Libre Start
Royal Infirmary of Edinburgh
You will find one of these forms in your Libre pack. Please complete this – front and back (it’s double sided) and then hand it in to us before you leave tonight. This is the form we will be using to generate letters to GPs and if we don’t get a form we won’t be able to send a letter to your GP requesting that they prescribe Libre sensors…
Introduction

Why glucose is important
In the 1980s it was not entirely clear whether controlling glucose levels was important in reducing the risk of diabetes complications: such as eye, kidney and nerve damage – as well as cardiovascular disease such as heart attacks and strokes. A large study called the DCCT – Diabetes Control and Complications Trial – was performed in the United States to answer this question. People with T1 were randomised to usual care (and maintained an HbA1c of around 9% (75 mmol/mol) or intensive control achieved by multiple injections (or pumps) – the intensive control group achieved an HbA1c of around 7% (53 mmol/mol). People were in the study for an average of six years – afterwards the average HbA1c of both groups merged to around 8% (64 mmol/mol).
The DCCT was a real landmark study in diabetes. The early results showed huge reductions in diabetes complications such as eye and kidney disease.
Even more impressively that HbA1c difference achieved for 6 years in the 1980s is still making a difference decades later – intensive control patients still have much lower rates of eye and kidney complications. Importantly the risk of cardiovascular disease is reduced by 42% and the risk of death by 33%. Tight glucose control makes a big difference and that difference lasts a long time! Finding ways to help people with diabetes get their glucose levels to target is very important.
The following are the recommend glucose targets for adults with T1 diabetes in Scotland. Targets do need to be individualised as, in some circumstances, they may not be appropriate – this is something to discuss with your diabetes team.
You are likely to be familiar with the term HbA1c. This is a measure of glucose levels over a 2 – 3 month period. What is actually being measured is the amount of glucose stuck to haemoglobin in red blood cells. The higher the glucose level the more sticks to blood cells. Over the last few years the unit for HbA1c has changed from % to mmol/mol. Good control is typically described as 58 mmol/mol or less. Ideal control is less than 48 mmol/mol but this can be very difficult to achieve without significant hypoglycaemia.
When you come to our clinics you may have seen HbA1c presented like this. Our aim is to help people achieve HbA1c levels within the green range. At the moment just under 30% of people attending RIE achieve this target HbA1c. In some other centres in the Europe, particularly in the Netherlands and Scandinavia, closer to 50% of people achieve this target. One of the major differences between these centres and our is that there is a long-established system for people to review their glucose results and share this information with their diabetes team using technology. We hope that widening Libre use will make this easier for people attending RIE clinics.
It is not easy to achieve tight glucose control. Many people with on target HbA1c are checking finger-prick blood glucose over 7 times per day.
We would strongly recommend all people with T1 diabetes do the DAFNE course. This has been proven to improve well-being and diabetes control, including fewer hypos, and is offered at all 3 major hospitals in NHS Lothian. Please speak to your diabetes specialist team to reserve a place on the course or see our website for further details.
We have also included information in your packs on signing up to My Diabetes My Way which allows you access to your own diabetes medical record (including clinic letters and results). We have also provided information on signing up to the Scottish Diabetes Research Register which gives us permission to contact you regarding studies which may be of interest and also permission to use spare blood (from routine tests) for research purposes. The Libre form we have asked you to hand in tonight also offers the option of giving us permission to contact you by email with news and updates from the diabetes clinic.
These two guides – one on improving control in type 1 diabetes and the other a guide to using the Libre – have been included in your Libre packs. We would recommend having a look over both of them, as they summarise a lot of what will be discussed here. If you use an insulin pump there is a pump specific version of the 10 steps guide which you can download on our website.
Other guides

