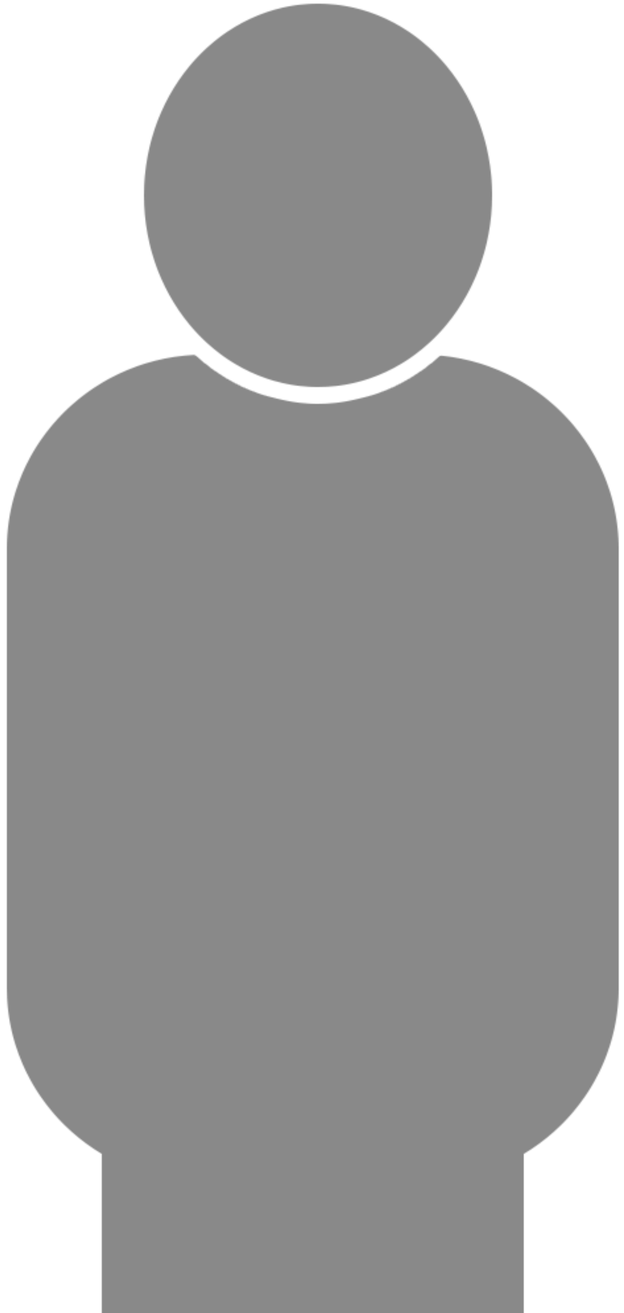

Understanding Arrows

Dr Pratik Choudhary

King’s College, London

Supported by a restricted educational grant from Abbott

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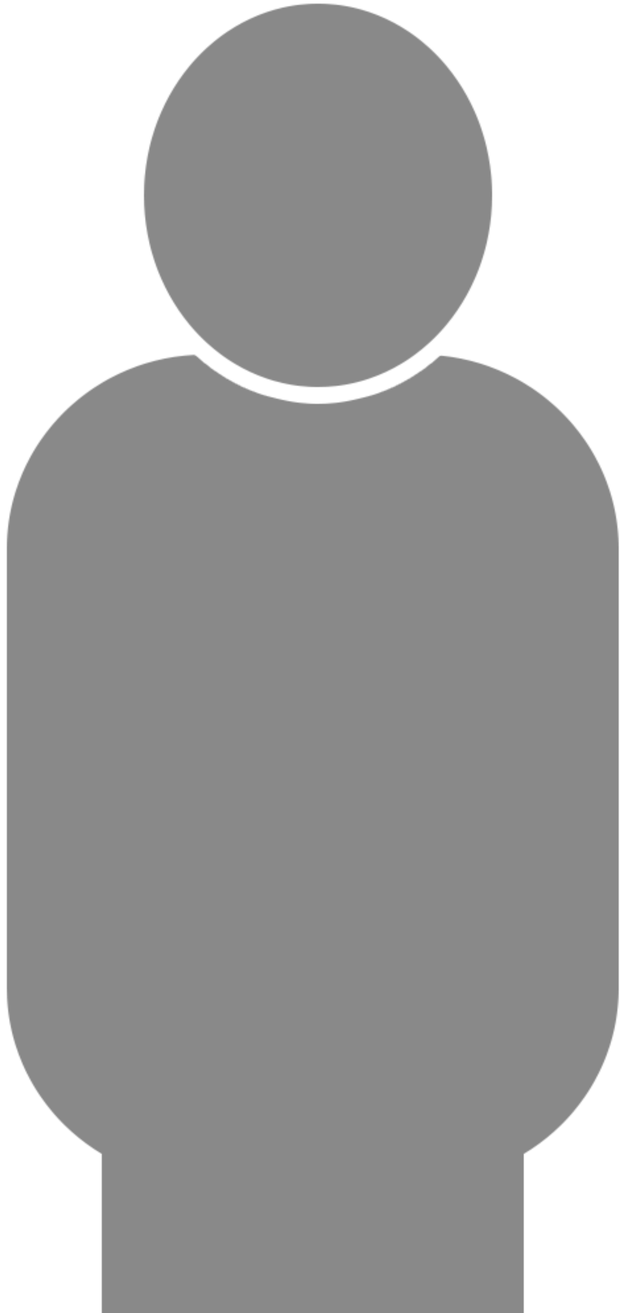

Dr Pratik Choudhary

- Senior Lecturer and Consultant in Diabetes, King’s College London
- DTN Chair Elect
- DAFNE Doctor

Disclosures:

Speaker fees and advisory boards for Medtronic, Abbott, Dexcom and Roche

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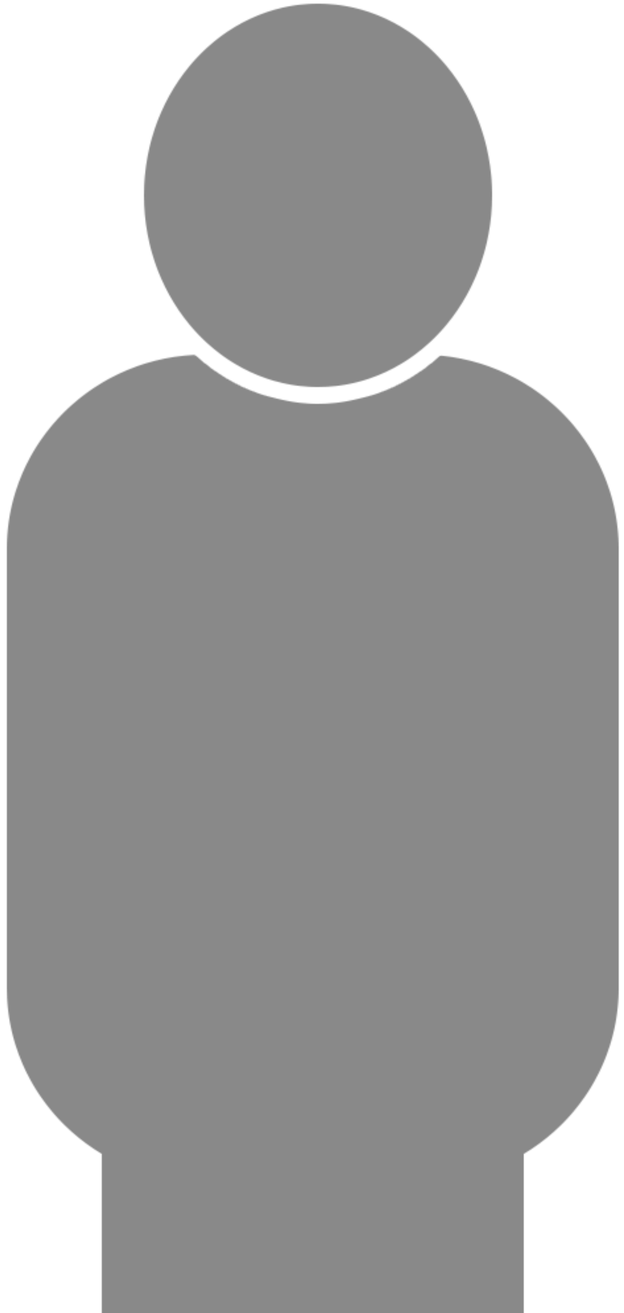

Advanced Libre Use

Learning objectives :

- Understanding what the arrows mean
- Making decisions based on arrows
- Using the data with bolus advisors

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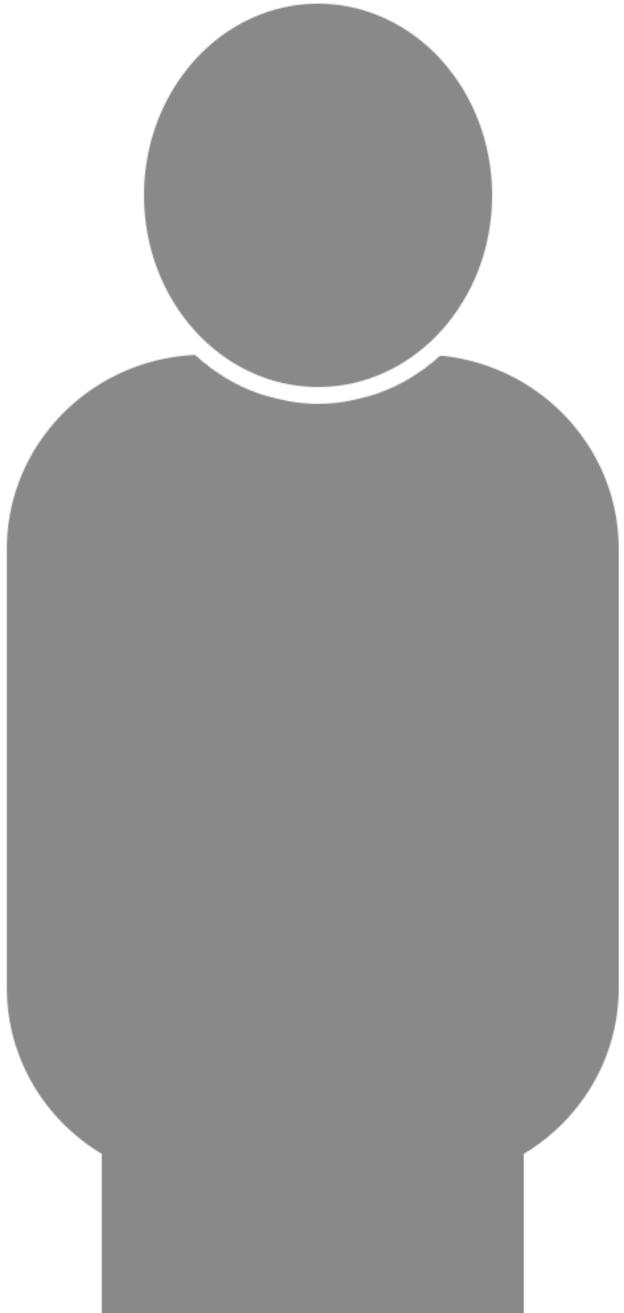

Arrows

- The extra information can be overwhelming
- Need to understand how quickly the glucose is actually changing to avoid over-reacting
- Need to have a plan
- Use the arrows to be strategic when you look at the data to make useful decisions

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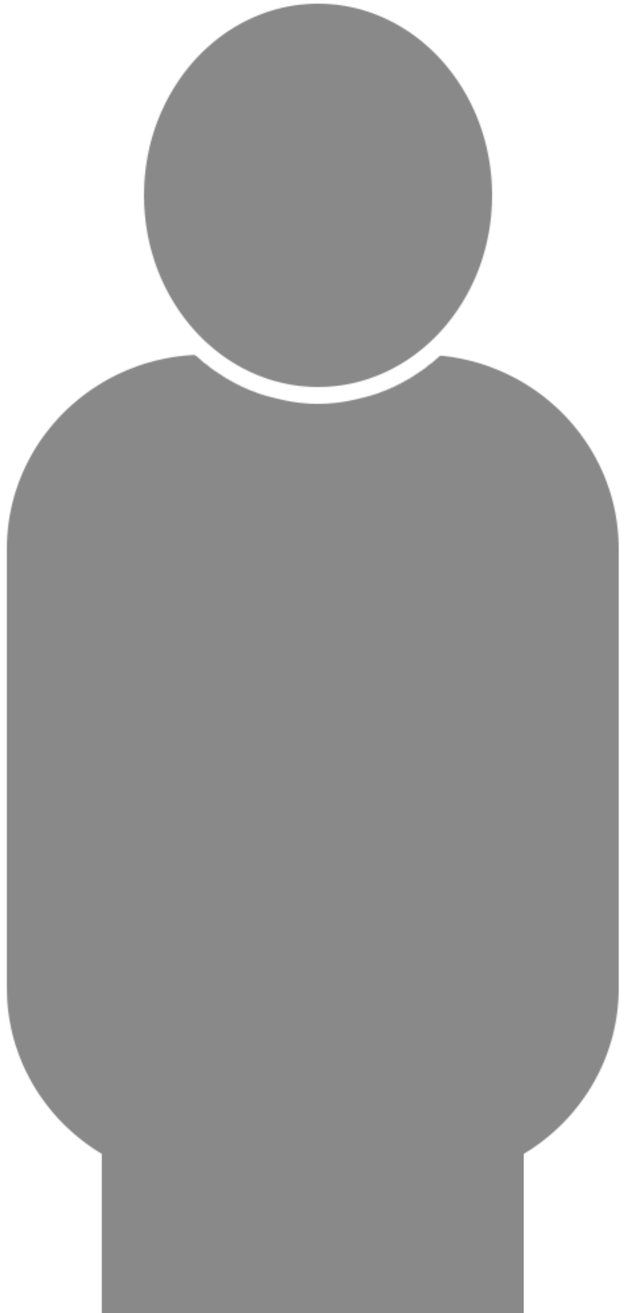

What do the arrows mean?

