STEP
Scottish Type 1
Educational Programme

Ten steps to improving your Type 1 diabetes control

MORE CONTROL. FEWER SURPRISES. FEWER HYPOS. FEWER HIGHS.

Introduction

Ten steps to improving your Type 1 diabetes control

This booklet is a brief guide to help you achieve the best possible glucose results. It can be daunting to know where to start - this guide offers some suggestions on how to do this in a step-wise manner. Taking things a step at a time (sometimes over days, sometimes over weeks and months) should result in meaningful improvements – fewer highs, fewer lows and a greater feeling of being in control.

Introduction

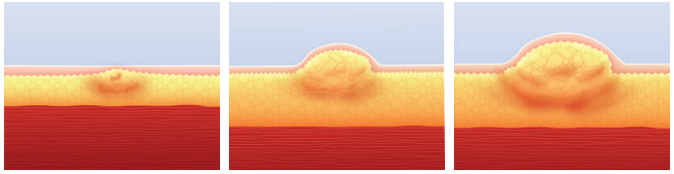
Why is it important to achieve good blood glucose management?

Perhaps the biggest reason is that people who have more predictable, 'on target' blood glucose readings tend to feel better and diabetes becomes less of a burden on quality of life. In the long-term, good diabetes control results in a hugely reduced risk of developing complications, including a significantly reduced chance of developing cardiovascular disease. The beneficial effects of good diabetes control last for several decades.

Targets

Blood glucose targets should be individualised and agreed between patient and doctor / nurse specialist. Below is a suggested set of target glucose readings for patients with type 1 diabetes:

Time	Target glucose
Before breakfast	5–7mmol/L
Before other meals	4–7mmol/L
2 hours after meals	less than 8mmol/L
Before bed	5–7mmol/L



Injection sites and lipohypertrophy

It is difficult to over-emphasise the importance of rotating injection sites. Every insulin injection will deliver a slightly different amount of insulin to the body, but this variation can be even greater when patients develop lipohypertrophy (fatty lumps caused by injecting in to the same site repeatedly). Lipohypertrophy increases the risks of hypos (and unexplained highs). The photographs above are quite extreme examples and it is always worth feeling your injection areas to make sure 'lipos' are not developing.

It is also worth bearing in mind that insulin is absorbed faster from the abdomen (tummy) than the thighs – making the abdomen a better site for injecting quick acting insulin. It is worth considering the thighs for long-acting background insulin. Be aware that using different zones (abdomen, thighs etc.) with different insulin types (long-acting, quick-acting etc.) may result in a variation in the effect or speed of onset of the insulin. Similarly, exercise will speed up the absorption of insulin from the thigh.

How often should I check my blood glucose levels?

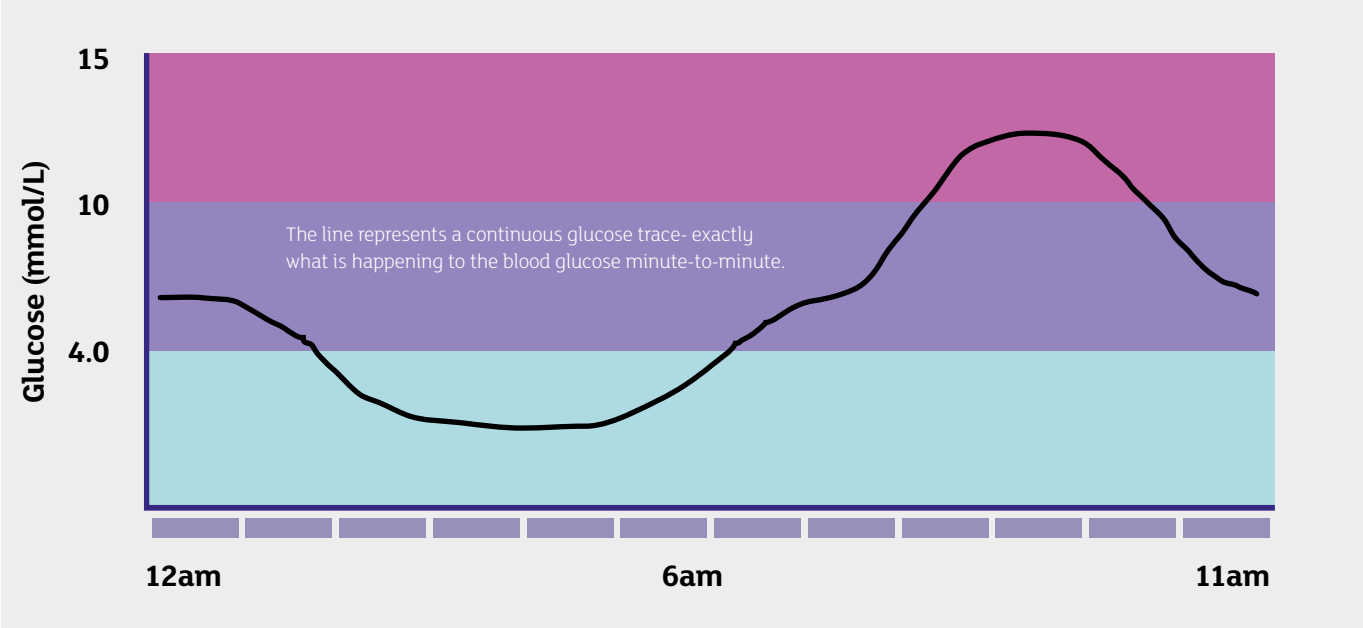
It is difficult to achieve good, safe control of type 1 diabetes with any fewer than 4 blood glucose tests per day. Indeed, when adding in driving, sport, avoiding hypos and stressful events, it may be difficult to achieve control with any fewer than 6 or 7 tests per day. We realise that for many people this is not something they can manage on a daily basis and, in that situation, checking frequently every now and then is better than not at all. This guide has been designed to help convert the information gained from regular glucose testing, into actions that will make your diabetes more predictable and easy to manage in the long-term.

Should I keep a diary?

It can be useful, during spells of 'intensive glucose monitoring' to keep a detailed diary, which takes in to account exercise, food intake, insulin doses and insulin timing. For the most part, it is probably more useful to upload your glucose meter and review the results on your home computer (see step 9, page 13 for more details on how to do this).

Introduction

Explaining the figures used in this booklet:



Exercise

Food intake

CF carb free

Insulin injection

QA quick acting

B background

Above target

In target

Below target

Glossary of terms used in this booklet:

Background insulin: the long-acting insulin (also known as basal) which tends to be given once or twice a day (the most commonly used background insulins are Lantus and Levemir).

