Day-to-Day Diabetes Management

It is important to understand how basal and bolus insulin injections affect blood glucose levels. This will help you feel confident to make adjustments to your/your child's insulin doses.

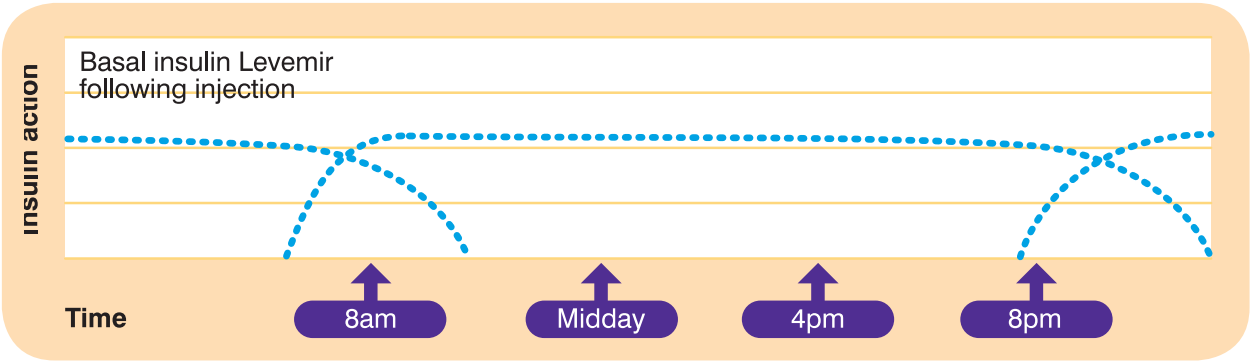
How do the basal and bolus insulin injections work?

Basal (background) Insulins

Basal (background) insulin should give a steady level of insulin between meals during the day and overnight. When more than 2-3 hours have passed since the last meal, the liver will release stored glucose leading to an increase in blood glucose levels. Therefore a low basal/ background level of insulin is needed to keep the blood glucose level stable.

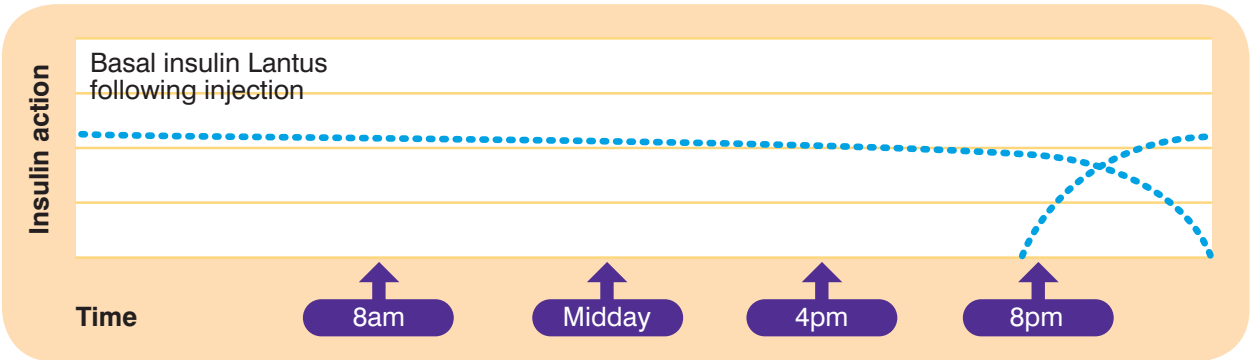
Levemir

- The action of Levemir lasts for 12-16 hours. It is injected twice a day at the same time every day, 12 hours apart (+/- one hour at most). Therefore the dose of basal insulin for daytime and night-time can be adjusted independently.



Lantus

- The action of Lantus lasts for 20-24 hours. It is injected once daily at the same time every day (+/- one hour at most). Lantus is taken either with the evening meal or around bedtime to ensure that if the dose 'wears off' before 24 hours, it does so during the day and not during the night.
- An older child may choose to use this once daily background insulin, as it allows a 'long lie' during weekends or holidays. However this limits the opportunities to adjust the background insulin dose, which may be useful before and after exercise.



Bolus (very fast acting) Insulins

Novorapid or Humalog

- The onset of action is 15-30 minutes following the injection. It is injected **before** the start of a meal - ideally 20 minutes before breakfast and 10 minutes before other meals, for improved blood glucose control.