	Rate of change	How long to change by 1 mmol/l	How much will it change in 30 mins
↑	> 0.11 mmol/l / min	Average 7 mins	At least 3 mmol/l
↗	Between 0.11 and 0.06 mmol/l / min	Average 15 mins	2-3 mmol/min
→	Less than 0.06 mmol/min	More than 20 mins	< 2 mmol/l
↘	Between 0.11 and 0.06 mmol/l / min	Average 15 mins	2-3 mmol/min
↓	> 0.11 mmol/l / min	Average 7 mins	At least 3 mmol/l

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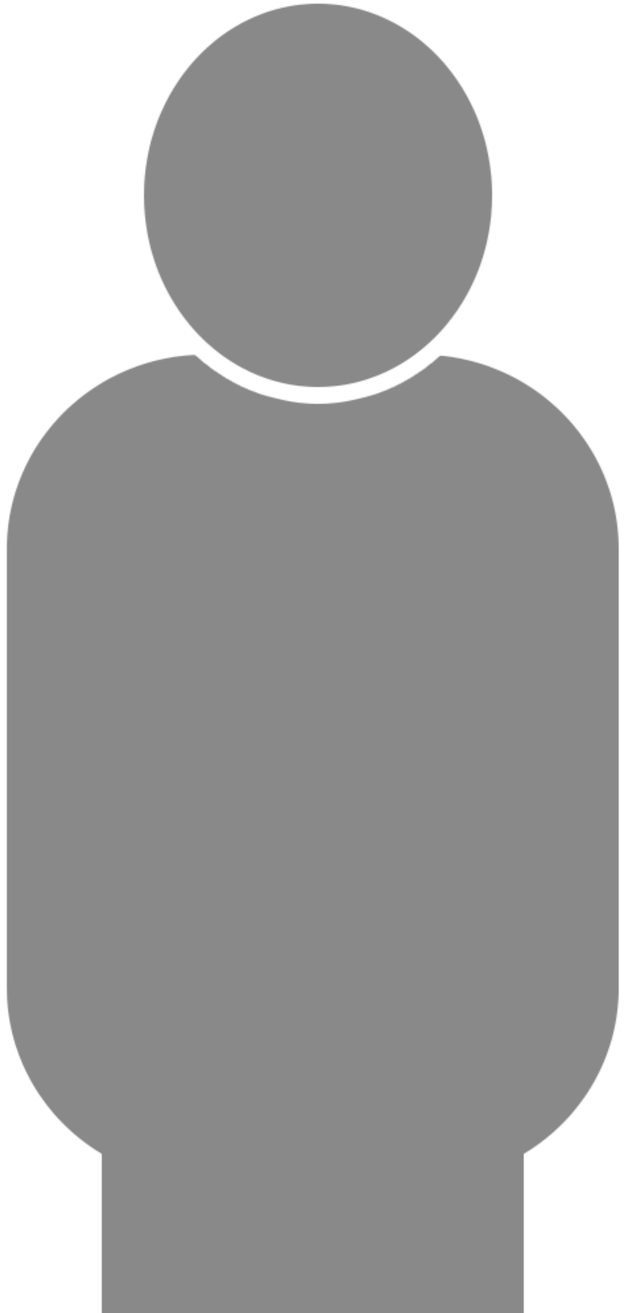
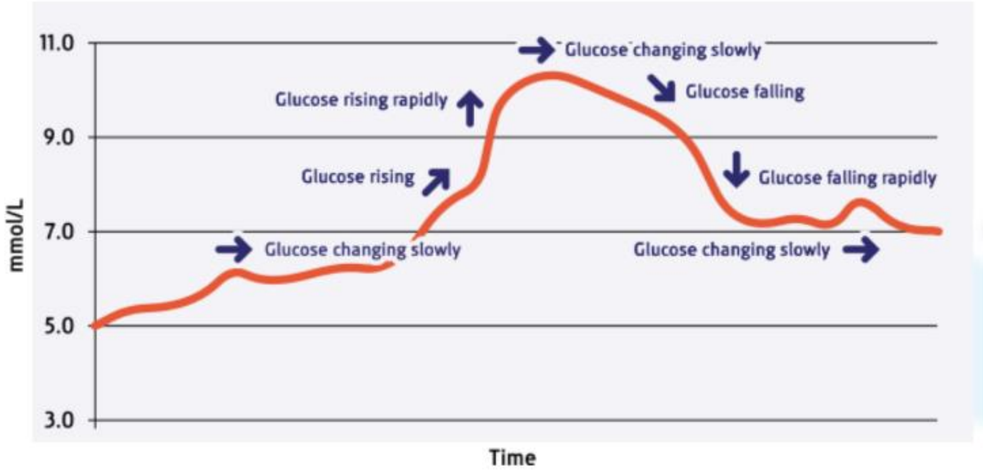


Understanding post–meal data

- Dose calculations are designed for pre-meal glucose levels
- A glucose reading of 12 mmol/l will require a different action pre-meal, 1 hour post meal, 2 or 3 hours post meal.



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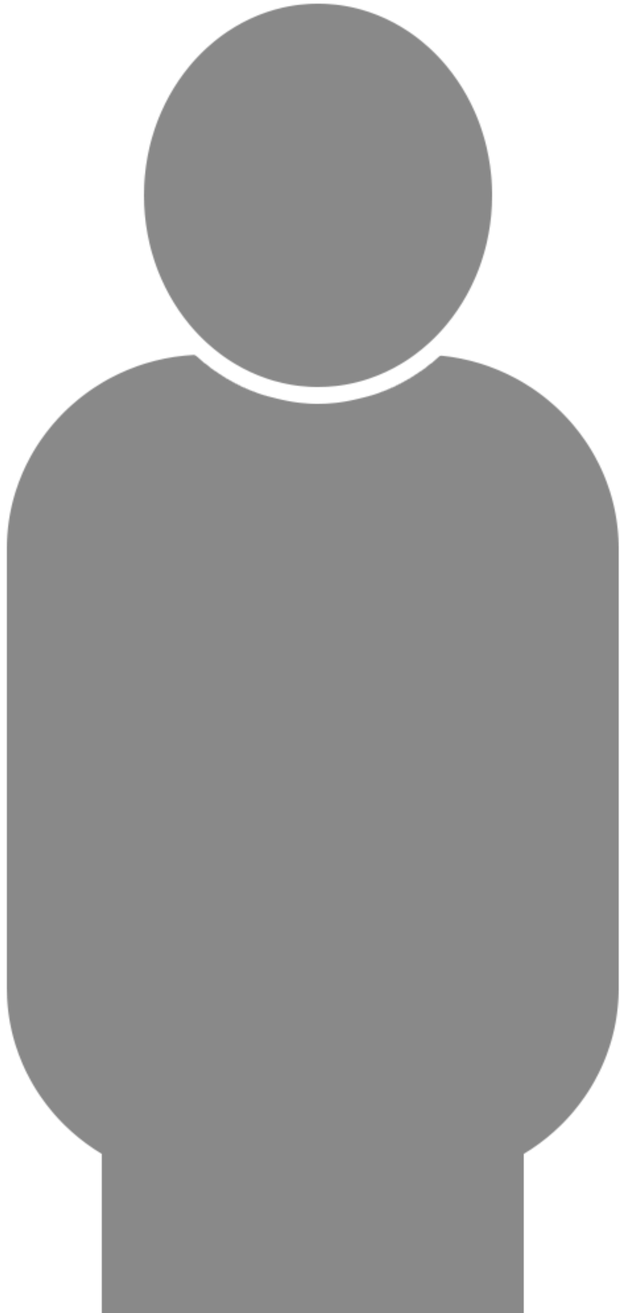
Realistic Expectations…

- Even after you have calculated the meal dose there is still a large chance that your blood glucose will not arrive “on target”
- Those with HbA1c of 7% [53mmol/mol] have on average 60-65% of readings between 3.9-10 mmol/l, and have up to a third of their readings over 10 mmol/l
- Imagine you are Teeing off on a golf course – we calculate the dose that will get us on the green. But even the best players will hit the sand bunkers or need an extra shot [correction], so it isn’t surprising if you have to take some carbs or extra insulin to keep glucose in range.
- If you can get 60-65% of your readings between 3.9-10 mmol/l, you are doing a fantastic job!!



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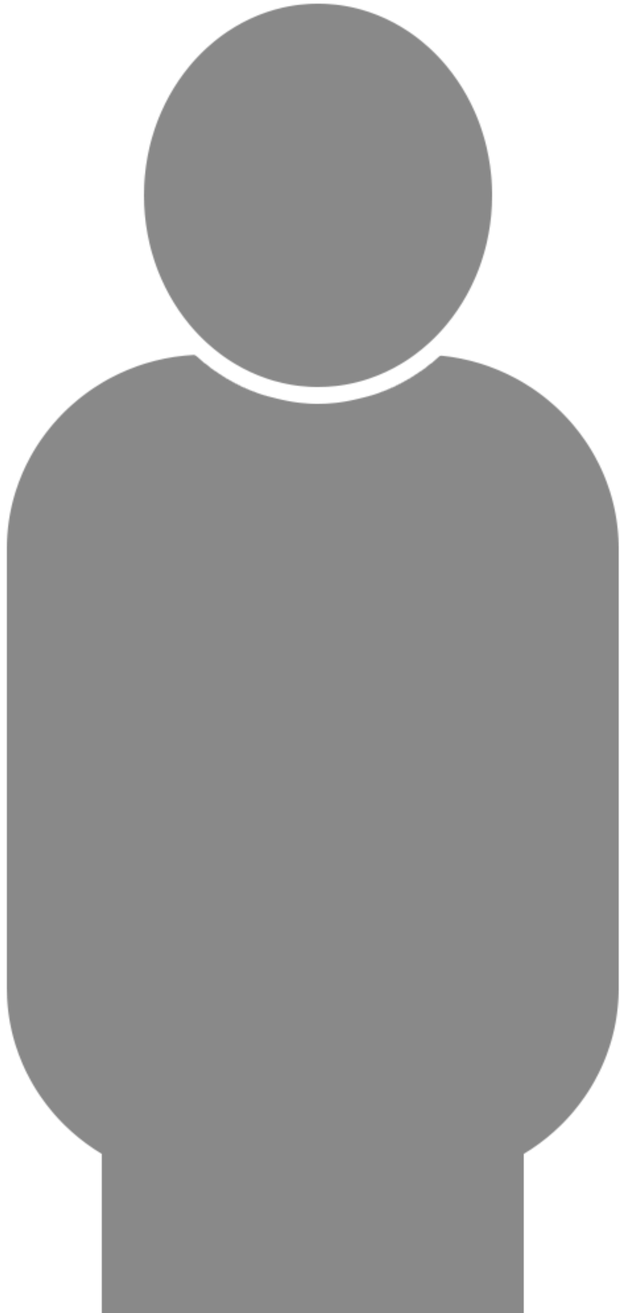
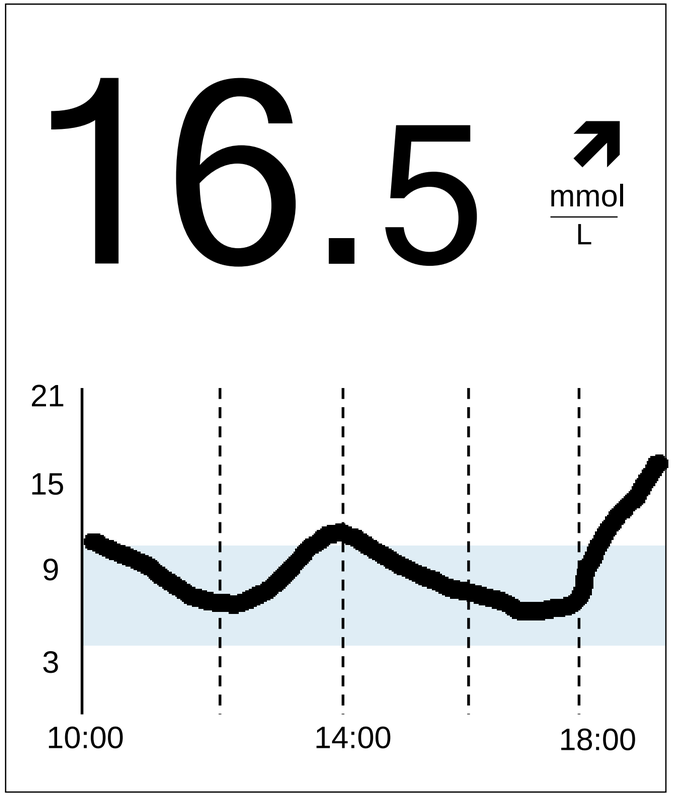


The 1 hour glucose



Your glucose 1 hour after a meal is likely to be rising..

How far the glucose rises depends on how early before your meal you were able to take the meal time insulin

If you take your insulin just before or just after a meal, the average rise in glucose can be up to 8 – 10 mmol/l higher than your pre meal glucose

If you correct here – you may risk a hypo later as the insulin will take up to 30 minutes to turn the glucose around (and last for ~ 4 hours)

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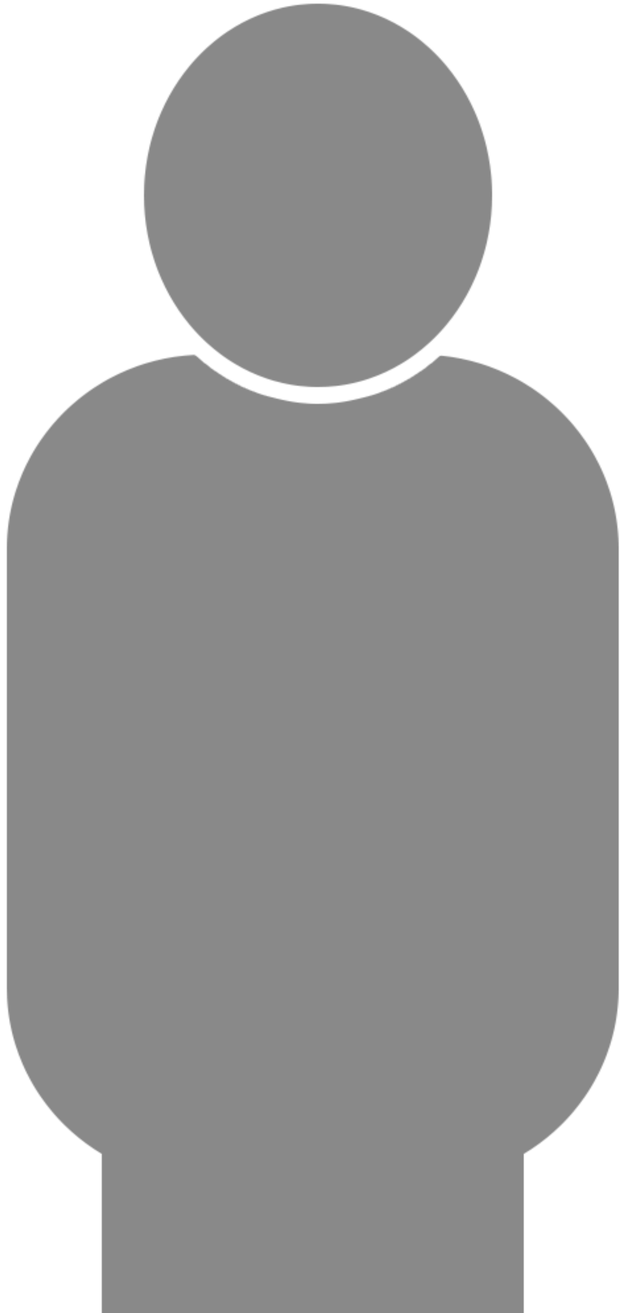
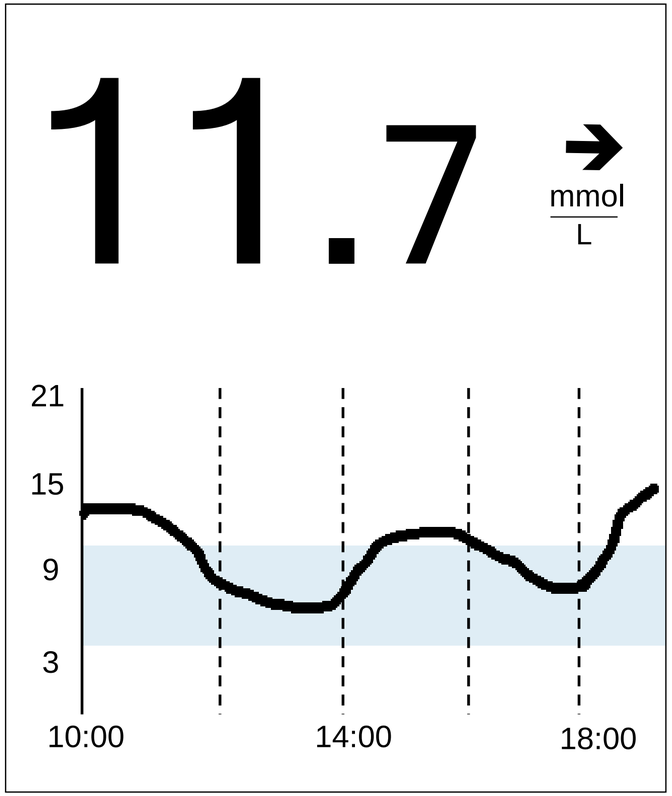