Video guides on exercise and carb counting

www.edinburghdiabetes.com/exercise

www.edinburghdiabetes.com/carbcount

There are also specific video guides to help keep your blood glucose in target in relation to exercise and a video guide to carbohydrate counting.
Flash Glucose Monitoring
The Freestyle Libre
Many of you will have already used the Libre but, in brief, it is a glucose sensing technology which measures the glucose level in the interstitial fluid under your skin. The sensor lasts for 2 weeks after which it is simply peeled off like a plaster. We are not going to dwell too much on the practicalities of putting the sensor on, as the videos on the Abbott website are probably the best way to learn how to do this. The sensor is waterproof and you can bath, shower and swim whilst wearing it.
When the Libre sensor is applied, a very small filament remains just under the skin to measure glucose – you cannot feel this and it is not a needle.
You can either use the reader provided by Abbott – which is also a blood glucose and ketone meter – or you can download the LibreLink app on Android phones or iPhones (so long as it is iPhone 7 or above). One major benefit of using the phone app is that it will automatically transfer data to the LibreView system without you having to plug anything in to a computer. If you use the reader and a phone always be sure to activate the sensor on the Reader first. The screen on the reader shows the current glucose level, an arrow to show you whether the glucose is going up or down. There is also a trace at the bottom of the screen which shows you what has happened in the last 8 hours – the Libre records across the whole day, including overnight, as long as you scan several times per day.
The arrows offer a huge advantage compared to finger-prick testing. If it is a straight-down or straight-up arrow, this means the glucose will have changed by 1.7 in 15 minutes time and by over 3 in half an hour. If it is a slanted-up or slanted-down arrow, the glucose will have changed by 1 in 15 minutes and just under 2 in 30 minutes. You can start to use the arrows to avoid hypos before they happen and make some other changes which we will discuss later on.
It is important to point out that Libre is not measuring blood glucose but interstitial glucose which is the fluid between cells under the skin. This means there is a lag of around 10 minutes – blood glucose will rise first and fall first after food and the interstitial glucose then catches up. When the glucose level is not changing we would expect Libre and finger-prick tests to be similar.
Libre glucose is accurate
When compared to blood glucose

But…

And this graph shows that across the two weeks of usage, the Libre result is typically within 10% of the finger-prick test. However…
Sensor accuracy can vary – some sensors will be highly accurate and others slightly less so – although this should never be dramatic. Some people recommend checking a morning finger-prick glucose before breakfast (when the glucose should be relatively steady) to assess how accurate your current sensor is. Given that many people drive in the morning, DVLA regulations still stipulate finger-prick glucose tests before driving. In the example on this slide the sensor is reading 1.1 to 1.8 lower than the finger-prick reading.
Many people notice that the sensor reads too low in the first 24 hours. As you will see in this example, many of the episodes which seems like hypos on the Libre are not actually hypos on finger-prick testing. Some people insert a new sensor and leave it in place for 24hrs before activating it – this seems to help.
Many people ask whether the you can rely on the Libre reading when selecting an insulin dose. It is worth bearing in mind the issues raised in the previous few slides but the answer most people with diabetes reach is ‘yes’. This is supported by the biggest study of Libre in type 1 diabetes where people with on-target HbA1c were randomly assigned Libre or continued with finger-prick testing. The Libre group dropped to testing finger-prick glucose every other day – the other group continued with an average of 5 finger-prick tests per day. HbA1c remained excellent on both groups over 6 months but hypoglycaemia fell only in the Libre group who scanned around 15 times per day.
There is no ‘right amount of scanning’ – this will vary from person to person. The prescribing guidelines stipulate at least 6 scans per day which should generate enough information to help with meal-times and prior to bed. Remember you can always look back at the trace so you don’t need to scan multiple times after a meal. Generally it is only a good idea to scan if you feel the information is likely to result in an action.
Over-treating hypos and then giving too much insulin (or stacking insulin doses on top of each other) can result in swinging between highs and lows. Sometimes it pays to wait.
Skin reactions with Libre
How common and how to avoid

- Just under 10% of people in the largest Libre study – severe in 5%
- Since then changes have been made to the sensor
- Often responds to barrier sprays (Cavilon) or zinc ointment / hydrocortisone cream or change in position of sensor

Unfortunately a minority of people develop skin reactions to the sensor – often mild but sometimes severe enough to make it too uncomfortable to continue. Here are potential approaches to minimize the reaction where it has developed. There have also been changes made to the sensor to prevent it becoming too moist under the adhesive, so it is possible the number of people affected may be smaller than previously.
Many people ask if the sensor needs to be on the arm and the answer appears to be yes. The graph at the top is a way of assessing how accurate a glucose measurement is – you basically want to see all the results form along the diagonal line in the middle and just around it – Zone A. The further out into zones B to E, the less accurate the result. The one study that looked at arm vs. tummy suggested 86% of arm readings were in zone A compared to only 64% on the tummy.
There are two extremely important times when finger-prick glucose testing is still essential. It remains the law, as mandated by the DVLA, that insulin-treated individuals check finger-prick blood glucose before driving (and every 2 hours during longer drives). Libre results would not be regarded as acceptable and would leave you open to prosecution or invalidate your insurance in the context of an accident. This situation may change in the future and if that occurs we will inform people. The other important time to check a finger-prick test is if you are feeling hypoglycaemic and the Libre suggests you’re not – it is always better in this situation to trust the blood glucose.
If you haven’t had the opportunity to sign-up and complete the free Libre Academy course, we would highly recommend it. Particularly in relation to the use of LibreView, LibreLink and making sense of the summary glucose profiles.
Similarly, watching this series of introductory videos should leave you in no doubt about the basics and practicalities of getting started with the Libre.
Diabetes
We know it’s not easy
The purpose of this slide is simply to show how many factors people with diabetes often need to consider when working out the correct insulin dose. Although it can sometimes seem overwhelming, often picking one factor at a time can help you work through things step-by-step.
10 steps
Don’t need to solve every problem at once
Before talking in more detail about insulin dose adjustment – it is important to emphasise the importance of insulin injection site rotation (or in pump users the importance of replacing the giving set at least every 3 days). Injecting in to lipohypertrophy (caused by repeated insulin injection) leads to massive variation in the dose of insulin absorbed which will, in turn, result in very unpredictable glucose levels.

**Injection sites and lipohypertrophy**

*Important to avoid*

- Important to rotate injections sites – can have massive impact on insulin absorption

- Pump users should change giving sets at least every 3 days
For the remainder of this presentation we will be presenting glucose traces like the one on this slide. The black line represents the glucose level over time. Ideally we want to see this in the green band 65% of the time or greater. The traces on these slides are similar to the type of traces you will see on a Libre.
One of the striking discoveries for many people using a Libre is how often their glucose level dips low overnight – difficult to detect when using only finger-prick tests. This is a problem as, if it occurs often, it reduces your ability to detect hypos. Low glucose overnight can also make it difficult to control the glucose level after breakfast.
If you detect lows overnight, it is important to consider why they are happening – is it too much background insulin (too high overnight basal for pump users)? Is it related to exercise the previous day (in which case a 10 – 20% reduction in dose of overnight insulin could be considered with future exercise) or was it related to alcohol (which initially causes glucose to go up but then later causes it to drop significantly).

Avoiding overnight hypos
Consider effects of exercise and alcohol

If this example, the glucose levels were fine in bed but drops into the hypo range at 2am before rising just before waking. This was caused by a combination of exercise and alcohol. A reduction in insulin dose was recommended following exercise and helped avoid future hypos.

Too much background insulin
Exercise
Alcohol
The view you see here is a summary of glucose results over the past 2 weeks. The dark blue line is the average glucose and the dark blue shading is where half of all the glucose results have fallen over that period. The lighter blue shading is where 80% of all results in the past 2 weeks have fallen. LibreView provides a traffic light style guide to the risk of hypos at different times of the day. This person appears to be at quite high risk of hypos at all times – perhaps because their background insulin dose is too high.
After excluding frequent overnight lows it is often a good idea to make ‘getting the morning glucose on target’ a priority. If glucose is persistently too high overnight then people are exposed to 8 hours or so of high glucose – whereas during the daytime you have the opportunity to identify that and correct it down if necessary. There are two main causes of higher morning glucose. The first possible reason is too little basal/background insulin cover over night but this is often not the case but despite this background insulin doses are increased. A much commoner cause for high glucose in the morning is that the bolus dose of insulin with the previous night’s evening meal (or later snack) has not been enough to bring the glucose back down to target – so it remains high and steady overnight. Background insulin’s job is to keep the glucose steady – not to bring it down when it’s high. Some people have something called the Dawn phenomenon where their glucose is fine until around 3am and starts to rise consistently up until breakfast time – this can be tricky and if it is genuinely happening often pump is the best option.
Too much background insulin is a problem as it tends to increase the risk of hypos and also weight gain. As a rule of thumb background insulin is usually 40 – 50% of the total dose in people with well-controlled diabetes, although there are always exceptions. The best way to assess background insulin is to see what happens to the glucose trace after either missing a meal or having a carb-free meal. The ideal trace is the black line – nice and steady. The red line shows what might happen to someone with too much background insulin and the blue line shows what might happen with not enough background. It is important to look at this at all the time windows across the day – ideally on different days. These things can change over time and it’s worth reassessing every few months, particularly if your weight or activity levels change. Lantus can sometimes run out before 24 hours – twice daily Levemir or once daily Tresiba may be better for some people.
These examples of carb free meals are also listed in the ‘10 steps guide’ in your Libre pack.
To test this – carefully assess the amount of carb in your meal (ideally less than 50g to test ICR) – no other QA insulin in previous 4 hours. Ideally not much more than 2 higher at 2 hours than before meal and roughly back to baseline at 4 hours.
Quick acting (bolus) insulin
Matching it with meals

• Rule of 500
  – Take your total daily insulin dose (i.e. all quick-acting and background insulin) and divide into 500
  – So if you typically take 24 units of background insulin and around 26 units of quick-acting insulin the TDD is 50
  – 500 divided by 50 = ICR of 10
  – So 1 unit of insulin for every 10 grams carb

Are your ratios roughly in keeping with this?
This quick guide to ICR is at the back of the 10 steps guide.

### Quick acting (bolus) insulin

**Matching it with meals**

<table>
<thead>
<tr>
<th>Average daily insulin dose (background and quick acting)</th>
<th>Appropriate T/C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 - 11</td>
<td>1.50</td>
</tr>
<tr>
<td>12 - 14</td>
<td>1.40</td>
</tr>
<tr>
<td>16 - 18</td>
<td>1.30</td>
</tr>
<tr>
<td>19 - 21</td>
<td>1.25</td>
</tr>
<tr>
<td>22 - 27</td>
<td>1.20</td>
</tr>
<tr>
<td>28 - 35</td>
<td>1.15</td>
</tr>
<tr>
<td>36 - 45</td>
<td>1.12</td>
</tr>
<tr>
<td>46 - 55</td>
<td>1.10</td>
</tr>
<tr>
<td>59 - 69</td>
<td>1.08</td>
</tr>
<tr>
<td>66 - 80</td>
<td>1.05</td>
</tr>
<tr>
<td>81 - 120</td>
<td>1.04</td>
</tr>
<tr>
<td>&gt;120</td>
<td>1.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kilograms</th>
<th>Starches</th>
<th>Appropriate T/C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7</td>
<td>&lt;4.2</td>
<td>1.50</td>
</tr>
<tr>
<td>27 - 30</td>
<td>4.2 - 5.7</td>
<td>1.25</td>
</tr>
<tr>
<td>37 - 45</td>
<td>5.8 - 7.1</td>
<td>1.20</td>
</tr>
<tr>
<td>38 - 54</td>
<td>7.2 - 8.6</td>
<td>1.18</td>
</tr>
<tr>
<td>55 - 64</td>
<td>8.7 - 90</td>
<td>1.15</td>
</tr>
<tr>
<td>65 - 77</td>
<td>10.1 - 12.1</td>
<td>1.12</td>
</tr>
<tr>
<td>78 - 90</td>
<td>12.2 - 14.2</td>
<td>1.10</td>
</tr>
<tr>
<td>91 - 104</td>
<td>14.3 - 16.4</td>
<td>1.1</td>
</tr>
<tr>
<td>105 - 122</td>
<td>16.5 - 19.3</td>
<td>1.05</td>
</tr>
<tr>
<td>&gt;122</td>
<td>&gt;19.3</td>
<td>1.05</td>
</tr>
</tbody>
</table>
Insulin to carb ratio (ICR)

When to adjust

- ICR is not written in stone forever
- Consider adjusting when:
  - Requiring 2 or 3 daily correction doses that total more than 8% of your daily dose
  - You’re having to give correction doses at the same time of day consistently
  - 2 hour post-meal glucose is consistently above/below target
The first change would mean that a meal with 80 grams of carb would be covered with 10 units of insulin rather than 8 units previously.

