

Insulin Masterclass: Initiation and adjustment, CGM interpretation

Su Down, May 22nd 2025

Disclaimer/disclosure

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- Diabetes Nurse Consultant, MSc, RGN, NMP. Somerset Foundation Trust
- Tutor PG Diabetes Diploma: I-Heed, Warwick University
- Editor-in-Chief Journal Diabetes Nursing
- Committee member Primary Care Diabetes Society

I have received funding from the following companies for providing educational sessions and documents, and for attending advisory boards:

- | | |
|------------------------|----------------|
| • Astra Zeneca | • Lilly |
| • Abbott | • Novo Nordisk |
| • Ascencia | • Sanofi |
| • Boehringer Ingelheim | • Viatris |
| • Dexcom | |

Content

- When and how to initiate
- Case studies: CGM and insulin adjustment

Do not copy

There are currently 27 different insulin preparations



Abasaglar®
Humalog® Mix25
Humalog® Mix50
Humulin® I
Humulin® M3
Humulin® S
Humalog® U100
insulin
Humalog® U200
insulin
Lyumjev® U100
insulin
Lyumjev® U200
insulin



Actrapid®
Insulatard®
Levemir® going 2026
NovoMix® 30
NovoRapid®
Tresiba® U100 insulin
Tresiba® U200 insulin
Fiasp®

SANOFI

Lantus®
Apidra®
Admelog®
Trurapi®
Toujeo® U300



Semglee®



Hypurin® Porcine 30/70
Hypurin® Porcine Isophane
Hypurin® Porcine Neutral

Insulins and types

- Short or quick acting
- Premixed
- Intermediate or long acting
- Animal, Human, Analogue or Biosimilar

Keep It Simple Summary

	Quick/Fast	Mixed	Intermediate	Long
	Also referred to as prandial or bolus insulin	Also referred to as Biphasic insulin (a mixture of quick/fast and intermediate insulin)	Also referred to as NPH (neutral protamine Hagedorn) background or basal insulin	Also referred to as background or basal insulin
Human	Humulin®S Actrapid®	Humulin® M3	Humulin® I Insulatard®	
Analogue	Humalog® U100 Humalog® U200 NovoRapid® Apidra® Fiasp® Lyumjev U100® Lyumjev U200® Admelog® Trurapi®	Humalog® Mix25 Humalog® Mix50 NovoMix® 30		Lantus® Abasaglar® Semglee® Levemir® Tresiba® U100 Tresiba® U200 Toujeo®
Animal	Hypurin® Porcine Neutral	Hypurin® Porcine 30/70	Hypurin® Porcine Isophane	

Insulin discontinuations from Novo Nordisk

Medicine	Presentations to be discontinued	Date of anticipated supply end	Presentations remaining available
Levemir® (insulin detemir) ¹	Penfill® FlexPen®	December 2026	N/A
Insulatard® (insulin isophane human) ²	Penfill®	March 2025	Vial
NovoRapid® (insulin aspart) ³	FlexTouch®	March 2025	FlexPen® Penfill® PumpCart® Vial

Insulin should be considered in type 2 diabetes when:

- Patient is on maximum tolerated oral antidiabetes agents (+/- GLP1-RA) and desired HbA1c is not achieved ($>58\text{mmol/mol}$)
- If experiencing osmotic symptoms related to poor glycaemic control & HbA1c is particularly high (and unlikely to reach desired target with the addition of other agents). Maybe temporarily used as a 'rescue therapy'
- Where HbA1c target is not achieved and other agents are contraindicated (e.g. $\text{eGFR} < 30$).

Selecting an appropriate starting regimen

There is no evidence that starting a basal, a twice daily pre-mixed or a prandial regimen was definitively more effective, *however*:

- More effective blood glucose control was seen at 1 year when a twice daily premixed insulin or pre-prandial rapid-acting insulin were used first.
- Basal insulin regimen led to fewer hypoglycaemic episodes and less weight gain.
- Regardless of initial insulin regimen over 50% required the addition of a second insulin type.

These findings provide clear evidence in people with type 2 diabetes to support starting insulin therapy with a once a day basal insulin and then adding a mealtime insulin if glycaemic targets are not met.

The key is to make regular dose increases– some general rules

A basic principle in up titrating is to increase doses in 10% increments. However:

- If hypoglycaemia occurs reduce insulin dose by at least 20% and monitor
- Preventing hypos **always** takes priority over correcting hyperglycaemia
- Hypoglycaemia is potentially dangerous and can damage patient confidence

Insulin concentrations



The concentration of insulin is the number of units of insulin in 1 mL of fluid. All Insulin vials and most insulin pens commonly have a concentration of 100 units/mL.



However, some insulin products come in a higher concentration. 200 units/mL means that there are 200 units of insulin in 1 mL of fluid, 300 units/mL means that there are 300 units of insulin in 1 mL of fluid



There is currently one concentrated insulin available: HUMULIN R U-500 vial, and there is a corresponding U-500 syringe. HUMULIN R U-500 is only ever prescribed by secondary care.

Higher concentration insulins

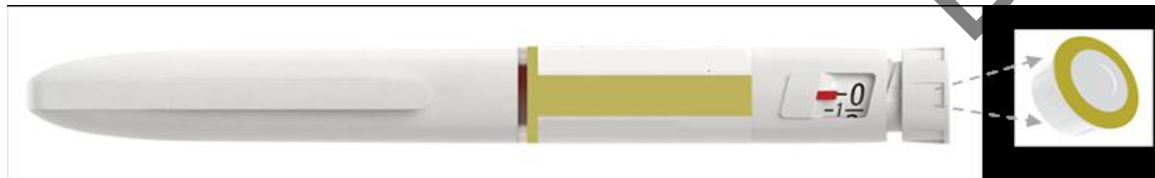
- There are many reasons why a health care provider chooses to prescribe a concentrated insulin, although the primary reason is often to decrease the volume given with an injection.
- The insulin pen device displays the number of *insulin units* to be delivered.
- Concentrated insulin should not be transferred to a different device (such as from an insulin pen to a syringe or pump), as this can result in over dosage and severe hypoglycemia.



Biosimilar Insulins

A “biosimilar” is a biological copy that is not identical, but demonstrates similarity to the original product, in terms of quality, efficacy and safety.

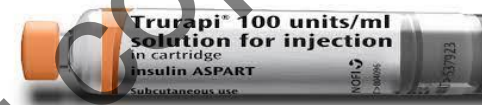
Abasaglar® [Insulin glargine injection (rDNA origin)
100 units/mL]



Insulin Semglee® [Insulin glargine
injection (rDNA origin) 100 units/mL]



Admelog and Trurapi



Admelog ▼ 100 units/ml solution

- Admelog 100 units/ml solution for injection in vial
- Admelog 100 units/ml solution for injection in cartridge
- Admelog 100 units/ml solution for injection in a pre-filled pen

Trurapi ▼ 100 units/ml solution

- Trurapi 100 units/ml solution for injection in vial
- Trurapi 100 units/ml solution for injection in cartridge
- Trurapi 100 units/ml solution for injection in a pre-filled pen

Why is this important?

Originator insulin (insulin aspart 100 units/ml) and device(s)	Cost (NHSBSA dm+d April 2023)	Biosimilar insulin (insulin aspart 100 units/ml) and device(s)	Cost (NHSBSA dm+d April 2023)	Potential cost saving
NovoRapid® 5 x 3ml FlexPens	£30.60	Trurapi® 5 x 3ml SoloStar pens	£21.42	£9.18
NovoRapid® 5 x 3ml FlexTouch pens	£32.13			£10.71
NovoRapid® 5 x 3ml cartridges	£28.31	Trurapi® 5 x 3ml cartridges	£19.82	£8.49
NovoRapid® 1 x 10ml vial	£14.08	Trurapi® 1 x 10ml vial	£11.97	£2.11

Originator insulin (insulin glargine 100 units/ml) and device(s)	Cost (NHSBSA dm+d April 2023)	Biosimilar insulin (insulin glargine 100 units/ml) and device(s)	Cost (NHSBSA dm+d April 2023)	Potential cost saving
Lantus® 5 x 3ml SoloStar pens or 5 x 3ml cartridges	£34.75	Semglee® 5 x 3ml prefilled pens	£29.99	£4.76
		Abasaglar® 5 x 3ml KwikPens or 5 x 3ml cartridges	£35.28	None

Originator insulin (insulin lispro 100 units/ml) and device(s)	Cost (NHSBSA dm+d April 2023)	Biosimilar insulin (insulin lispro 100 units/ml) and device(s)	Cost (NHSBSA dm+d April 2023)	Potential cost saving
Humalog® 5 x 3ml KwikPens	£29.46	Admelog® 5 x 3ml SoloStar pens	£22.10	£7.36
Humalog® 5 x 3ml cartridges	£28.31	Admelog® 5 x 3ml cartridges	£21.23	£7.08
Humalog® 1 x 10ml vial	£16.61	Admelog® 1 x 10ml vial	£14.12	£2.49

£ Potential savings

Safe Use of Insulin and Insulin Safety Agenda

Do not copy

FREE CPD MODULE

The six steps to insulin safety

UPDATED JUNE 2024: An essential module for all those prescribing, managing or administering insulin, with the overall aim of reducing insulin errors in clinical practice, particularly within the primary care setting.