The 1 hour glucose



If you take your meal insulin 15-20 mins before your meal, the average rise is 3 – 5 mmol/l

Here blood glucose only rose from about 8 mmol/l to 11.7 mmol/l at 90 mins post meal

Of course, it isn't always possible to inject or bolus 15mins early, but important to remember to do so whenever possible…

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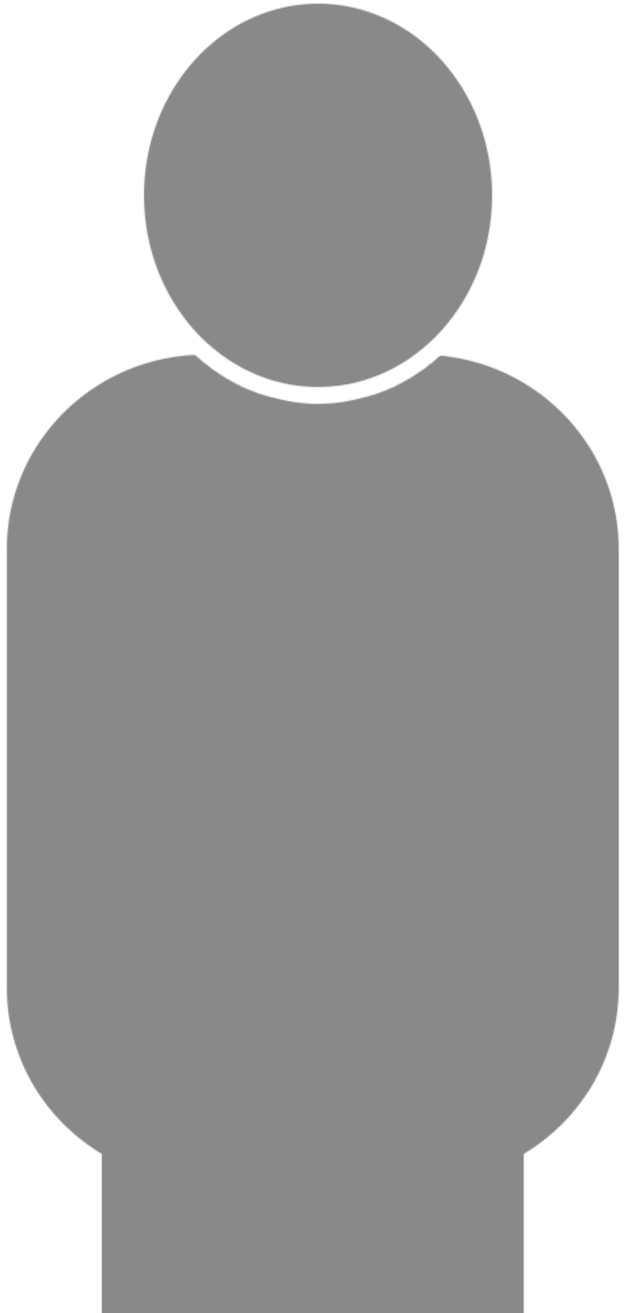
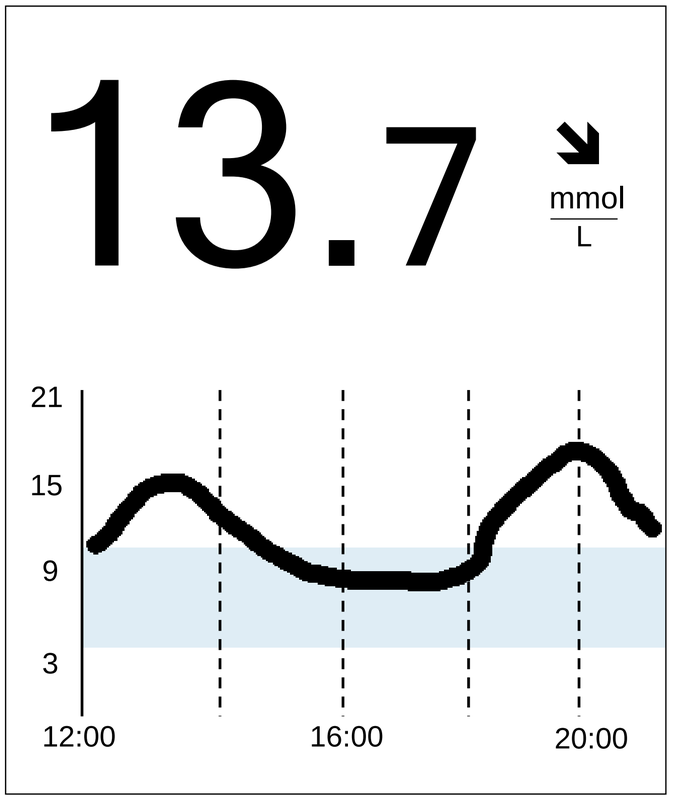


The 2 hour glucose



Your glucose at 2 hours tells you if you took enough insulin

If you are still rising – you probably needed more

If you took the right amount, you should be starting to come down (unless high fat/protein meal)

If glucose is lower than 6 mmol/l and still falling, you may be at risk of hypoglycaemia

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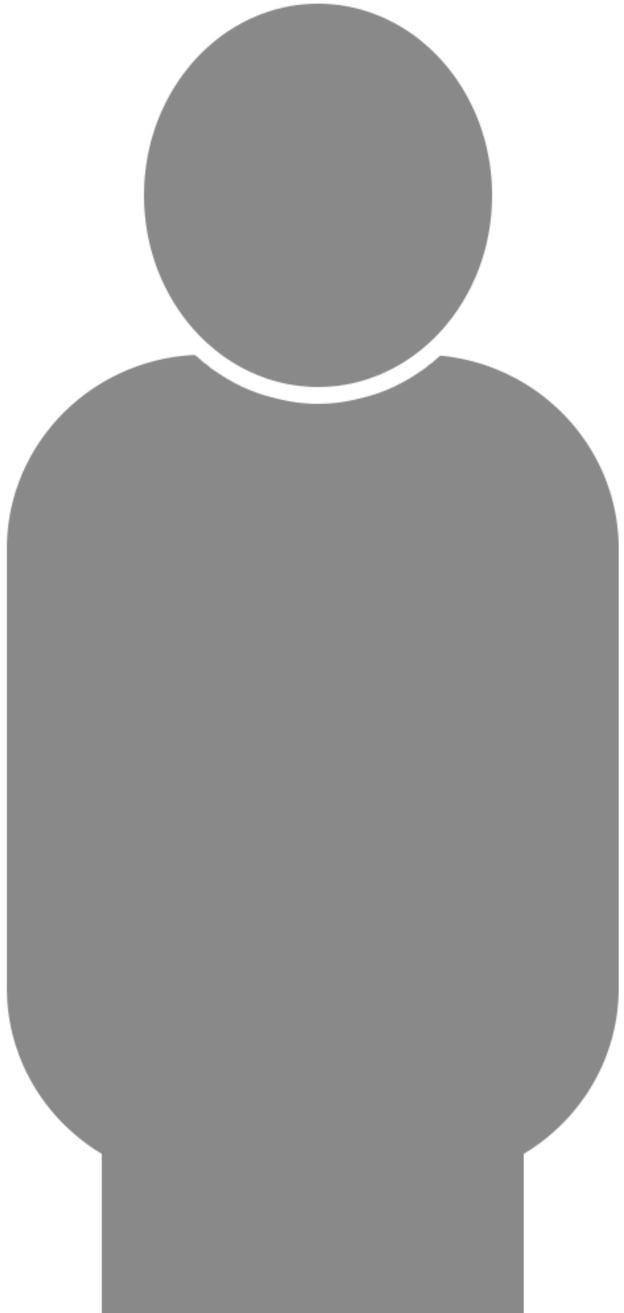
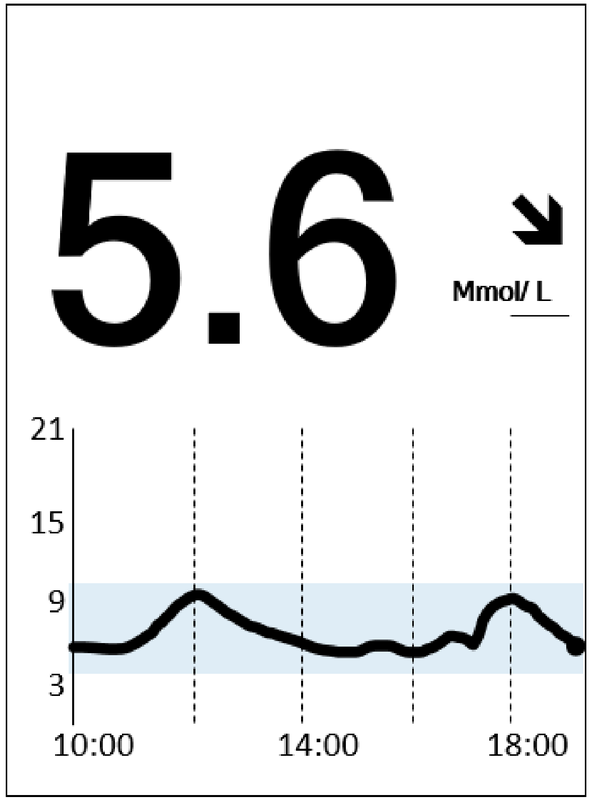


The 2 hour glucose



Your glucose at 2 hours tells you if you took enough insulin

If you are still rising – you probably needed more

If you took the right amount, you should be starting to come down

If glucose is lower than 6 mmol/l and still falling, you may be at risk of hypoglycaemia

Common causes include
- over estimated the carbs
- exercise
- previous hypos in the day

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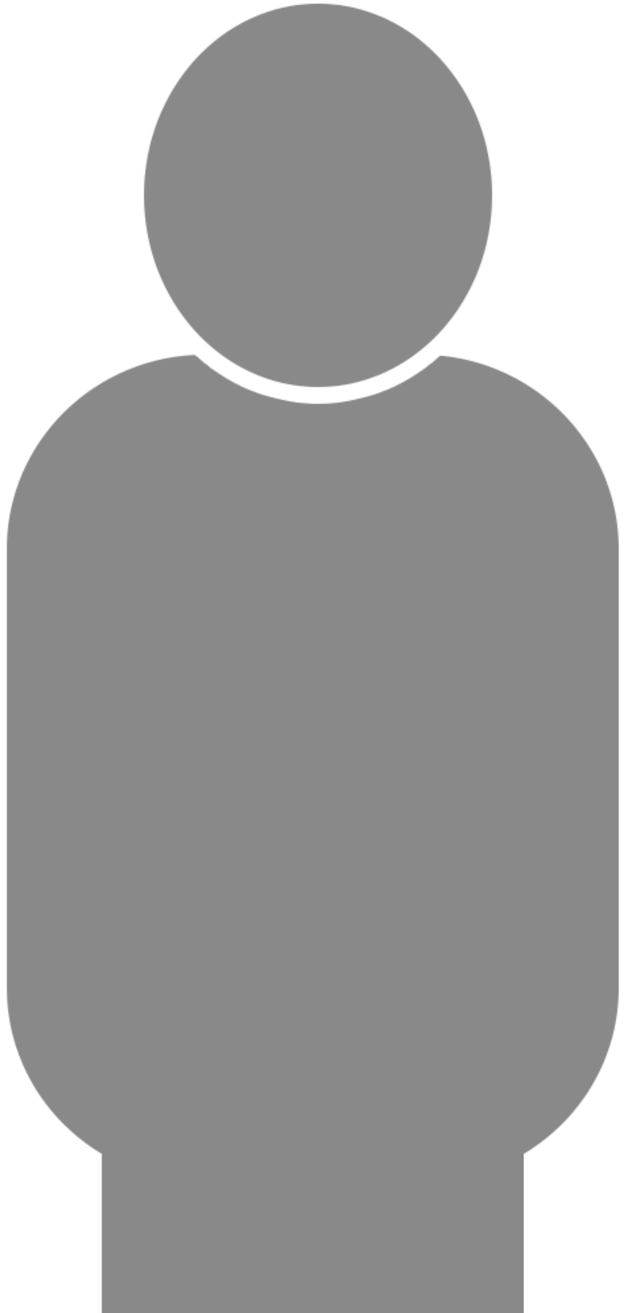

Using arrows to avoid hypoglycaemia

- Rules of thumb:

- 6 ↘ 4-5 grams e.g. 1 jelly baby
- 6 🡻 8-10 grams e.g. 2 jelly babies

- However, the action needed will depend on a number of factors including your insulin on board, recent activity etc.