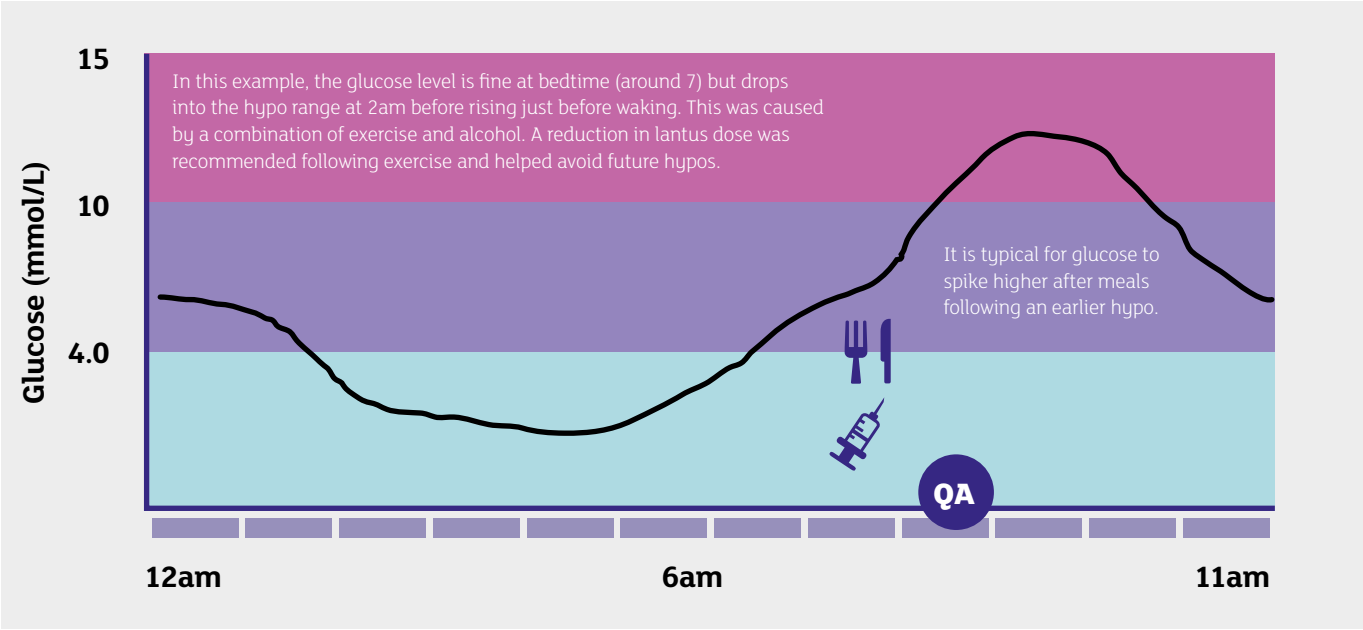
Correction factor (insulin sensitivity): The amount your blood glucose changes with 1 unit of quick-acting insulin (e.g. correction factor of 2 means that 1 unit of insulin will change your blood glucose level by 2 mmol up or down).

Hypoglycaemia: A low blood glucose level (typically defined as less than 4 mmol/L).

Insulin carbohydrate ratio: The amount of insulin that should be taken for every 10 grams of carbohydrate ingested. A ratio of 1:10 would mean taking 4 units to cover a meal with 40 grams of carbohydrate.

Quick- acting insulin: The insulin taken 15 minutes before meals which has a fast onset of action (around 30 minutes) and lasts for approximately 4 hours. The commonest quick- acting (or bolus) insulins are Apidra, Humalog and Novorapid.

Step 1: Avoiding overnight hypos



Headline

Hypos overnight are a problem for several reasons:

- They are harder to detect than hypos during the day.
- If they occur frequently they can affect your ability to detect hypos early.
- They tend to cause the glucose to rise in the morning and after breakfast.

You can't really exclude overnight hypos unless you have checked your blood glucose at 3am on a few occasions – your glucose level can be normal on waking, even if it was low earlier. We don't recommend you do this routinely, but it is certainly worth considering every now and then.

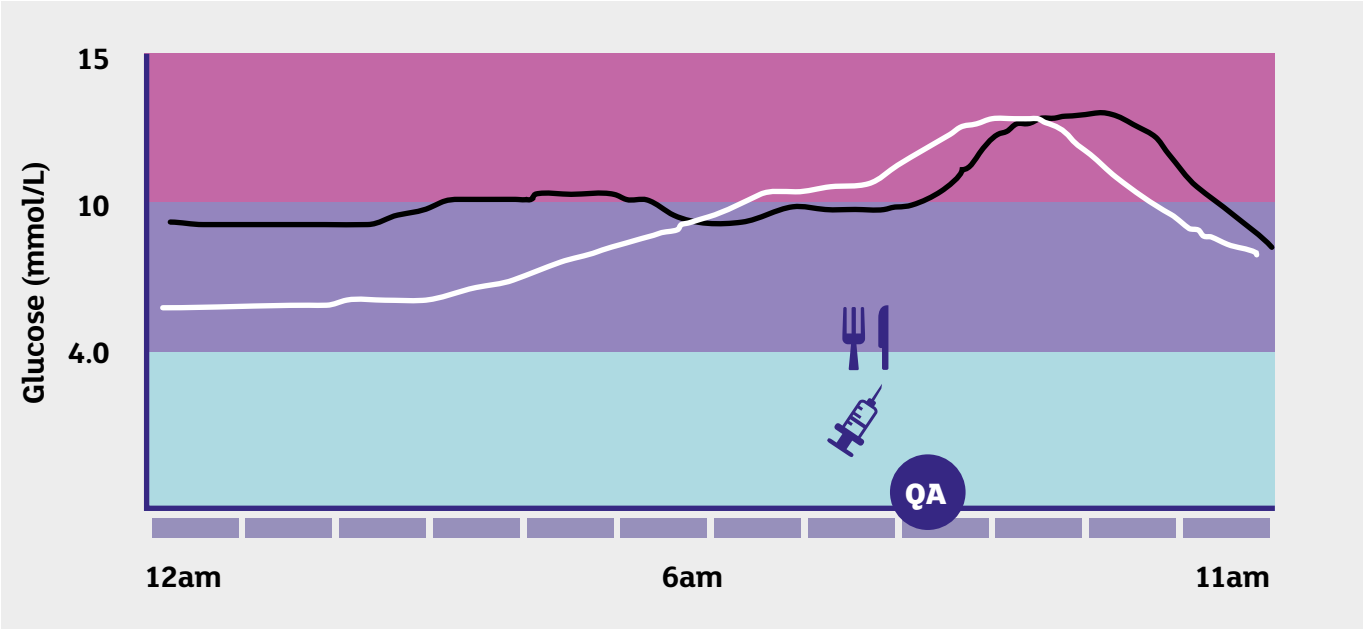
What causes overnight hypoglycaemia?

