

Finger-prick Blood Sugar Testing and Adjusting Insulin

A Guide for Patients & Carers

Version 3a

(Original version September 2020, Revised Version 3a, November 2024)

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Introduction

The aim of this guide is to help with 2 things:

- (1) Understanding finger-prick blood sugar test results
- (2) Understanding how to use those test results to safely adjust insulin

Important note: this guide does not discuss so-called continuous glucose monitoring (CGM), insulin pumps or other aspects of diabetes care.

What you need to know, to use this guide

- (1) What insulins you use, what doses you take and when you take them.
- (2) Your finger-prick blood sugar test goals (linked to your A1c target – see below).

What insulins you use and when

Most of ‘our’ patients use one of 4 insulin treatment plans (regimen):

- (a) A ‘basal-bolus regimen’ or ‘MDI regimen’ (they’re the same): once-daily long-acting basal insulin (usually at bedtime) and a fast-acting ‘bolus’ insulin 10-15 mins before each meal.
- (b) A twice-daily mixed insulin. You take an injection of premixed insulin 10-15 mins before breakfast and an injection of premixed insulin 10-15 mins before your evening meal.
- (c) Insulin-tablet combination therapy. You take long-acting basal insulin at bedtime and one or more diabetes tablets during the day.
- (d) Insulin pump therapy. You use an insulin pump. **Pump treatment is not dealt with in this booklet.**

Other specialist teams and other areas may do things differently: there are many variations on these insulin treatment plans, but using finger-prick blood sugar test results to adjust your insulins is more or less the same.

If you’re on an unusual insulin treatment plan and you’re unsure – ask your doctor or nurse.

Insulin treatment regimens (note: all doses are in units e.g. 36 = 36 units)

Basal-bolus regimen

- | | | |
|-----|--|--------------|
| (i) | Insulin Toujeo (long-acting basal insulin) | 36 |
| | Insulin Trurapi (fast-acting, bolus insulin) | 12 + 14 + 18 |

This shorthand means you take long-acting Insulin Toujeo, 36 units at bedtime and fast-acting Insulin Trurapi, 12 units before breakfast, 14 units before lunch and 18 units before evening meal (tea).

Twice daily premixed Insulin

- | | | |
|------|------------------------|---------|
| (ii) | Insulin Humalog Mix 25 | 26 + 14 |
|------|------------------------|---------|

This is shorthand means you take Humalog Mix 25, 26 units before breakfast and 14 units before the evening meal.

Insulin-tablet combination therapy

- | | | |
|-------|---|----|
| (iii) | Insulin Toujeo | 66 |
| | Metformin 1000 mg b.d. and Gliclazide 160 mg b.d. | |

This is shorthand tells us you use long-acting Insulin Toujeo, 66 units at bedtime and Metformin tablets 1000 mg (= 1g) twice-daily with breakfast & evening meal and Gliclazide tablets 160 mg twice-daily before breakfast and evening meal.

Finger-prick blood sugar tests

This guide assumes that you already test finger-prick blood sugars. If you don't and you're taking insulin, ask your GP or nurse about blood sugar testing.

When is a single reading useful?

1. A single low reading (less than 4.0) – should prompt you to take immediate action to raise your blood sugar (this booklet does not discuss how you treat low blood sugars (hypos)).

2. A single very high reading (for example 24.2 mmol/l) – ask yourself – do I feel well, or do I feel unwell? If you feel fine, no action is required, if you feel unwell, check your blood ketone level and especially if ketones are raised, seek urgent medical help.
3. A single reading is also useful when it is associated with driving so that you can ensure that you comply with DVLA guidance.
4. There may be other similar situations when knowing your blood sugar is ok is reassuring, for example before, during or after exercise or when operating machinery.

Multiple readings

Single readings can be useful, but usually to monitor longer-term blood sugar balance and to guide insulin treatment change, we look at **multiple** readings, often over a number of days.

Consider a set of readings:	Before Breakfast	Before Lunch	Before Tea	Before Bed
Random day	6.1	11.3	5.5	9.7

What does this tell us?

The answer is – not a lot! Everyone who has diabetes knows that blood sugar readings vary and making sense of a single reading or several readings on a single day is tricky.