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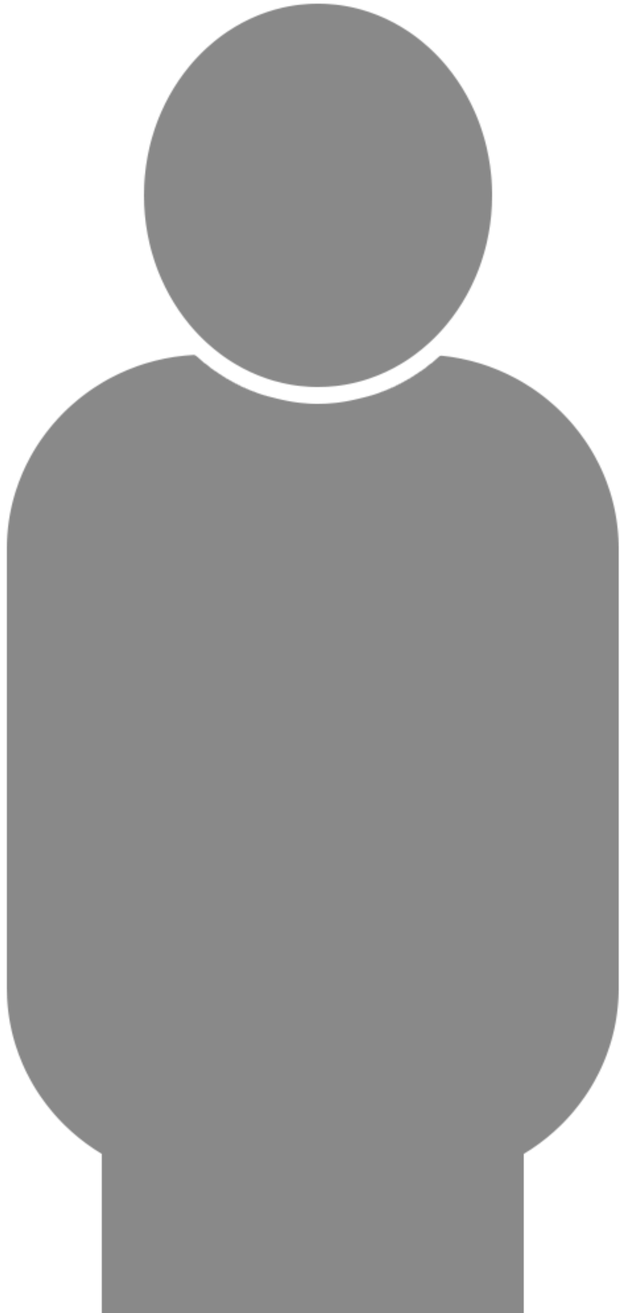
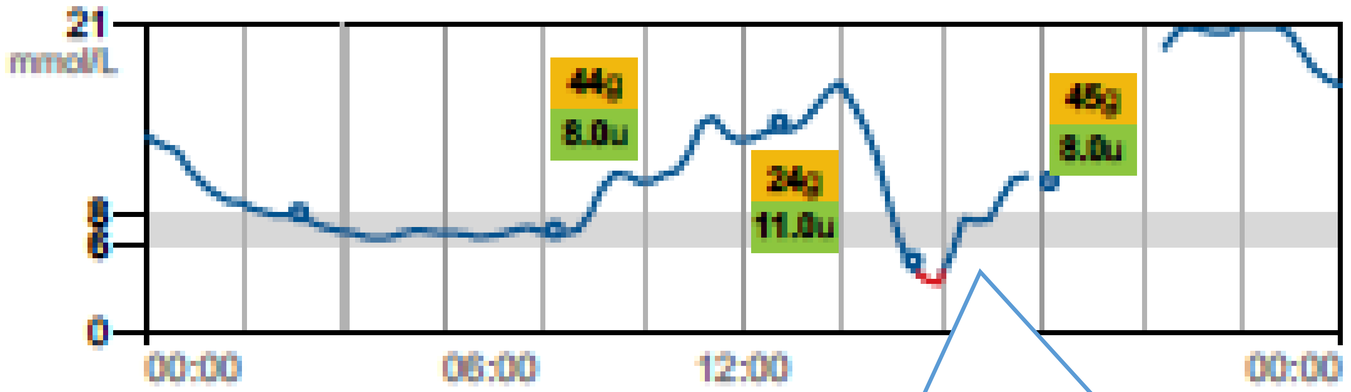


Thu
15 Nov



- Some carbs in the normal range may prevent the greater amount of carbs needed to treat the hypo
- This may also avoid the rebound high and “roller-coaster” effect

“Dab of the brakes” to prevent hypoglycaemia vs “U turn” to treat hypoglycaemia

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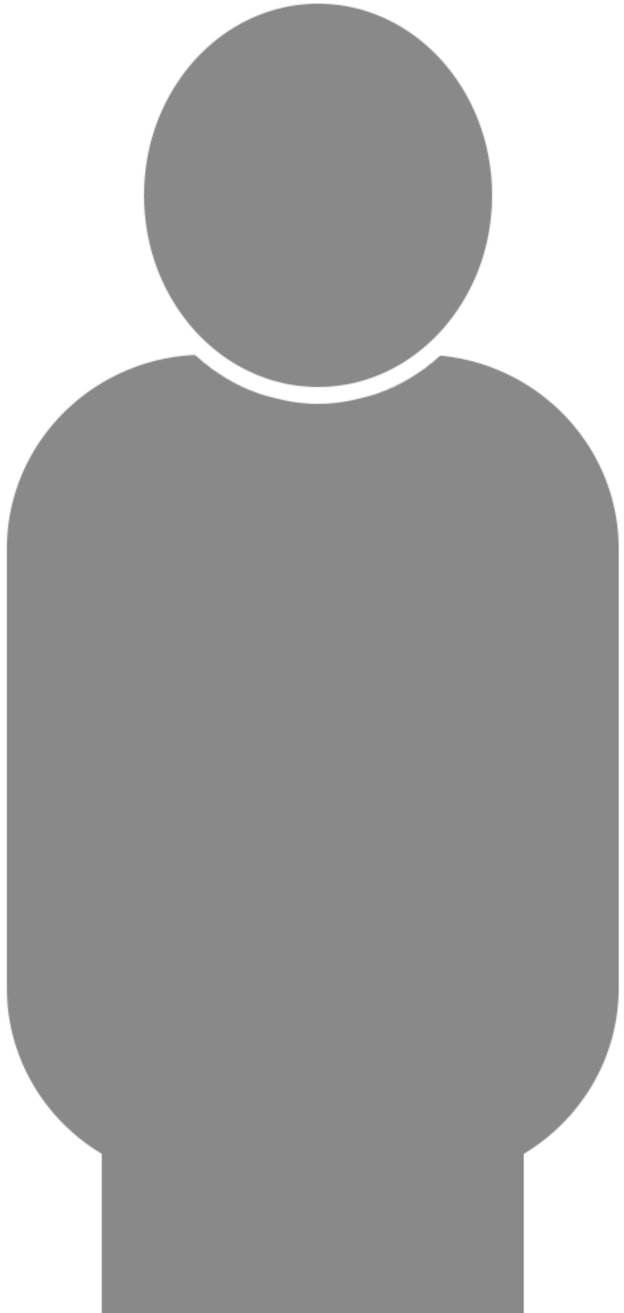
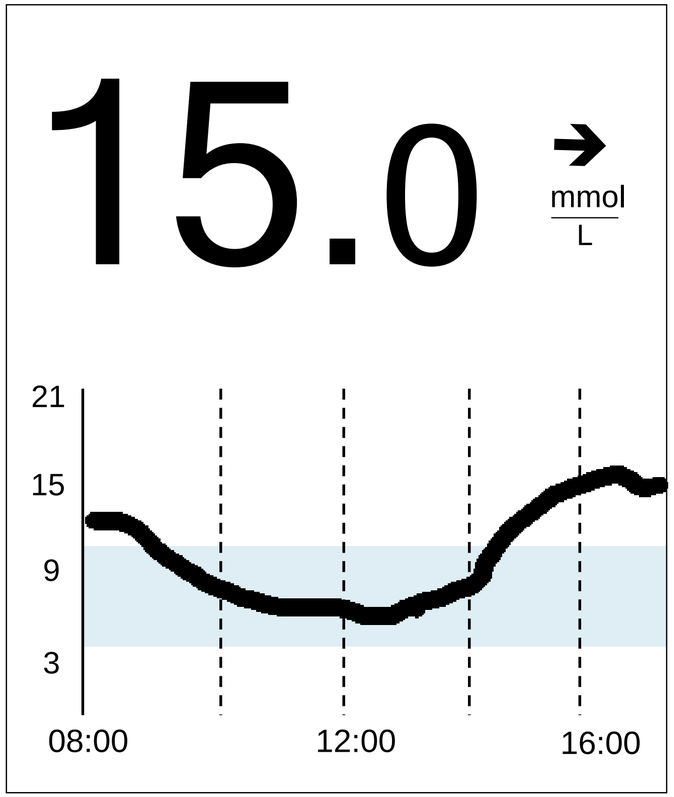


The 3 hour glucose



This person has had a lunch at 13:00 and had bolused 20 minutes before eating 70 gms of carb and taking 8 units of insulin

Just after 16:00 their glucose is 15 and stable. They are not planning to have their evening meal until 19:00. It is three hours since their last insulin bolus.

There will still be some of the 8 units working at present

This needs to be taken into consideration when calculating the correction dose.

You can either use a bolus advisor app or for safety use ½ the usual correction dose if there is insulin on board

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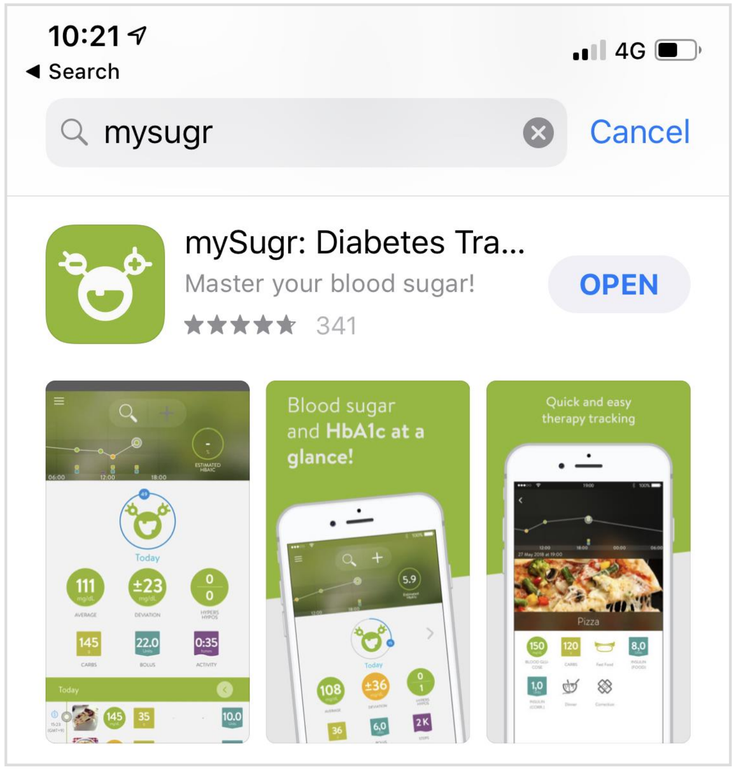
Some Apps you can use to help calculate boluses that account for insulin on board



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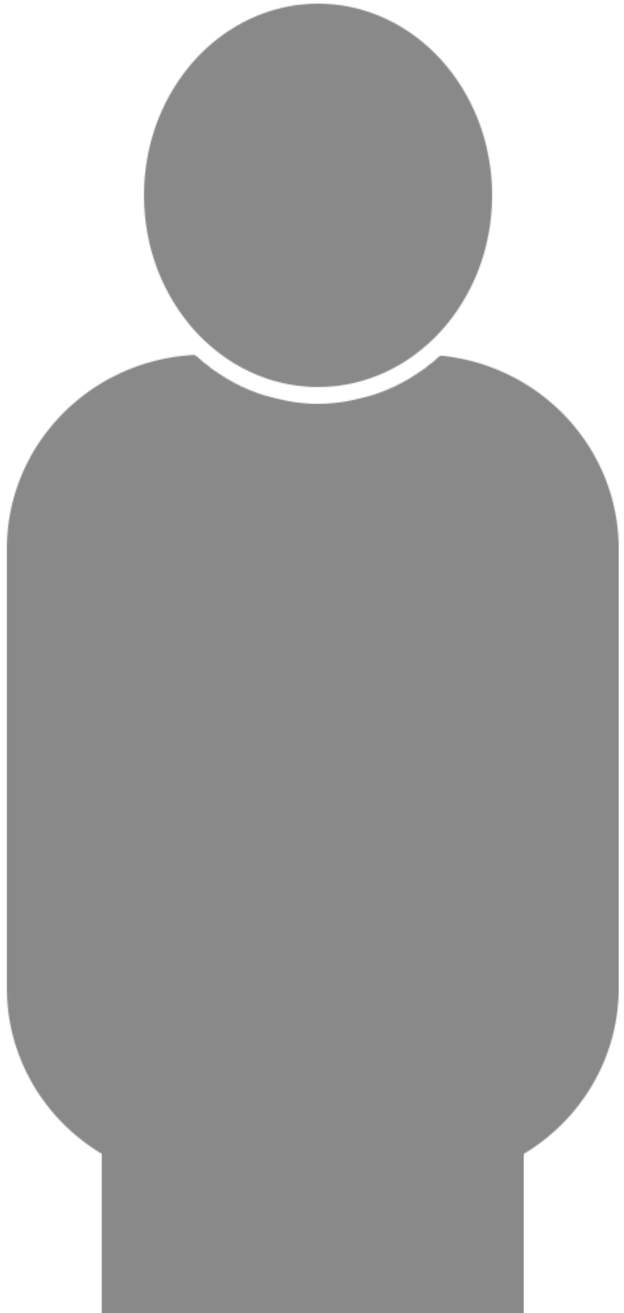
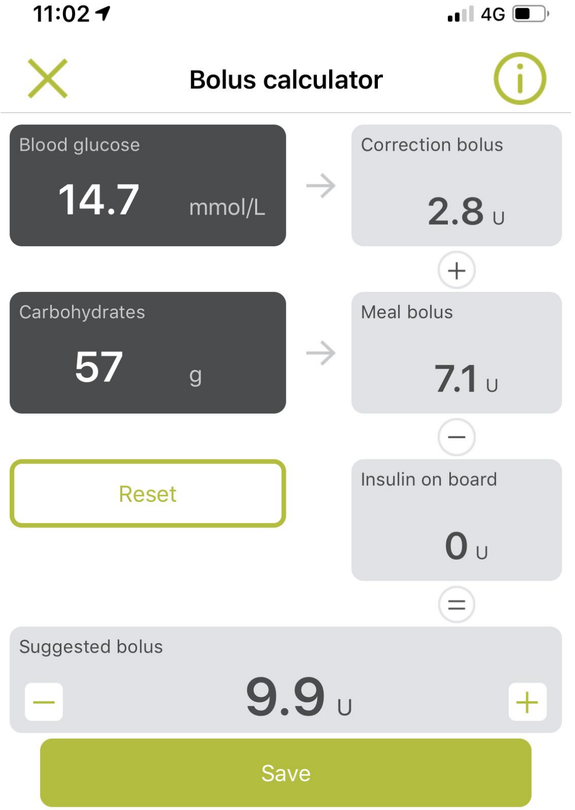