- Too much background insulin.
- Prolonged exercise the day before (without appropriate carbohydrate replacement or reduction in insulin dose).
- Drinking alcohol the night before (alcohol stops the liver making glucose – which normally maintains the blood glucose overnight).

How to solve this problem

- If you're going to bed with a normal glucose and it is consistently dropping overnight – you need less background insulin (consider a 10% reduction in dose).
- After prolonged exercise you may need to adjust your background insulin down. This is easier to do if you are on twice daily background insulin (see Step 3, page 7).
- Consider a reduced dose of background insulin on evenings where significant amounts of alcohol are consumed (and ensure you have had a carbohydrate snack before bed).

Step 2: Getting the morning blood glucose on target



Headline

Starting the day with a high blood glucose makes getting things under control much more difficult than starting the day with an 'on target' glucose. If the first priority is avoiding hypoglycaemia, the second is certainly getting control of the morning glucose.

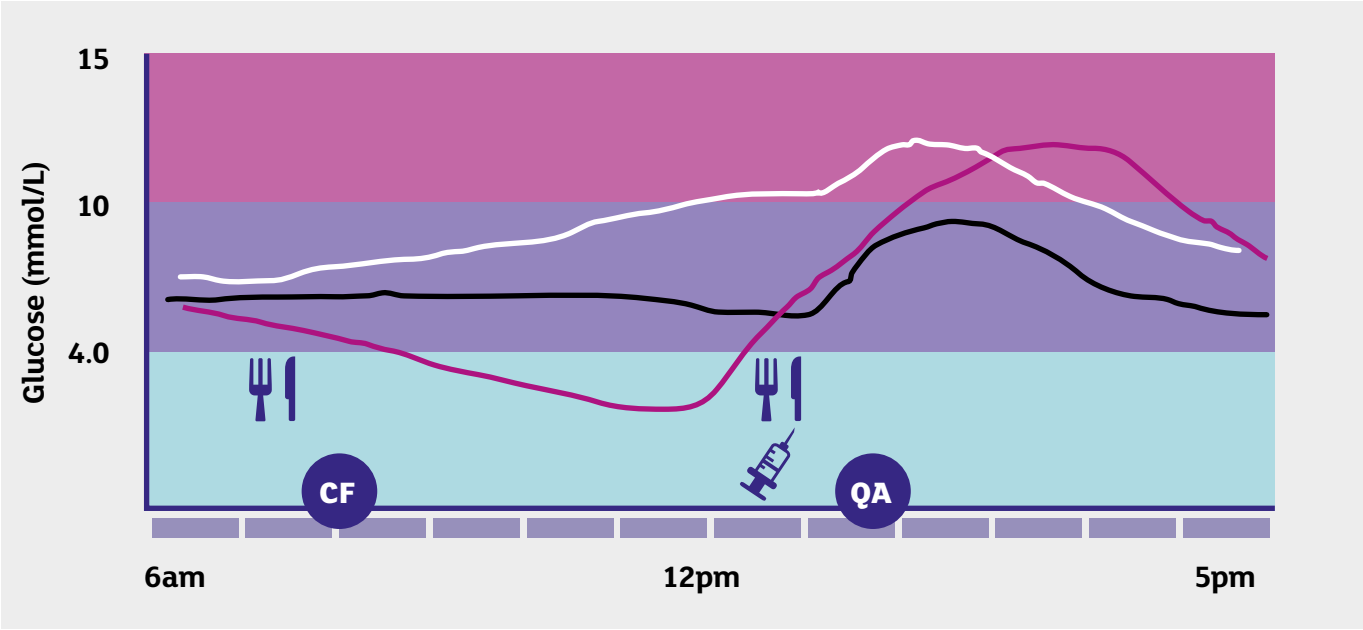
What causes high morning blood sugar levels?

- The **black line** in the figure above is an example of someone going to bed with a high glucose (around 10) and waking up with a similarly high glucose. In situations like this, it is worth looking at how effective the previous evening's tea time dose of quick- acting insulin had been. The background insulin is supposed to keep the glucose steady overnight and it appears to have done so (see step 4 [page 8] for more details on assessing the effectiveness of mealtime insulin doses).
- The **white line** is an example of not enough background insulin. The glucose starts off fine at bedtime but rises progressively through the night. This may be because the dose of background insulin is too low. In people who take their background insulin in the morning, it may be because it is wearing off through the night (this happens in about a quarter of people on once a day background).
- The 'Dawn Phenomenon' is a situation where blood glucose levels rise significantly between 3am and waking. This affects some patients more than others and is caused by the early morning rise in hormones (cortisol and growth hormone) which make the body more resistant to the effects of insulin.

Solutions

- Firstly it is important to make sure that pre- bed glucose readings are generally OK.
- If it appears to be related to a lack of background insulin, this can be dealt with by increasing the dose or splitting the dose in two (see step 3, page 7).
- The Dawn Phenomenon can be tricky to deal with – sometimes an insulin pump is the best option.

Step 3: Sorting out the background insulin



Headline

As a 'rule of thumb', most people require around 50% of their insulin as background and 50% as quick- acting (with meals). If your background insulin dose comprises a much bigger proportion of your total dose, it may be too high. This is important as excessive background insulin can drive your appetite (weight gain) and also leave you open to hypos. In a quarter of people, once daily background insulin starts to wear off much earlier than 24 hours.

How can I tell if my background insulin dose is correct?