Why, *how* you inject is as important as *what* you inject

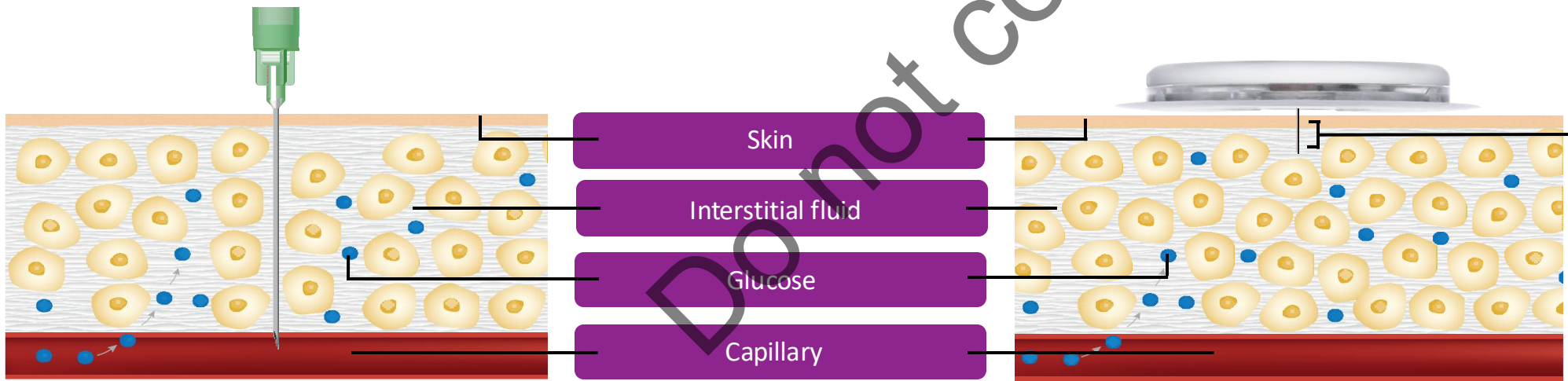
- Re checking technique and sites used
- Inadvertent Intramuscular injection
- Lipohypertrophy
- Injections by a 3rd party
- Poor technique can lead to fluctuating glucose control



Continuous Glucose Monitoring

Understanding interstitial fluid measurement

- Continuous glucose monitoring systems measure glucose in the interstitial fluid
- Blood glucose and sensor glucose are closely related but not identical

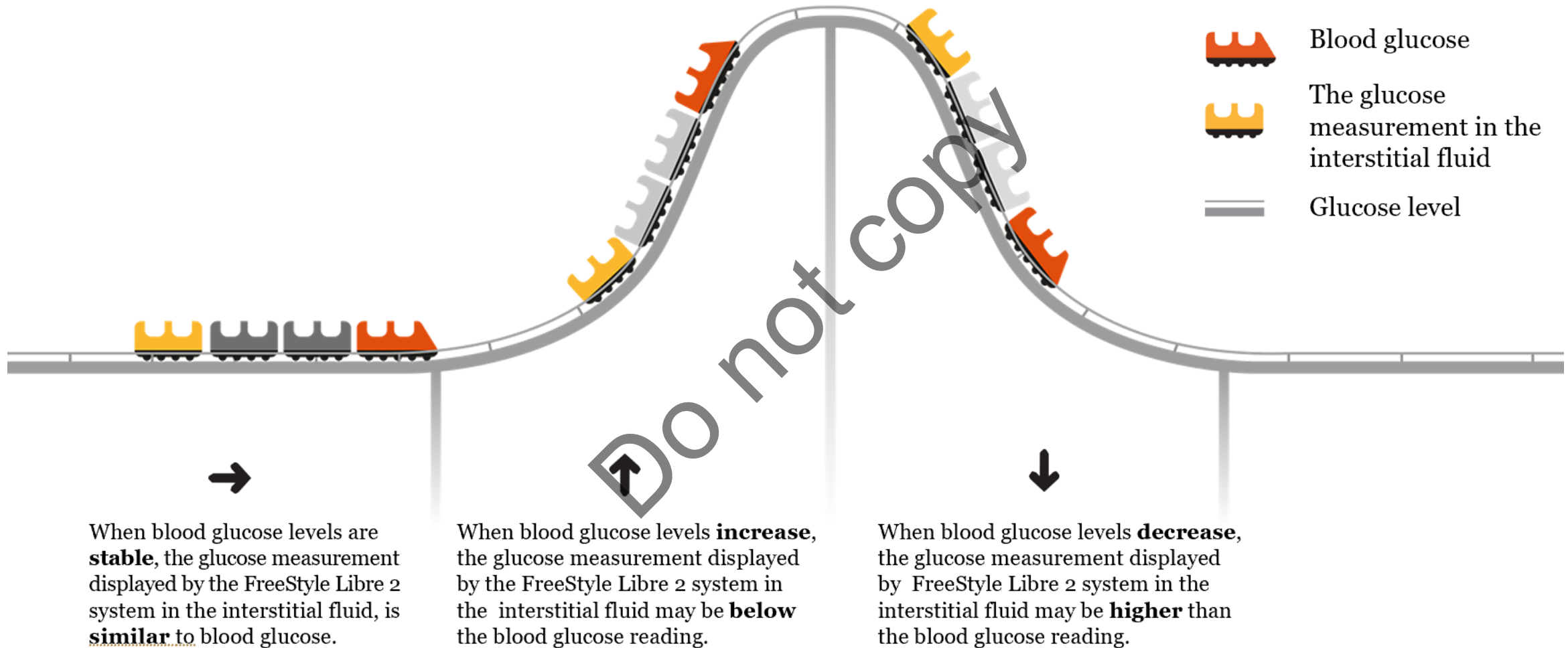


Classic capillary blood glucose meter

CGM sensor

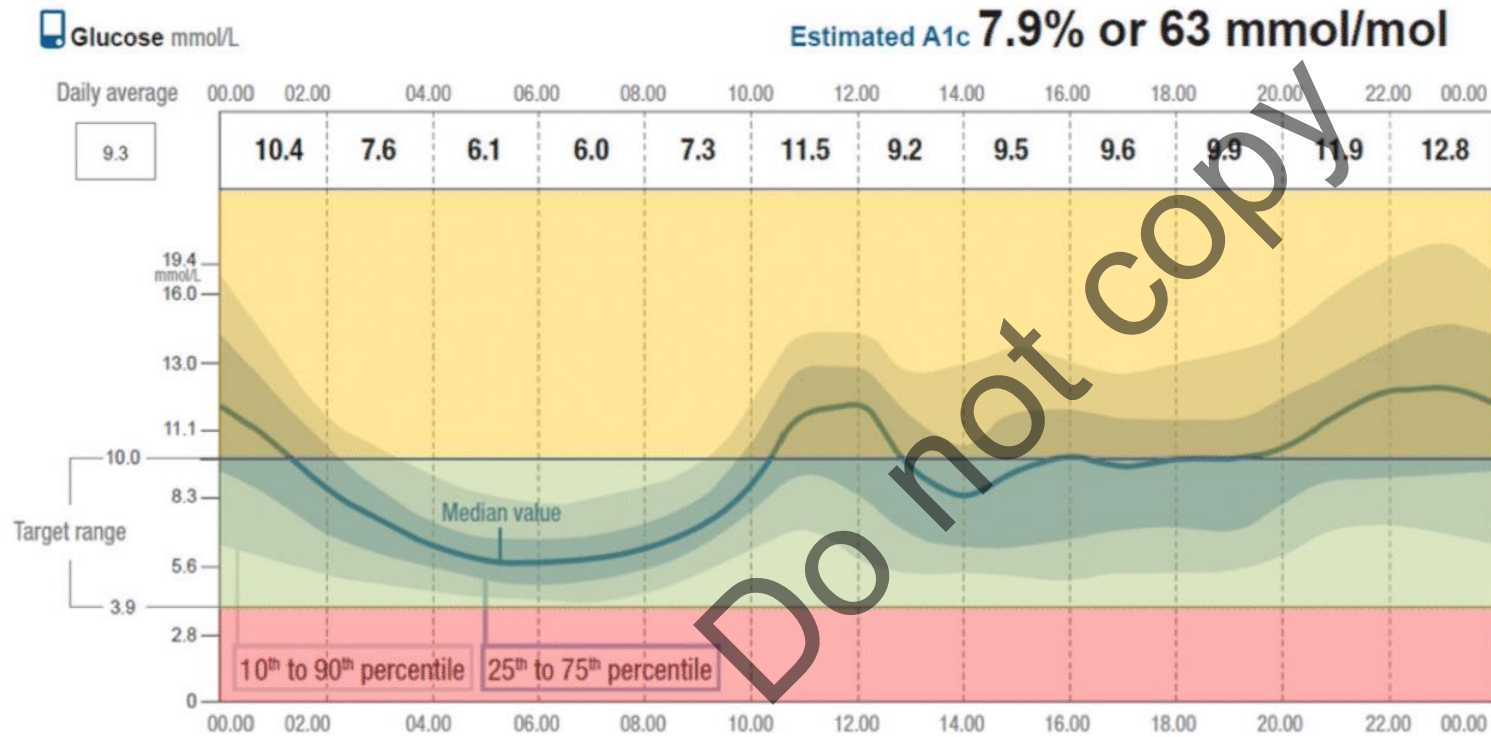
The soft microfilament is inserted approximately 5mm under the skin's surface

Understanding interstitial glucose measurement



- INTERNATIONAL CONSENSUS ON TIME IN RANGE

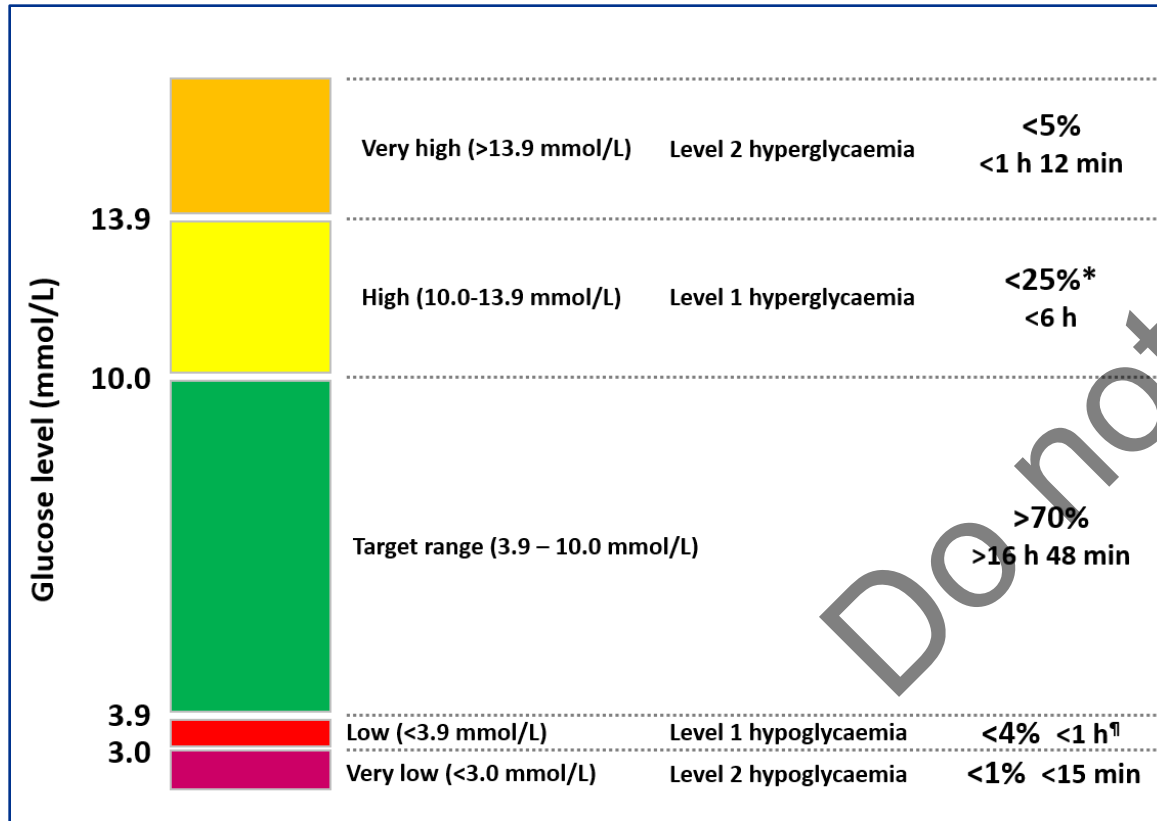
What is Time in Range?



Time in Range refers to the percentage of time that a person with diabetes spends within their Target Glucose Range, or above or below that target

Targets for adults, young people and children with type 1 or type 2 diabetes

Think about individual targets

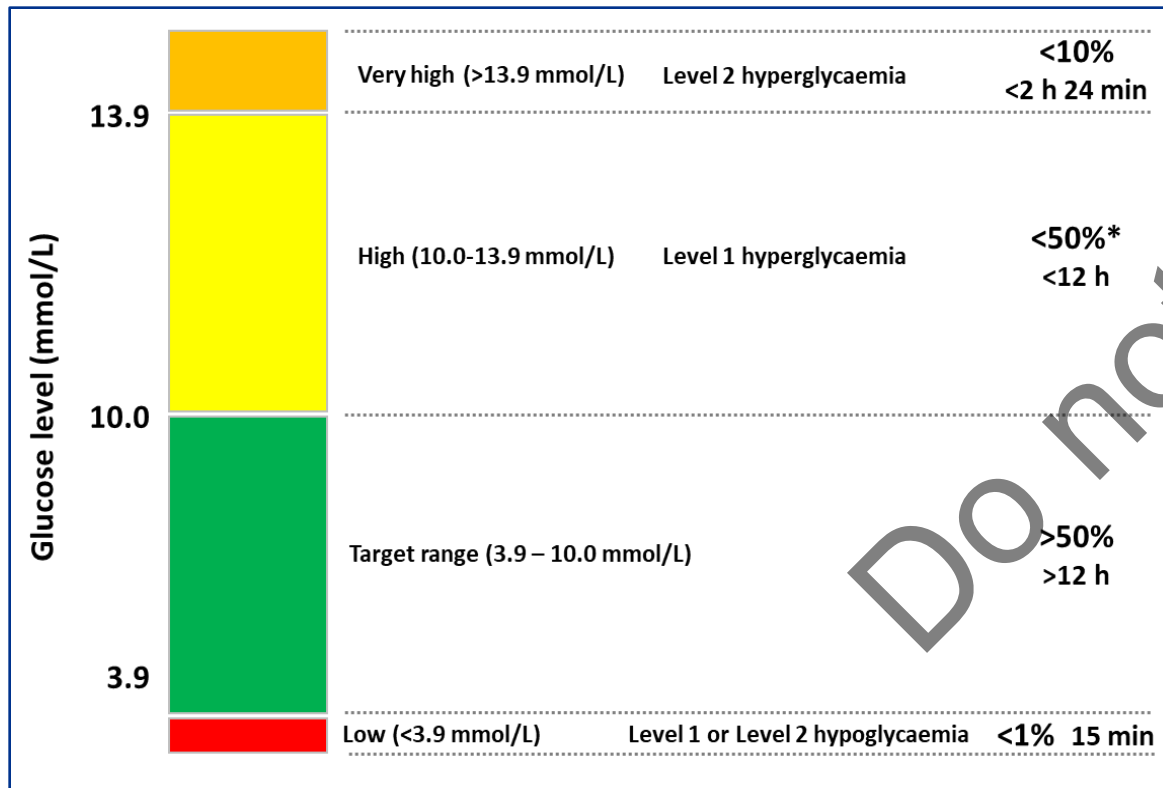


* Readings >13.9 mmol/L are also included in the <25% target

† Readings <3.0 mmol/L are also included in the <4% target



Targets for older people with type 1 or type 2 diabetes and those at high-risk from hypoglycaemia



THINKING ABOUT INDIVIDUAL TARGETS

Emphasise the need to **prioritise hypoglycaemia avoidance, reducing the %TBR <3.9 mmol/L**

Recommendation is to keep %TBR <3.9mmol/L to **<1% or 15 min per day**



High risk

* Readings >13.9 mmol/L are also included in the <50% target

Images are for illustrative purposes only. Not real patient data.

1. Battelino T, Danne T, Bergenstal RM, et al. Clinical targets for continuous glucose monitoring data interpretation: recommendations from the international consensus on time in range. Diabetes Care. (2019);42(8):1593-1603.

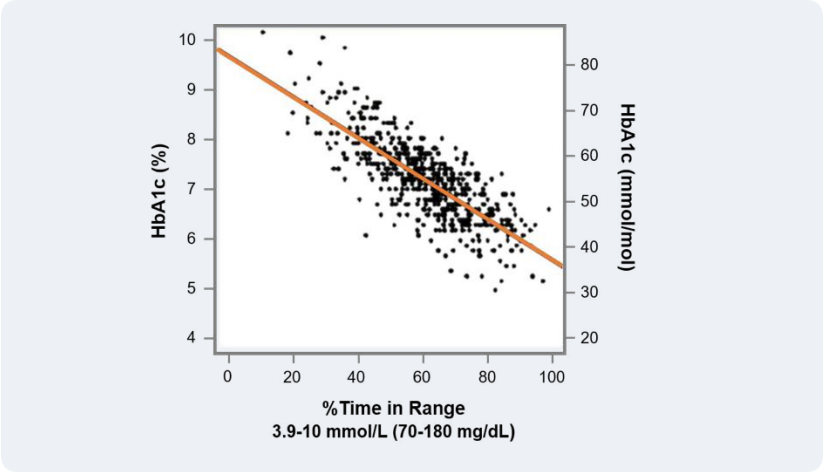
Estimate of HbA1c for a given TIR level

Data from randomized clinical trials involving adults with Type 1 or Type 2 diabetes have shown that TIR is correlated with laboratory-measured HbA1c.

	ANALYSIS BY BECK ET AL ¹	ANALYSIS BY VIGERSKY ET AL ²
TIR	HbA1c CORRELATE % (mmol/mol)	HbA1c CORRELATE % (mmol/mol)
90 %	6.0 (42)	5.1 (32)
80 %	6.5 (48)	5.9 (41)
70 %	7.0 (53)	6.7 (50)
60 %	7.4 (57)	7.5 (58)
50 %	7.9 (63)	8.3 (67)
40 %	8.4 (68)	9.0 (75)
30 %	8.9 (74)	9.8 (84)
20 %	9.4 (79)	10.6 (92)

Every 5% (~1 hour 12 mins per day) increase in Time in Range is associated with clinically significant benefits³

THE RELATIONSHIP BETWEEN TIR AND HbA1c¹

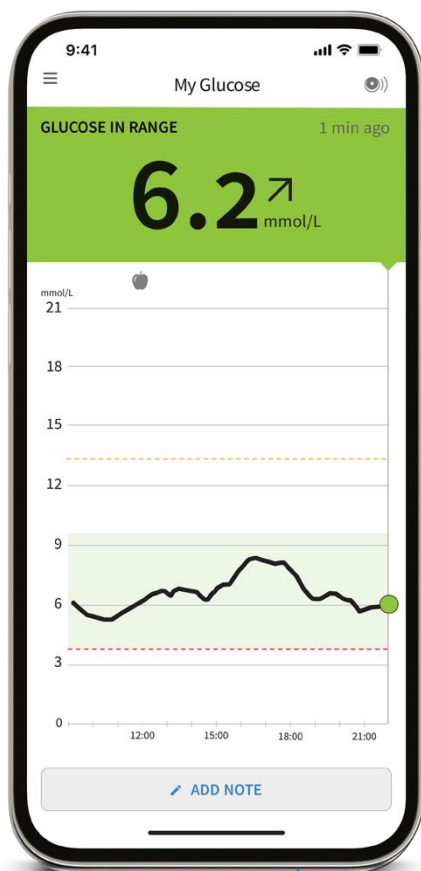


Key insights

- There is an **inverse correlation** –as TIR increases, HbA1c decreases
- Although highly correlated, a wide range of HbA1c values can be associated with a specific TIR and vice versa

* Correlations of %TIR with HbA1c for target glucose range 3.9-10 mmol/L (70-180 mg/dL). Analysis by Beck et al is based on data in T1D, analysis by Vigersky & McMahon includes data in T1D and T2D
1. Beck RW, et al. J Diabetes Sci Technol. 2019; 13:614-626. 2. Vigersky RA and McMahon C. Diabetes Technol Ther. 2018; 21:81–85. 3. Battelino T, et al. Diabetes Care. (2019);42(8):1593-1603.

How glucose values appear after a scan



Trend arrow

The trend arrow shows the direction that glucose is heading, along with rate of change. Indicates how glucose is changing.



Current glucose reading

Based on the most recently updated glucose value (1 minute). Text-to-speech when enabled.



8 hour history

The graph is made up of 15-minute readings stored over the last 8 hours (15 minute).



Rising quickly



Rising



Changing slowly



Falling



Falling quickly

Easily add notes

to record relevant events.

Images are for illustrative purposes only. Not real patient data.

The FreeStyle LibreLink app is only compatible with certain mobile devices and operating systems. Please check the website for more information about device compatibility before using the app.

Use of FreeStyle LibreLink requires registration with LibreView.

FreeStyle Libre 2 plus

acts as a rt-CGM if used with smart phone



or Intermittently scanned Continuous Glucose Monitoring (isCGM) commonly known as Flash if using a reader

Addition of 3 optional alarms;

- low glucose alarm
- high glucose alarm
- signal loss



Dexcom one+

Real time Continuous Glucose Monitoring (rtCGM)



- The Dexcom ONE+ system features one-touch sensor applicator with a 30-minute warm up.
- There is no separate transmitter.
- 12-hour grace period before a sensor must be changed

Continually transmits glucose data without need for scanning device.

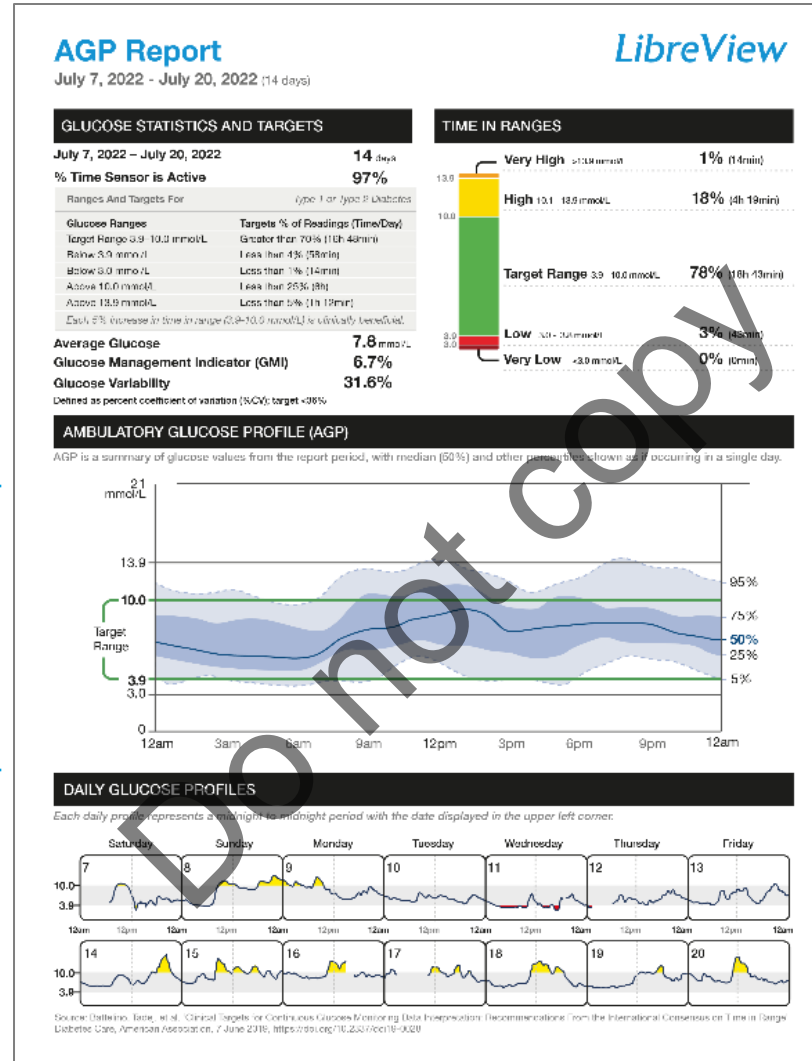
- Optional high and low glucose alerts
- Urgent low soon alarm



The AGP report – what are we looking for?

1. Glucose statistics and Targets

3. Ambulatory Glucose Profile (AGP)



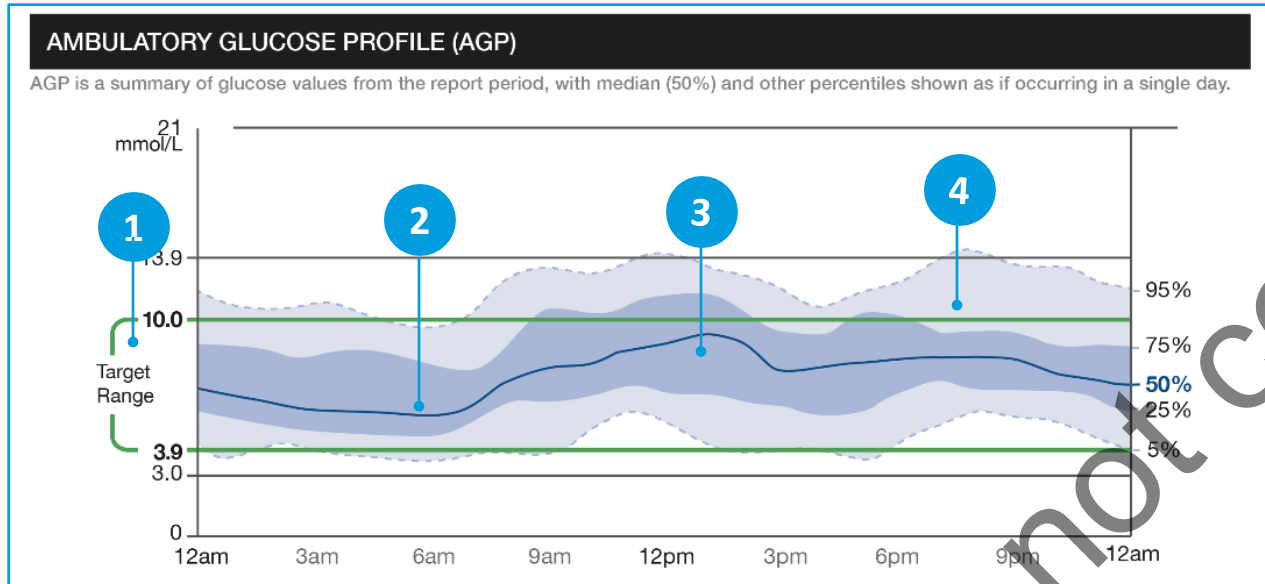
2. Time in Ranges

4. Daily Glucose Profiles

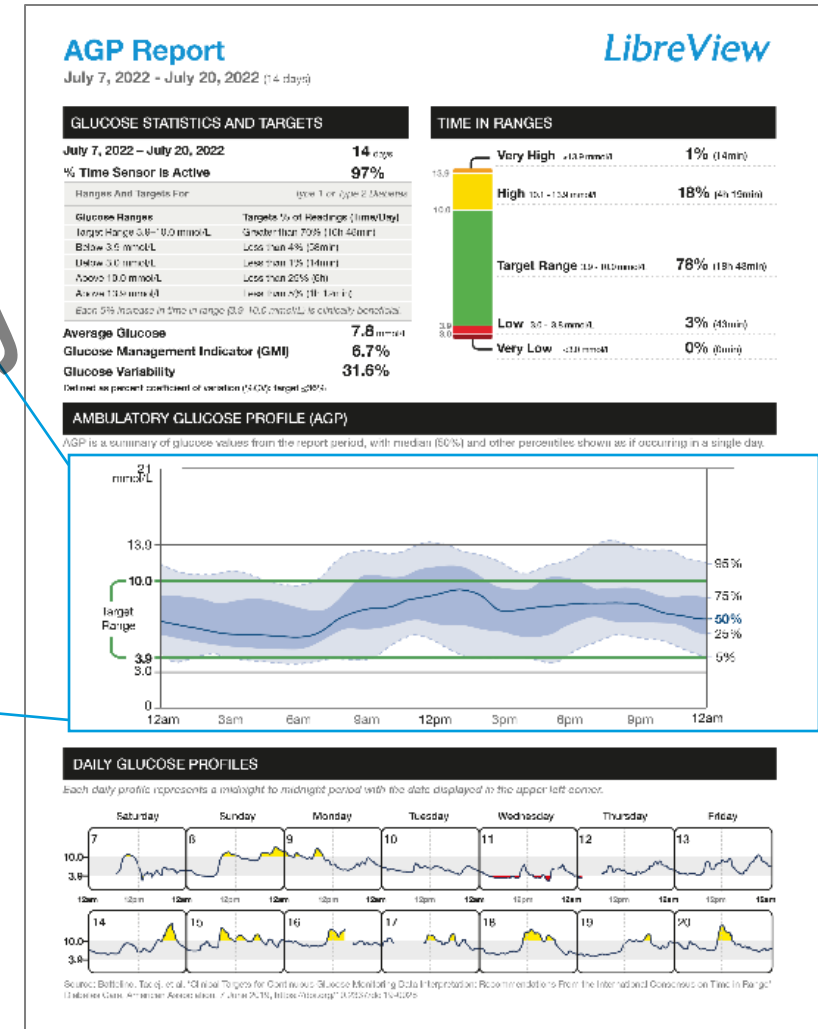
Images are for illustrative purposes only. Not real patient data.

1. Bergenstal RM, et al. Diabetes Technol Ther. 2013; 15: 198-211. 2. Battelino T, et al. Diabetes Care 2019; 42:1593-1603 doi:10.2337/dci19-0028.

Anatomy of the Ambulatory Glucose Profile (AGP)



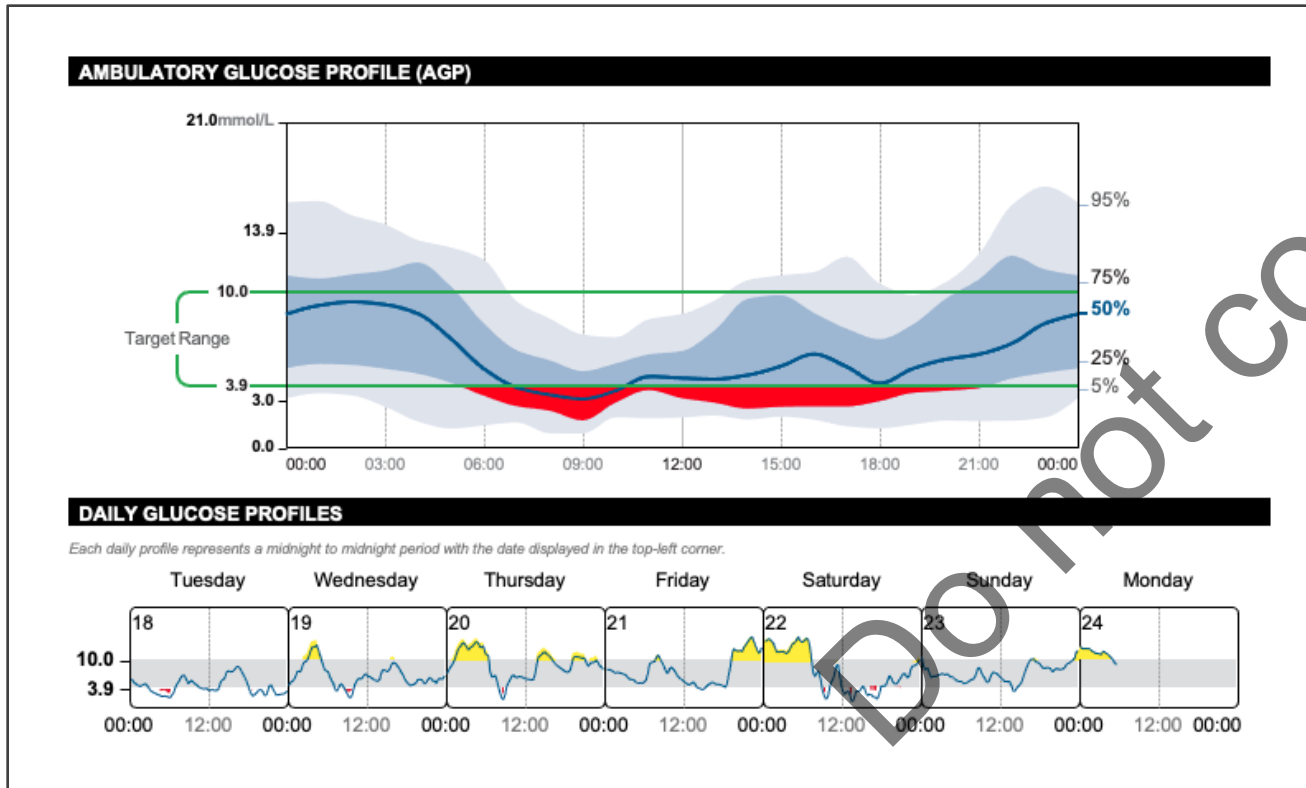
- 1 Target glucose range
- 2 Median line
- 3 Consistent glucose variability
- 4 Less common variability



Images are for illustrative purposes only. Not real patient data.

1. Bergenstal RM, et al. Diabetes Technol Ther. 2013; 15: 198-211.

Firstly look for patterns of hypoglycaemia



What time of day is hypoglycaemia occurring?

- Is there any nocturnal hypoglycaemia?

Investigate causes of low glucose

Discuss with your patient what may be the cause:

- Medication/insulin dose
- Meal size/CHO content
- Fasting – loss of appetite
- Alcohol consumption
- Exercise

Confirm with the daily glucose profiles

- Which days are hypos occurring?
- What is different about those days?

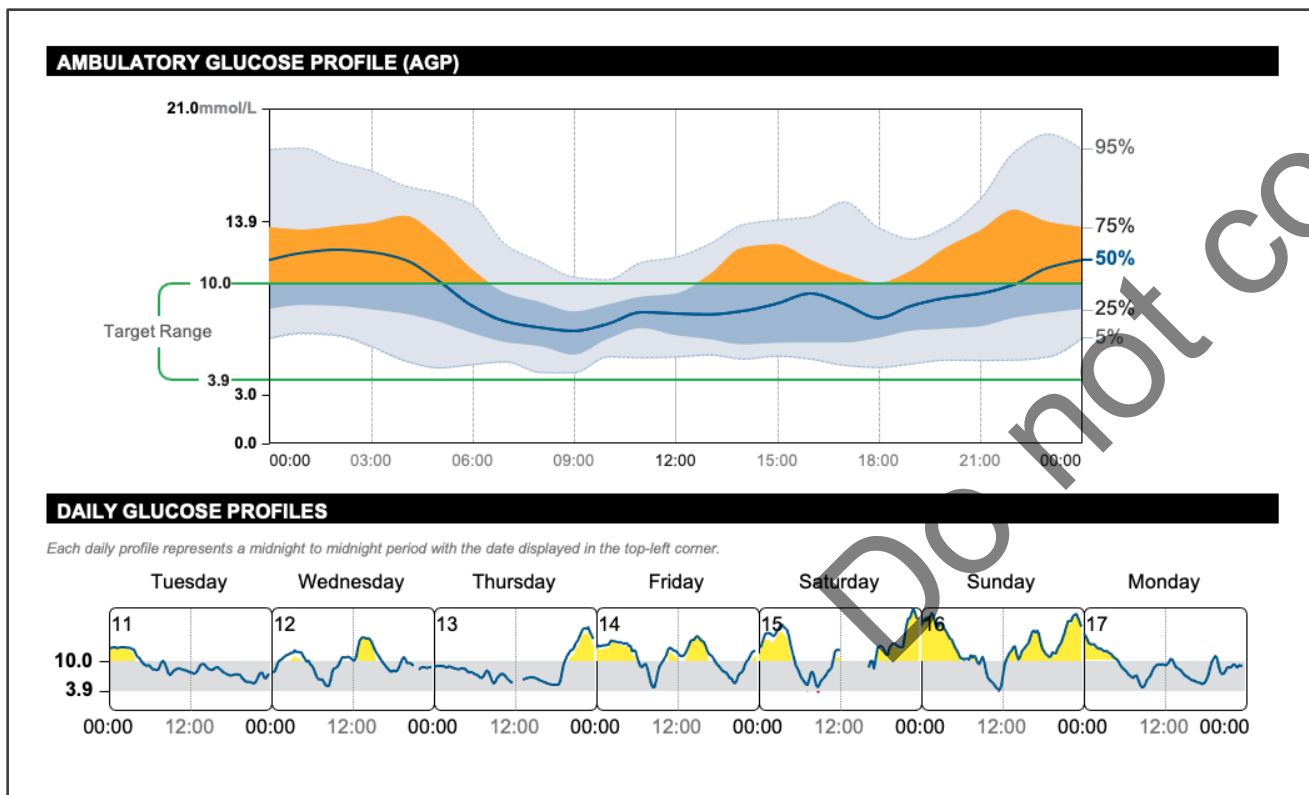
Images are for illustrative purposes only. Not real patient data.

*Guidelines recommend spending at least 70% of Time in Range (3.9 –10.0 mmol/L) for adults with Type 1 and Type 2 diabetes who are not pregnant, not older, or at risk.

1. Battelino T, et al. Diabetes Care 2019; 42:1593-1603 doi:10.2337/dci19-0028.

Secondly look for patterns of hyperglycaemia

Is any of the IQR Band above the target range?



What time of day is hyperglycaemia occurring?

- Is it after meals/throughout the night/dawn phenomenon?

Investigate causes of high glucose

Discuss with your patient possible causes:

Food intake

- Meal size and carbohydrate content
- Snacking
- Over-correcting hypoglycaemia

Medication/insulin

- Timing and dose
- Missed insulin or diabetes medication

Lifestyle and behaviours

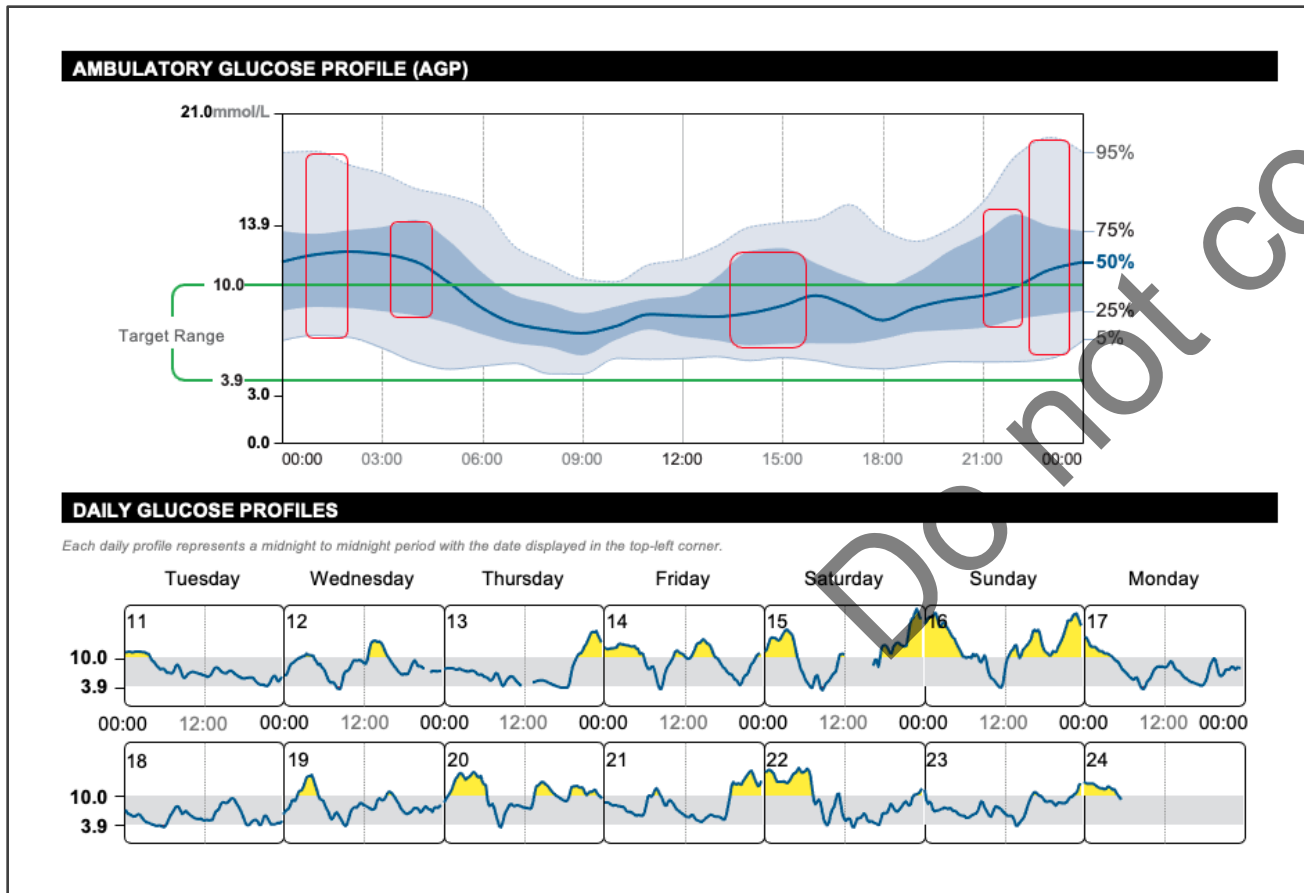
- Illness/stress
- Activity/daily routine

Confirm with the daily glucose profiles

- Is there a post-prandial spike?
- Does hyperglycaemia occur after hypoglycaemia?

Finally look for glucose variability

Look for a wider dark blue and grey outer band.



Images are for illustrative purposes only. Not real patient data.

What time of day are the bands widest?

Investigate causes of glucose variability

Talk to your patient and discuss what is changing from one day to the next around:

Insulin/oral medication

- Timing/dose
- Injection sites/technique

Food intake – erratic eating habits

- Missed meals
- Size/type of meals
- Snacking between meals

Lifestyle related

- Activity/alcohol/sleep/stress/routine

Confirm with the daily glucose profiles

- Look for a good day and review what is happening on that day.
- How do week/work/active days differ from weekends?

When you see high or low glucose, use the shaded bands to guide you to the cause.

A narrow darker blue band indicates a trend that is happening consistently each day, so consider medication and mealtimes.

wider blue or outer grey band reflects glucose variation for distinct reasons on different days, focus on aspects of behaviour or lifestyle such as a missed insulin injection, periodic exercise, social events or illness.

In discussion with the individual, the daily logs can provide insights into possible times and activities that have contributed to the variability shown in the AGP.

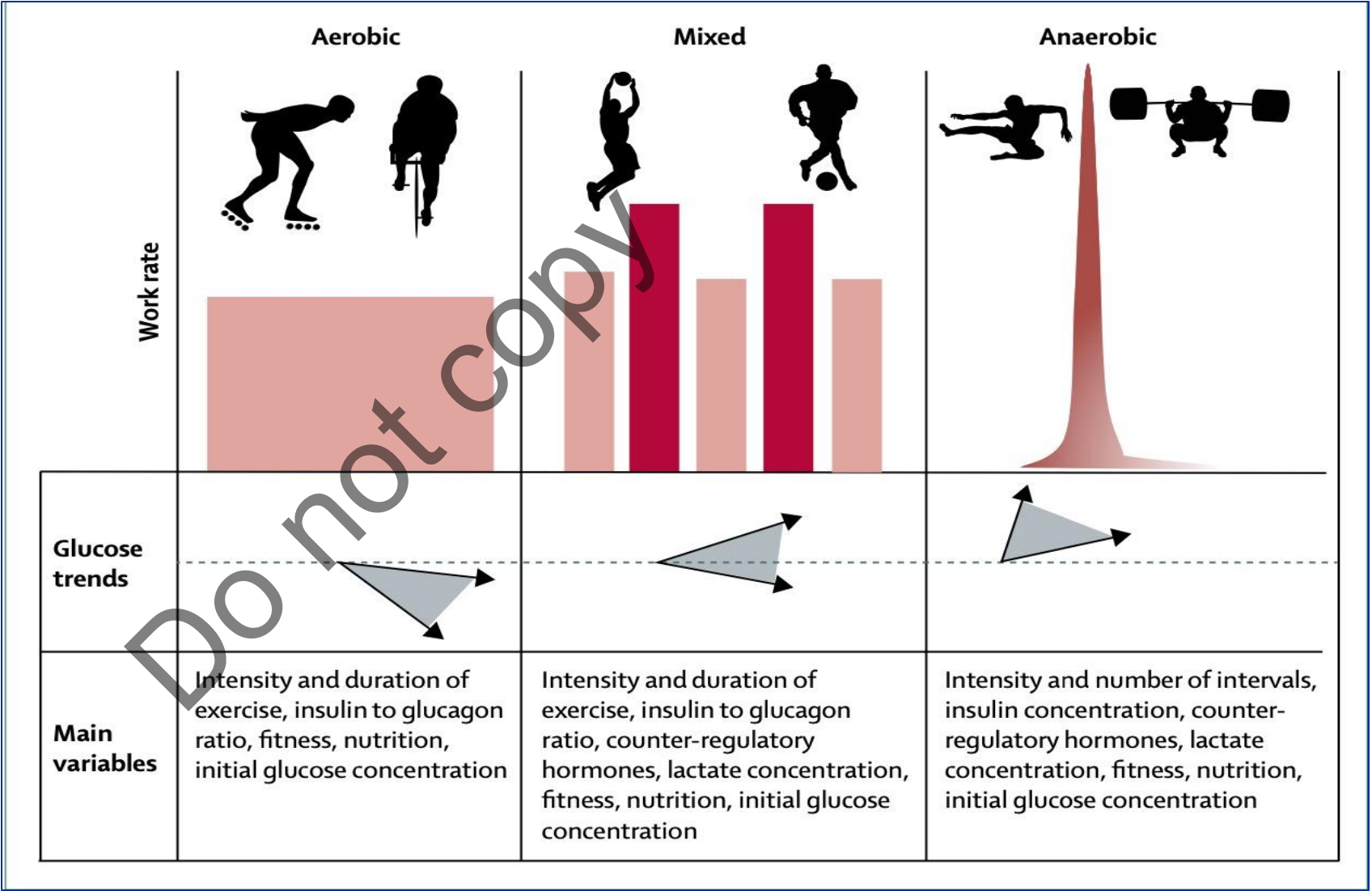


Exploring exercise

exercise takes many forms, and the type and duration can have very different effects on glucose levels

- explore exercise patterns
- explore regular exercise types
- explore how they deal with unplanned exercise and what form this took
- explore how effective previous attempts to manage exercise have been

Variability in blood glucose responses to different types of exercise





exploring diet

- explore their understanding and ability to calculate carbohydrates
- explore the timing of insulin to meal
- explore their dose ratios
- explore their snacking habits and if doses are given at the time
- explore their hypo treatment
- is problem with just one meal or all meals?

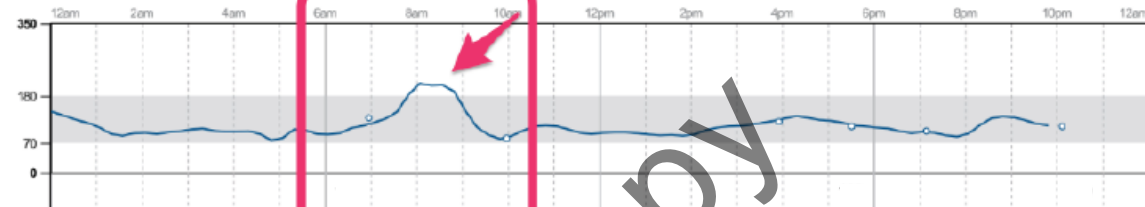
Daily Log

November 21, 2018 - December 4, 2018 (14 Days)

LibreView

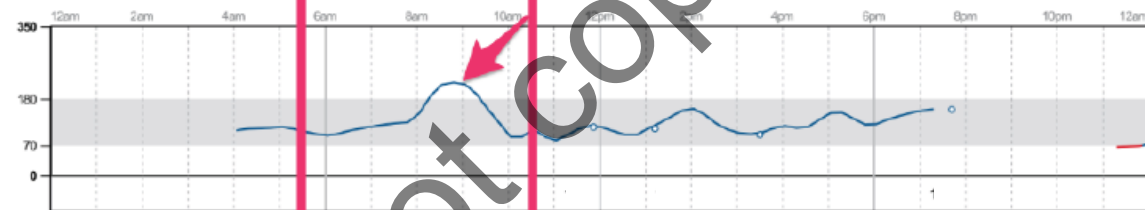
WED Nov 21

Glucose mg/dL



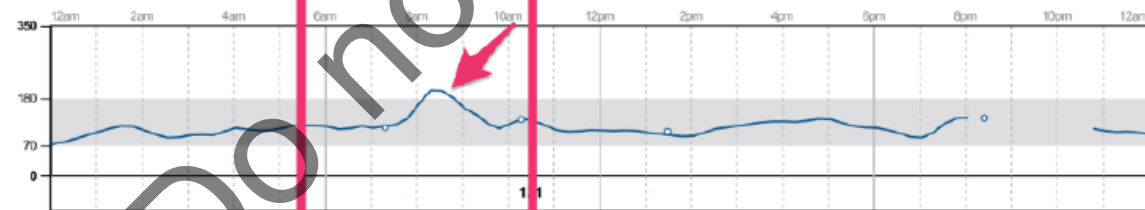
THU Nov 22

Glucose mg/dL



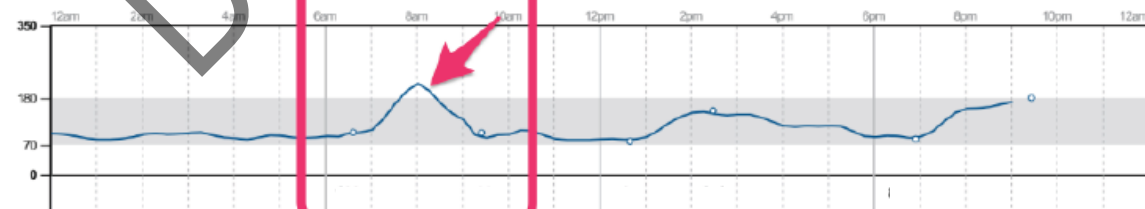
FRI Nov 23

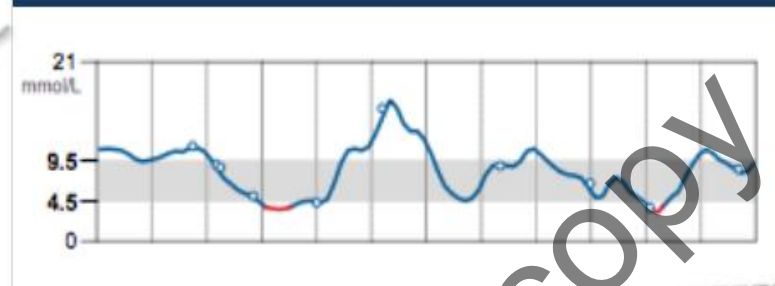
Glucose mg/dL



SAT Nov 24

Glucose mg/dL





Explore hypo treatment and reactions to high glucose readings

Progress your support for patients: utilising downloads more effectively

All information is important

Having access to equipment
alone is not likely to benefit
without the whole picture
and education to effectively
use it

glucose

insulin

food

exercise

exploring insulin overlays: insulin use, stacking and benefits of insulin overlays to data on AGP



explore insulin date/storage/sites



explore use of correction doses



explore the chasing the arrows with top ups



explore their awareness of insulin on board and insulin time profiles

Case Study

Do not copy

GLUCOSE STATISTICS AND TARGETS

24 March 2023 - 6 April 2023

14 Days

Time sensor active:

96%

Ranges And Targets For

Type 1 or Type 2 Diabetes

Glucose Ranges	Targets % of Readings (Time/Day)
Target Range 3.9-10.0 mmol/L	Greater than 70% (16h 48min)
Below 3.9 mmol/L	Less than 4% (58min)
Below 3.0 mmol/L	Less than 1% (14min)
Above 10.0 mmol/L	Less than 25% (6h)
Above 13.9 mmol/L	Less than 5% (1h 12min)

Each 5% increase in time in range (3.9-10.0 mmol/L) is clinically beneficial.

Average Glucose

9.1 mmol/L

Glucose Management Indicator (GMI)

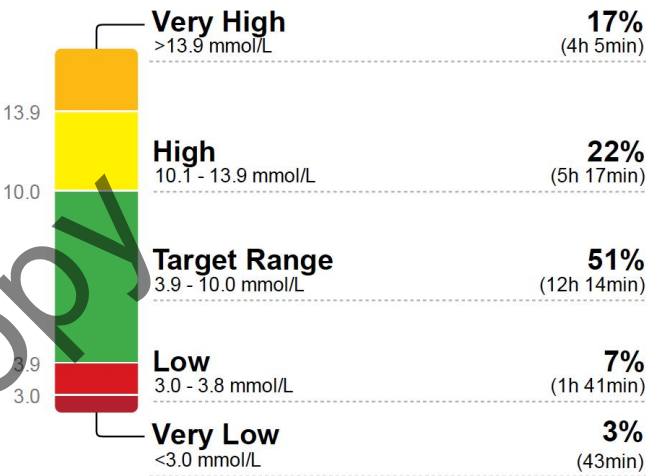
7.2% or 56 mmol/mol

Glucose Variability

49.9%

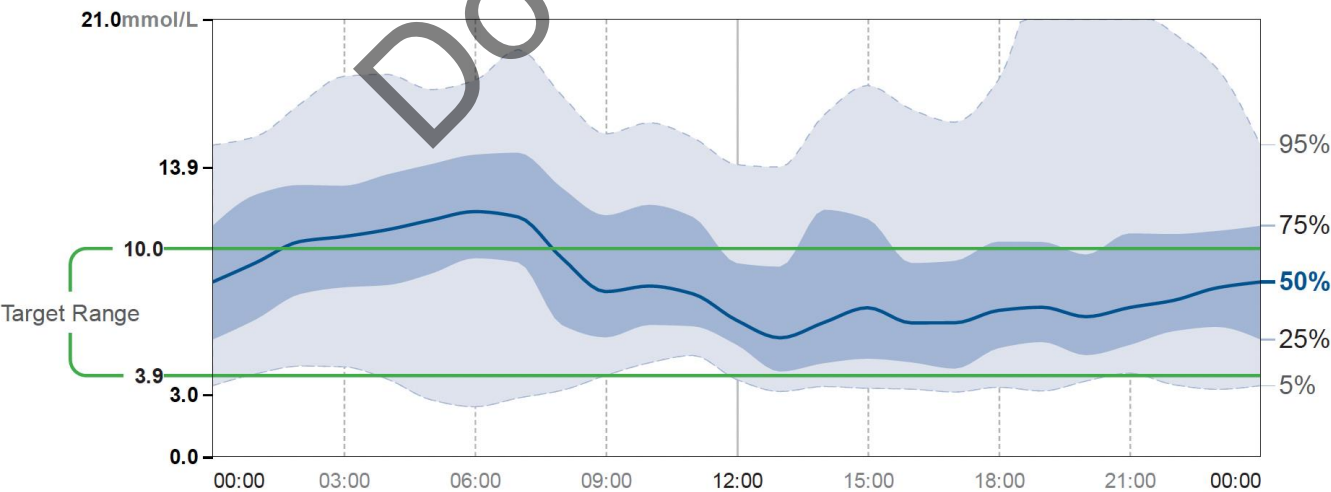
Defined as percent coefficient of variation (%CV)

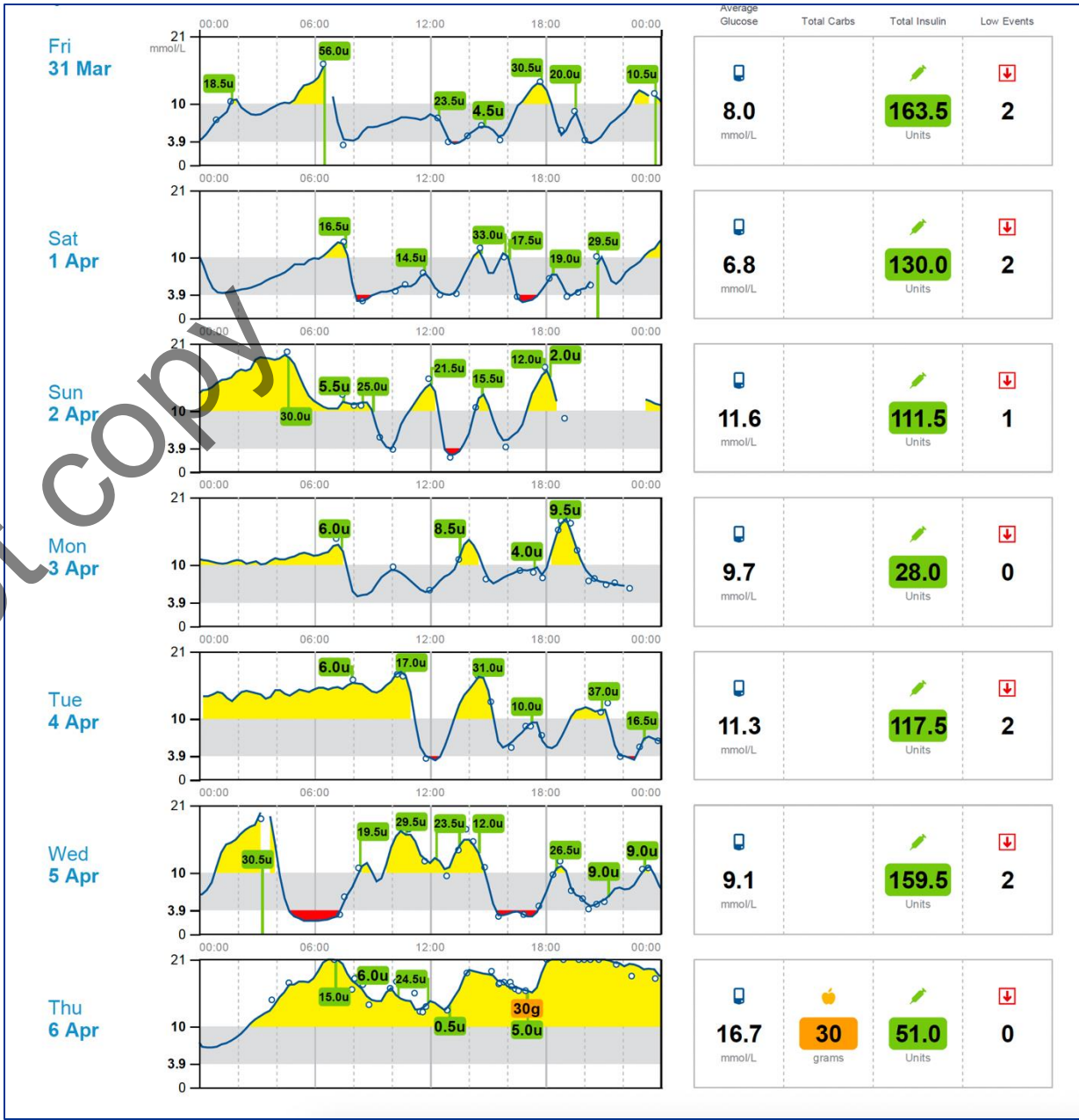
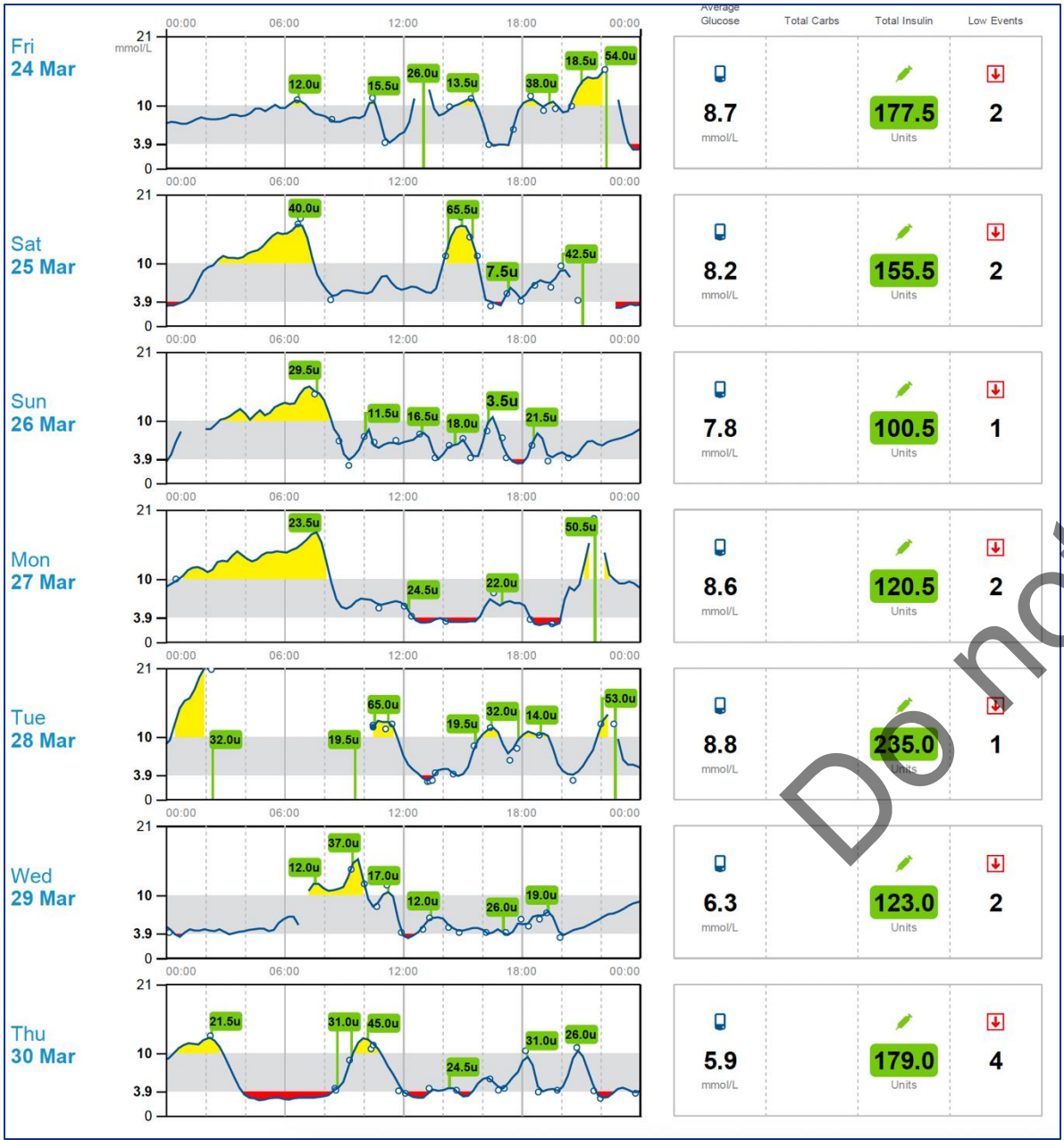
TIME IN RANGES



AMBULATORY GLUCOSE PROFILE (AGP)

AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.





clinical case

65yr lady with type 2 diabetes (2005)

Retinopathy since 2021 (R1M0 both eyes)

ACR 14.6mg/mmol (raised since 2021) eGFR 84ml/min

Hypertension (controlled on triple therapy)

most recent HbA1c 68mmol/mol

BMI 34kg/m²

Current concern – fear of hypos, erratic glucose levels

Current diabetes meds –
Humalog Mix 25 insulin twice daily
(40 units am and 44 units pm)
Metformin 1g twice daily
Dapagliflozin 10mgs daily

GLUCOSE STATISTICS AND TARGETS

6 January 2024 - 19 January 2024

14 Days

Time sensor active:

90%

Ranges And Targets For

Type 1 or Type 2 Diabetes

Glucose Ranges	Targets % of Readings (Time/Day)
Target Range 3.9-10.0 mmol/L	Greater than 70% (16h 48min)
Below 3.9 mmol/L	Less than 4% (58min)
Below 3.0 mmol/L	Less than 1% (14min)
Above 10.0 mmol/L	Less than 25% (6h)
Above 13.9 mmol/L	Less than 5% (1h 12min)

Each 5% increase in time in range (3.9-10.0 mmol/L) is clinically beneficial.

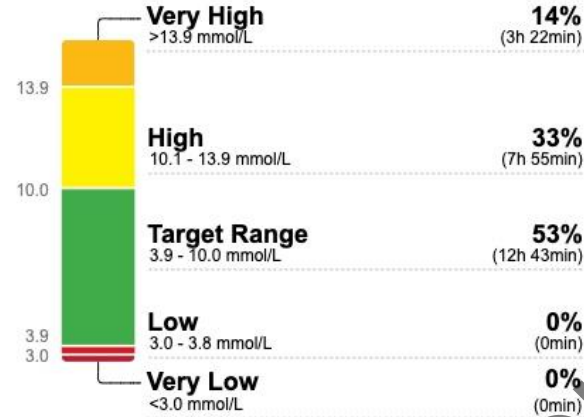
Average Glucose 10.2 mmol/L

Glucose Management Indicator (GMI) 7.7% or 61 mmol/mol

Glucose Variability 31.3%

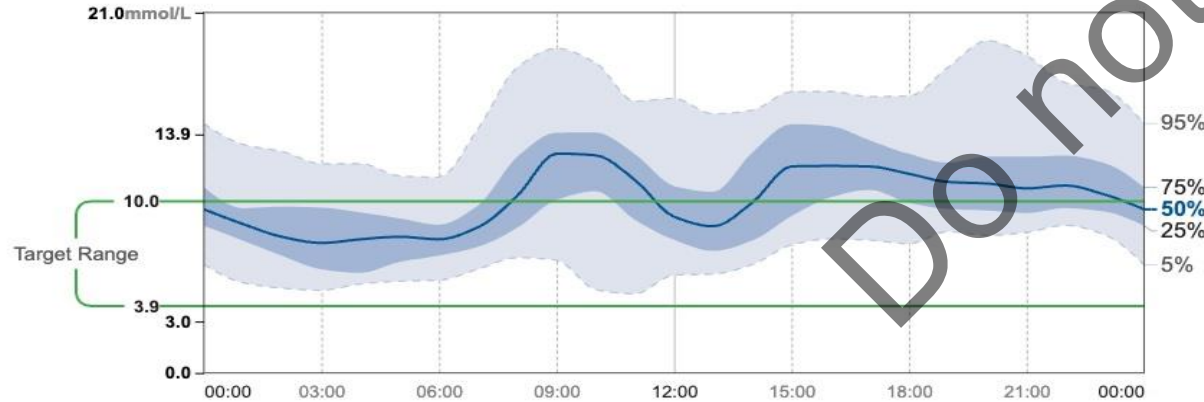
Defined as percent coefficient of variation (%CV); target ≤36%

TIME IN RANGES



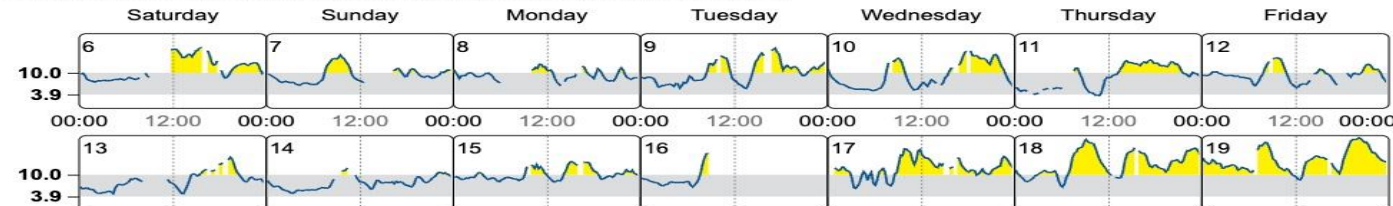
AMBULATORY GLUCOSE PROFILE (AGP)

AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.



DAILY GLUCOSE PROFILES

Each daily profile represents a midnight to midnight period with the date displayed in the top-left corner.



Visit 1

- Is there adequate data to review here?
- What do you consider her greatest risk to be?
 - a) Hyperglycaemia
 - b) Hypoglycaemia
 - c) Glucose Variability
- What advice around insulin (if any) would you offer?
- How would you use this data in her consultation?
- Is there anything else you'd like to know?

GLUCOSE STATISTICS AND TARGETS

15 May 2024 - 28 May 2024

14 Days

Time sensor active:

99%

Ranges And Targets For

Type 1 or Type 2 Diabetes

Glucose Ranges	Targets % of Readings (Time/Day)
Target Range 3.9-10.0 mmol/L	Greater than 70% (16h 48min)
Below 3.9 mmol/L	Less than 4% (58min)
Below 3.0 mmol/L	Less than 1% (14min)
Above 10.0 mmol/L	Less than 25% (6h)
Above 13.9 mmol/L	Less than 5% (1h 12min)

Each 5% increase in time in range (3.9-10.0 mmol/L) is clinically beneficial.

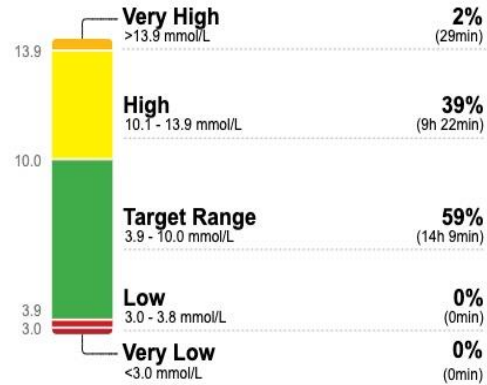
Average Glucose 9.4 mmol/L

Glucose Management Indicator (GMI) 7.4% or 57 mmol/mol

Glucose Variability 26.0%

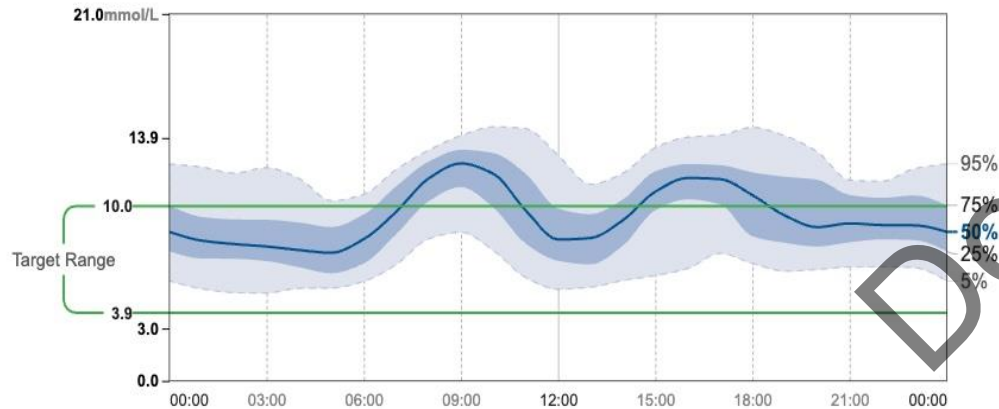
Defined as percent coefficient of variation (%CV); target ≤36%

TIME IN RANGES



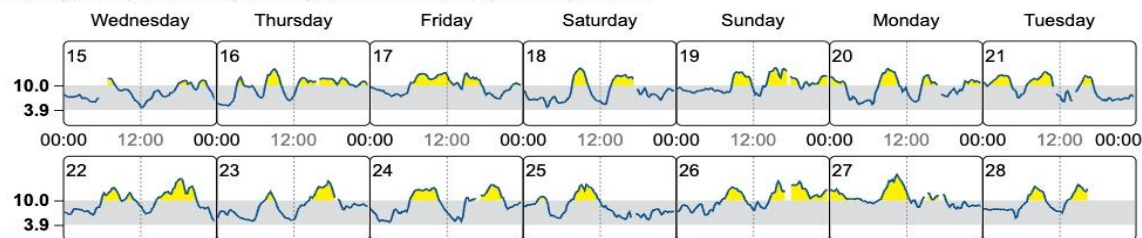
AMBULATORY GLUCOSE PROFILE (AGP)

AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.



DAILY GLUCOSE PROFILES

Each daily profile represents a midnight to midnight period with the date displayed in the top-left corner.



Visit 2 -now on basal bolus

Abasaglar 56 units daily

Humalog 6-8 units with meals

- Is there adequate data to review here?
- What do you consider her greatest risk to be?
 - a) Hyperglycaemia
 - b) Hypoglycaemia
 - c) Glucose Variability
- What advice around insulin (if any) would you offer?
- How would you use this data in her consultation?
- Is there anything else you'd like to know?

Key take home messages

Be familiar with the insulins you use often



Titrate to target without inducing hypoglycaemia



Injection technique and sites are equally as important as the regimen



Become familiar with AGP interpretation

Thank you.



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