Using a bolus advisor



These Apps allow more accurate calculation of boluses and help you record insulin, carbs and glucose readings

In particular they allow you to take Insulin On Board into account when doing corrections [important to avoid stacking]

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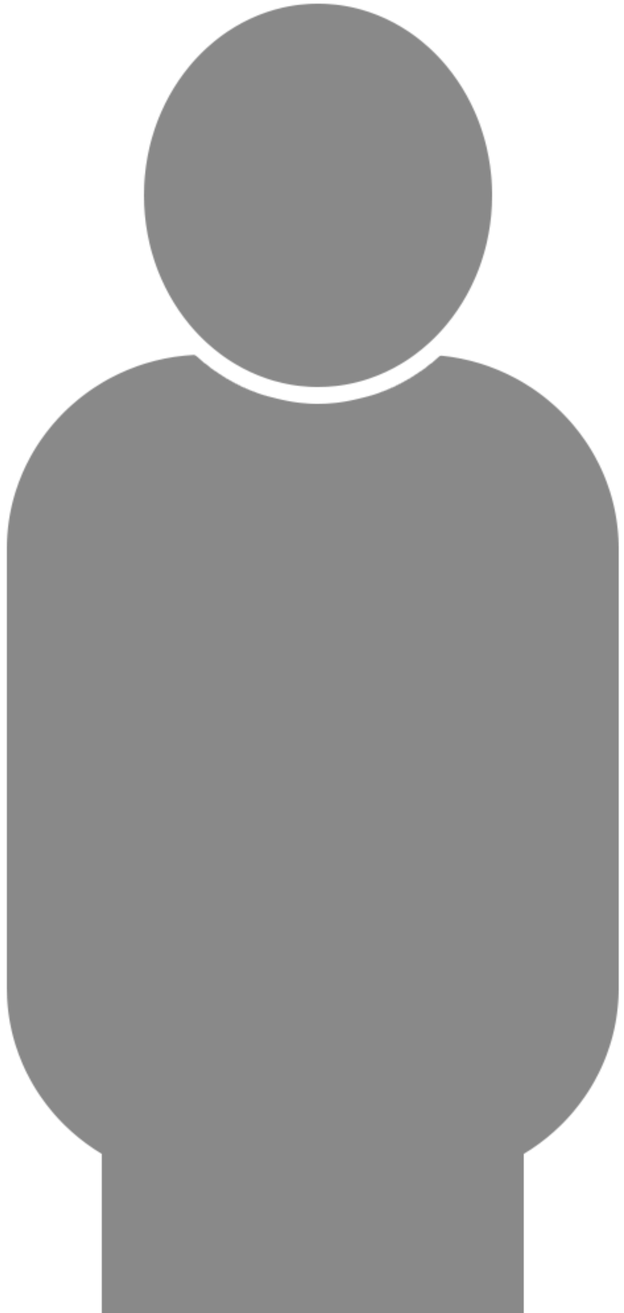
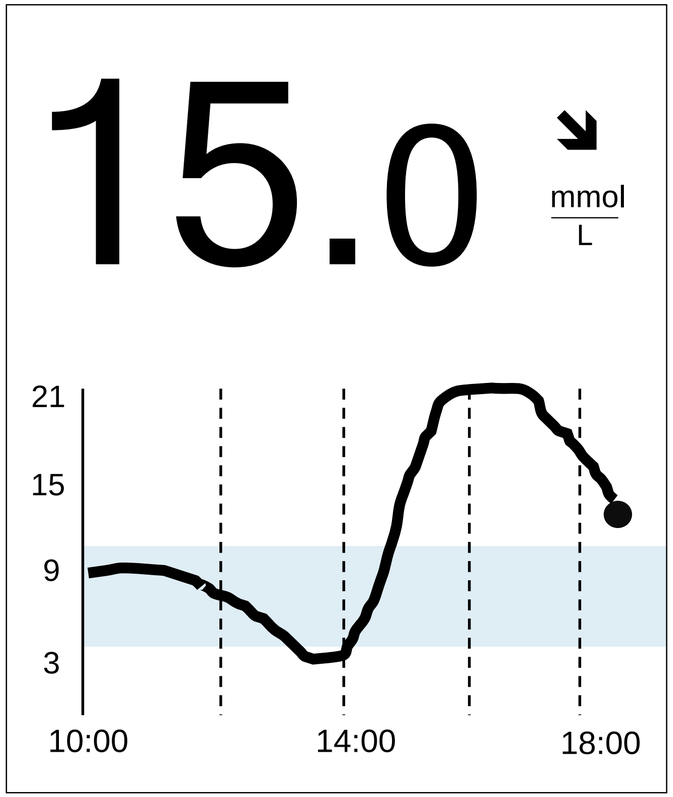


The 1 - 2 - 3 rule



- 1 -Hour glucose tells you about the timing of the insulin – did you take it early enough
- 2- hour glucose tells you a little about if you did take enough [and if too much, is a common time to hypo]
- 3- hour glucose tells you if you had fat / protein in your meal or if you need to take some extra correction.
- There is not much corrective action to be taken in the 2 hours post –meal, so not much point in scanning (unless you suspect a carb estimation problem). You should think about scanning between 2-3 hours post meal – that is the time when you may want to make a decision around carbs or insulin based on the results.

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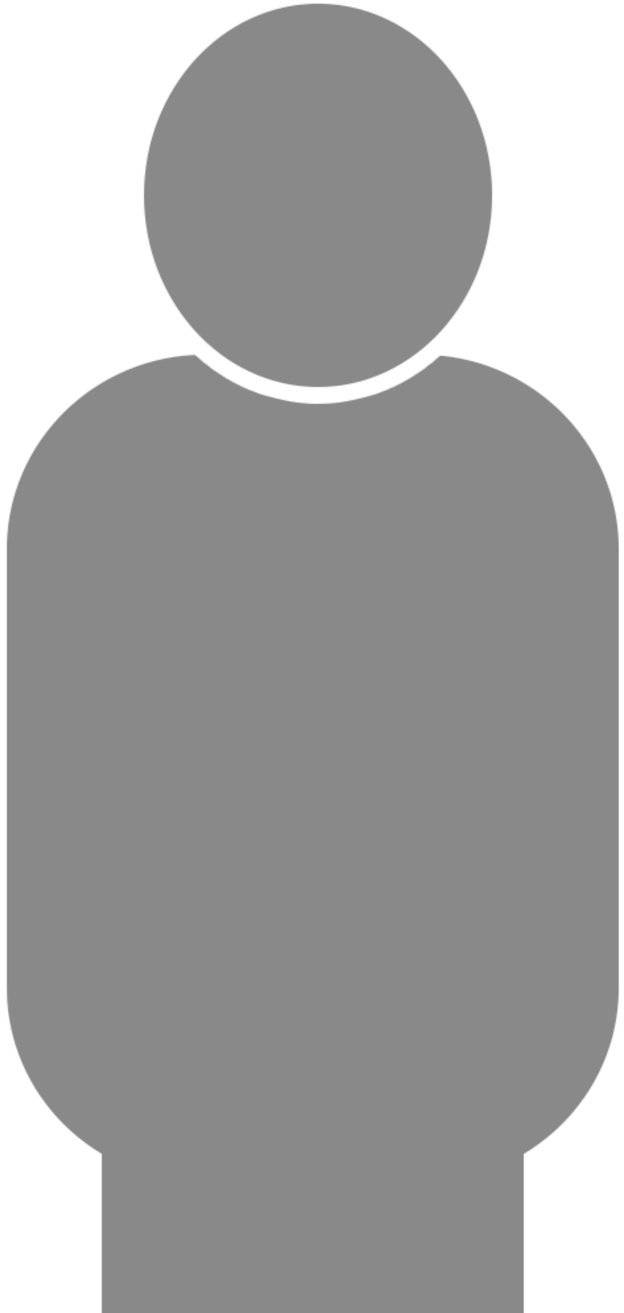

Using arrows to adjust pre-meal doses

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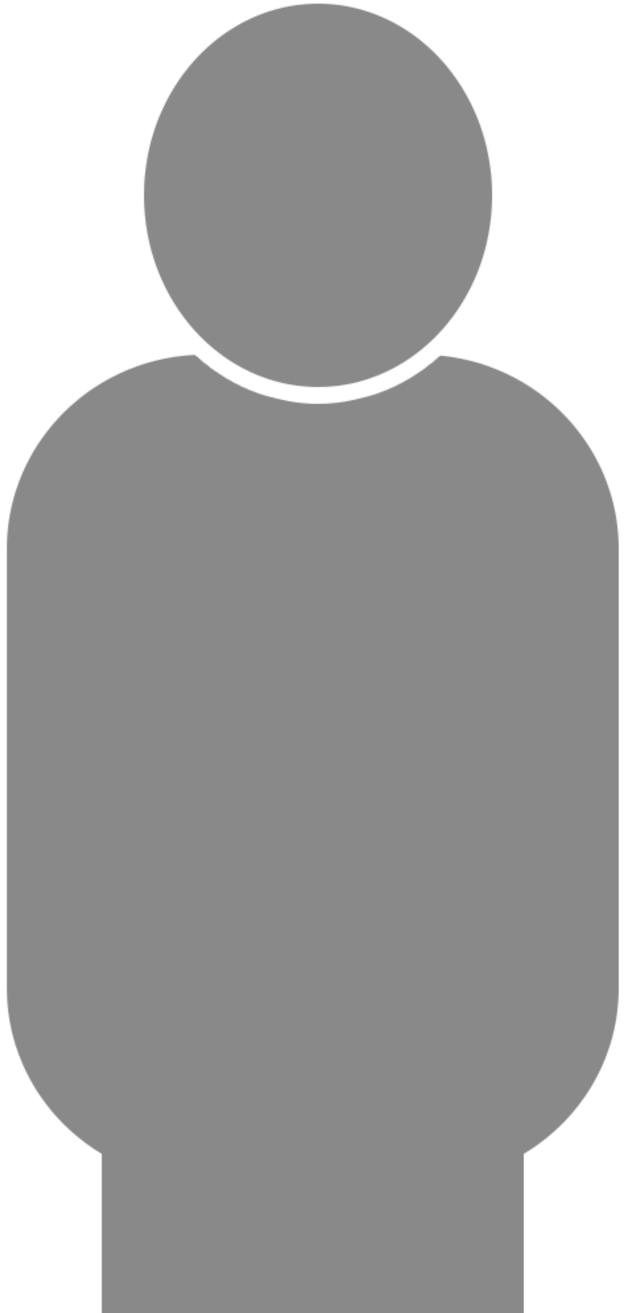

Adjusting bolus based on arrows

- As a rule
- if you have an ↗ OR ↑ you may want to add some insulin to the bolus to account for the direction and rate of change
- If you have an ↘ OR ↓ you may want to subtract some insulin to account for the direction or rate of change

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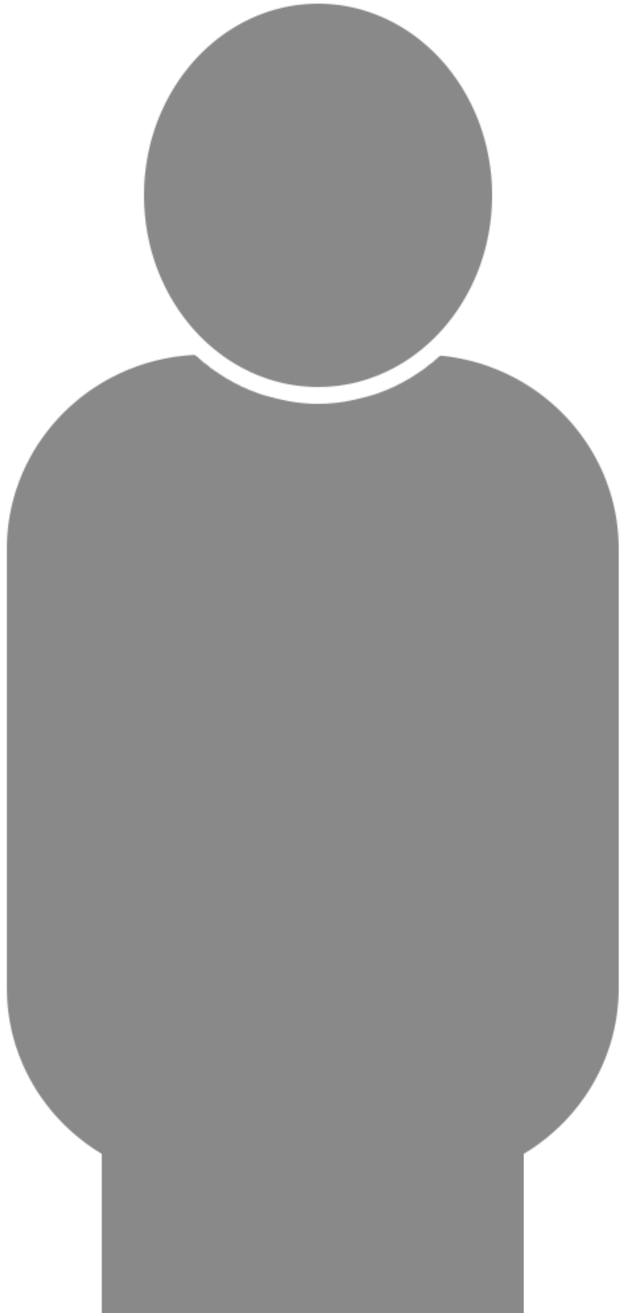

Possible options

Rate of change	Rule
ISF based rule	Add or subtract a fixed amount of insulin from the calculated dose based on the arrows
Predicted glucose rule	Based on the arrows, predict what the glucose will be in 30 mins and use that glucose value to calculate the dose
10/20% rule	Increase or decrease calculated bolus by 10 or 20% based on the arrows

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ISF rule for those with ISF 2.5 - 4 mmol/l

ISF 2.5 - 4	Calculation	Adjustment for arrows
↑	Calculate dose based on carbs and current glucose	Add 1 Unit
↗	Calculate dose based on carbs and current glucose	Add 0.5 units
→	Calculate dose based on carbs and current glucose	-
↘	Calculate dose based on carbs and current glucose	Subtract 0.5 unit
↓	Calculate dose based on carbs and current glucose	Subtract 1 unit

If insulin resistant [ISF < 2 or total daily dose > 60 units] – double the adjustment for arrows to 1 and 2 units respectively

If very insulin sensitive [ISF > 5 or total daily dose < 25 units] take ½ the amount – I.e. 0.2 and 0.5 units respectively