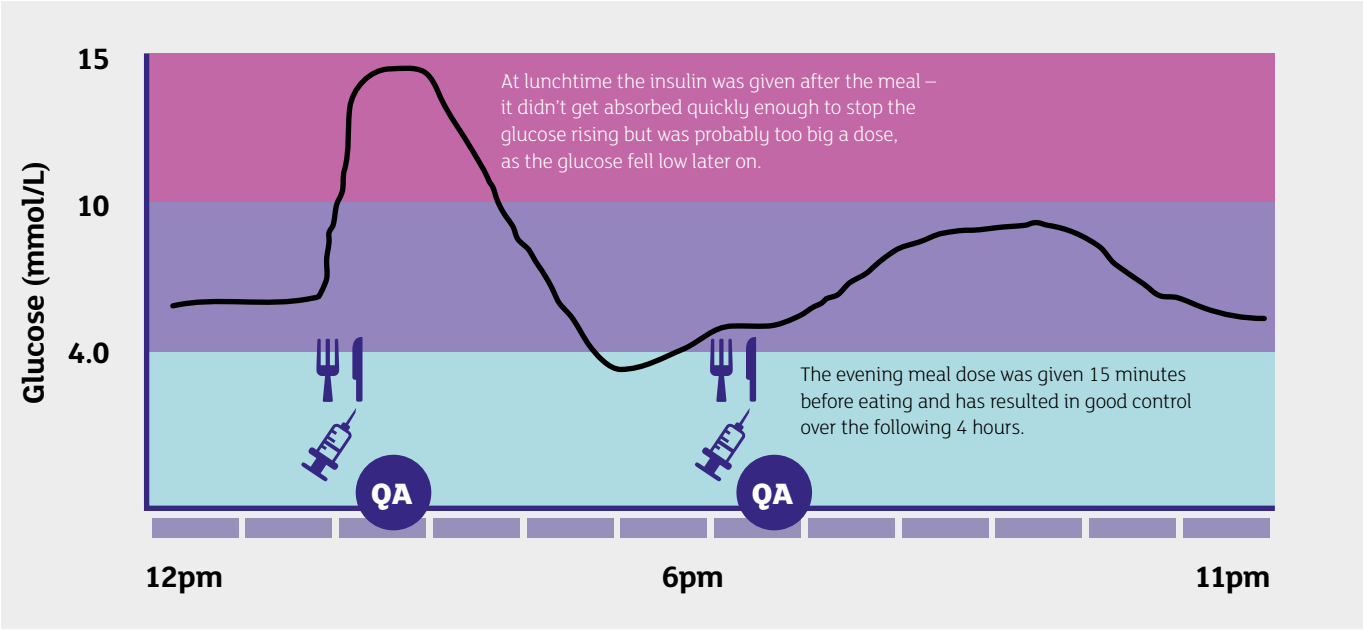
The best way to test this is by occasionally having carbohydrate free meals (or fasting), which means you do not have to take any quick- acting insulin at that time point. In the example above, the patient has taken a 'carb free' breakfast. The **black line** shows what should happen if the background insulin is 'doing its job' – the glucose more or less remains steady. The **pink line** shows what would happen if someone has too much background on board – the glucose levels fall into the hypo range. The **white line** shows what would happen if the background insulin dose is too low – the glucose level rise over the morning. You can also perform carb free (or fasting) at lunch and tea time to see how effective the background coverage is across those periods. It is best not to do more than one in a single day!

What changes can be made?

- If glucose is falling after carb free meals (or fasting) then this suggests a decrease in background insulin.
- If glucose is rising after carb free meals (or fasting) then this suggests an increase in background insulin.
- Splitting background insulin (taken approximately 12 hours apart) can have significant advantages:
  - More consistent profile (less variable glucose levels).
  - Doesn't run out towards the end of 24 hours.
  - Can adjust the morning or evening dose in response to exercise.
- The main disadvantage of splitting is that it can be difficult to find convenient times to administer the insulin (e.g. 8 am and 8 pm, 10 am and 10 pm, 12 am and pm 12m).

See Appendix 1 on page 15 for examples of carb free meals.

Step 4: Matching the quick acting dose with meals



Headline

The best way to match insulin doses with meals is to perform carbohydrate counting – adjusting your dose for what you eat and not adjusting what you eat to suit your insulin dose. If you're not doing carb counting, we would strongly recommend doing the New Deal course or 3 hour carb counting course (see page 14).

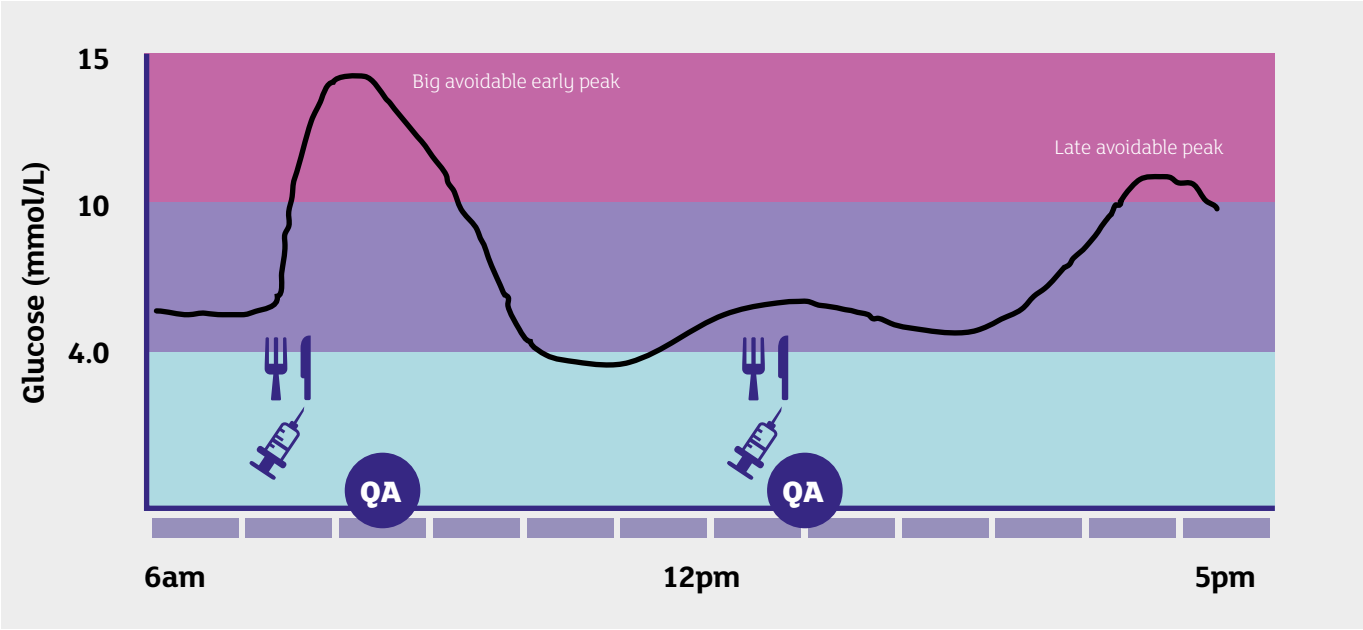
Matching the dose – what factors are important?

- Over time people gain experience in estimating the carb content of the foods they most commonly consume. The more you do it, the better you get. The mobile app (and book) 'Carbs and Cals' is a convenient reference to help with this.
- The required ratio of insulin to carbohydrate is different for each person and, even in the same person, can be different at breakfast (where sometimes more insulin is required) than with later meals. A rough guide to the expected insulin to carb ratio is provided in Appendix 2 (page 16). The ratio can also change over months and years – so it is worth assessing this periodically.
- Timing of quick- acting doses can be important and is discussed more is step 5.

Is my matching working?

- The first thing to do is make sure your background insulin is appropriate (step 3) – once you're happy with this.
- Checking a glucose level before a meal, two hours after eating and before the next meal can provide very useful information:
- If the two hour level is high (it should ideally be less than 8) this may mean your ratio needs to change to give more insulin (if dropping low at 2 hours – a reduction may be required).
- If the two hour level is high but drops low at 4 to 5 hours- this may mean the timing of the quick acting insulin needs adjusted (i.e. to be taken further in advance of the meal).

Step 5: Getting the timing right



Headline

Timing is potentially a significant issue, primarily for quick acting insulin. Although insulins like Novorapid, Humalog and Apidra are 'rapid acting', they still take around 30 minutes to be absorbed. This means that carbohydrate based meals (sugars, bread, potatoes, pasta) can result in a big peak of glucose before the insulin has had an opportunity to start working. On the other hand, meals which contain a lot of fat can delay glucose being absorbed from the gut and often respond better to slightly later administration of insulin (i.e. after eating).

Timing can be an issue with background insulin, particularly if it looks like a once daily dose is not lasting 24 hours (where splitting the dose in two is advisable) or in people who get a 'Dawn Phenomenon' where taking the background insulin dose as close to bedtime as possible can sometimes help prevent such a large rise between 3 and 7 am.

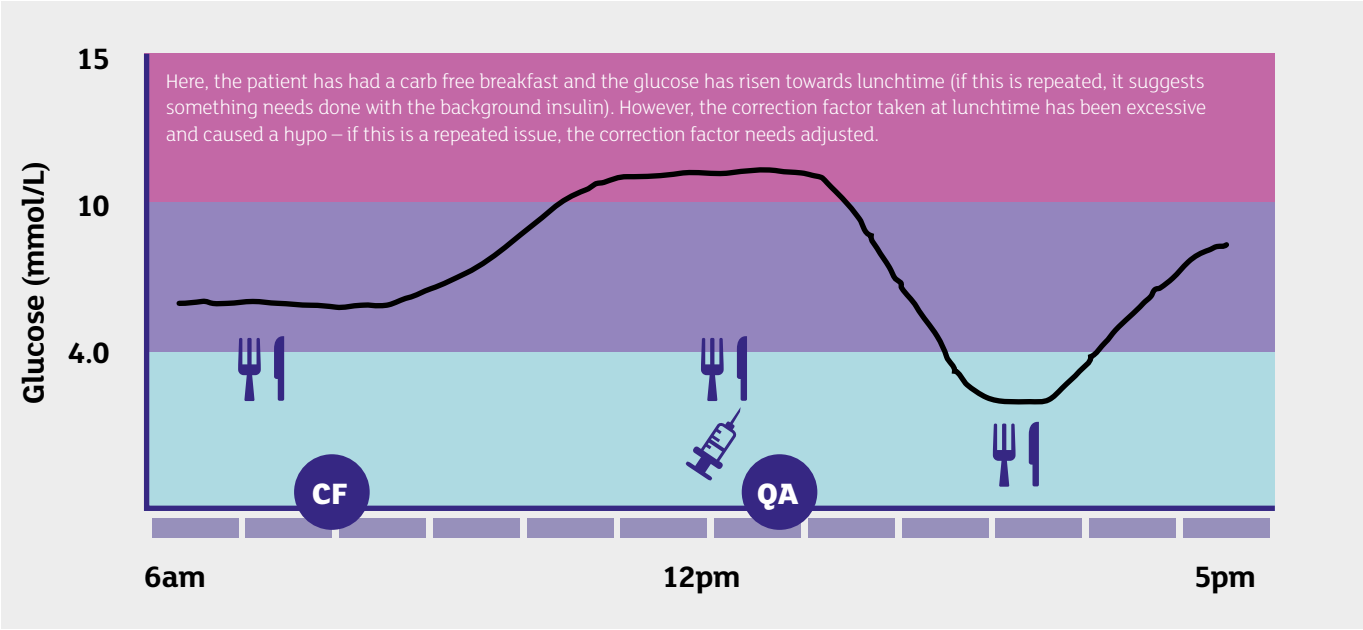
Working out the best timing

Looking at glucose results 2 hours after eating, and again prior to the next meal, provides good evidence of whether your quick acting timing is working effectively. It is worth thinking about this for different meal types. In the example above, taking insulin after a carb heavy breakfast has caused a big early rise in glucose but taking insulin before a fatty meal (with slowly absorbed carbohydrate – e.g. Mexican food) at lunch time has failed to match the later peak in glucose.

You can see, in the example above, that simply checking a glucose before lunch (which was quite low) may result in reducing the dose of breakfast insulin which would result in an even bigger glucose 'spike' after breakfast. Less insulin may be required but getting the timing right is the critical thing here.

Similarly, just looking at the pre- evening meal glucose level (which was high) may cause you to increase future doses of insulin at lunch time, which would increase the risk of hypoglycaemia in the early afternoon with this type of food. Again, timing and not the amount of insulin is perhaps a bigger issue in this case.

Step 6: Getting the correction factor right (and not over-using it)



Headline

Correction factors (or insulin sensitivity) are an important tool in helping to manage the blood glucose level. One of the major benefits of regularly checking glucose levels is the ability to 'correct down' unexpected high readings at meal times. However if corrections appear to be the norm at particular times of day, it is worth considering what factors are contributing to the persistently high glucose readings and addressing them, rather than relying on corrections.

Constant corrections can make it difficult to pick out underlying patterns and sometimes it can be useful to stop correcting for a spell to help work out what is causing the underlying problem.

Correction factors, like insulin: carbohydrate ratios, differ between individuals and can also be different at different times of day. Aiming to correct down to a glucose of 7 mmol/L is typical.