Consider ‘Bob’

- Bob has type 1 diabetes. Bob is meticulous! Bob gets up every morning at 07.17. Bob takes his insulin 15 minutes and 0 seconds before breakfast. Bob has 1.73 Weetabix, 109 ml of milk, and a standard cup of tea. Bob walks 300 yards to the Newsagents and buys his morning paper and then he checks his blood sugar:
 - On Monday, Bob’s blood sugar is 7.1 (Bob is happy)
 - On Tuesday, Bob’s blood sugar is 14.3 (Bob is surprised)
- How can this be? Bob feels that because everything that affects Bob’s blood sugar is the same his blood sugars should be too – but they never are! Why not?

The answer is that blood sugars are affected by more than just what we eat, what insulin we take and what we do. Blood sugars can be affected by our mood, pain, illness, the weather and for women their period, and many other factors. Day to day, we might absorb slightly more or less of our meal, and we might absorb slightly more or less of our insulin..... and when you add all of this together, it results in a blood sugar on Monday of 7.1 and a blood sugar on Tuesday of 14.3.

This is not a silly story. It's really important! Blood sugars vary – if you feel well, don't waste hours of your life trying to figure out what was different between Monday and Tuesday – do a quick back-check to look for something obvious and if nothing springs to mind, just accept it and move on!

What does this tell us about interpreting blood sugar tests?

- Whilst single readings can be useful (see above), usually we need multiple readings on multiple days to smooth out day-to-day variation to see what's going on.

If we have multiple readings, we see past the day-to-day variations:

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Day 1	6.1	11.3	5.5	9.7
Day 2	11.5	5.6	6.1	9.7
Day 3	12.1	4.7	6.1	9.1
Day 4	9.9	6.6	5.9	8.3
Day 7	13.2	6.8	9.1	6.5
Day 9	8.4	6.1	4.1	6.9
Day 10	7.1	5.9	3.8	4.1
Day 13	5.4	12.1	12.4	10.1
Day 14	4.8	4.6	5.6	6.9
Day 15	11.1	8.4	6.4	7.6

While it's good having columns of numbers like this, we need to translate the numbers into a **MESSAGE – what are the numbers telling us?**

We need to know what we're aiming for.

Targets for blood sugar readings vary – they are **INDIVIDUAL**. Let's return to Bob. Bob has a personalised target average 'blood sugar test' 'HbA1c' or 'A1c' (same thing) of 58 mmol/mol (7.5% in old units).

Important note, we refer to ‘HbA1c’ or ‘A1c’ as an ‘average blood sugar test’ but it is NOT an average of your finger prick checks - because the units of this test (the numbers used) are different.

We use a table to relate target average blood sugar test (A1c) to finger-prick checks:

A1c goal	Pre-breakfast	Pre-lunch	Pre-tea	Pre-bed
48	6 – 7	6 - 7	6 -7	7 - 8
53	7 – 8	7 – 8	7 – 8	8 – 9
58	8 – 9	8 – 9	8 – 9	9 – 10
64	9 – 10	8 – 9	8 – 9	9 – 10
69	9 – 10	9 – 10	9 – 10	10 – 13

Bob has a target A1c of 58, so we read across and note his goals for his finger-prick checks:

A1c goal	Pre-breakfast	Pre-lunch	Pre-tea	Pre-bed
48	6 – 7	6 - 7	6 -7	7 - 8
53	7 – 8	7 – 8	7 – 8	8 – 9
58	8 – 9	8 – 9	8 – 9	9 – 10
64	9 – 10	8 – 9	8 – 9	9 – 10
69	9 – 10	9 – 10	9 – 10	10 – 13
Your SMBG				

Bob is aiming for finger-prick checks mostly between 8-9 pre-breakfast, 8-9 pre-lunch, 8-9 pre-tea and 9-10 pre-bed. **Important note**: he will never get all of this readings in these ranges – they will always vary - his goal is to get **most** of his readings, **largely** within these target ranges. Sometimes this can be very difficult.

Let’s CONVERT Bob’s readings into a MESSAGE. Let’s use a highlighter to do this. We’ll colour any sugar that is in target range GREEN, we’re going to colour any sugar that is below target RED, and we’re going to colour any sugar that is above target AMBER.

Bob's readings (we sometimes use the abbreviation **SMBG** -self-monitored blood glucose).

	Before Breakfast (Bob's goal 8-9)	Before Lunch (Bob's goal 8-9)	Before Tea (Bob's goal 8-9)	Before Bed (Bob's goal 9-10)
Day 1	10.1	11.3	8.9	9.7
Day 2	9.4	8.1	8.9	9.7
Day 3	9.9	8.4	8.1	9.1
Day 4	14.1	8.9	8.0	9.3
Day 7	8.4	8.0	9.5	6.5
Day 9	11.1	12.1	8.4	9.1
Day 10	7.6	8.8	5.5	4.1
Day 13	9.9	8.8	8.5	10.1
Day 14	6.7	8.0	8.9	9.9
Day 15	9.1	9.1	8.1	9.6

Now let's transfer the colours into the MESSAGE. Are most of the readings OK, above target, or below target?