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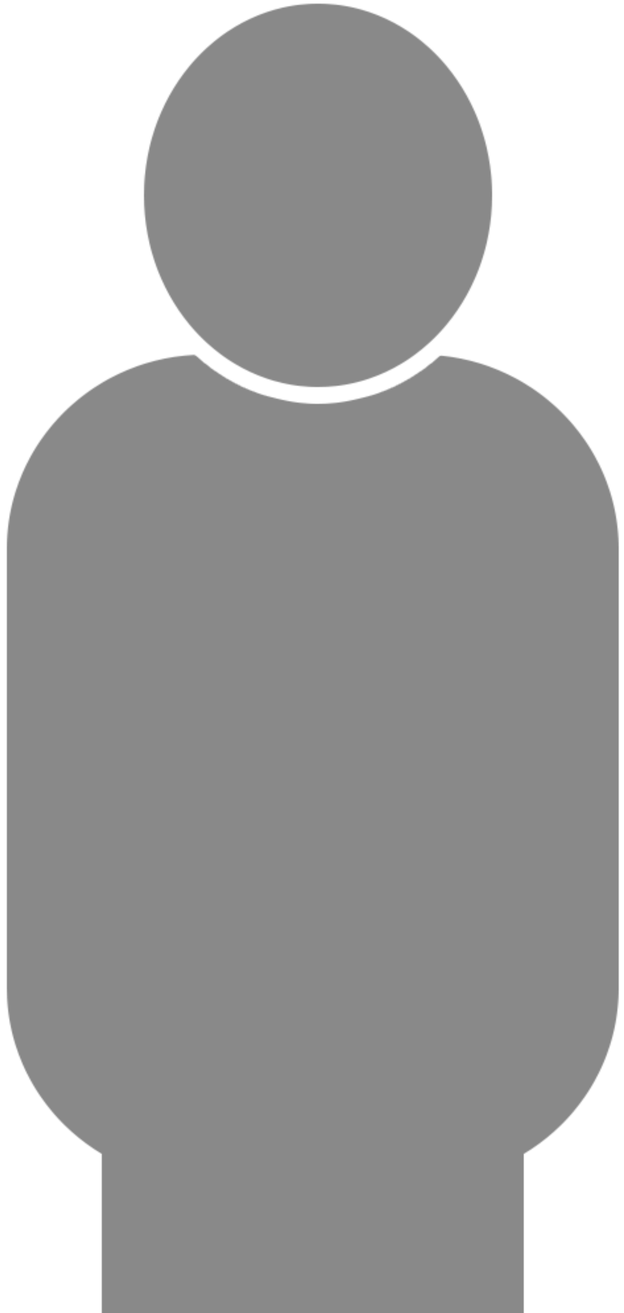
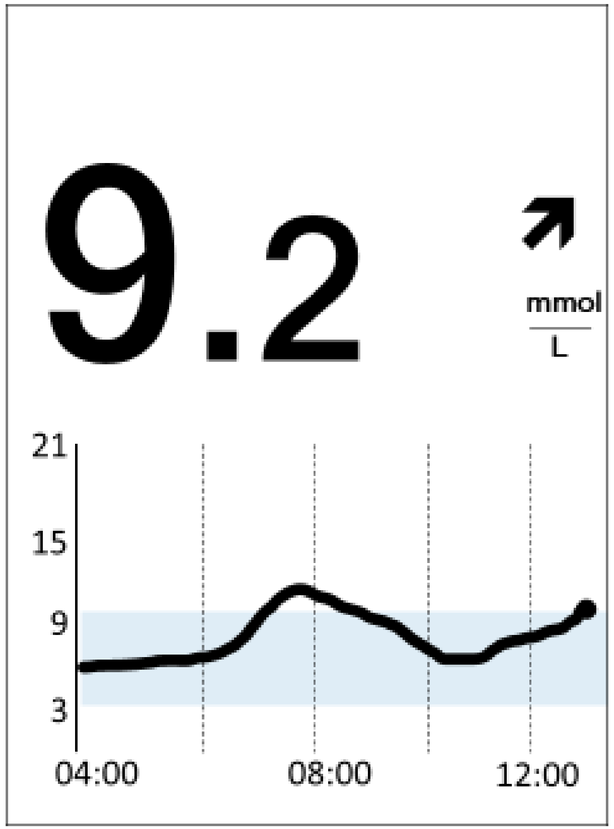


ISF method



Just before lunch BG is 9.2 and rising slowly

Usual ICR = 1 unit : 10 grams
Usual ISF = 1 unit to reduce by 3

Lunch - 40 grams

Calculated dose =
4 for the food + 1 correction = 5 units

↗. So add 0.5 units to the dose

So take 5.5 units.

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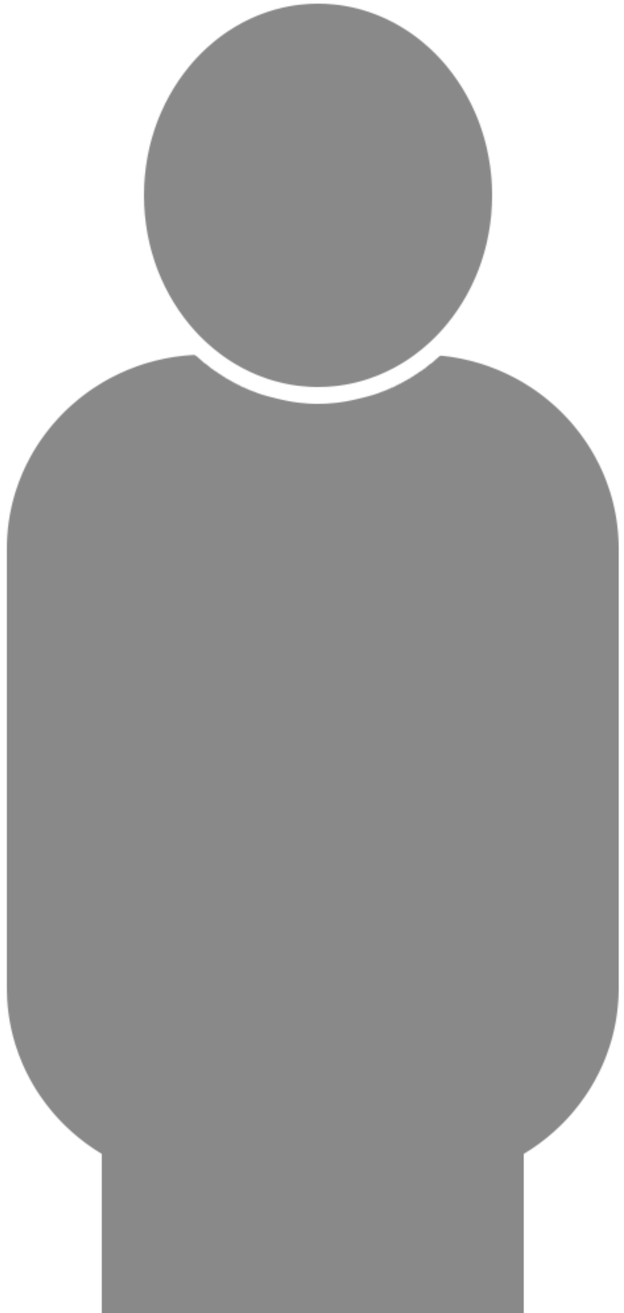

Predicted glucose method

	Rate of change	Change in 30 mins	Plan
↑	> 0.11 mmol/l / min	At least 3.5 mmol/l	Adjust up by 4 mmol/l
↗	Between 0.11 and 0.06 mmol/l / min	1.6 - 3.5 mmol/l	Adjust up by 2.5 mmol/l
→	Less than 0.06 mmol/min	Less than 1.5 mml/l	< 2 mmol/l
↘	Between 0.11 and 0.06 mmol/l / min	1.6 - 3.5 mmol/l	Adjust down by 2.5 mmol/l
↓	> 0.11 mmol/l / min	At least 3.5 mmol/l	Adjust down by 4 mmol/l

Pettus et al; JDST et al, 2017

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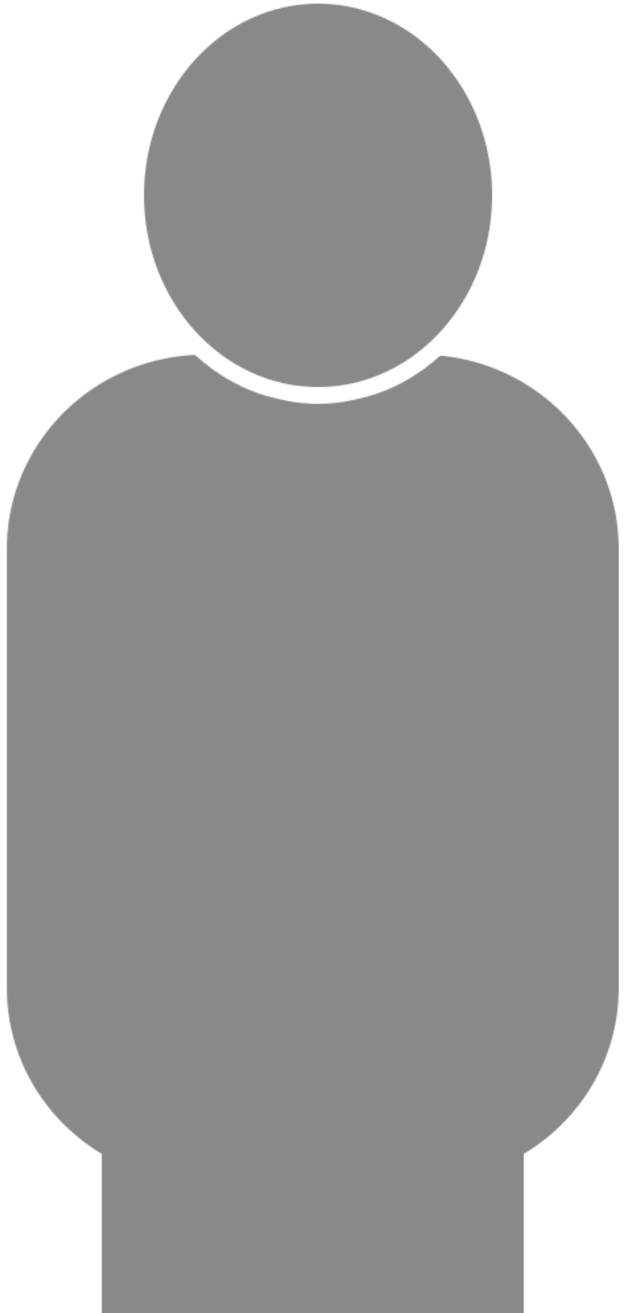
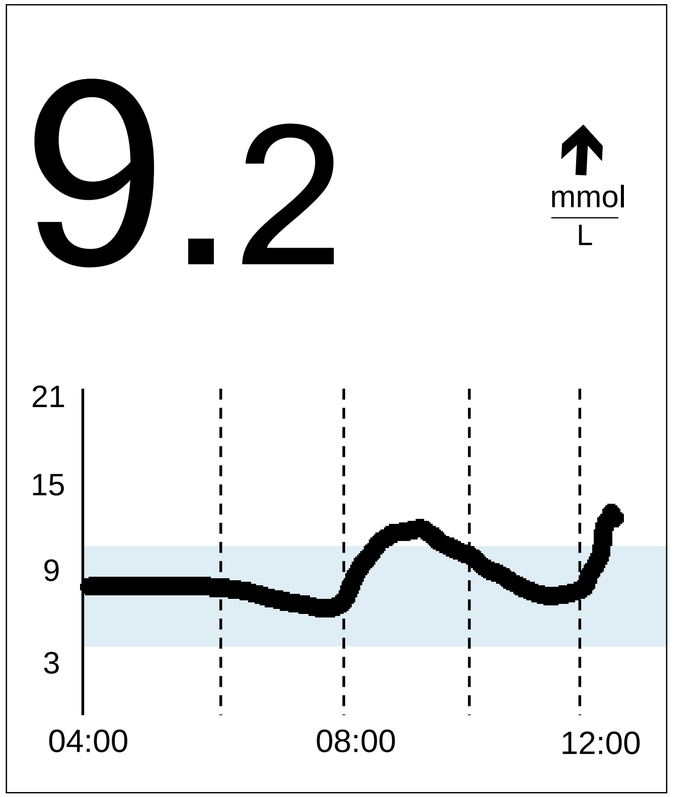


Predicted glucose method



Just before lunch BG is 9.2 and rising rapidly

Usual ICR = 1 unit : 10 grams
Usual ISF = 1 unit to reduce by 3

Lunch - 40 grams

In 30 mins – we would expect the glucose to rise by 4 mmol/l [ie 13.2 mmol/l]
So calculate the correction dose based on 13.2 rather than 9.2.

So calculated dose will be
4 for the food + 2.4 for the correction
= 6.4 units

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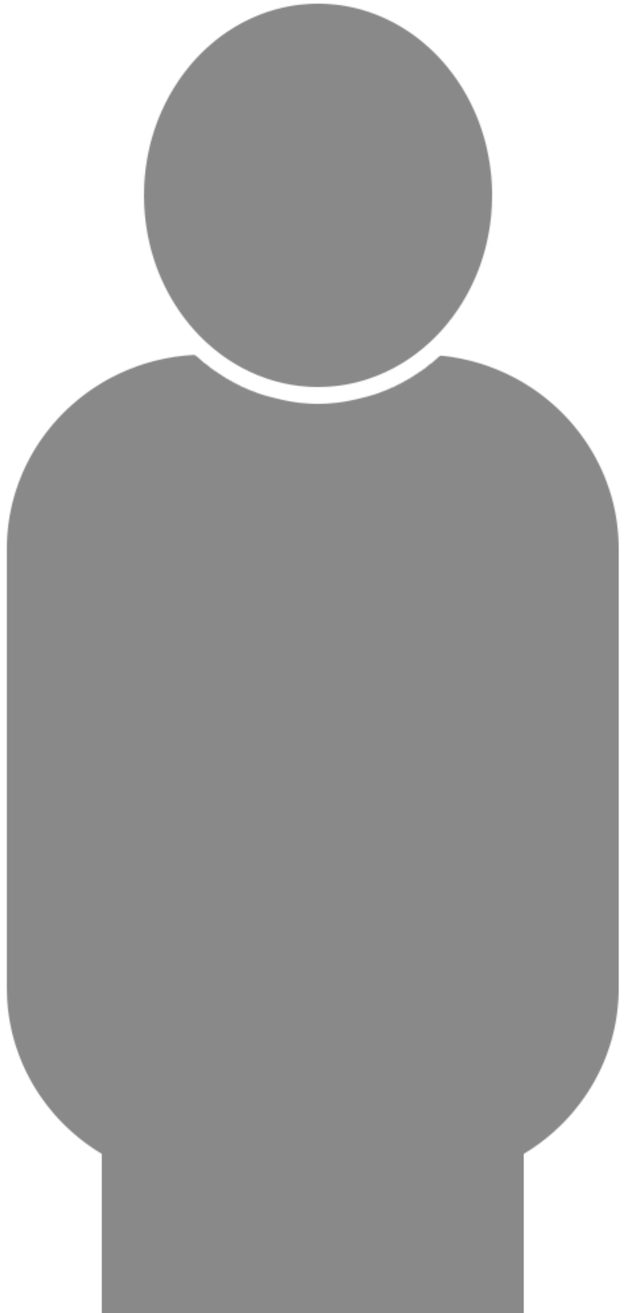

10-20% rule

	Rate of change	How long to change by 1 mmol/l
↑	Calculate dose based on carbs and current glucose	Add 20%
↗	Calculate dose based on carbs and current glucose	Add 10%
→	Calculate dose based on carbs and current glucose	-
↘	Calculate dose based on carbs and current glucose	Subtract 10%
↓	Calculate dose based on carbs and current glucose	Subtract 20%

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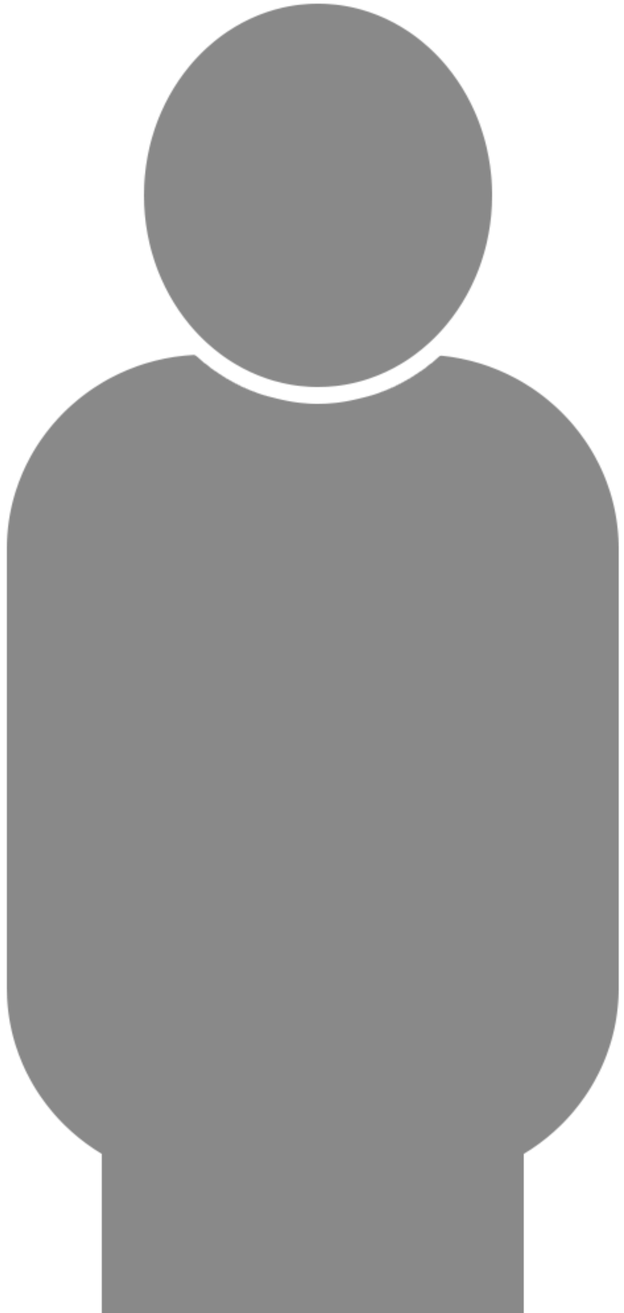
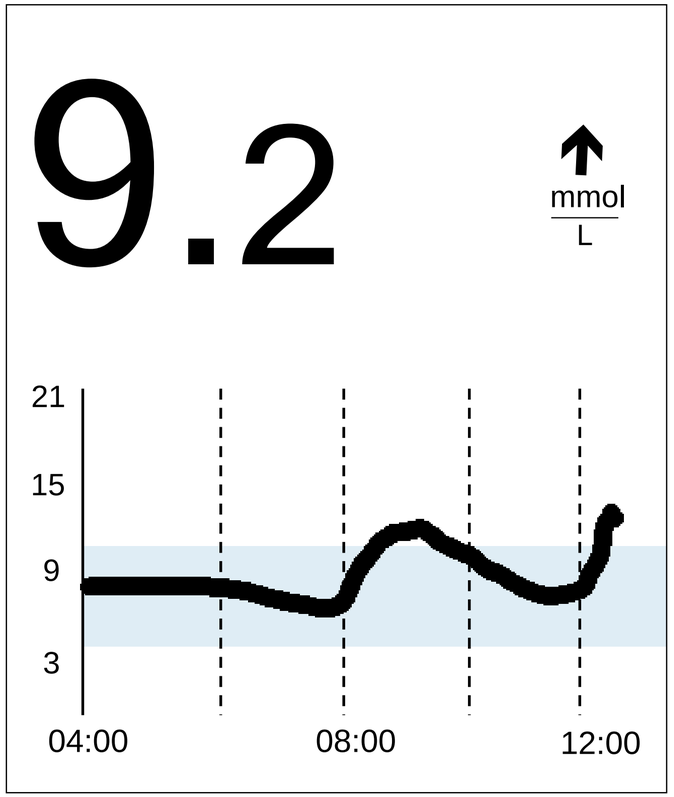


10/20% rule



Just before lunch BG is 9.2 and rising rapidly

Usual ICR = 1 unit : 10 grams
Usual ISF = 1 unit to reduce by 3

Lunch - 40 grams

Calculated dose =
4 for the food + 1 correction = 5 units

Arrow is ↑
So add 20% [= 1.0 units] to the dose

So take 6 units.

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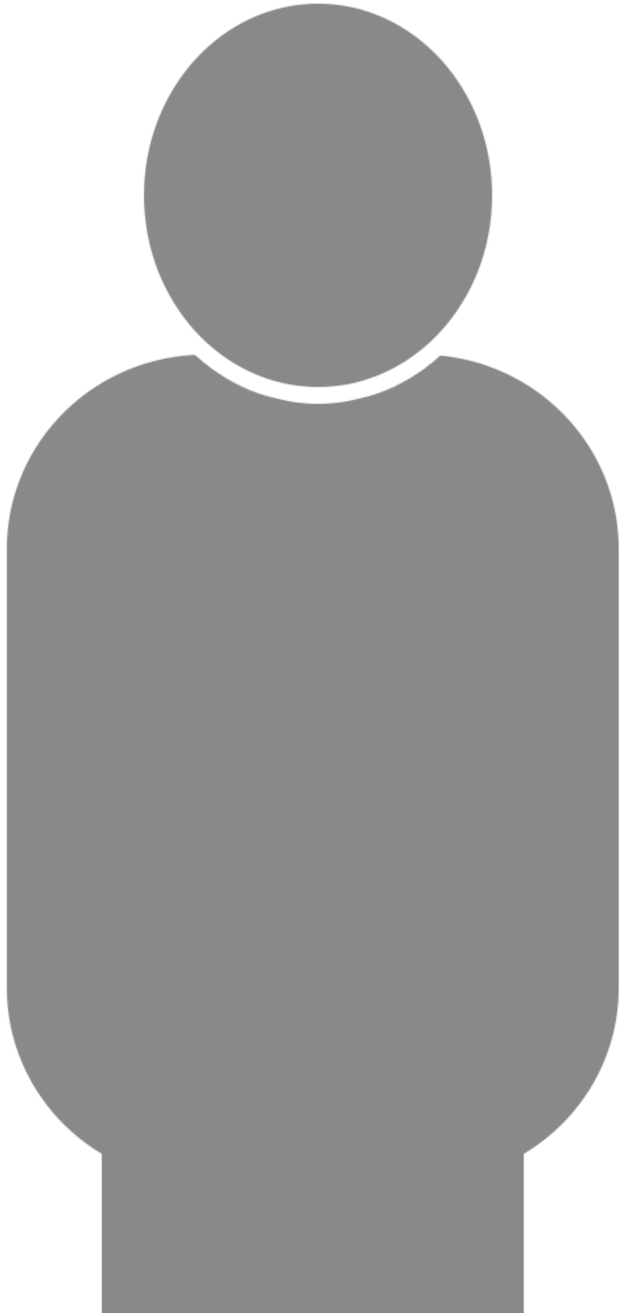
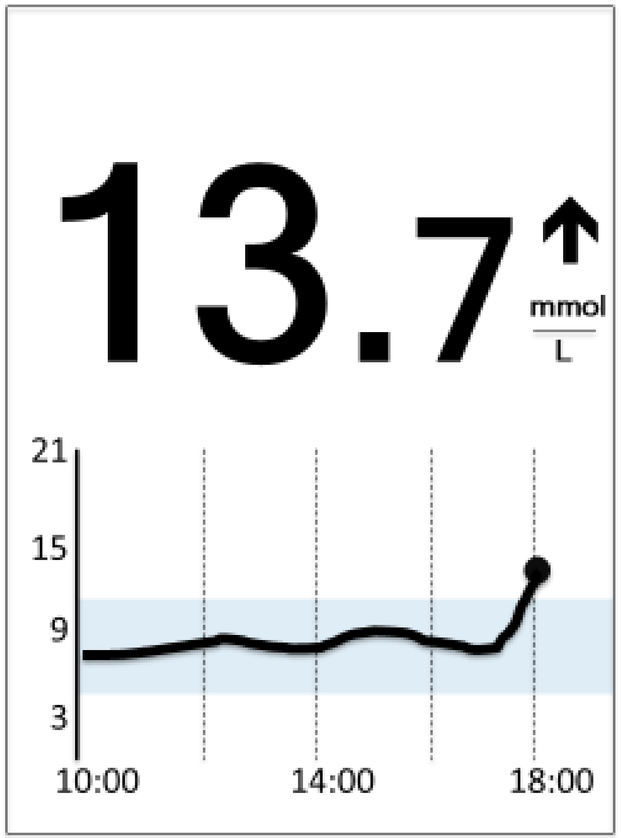


Which method to use?



Option 1. Based on 10/20% rule
Add 20% to the total calculated mealtime dose
e.g. so 6.6 u + 20 % = **7.9 units**

Option 2. Based on insulin sensitivity factor
Add 1 unit to the calculated dose to account for the straight up arrow
e.g. so 6.6 + 1 = **7.6 units**

Option 3: Predicted glucose method
In 30 mins we expect the glucose to be 13.7 + 4 = 17.7.
So 4 for carbs + 3.9 correction = **7.9 units**

ICR = 10; ISF = 3
Carbs - 40 gms
Glucose target 6mmol/l
Calculated meal dose = 4 + 2.6 = 6.6 units

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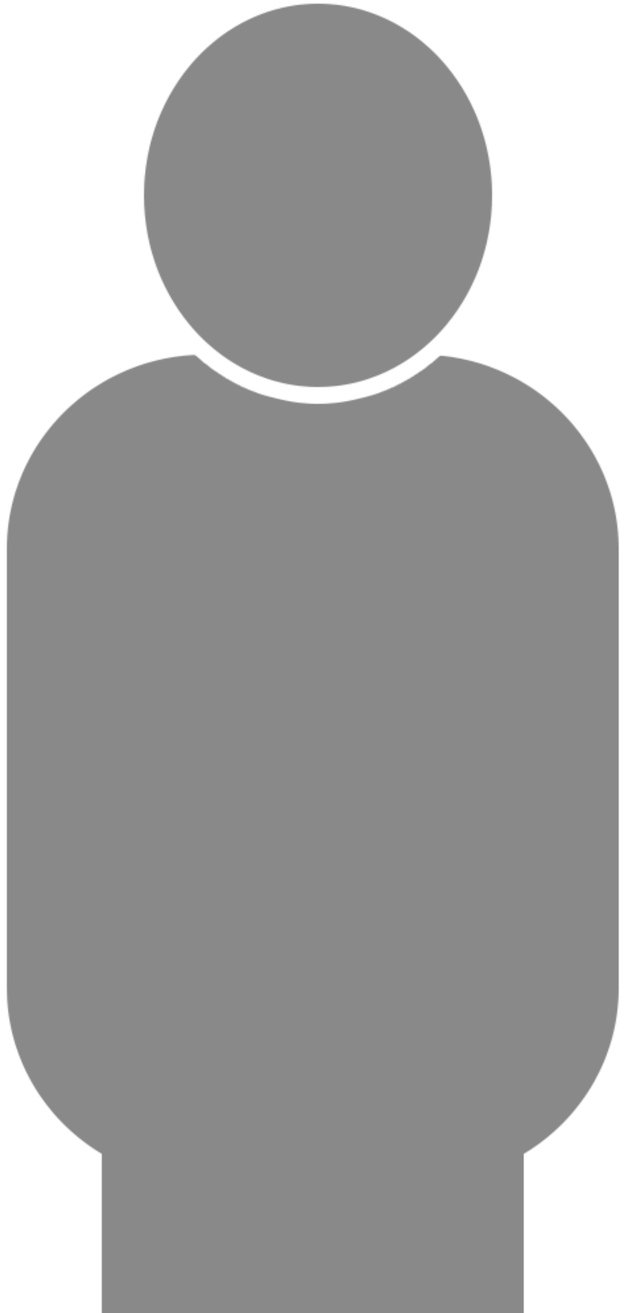
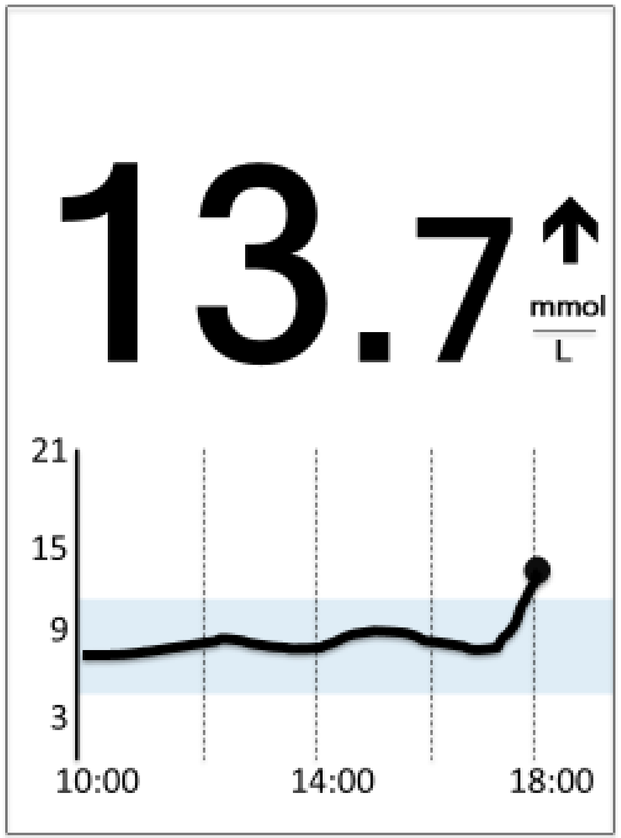


Which method to use?