What is my correction factor?

A simple way to estimate your correction is:
Correction factor = 100 / (total daily insulin dose)

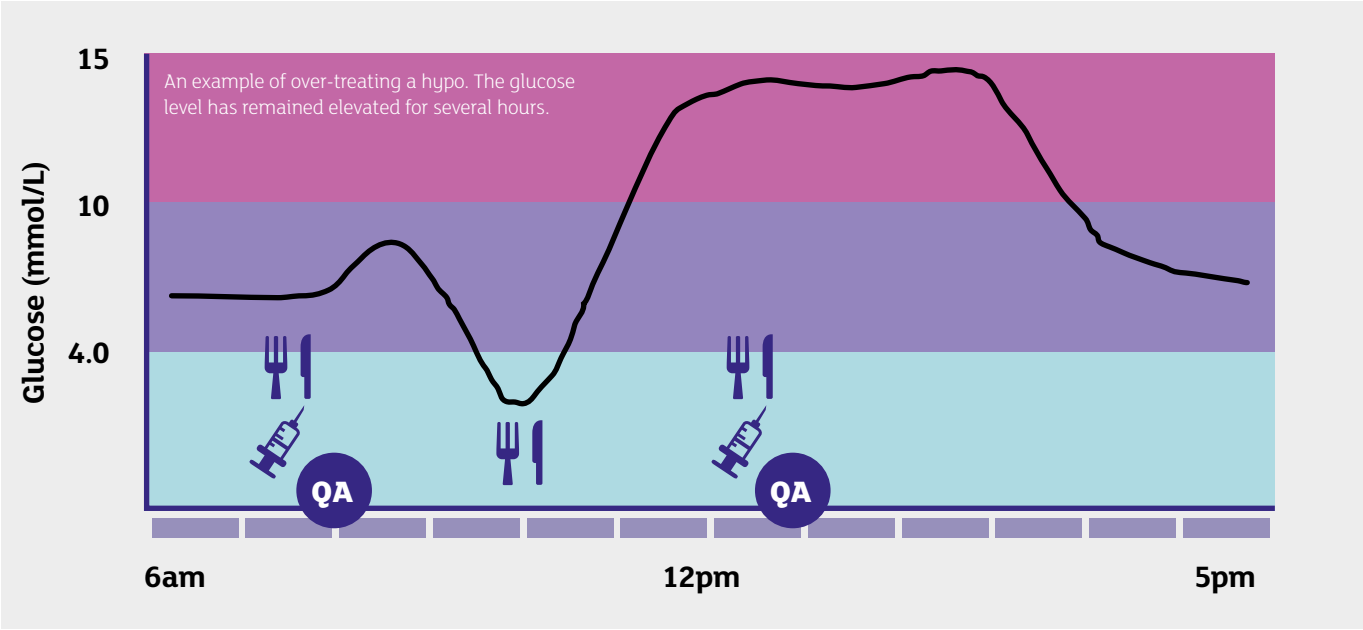
So in someone taking roughly 25 units of novorapid and 25 units of levemir (total insulin = 50 units):
Correction factor would be 100 / 50 = 2

This means 1 unit would be expected to drop the blood glucose by 2 mmol/L.

If at lunch time their blood glucose was 13 they would take 3 extra units on top of their calculated dose (those 3 units would be expected to drop the glucose by 6, therefore getting them to their target glucose of 7).

If correction factors start to become associated with subsequent hypos, then they should be increased (e.g. from 1 unit lowering 2 mmo/L to 1 unit lowering 2.5 mmol/L). If they do not seem to be getting the glucose down to target, they may need decreased (e.g. down to 1 unit lowering 1.5 mmol/L glucose).

Step 7: Treating hypos appropriately



Headline

With regular monitoring and appropriate adjustment of insulin, episodes of hypoglycaemia (glucose less than 4 mmol/L) can be kept to a minimum. However, it is not unusual to experience a few episodes of 'mild' hypoglycaemia and the important thing is to be aware of the warning signs and treat them at the earliest possible opportunity.

If hypos are occurring at the same time each day on a regular basis, it is important to consider why and aim to prevent them – the earlier steps in this booklet should help reveal most of the common reasons.

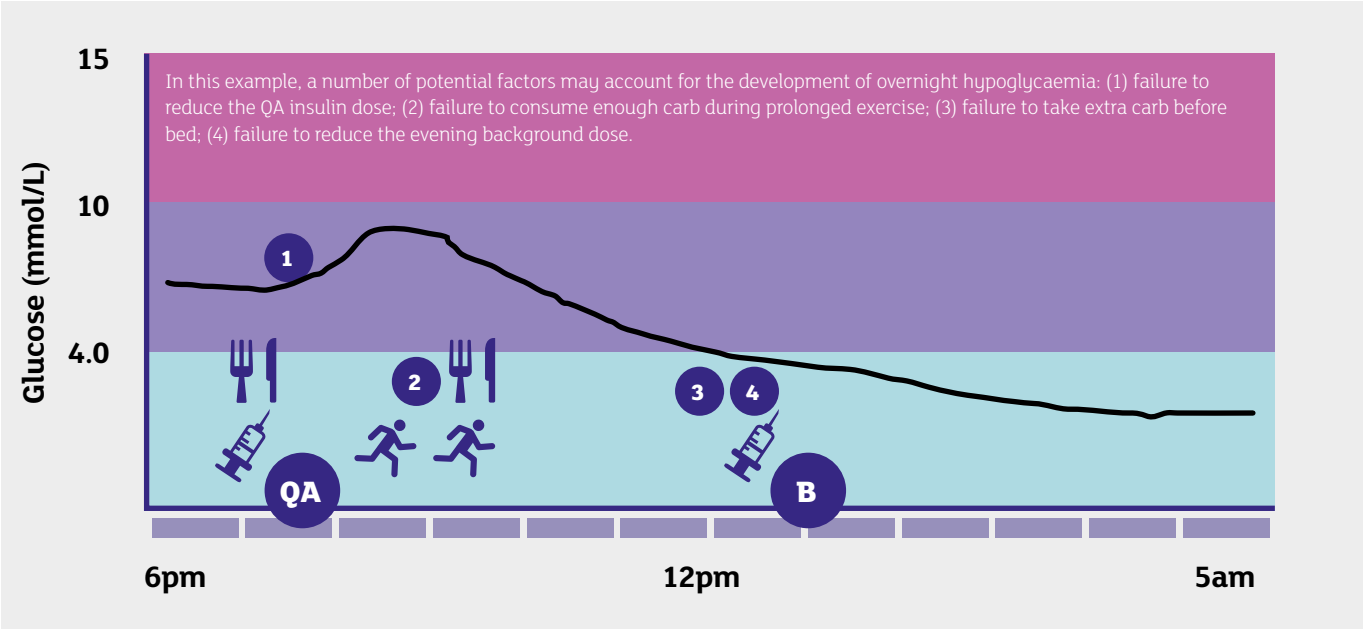
What is the best way to treat hypoglycaemia?

