes and type 2 diabetes

The following factors that lead to higher insulin resistance and/or type 2 diabetes:

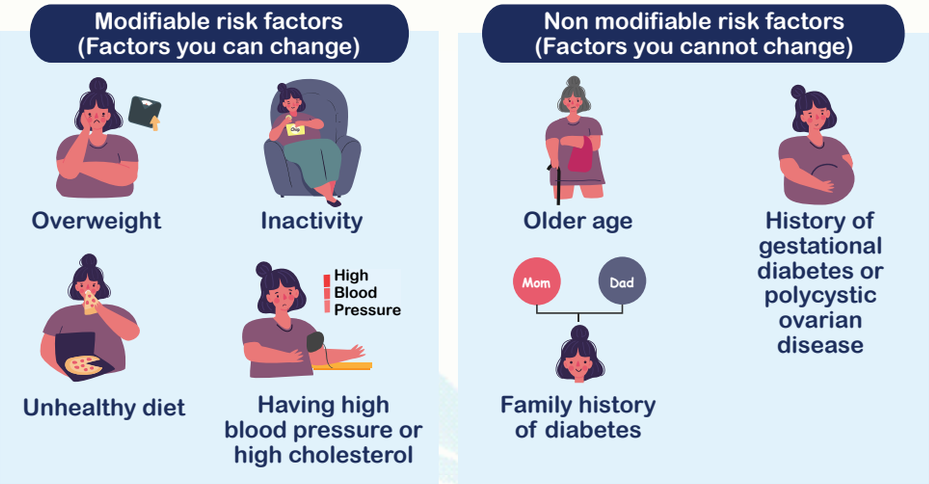


Figure 1.3: Factors leading to higher insulin resistance and or type 2 diabetes

With increased insulin resistance, the pancreas will need to work harder to produce more insulin to try to bring BG levels down to healthy levels. Over time, the pancreas will not be able to work well and type 2 diabetes develops.

People with type 2 diabetes can work on factors such as eating a low fat diet, reducing body weight and exercising. This will improve insulin resistance and reduce the need or dose of insulin required.

1.2 Diabetes remission: type 2 diabetes reversal in the early stages

Many often ask if there is a cure for type 2 diabetes. While there is no cure for type 2 diabetes, it is possible for you to work towards reversing it! The key is to understand insulin resistance and work on it for good diabetes control and even reversal.

Diabetes reversal (remission) happens when BG improves with **sustained lifestyle efforts** to non-diabetic range where no medications are required. Some of these are working on modifiable risk factors such as lifestyle changes which include having a healthy diet, regular exercise and weight loss. The earlier this is done upon the diagnosis of type 2 diabetes, the more likely one could successfully reverse the diabetes.

Some patients may not be able to achieve complete remission and to stop all medications, but many can reduce the dose of their usual diabetes medications including insulin.

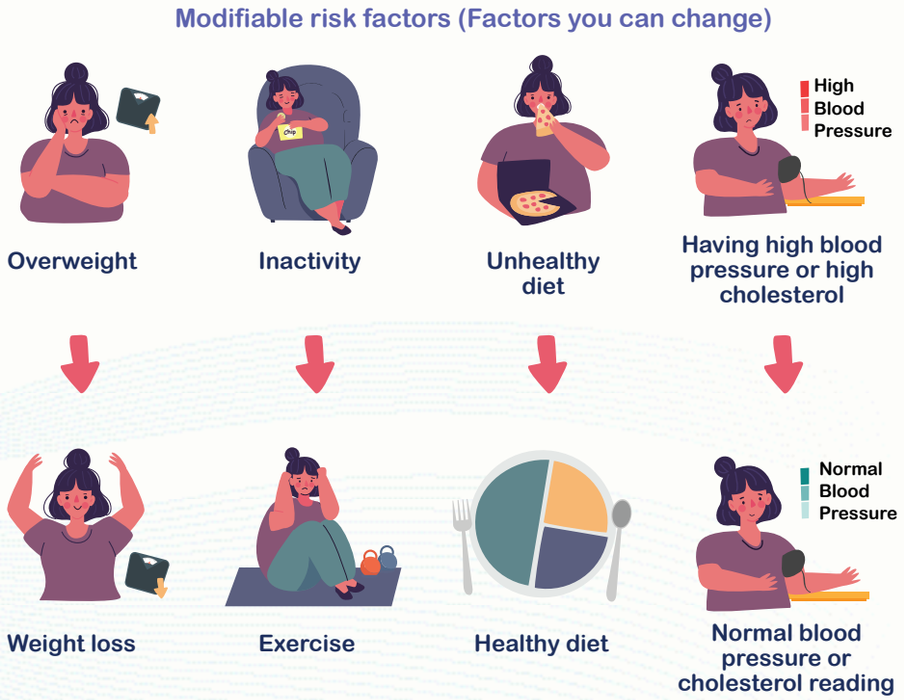


Figure 1.4: Modifiable risk factors (Factors you can change)

1.3 Reasons for starting insulin therapy

Type 2 diabetes is known to be a progressive disease. As mentioned earlier, lifestyle changes and 1 to 2 types of diabetes tablets may be enough to manage good diabetes control. Eventually, most people with type 2 diabetes will require insulin treatment as the pancreas will not be able to produce enough insulin on its own to make use of these oral diabetes medication to lower BG.

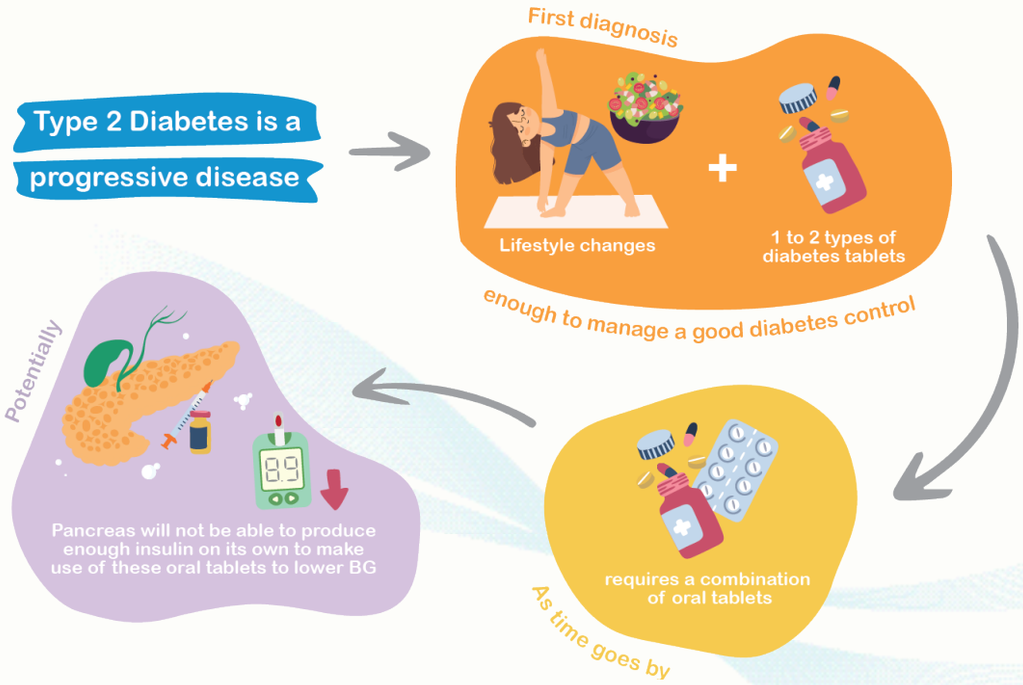


Figure 1.5: Type 2 diabetes is a progressive disease

Insulin treatment is not a "last resort" in your diabetes journey. It may also not be because of a lack of good diabetes self-care. It is a common misconception that being on insulin treatment means that one has failed in taking care of his or her diabetes.

Insulin treatment should not be seen in this way. It is not uncommon to feel guilty or frustrated when being offered insulin. However, you can overcome this by going through the chapters in this book to learn more! This transition to insulin treatment can be the key in good diabetes care, improved self-confidence through better self-care and enjoying the fruits of your labour by avoiding long-term diabetes complications.

Your doctor may start you on insulin based on your needs and specific medical conditions including:

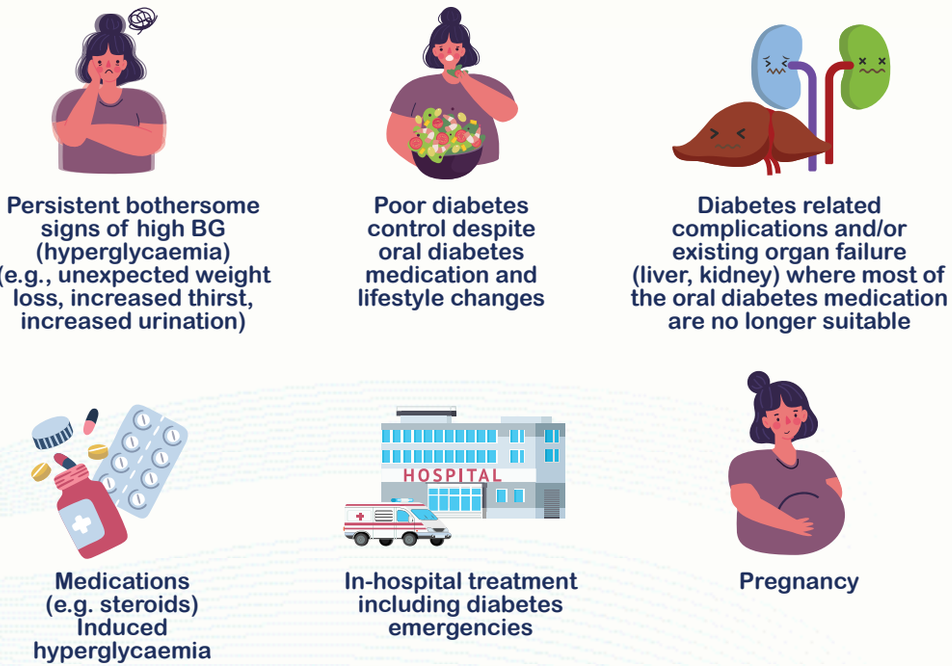


Figure 1.6: Reasons for starting insulin injections

This guidebook will also guide you along safe exercise tips and some diet advice when on insulin.

1.4 Benefits of starting insulin therapy early

It is never too early to consider insulin treatment. Starting insulin therapy early can protect the pancreas function for a longer time. Insulin treatment is used in diabetes if BG is very high on the initial diagnosis. During such times, the pancreas may be too sick to produce insulin on its own due to **glucose toxicity**. Diabetes tablets hence may not work well in bringing down BG levels. With the help of insulin usage at such an early stage, it will help the body and pancreas recover and cope. It may be possible to simplify the diabetes treatment regime by gradually reducing insulin doses and adjusting the combination of diabetes oral diabetes medication. This strategy may help to avoid more complex regimes in the future. In addition, starting insulin will improve diabetes control, which is important in avoiding the long-term complications of high BG.

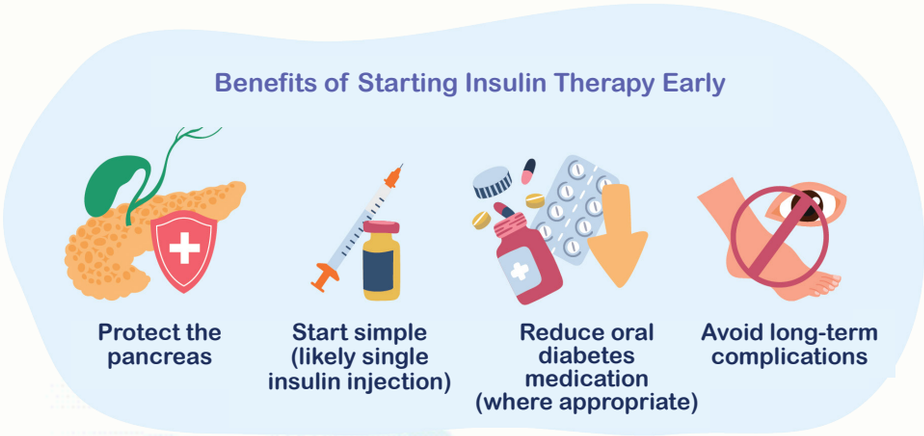


Figure 1.7: Benefits of starting insulin therapy early

Many people also worry about the safety of insulin treatment. The next few chapters will guide you through the understanding of insulin and how to use it safely at home.

NOTES

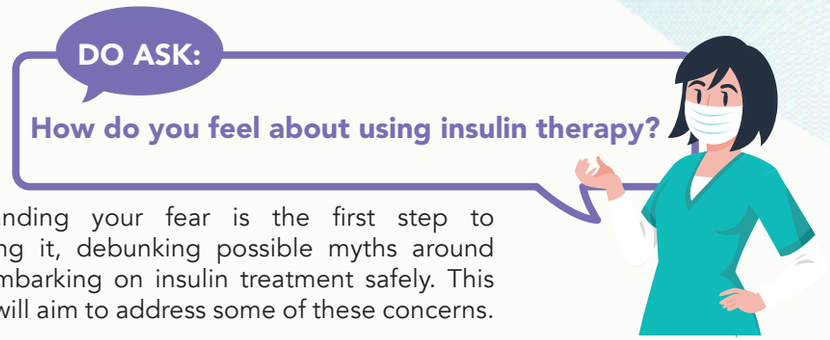
CHAPTER 2: OVERCOMING BARRIERS TOGETHER – COMMON FEARS ABOUT INSULIN THERAPY EXPLAINED

Learning Objectives:

1. Understand common fears surrounding insulin therapy
2. Learn about common myths about insulin therapy
3. Know what you can do to overcome the fear of insulin therapy

2.1 Common fears about insulin therapy

You may have many questions after being offered insulin therapy. Do not be afraid, you are not alone! People who have concerns often delay starting on insulin therapy. Patients who are already on insulin therapy, may skip or stop their treatment insulin altogether because they are worried or fearful. Waiting to start or omitting insulin therapy, may result in more issues in the long run. Holding off insulin therapy can be more harmful to long-term diabetes control than the insulin treatment itself.



Understanding your fear is the first step to addressing it, debunking possible myths around it and embarking on insulin treatment safely. This chapter will aim to address some of these concerns.

Concerns about insulin therapy among people with type 2 diabetes can be grouped into 6 main categories:

- Insulin side effects – hypoglycaemia, weight gain
- Myths such as insulin therapy leading to diabetes complications such as kidney failure or leg amputations
- Fear of injections or pain
- Being unable to cope with insulin injection techniques
- Impact of multiple injections on daily life
- Costs

2.2 Barriers and myths about insulin therapy

Insulin Therapy Barriers / Myths	Facts
Insulin therapy causes hypoglycaemia	It is true that insulin therapy will lower BG level as this is how it works to keep your BG and hence diabetes within good control. Hypoglycaemia occurs when your BG level falls too low. This not only happens with insulin therapy, but also with many other oral diabetes medication. In fact, insulin therapy can be adjusted more precisely to avoid hypoglycaemia when paired with appropriate self-monitoring of BG at home! The important goal is to understand hypoglycaemia, how to recognise, prevent and treat it and therefore avoid severe hypoglycaemia events. Chapter 6 will tell you more about this information.
Insulin therapy causes weight gain	It is true that many patients who have started on insulin therapy may experience weight gain. A healthy diet, regular exercise and appropriate insulin doses can reduce the chance of weight gain. Refer to Chapter 10 for weight management tips. In addition, self-monitoring of BG levels at home is the key to help your healthcare team adjust your insulin doses as accurately as possible. Smaller doses of insulin are usually associated with less weight gain.

Insulin therapy causes complications	This is not true! It is a common myth that insulin causes diabetes complications such as kidney failure and leg amputations. This may come from what people see or hear from affected family members or friends with diabetes. However, it is more likely that these people experienced complications due to poor control of diabetes and possibly from starting insulin therapy late. In fact, if insulin therapy is started early for them, with improved diabetes control, diabetes complications could be avoided. Hence, always remember to ask your healthcare team when in doubt.
Insulin injections are painful and/or complicated	Most people would imagine that injections are scary and painful. You would be surprised that many patients who are already on insulin injections would tell you how little an insulin injection hurts. Nowadays, insulin needles are thinner and shorter, thus minimising pain. Speak with your healthcare team to show you the injection process and techniques. Injections are much simpler now with insulin pens. Practice will help build confidence and reduce fear. There are various techniques including deep breathing relaxation before injection and choosing the appropriate needle size to help reduce the fear of injections and the pain. Refer to Chapter 4 for further information on practical tips such as choosing an appropriate needle size and proper insulin technique.
Starting insulin therapy means my life will change negatively	Many people worry that insulin treatment will drastically restrict their activities including work and travel. However, this is not true! With the proper skill set, people with diabetes on insulin treatment can do what they enjoy and live a life no different from what it was before. Many people using insulin have shared that they feel more confident and energetic after their diabetes control improves. There are many types of insulin available these days that are compact and easy to travel about with. Discuss with your healthcare team about how you can better fit insulin therapy into your lifestyle and schedule.
Cost - Insulin therapy is expensive	It is true that more money may be needed as patients will have to do more self monitoring of BG and buy the needles for the injections. Some oral diabetes medication are however more expensive than insulin and may even not be as effective as insulin in improving your BG levels. Please let your healthcare providers know if you are facing financial difficulties and they can refer you to the Medical Social Worker for assistance.

Table 2.1: Insulin barriers and myths

2.3 Steps you can take to overcome fears about insulin therapy

1. Be informed
   Learn about insulin therapy and how they work by reading through the information in this book and speak to your healthcare team to clarify any doubts. Having a good understanding of your condition and treatment will allay some of your fears. The benefits of insulin therapy are shared in Chapter 1.

2. Identify your thoughts and feelings
   Ask yourself: How do you feel about starting/using insulin? Talk with people you trust about your concerns – they could be your family, friends or diabetes healthcare professional.

3. Clarify your concerns
   Write down a list of questions and concerns you may have and discuss them with your diabetes healthcare team at your next follow up appointment. Your diabetes healthcare professional will appreciate you sharing your concerns and offer you the best support.

4. Ask yourself what is important
   Understanding what matters most to you is an important step towards deciding about insulin treatment. Some important goals can include avoiding diabetes complications or being able to enjoy hobbies and activities that you like in good health. Do think about them and write them down. Then, ask yourself, "What can I do to achieve this?" When you are ready, have this discussion with your diabetes healthcare team to set some short and long-term goals.

5. Get connected
   We have shared some ideas about how to manage your concerns but they cannot replace professional advice. It is always a good idea to talk about your concerns and ask any questions that you may have with your healthcare team or other individuals with type 2 diabetes on the same journey as you. NHG regularly organizes workshops and events for individuals journeying with diabetes. Ask your healthcare team about the upcoming events.

It is important to know that it is in your hands to make this transition journey as comfortable as possible. Your diabetes health care team is here to support you. If you have any concerns about using insulin therapy, speak with your healthcare team to share with them how you feel about insulin therapy so that they can address your concerns to make you more empowered and confident.

NOTES

CHAPTER 3:
DIFFERENT TYPES OF INSULIN

Learning Objectives:

1. Understand the differences between basal (background) and bolus (mealtime) insulin
2. Be familiar with the properties (onset of action, peak action, duration of action) of the various types of insulin
3. Understand how basal, bolus and/or premixed insulin are usually started

There are different types of insulin available. Your healthcare team will discuss with you what is suitable based on your needs. This chapter will explain the various types of insulin available.

There are 2 broad categories of insulin:

- Basal (background) insulin and
- Bolus (mealtime) insulin

Each broad category of insulin has a different:

- Onset of action: length of time to start working in the body
- Peak action: time taken to reach its maximum effect
- Duration of action: length of time that it has effect on our BG

Recall:
You may remember asking your doctor why your fasting BG level was high when you had not taken any supper overnight.

3.1 Basal Insulin

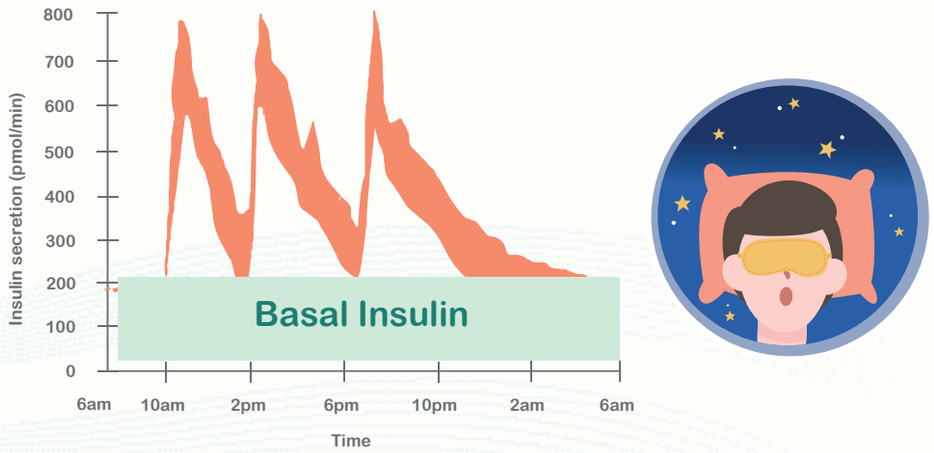


Figure 3.1: Basal insulin

Basal insulin is also known as 'background insulin' where the healthy pancreas produces a background (basal) level of insulin throughout 24 hours even when sleeping or not eating. This keeps BG at consistent levels during these periods of inactivity.

Most patients are started on basal insulin as a first introduction to insulin therapy. This is usually added on top of their oral diabetes medication when they cannot achieve their target fasting BG level. The benefits of starting basal insulin include:

- When used on its own, the injection does not need to be paired with a meal. People may choose to inject at a time which is consistently convenient for them. It is usually prescribed to be given before bed or upon waking up.
- Slow and steady action and hence may have reduced hypoglycaemia risks when used with appropriate self-monitoring of BG.

How to start basal insulin?

Your doctor will decide the starting dose for you based on your age, relevant medical issues and diabetes control at that point in time. It is usually injected once or twice a day and the dose is mostly fixed. The dose will likely need to be adjusted along the way based on your response. Therefore, it is important to check fasting (before breakfast) BG readings at home frequently to guide the dose adjustment when you see your healthcare team.

There are two main types of basal insulin available. You may be on either type of them but not both. Your healthcare team will discuss with you which is more suitable for you.

Intermediate-acting insulin

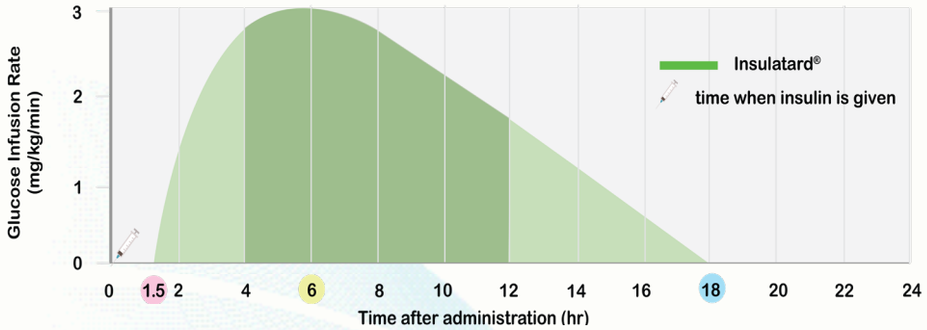


Figure 3.2 Action profile of intermediate-acting insulin





Type of insulin*	It can be taken once or twice a day. Example: Insulatard® (also known as NPH, Isophane insulin or Humulin® N). The figure above shows the action profile of intermediate-acting insulin.
Profile	- Starts working: 1.5 hours after injection. - Peak (Max) action: 4 to 12 hours. - Last for: 14 to 18 hours in our body in total.
Benefits	1. More affordable. 2. Can be mixed together with mealtime insulin into 1 single injection, reducing total number of injections each time compared to pen insulins.
Things to take note of	1. It is a cloudy mixture (suspension with particles). Mix well before use. 2. Usually comes in a glass vial. To be used with insulin syringes. 3. Also available in penfill cartridge. To be used with a pen (e.g. Novopen®) and pen needle. Penfill insulin cannot be mixed with mealtime insulin into 1 injection.

Table 3.1: Basal insulin - intermediate-acting insulin

Long acting insulin

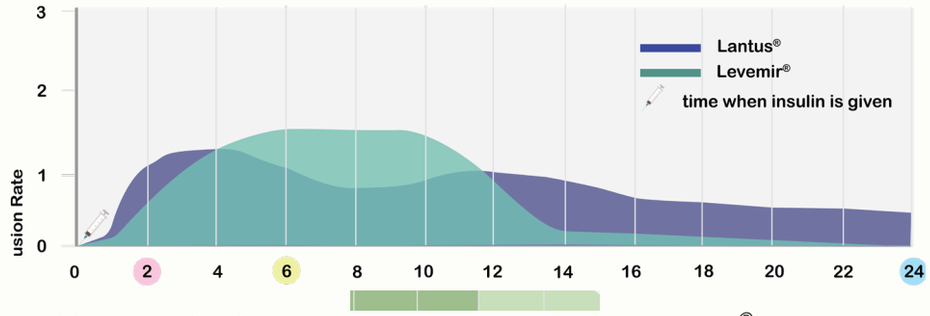


Figure 3.3 Action profile of commonly used long-acting insulin, Glargine (Lantus®) and Detemir (Levemir®)



Type of insulin*	These are newer basal insulins and have a longer action. Long-acting basal insulin can be taken once or twice a day. Example: - Glargine U-100 (Lantus®) - Detemir (Levemir®) - Glargine U-300 (Toujeo®) - Degludec (Tresiba®) The figure above shows the action profile of commonly used long-acting insulin, Glargine (Lantus®) and Detemir (Levemir®).
Profile	- Starts working: 2 hours after injection. - Peak (Max) action: much less defined max action, more steady slow action. - Last for: 18 to 24 hours in our body in total.

Benefits	1. Usually taken once a day. 2. Less defined peak action as compared to Intermediate acting insulin: reduced chances of hypoglycaemia. 3. Commonly in the form of a pen. 4. Glargine U-100 (Lantus®) is available in vials for those who required high doses.
Things to take note of	These insulin cannot be mixed & given in as a single shot with other insulin types in a syringe. Do not syringe the insulin solution from insulin pre-filled pens.

**Availability of these medications may be different at the various NHG institutions.*

Table 3.2: Basal insulin - long-acting insulin

Types of Insulin and their action in the body

Name of insulin	Onset of action	Peak action	Duration of action
BASAL INSULIN (Intermediate-acting)			
Insulatard®/Humulin®N (Isophane insulin or NPH)	1.5 hours	4-12 hours	14-18 hours
BASAL INSULIN (Long-acting)			
Detemir (Levemir®)	1-2 hours	3-14 hours	Up to 24 hours
Glargine (Lantus®)	3-4 hours	No significant peak	Up to 24 hours
Glargine U-300 (Toujeo®)	6 hours	12-16 hours	Up to 36 hours
Degludec (Tresiba®)	1-4 hours	9 hours	42 hours

3.2 Bolus Insulin (Mealtime insulin)

A healthy pancreas produces extra insulin in response to food, activities and stress. With diabetes, the pancreas may not be able to produce sufficient insulin to cover even a regular meal. This is when you will require a short or rapid acting insulin to take care of the meal you are about to eat.

How to start bolus insulin?

Your doctor will usually start by adding one or two bolus insulin injections before the largest meal(s). However, some people will need a more intensive treatment plan of up to three injections for each of the meals. Bolus insulin is usually an add-on therapy to the basal insulin injection.

The dose of rapid or short-acting insulin will depend on the carbohydrate load of the food that you eat and your BG readings. It is important to take your meals regularly and maintain a consistent carbohydrate intake in each meal. We will be covering this topic in greater detail in Chapter 10 Insulin and Food.

Do self-monitor paired BG levels (pre-meal and 2-hour post meal) to know if the amount of bolus insulin is sufficient to cover the meal that you have eaten. You can find out more in Chapter 5 Getting to know your BG level at home.



It is important to administer bolus insulin together with your meals to prevent hypoglycaemia.

Bolus insulin is administered immediately or up to 15-30 minutes before a meal to cover the carbohydrate intake. In the case of type 2 diabetes patients, the dose of bolus insulin is usually fixed for the ease of understanding and usage. This book will only cover the understanding of fixed dosages of insulin as this is the more common prescription for patients with type 2 diabetes. For patients who are keen to learn how to vary the dose of their insulin more precisely, please refer to our other guidebook on Flexible Insulin Therapy eBook instead. Please check with your healthcare provider about this.

There are two main types of bolus insulin available. You may be on either type of them but not both. Your healthcare team will discuss with you which is more suitable for you.

Short-acting insulin

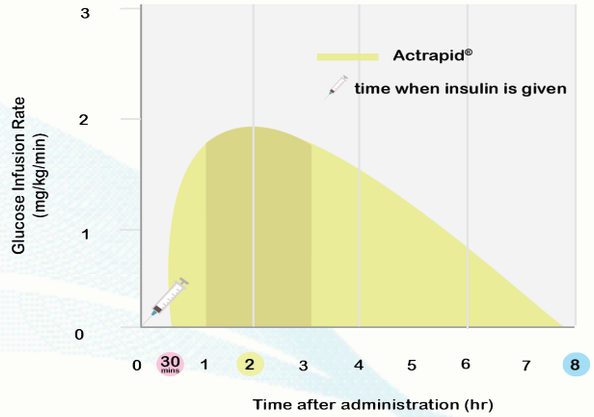


Figure 3.4: Action profile of short-acting insulin



Type of insulin*	Examples: - Actrapid® - Humulin®R The graph above shows the action profile of short-acting insulin.
Profile	Usually taken 30 minutes before a meal. - Starts working: 30 mins after injection. - Peak (Max) action: 1 to 3 hours. - Last for: 7 to 8 hours in our body in total.
Benefits	1. More affordable. 2. Can be mixed together with basal (intermediate-acting insulin) into 1 single injection shot.
Things to take note of	1. You will need to wait for 30 mins between the injection and the meal for the medication to work well. 2. Usually comes in a glass vial. To be used with insulin syringes. 3. Also available in penfill cartridge. To be used with a pen (e.g. Novopen®) and pen needle. Penfill insulin cannot be mixed with basal insulin into 1 injection.

Table 3.3: Bolus insulin - short-acting insulin

Rapid-acting insulin

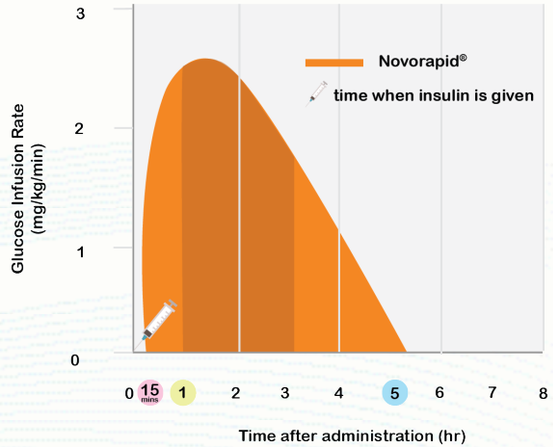


Figure 3.5: Action profile of rapid-acting insulin.



Type of insulin*	Examples: - Insulin Aspart (Novorapid®) - Insulin Glulisine (Apidra®) - Insulin Lispro (Humalog®) The graph above shows the action profile of rapid-acting insulin.
Profile	Usually taken 10 to 15 minutes before a meal. - Starts working: 15 mins after injection. - Peak (Max) action: 1 to 3 hours. - Last for: 3 to 5 hours in our body in total.

Benefits	1. Faster onset of action meaning that you can eat almost immediately after the injection. 2. Comes in the form of a pen.
Things to take note of	These insulin cannot be mixed & given in as a single shot with other insulin types in a syringe. Do not syringe the insulin solution from insulin pre-filled pens.

**Availability of these medications may be different at the various NHG institutions.*

Table 3.4: Bolus insulin - rapid-acting insulin

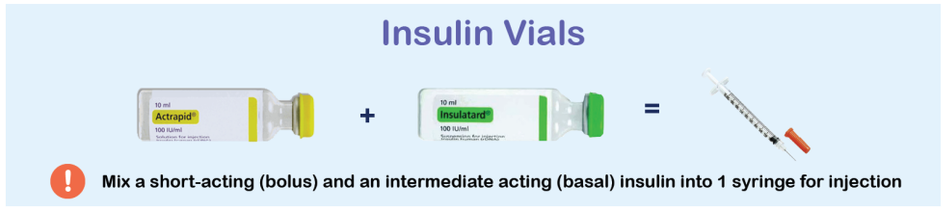
Types of Insulin and their action in the body

Name of insulin	Onset of action	Peak action	Duration of action
BOLUS INSULIN (Short-acting)			
Actrapid®/Humulin®R (Soluble insulin)	30 mins	1-3 hours	7-8 hours
BOLUS INSULIN (Rapid-acting)			
Aspart (Novorapid®)	10-20 mins	1-3 hours	3-5 hours
Glulisine (Apidra®)	10-20 mins	1.5-2.5 hours	3-4 hours
Lispro (Humalog®)	10-15 mins	0.5-2.5 hours	3-5 hours

3.3 Multiple Daily Insulin (MDI) Injections

When one starts on bolus insulin in addition to basal insulin, this person is said to require multiple injections in a day. The healthcare team refers to this as multiple daily insulin (MDI) injection or basal-bolus regime. This type of insulin therapy can be more complex as it **may involve mixing of different types of insulin before injecting it into the body or preparation of different insulin pens before injection.**

Here are some potential combinations; this can be adjusted based on your unique needs.



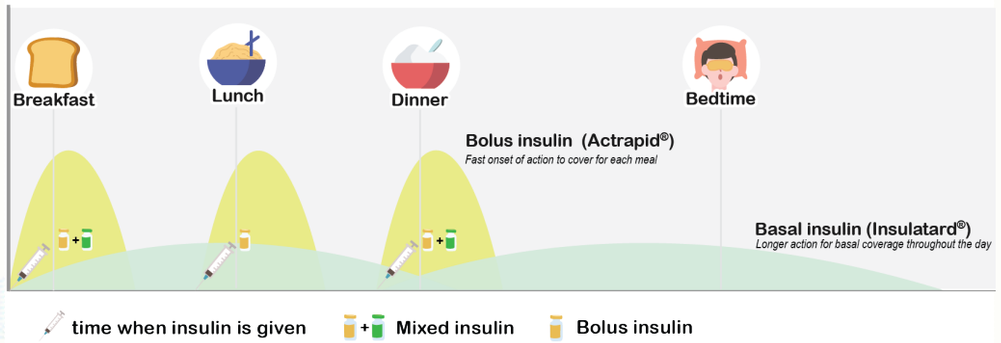
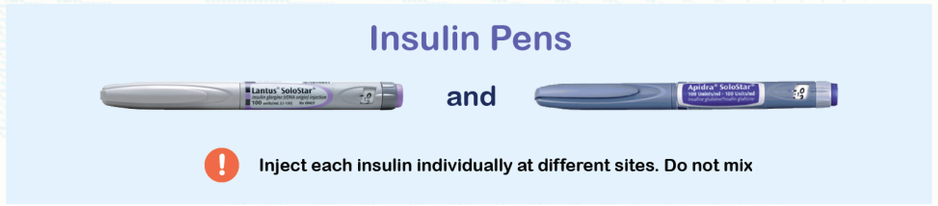


Figure 3.6: Basal-Bolus insulin injection (Insulin Vials)

The total number of injections per day is different for every patient. It usually can range from 2 to 4 injections a day based on your needs and ability to cope with these injections. Discuss this with your healthcare team.