The second change would mean a meal with 60 grams of carb would be covered with 5 units of insulin rather than 6 units previously.

The maths for 1:10 tend to be fairly easy – but harder for other rations – consider using a bolus calculator – ask your diabetes team – unfortunately the Libre reader bolus calculator requires finger-prick glucose tests!

**Insulin to carb ratio (ICR)**

**How to adjust**

- If your ICR is 1:10 (1 unit for 10 grams) but you find glucose levels are consistently too high after meals, consider changing to 1:8 (1 unit for 8 grams) and reassess over the next week.
- If your ICR is 1:10 but you are consistently having lows after meals, consider changing to 1:12 and reassess.
- Small changes are advised.
Carb counting

Getting help
This is one of the biggest insights from Libre use. Glucose almost always peaks very high in people who don’t bolus 15 to 20 minutes before meals and peaks extremely high in people who bolus after meals. Whilst the new quicker-acting insulin FiAsp may be a little better – dosing before meals is always preferable. Delayed insulin runs the risk of hypoglycaemia at 3 – 4 hours.
Using Libre gives the opportunity to watch and see when your insulin bolus starts to work. So long as you’re not close to hypoglycaemia – you can ‘wait for the bend’ as blood glucose starts to fall and start your meal. This strategy will help avoid big peaks in the 2 hours after meals. There is more information on this in our CGM guide.
High fat meals, in particular, cause a delayed and prolonged rise in blood glucose. It is quite often the reason why people wake up with high glucose levels the following morning. This is often very clearly seen when people have the benefit of continuous glucose monitoring. High fat content (around 40g of fat) may require an additional bolus dose of quick acting insulin an hour or two after the pre-meal bolus (around 1/3 the dose of the pre-meal bolus) or, in pump users, an increased bolus dose (an extra 1/3) given as a dual wave with 50% given immediately and the remainder infused over the following 2 – 3 hours. There are no hard and fast rules about the best way to deal with protein and fat – it is worth discussing this with your specialist team and learning what works for you through trial and error.
Correction factor
What is it and how to calculate it

- The amount of blood glucose lowering expected from 1 unit of insulin
- Typically added at mealtimes to get glucose down to target (normally 6 or 7 mmol/L)
- Rule of 100
  - Take your TDD and divide it into 100
  - So if taking 50 units per day = 100 / 50 = CF of 2
  - That is – 1 unit lowers 2 mmol/L glucose

Correction factor is important as it gives you an opportunity to correct down a high blood glucose. If you start with a high glucose value and only give the insulin to cover carbs in your next meal it is likely you will remain high over the next few hours. You can give a correction dose even if you don’t plan to eat but it is important to avoid insulin stacking – that is giving extra insulin doses before your last insulin dose has peaked and taken its full effect – doing so runs the risk of hypoglycaemia.
In the example here – the correction factor at lunchtime has been too much and resulted in a hypo – if this is a consistent finding, the correction factor would need adjusted.
You can also use the Libre to work out exactly what your correction factor is – for example if your glucose is high first thing in the morning and you take only a correction but skip breakfast – then how much your glucose drops in the next few hours will be your correction factor. For example if you took 2 units and dropped 4 in the next 3 hours – 1 unit lowers 2. This can be different at different times of day.
Correction factor
When and how to adjust it

- First – is your background insulin appropriate?
- Assess background using Libre and carb-free / fasting
- If correction factor consistently failing to get next glucose to target may need adjusted
  - If ‘1 lowers 2’ may need to change to ‘1 lowers 1.5’
- If correction factor consistently leading to low glucose (hypo) may need adjusted
  - If ‘1 lowers 2’ may need to change to ‘1 lowers 2.5’
### Meal time dose

#### Using the arrows

<table>
<thead>
<tr>
<th>Sensitivity factor</th>
<th>Direction of needle arrows</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Glucose rising moderately - ADD the amount of units below the total bolus dose</td>
</tr>
<tr>
<td>1.5</td>
<td>Glucose rising quickly - ADD half the amount of units below the total bolus dose</td>
</tr>
<tr>
<td>2.0</td>
<td>Glucose falling moderately - Subtract the amount of units below the total bolus dose</td>
</tr>
<tr>
<td>2.5</td>
<td>Glucose falling quickly - Subtract half the amount of units below the total bolus dose</td>
</tr>
<tr>
<td>3.0</td>
<td>0.5</td>
</tr>
<tr>
<td>3.5 - 4.0</td>
<td>0.4</td>
</tr>
</tbody>
</table>