Remember that insulin is absorbed more quickly by the effects of exercise and heat.
Do not wait 10-20 minutes before eating if immediately after a hypo.

- The peak action of these insulins is within the first hour of administration but can last for up to three hours.
- As an **exception** they can be given immediately after a meal but this approach is **not** recommended as a routine. This can be a practical strategy during illness if you are not sure how much will be eaten, but the aim is a bolus injection before the start of a meal with an additional top-up injection immediately after a meal if more is eaten than expected. A bolus injection given after a meal can lead to high BG readings two hours after the meal, with unexpected hypoglycaemia 1-2 hours later.
- Bolus insulins will not cover a snack of more than about 15g CHO, eaten between meals, (the amount varies between individuals and also depends on activity levels).

Insulin to Carbohydrate Ratio (ICR)

- This is the number of grams of carbohydrate covered by a certain amount of bolus insulin. The ICR is used to calculate how much bolus insulin is required for each meal. The dose of insulin can be calculated as below:

Dose of bolus insulin (units)
= Amount of CHO eaten (grams) divided by insulin to carbohydrate ratio (ICR)

e.g. 60g CHO
ICR 1 unit: 20g
Dose = 60g divided by 20g
= 3 units (Novorapid or Humalog)

Alternatively, you can look up the bolus insulin dose using the 'Bolus Calculator' table at the end of this section (page 9) or in the SNDRI workbook (Workbook 1 'An Introduction to Carbohydrate Counting', page 24).

How do we calculate the ICR?

- The Dietitian will guide you with your first ICR. The ICR will change over time. A guide to changing the ICR is given on page 7.

Blood glucose (BG) target when using a correction factor

- BG before a meal 4-7mmol/L (pre meal BG).

Correction Factor

- If the BG is above target extra insulin needs to be given. This is called the correction factor. Follow the examples to work out how much 1 unit of insulin will lower your BG. The correction factor depends on the average total daily dose of the insulin.

  Correction factor = 100 divided by the total daily dose insulin (TDD).

  This is given, **in addition** to the bolus insulin to cover carbohydrate, to 'correct' pre meal BG readings which are above the target of 7mmol/L.

Example

Calculation of correction factor for TTD = 34 units
Calculation: 100 ÷ 34 = 3
Therefore the correction factor = 1 unit of bolus insulin lowers the BG by 3mmol/L.

You are about to eat a meal containing 60g of CHO. Your pre meal BG is 13mmol/L.

Insulin to carbohydrate ratio (ICR)	= 1 unit to 10g CHO
Correction factor	= 1 unit bolus insulin lowers BG by 3mmol/L
Target BG	= 7mmol/L

↓

Calculate bolus insulin to cover CHO	= 60g divided by 10g (ICR) **= 6 units**

↓

Calculate corrective dose of bolus insulin	= (Actual BG minus Target BG) divided by correction factor = (13mmol/L – 7mmol/L) divided by 3 = 6 divided by 3 **= 2 units**

↓

Calculate total dose of bolus insulin	= Dose to cover CHO **PLUS** corrective dose = 6 units + 2 units **= 8 units**

Round the correction dose to the nearest unit for older children, and nearest 0.5 unit for younger children.

A correction factor should always be used before meals if BG is above target. If BG is high between meals, correct at the next meal time.

A correction at supper can be given if the last bolus dose was given more than three hours ago.

Do not use a correction factor at supper if you/your child have/has been very active, and you expect the BG to normalise.

What am I aiming for in day-to-day diabetes management?

Blood glucose (BG) targets

- BG before a meal 4-7mmol/L (pre meal BG).
- BG 2 hours after a meal within +/- 2mmol/L of the pre meal BG.
- Expect to have 2-3 mild hypos per week.

When should I check my blood glucose?

- **If BG stable and HbA1c in target: At least 4 blood glucose readings per day, a 4 point profile.**

4 point profile
before breakfast
before lunch
before evening meal
before bed

- **8 point profile – this is the ideal profile but check every 1-2 weeks as a minimum.** Paired glucose readings before and two hours after a meal, to check the insulin to carbohydrate ratios are correct.

8 point profile
before breakfast AND two hours after breakfast
before lunch AND two hours after lunch
before evening meal AND two hours after evening meal
before bed AND two hours after last food eaten before bed

- However, it is important to check an 8 point profile on a more regular basis (daily) if the readings are outwith target.
- One or two overnight readings (2-3am) are recommended following changes to basal insulin, or if pre breakfast BG's are low or high with no obvious explanation.

How important is it to record BG results?

Recording blood glucose results every day, in a blood glucose diary will allow you to look for trends in blood glucose and make adjustments to your/your child's insulin doses promptly.

Some young people prefer to use their smartphone rather than a diary to record their blood glucose readings. Details of 'apps' available for electronic devices can be found on the Diabetes UK website: www.diabetes.org.uk

Individuals who record BG readings in a written/printed format are much more likely to achieve better diabetes control than those who do not regularly review written results.

Meters

Blood glucose meters must not be shared, they are for your/your child's use only.

There are a variety of BG meters available, they generally share a number of basic features:

- A memory which will store up to 500 blood glucose readings.
- Display of average blood glucose readings from the previous 7, 14, 30 or 90 days.
- Pre and post meal markers.
- Reminder alarms.

Please refer to the manufacturer's reference manual or view the meter training online demo.

Please register your meter(s) with the manufacturer as soon as possible.

On registering your meter you will benefit from:

- A 3 year warranty on your meter(s) and a replacement meter free of charge should you lose or break your current one.
- Complimentary batteries and quality control solution as required.

It is important to ensure that the date and time are set correctly on your/ your child's meter.

You/your child will require regular supplies of blood glucose test strips and lancets for the finger pricker device. These are available on repeat prescription from your GP.

If you require a spare meter these are available from the manufacturer or alternatively from the diabetes nurse specialists at clinic.

Please ensure you quality control check your/your child's meter according to the manufacturer's guidelines. This will ensure accuracy of reading. The diabetes nurse specialists will tell you which meters need quality control.

Meter averages

Meter averages are a quick guide to monitoring blood glucose control over time. If the 30 day average is below 9mmol/L we would expect that the HbA1c will be within target, as long as enough BG readings have been taken on a daily basis.

Expected total daily insulin dose

After the initial partial remission phase, the total daily dose of insulin (TDD) is around 0.7 – 0.9 units of insulin per kg of body weight per day. During puberty and rapid growth, the daily insulin requirements can increase up to 1.3 units per kg of body weight per day.

Too much insulin can drive your appetite, causing you to eat more, gain weight, and can increase your BG readings. This makes you think you need to increase your insulin further, when it actually needs to be cut back.

How do I adjust insulin doses?

It can be confusing to try to identify which insulin doses need to be changed. The following sections will give you guidance. If you need further advice the diabetes nurse specialists are available Monday to Friday.

Telephone number: **0131 536 0375**.

Look for trends in the written BG diary

A pattern of three high readings in a row at a particular time of day, or three unexplained low readings in a row at a particular time of day suggests that insulin should be adjusted. Remember that a single unexpected high reading might follow treatment of a 'hypo' (see page 4 of the Hypoglycaemia section).

Example

BG targets

Pre meal:
4-7mmol/L

Post meal:
pre meal BG +/- 2mmol/L

Tues/Wed/Thurs before breakfast

Three high blood glucose readings in a row

BG in target 2 hours after supper

Action: increase basal insulin

Saturday

8 point profile recommended every 2 weeks

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
Before breakfast	6.9	12.6	16.2	14.3	6.7	5.7	7.8
2 hours after breakfast						7.2	
Before lunch	5.6	7.0	6.4	8.4	3.5	4.9	6.9
2 hours after lunch						5.2	
Before tea	6.9	13.9	3.7	5.8	5.5	6.8	7.2
2 hours after tea					10.2	9.4	
Before supper	6.5	7.9	6.6	10.8	12.2	11.4	6.3
2 hours after supper			5.9			6.8	

blue = hypo

green = in target

orange = above target

Wednesday

Low related to exercise

Action: see Exercise Management section

Thurs/Fri/Sat

High BG before supper

BG 2 hours after tea high Fri/Sat

Action: change tea time ratio

Is the dose of bolus insulin correct?

This can be checked by looking at the BG two hours after the start of a meal if the pre meal BG is in range. A reading within 2mmol/L of the pre meal BG identifies that the insulin dose (i.e. ICR) is correct.

If there is a **pattern** where the BG two hours after a meal is either more than 2mmol/L higher, or more than 2mmol/L lower than the pre meal BG, **consider these points before adjusting bolus insulin dose**:

- Is carbohydrate counting accurate?
- Are injection sites lumpy?
  Remind yourself of the correct injection technique on page 7 of the 'Introduction to Diabetes' section.
- Are bolus insulin injections being given 10-20 minutes before the meal?
- Has there been any exercise over this time period and how was it managed?
  Refer to the 'Exercise and Sport' section.
- Have there been any missed injections?
  This is unfortunately a common cause of poor diabetes control.

Is the correction factor correct?

If BG high pre meal and high two hours after the meal, review the correction factor. As the TTD of insulin increases, the correction factor will change.

How to adjust the dose of bolus insulin

The dose of bolus insulin is adjusted by the ICR. Refer to the table below as a guide.

BG 2 hours after the meal	Action needed	Suggested ratio change
High (More than 2mmol/L above the pre-meal BG)	Decrease the number of grams of CHO that 1 unit of insulin will cover	1:5 →1:4 1:8 →1:6 1:10 →1:8 1:15 →1:12 1:20 →1:18 1:25 →1:20 1:30 →1:25 1:35 →1:30
Low (More than 2mmol/L below the pre-meal BG)	Increase the number of grams of CHO that 1 unit of insulin will cover	1:4 →1:5 1:6 →1:8 1:8 →1:10 1:12 →1:15 1:18 →1:20 1:20 →1:25 1:25 →1:30 1:30 →1:35

Is the dose of basal insulin correct?

The basal insulin should give a steady level of insulin during the day and night, therefore the BG readings on waking and before meals should be within target, if the dose is correct.

How to adjust basal insulin doses

Basal insulin should be adjusted gradually.

It can take two days to see the full effect following a change in basal insulin dose, so wait two days before making any further adjustments.

Levemir

Change the relevant dose by:

- 0.5 unit at a time for a dose less than 10 units.
- 1 unit at a time for doses between 10 - 20 units.
- 2 units at a time for doses greater than 20 units.

Lantus

Change dose by:

- 1 unit at a time for doses less than 20 units.
- 2 units at a time for doses more than 20 units.

Blood Glucose Trends	Time of Day	
	On wakening/overnight	Before meals
Low	**Points to consider before adjusting insulin** Exercise the previous day **ACTION** Decrease evening lantus/levemir dose	**Points to consider before adjusting insulin** Effect of exercise **ACTION** Decrease morning levemir/evening lantus dose
High	**Points to consider before adjusting insulin** Rebound phenomenon? (Page 4 Hypoglycaemia section) Review BG readings 2 hours after supper. If currently eating 15g free CHO, and BG 2 hours after supper high, either reduce free CHO to 10g or lower, OR cover supper with a bolus insulin dose, as advised by diabetes team, and review. **ACTION** Increase evening lantus/ levemir dose.	**Points to consider before adjusting insulin** Amount of CHO eaten between meals (Target 0 - 15g CHO) **ACTION** Increase morning levemir/ evening lantus dose

Bolus Calculator

Insulin to Carbohydrate Ratio (ICR)

CHO(g)	2	3	4	5	6	7	8	9	10	12	15	18	20	25	30	35	40
150	75.0	50.0	37.5	30.0	25.0	21.5	19.0	16.5	15.0	12.5	10.0	8.5	7.5	6.0	5.0	4.5	4.0
145	72.5	48.5	36.5	29.0	24.0	20.5	18.0	16.0	14.5	12.0	9.5	8.0	7.5	6.0	5.0	4.0	3.5
140	70.0	46.5	35.0	28.0	23.5	20.0	17.5	15.5	14.0	11.5	9.5	8.0	7.0	5.5	4.5	4.0	3.5
135	67.5	45.0	34.0	27.0	22.5	19.5	17.0	15.0	13.5	11.5	9.0	7.5	7.0	5.5	4.5	4.0	3.5
130	65.0	43.5	32.5	26.0	21.5	18.5	16.5	14.5	13.0	11.0	8.5	7.0	6.5	5.0	4.5	3.5	3.5
125	62.5	41.5	31.5	25.0	21.0	18.0	15.5	14.0	12.5	10.5	8.5	7.0	6.5	5.0	4.0	3.5	3.0
120	60.0	40.0	30.0	24.0	20.0	17.0	15.0	13.5	12.0	10.0	8.0	6.5	6.0	5.0	4.0	3.5	3.0
115	57.5	38.5	29.0	23.0	19.0	16.5	14.5	13.0	11.5	9.5	7.5	6.5	6.0	4.5	4.0	3.5	3.0
110	55.0	36.5	27.5	22.0	18.5	15.5	14.0	12.0	11.0	9.0	7.5	6.0	5.5	4.5	3.5	3.0	3.0
105	52.5	35.0	26.5	21.0	17.5	15.0	13.0	11.5	10.5	9.0	7.0	6.0	5.5	4.0	3.5	3.0	2.5
100	50.0	33.5	25.0	20.0	16.5	14.5	12.5	11.0	10.0	8.5	6.5	5.5	5.0	4.0	3.5	3.0	2.5
95	47.5	31.5	23.5	19.0	16.0	13.5	12.0	10.5	9.5	8.0	6.5	5.5	5.0	4.0	3.0	2.5	2.5
90	45.0	30.0	22.5	18.0	15.0	13.0	11.5	10.0	9.0	7.5	6.0	5.0	4.5	3.5	3.0	2.5	2.5
85	42.5	28.5	21.5	17.0	14.0	12.0	10.5	9.5	8.5	7.0	5.5	4.5	4.5	3.5	3.0	2.5	2.0
80	40.0	26.5	20.0	16.0	13.5	11.5	10.0	9.0	8.0	6.5	5.5	4.5	4.0	3.0	2.5	2.5	2.0
75	37.5	25.0	18.5	15.0	12.5	10.5	9.5	8.5	7.5	6.5	5.0	4.0	4.0	3.0	2.5	2.0	2.0
70	35.0	23.5	17.5	14.0	11.5	10.0	9.0	8.0	7.0	6.0	4.5	4.0	3.5	3.0	2.5	2.0	2.0
65	32.5	21.5	16.5	13.0	11.0	9.5	8.0	7.0	6.5	5.5	4.5	3.5	3.5	2.5	2.0	2.0	1.5
60	30.0	20.0	15.0	12.0	10.0	8.5	7.5	6.5	6.0	5.0	4.0	3.5	3.0	2.5	2.0	1.5	1.5
55	27.5	18.5	14.0	11.0	9.0	8.0	7.0	6.0	5.5	4.5	3.5	3.0	3.0	2.0	2.0	1.5	1.5
50	25.0	16.5	12.5	10.0	8.5	7.0	6.5	5.5	5.0	4.0	3.5	3.0	2.5	2.0	1.5	1.5	1.5
45	22.5	15.0	11.5	9.0	7.5	6.5	5.5	5.0	4.5	4.0	3.0	2.5	2.5	2.0	1.5	1.5	1.0
40	20.0	13.5	10.0	8.0	6.5	5.5	5.0	4.5	4.0	3.5	2.5	2.0	2.0	1.5	1.5	1.0	1.0
35	17.5	11.5	9.0	7.0	6.0	5.0	4.5	4.0	3.5	3.0	2.5	2.0	2.0	1.5	1.0	1.0	1.0
30	15.0	10.0	7.5	6.0	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.5	1.0	1.0	1.0	1.0
25	12.5	8.5	6.5	5.0	4.0	3.5	3.0	3.0	2.5	2.0	1.5	1.5	1.5	1.0	1.0	0.5	0.5
20	10.0	6.5	5.0	4.0	3.5	3.0	2.5	2.0	2.0	1.5	1.5	1.0	1.0	1.0	0.5	0.5	0.5
15	7.5	5.0	4.0	3.0	2.5	2.0	2.0	1.5	1.5	1.5	1.0	1.0	1.0	0.5	0.5	0.5	0.5
10	5.0	3.5	2.5	2.0	1.5	1.5	1.5	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	2.5	1.5	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0

Example:

You are going to eat 95g of CHO

Your ICR is 1u:9g

Reading from the table above, the dose of bolus insulin is 10.5 units (see highlighted example above).