Green = OK

Amber = above target

Red = below target

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Day 1	10.1	11.3	8.9	9.7
Day 2	9.4	8.1	8.9	9.7
Day 3	9.9	8.4	8.1	9.1
Day 4	14.1	8.9	8.0	9.3
Day 7	8.4	8.0	9.5	6.5
Day 9	11.1	12.1	8.4	9.1
Day 10	7.6	8.8	5.5	4.1
Day 13	9.9	8.8	8.5	10.1
Day 14	6.7	8.0	8.9	9.9
Day 15	9.1	9.1	8.1	9.6
Overall colour	Mostly amber	Mostly green	Mostly green	Mostly green
Overall MESSAGE	Above target	OK	OK	OK

Once we've got the overall message, we can forget/ignore the numbers. All we are now interested in is the final row:

Overall <u>MESSAGE</u>	Above target	OK	OK	OK
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This will now guide insulin dose adjustment (more about that a bit later).

Which insulin do we adjust?

If we're going to use blood sugar test results to adjust insulin doses, we need to know which insulin to adjust when the **MESSAGE** from a particular blood sugar column is out of target.

Remember the different insulin treatment plans (above):

1. **Basal-bolus regimen.** Once-daily longer-acting basal insulin (usually at bedtime) and a 'bolus' injection of fast-acting insulin 10-15 mins before each meal. In shorthand:

Insulin Toujeo (longer-acting basal insulin) 36

Insulin Trurapi (fast-acting, bolus insulin) 12 + 14 + 18

For a Basal-bolus 4-injection insulin plan				
	Before Breakfast	Before Lunch	Before Tea	Before Bed
Day 1	These Blood Sugar readings tell us about long-acting insulin BEDTIME TOUJEO	These Blood Sugar readings tell us about fast-acting, Pre-Breakfast TRURAPI	These Blood Sugar readings tell us about fast-acting, Pre-Lunch TRURAPI	These Blood Sugar readings tell us about fast-acting, Pre-Tea TRURAPI
Day 2				
Day 3				
Day 4				
Day 7				
Day 9				
Day 10				
Day 13				
Day 14				
Day 15				

2. **Twice-daily mixed insulin.** You take an injection of premixed insulin 10-15 mins before breakfast and an injection of premixed insulin 10-15 mins before your evening meal. In shorthand:

Humalog Mix 25

26 + 14

For a twice daily Insulin Mixture treatment plan				
	Before Breakfast	Before Lunch	Before Tea	Before Bed
Day 1	These Blood Sugar readings tell us about long-acting insulin Pre-Tea Humalog Mix 25	These Blood Sugar readings tell us about fast-acting, Pre-Breakfast Humalog Mix 25	These Blood Sugar readings tell us about fast-acting, Pre-Breakfast Humalog Mix 25	These Blood Sugar readings tell us about fast-acting, Pre-Tea Humalog Mix 25
Day 2				
Day 3				
Day 4				
Day 7				
Day 9				
Day 10				
Day 13				
Day 14				
Day 15				

Insulin-tablet combination therapy

- (i) Typically, you will take an injection of long-acting basal insulin at bedtime and one or more diabetes tablets during the day.
In shorthand:

Insulin Toujeo

40

Plus Metformin 500 mg three times daily (TDS) with meals

For a basal insulin with tablets combination treatment plan				
	Before Breakfast	Before Lunch	Before Tea	Before Bed
Day 1	These Blood Sugar readings tell us about long-acting insulin BEDTIME TOUJEO	These Blood Sugar readings tell us about fast-acting, METFORMIN tablets	These Blood Sugar readings tell us about fast-acting, METFORMIN tablets	These Blood Sugar readings tell us about fast-acting, METFORMIN tablets
Day 2				
Day 3				
Day 4				
Day 7				
Day 9				
Day 10				

By how much do we adjust each insulin dose?

Generally we adjust the dose by 10-20%.