An alternative approach is to add/subtract 10% of the meal-time dose when the arrows are 

You can use the direction arrows to help guide how much more/less insulin to use with a meal in addition to your normal carb counting and correction factor.
Avoid stacking insulin
Over-correcting leads to ‘see-sawing’ glucose

• Quick-acting insulin peaks between 60 – 90 minutes and lasts around 4 hours
• Don’t take extra insulin doses in the first 2 hours after a meal
• If the glucose is rising after 2 hours (↑ or ↓ you could consider a correction dose)

You can also see here (using the example of Humalog – although Novorapid and Apidra are pretty much the same) that almost no insulin reaches the bloodstream in the first 15 minutes after an injection – emphasizing the importance of pre-meal dosing. Insulin peaks at around 1 hour and is falling to around half maximum by 2 hours.
Use the Libre to develop the confidence to take just enough carb to correct a hypo and not over-correct. Previous hypos are the biggest risk for a further hypo and you should scan regularly to identify/prevent recurrent hypos.
If this is too much for you – you can modify your approach.
Dealing with exercise
Insulin and carbohydrate adjustments

There is a lot to say about exercise and most of it is covered in our website video guide. Overnight hypos are one of the biggest risks and reduction in overnight basal insulin after exercise is often needed.
Reviewing your own glucose results is the best way to identify patterns – find out what works, what doesn’t work and solve problems related to exercise, stress, different types of food, exercise etc. LibreView or Diasend are both ways to do this. If you link your LibreView or Diasend accounts to our clinic, we can have a look and try and provide some useful advice. If you use your phone – this data is transferred automatically to your LibreView account. If you use the Reader, you will need to connect it to your computer using the provided USB cable.
We typically see you in a clinic for a few minutes once or twice a year. You deal with your diabetes 24/7. We want to provide flexible support when you need it. One of the best ways to do this is through sharing data remotely – and as technology develops this may become a central part of the diabetes service – replacing the need for many clinic visits. However we equally happy to arrange face-to-face consultations...
Phone us. Email us. We will keep working with you until you’re happy with how things are.
It is really difficult to resist the temptation to take lots of extra carb during hypoglycaemia but it is worth reflecting on how often this results in large glucose peaks. If so, aim to take less carb the next time and carefully monitor your glucose to make sure it is rising. Whenever practical aim to take your bolus insulin well in advance of meals. Aim to take bolus insulin with snacks – particularly if they have more than 10g carb. Aim to use your pump bolus wizard or ‘smart meter’ dose calculator – if you find you are over-riding it, consider why – is the ICR wrong? Is the CF wrong? Could you do with a carb counting refresher? Using bolus calculators is typically associated with improved control so it is worth sticking with it. Good injection sites and regularly changed pump sets are essential to predictable insulin delivery. Just because your ICR or CF or basal insulin was correct 6 months ago – doesn’t mean it is now – assess this periodically and change your settings as needed. If you’re not confident – ask your specialist team for help – it’s what they’re there for!

Common pitfalls
How to avoid them...

- Over-treating hypos
- Not getting insulin on board 15 minutes before eating
- Snacking with no bolus insulin
- Over-riding bolus wizard / dose calculator
- Not changing pump giving sets / not rotating injection sites
- Persisting with wrong ICR / CF / basal insulin
Abbott have agreed with NHS Lothian to provide one box of glucose test strips per month to people getting Libre on prescription. The process for this is perhaps not as easy as we’d like but following it will save the NHS money. This is important as we need to be able to show that Libre is not just an additional cost but is saving money elsewhere (i.e. test strips). Of course, if you need more test strips we will still be advising your GP to provide them to you without any hindrance – as glucose testing remains mandatory for driving and is important as a safety measure to back up Libre use.
Getting Libre on prescription

What you need to do

Please hand this completed form in to one of the members of staff tonight before you leave. We will be using this to generate the letter to your GP.

Don’t leave without handing it in!

Both sides!