Option 1. Based on 10/20% rule
Add 20% to the total calculated mealtime dose
e.g. so 10.6u + 20 % = **12.7 units**

Option 2. Based on insulin sensitivity factor
Add 1 unit to the calculated dose to account for the straight up arrow
e.g. so 10.6 + 1 = **11.6 units**

Option 3: Predicted glucose method
In 30 mins we expect the glucose to be 13.7 + 4 = 17.7mmol/l
So 8 for carbs + 3.9 correction = **11.9 units**

ICR = 10; ISF = 3
Carbs - 80 gms
Glucose target 6mmol/l
Calculated dose = 8 + 2.6 = 10.6 units

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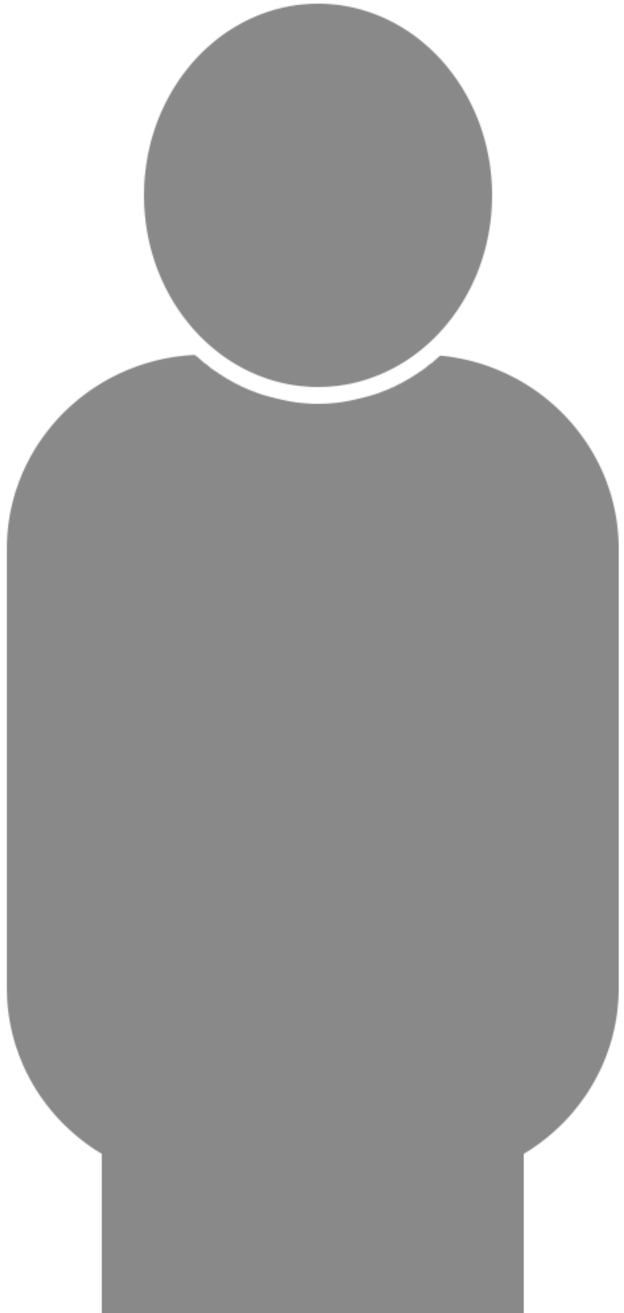

Which system to use?

- As you can see they all give slightly different results, and none of these are an exact science
- Differences are a little larger for larger meals and those who are less insulin sensitive
- For simplicity, we advise using the ISF [± 0.5 or ± 1.0] method…

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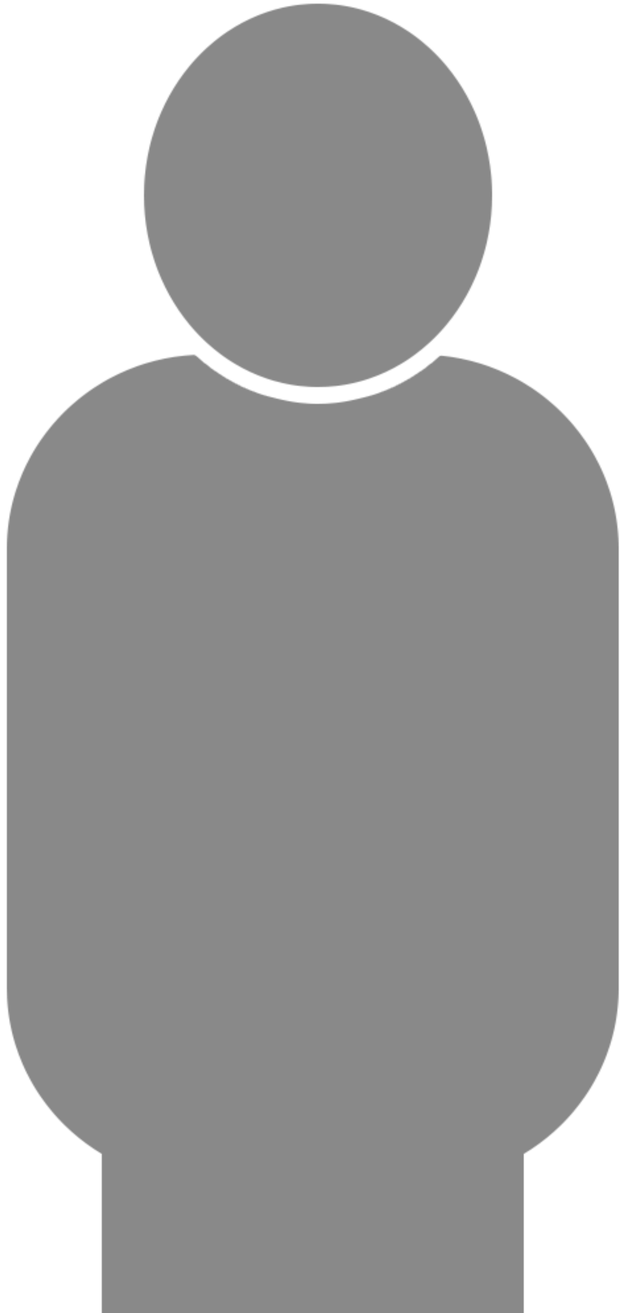
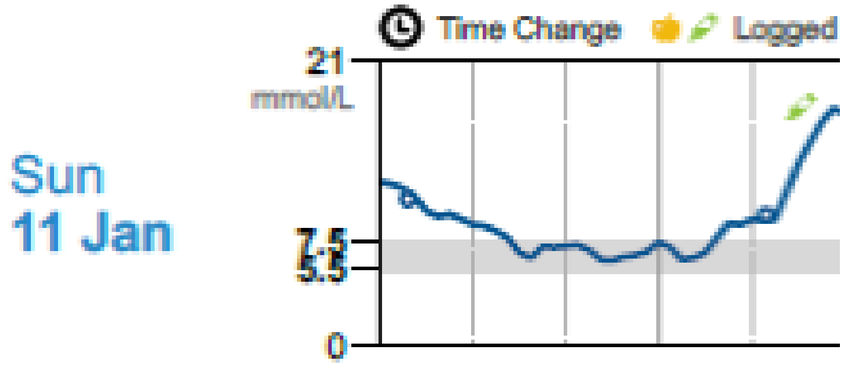


What would you do ?



- 1 ½ hour after breakfast glucose is now 18.1 and has just stopped rising
- What should you do?
  - Correction dose
  - Wait and see?

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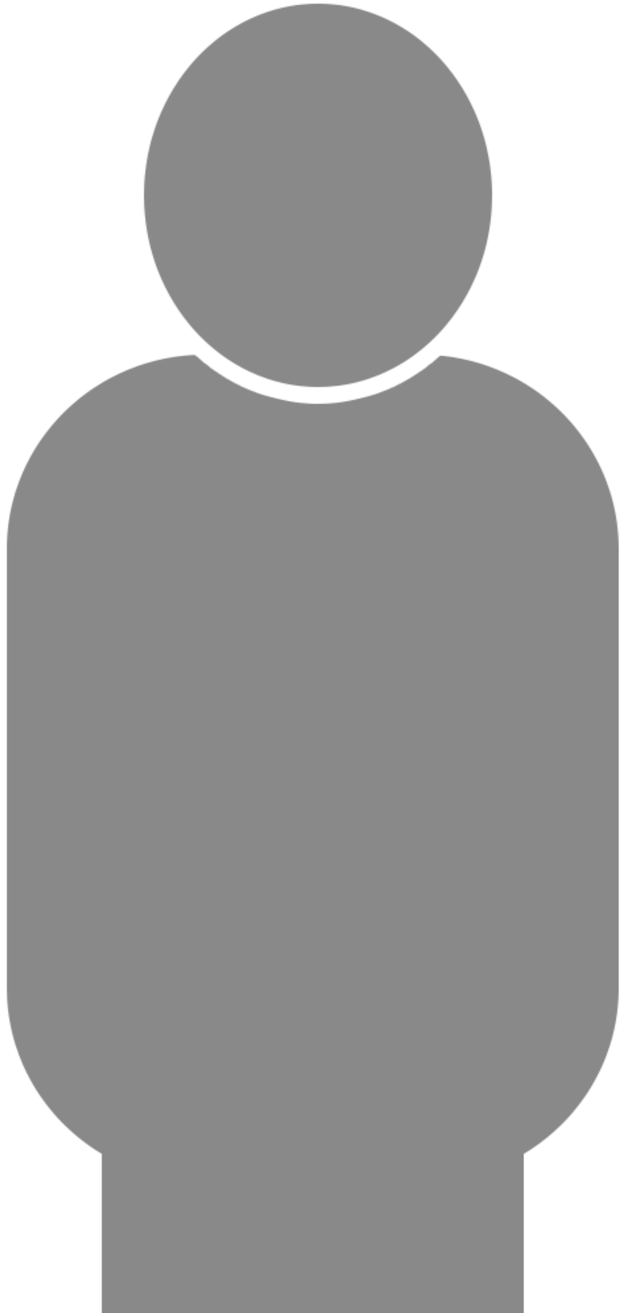

Sun
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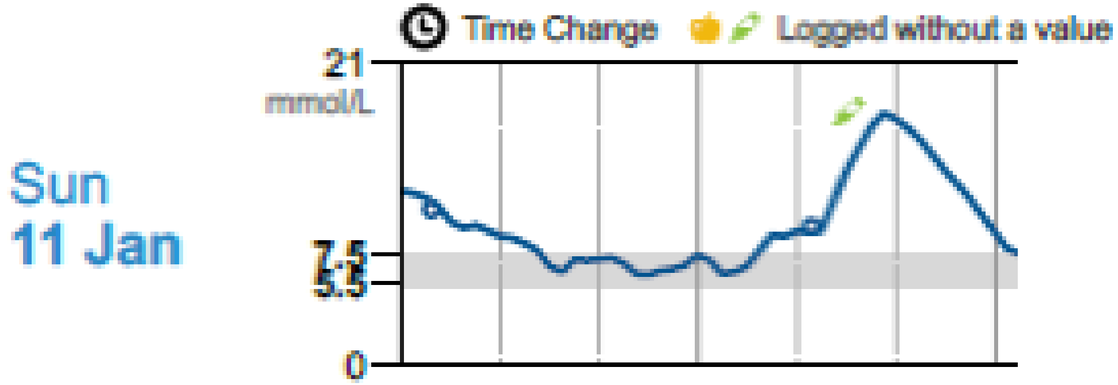

- 4 hours post meal glucose is back in range

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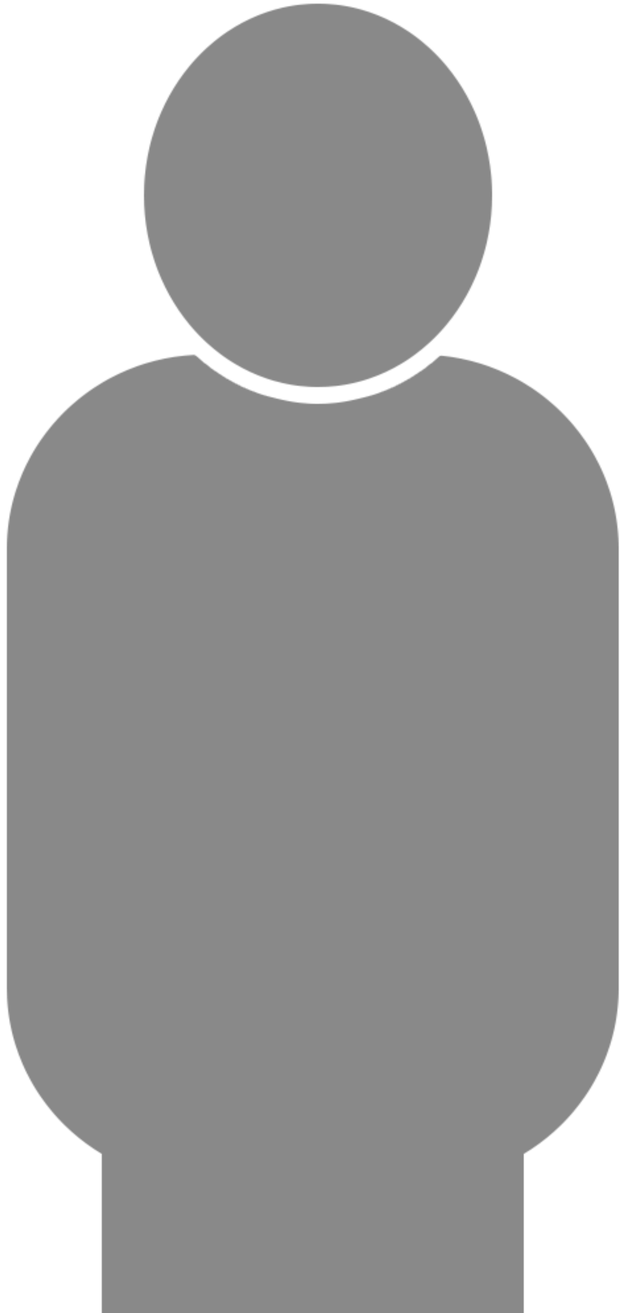

Summary

- Best times to scan are
  - Pre meal to help calculate the dose
  - About 2-3 hours post-meal – to make sure you are not going low OR to decide if you need to correct
- If glucose rising – think where you will be in 30 mins
- If glucose falling – think how long it will take you to reach hypo levels and what action is needed
- Small doses of carb to prevent hypos
- Can also adjust rapid acting insulin based on allows pre- meal

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