For example:

- Pre-breakfast sugars **too high** → Increase bedtime Toujeo by 10% from 40 units to 44 units (10% of 40 = 4, so add 4 units to the 40, so new dose = 44)
- Pre-lunch sugars **too high** → Increase breakfast Trurapi by 20% from 10 to 12 units (20% of 10 = 2, so add 2 units to the 10, so new dose = 12)

Putting it all together: worked examples

Danielle

Danielle has type 1 diabetes, treated with a basal-bolus regimen. In shorthand:

Toujeo 24

Trurapi 8 + 8 + 8

Danielle's agreed target HbA1c is 58 so her agreed target blood sugars are:

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10

Always start by looking at the before breakfast column

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	11.4			
Day 2	8.9			
Day 3	14.1			
Day 4	10.3			
Day 7	9.9			
Day 9	11.1			
Day 10	10.9			
Day 13	6.7			
Day 14	9.9			
Overall MESSAGE	Mostly TOO HIGH			

ACTION: Danielle INCREASES her bedtime long-acting insulin Toujeo from 24 to 28 and continues monitoring for another 7-10 days.

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	9.1			
Day 2	6.2			
Day 3	10.1			
Day 4	9.5			
Day 7	9.8			
Day 9	8.1			
Day 10	8.4			
Day 13	9.9			
Day 14	10.5			
Overall MESSAGE	Better but Mostly still TOO HIGH			

Much improved, but still overall just a little bit **too high**. **ACTION:** Danielle INCREASES her bedtime longer-acting insulin Toujeo again from 28 to 30 and continues monitoring again.

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	8.6			
Day 2	8.1			
Day 3	8.4			
Day 4	9.2			
Day 7	8.8			
Day 9	7.1			
Day 10	8.1			
Day 13	8.2			
Day 14	8.0			
Overall MESSAGE	Mostly OK			

Having sorted her pre-breakfast sugars, Danielle maintains her bedtime long-acting insulin Toujeo at 30 units and looks at her pre-lunch sugars.

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	8.6	8.1		
Day 2	8.1	8.8		
Day 3	8.4	8.3		
Day 4	9.2	8.1		
Day 7	8.8	9.5		
Day 9	7.1	8.5		
Day 10	8.1	8.5		
Day 13	8.2	8.9		
Day 14	8.0	9.4		
Overall MESSAGE	Mostly OK	Mostly OK		

They're ok, so she knows her breakfast time dose of Trurapi (8 units) is about right and now she looks at her pre-tea sugars.

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	8.6	8.1	3.8	
Day 2	8.1	8.8	4.1	
Day 3	8.4	8.3	3.2	
Day 4	9.2	8.1	9.9	
Day 7	8.8	9.5	8.4	
Day 9	7.1	8.5	8.6	
Day 10	8.1	8.5	8.1	
Day 13	8.2	8.9	8.5	
Day 14	8.0	9.4	4.1	
Overall MESSAGE	Mostly OK	Mostly OK	Mostly TOO LOW	

ACTION: Danielle sees that her pre-tea sugars are mostly below target so she reduces her lunchtime fast-acting insulin Trurapi from 8 to 6.

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	8.6	8.1	8.1	
Day 2	8.1	8.8	8.8	
Day 3	8.4	8.3	8.6	
Day 4	9.2	8.1	8.0	
Day 7	8.8	9.5	8.9	
Day 9	7.1	8.5	6.8	
Day 10	8.1	8.5	8.1	
Day 13	8.2	8.9	9.5	
Day 14	8.0	9.4	8.4	
Overall MESSAGE	Mostly OK	Mostly OK	Mostly OK	

The change Danielle made to her pre-lunch Trurapi has now sorted out her pre-tea sugars. Now she can turn her attention to her pre-bed sugars:

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	8.6	8.1	8.1	10.5
Day 2	8.1	8.8	8.8	11.1
Day 3	8.4	8.3	8.6	9.9
Day 4	9.2	8.1	8.0	9.5
Day 7	8.8	9.5	8.9	9.1
Day 9	7.1	8.5	6.8	9.0
Day 10	8.1	8.5	8.1	9.7
Day 13	8.2	8.9	9.5	9.5
Day 14	8.0	9.4	8.4	9.3
Overall MESSAGE	Mostly OK	Mostly OK	Mostly OK	Mostly OK

Danielle's sugars are now mostly fine and 3 months later her HbA1c (average blood sugar test) is 52 - reducing her risk of long-term complications (eye damage, kidney damage and nerve damage) – and she feels better! Well done, Danielle! She will still have occasional

sugars which are out of range – that’s ok so long as the overall message from her columns of numbers is OK.