The best way to immediately treat a hypo is to consume 15 grams of rapid acting carbohydrate. It is important to recheck your glucose level after 15 minutes – if it is still below 4 mmol/L, repeat the treatment. If above 4 mmol/L then have 15g longer acting carbohydrate.

15 grams carb	
Lucozade	170ml
Cola	150ml (mini-can)
Glucotabs	4 tablets
Dextrose Tabs	5 tablets

Over-treating hypos is not a good idea, as it can make managing your blood glucose very difficult in the following hours (like the example above). If you find your typical treatment of hypo tends to 'overshoot' you may wish to consider using a lower dose of carbohydrate – for safety, it is important to check blood glucose regularly following a hypo. After a hypo, another hypoglycaemic episode is more likely in the next 24 hours and it important to monitor carefully to avoid this.

Step 8: Dealing with exercise



Headline

Exercise is hugely important – it has the potential to improve wellbeing (physical and mental) as well as providing long- term benefits in maintaining health. Unfortunately many people with diabetes will avoid exercise due to fear of hypoglycaemia. However, with the correct precautions, there is no reason to fear exercise and indeed there are many examples of elite athletes with type 1 diabetes. Getting dose adjustments and carb intake just right, tends to require some 'trial and error' and can vary a lot from person to person.

Preparation

- Ideally aim for a glucose between 5 – 10 mmol/L prior to exercise.
- If the activity is less than 45 minutes:
  - Take 20 – 30g of carb if glucose less than 7 mmol/L.
  - Take 10 – 20g of carb if glucose between 7 and 10 mmol/L.
  - If glucose between 10 to 14 mmol/L – no extra carb required.
  - If glucose greater than 14 mmol/L – consider postponing exercise.
- If exercise is prolonged (more than 4 hours) or intense (running / aerobic class) reduce quick acting insulin before exercise by 30 – 50% (you will need to assess what is right or you).
- For exercise more than 4 hours, background and quick acting may need cut by up to 50%.

During

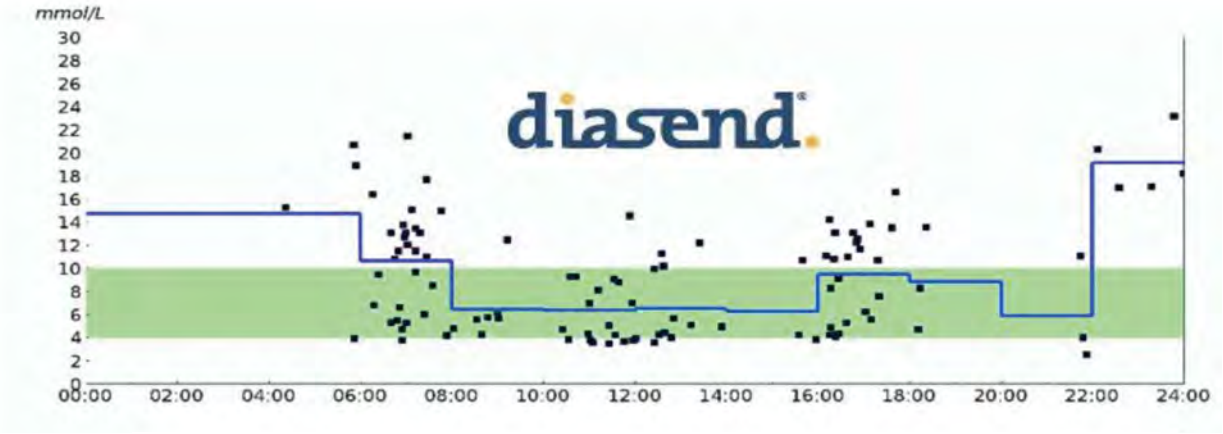
Depending on the intensity and duration of the exercise, it is likely that extra carbohydrate will need to be consumed during the exercise (see appendix 3, page 17 for specific advice on extra carbs)

After

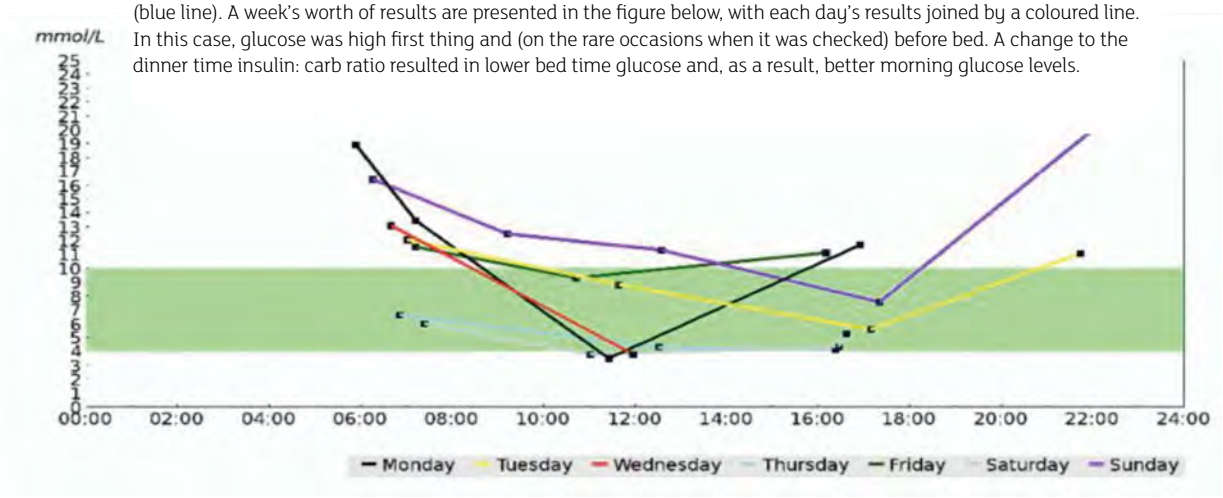
- A 10 – 20% reduction in night time background insulin is likely to be required after exercise – it is easier to do this if you are on a split twice- daily background insulin (like Levemir).
- Extra carbohydrate before bed may be required to help restore muscle glucose stores.

See appendix 3 for more information.

Step 9: Periodically review your patterns (and share them)



This example shows the glucose results for an entire month (above) along with the average glucose at each time point (blue line). A week's worth of results are presented in the figure below, with each day's results joined by a coloured line. In this case, glucose was high first thing and (on the rare occasions when it was checked) before bed. A change to the dinner time insulin: carb ratio resulted in lower bed time glucose and, as a result, better morning glucose levels.



Headline

We know that regular blood glucose checks are associated with better diabetes management (as demonstrated in the table below). The next step is to understand what influences your glucose levels and periodically look for patterns. We would recommend signing up for Diasend Personal, which allows you to look over your glucose patterns and recognise problems (example images above). Ideally it is worth reviewing this information for around 5 – 10 minutes each week. You can also share this information with staff at the clinic, who will be very happy to offer advice.

To sign up to Diasend Personal please visit Diasend website at www.diasend.com.

Number of blood glucose tests per day	Average HbA1c% (old units)	Average HbA1c mmol/mol (new units)
0 to 2	8.6	71
3 to 4	8.0	64
5 to 6	7.6	60
7 to 9	7.4	57

Diasend clinic code:

17-17161

Step 10: Use your diabetes clinic to suit you

Headline

You manage your diabetes for over 5000 waking hours each year. We see you in clinic for perhaps 1 or 2 hours over that period. We don't want to wait for 6 months to hear about any problems you may be having – we want to know as soon as possible, to help put a plan in place to put you back in control.

Over time, with regular blood glucose checks, review of patterns and putting changes in place, we are confident that most people can achieve good management of their diabetes. The aspiration of our clinic is to empower people to do this by themselves but also to be available for advice whenever it is required. Over time, this process should become more automatic: you control your diabetes – it doesn't control you.

Contact us

We would urge you to contact us for advice whenever you like by either email or telephone. You can also ask us to review your Diasend or look over scanned diaries:

Telephone us (leave a message):

0131 242 1470

Email us:

diabetesclinic.rie@nhslothian.scot.nhs.uk

Appendix 1: Carb free meals

Breakfast

- Fried/ poached/ boiled egg
- Fried/ poached/ boiled egg and bacon/ smoked salmon
- Fried/ poached/ boiled egg with avocado
- Avocado
- Cheese selection e.g. cheddar, brie, feta, mozzarella

Main Meals – moderate portions

- Omelette (without milk) – cheese and ham (or meat/ cheese/ vegetable of choice)
- Seasoned/smoked Fish (no breaded/ battered/ lightly coated varieties)
- Roast/grilled/baked/fried meat of choice e.g. gammon, chicken, beef, steak, lamb
- Chilli con Carne with meat/ vegetables of choice (without kidney beans or rice)
- Curry – Meat or vegetable (without rice)
- Stew/ Casserole (no flour/ potato)
- Homemade Beef/ Turkey/ Spiced lamb burger (no added breadcrumbs or bun)
- Cold meat/ fish salad
- Tofu

Accompaniments

- x1 tbsp mayo
- Olive oil/ extra virgin olive oil
- x1 tsp mustard
- x1 tbsp cider/red wine/malt vinegar
- Garlic/ Herb butter

Sides – (raw, boiled, steamed, fried)

- Salad leaves/ celery sticks/ broccoli/ cucumber/ mushrooms/ bamboo shoots/ asparagus/ sprouts/ cabbage/ cauliflower/ beans (no baked beans) / avocado / onions/ tomatoes.

Drinks

- Diet fizzy juice e.g. diet cola, diet orange, diet lemonade
- Mineral/ Tap water
- Carbonated water
- Some flavoured sparkling water (~ 0.5g CHO/250ml – always check labels)

Appendix 2: Insulin: carb ratio guide

Average daily insulin dose (background)	Approx I:C ratio
8 – 11	1:50
12 – 14	1:40
15 – 18	1:30
19 – 21	1:25
22 – 27	1:20
28 – 35	1:15
36 – 45	1:12
46 – 55	1:10
56 – 65	1:8
66 – 80	1:6
81 – 120	1:5
>120	1:4

Kilograms	Stones	Approx I:C ratio
<27	<4.2	1:30
27 – 36	4.3 – 5.7	1:25
37 – 45	5.8 – 7.1	1:20
38 – 54	7.2 – 8.6	1:18
55 – 64	8.7 – 10	1:15
65 – 77	10.1 – 12.1	1:12
78 – 90	12.2 – 14.2	1:10
91 – 104	14.3 – 16.4	1:8
105 – 122	16.5 – 19.3	1:6
>122	>19.3	1:5

The table on the left uses total daily insulin dose to estimate insulin: carbohydrate ratio, whilst the table on the right uses weight to make the same estimate. These are only guides and assessment of response, as detailed in step 4 (page 8) is the best way to determine the appropriate I:C ratios for each meal time.

Appendix 3: Carbohydrate intake during exercise

Pulse	% Max pulse	Borg scale	Description	Recommended carbs per hour
60		6	No exertion at all	
70		7	Extremely easy	
80		8		
90		9	Very easy	
100		10		
110	65%	11	Light exertion	30 – 60 g/hr
120		12		
130		13	Moderate exertion	60 g/hr
140	75%	14		
150		15	Exhausting	60 g/hr
160	85%	16		
170		17	Very exhausting	60 – 90 g/hr**
180		18		
190		19	Extremely exhausting	
200	100%	20	Maximally exhausting	

This table offers suggestions for how much carbohydrate should be consumed during exercise, pending on how intensive it is. As a rough guide, if you are unable to talk to someone whilst exercising – you are likely to be at level 17 or above (i.e. requiring >2g/kg/hr).

Try:
www.runsweet.com
www.excarbs.com

** If consuming over 60 g carbohydrate use sports product with 2:1 glucose: fructose mix

Notes

Notes

Your Diabetes Team

If you have worries or questions about your diabetes you don't need to wait until your next appointment – contact your diabetes team below.

Telephone us (leave a message):
0131 242 1470

Email us:
diabetesclinic.rie@nhslothian.scot.nhs.uk

Developed by Dr. Fraser Gibb Royal infirmary of Edinburgh and produced by:

Type 1 Sub-Group –
Scottish Diabetes Group

healthier scotland
SCOTTISH GOVERNMENT

NHS
SCOTLAND