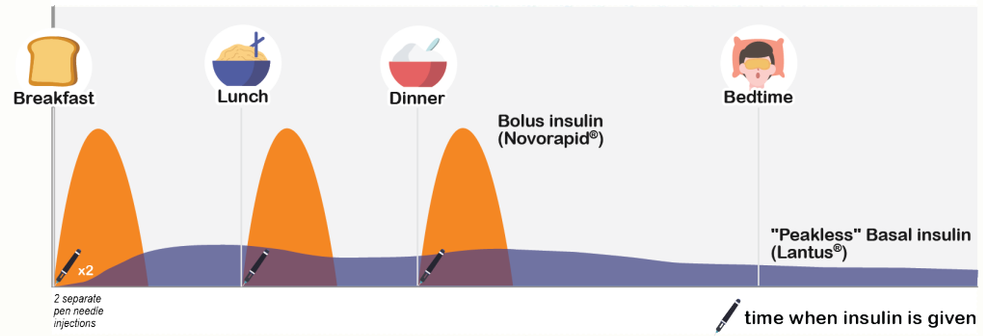


Figure 3.7: Basal-Bolus insulin injection (Insulin pens)

3.4 Premixed insulin

Premixed insulin, as the name suggests, is a **ready-made** combination of two types of insulins. It contains a basal insulin to provide continuous background coverage and a bolus insulin for meal coverage mixed in a **fixed proportion.** This may be a more convenient option for people who are not able to manage MDI injections.

Premixed insulins are usually injected twice a day, before breakfast and before dinner.

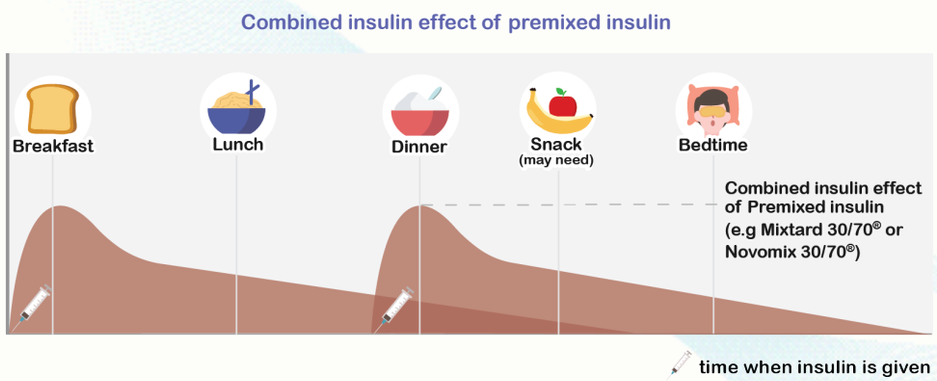


Figure 3.8: Premixed insulin (Insulin vial or pen)

Benefits of Premixed insulin

- More convenient for some people due to the following reasons:
  - Fewer injections are needed compared to basal-bolus regimens
  - Ready-made, premixed: Takes away the hassle of mixing the two types of insulin together

Disadvantages of Premixed insulin:

- **Not flexible in terms of dose of insulin** as proportions of the 2 types of insulin is fixed so one needs to take regular and fixed portions of carbohydrates at meal times otherwise this insulin can put one at higher risk of having low BG
- Does not allow for adjustment of each insulin components based on individual needs
- Not suitable for people who are not regular with meal timings and portions due to greater risk of hypoglycaemia with erratic meal timings and portions

The examples of premixed insulin available locally shown in Table 3.5 in the next page. Availability of these medications may be different at the various NHG institutions.



Premixed insulin*	Bolus insulin component	Basal insulin component	Timing of injection	Comments
Mixtard® 30/70	30% short-acting - Actrapid®	70% intermediate acting - Insulatard®	Inject 30 mins before meals due to the short-acting insulin (Actrapid®).	The 30%-70% ratio is usually injected at breakfast and can cover for the 2nd meal at lunch too. If used at dinner, you may need to take supper otherwise you might be at risk of having overnight hypoglycaemia.
NovoMix® 30	30% rapid-acting - Aspart	70% intermediate acting - Aspart protamine	Inject 15 mins before meals due to the rapid-acting insulin (Lispro/ Aspart).	
Humalog® Mix 50	50% rapid-acting - Lispro	50% intermediate acting - Lispro protamine		This type of insulin is useful for those with heavy dinners and do not take suppers. It is also good for people who experience hypoglycaemia on 30-70 ratio premixed insulin.
Ryzodeg®	30% rapid-acting - Aspart	70% long-acting - Degludec		Ryzodeg can be administered once daily with the largest meal or twice daily with the main meals.

**Availability of these medications may be different at the various NHG institutions.*

Table 3.5: Premixed insulin available locally

Types of Insulin and their action in the body

PREMIXED INSULIN	
Mixtard®30/70 - 30% soluble insulin, 70% isophane insulin	See sections on short-acting insulin and intermediate-acting insulin
Novomix®30 - 30% Aspart, 70% Aspart protamine	See sections on rapid-acting insulin (Aspart) and intermediate-acting insulin
Humalog® Mix 50 - 50% Lispro, 50% Lispro protamine	See sections on rapid-acting insulin and intermediate-acting insulin
Ryzodeg® - 30% Aspart, 70% Degludec	See sections on rapid-acting insulin and long-acting insulin

3.5 Activity – Knowing my insulin

Highlight the insulin that you are on and familiarize yourself with the properties of the insulin.

My Insulin Regimen

Write down your the type(s) of insulin you are using and the dosage here:

	Before Breakfast	Before Lunch	Before Dinner	Bedtime
Basal (intermediate/ long-acting insulin)				
Bolus (short/rapid-acting insulin)				

Table 3.6: Activity - Knowing my insulin

This chapter serves as a guide for a basic introduction to types of insulin available as medications. If you are unsure how to prepare or inject insulin, speak to your healthcare team.

NOTES

CHAPTER 4:
INSULIN PRACTICAL TIPS

Learning Objectives:

1. Learn about the different insulin delivery devices, needles and syringes
2. Know insulin injection sites and importance of site rotation
3. Understand the factors which affect insulin action
4. Learn about proper insulin storage
5. Learn about the safe disposal of used insulin syringes and pen needles

Now that you have learnt about insulin and how they work, this chapter will share more on the practical tips about insulin needles, injection techniques, storage and safe disposal.

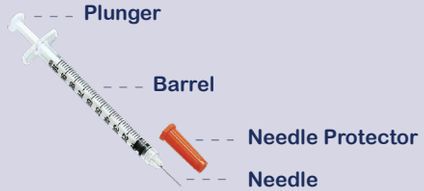
4.1 Insulin delivery devices

There are different insulin delivery devices that are now available other than the traditional insulin vial and syringe. Using insulin pens with pen needles may be more convenient for some people.

Insulin Vial



To be used with insulin syringe



Benefits:

1. For Insulatard® and Actrapid® you can draw up different types of insulin from the respective glass vials and mixed to be given in just 1 shot. This cannot be done for Insulin Glargine vial

Disadvantages:

1. Some people may have difficulty seeing the small markings and numbers on the syringes and handling the delicate syringes
2. You will have to manually add up to the total dose if mixing 2 types of insulin together

Scan this QR code to learn how to inject insulin

1. Insulin Single Vial Injection Technique
2. Insulin Vial with Mixing

If you face any difficulties accessing the external materials, please contact DM_Edu@nhg.com.sg

Insulin Pen



To be used with insulin pen needles



Outer Cap

Inner Cap

Needle

** You do not need to buy or use any insulin syringes

Benefits:

1. People with poorer eyesight may find it easier to use a pen insulin as the numbers are bigger or they can count the number of clicks

Disadvantages:

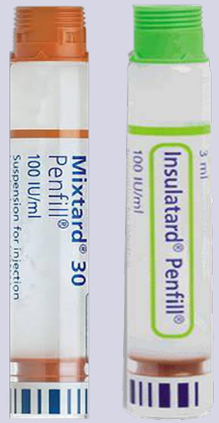
1. Need to learn how to operate the insulin pen and assemble pen needles
   - It takes some effort to learn the steps to attach and prime the needle when using a pen insulin

Scan this QR code to learn how to inject insulin

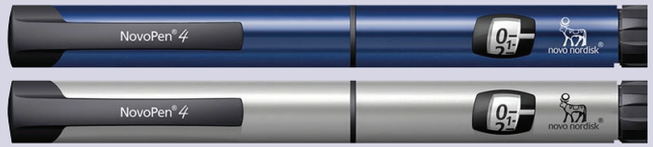
1. Single Insulin Pen Injection Technique
2. Mixed Insulin Pen Injection Technique

If you face any difficulties accessing the external materials, please contact DM_Edu@nhg.com.sg

Insulin Penfill (cartridge)



To be used with insulin pen (e.g. NovoPen®4)



And insulin pen needles



Outer Cap

Inner Cap

Needle

** You do not need to buy or use any insulin syringes

Benefits:

1. More environmentally friendly
2. May be easier for patients on Mixtard® / Insulatard® / Actrapid® with poorer eyesight and unable to see the markings or numbers on the insulin syringes

Disadvantages:

1. NovoPen® is heavier
2. Need to learn how to operate the insulin pen and assemble pen needles

Scan this QR code to learn how to inject insulin

If you face any difficulties accessing the external materials, please contact DM_Edu@nhg.com.sg

Table 4.1: Types of insulin and the delivery devices

4.2 Insulin needles

Here are some details to look out for when purchasing pen needles and or syringes.

What to look out for when buying them?

Firstly, select the correct type of needle for the insulin type prescribed highlighted in the segment above.

Needle length

Different lengths of needles are available for insulin syringes and pen needles. Using the appropriate length of insulin needle is important for effective insulin absorption.

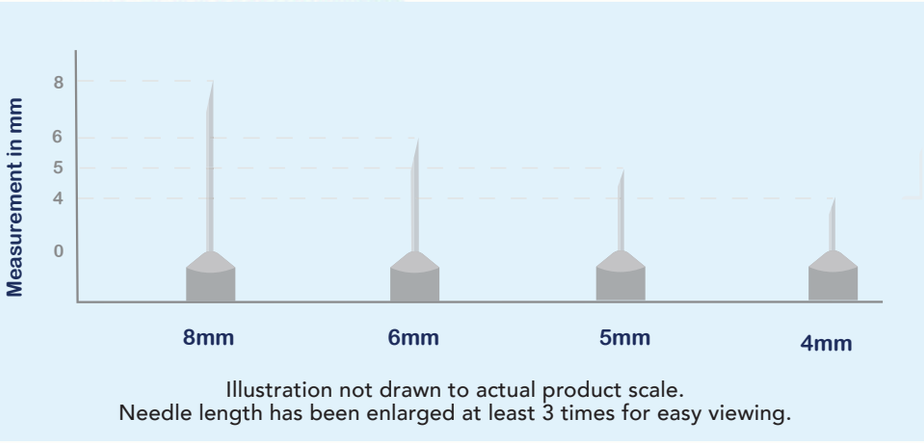


Figure 4.1: Different lengths of insulin pen needles

It is recommended to use the short 4mm or 5mm pen needle length, and insulin syringe needle length of 6mm. Use of longer needle length (e.g. 8mm and 12.7mm) may inject insulin into the muscle instead of fat, and cause hypoglycaemia. If in doubt, do discuss with your healthcare team on the appropriate insulin syringe / pen needle selection.

4.3 Insulin syringes - the specifics

Choosing the right size (volume/ number of units)

As discussed earlier, insulin syringes are used with insulin vials.

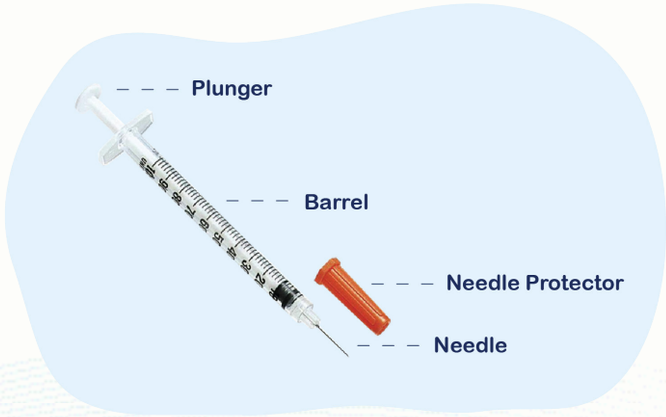


Figure 4.2: Insulin syringe

Insulin syringes are available in different sizes: 0.3 ml (to draw up to 30 units of insulin), 0.5 ml (up to 50 units of insulin) and 1 ml (up to 100 units of insulin).

The choice depends on the amount of insulin you need to inject each time. If you are on a lower dose of insulin (less than 30 units per injection), choose a 0.3ml U-100 syringe. It is easier to measure the dose out. Also, If your largest insulin dose is close to the syringe's maximum capacity, you may wish to buy the next size up to handle any potential increase in dose.

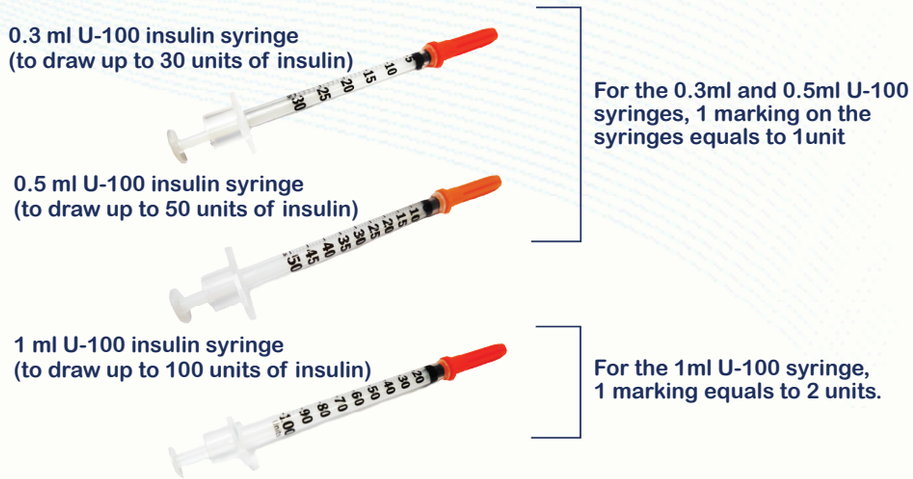


Figure 4.3: Different sizes of insulin syringes

Reading an insulin syringe

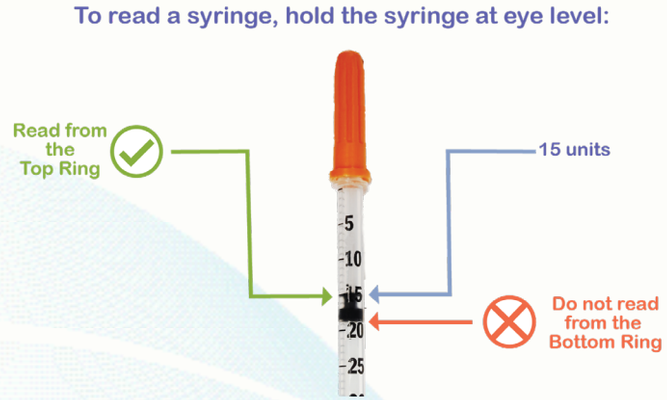


Figure 4.4: How to read an insulin syringe

4.4 Sites of insulin delivery

Insulin injection sites

Insulin works best when injected into a layer of fat under the skin, above the muscle tissue.

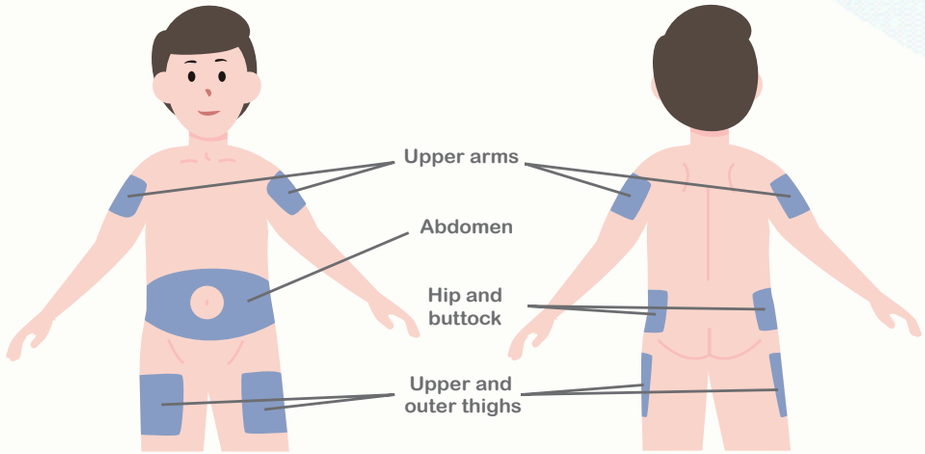


Figure 4.5: Sites for insulin delivery

Insulin absorption is fastest and most consistent when injected into the **abdomen**. It is therefore the preferred site for insulin injection for most patients. Other sites to consider include:

i. Thighs - Upper 1/3 of the front of the outer thighs

ii. Buttocks - Upper part of the outer buttocks

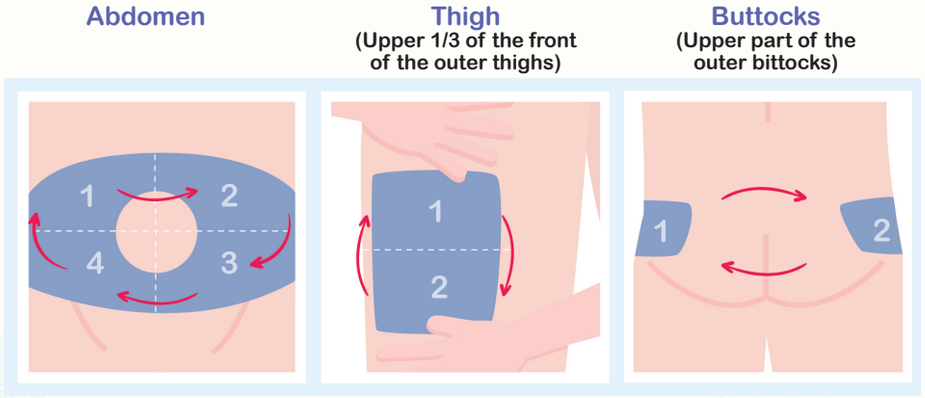
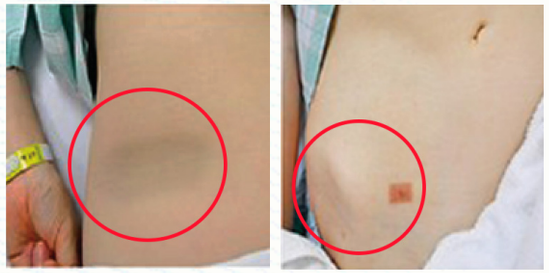


Figure 4.6: Site rotation for insulin delivery

Rotate injection sites within a particular area (Figure 4.5 and 4.6) in a systematic manner to avoid developing problems in and under the skin. Always look and feel for lumpy (lipohypertrophy) and dented (lipoatrophy) areas in the skin. Avoid injecting into these areas as these changes in the skin can affect the action of the insulin. Inform your doctor if you suspect these changes in your skin. Your doctor will also check your injection sites periodically.



Lipoatrophy **Lipohyperthrophy**

Figure 4.7: Lipoatrophy and Lipohypertrophy

Insulin action is also affected by local factors around the skin. Exercise, heat and massaging of the injection site may speed up the absorption of insulin and cause the action of insulin to be faster. This can result in hypoglycaemia.

4.5 Insulin storage

When you collect your regular supply of medications, keep the insulin in a well-insulated cooler bag and go home right away. It is important to arrange your insulin into those that are currently in use and those that are unopened as their storage recommendations are different.

If you do not store your insulin correctly or use an opened vial of insulin or insulin pen beyond its in-use expiry date, it may become contaminated or lose its effectiveness.

	Insulin supply you are currently using – "opened" for use	New, unused, unopened insulin pen or vial
Where to store	Can be kept at room temperature (2 to 30 degrees). - Avoid direct sunlight or warm areas.	All unused insulin should be stored in the refrigerator, but not in the freezer.
Duration it can be kept	Up to 4 to 6 weeks – the exact duration varies depending on type of insulin. Please check the in-use expiry date when collecting the medication.	Until the expiry date on the medication itself.
Quick tip: ** Make it a habit to label the date you first open the vial/pen so that you are aware when you need to discard it.		

Table 4.2: Insulin storage

4.6 Safe disposal of used insulin needles and syringes

To prevent injury to self and others, discard needles into a puncture-proof bottle or container (see picture). Do not throw them into the waste bin with the needles exposed. When the container is ¾ full, it should be covered and taped securely before disposal.



Figure 4.8: A picture of a sharp box

4.7 Missed insulin or accidental double dosing of insulin

You may run into a situation where you miss or double dose your insulin. Here are some general principles that you can follow. Do consult your healthcare provider as the solution may be unique to each individual. The information below will be categorised into the types of insulin that is commonly prescribed.

Missed insulin - Basal and bolus insulin

If you missed an insulin dose, you would expect your BG level to rise. The amount and duration expected for the BG rise is different depending on the type and timing of insulin dose missed.

Insulin missed	How long was the delay?	Can I still take the dose?	What to do when you discover the problem?
Basal insulin	Within 1 to 2 hours	Yes. Usually safe.	Take the dose.
	>2hours	No. It may not be safe to dose yourself if the delay has occurred for more than 2 hours.	Monitor your BG closely. It is expected to be high with the missed dose. Consider reducing portion of carbohydrates or to increase physical activity to reduce BG. With repeated missed insulin injections, there is the risk of severe and sustained high BG including Diabetes Ketoacidosis (DKA) and Hyperosmolar Hyperglycaemia Syndrome (HHS). Discuss with your doctor if you have difficulty with the timing of insulin injections.

Bolus insulin	After the meal	Short-acting: No. It is usually not safe to dose your bolus insulin after you have finished your meal.	Monitor your BG closely. It is expected to be high with the missed dose and with your food intake. Avoid taking additional carbohydrates or to increase physical activity to reduce BG during this period. Stay well hydrated. Take your next dose of bolus insulin on time before the next meal. With repeated missed insulin injections, there is the risk of severe and sustained high BG including DKA and HHS. Discuss with your Dr if you have difficulty with the timing of insulin injections.
		Rapid-acting: If you are on a rapid-acting insulin (Novorapid®, Apidra®, or Humalog®), you may inject the insulin immediately or 10-15 minutes after the meal. If it is more than 30 minutes after the meal, you may give half your usual dose of rapid-acting insulin (e.g. if you usually give 8 units of Novorapid®, you may give 4 units of Novorapid®).	

*** HHS/DKA can be life threatening. You should seek medical attention immediately if you have possible HHS/ DKA.*

Table 4.3: Action plan for missed insulin dose

Accidental double dosing of insulin - basal / bolus insulin

If you had accidentally double dosed your insulin, you may run into the problem of hypoglycaemia. It is therefore important to check your BG level more closely in order to identify and treat hypoglycaemia. You may also need to eat carbohydrate-containing snacks about 2 hours from your previous meal (e.g. biscuits or a slice of bread) to avoid hypoglycaemia.

It is important to inform the people around you that you have received a double dose of insulin so that they are able to help you in the event you become confused and are unable to rescue yourself when severe hypoglycaemia occurs. Refer to Chapter 6 for hypoglycaemia management.

The duration of closer monitoring will correspond to the duration of action of the type of insulin injected (refer to Chapter 3 for insulin action profile). You should monitor your BG more closely for the entire expected duration of the insulin action.

If your BG is:

Above your usual expected range	Continue monitoring BG for the entire expected duration of the insulin action.
Below your expected range	Take an extra carbohydrate snack. Please refer to Chapter 10 for examples.
Below 4.0 mmol/L (hypoglycaemia)	Treat for hypoglycaemia immediately with 15g of fast acting carbohydrates Please refer to Chapter 6 for Hypoglycaemia management.
Persistently/ recurrently below 4.0 mmol/L (hypoglycaemia)	See a doctor immediately. You may need medical assistance including a glucose containing drip.

Table 4.4: Action plan for double insulin dosing

Premixed insulin - missed dose or double dosing

Premixed insulins as discussed in chapter 3.4 is a ready made insulin with a fixed proportion of basal and bolus insulin. It is hence taken before a meal due to the bolus insulin component. It is not recommended to take the missed dose after the meal. Having missed the dose has a risk of (severe) hyperglycaemia that can be harmful. Catching up with the missed dose can put a person at risk of hypoglycaemia if the delay is only picked up after the meal is taken. Premixed insulins as discussed in chapter 3.4 is a ready made insulin with a fixed proportion of basal and bolus insulin. It is hence taken before a meal due to the bolus insulin component. Having missed a dose of premixed insulin can put a person at risk of (severe) hyperglycaemia. You may need to reduce your carbohydrate intake with a missed dose. Catching up the missed dose after the meal is not recommended as may put one at the risk of hypoglycaemia. Keep well hydrated. Monitor your BG more closely. You may need to reduce your carbohydrate intake with a missed insulin dose. Keep well hydrated.

If you accidentally gave yourself a double dose, please monitor your BG level more closely to look out for hypoglycaemia and correct appropriately. More details on what you can do when you discover the problem can be found in the segment above. Inform people around you of your double dosing incident so that they can help you in the event of severe hypoglycaemia.

Please discuss with your healthcare provider if you find it hard to get your insulins on time, or experience frequent double dosing. This can be dangerous if it happens repeatedly.

4.8 Frequently asked questions

1. Can I inject insulin anywhere else apart from the abdomen (tummy area)?
   Insulin is absorbed at different rates in different parts of the body. This will affect how fast the insulin works to lower our BG level. Other sites include the upper and outer thighs, upper arms, hips and buttocks (refer to Figure 4.6). If you do change your injection sites (e.g. from abdomen to thigh), your body may experience a difference in speed of response to the insulin.

2. My needle looks brand new after 1 use. Can I keep using it till it is blunt?
   No. Re-using needles increases a person's risk of skin infection and needle breakage. Re-using needles is the common cause of skin lumps and painful injections. It is therefore not advisable to re-use needles.

3. It is quite painful when I inject my insulin. What can I do to reduce the pain?
   The level of injection discomfort has improved with single use of shorter and narrower needles. However, do note that if you feel excessive pain, please check on the following:

   - **Check the injection area for signs of swelling, pus or lumps.** This may indicate infection or lumpiness of fats around the injection site. You may need to see a doctor if there are signs of infection. Otherwise, rotate the injection location frequently to avoid lump formation.
   - **Check that you did not re-used the needle**. Never re-use needles as this is a common reason for pain.
   - **Check your insulin needle length.** You may be using a needle longer than you need and hence, it is causing you more pain.
   - **Check your injection technique.** You may wish to refer to Chapter 4 or the HealthHub website for resources on insulin injection techniques. Otherwise, speak to your healthcare team for an insulin injection technique assessment.
   - **Deep breathing exercises.** You may be nervous just before the injection leading to more pain that you should experience. Try some deep breathing exercises before and after the insulin injections to relieve the pain.

NOTES

CHAPTER 5:
GETTING TO KNOW YOUR BLOOD GLUCOSE (BG) LEVELS AT HOME

Learning Objectives:

1. Understand the difference between HbA1c and BG
2. Understand the importance of self-monitoring of BG
3. When to check BG at home based on the type of insulin prescribed

5.1 What is HbA1c?

HbA1c indicates your diabetes control based on your average BG level over the previous 2-3 months. The more glucose you have in your blood, the higher your HbA1c will be. The higher the HbA1c, the greater the risk of developing diabetes related complications. Your HbA1c and BG targets are individualised according to your goals and health condition.

5.2 What is BG?

BG is the amount of glucose in your blood. This is measured at a single point in time using self monitoring of BG (SMBG) with a blood glucose meter, also known as glucometer. This measures the BG in our capillaries (small blood vessels) in our finger tips. Hence, it is also commonly referred to as capillary blood glucose (CBG).

5.3 Importance of BG home checks

Maintaining safety

Many people worry about the safety of insulin therapy. You can overcome this by being familiar with your BG pattern. The best way to do so is to monitor your BG regularly with a glucometer, and to record these readings at home. There are different brands and models available, each with its own features. Some glucometers have additional features such as Bluetooth-enabled mobile health applications to make it easier for you to log a BG diary. If you are unsure how to use a glucometer, speak to your healthcare team to choose a model that best suits your needs.

Improving diabetes control

Your BG records will help you and your doctor evaluate and determine the best treatment for your diabetes.

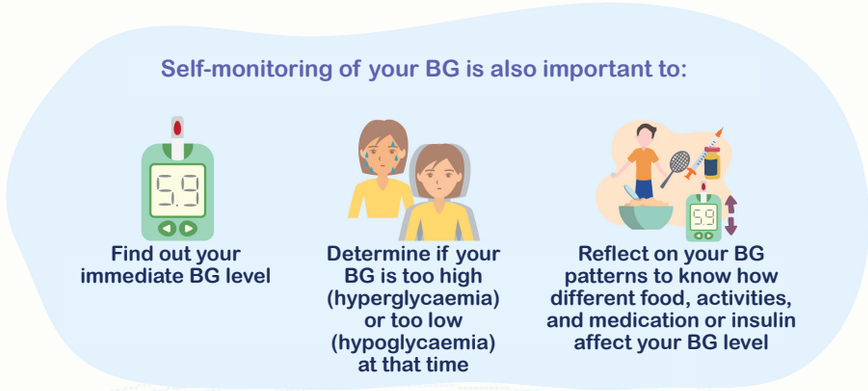


Figure 5.1: Benefits of Self-Monitoring of BG (SMBG)

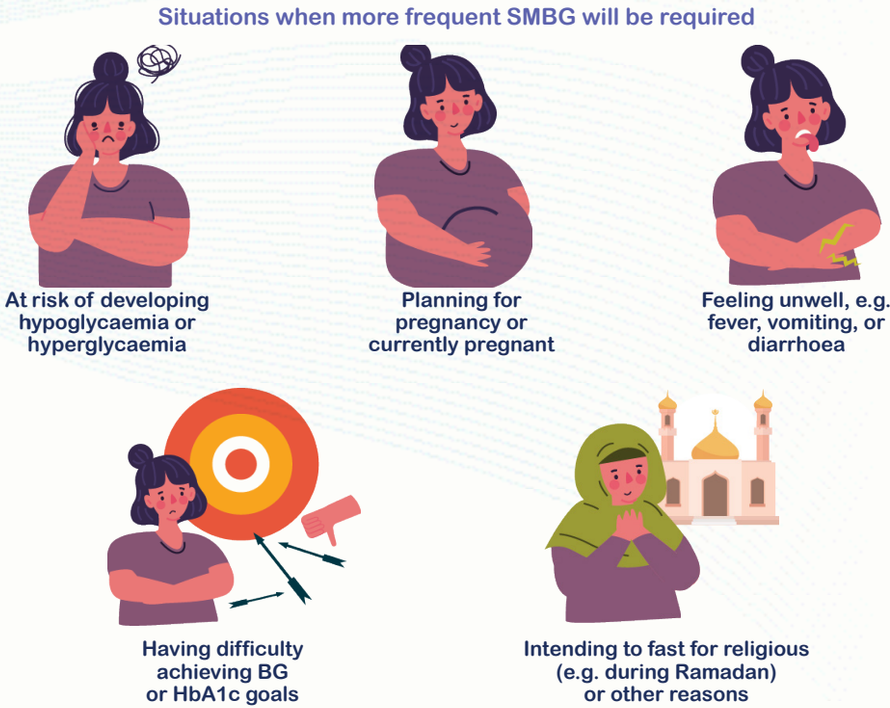


Figure 5.2: Situations requiring more frequent SMBG

5.4 Self-monitoring of Blood Glucose (SMBG)

Tips to reduce fingertip pain when checking BG:



Figure 5.3: Tips for reducing pain

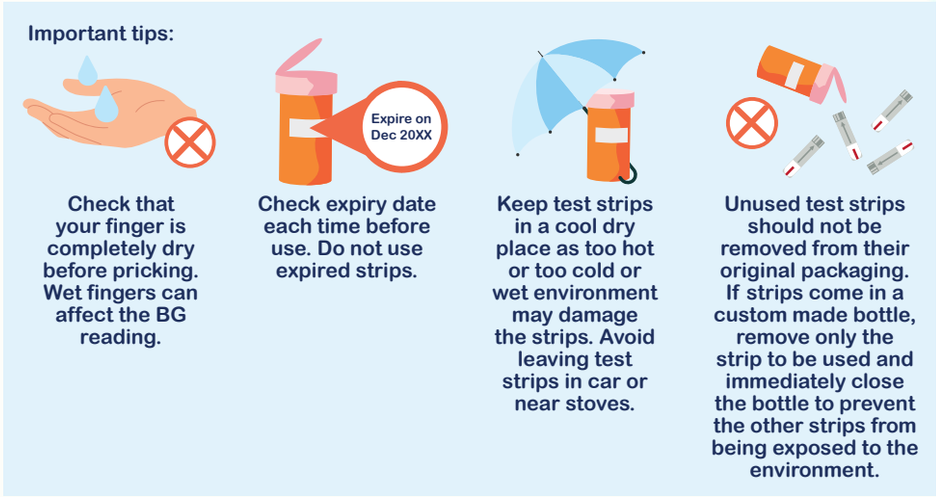


Figure 5.4: Other SMBG tips

5.5 Making sense of BG readings through correlation with HbA1c

There is a good correlation between BG range and HbA1c results. To achieve good diabetes control, you will have to keep BG levels within the target range to reach your optimal HbA1c.

The table below shows the correlation of BG level with HbA1c; your BG targets should be individualised. Do discuss with your healthcare team.

BG Range	HbA1c result
Under 7.0 mmol/L	Less than 6%
Mostly under 10.0 mmol/L	6-7%
Mostly between 10.0 - 16.0 mmol/L	8-12%
Mostly over 17.0 mmol/L	More than 13%

Table 5.1: BG correlation with HbA1c

Write your BG and HbA1c targets here:

	Good	Sub-optimal	Poor	My Targets
Fasting/waking up glucose (mmol/L)	5.0 - 7.0	7.1 - 10.0	> 10.0	
Pre-meal glucose (mmol/L)	4.0 - 7.0	7.1 - 10.0	> 10.0	
Post-meal glucose (mmol/L)	< 10.0	10.1 - 13.0	> 13.0	
HbA1c (%)	≤ 7.0	7.1 - 8.0	> 8.0	

Table 5.2: My BG and HbA1c targets

5.6 When to check BG readings?

Depending upon your type of treatment, you may need to check your BG once every few days or multiple times a day. BG levels can be checked pre-meals or 2-hour post-meals, depending on the type of insulin you are on.

The table on the next page shows a guide to timings that you can check your BG. Discuss with your healthcare provider which are the best timings and the frequency of BG checks to help you to achieve your BG goals.

Recommended timing	Reason
Fasting / Pre-breakfast BG level Before the first meal of the day, after fasting for 8 to 12 hours	• Determines how well your body manages BG while you sleep. • Provides a baseline to see changes in your BG level throughout the day and if your basal insulin dose is appropriate.
Pre-meals 0 – 30 minutes before meals To correctly interpret a pre-meal reading, the previous meal or snack must be more than 4 hours earlier	• Provides a baseline reading of your BG level before you eat and if your basal insulin dose is appropriate. • When tested in pairs (pre-meal and post-meal), a pre-meal reading can serve as a reference for how the food you eat, and any pre-meal medications affect your BG levels and if your mealtime insulin dose is appropriate.
Post-meals 2 hours after the start of a meal	• Gives an estimate of how much a person's BG rises in response to food.
Bedtime Check before going to bed, more than 3 hours after dinner with no supper or snacks in between	• To detect any potential night or bedtime hypoglycaemia. • Bedtime reading with the following day's pre-breakfast reading helps to gain insight to your overnight BG pattern.
When having any possible hypoglycaemia symptoms such as hunger, feeling shaky, sweating, fast heartbeat, light-headedness/ headaches	• Testing your BG level confirms the presence of low BG. • For more information on hypoglycaemia, refer to Chapter 6: Hypoglycaemia.
Before and after exercise	• A person who is on insulin therapy or certain diabetes medications may experience hypoglycaemia during or after exercise. • For more information, refer to Chapter 11: Insulin and Exercise.
When you are sick and not eating well	• BG level may increase when you are sick even if you are not eating much. At the same time, you may also lose your appetite when you are sick and may be at risk of hypoglycaemia. • Check your BG every 4-6 hours when you are awake (or more frequently if you are unwell). • *For more information, refer to Chapter 9: Sick Day Management.*

Table 5.3: Timings to check SMBG

5.7 Alternative methods of glucose monitoring

Flash glucose monitoring (FGM)



Figure 5.5: Flash glucose monitoring (FGM) sensor, and reader vs smartphone to read FGM



*Figure 5.6: Using a smartphone to read FGM (*only applicable to smartphones that can download required FGM app)*

Flash glucose monitoring (FGM) enables you to tell your glucose levels without pricking your finger for each reading. A sensor is placed into the skin of the upper arm to measure glucose levels in the tissue fluid. A reader or a mobile phone app can then reflect the current tissue glucose level when held over the sensor. Each sensor can last up to 2 weeks.

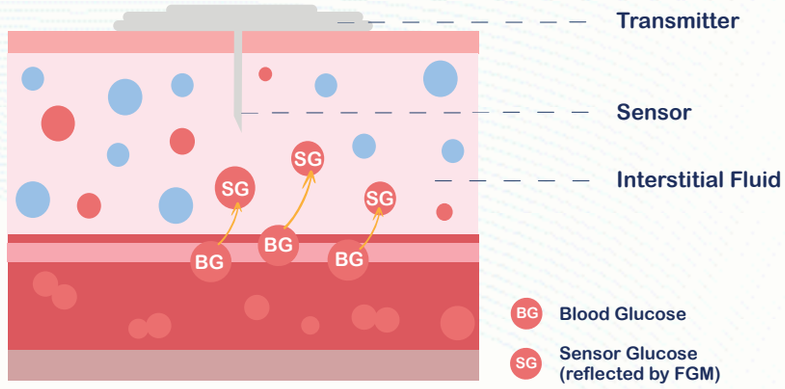


Figure 5.7: How a FGM sensor works

The sensor reads the glucose reading from your tissue fluid, **not** BG directly. This reading is used to estimate your BG reading.

The advantage of FGM is that it is useful for detecting glucose trends and patterns throughout the day with various activities and food intake and for patients who may be fearful of repeated finger pricks.

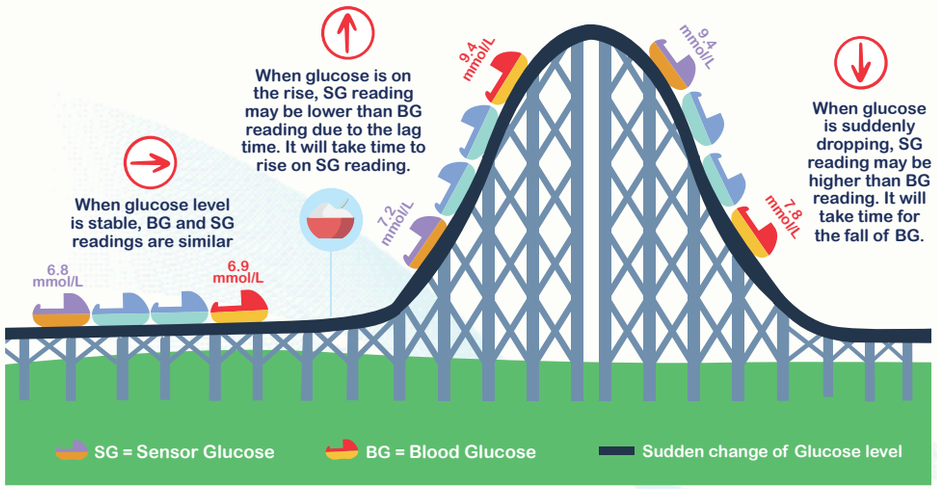


Figure 5.8: Lag-time between SG and BG reading

However, the SG readings will not always match finger-stick BG readings. SG readings will always lag 5-10 minutes behind BG readings. If you are in doubt of the readings shown on the FGM device, always confirm with finger-stick BG reading before taking action.

5.8 Keeping a diary

Keep a record of your BG readings so that you can recognise patterns in your BG levels. You will also learn how your activities, food intake and medication affect your BG. With a diary of your BG readings, you can then make changes to your lifestyle and diet. Bringing your BG diary for your appointments is also very important as it allows your healthcare team to adjust your medications and insulin therapy accurately.

This BG diary can be in the form of BG charts, notebook or a digital diary on mobile health applications. Discuss with your healthcare provider what is best for you. Some BG meters are now linked to mobile health applications which make it easier for you to log your BG readings.

An example of how you can record your readings in a diary:

Home BG monitoring record										
Date	Breakfast		Lunch		Dinner		Bedtime	2am	Remarks	Others
	Before	2 hours after food	Before	2 hours after food	Before	2 hours after food				

Figure 5.9: BG diary

CHAPTER 6: HYPOGLYCAEMIA – LOW BLOOD GLUCOSE

Learning Objectives:

1. Understand what is hypoglycaemia
2. Learn how to treat hypoglycaemia

A sudden drop in BG level can result in immediate symptoms and pose a danger to our bodies. We will explore how to identify, avoid and treat hypoglycaemia in this chapter.

6.1 What is hypoglycaemia?

It is a low BG reading, which is, less than 4.0 mmol/L. You may have symptoms and hence feel unwell from it. However, some individuals do not have symptoms with such low BG levels. Hypoglycaemia can sometimes result from diabetes treatment. Hypoglycaemia is usually due to a mismatch between food intake and diabetes medications, including insulin.

Hypoglycaemia Symptoms

Some of us feel unwell when BG levels fall into the hypoglycaemia range. Early symptoms can include:



Figure 6.1: Hypoglycaemia symptoms

Severe (dangerous) hypoglycaemia

If these early symptoms of hypoglycaemia are not treated, the BG levels can continue to fall. Once BG falls even lower (usually to less than 3.0 mmol/L or undetectably low), the brain is unable to function normally. The brain is only able to make use of glucose as a source of fuel. Untreated hypoglycaemia can become dangerous for the brain.

You may then feel:



Figure 6.2: Severe hypoglycaemia symptoms

If left untreated at this stage, you may lose consciousness or experience fits (uncontrolled shaking movements) as the brain is not able to function properly. This is potentially life-threatening and you will require someone else to rescue you.

Hypoglycaemia without symptoms (hypoglycaemia unawareness)

The symptoms of hypoglycaemia can be different for everyone and may not always be the same every time in a person. Some people also lose the warning signs of hypoglycaemia. They are not aware until a severe and/or serious hypoglycaemia episode takes place. This is usually a result of having repeated episodes of untreated hypoglycaemia where the body has been forced to "get used to" hypoglycaemia. This is potentially dangerous. This loss of warning signs means that having a severe hypoglycaemia episode is more likely. The only way to know for sure whether a hypoglycaemia event is happening is to check your BG regularly! If you have lost your warning signs to hypoglycaemia and you are less aware of hypoglycaemia episodes, you should alert your healthcare team. Your medication doses may need to be adjusted. You should not drive if you have lost your awareness to hypoglycaemia.

It is possible to regain your hypoglycaemia warning signs by reducing its occurrence. Check your BG levels more frequently and correct hypoglycaemia immediately when it happens.

Relative (pseudo) hypoglycaemia



Figure 6.3: Relative hypoglycaemia - feeling the "hypos" symptoms with a normal BG value

Some of us may experience hypoglycaemia symptoms described above even when our BG levels are above 4.0 mmol/L. This is known as relative (pseudo) hypoglycaemia. This is not real hypoglycaemia and it happens when your body is used to higher BG levels, especially in poorly controlled diabetes. You hence start to feel "hypoglycaemia" symptoms when good BG levels (i.e., 4.0 – 6.0 mmol/L) are achieved. The body will need time to adjust to this new healthier BG level.

6.2 How to correct Hypoglycaemia?

It is important to be able to self-treat and rescue yourself when you experience hypoglycaemia.

Follow this chart to correct hypoglycaemia on your own.

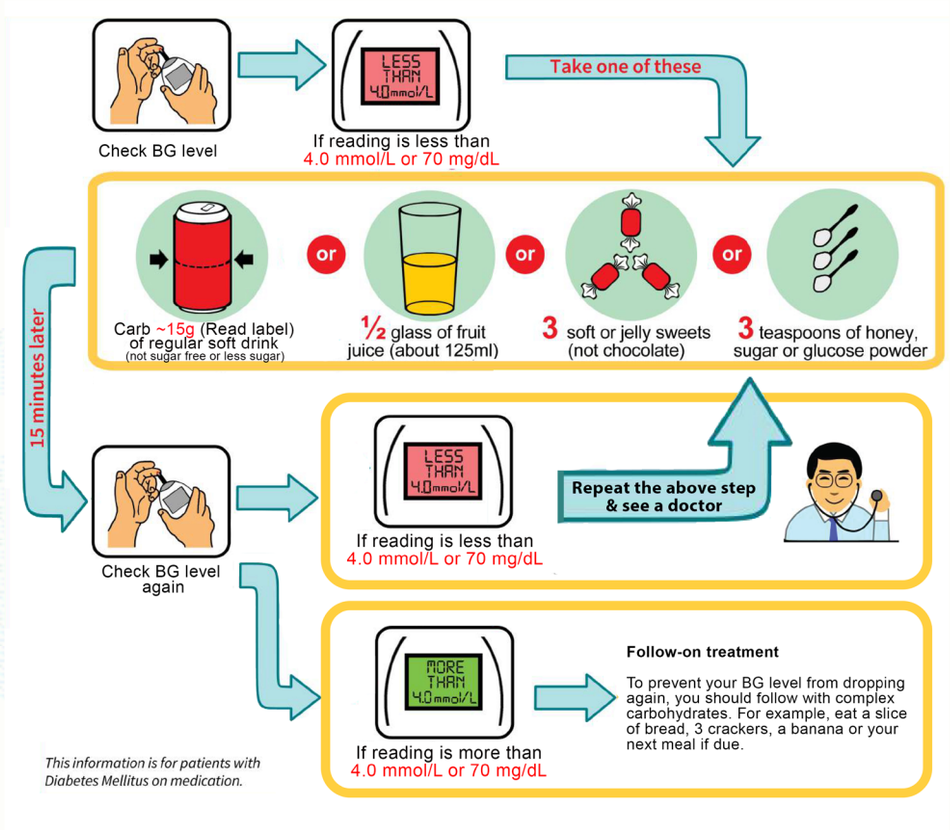


Figure 6.4: Hypoglycaemia action plan

Do not eat chocolate, biscuits, chips or drink milk for hypoglycaemia as the fat content in these foods will slow down the absorption of glucose.



Figure 6.5: Inappropriate hypoglycaemia rescue options

Mild Hypoglycaemia	Severe Hypoglycaemia
3.0 to 3.9 mmol/L	< 3.0 mmol/L

Table 6.1: Mild and Severe Hyperglycaemia readings

Mild Hypoglycaemia

Low BG levels are usually mild, usually in the range of 3.0 to 3.9 mmol/L. You should be well and alert enough to treat yourself. If you are able to, treat yourself immediately.

Severe hypoglycaemia

If BG falls too low (usually less than 3.0 mmol/L), you may become confused and unable to rescue yourself in a severe hypoglycaemia episode. Someone else near you will need to treat you. As such, it is important for family members or close friends who are aware of your diabetes, to know how to recognise and assist you during a severe hypoglycaemia episode.

Teach your family and friends these simple instructions:

If you are unconscious.

- Call emergency services at 995 immediately.
- As you are unconscious, you will not be able to have anything by mouth. The paramedics will need to give you a glucose injection.

If you are conscious, but confused (Your family / friends should be taught how they can help to rescue you from a hypoglycaemia episode):

- Check your BG level.
- Do hypoglycaemia correction as shown in Figure 6.4.

Ensuring safety

Make sure that your hypoglycaemia symptoms have resolved. Check your BG again in 15 minutes. If BG is still less than 4.0 mmol/L, repeat the treatment with 15g of simple carbohydrates again. This should be sufficient to treat mild hypoglycaemia. However, if repeating the treatment for 2 rounds still does not resolve the hypoglycaemia, do see your doctor immediately.

Once your hypoglycaemia has resolved, do have your next meal if it is about time. However, if your main meal is not within an hour, you may consider bringing forward your next meal or taking an additional 10-20g of complex carbohydrates., e.g. a serving of fruit, or a slice of bread or 3 pieces of crackers.

Once you are well, it is important to figure out the possible cause of your hypoglycaemia episode to avoid it from happening again.

6.3 Causes of hypoglycaemia

Hypoglycaemia is caused by too much insulin or too little glucose.

Too much insulin	Too little glucose
Wrong insulin dose - Double check your medication label and that you have given yourself the correct dose. - If you have given yourself the correct dose, monitor for another episode of hypoglycaemia. If you experience repeated episodes of hypoglycaemia, call your medical team for an earlier appointment. Your insulin dose may need to be reduced.	**Skipped or delayed meal** - Insulin starts working at a fixed timing after it has been injected. - It is just as important to have fixed and regular meals as taking your insulin injections on time.

Too much insulin	Too little glucose
Improved insulin sensitivity (reduced dose requirement) - With physical activities including exercise, your body is able to use the insulin more effectively when and after you exercise. Try to have a fixed exercise regime and monitor your BG regularly before, during and after exercise to understand your own body's response to exercise. Refer to Chapter 11: Insulin and Exercise for more information.	**Reduced meal portions** - As your insulin doses are fixed, you are encouraged to eat a fixed meal portions. - A sudden reduction in meal (especially carbohydrate portion) can lead to hypoglycaemia (if you are ready to have a more flexible approach to your insulin doses, inform your healthcare team so that you can be taught to estimate carbohydrate portions and self-adjust your bolus insulin). Refer to Chapter 10: Insulin and Food for more information.
	Falling ill - If you are unable to eat well and/or vomiting from an illness, you may experience hypoglycaemia.
	Alcohol intake - Alcohol reduces glucose release from the liver and can lead to hypoglycaemia.

Table 6.2: Causes of hypoglycaemia

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CHAPTER 7: HYPERGLYCAEMIA – HIGH BLOOD GLUCOSE

Learning Objectives:

1. Understand what is hyperglycaemia
2. Learn how to troubleshoot hyperglycaemia at home

7.1 What is hyperglycaemia?

Hyperglycaemia is the term used to describe high BG levels, usually more than 15.0 mmol/L. These high BG levels may cause persons with diabetes to feel sick and uncomfortable. In addition, persistently high BG levels will result in poorly controlled diabetes and eventually lead to long-term complications.

Hyperglycaemia symptoms

You may have experienced some of these symptoms when you were first diagnosed with diabetes or when your BG control was poor.

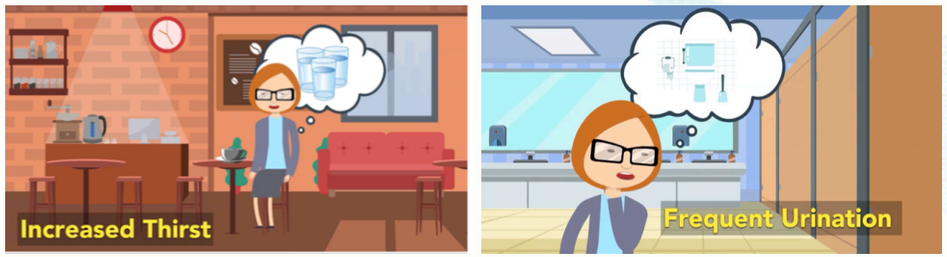


Figure 7.1: Hyperglycaemia symptoms

Excessive amount of glucose is passed out from kidneys causing water loss and hence increased thirst. If one does not hydrate well enough, there may be symptoms of dehydration.

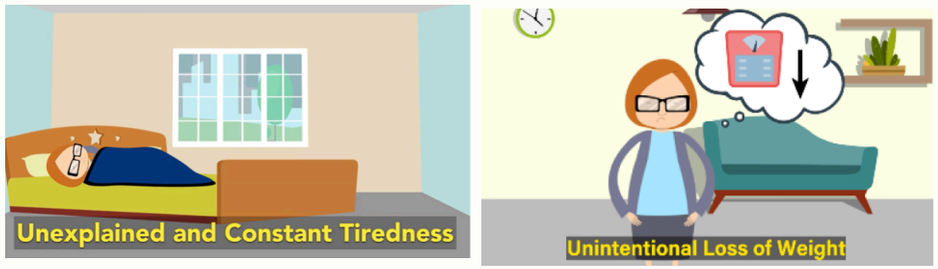


Figure 7.2: Hyperglycaemia symptoms

One may experience weight loss despite eating as usual. This is due to the lack of insulin action to bring sugar from the bloodstream into cells. This is why insulin therapy is started early for some people with type 2 diabetes.



Figure 7.3: Hyperglycaemia symptoms

Poor wound healing and more severe forms of infection can happen as high BG weakens our immune (defence) system and reduce our ability to fight infection.

These symptoms are not permanent. They can be reversed once diabetes control improves and BG returns to an acceptable level.

Hyperglycaemia without symptoms (Asymptomatic hyperglycaemia)

Persons with type 2 diabetes may not feel anything out of the norm (asymptomatic) with hyperglycaemia. That's the reason why our health screening program includes BG checks to pick up people with asymptomatic diabetes. It is important to understand that high BG levels, when left unnoticed, and untreated continue to harm the body without one realising it. It is hence very important to check your BG regularly.

7.2 Causes of hyperglycaemia

Here are some common reasons for having high BG levels, more than 15.0 mmol/L in most cases. Some of these reasons can be easily handled at home with some tips below.

Cause of hyperglycaemia	Reason	Troubleshooting (What you can do at home)
Insulin / medication related		
Insulin injection site problem – having "hard lumps" at injection sites	The skin and subcutaneous tissue underneath can develop hard lumps if you do not change the site of your injections frequently or if you re-use your insulin needles. This will lead to poor and variable insulin absorption.	Rotate injection site regularly (refer to Chapter 4 for insulin practical tips). Check the skin area for lumps before injection. Rest lumpy area until they recover. If you are unsure how to select and rotate injection site, speak to your healthcare team.
New medications	Some medications including traditional Chinese medicine (TCM) and steroids can cause hyperglycaemia.	Inform your doctor if you have been taking TCM / prescribed new medications from any other doctor.
Skipped insulin doses	The effects of skipping insulin usually last from a few hours to an entire day. You will need to be consistent with all prescribed doses of insulin for good diabetes control.	Be regular with your insulin doses. Set reminders for medications if needed.
"Spoilt" insulin	Inappropriately stored or expired insulin can be ineffective.	Store insulin properly. Check the expiry date of insulin before using. Refer to Chapter 4 for insulin storage.
Lifestyle related		
Increased carbohydrate intake	Your insulin doses are prescribed based on your diabetes control, weight and usual expected carbohydrate intake. You can experience hyperglycaemia if you take more than expected amounts of carbohydrates.	Stick to a consistent meal pattern and carbohydrates intake as much as possible. Keep a food diary. Refer to Chapter 10 for advice on insulin and food.
Falling sick	Our bodies are under stress and act differently when we fall ill. Our BG can rise as a result of this stress response.	Monitor BG levels more frequently. Keep well hydrated. Refer to Chapter 9 for more information on sick day management.

Table 7.1: Causes and management of Hyperglycaemia

Hyperglycaemia may also be a result of long-standing poor diabetes control as a result of insufficient medications, the need for insulin therapy, or poor adherence to medications and insulin therapy.

Do monitor your BG levels regularly and keep a food diary to allow your healthcare team to adjust your insulin doses effectively at your clinic visits.

CHAPTER 8:
SEVERELY HIGH BLOOD GLUCOSE STATES – HYPEROSMOLAR HYPERGLYCAEMIC SYNDROME (HHS) AND DIABETES KETOACIDOSIS (DKA)

Learning Objectives:

1. Learn about the causes of HHS and DKA
2. Know the signs and symptoms of HHS and DKA

8.1 What is HHS and DKA?

In type 2 diabetes, prolonged high BG levels coupled with other acute health issues such as an infection or illness, can lead to diabetes emergencies known as Hyperosmolar Hyperglycaemic Syndrome (HHS) or Diabetes Ketoacidosis (DKA).

If left untreated, both HHS and DKA can lead to coma and even death. Persons with HHS or DKA require admission to the hospital for urgent treatment.

How does it happen?

In HHS, BG in a person with diabetes has become too high (hyperglycaemia) for a long time (days to weeks). This excess glucose is passed into the urine, which causes the person to urinate frequently and can lead to extreme thirst and severe dehydration. HHS tends to develop in people who do not have their type 2 diabetes under control or have stopped their medications to manage their diabetes. At the same time, they may be suffering from an acute illness such as a chest or urinary tract infection.

DKA mostly affects individuals with type 1 diabetes. However, it can also happen in type 2 diabetes when one is ill with infections, or other sicknesses. In DKA, the body is unable to produce enough insulin to take up the glucose in our blood, it in turn uses fats as fuel (energy) to stay alive. An acid, known as ketones, is the end product of using fats as fuel (fat burning). Excessively high BG levels due to the little/less insulin produced, causes one to pass more urine and become dehydrated. A combination of high BG levels, accumulation of ketone acid and dehydration leads to DKA.

What can cause an episode of HHS/DKA?

The common reasons (triggers) for an episode of HHS/DKA include:

- Having poor control of diabetes
- Missed medication / insulin doses
- Having an acute illness (e.g. infections, heart attack, stroke etc)

8.2 How to recognise HHS/DKA?

1. Check your BG regularly.
2. When BG levels are persistently more than 15.0 mmol/L, monitor symptoms of HHS/DKA:



Figure 8.1: Symptoms of HHS / DKA

When to call for help?

You should see a doctor immediately when

- There are any signs and symptoms of HHS/DKA.
- Glucometer consistently showing readings of "HI" indicating that BG level is more than 33.3 mmol/L which is considered dangerously high.



Figure 8.2:Glucometer showing "HI" BG reading

NOTES

CHAPTER 9:
SICK DAY MANAGEMENT

Learning Objectives:

1. Understand what a sick day is
2. Understand how a sick day can affect your BG level
3. Learn how to self-manage a sick day
4. Know when to seek medical attention

9.1 What is a sick day?

A sick day is when you have fallen acutely unwell. It can be something as minor as a common flu, or major such as pneumonia.

9.2 How can a sick day affect your BG level?

During sick days, your BG levels can swing either way. You may even experience both hypoglycaemia and hyperglycaemia. Hypoglycaemia may happen if you do not eat well when you are sick and continue your usual diabetes medications. On the other hand, BG levels can be high due to the additional stress hormones, such as cortisol and adrenaline, in your body. This causes the liver to release some of its stored glucose, causing BG to increase even if you are not eating as much food as you normally would.

As such, it is important to check your BG more frequently when you are sick.

9.3 Managing a sick day

It is good practice to learn how to manage a sick day even before it happens. This chapter will provide you with a guide. Do discuss any details with your healthcare team if you are unsure.

How should I take care of myself on a sick day?



Come up with a sick day management plan in advance. Discuss with your healthcare team what to do before hand if you were to fall ill



Monitor your BG

- **Check your BG before each meal if you are eating well. (This will mean about 3 - 4 times per day)**
- **Continue monitoring BG at this frequency or more frequently if**
  - **Your BG level is out of the target range.**
  - **You cannot follow your regular meal timings.**
  - **You are not feeling well. (Dehydrated, hypo or hyperglycaemia symptoms)**



Eat and drink regularly

- **Follow your usual meal plan and eat regularly.**
- **If your appetite is poor or you are not able to eat solid food, try to replace your carbohydrate intake with fluid or foods that are easy to swallow. (Examples given in the table below)**

Foods that contain 15g carbohydrate	
Rice porridge	1/2 rice bowl
Oatmeal (uncooked)	3 dessertspoons
Nestum Cereal (uncooked)	3 heaped dessertspoons
Bread (white/wholemeal)	1 slice
Cream crackers	3 pieces

Drinks that contain 15g carbohydrate	
Powdered milk	6 heaped teaspoons
Liquid milk (non-flavoured)	250 ml (1 cup)
Soya milk	200 ml (3/4 cup)
Milo powder	4 teaspoons
Fruit juices	125 ml (1/2 cup)



- **Keep yourself well hydrated. Drink water and sugar-free drinks.**
- **Avoid caffeinated drinks.**



Continue your usual diabetes medication

- **You may take your usual diabetes medications if you are able to eat and drink well.**
- **The following diabetes medications may need to be adjusted when you are not well.**

Diabetes Medication	What happens during acute illness	Quick guide before visiting the doctor
Metformin	May worsen gastro-intestinal symptoms such as diarrhoea and vomiting May need to be adjusted or stopped if kidney injury occurs (usually due to dehydration)	Stop Metformin temporarily if you have these symptoms Ensure good hydration
SGLT-2 inhibitors Dapagliflozin Empagliflozin	Can cause dehydration, urinary tract infections. DKA can occur as a result	Stop this medication when you have a fever, eating poorly or have urinary tract infection symptoms (e.g. pain on passing urine, foul-smelling urine)
Sulphonylurea Glipizide Gliclazide Tolbutamide **Insulin**	Can cause hypoglycaemia with poor appetite and intake of food	Ensure good intake of food You may need to reduce the dose or stop this medication temporarily when you are unwell. This dose adjustment should be advised by your healthcare team



See a doctor urgently if you are not able to maintain your water and food intake, or have adjusted any of your diabetes medication due to the sickness

When should you seek medical help?

See a doctor as soon as possible if the following occurs:



1. BG readings out of range

- Repeated episodes of hypoglycaemia (less than 4.0 mmol/L)
- Repeated episodes of hyperglycaemia (more than 15.0 mmol/L) or out of your usual expected range

2. Symptoms of

- Severe vomiting such that you are unable to keep any fluid, food or oral medication down.
- Signs of dehydration including giddiness upon standing up, low or no urine output
- Feeling extremely unwell
- HHS / DKA as discussed earlier

3. Adjusted your diabetes medications in any way at home on your own

CHAPTER 10:
INSULIN AND FOOD

Learning Objectives:

1. Learn about carbohydrates in your diet and how to gauge your daily requirements
2. Understand the time relationship between insulin injection and food
3. Learn simple carbohydrate counting and estimation in your food with regards to insulin dosing
4. Read about sample meal plans for people with type 2 diabetes on insulin
5. Discover some healthy snack options for people with diabetes
6. Learn about other food sub-groups (non-starchy vegetables, proteins) to include in your diet
7. Learn about some quick tips on weight management and diet

Diet plays an important role in diabetes self-care. It is important to understand how food affects BG. The main nutrient that raises BG is carbohydrate. This chapter on diet will mainly focus on understanding carbohydrates, and how to match the insulin you are on to the amount of carbohydrates you normally consume.

10.1 What are Carbohydrates?

Carbohydrates in your diet provides energy to the body.

Food like brown rice, noodles, cereal, bread, fruits, potatoes, dairy and dairy products contain carbohydrates.

Rice and alternatives



Figure 10.1: Rice and alternatives

Baked goods and others

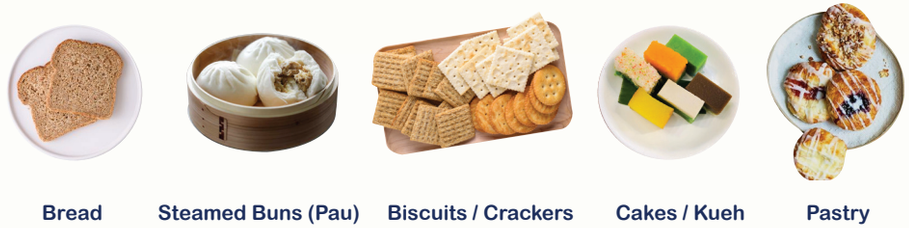


Figure 10.2: Baked goods and others

Dairy and dairy products



Figure 10.3: Dairy and dairy products

Nuts and legumes



Figure 10.4: Nuts and legumes

Fruits and juices



Figure 10.5: Fruits and juices

Starchy vegetables



Figure 10.6: Starchy vegetables

Carbohydrate requirements

This is an example of a formula used by dietitians to estimate one's daily energy requirement based on body weight. You may use this as a reference. However, this estimated energy will differ based on your gender, age and physical activity level. Speak to your dietitian for more details where needed.



Estimation of daily energy requirement =
Current body weight (kg) x 25-30kcal/day (adjusted based on body size)

From one's estimated energy requirement, you can then work out your carbohydrate requirement. However, if you are overweight or obese, you may wish to reduce about 15-30g of carbohydrates from the total carbohydrate requirements. Your carbohydrate requirements based on body weight may also differ based on your medical condition and diabetes control. Discuss them with your healthcare team. These estimations only serve as a guide.

Estimated energy requirement (kcal)	Approximate carbohydrate requirement (g)	Carbohydrate distribution			
		Breakfast (g)	Lunch (g)	Dinner (g)	Snack(s) (g)
1200	150g	30-45	30-45	30-45	0-15
1500	180g	30-45	45-60	45-60	0-15
1800	210g	45-60	45-60	45-60	15-30

Table 10.1: Carbohydrate requirement estimation based on daily energy requirement

10.2 Timing of insulin and meal intake

If you are on insulin therapy, it is important to match the timing of carbohydrate intake with the type of insulin you are on.

Type of insulin prescribed	Meal-intake advice	Remarks
Mealtime bolus insulin (Short or rapid acting insulin)	Keep carbohydrate intake to your main meals shortly after injecting bolus insulin.	If a snack is needed, try to choose snacks with minimal carbohydrates to prevent BG spikes at snack-times where no bolus insulin is injected.
Premixed insulin	Keep carbohydrate intake to your main meals shortly after injecting the premixed due to the bolus component.	You may need a carbohydrate-containing snack mid-morning or before you sleep to prevent a hypoglycaemia event due to the intermediate-acting insulin.
Basal insulin only		
Long-acting insulin	There is no need to eat immediately or shortly after injection. Some patients may even take these insulins just before bedtime due to its long-acting nature.	Nil.
Intermediate-acting insulin		You may need a carbohydrate-containing snack mid-morning or before you sleep to prevent a hypoglycaemia event due to peak action of the intermediate-acting insulin at these timings.

Table 10.2: Matching insulin injection, meal timing to the type of insulin prescribed

Do discuss the timing and need for snacks with your healthcare provider.

**You may refer to Chapter 3 for the types of insulin available.*



Figure 10.7: Common household measuring items

10.3 Counting carbohydrates

After learning the approximation of carbohydrates in your daily requirements, here are some examples of carbohydrates and their respective portions in our daily food. The common concern that many patients have is that they are not aware of the common food that contains carbohydrates and the amount of carbohydrates these food items may contain. This often leaves one puzzled and upset trying to explain why his or her BG is high without "much rice or noodles intake". The pictures below will show you some common carbohydrates and "hidden carbohydrates" in your daily diet.

For someone on insulin therapy, it is important to take into account these details to be able to maintain relatively similar amount of carbohydrate on a day-to-day basis as your insulin doses are fixed. It is important not to over-eat or under-eat the portions when switching around the different food items to avoid hyperglycaemia or hypoglycaemia.

Rice and alternatives - 15g carbohydrate

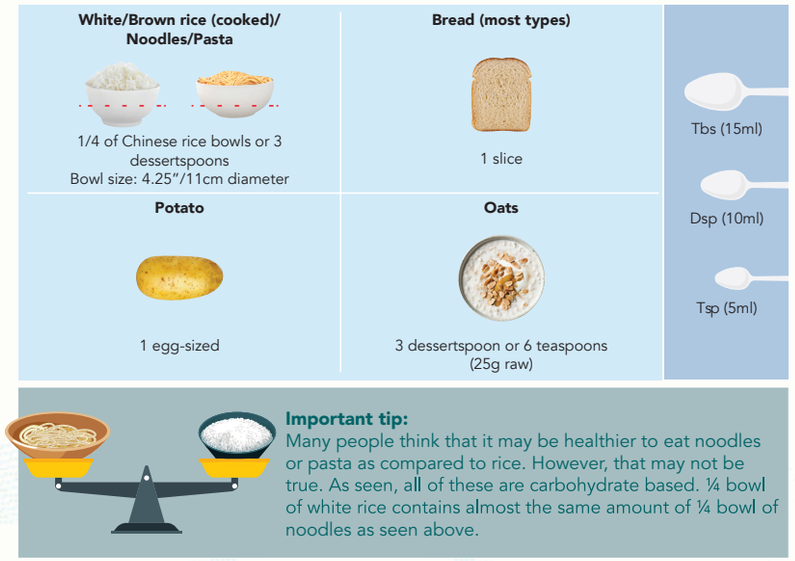


Figure 10.8: 15g carbohydrate portions – for staples

Fruits - 15g carbohydrate

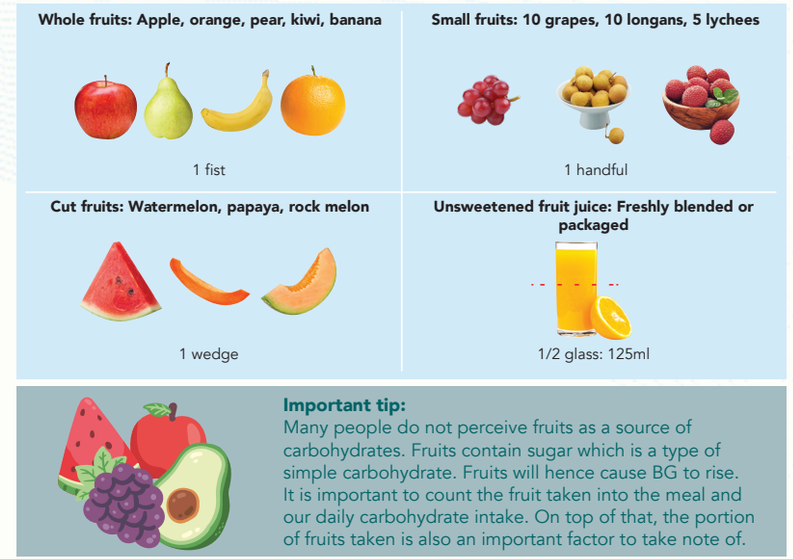


Figure 10.9: 15g carbohydrate portions – for fruits

Milk and alternatives - 15g carbohydrate

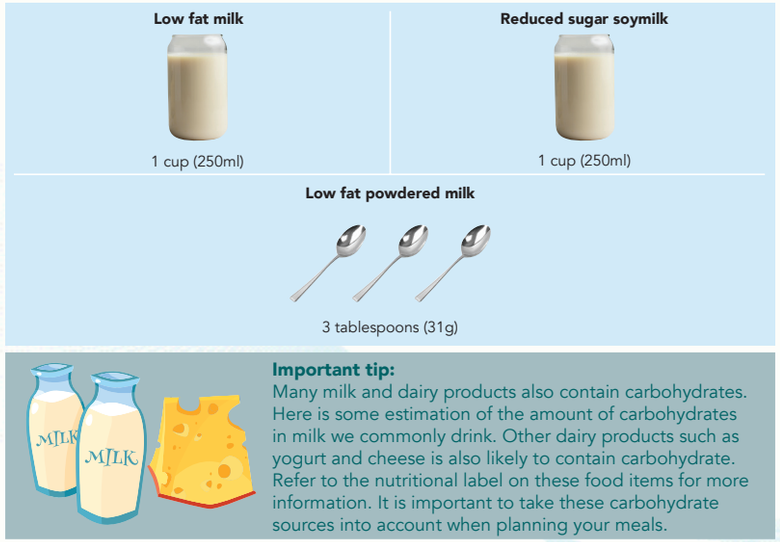
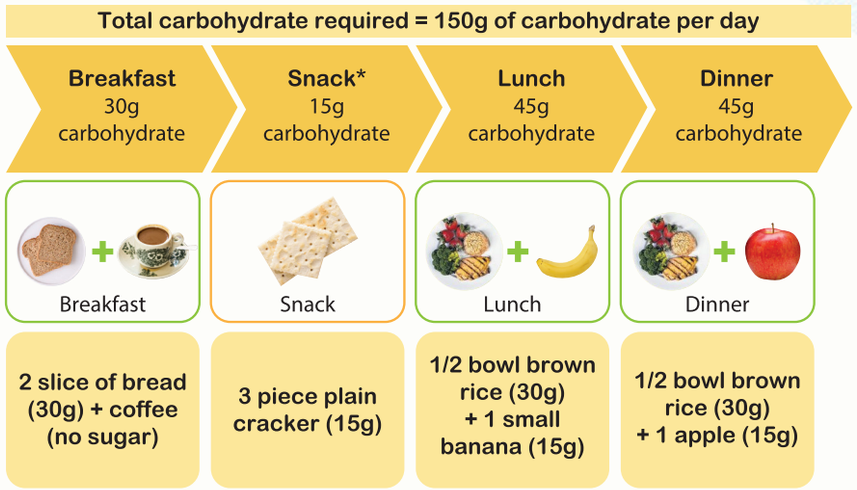


Figure 10.10: 15g carbohydrate portions for milk products

10.4 Sample meal plans

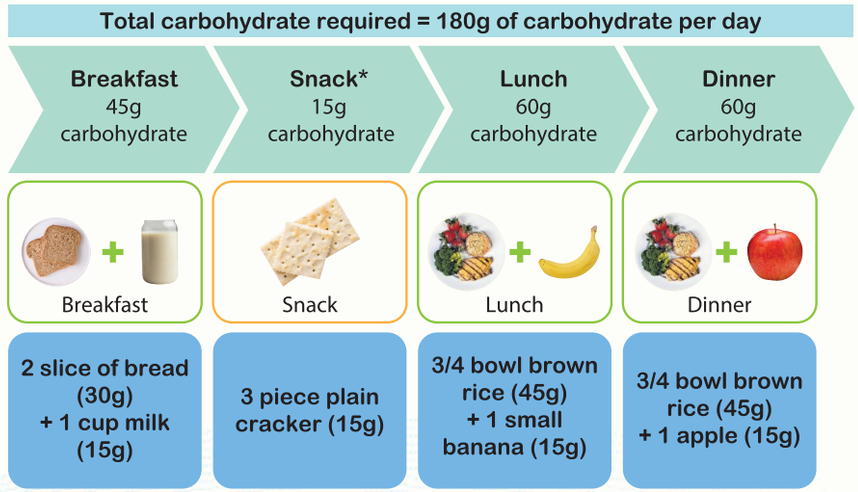
Sample meal plan for 1200kcal per day



**Snack time could individualized (e.g. at mid-morning or bedtime)*

Figure 10.11: Sample meal plan 1

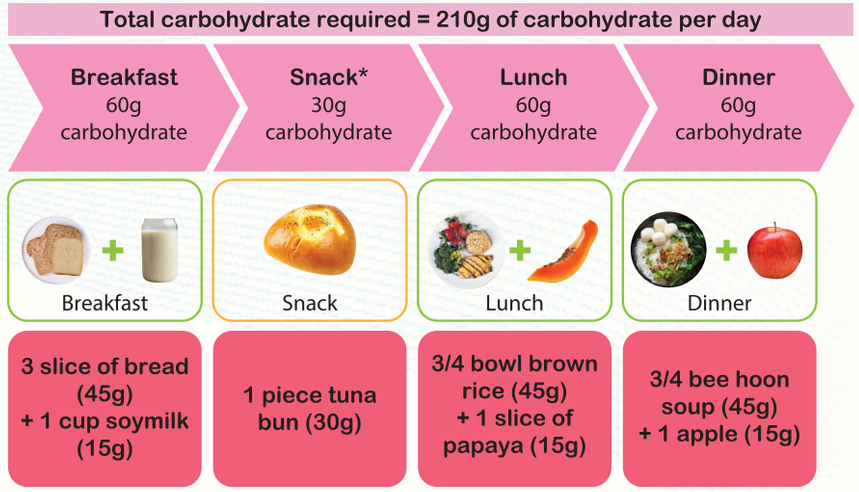
Sample meal plan for 1500kcal per day



**Snack time could individualized (e.g. at mid-morning or bedtime)*

Figure 10.12: Sample meal plan 2

Sample meal plan for 1800kcal per day



**Snack time could individualized (e.g. at mid-morning or bedtime)*

Figure 10.13: Sample meal plan 3

10.5 Healthier snack ideas

The following are some healthier snack ideas that have minimal carbohydrates. You can consider these snacks if you are looking for an option that does not cause much BG spikes.

Snacks with minimal carbohydrates

Drinks



Figure 10.14: Beverages

Vegetables and fruits

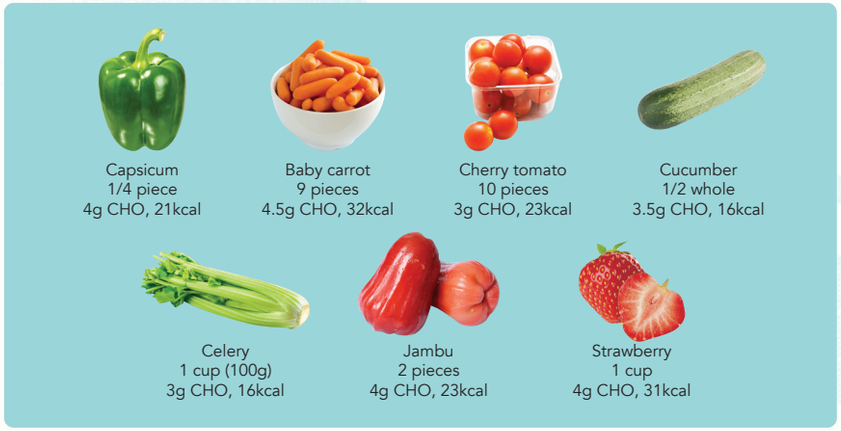


Figure 10.15: Vegetables and fruits

Other snacks



Figure 10.16: Other snacks

Snacks with Carbohydrates

If you are on premixed insulins (due to the component of intermediate-acting insulin) or intermediate-acting insulins, you may require a carbohydrate-containing snack mid-morning or before you sleep to prevent a hypoglycaemia event.

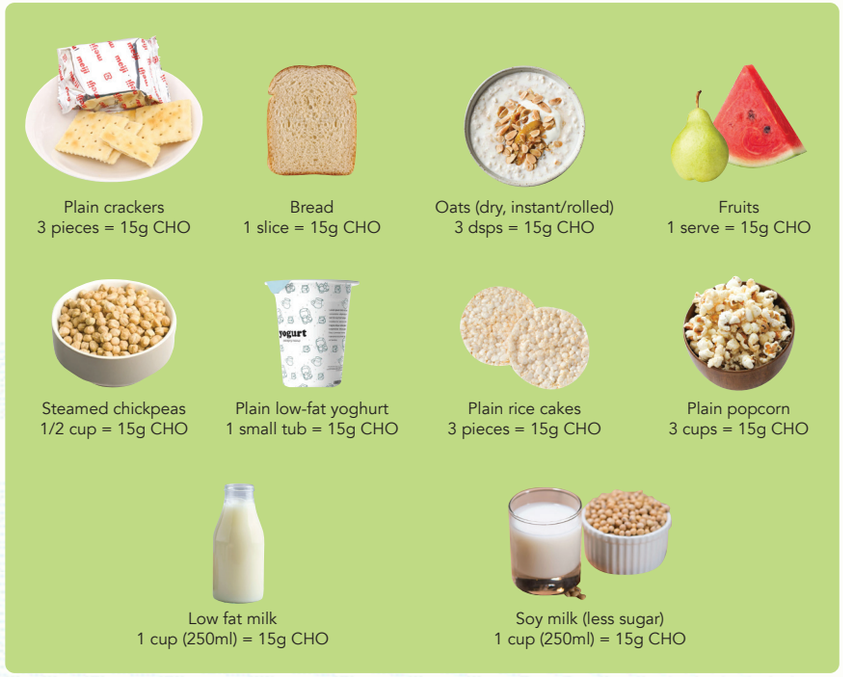


Figure 10.17: Snacks with Carbohydrates

10.6 Other food sub-groups to include in your diet

The following foods should be included in your diet as they are important for good health. They contain little to no carbohydrates and will not have a significant direct effect on your BG levels.

Non-starchy vegetables

Non-starchy vegetables contain fibre which can prevent a rapid rise in BG levels. They also contain various vitamins and minerals. Aim to eat at least two servings of vegetables daily. To improve your BG levels, adopt a high fibre and low-fat diet.

1 serving of vegetables equals to			
3/4 cup of cooked vegetables (100g)	1/4 plate of cooked vegetables (100g)	Raw non-leafy vegetables (100g)	Raw leafy vegetables (100g)

Table 10.3: Vegetable portions



Figure 10.18: Non-starchy vegetables

Protein sources

Meat, eggs and tofu are good sources of protein for maintaining and building muscles. Protein, on its own, does not raise your BG. Legumes (beans) are also a good source of protein. However, they do contain a significant amount of carbohydrates.

You should also choose lean meat or poultry without skin to reduce fat and cholesterol intake.

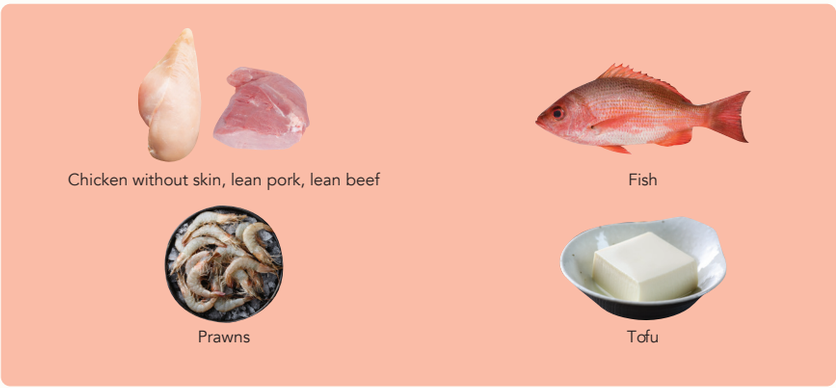


Figure 10.19: Protein sources

10.7 Weight management tips

Many people with type 2 diabetes are overweight. On top of that, weight gain is a common known side-effect of insulin that many are concerned about.

Here are some tips for your diet management to avoid weight gain with insulin.

1. My Healthy Plate

   - Use this visual guide for a balanced and healthy meal. Fill 1/2 your plate with non-starchy vegetables, 1/4 with wholegrains and 1/4 with protein (lean meat or others).
   - Aim for 2 servings of vegetables daily



Figure 10.20: My Healthy Plate, credits to HPB

2. Reduce Sugar Intake

   Foods and beverages with added sugars contribute extra calories to your diet without providing valuable nutrients. It is recommended to keep sugar intake to less than 10% of your daily energy intake. That is approximately 9 teaspoons of sugar (based on a 1800kcal per day intake). A further reduction to 4-5 teaspoons of sugar can bring about additional health benefits such as weight loss.



Some tips:

- Choose diet/sugar-free/no sugar, reduced/less sugar or unsweetened/no added sugar beverages.
- Ask for "siu dai/kosong" or "25%/0% sugar".
- Enjoy water infused with fruits (e.g. lemon), rose or mint leaves.

High sugar foods Choose less of these	**Lower sugar alternatives** Take more of these
White sugar, brown sugar, rock sugar, glucose, gula melaka, syrup	Cinnamon powder, natural flavours (e.g. pandan), artificial sweeteners
Condensed milk	Low fat evaporated milk
Sweets/lollies	Sugar-free sweets / lollies
Canned/dried fruits	Fresh/frozen fruits
Coffee/tea with condensed milk *4 tsp sugar*	Coffee/tea without milk and sugar *0 tsp sugar*
Milk tea with pearls *10 tsp sugar*	Oolong tea without milk and sugar *0 tsp sugar*
Green tea frappuccino *7tsp sugar*	Green tea without milk and sugar *0 tsp sugar*
Soya bean with syrup *4 tsp sugar*	Soya bean milk without syrup *1 tsp sugar due to the carbohydrate content in soya beans*

1 teaspoon (tsp) = 5g sugar

Table 10.4: Reducing sugar intake

3. Reduce Fat Intake

Meals that are high in fat can cause food to be digested more slowly and keep BG levels high for longer.

- Choose lean meat over fatty or processed meat.
- Use less fats (e.g. oil and butter) when cooking.
- Choose lower fat cooking methods such as grilling, baking, steaming and microwaving.
- Reduce the amount of spreads (e.g. margarine and peanut butter) and salad dressings.

High fat foods Choose less of these	**Lower fat alternatives** Take more of these
Regular/Japanese-style mayonnaise	Light mayonnaise
Cream or oil based salad dressings (e.g. Caesar and thousand island)	Omit salad dressing. Use lemon juice or vinegar based salad dressings (e.g. balsamic vinegar)
Fatty meat and processed meat (e.g. sausage, salami, bacon and ham)	Lean meat (e.g. chicken breast meat, lean pork)
Full fat/cream dairy products	Low fat or skim dairy products
Potato chips, chocolates, cakes, kuehs, ice cream	Plain baked potato, low fat yoghurt, fruits
Nasi lemak with deep fried chicken wing, fried egg, ikan bilis and chilli *10 tsp oil*	Nasi padang with ayam panggang (skinless), boiled egg and stir-fried vegetables *3 tsp oil*

1 teaspoon (tsp) = 5g oil

Laksa *15 tsp oil*	Sliced fish beehoon soup (no milk) *1 tsp oil*
Nasi briyani with masala chicken *12 tsp oil*	Plain white rice with tandoori chicken thigh, skin removed *3 tsp oil*

Table 10.5: Reducing fats intake

1 teaspoon (tsp) = 5g oil



Tips to reduce fat intake when eating out:

- Trim off visible fat and skin of meat.
- Choose unflavoured white/brown rice over flavoured rice (e.g. chicken rice, coconut rice and briyani rice).
- Choose noodles in clear soup over noodles in gravy or fried/dry noodles.
- Avoid adding fried shallots, sauces and gravies.

4. Increase Fibre Intake

High fibre foods take a longer time to digest. This will make you feel full for a longer period of time while consuming lesser calories.

- Aim for two servings of vegetables and two servings of fruits daily.
- Choose wholegrains (e.g. brown rice, oats and wholemeal bread).

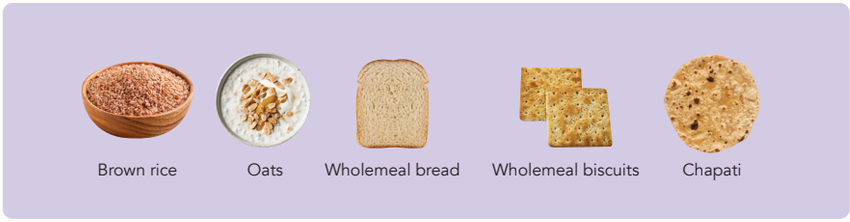


Figure 10.21: Whole-grain options

NOTES

CHAPTER 11:
INSULIN AND EXERCISE

Learning Objectives:

1. Understand the benefits of exercise for people with type 2 diabetes
2. Learn how to exercise safely while on insulin

It is recommended for people with type 2 diabetes to exercise. The American Diabetes Association recommends daily exercise, or at least not allowing 2 consecutive days without exercise, with a target of 150min/week and 5-7% weight loss. You can exercise safely with insulin. In fact, exercising can reduce your insulin requirements through weight loss and reduction of insulin resistance.

11.1 Benefits of exercise

Physical activity includes any activity that increases energy usage, whereas exercise is a planned activity. Regular physical activity and exercise improve overall health. It increases your energy level, muscle tone and strength and is also good for mental health.



Figure 11.1: Benefits of exercise

11.2 Safe exercising

Insulin injections and certain oral diabetes medication have a risk of causing hypoglycaemia. One may experience hypoglycaemia during or after exercise.

This is because when exercising, the body uses glucose as an energy source, lowering BG levels. It also increases blood flow to the muscles, making insulin more effective. This increased risk of hypoglycaemia applies to times of increased physical activity (e.g. sports, housework, shopping, moving house, sex, or gardening). Certain types of exercise can also result in hyperglycaemia. During vigorous exercise, the liver may be activated to release stored glucose.

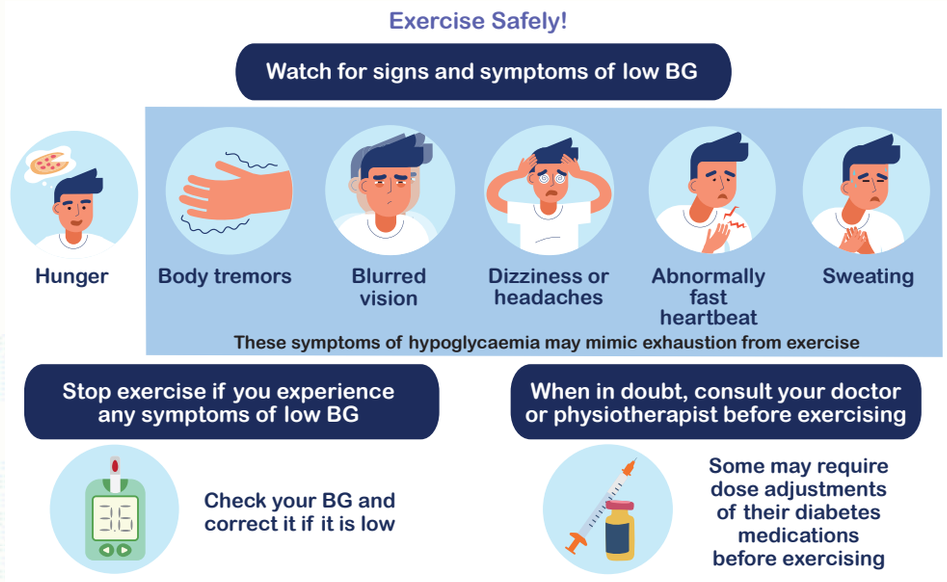


Figure 11.2: Tips to exercise safely

Use the Physical Activity Readiness Questionnaire (PAR-Q) to assess safety and possible risks for exercise before you begin. It is included as an appendix at the end of the chapter. If unsure, consult your healthcare team.

If you are exercising for the first time or have stopped for some time, always start with light exercise and gradually increase as tolerated. Do bring along your glucometer and quick-acting carbohydrates in case of hypoglycaemia while exercising. You should gradually increase the intensity and duration of physical activity with regular BG monitoring to ensure safety.

Exercise Duration	
Less than 30 mins	Check BG before and after exercise. Stop immediately if you feel unwell.
More than 30 mins	Check BG every 30 minutes if you feel well. Build up on the duration gradually.

Table 11.1: Checking SMBG with the duration of exercise

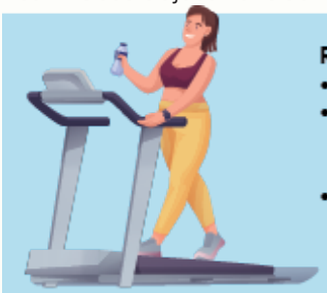
11.3 Types of exercise

Type of Exercise	Example	Effect on diabetes / insulin dose
Aerobic or Cardiovascular • Any exercise that increases the amount of oxygenation your body needs, and usually rises your heart rate • Makes you breathe harder than at rest	Brisk walking, jogging, stair climbing, cycling, cross trainer	Lowers BG May need to reduce insulin dose if BG is tightly controlled
Resistance • Build stronger muscle • Use your own body weight, equipment or machines	Lunges, push-up, resistance band exercises, machine exercises	Lowers BG Some intense exercises may increase BG due to stress hormone response Monitor your BG to find out your body's response
Flexibility • To reduce stiffness so that our joints can maintain movement important for carrying out our daily tasks	Stretches	Minimal impact on BG as these exercises are generally light

Table 11.2: Types of exercises and effect on BG

11.4 Keeping an activity diary

An activity diary is as important as a food diary. Everyone's body responds differently to exercises. Note down your body's response such as symptoms and BG results according to the exercise type, duration and intensity. This will allow you to build on your activity level gradually in a safe manner. A continuous glucose monitoring device may be helpful to monitor BG fluctuations during and after exercise. The BG report with the exercise diary will be useful to guide insulin dose adjustment during your doctor's visit.



Remember to:

- Stay hydrated during exercise.
- Always carry hypoglycaemia treatment with you (simple carbohydrates such as sweets, fruit juice or soft drinks containing 15g of carbohydrate).
- Know your BG response to different types of exercise. Learn this by monitoring before, during (every 30-60 minutes of exercise) and after different types of exercise.

Appendix 1 for Chapter 11: PAR-Q (physical activity readiness questionnaire)

Physical Activity Readiness Questionnaire (PAR-Q) is a self-test for someone between the age of 15 to 69 years old to find out more about your physical ability before doing any form of exercise.

		Y	N
1	Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?		
2	Do you feel pain in your chest when you do physical activity?		
3	In the past month, have you had chest pain when you were not doing physical activity?		
4	Do you lose your balance because of dizziness or do you ever lose consciousness?		
5	Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?		
6	Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?		
7	Do you know of any other reason why you should not do physical activity? Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?		

Table 11.3: PAR-Q (physical activity readiness questionnaire)

If you have answer "YES" to any of the 7 PAR-Q, it is recommended that you consult your Doctor before becoming physical active. If the answer is "NO" to all the questions, then you may gradually begin to engage in a physical activity regimen.

CHAPTER 12:
INSULIN AND DRIVING

Learning Objectives:

1. Understand how to drive safely while being on insulin
2. Learn the importance of BG testing before driving

Safe Driving

It is generally safe to drive when you are on insulin therapy. The main safety concern is the risk of hypoglycaemia while being on the road. It is possible for people with diabetes on insulin therapy and oral diabetes medications (Sulphonylureas / Meglitinides) to drive as long as you are equipped with the appropriate self-care knowledge.

You should:

- Understand what is hypoglycaemia (Refer to Chapter 6)
- Recognize your hypoglycaemia symptoms
- Be able to recognise your warning signs of hypoglycaemia
- Know how to manage hypoglycaemia safely

Condition to avoid driving - hypoglycaemia unawareness (HU)

You must not drive until you regain awareness of hypoglycaemia as your reaction and concentration on the road will not be as good as usual. This will put you and other road users at risk.

Before driving, you should keep your BG >5.0 mmol/L to minimise hypoglycaemia from occurring. Follow the tips below for a safe and smooth driving experience.

Safe driving tips for people without hypoglycaemia unawareness



Figure 12.1: Safe driving tips

Items to bring along in your vehicle

1. Snacks:
   - Simple carbohydrates (15g): 3 soft sweets, 3 glucose tablets, 15g of sugar in soft drinks or fruit juice containing 15g of carbohydrates within easy reach for immediate hypoglycaemia rescue
   - Complex carbohydrates: a packet of plain crackers or biscuits after an episode hypoglycaemia episode
2. Glucometer, lancing device and test strips

CHAPTER 13:
TRAVELLING WITH INSULIN

Learning Objectives:

1. Understand how to travel safely while being on insulin
2. Learn how to prepare in advance for travelling

Many people enjoy travelling as a form of relaxation, while others travel frequently for work. Being on insulin should not stop you from travelling as long as you are able to prepare for it.

Preparing to travel

In the clinic

It is best to inform your healthcare team ahead of time to plan for a safe trip.

Key information to tell your healthcare team to help plan your medications will include:



Anticipated dates and duration of travel



Types of activities (e.g. sports)



Destination time-zone

- In general, when travelling east to west, your day will be longer, and you will need an extra dose of rapid-acting insulin for the additional meal. Take your long-acting insulin as usual once you arrive at your destination.
- When travelling west to east, your day will be shortened. You may need to reduce your dose of basal insulin to avoid overlap of dosage.

At the clinic visit, request for:



Doctor's letter stating that you have diabetes and need your insulin, medication supplies, BG meter and test strips



Prescriptions for all medications and essentials including insulin cooler box, oral diabetes medication, syringes, pen needles (and extra supply)



Glucometer and test strips



Vaccinations (if required)

Figure 13.1: Tips for trip planning

At home

A sample packing list will include (these items should be in your hand-carry baggage as check in luggage might go missing or be delayed):



All regular long-term medication



Insulated cooler bag with ice pack to store insulin



Written, clear instructions on insulin adjustments for dose and timing, especially if you are changing time-zones and mealtimes



Glucometer and test strips



Sharps container for safe disposal of needles to avoid injury



First aid kit including medications for minor illness such as fever, diarrhea, etc



Comfortable shoes you have worn before

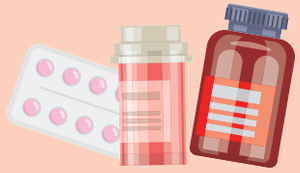


Hypoglycaemia treatment

Simple carbohydrates (15g):

- 3 soft sweets, glucose tablets, regular soft drinks or fruit juice containing 15g of carbohydrates within easy reach to treat any hypoglycaemia quickly
- Complex carbohydrates: a packet of plain crackers or biscuits to take after BG level rises above 4.0 mmol/L

Figure 13.2: Items to be packed in your hand carry luggage

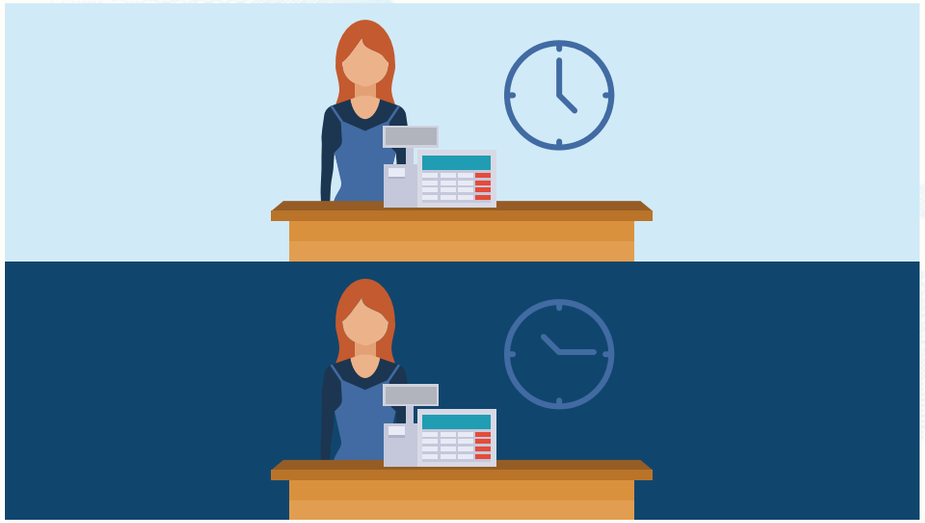


You are encouraged to bring along extra medications and essential supplies in case of travel delays.

CHAPTER 14:
DOING SHIFT WORK WITH INSULIN

Learning Objectives:

1. Understand the impact of shift work and night shift on diabetes care
2. Learn how to cope with shift work in self-care of diabetes and insulin



Doing shift work can be challenging. It can affect your routine, sleep hours and meal timings. Our internal body clock (circadian rhythm) may also be disrupted due to the change in our sleep quality and duration. This will add on additional challenges for people with diabetes on insulin as these factors can affect our BG levels, meal, and injection timings.

It is important to highlight to your healthcare team if you are on any type of shift work – rotating or permanent night shift or expect to have a change in daily routine in the near future. Your healthcare team will advise if you need to adjust your medication timing accordingly.

Thing to take note of in shift work

Draw out a typical timetable for the days you work and rest.
These are some key factors to note down and highlight to your doctor in terms of shift work:

Factor	Effect on diabetes / insulin management	What to highlight to your healthcare team
Timing of work hours	Shift work can affect the timing you eat your meals. It may be difficult to fix your regular meal timings, and this can affect timing of medications. For example: **Schedule A** Morning shift (Working hours: 9am to 5pm) Sleeping hours: 11pm to 7am Meal timings: 8am, 8pm and 2am **Schedule B** Afternoon shift (Working hours: 12pm to 8pm) Sleeping hours: 1am to 8am Meal timings: 9am, 4pm and 9pm **Schedule C** Night shift (Working hours: 10pm to 6am) Sleeping hours: 10am to 6pm Meal timing: 8am, 8pm and 2am A, B and C can happen in 3 different people or to the same person with rotating shift. You may also eat different food depending on your work timing and food availability. There are usually less food options available at night. You may also skip a meal when changing shift and adjusting sleeping hours. It is important to match your insulin timing to your mealtime. The dose of insulin also may change depending on the food we eat.	On days and Off days. Take special note of: 1. Working hours and duration. 2. Meal timings, number of meals and meal patterns for on and off days. 3. Timing to do BG monitoring, especially if you are on 3 rotating shifts. 4. It is useful to note your meals as first meal (the meal after your sleep), second meal & third meal (the meal before you go to bed), especially for those on premixed insulins. Some people may just take 2 main meals and snacks in between. 5. Do note that you may be recommended to use different dosages or insulins for working and non-working days if there is marked difference in your eating habits.
Sleeping hours (on working and rest days)	Doing shift work can affect the timing that you are able to plan your sleep around. In addition, shift work can affect your internal body clock and your ability to fall asleep and stay asleep. Poor quality of sleep and reduced sleep can affect your BG levels.	Sleep pattern and hours on working days and off days. This will be helpful for understanding your BG pattern.

Table 14.1 Effects of shift work on diabetes care

CHAPTER 15: PREGNANCY AND INSULIN

Learning Objectives:

1. Understand the importance of pre-pregnancy planning (with your doctor)
2. Understand the goals of good diabetes control throughout pregnancy
3. Understand the need and targets for 7-point BG tests
4. Familiarize with BG targets during pregnancy

Importance of pre-pregnancy planning

Having good BG control during pregnancy is vital for a healthy pregnancy. Insulin is safe for diabetes management in pregnancy. In fact, it is often started for women with type 2 diabetes while preparing for pregnancy to optimise diabetes control. Many oral diabetes medication are not recommended to be used while trying to conceive or during pregnancy and breastfeeding.

It is important to plan ahead if you are intending to be pregnant.



Figure 15.1: Tips when planning for pregnancy

Before pregnancy

Discuss with your doctor at least 1 year in advance if you have plans to have a baby. Use a reliable form of contraception until your HbA1c is ideal (HbA1c <6.5% where tolerated). Having a well-planned pregnancy will reduce the risk of miscarriage and birth defects due to poor diabetes control. You will also need to start on folic acid supplementation before pregnancy.

If you are currently on follow-up with a primary care doctor (at the polyclinic), you may need to be referred to a hospital diabetes specialist (endocrinologist) before getting pregnant.

During pregnancy

Your BG levels and insulin requirements will change significantly. Refer to Figure 15.2 for BG targets during pregnancy. It is different from your usual BG targets.



Figure 15.2: BG targets during pregnancy

Your doctor may also test your HbA1c at each trimester and even more frequently to get your HbA1c on target. Inform your obstetrician that you have diabetes as early as possible.

You may experience hypoglycaemia while trying to achieve your new BG targets for your pregnancy. During early pregnancy, you may also experience more frequent hypoglycaemia especially if you are not eating well with morning sickness symptoms. There also might be changes in your hypoglycaemia symptoms – hypoglycaemia symptoms may be less obvious with repeated episodes of hypoglycaemia. This may increase the risk of severe hypoglycaemia.

It is therefore essential to keep up with regular BG monitoring. Be familiar with hypoglycaemia correction methods. It is important that your partner knows how to treat your hypoglycaemia as well.

In the later stages of pregnancy, your insulin requirements will increase as your placental demands increases and the baby continues to grow. Regular BG monitoring allows for safe adjustments of insulin doses. Do not be surprised if your insulin doses have more than doubled by the end of pregnancy.

In addition, check your blood pressure regularly.

Your doctor / obstetrician may also recommend that you start on certain additional medications (e.g. Aspirin) during pregnancy.

Aspirin is useful in the prevention of new onset high blood pressure and other organ injury (such as the liver and kidney) in the second half of pregnancy.

Immediately after delivery

Your insulin doses should return to pre-pregnancy levels. Continue to test your BG regularly. You may need to reduce the insulin dose further if you are breastfeeding your baby. Many women with diabetes can breastfeed successfully. Discuss your BG targets during breastfeeding with your doctor. Some of the previous oral diabetes medication may also need to be resumed but if you are breastfeeding, do check with your doctor.

NOTES

CHAPTER 16: RAMADAN AND INSULIN

Learning Objectives:

1. Understand how fasting during Ramadan can affect BG levels
2. Learn how to fast safely during Ramadan while being on insulin

Fasting can increase the risk of high and low BG for people with diabetes. It can be done safely with good preparation.

Fasting is not recommended if you are/have:

- Frequent hypoglycaemia or unawareness of hypoglycaemia
- Recent admission for a diabetes related crisis such as hypoglycaemia or hyperglycaemia emergencies
- Late-stage complications such as kidney problems, heart problems or stroke
- Uncontrolled high BP
- Pregnant or breastfeeding

16.1 The month before Ramadan

Preparing to fast

1. Inform your doctor

- If you wish to fast during Ramadan, please inform your healthcare team at least 2-3 months in advance
- If your next appointment falls after the start of Ramadan, do fix an appointment before you start fasting. It is important to have a habit of monitoring BG regularly before the fasting month

2. Hypoglycaemia– awareness and correction

- It is important to revise through the symptoms you might feel with hypoglycaemia and its correction method

Adjusting your medications beforehand

Your insulin and oral diabetes medication doses and frequency will usually be reduced during the long hours of fasting. It is not safe to adjust these medication doses on your own. This will need to be done and planned with your healthcare team.

You may wish to try out these doses with a trial day of fasting before Ramadan. Keep a record of your regular and Ramadan doses for your reference.

16.2 During Ramadan

Checking BG during the fasting hours does not violate the fast. Do check your BG more often than usual to make sure that you stay safe during the fast. The recommended timings to check your BG are:



Figure 16.1: Recommended timings to check home BG level during fasting month of Ramadan

- Pre-dawn meal (Suhoor)
- 2-3 hours post Suhoor
- 12 noon
- 3-4pm
- Pre-sunset meal (Iftar)
- 2-3 hours post Iftar
- At any time when there are symptoms of hypoglycaemia/ hyperglycaemia or if you are feeling unwell
- You may also wish to consider using FGM (refer to chapter 5) for closer monitoring during Ramadan fasting

Medication Doses

Remember to adjust the doses of your medications as discussed above for the entire fasting month.

Dietary advice



Figure 16.2: Dietary advice for fasting month

Adopt the Healthy Plate concept. Before starting the fast, take a healthy pre-dawn meal (Suhoor) consisting of more slowly absorbed food with higher fibre content such as brown rice or basmati rice, with beans or dhal, vegetables using the healthy plate concept. Drink plenty of water if your doctor has not told you to limit your fluid intake.



Figure 16.3: Keeping hydrated while fasting

When to stop your fast

Stop your fast immediately if you have:

- Symptoms of hypoglycaemia or BG is less than 4.0 mmol/L
- Symptoms of HHS/DKA (increased thirst, frequent urination, confusion, nausea / vomiting, abdominal pain or shortness of breath)
- Symptoms of dehydration (e.g. severe thirst, frequent urination at first, followed by passing small amount of dark coloured urine, headache / dizziness, fast heart beat)
- Feel unwell

It is dangerous to continue fasting if the above occurs. Refer to Chapter 6 on hypoglycaemia, Chapter 7 on hyperglycaemia and Chapter 8 on HHS/DKA.

Exercising during fasting month

It is important to avoid vigorous exercise during fasting hours as you may run into problems with dehydration or hypoglycaemia. Consider light exercises in hours after you have ended your fast. Check BG level before exercise. The tarawih prayers should be considered as part of your daily exercise routine.

16.3 After Ramadan

Resume your routine BG monitoring, insulin and oral diabetes medication doses. Refer to the doses you have jotted down earlier.

Dietary advice

Avoid over-feasting during the Hari Raya festive celebrations and bazaars. Continue to keep yourself well hydrated with non-sugary drinks.

For further information on fasting during Ramadan, you may refer to this website:

For iOS users, you may download this app:

If you face any difficulties accessing the external materials, please contact DM_Edu@nhg.com.sg

16.4 Ramadan myth busters

1. **Checking SMBG breaks the fast**
   Not true! Checking SMBG ensures a safe fasting month. It does not break the fast.

2. **It is OK to stop my insulin as I will eat less during fasting month**
   Not true! You should not stop your insulin, even if you are planning to fast. However, the dose may need to be adjusted. Check and plan ahead with your healthcare team.

3. **It is OK to fast when I am pregnant (and have diabetes)**
   Not true! It can potentially be dangerous to fast when you are pregnant. This is not advised as both hyperglycaemia and hypoglycaemia can pose additional danger to the mother and the unborn baby.

4. **There is no need to inform my doctor that I want to fast if my diabetes control is good**
   Not true! This is a wrong concept. Your doctor will discuss with you if it is safe to fast, review and adjust your insulin and or oral diabetes medications before the fasting month. The healthcare team will encourage fasting whenever possible.

Congratulations for coming to the end of the FITT2 book! We hope that you have read through the contents thoroughly and will practice the concepts learnt. We wish you the very best in your journey with diabetes.

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