Not everyone is the same!

Fred

Fred is 69, he has had type 1 diabetes for 40 years. He has had a heart attack and suffers with angina; he is also a bit unsteady on his feet after a stroke and his memory isn’t perfect.

Fred has switched from a basal-bolus regimen to a twice-daily mix because he finds it easier to manage:

Humalog Mix 25 36 + 18

In view of his heart disease, poor mobility and poor memory, Fred, his carer and his doctor have agreed a target HbA1c of 69 and blood sugar targets of:

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	9 – 10	9 – 10	9 – 10	10 – 13

His monitoring results are as follows:

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	9 – 10	9 – 10	9 – 10	10 – 13
Day 1	11.6	5.1	5.5	10.4
Day 2	9.1	3.8	4.1	11.3
Day 3	9.5	4.4	9.9	10.9
Day 4	9.4	6.1	6.3	11.9
Day 7	9.9	9.7	9.3	14.5
Day 9	9.9	7.1	11.5	12.3
Day 10	9.6	3.4	5.1	12.1
Day 13	5.6	3.9	5.1	11.6
Day 14	9.4	5.1	3.3	12.1
Overall MESSAGE	Mostly OK	Mostly TOO LOW	Mostly TOO LOW	Mostly OK

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	10.4			
Day 2	11.5			
Day 3	11.1			
Day 4	7.8			
Day 7	10.1			
Day 9	9.9			
Day 10	13.4			
Day 13	9.5			
Day 14	10.4			
Overall MESSAGE	Mostly TOO HIGH			

ACTION: Joan notes that her pre-breakfast sugars (reflecting her bedtime Toujeo) are too high, so she increases the dose of her Insulin Toujeo from 32 units to 36 units

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	8 – 9	8 – 9	8 – 9	9 – 10
Day 1	8.4			
Day 2	9.5			
Day 3	10.1			
Day 4	8.2			
Day 7	9.5			
Day 9	9.2			
Day 10	8.6			
Day 13	9.3			
Day 14	9.1			
Overall MESSAGE	Better but still Mostly TOO HIGH			

ACTION: Joan is pleased - her insulin increase has improved her pre-breakfast sugars, but they are still a little too high, so she increases her Insulin Toujeo by 20% to 44 units.

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Target	5.0 – 7.0	4.0 – 7.0	4.0 – 7.0	6.0 – 10.0
Day 1	6.1			
Day 2	6.6			
Day 3	5.9			
Day 4	7.1			
Day 7	5.5			
Day 9	6.9			
Day 10	5.1			
Day 13	5.5			
Day 14	6.8			
MESSAGE	OK			

Joan’s sugars are now fine. Her Toujeo dose is fine. If her sugars throughout the rest of the day are also fine, then this insulin-tablet combination is right for her. If her pre-breakfast sugars are OK, but they are mostly above target later in the day, then her treatment plan needs changing – she may need an insulin mix injection twice-daily.

What happens when the message isn’t clear?

Sometimes we have a column of 10 readings and 5 are high and 5 are ok. What do we do? Continue monitoring and it will typically become clear with more readings whether overall they’re too high or ok.

What to do next?

1. Know what insulins you use, when you take them and what doses you take.
2. Know your target HbA1c and your related target blood sugars goals.
3. Use above to understand which blood sugars are affected by which insulin dose.
4. Test your sugars and record them in a table (blank table below can be copied).
5. Start with pre-breakfast sugars - once you’ve sorted them, do pre-lunch sugars, then pre-tea sugars and finally pre-bed sugars. Sort one column at a time – don’t adjust multiple insulins at the same time. Once you have 6-10 readings in the relevant column, compare them to your personal target and translate them to a message.
6. Adjust the relevant insulin by increasing or decreasing it by about 10-20%.
7. Repeat the monitoring until you have a further 6-10 readings.
8. Keep repeating until most of your sugars are where you want them to be.
9. If in doubt, seek advice from your GP or practice nurse or from the specialist team if you attend a hospital clinic.

Appendix 1: My goals, my results and what I changed (copy as many times as you need to)

My insulin treatment plan is:

My current HbA1c is:

The TARGET HbA1c is

My target blood sugars are (see table relating target HbA1c to target finger-prick blood sugars):

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Personal Target				

My monitoring results are:

	Before Breakfast	Before Lunch	Before Tea	Before Bed
Personal Target				
Write date below	Write blood result	Write blood result	Write blood result	Write blood result
Overall MESSAGE				

The action I took was: