

Time in range and CGM data interpretation

What we need to know in Primary Care?

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Do not copy



Disclosures



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

- Astra Zeneca, Abbott, Ascencia, Boehringer Ingelheim, Lilly, Novo Nordisk, Sanofi, Viatris

Disclosures



Nicola Milne

Queen's Nurse | Primary Care DSN | DiAST Lead Brooklands and Northenden PCN | Diabetes Specialist Nurse
Clinical Lead for Greater Manchester and East Cheshire SCN | Diabetes UK Clinical Champion | Chair Diabetes
UK Professional Conference Organising Committee Liverpool 2019 | Primary Care Diabetes Society
Committee Member | Faculty Member 4FRONT Academy | Diabetes UK Council of Healthcare Professionals
Member | NICE Diabetes Suite Committee Member 2019-2021 | Tutor PG Diabetes Diploma: I-Heed, Warwick
University

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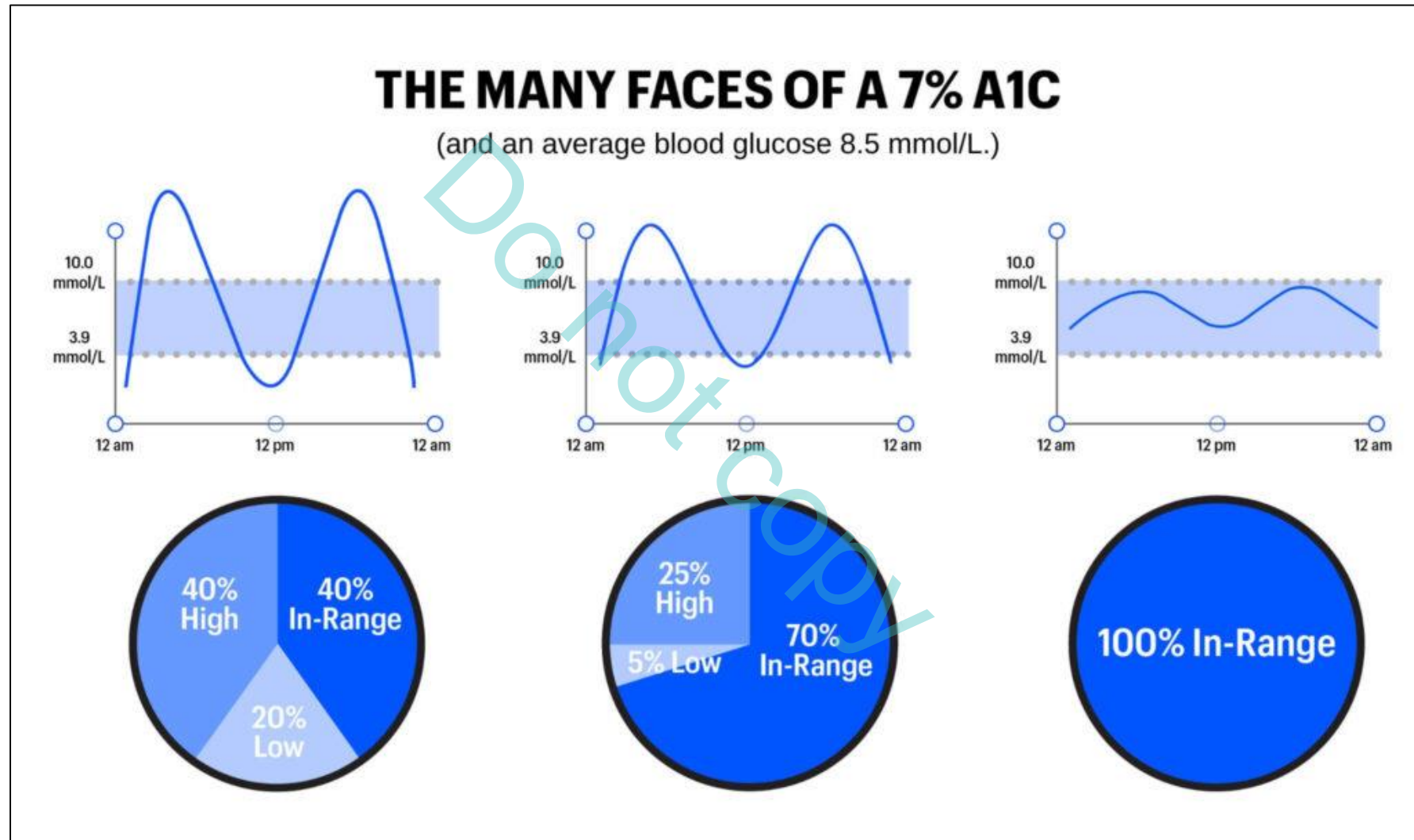
Boehringer Ingelheim, Astra Zeneca, Lilly, MSD, Takeda, Novo Nordisk, Sanofi, Napp, Abbott, MyLan, Roche and Ascensia

For discussion...



- Time in range: The new HbA1c?
- Practicalities of prescribing CGM
- Basic data interpretation
- Useful Resources

Do not be misled by HbA1c



Time in Range

Received: 8 July 2020 | Accepted: 15 October 2020

DOI: 10.1111/dme.14433

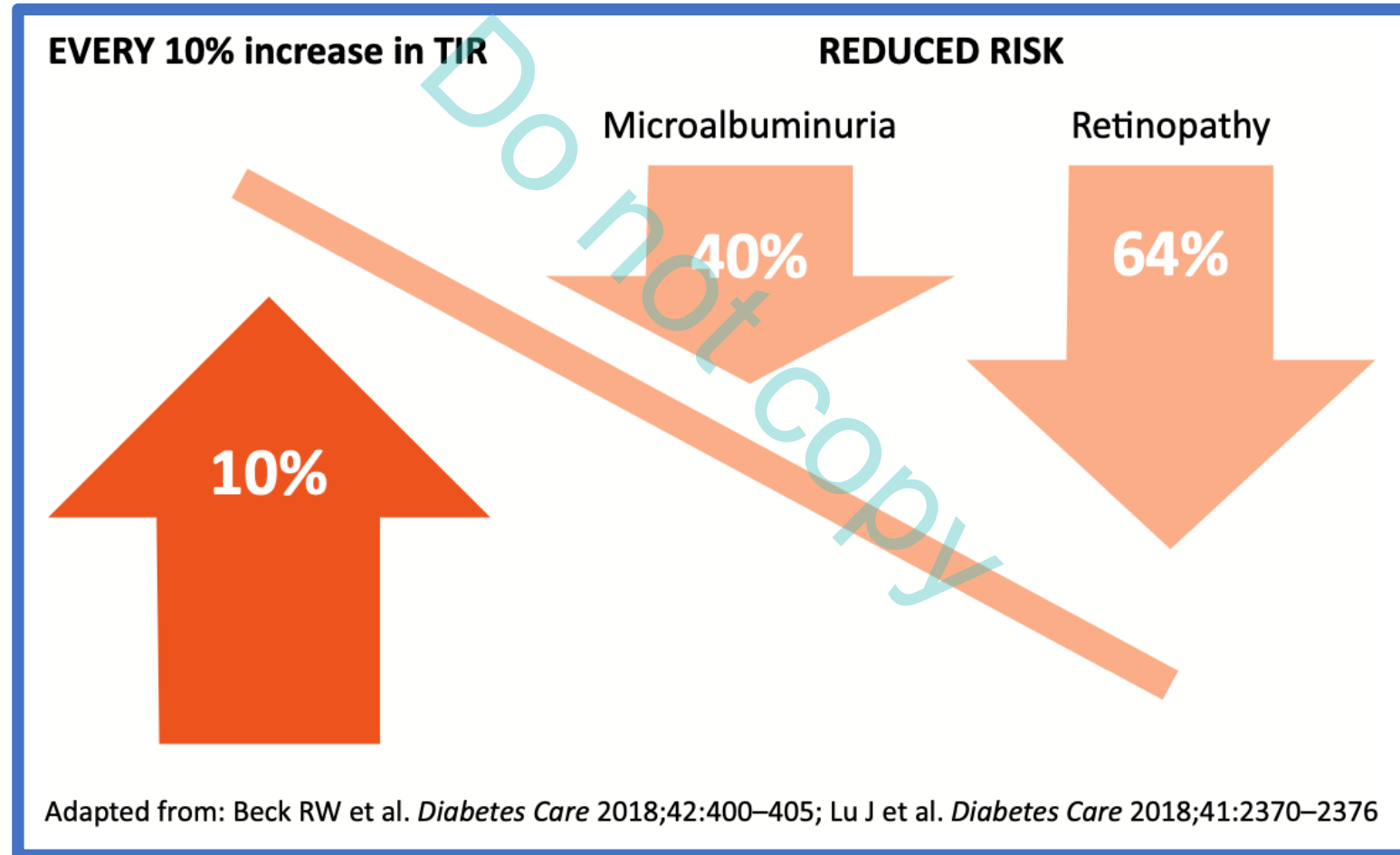
DIABETIC
Medicine

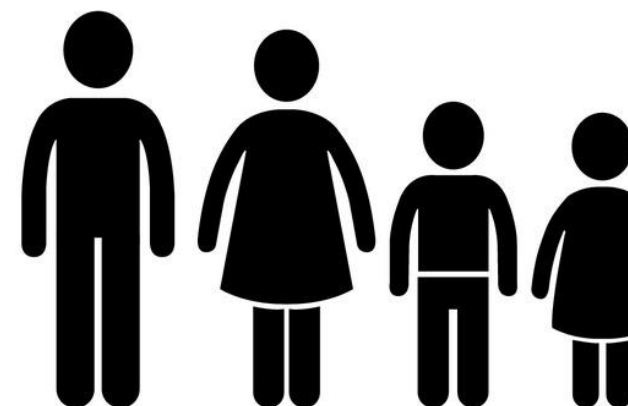
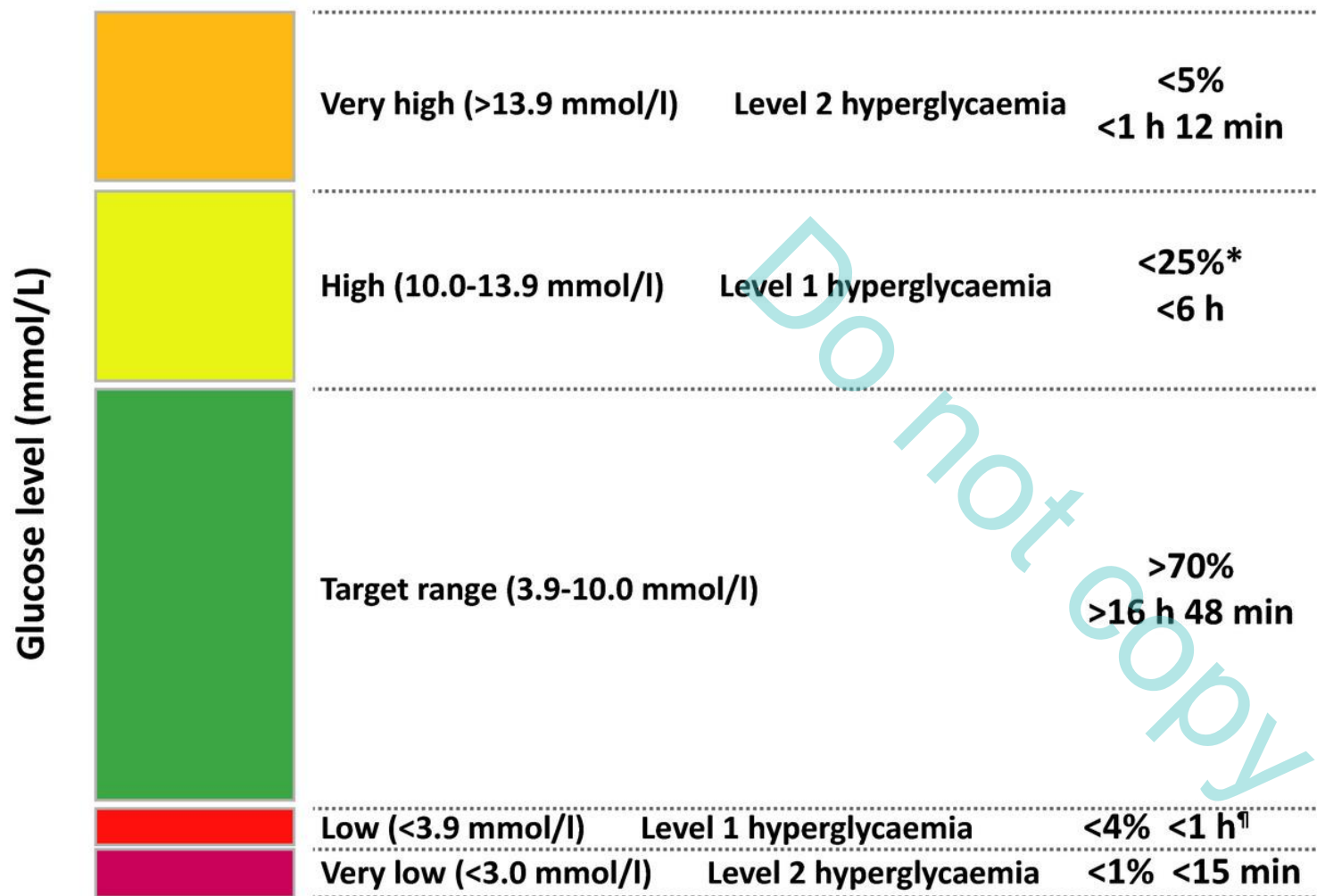
REVIEW ARTICLE

Time in range: A best practice guide for UK diabetes healthcare professionals in the context of the COVID-19 global pandemic

E. G. Wilmot^{1,2} | **A. Lumb^{3,4}** | **P. Hammond⁵** | **H. R. Murphy^{6,7}** | **E. Scott⁸** |
F. W. Gibb^{9,10} | **J. Platts¹¹** | **P. Choudhary^{12,13}**

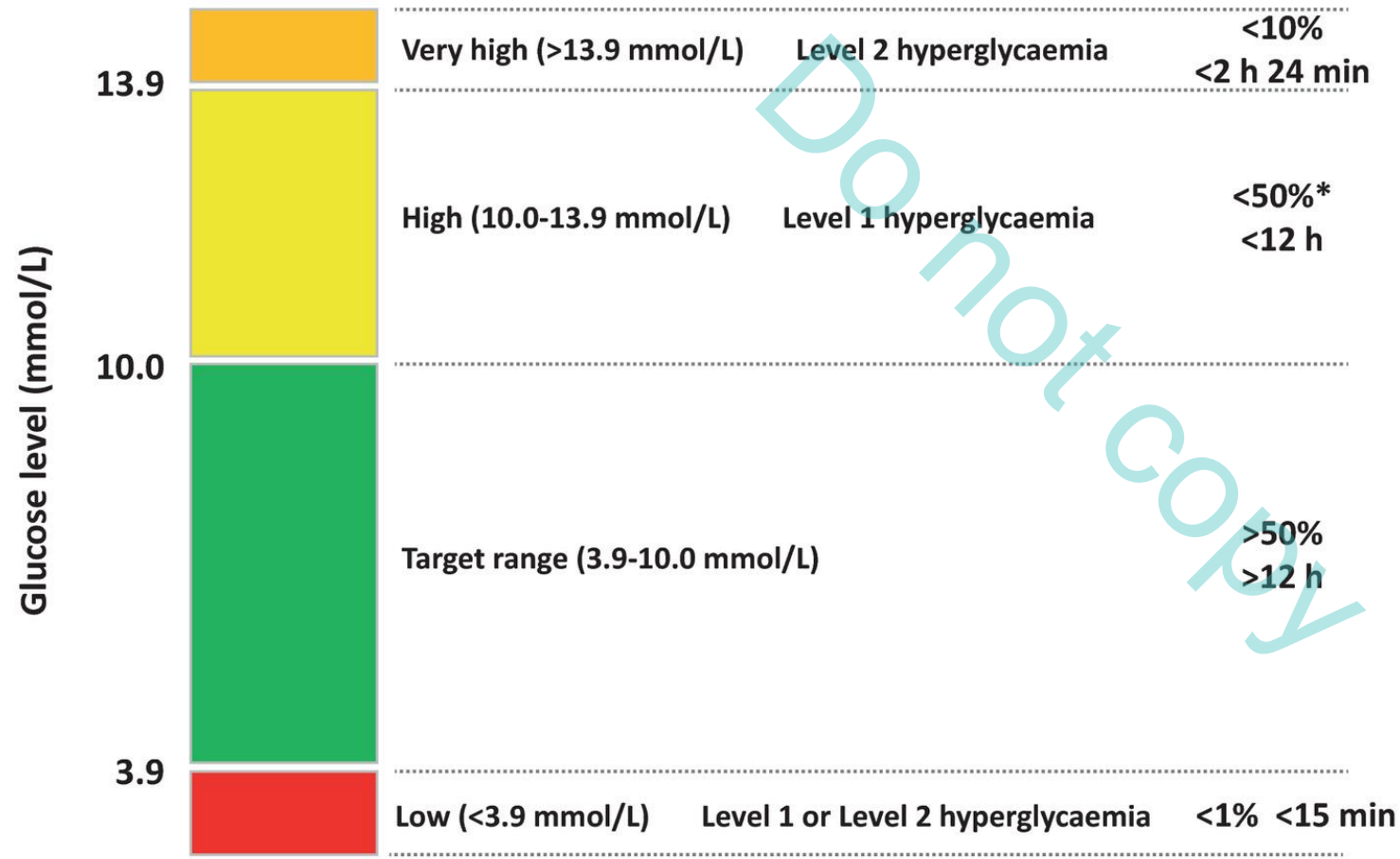
Why Time in Range matters





* Readings >13.9 mmol/l are also included in the <25% target
 Readings <3.0 mmol/l are also included in the <4% target

Time in Range: targets for older people and those at high-risk of hypoglycaemia



Thinking about individualised targets

Emphasise the need to **prioritise hypoglycaemia avoidance**, reducing the 5TBR <3.9 mmol/L

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



[Home](#) > [NICE Guidance](#) > [Conditions and diseases](#) > [Diabetes and other endocrinal, nutritional and metabolic conditions](#) > [Diabetes](#)

Type 1 diabetes in adults: diagnosis and management

NICE guideline [NG17] Published: 26 August 2015 Last updated: 17 August 2022

<https://www.nice.org.uk/guidance/ng28>



[Home](#) > [NICE Guidance](#) > [Conditions and diseases](#) > [Diabetes and other endocrinal, nutritional and metabolic conditions](#) > [Diabetes](#)

Type 2 diabetes in adults: management

NICE guideline [NG28] Published: 02 December 2015 Last updated: 29 June 2022

<https://www.nice.org.uk/guidance/ng17>

Practicalities of prescribing

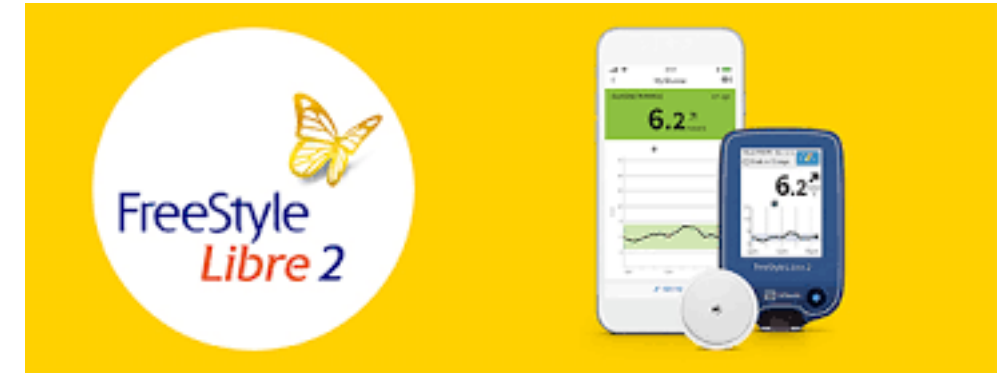
	FreeStyle Libre 2	FreeStyle Libre 3	Dexcom One	Dexcom G6	Dexcom G7	Medtronic G4	GlucoRx AIDEX	Medtrum Touch Care Nano
Real-time CGM	Yes*	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MARD	9.2	7.8	9.0	9.0	8.2	10.6	9.1	9.1
Published accuracy data	Yes (T1 n=133)	Yes (T1 n=83)	Yes (T1 n=260)	Yes (T1 n=260)	Yes (T1 n=257)	Yes	Yes (T1 n=14)	Yes (T1 n=10)
RCT data	Yes	Yes (FSL/FSL2)	Yes (G4/5/6)	Yes	No	No	No	No
Sensor life	14 days	14 days	10 days	10 days	10 days + 12 hr grace period	7 days	14 days	10-14 days
Sensor warm up time	60 mins	60 mins	120 mins	120 mins	30 mins	120 mins	60 mins	60 mins
Separate transmitter	No	No	Yes	Yes	No	Yes	Yes	Yes
Transmitter Life	N/A	N/A	3 months	3 months	N/A	12 months	4 years	12 months
Smartphone app	LibreLink	Libre 3	Dexcom One	Dexcom G6	Dexcom G7	MiniMed	GlucoRx AIDEX	EasySense
Reader available	Yes	No	Yes	Yes	Yes	No	No	Yes
Capillary glucose calibration	No	No	No	No	No	No	No	No
High & low alarms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Predictive alarms	No	No	No	Yes	Yes	Yes	No	Yes
Stand-alone use	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Pump compatibility	No	YpsoPump	No	Tandem T:slim DANA-i YpsoPump Omnipod 5	No	Medtronic 780G	No	Touch Care Nano pump
Closed loop compatibility	No	Yes	No	Yes	No	Yes	No	Yes**
Data share HCP	Libreview	Libreview	Clarity	Clarity	Clarity	CareLink	CGM Viewer	EasyView
Data share friends/family app	LibreLinkUp	LibreLinkUp	N/A	Dexcom Follow	Dexcom Follow	CareLink Connect	GlucoRx AIDEX	EasyFollow
UK approved wearable site	Upper arm	Upper arm	Abdomen Upper arm Buttocks +	Abdomen Upper arm Buttocks +	Abdomen Upper arm Buttocks +	Abdomen Upper arm	Abdomen Upper arm	Abdomen Upper arm

 = available on prescription (FP10)

* 2-17 years old as per manufacturers' guidelines.

**Expected late 2023

Version 5.0 August 2023



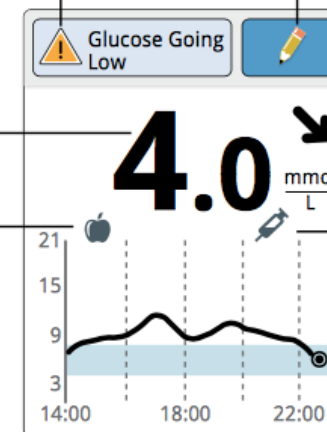
<https://www.diabetesspecialistnurseforumuk.co.uk/whats-new>

Data interpretation-what the person can see instantly

- ↑ Rising quickly
- ↗ Rising
- Changing slowly
- ↘ Falling
- ↓ Falling quickly



Sensor Glucose Readings



Add Notes

Touch to add notes to the glucose reading.

Glucose Trend Arrow

Direction your glucose is going.

Rapid-Acting Insulin Note

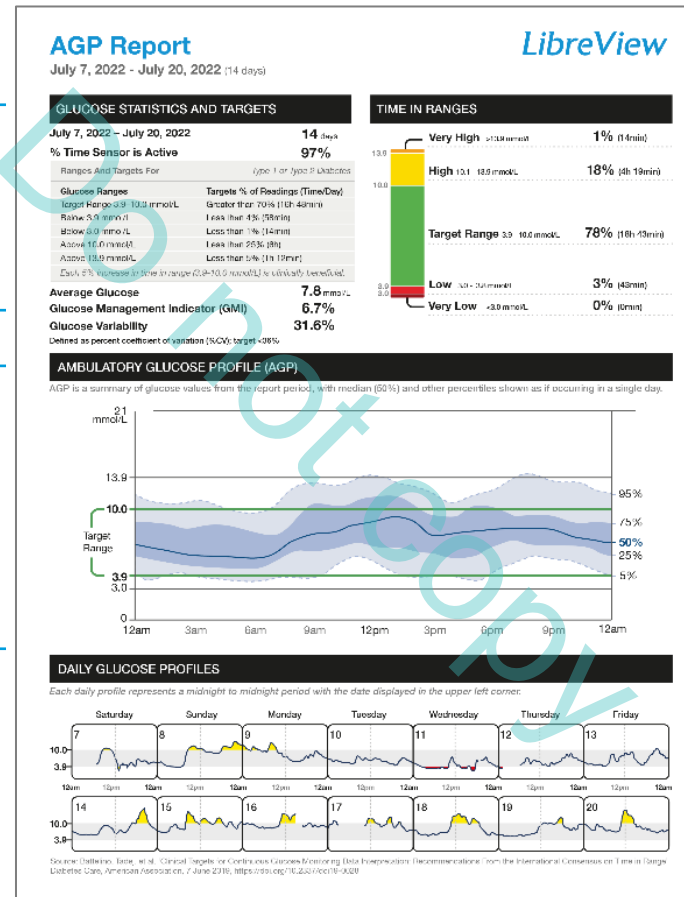
Glucose Graph

Graph of your current and stored glucose readings.

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

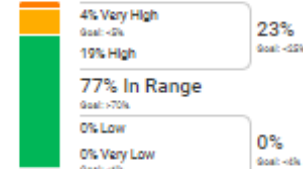
Images are for illustrative purposes only. Not real patient data.

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.

The AGP report – what are we looking for?

Time in Ranges Goals for Type 1 and Type 2 Diabetes

Each 1% increase in the Target Range is clinically beneficial.
Each 1% time in range = about 12 minutes per day



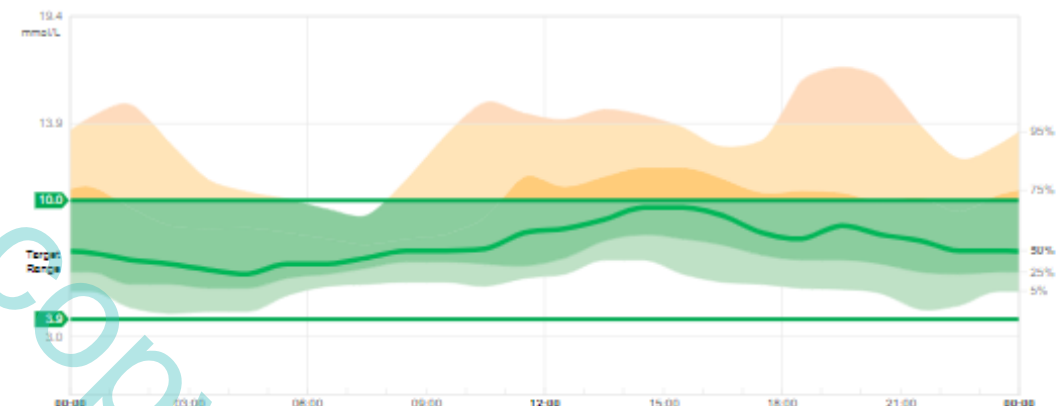
Target Range: 3.9-10.0 mmol/L
Very High: Above 12.0 mmol/L
Very Low: Below 3.0 mmol/L

Glucose Metrics

Average Glucose	8.3 mmol/L
Goal: <8.5 mmol/L	
GMI	6.9%
Goal: <7%	
Coefficient of Variation	30.9%
Goal: <36%	
Time CGM Active	100.0%

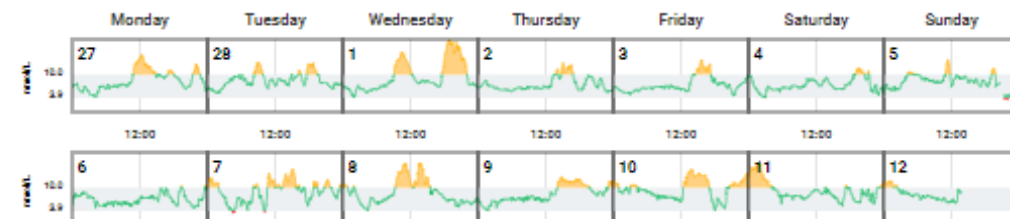
Ambulatory Glucose Profile (AGP)

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

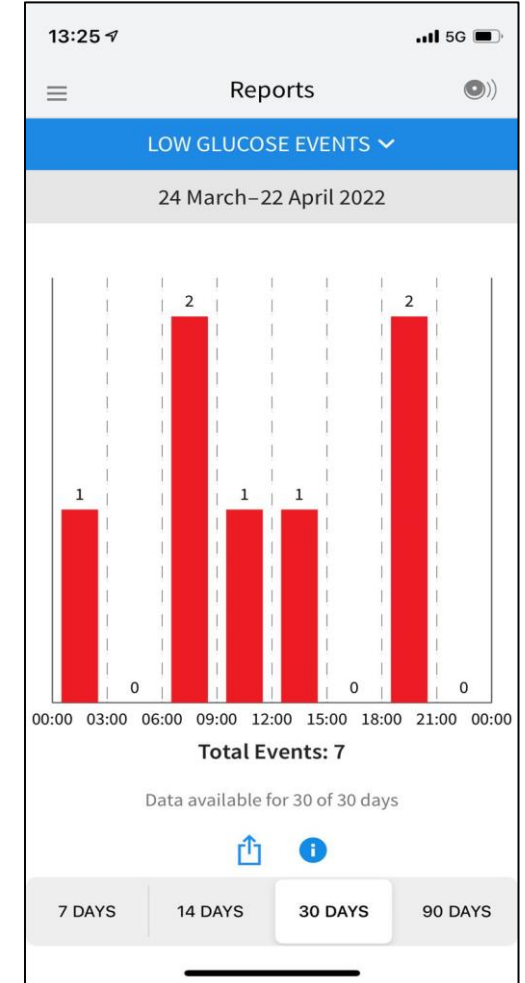
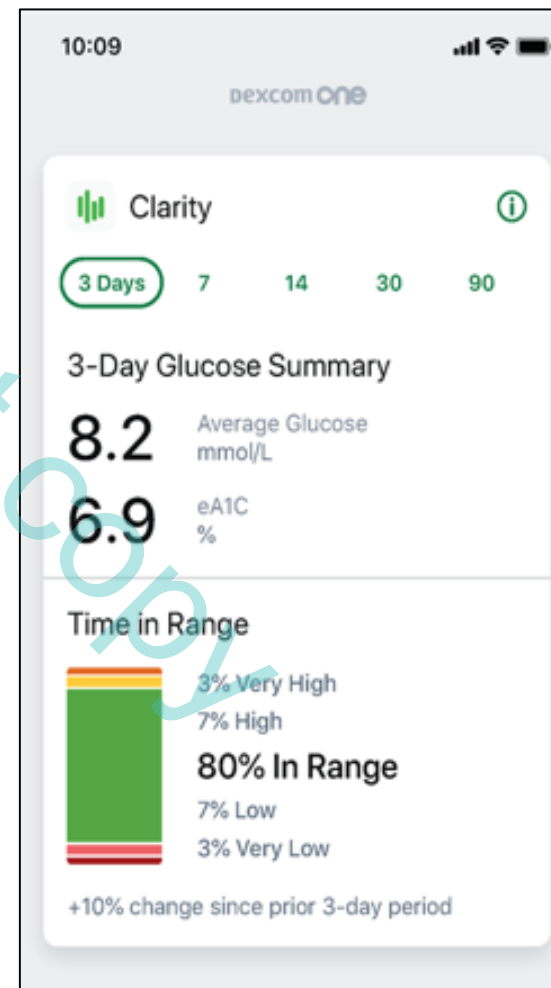
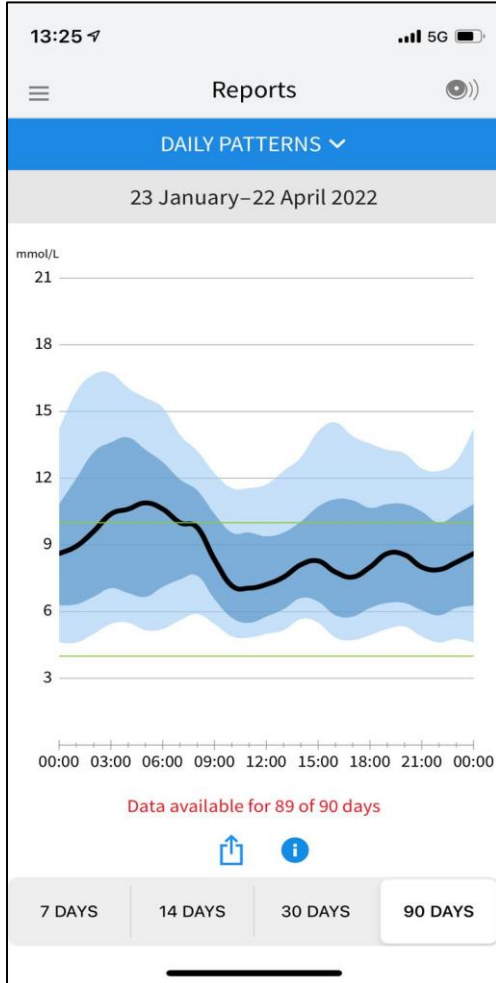


Daily Glucose Profile

Each daily profile represents a midnight-to-midnight period.

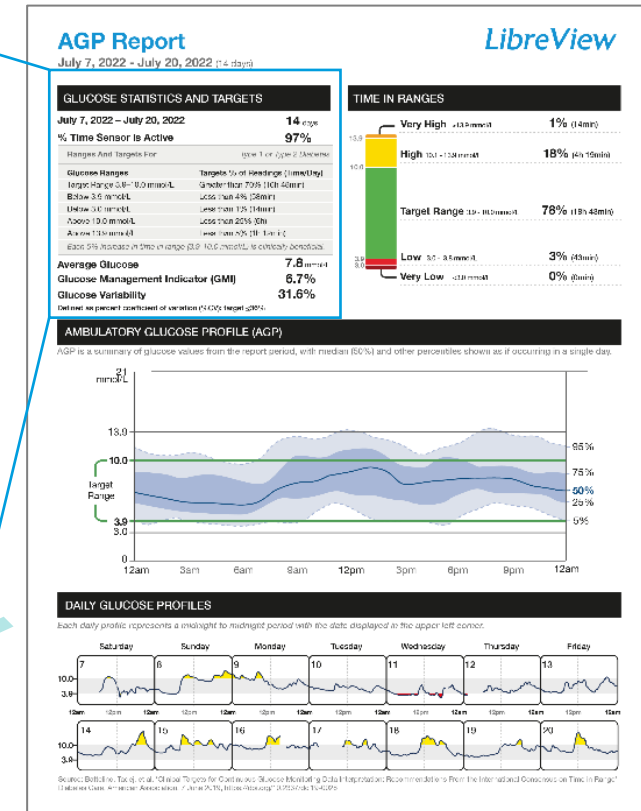
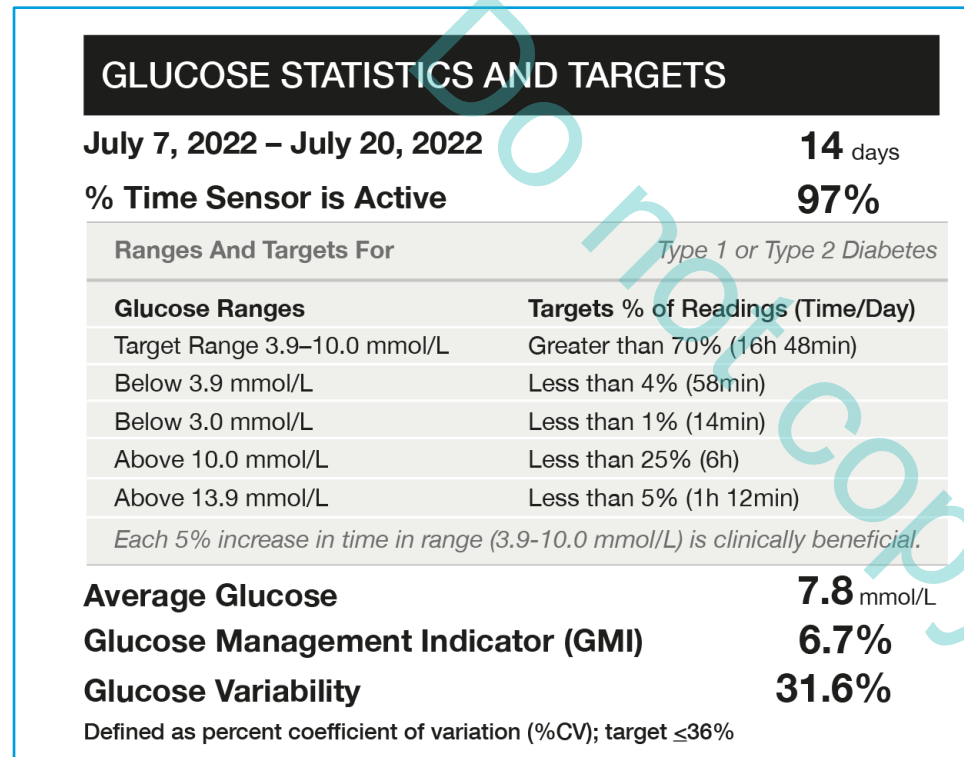


Using the smart devices apps



The AGP report – what are we looking for?

Time in target guidelines and an overview of patient glucose data.



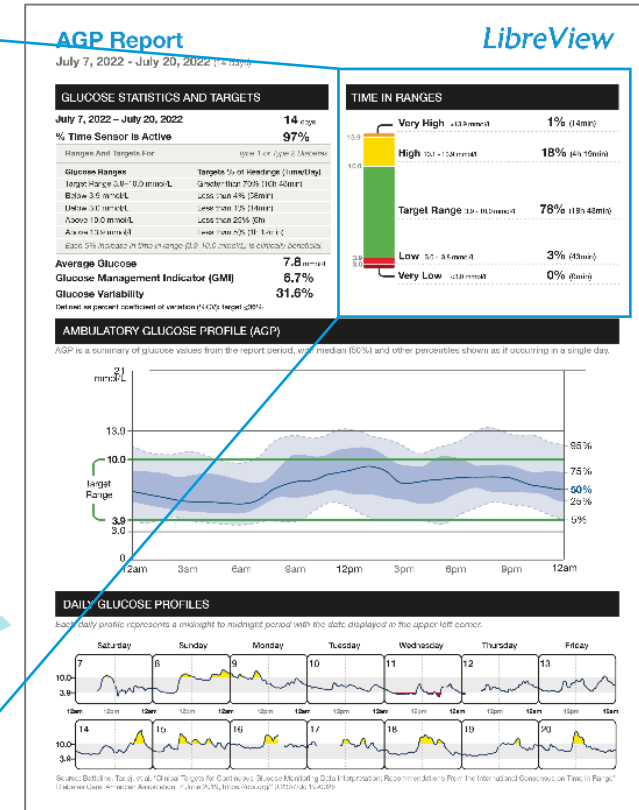
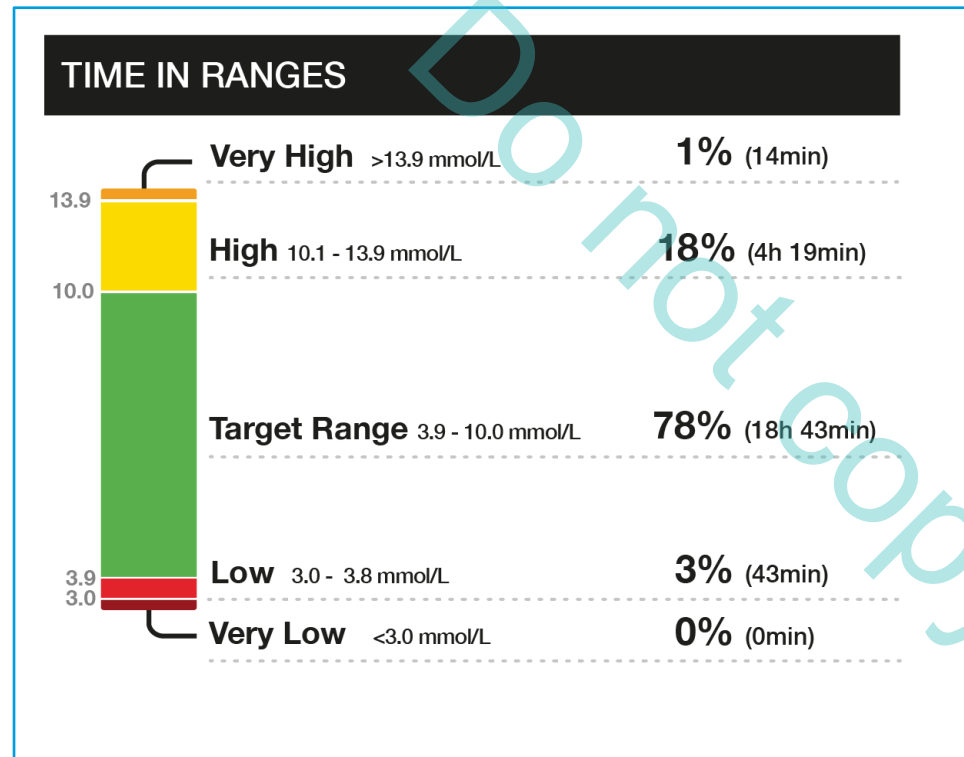
Images are for illustrative purposes only. Not real patient data.

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.

The AGP report – what are we looking for?

Quickly assess your patient's Time in Range, Time below Range and Time above Range.

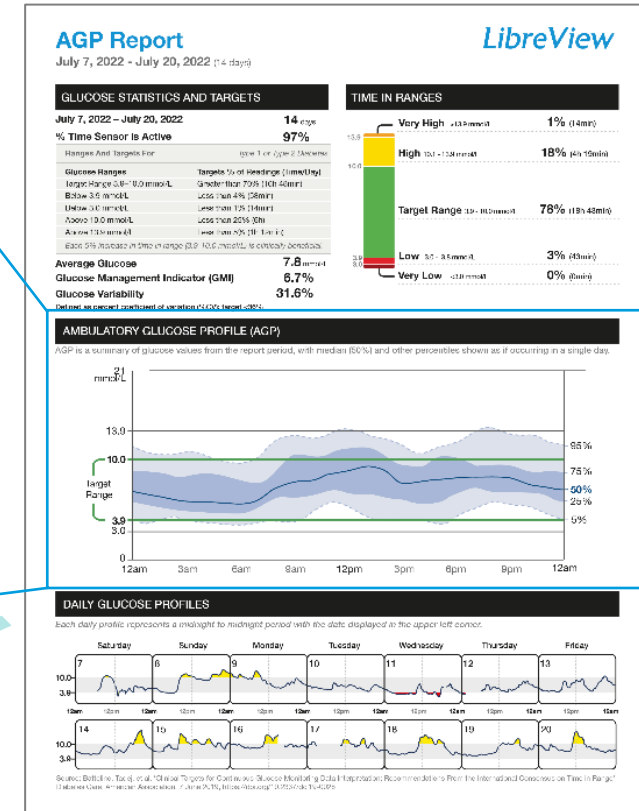
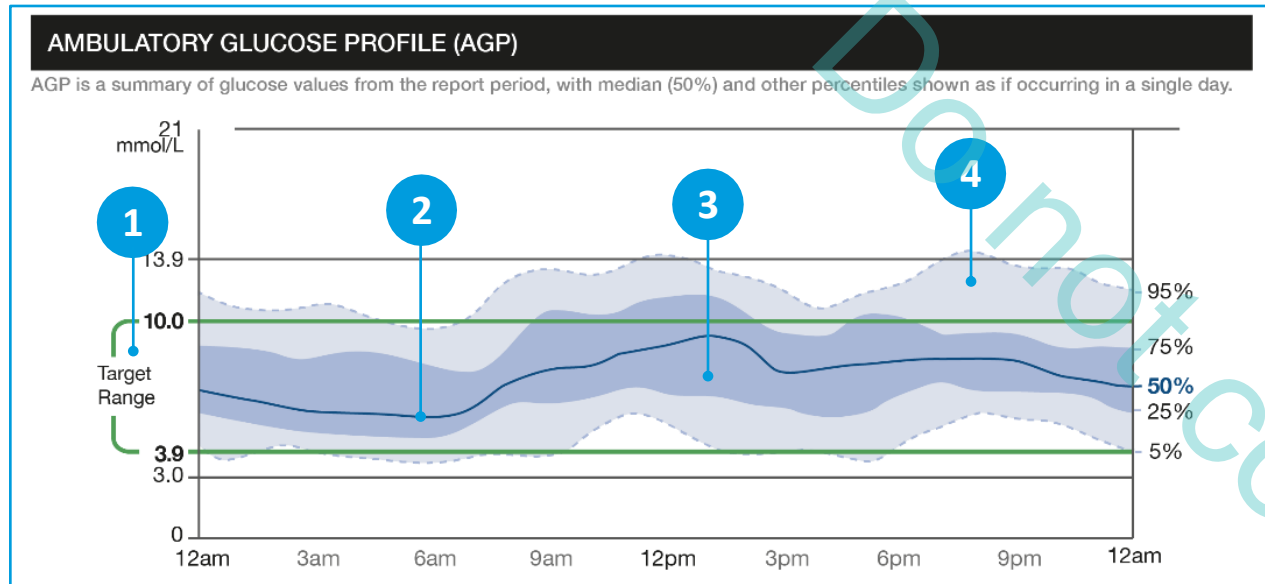
Objective:
More green,
less red



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.

Anatomy of the AGP



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

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

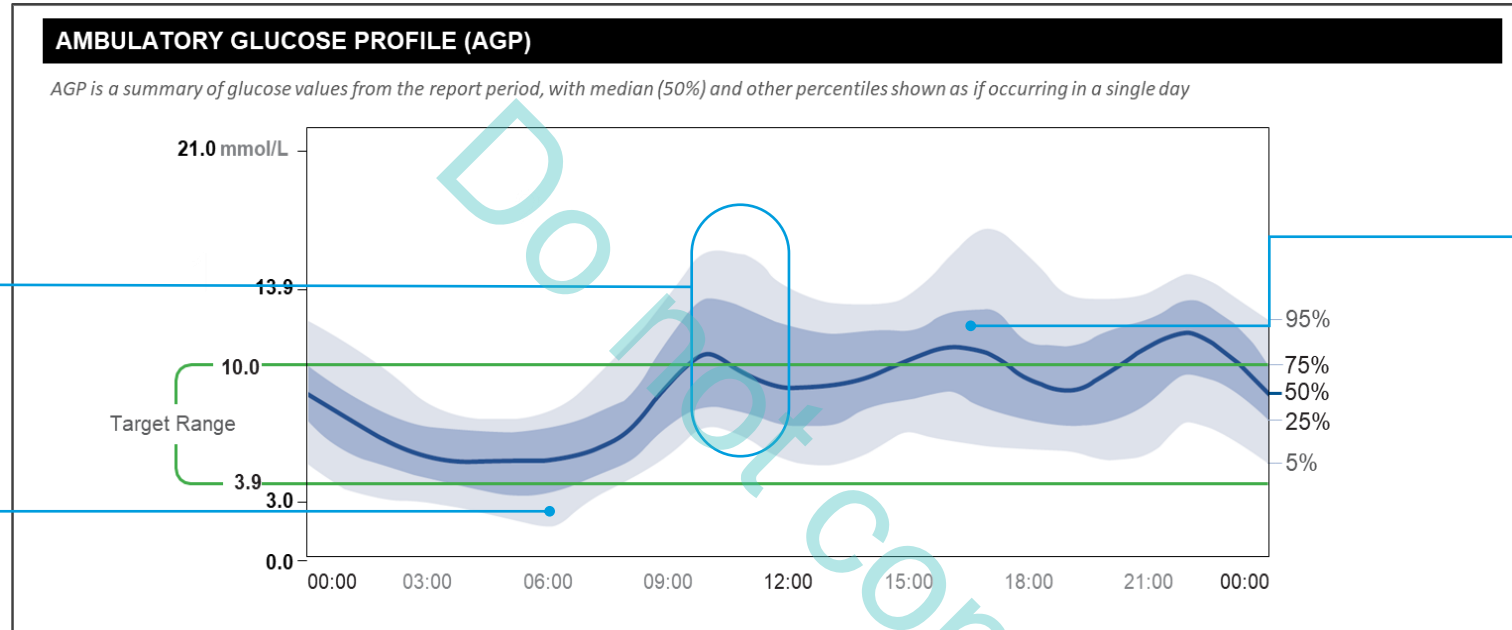
Uncover patterns of hyper- and hypoglycaemia and see glycaemic variability

GLUCOSE VARIABILITY

Examine how glucose levels vary throughout the day

HYPOGLYCAEMIA

Uncover trends to low glucose



HYPERGLYCAEMIA

Identify when patients are above their target glucose range

AGP when used with Time in Range can reveal when patients are out of their target glucose range

AGP goal: Flat, Narrow, In Range (FNIR)

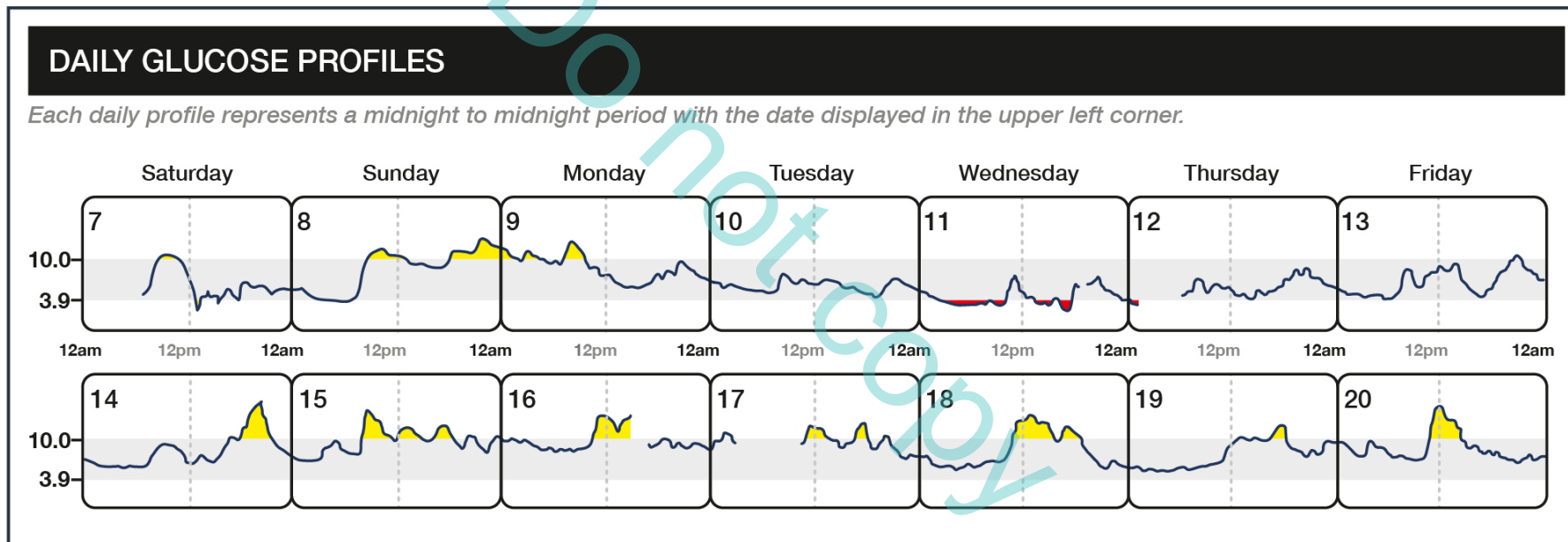
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AGP = ambulatory glucose profile. * The AGP requires a minimum of 5 days of glucose data to generate reports and can use a maximum of 90 days of data.

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

Identify glucose variability at specific times or days

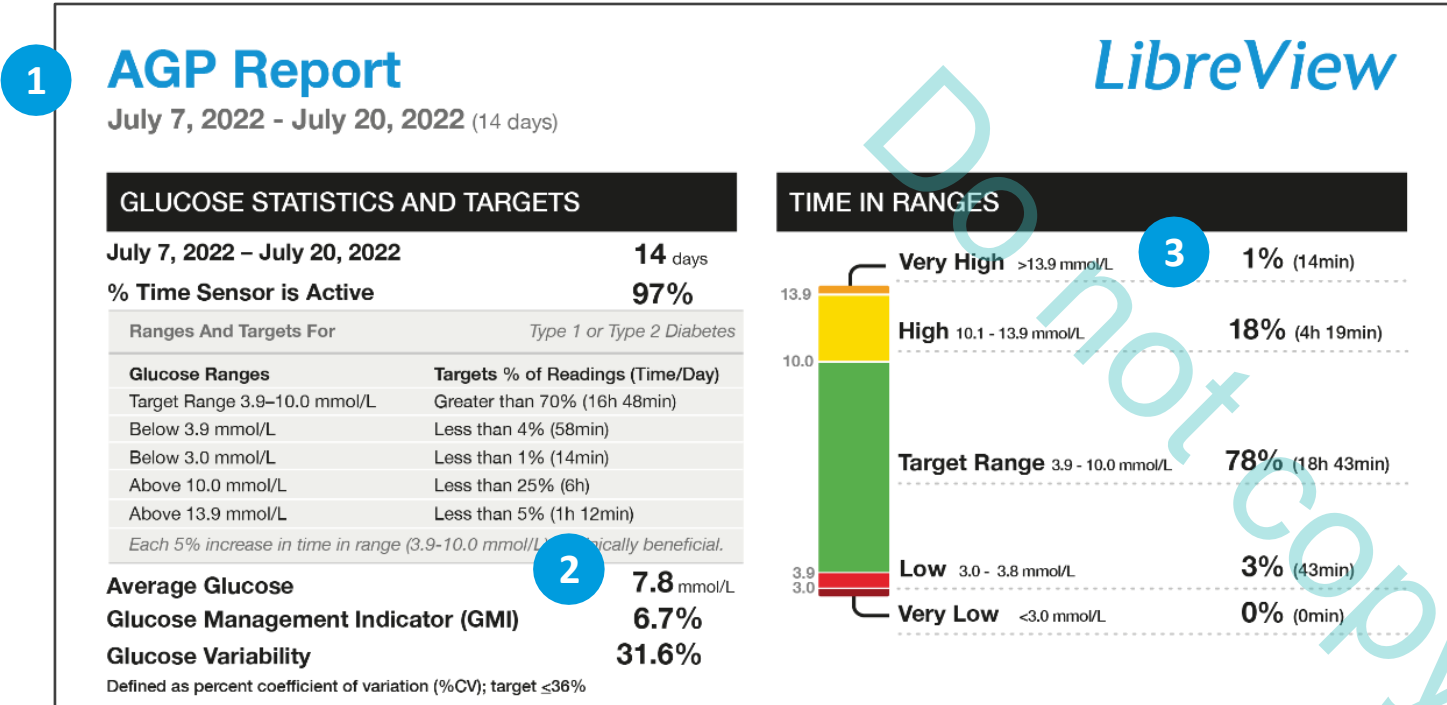
A way for you and your patients to see specific daily glucose activity, which could help identify causes for deviations from Time in Range



Use these daily glucose values profiles to help guide your patients through a clinical and engaging dialogue

Step 1: Validate the data, assess TIR

Look for the positives



1 Validate the data

- Date range
- 14 days data
- > 70% time sensor active

2 Assess key glucose metrics

- GMI
- Glucose variability – target $\leq 36\%$

3 Assess Time in Range*

- %TIR – target > 70%
- %TBR – target < 4%
- %TAR – target < 25%

4 Discuss with the patient

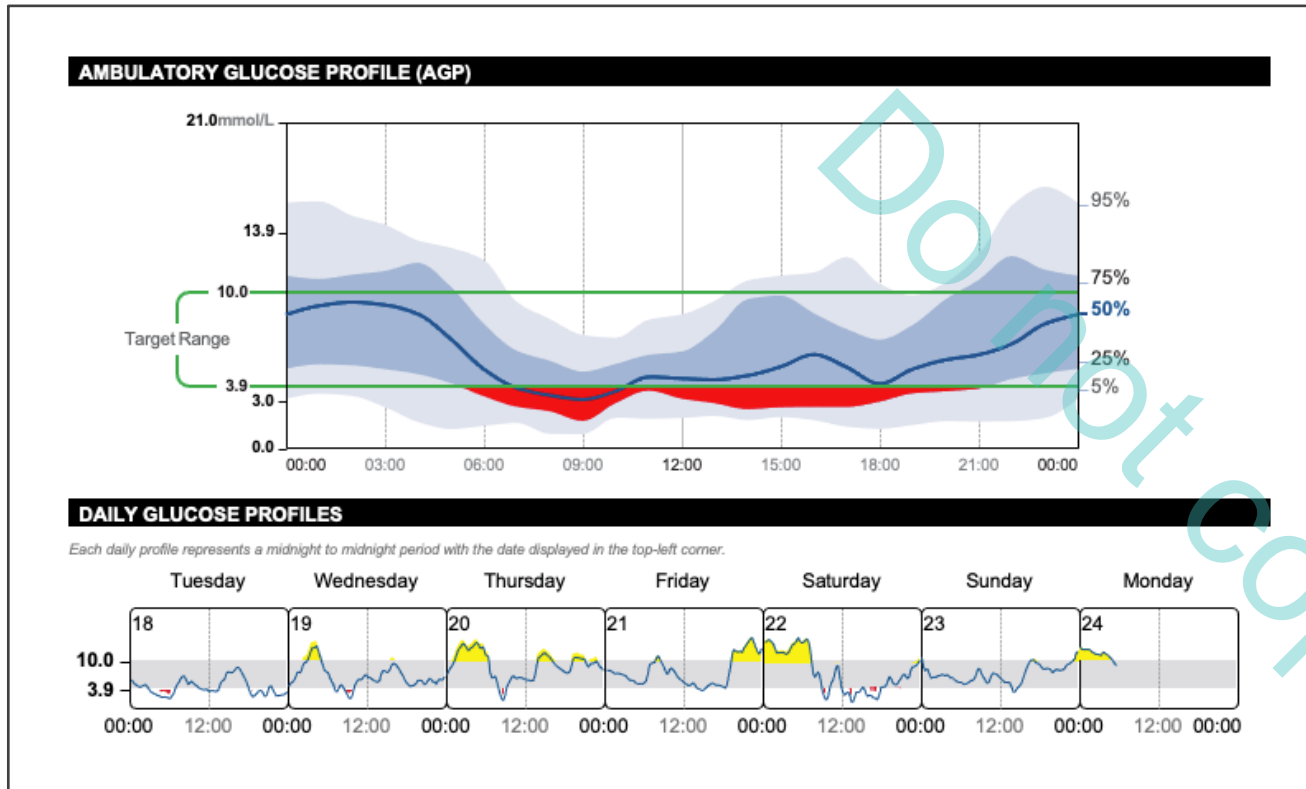
Reinforce positive achievements
before focusing on areas for attention.

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.

Step 2: 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?

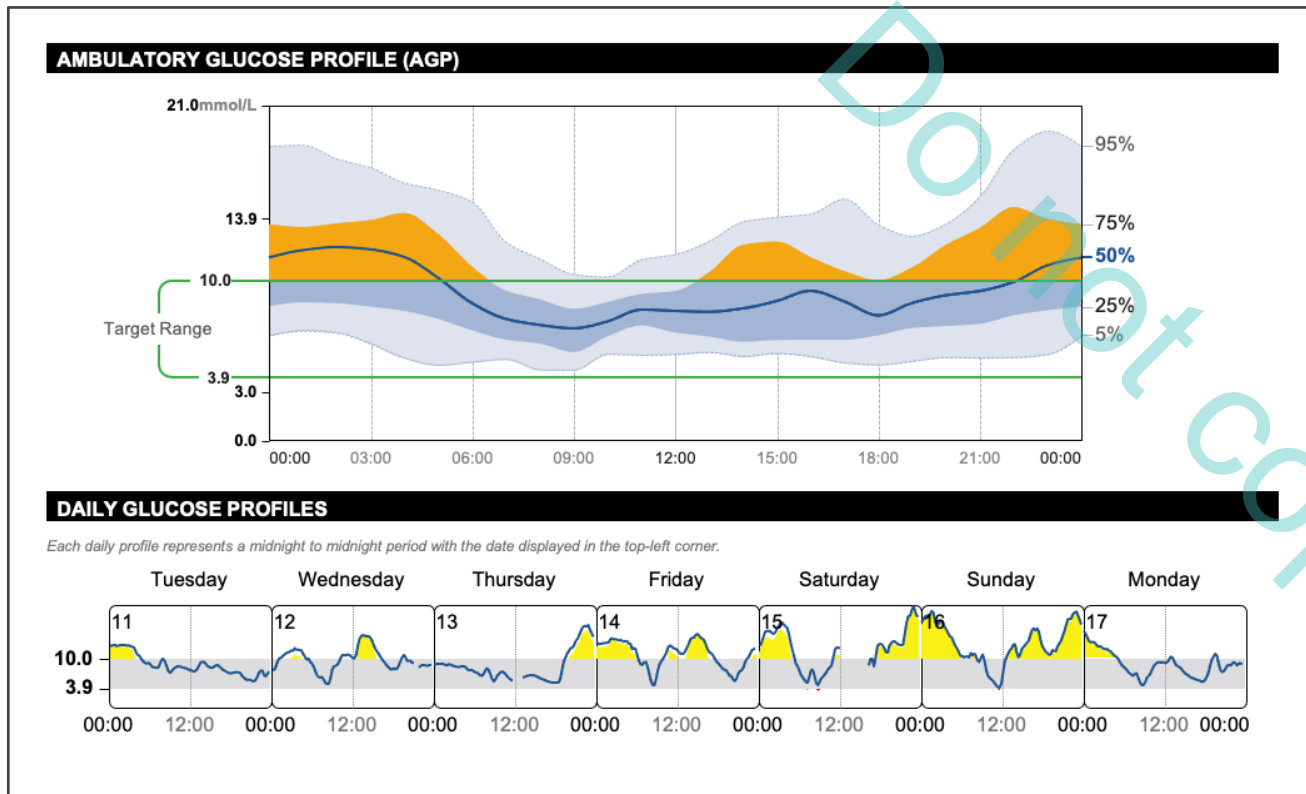
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1. Battelino T, et al. Diabetes Care 2019; 42:1593-1603 doi:10.2337/dci19-0028.

Step 3: look for patterns of hyperglycaemia

Is any of the IQR Band above the target range?



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

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

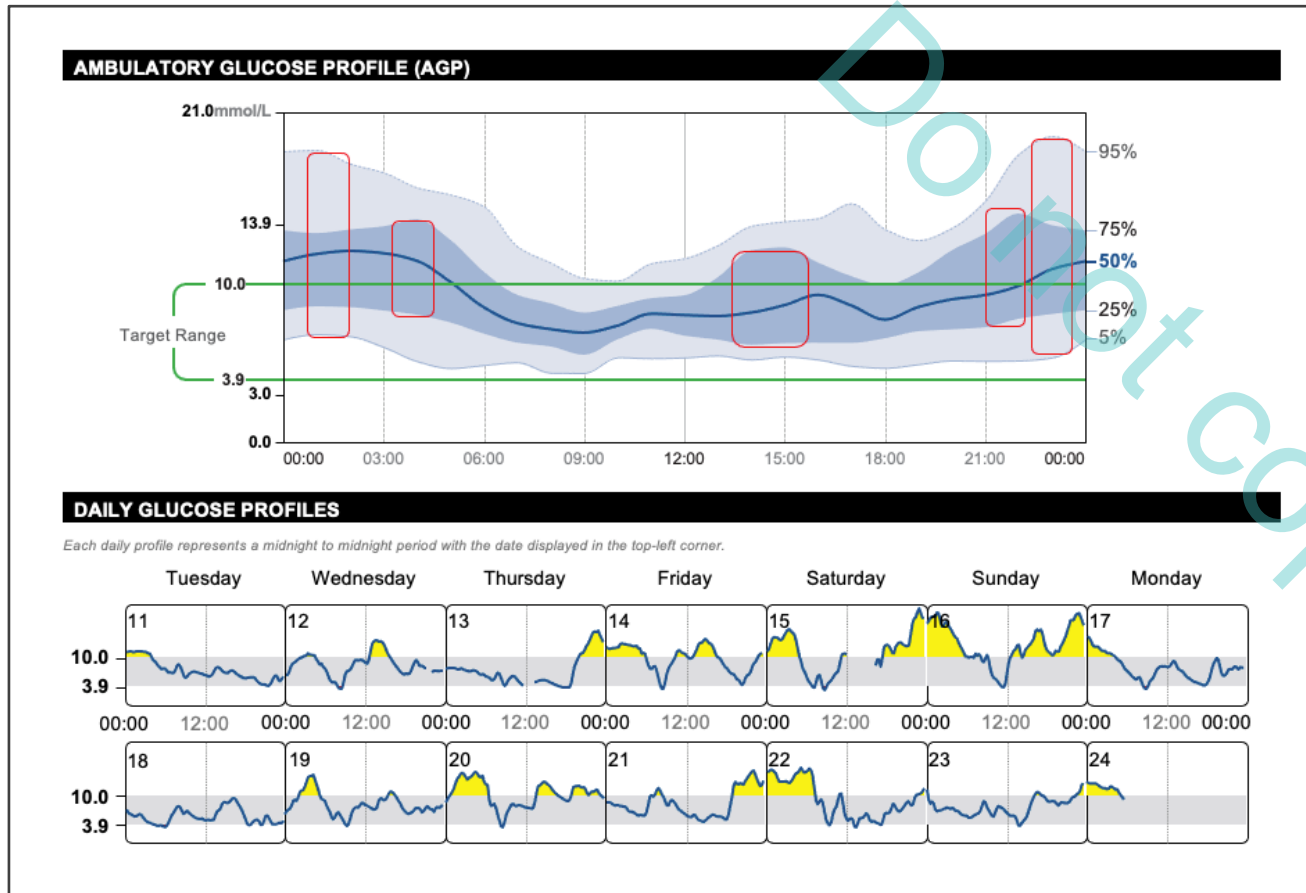
- Illness/stress
- Activity/daily routine

Confirm with the daily glucose profiles

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

Step 4: 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

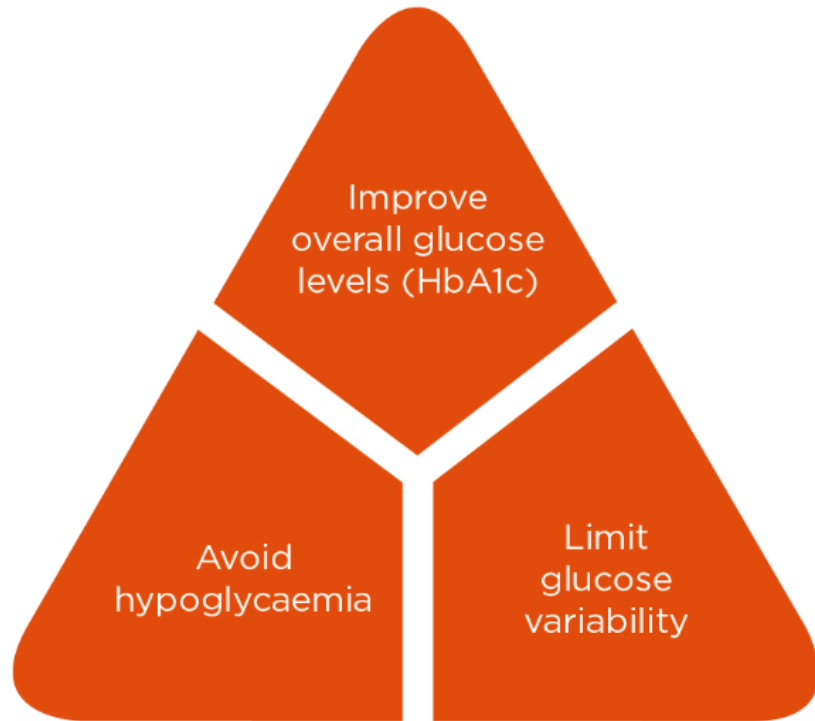
Lifestyle related

- 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?

A step-by-step approach for reviewing and interpreting an AGP:



Step 1: Validate the data – can we interpret what we need to from the data available?

Step 2: Hypoglycaemia - Hypoglycaemia is the major limiting factor in the glycaemic management of type 1 and type 2 diabetes₁

Step 3: Hyperglycaemia - long-term exposure to high glucose has adverse consequences_{2,3}

Step 4: Glucose variability - Glycaemic variability is emerging as an important risk factor for cardiovascular complications of diabetes, independent of long-term HbA1c or sustained hyperglycaemia₄

1. American Diabetes Association. Glycemic targets: standards of medical care in diabetes—2019. Diabetes Care 2019;42:S6170. <https://dx.doi.org/10.2337/dc19-S006>

2. Diabetes Control and Complications Trial Research Group, Nathan DM, Genuth S, Lachin J, et al. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993;329:977-86. <http://dx.doi.org/10.1056/NEJM199309303291401>

3. Stratton IM, Adler AI, Neil AH, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ 2000;321:405-12. <https://dx.doi.org/10.1136/bmj.321.7258.405>

4. Ceriello A, Monnier L, Owens D. Glycaemic variability in diabetes: clinical and therapeutic implications. Lancet Diabetes Endocrinol 2018;7:221–30. [https://dx.doi.org/10.1016/S2213-8587\(18\)30136-0](https://dx.doi.org/10.1016/S2213-8587(18)30136-0)

Case for discussion: Ben aged 32 years

Type 1 diabetes: Diagnosed aged 21 years

Attended for review of diabetes in GP practice

Takes basal bolus regime insulin: Lantus 20 units: Novorapid: Carb Counting
1:10 ratio

Not attended secondary care services review since 2021

GLUCOSE STATISTICS AND TARGETS

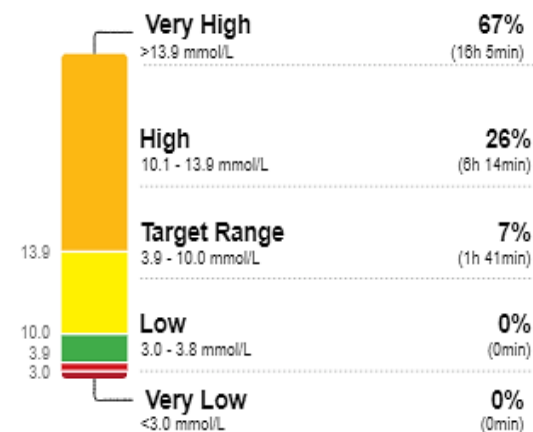
14 Days
% Time Sensor is Active 84%

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% (8h)
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.	

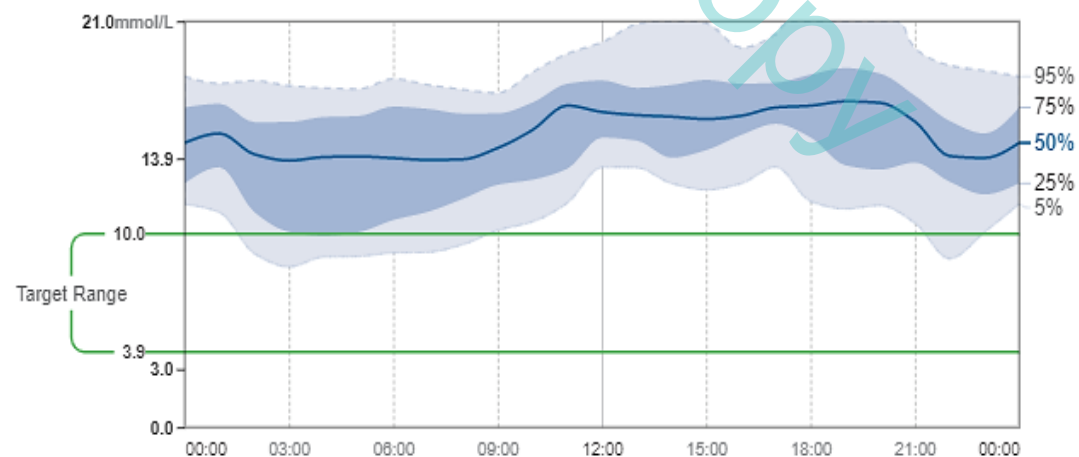
Average Glucose 15.1 mmol/L
Glucose Management Indicator (GMI) 9.8% or 84 mmol/mol
Glucose Variability 21.2%
Defined as percent coefficient of variation (%CV)

TIME IN RANGES



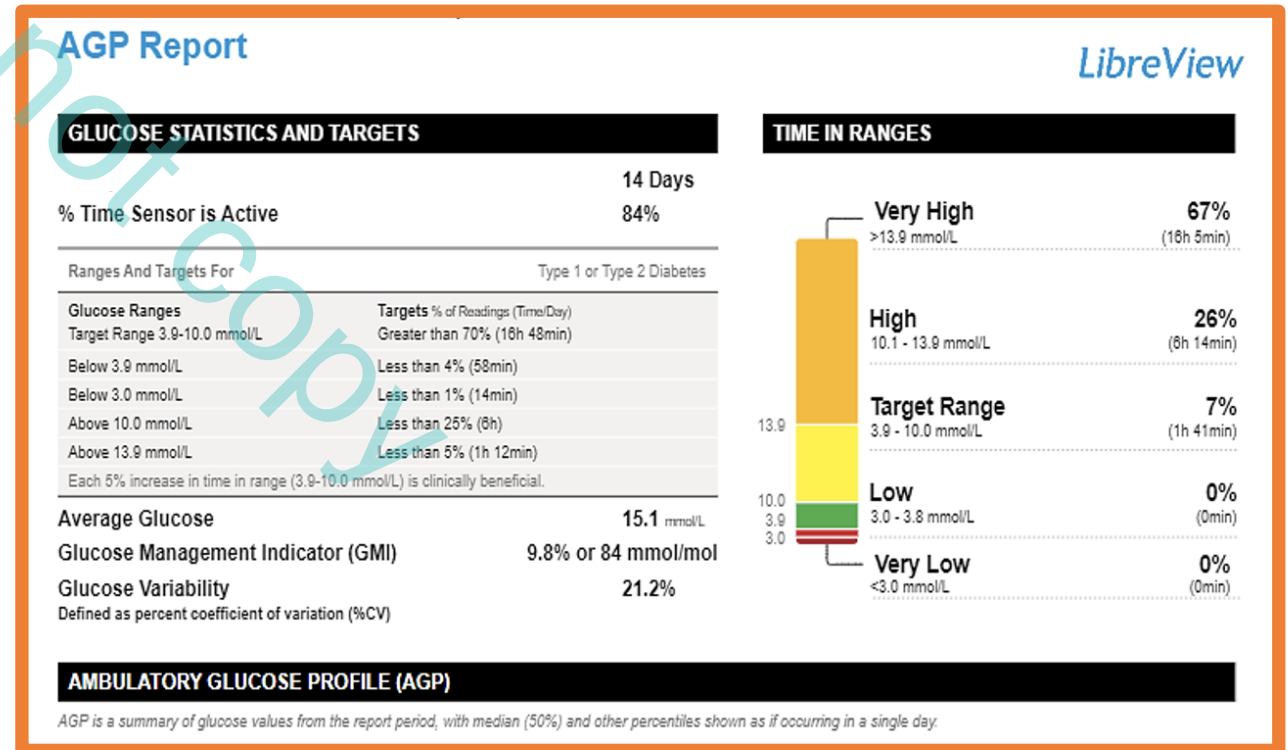
AMBULATORY GLUCOSE PROFILE (AGP)

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.



The main concern here is...

- A. High variability
- B. Hypoglycaemia
- C. Hyperglycaemia



AGP Report

LibreView

GLUCOSE STATISTICS AND TARGETS

% Time Sensor is Active

14 Days
84%

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)
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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

15.1 mmol/L

Glucose Management Indicator (GMI)

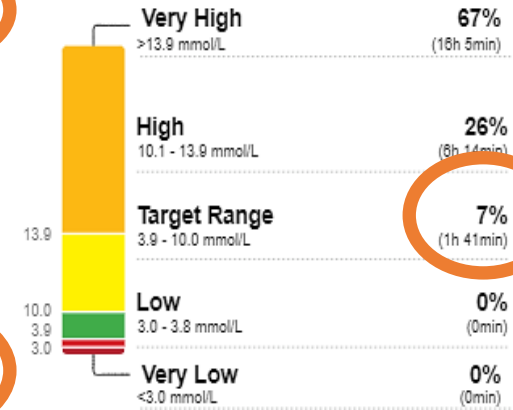
9.8% or 84 mmol/mol

Glucose Variability

21.2%

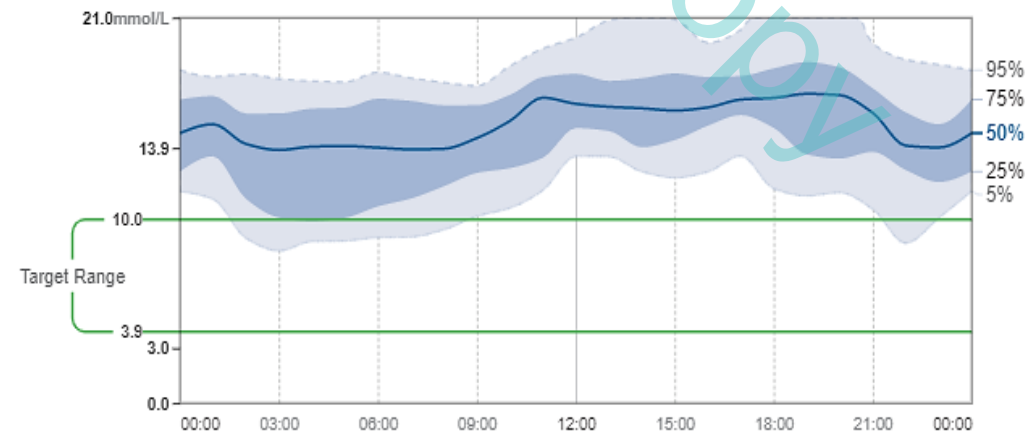
Defined as percent coefficient of variation (%CV)

TIME IN RANGES



AMBULATORY GLUCOSE PROFILE (AGP)

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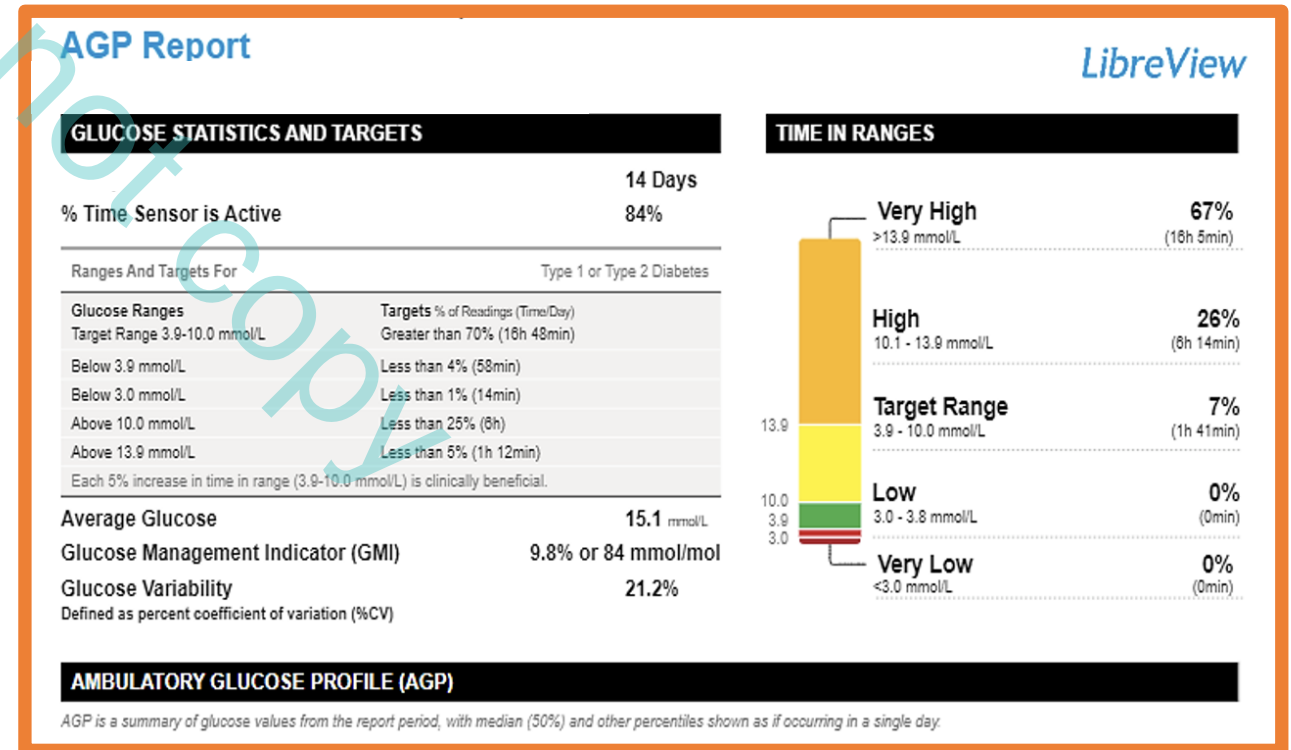


The main concern here is....

A. High variability

B. Hypoglycaemia

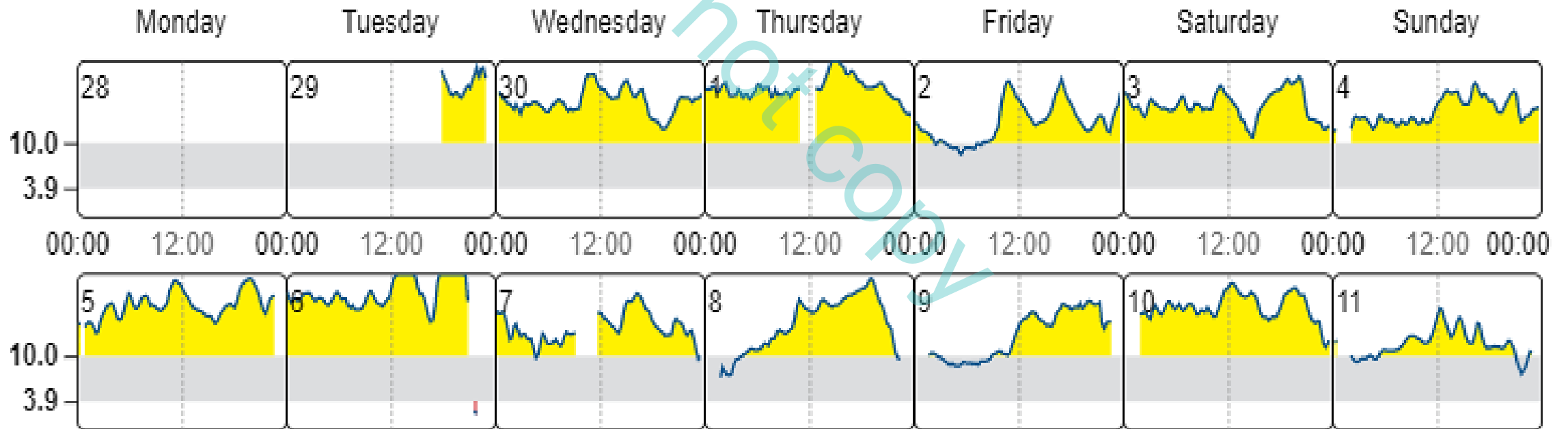
C. Hyperglycaemia



How can we help Ben?

DAILY GLUCOSE PROFILES

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



Case for discussion: Bill aged 74 years

Pancreatectomy 20 years ago

Attended for annual review of diabetes in GP practice

Takes basal bolus regime insulin: Lantus 14 units: Novorapid: Varies dose depending on what is being eaten and what his current glucose level is.
Does not 'carb count'

BMI 19.4 kg/m²

Has severe frailty

HbA1c 60 mmol/mol

Case for discussion: Bill aged 74 years

Are we happy with Bill's HbA1c?

A. Yes

B. No

Pancreatectomy 20 years ago

Attended for annual review of diabetes in GP practice

Takes Basal Bolus regime insulin: Lantus 14 units:
Novorapid: Varies dose depending on what is being
eaten although does not 'carb count'

BMI 19.4 kg/m²

Severe frailty

HbA1c 60 mmol/mol

Case for discussion: Bill aged 74 years

Are we happy with Bill's HbA1c?

A. Yes

B. No

Pancreatectomy 20 years ago

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Takes Basal Bolus regime insulin: Lantus 14 units:
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eaten and what current glucose levels are.

Does not 'carb count'

BMI 19.4 kg/m²

Severe frailty

HbA1c 60 mmol/mol

AGP Report

Name _____

MRN _____

GLUCOSE STATISTICS AND TARGETS

% Time CGM is Active **13 days**
99.9%

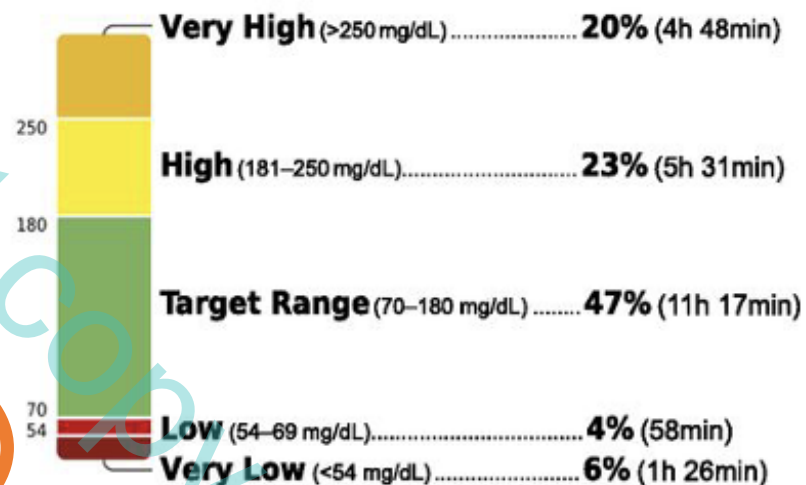
Glucose Ranges	Targets [% of Readings (Time/Day)]
Target Range 70–180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)

Each 5% increase in time in range (70–180 mg/dL) is clinically beneficial

Average Glucose 9.6 mmol/L
Glucose Management Indicator (GMI) 60 mmol/mol
Glucose Variability 49.5

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.

AGP Report

Name

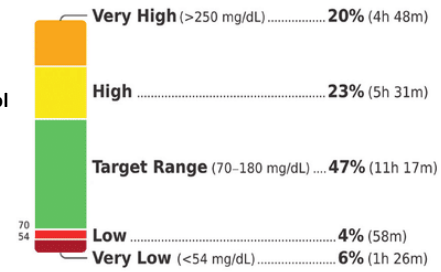
MRN

GLUCOSE STATISTICS

% Time CGM is Active 13 days
99.9%

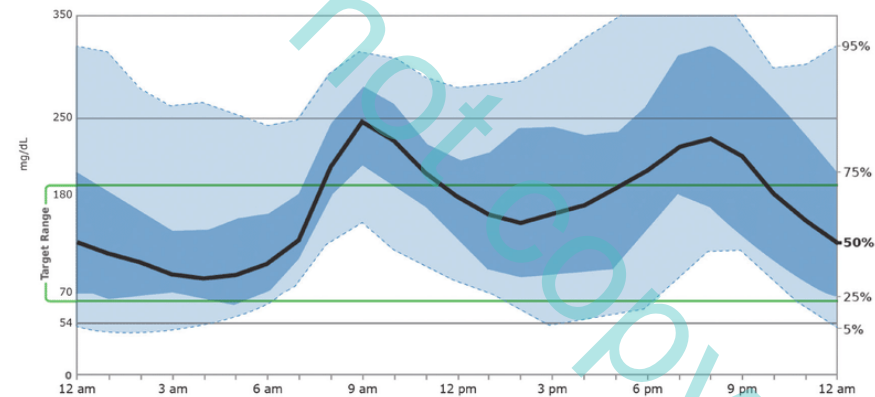
Average Glucose 9.6 mmol/L
Glucose Management Indicator (GMI) 60 mmol/mol
Glucose Variability 49.5
Defined as percent coefficient of variation (%CV); target :

TIME IN RANGES

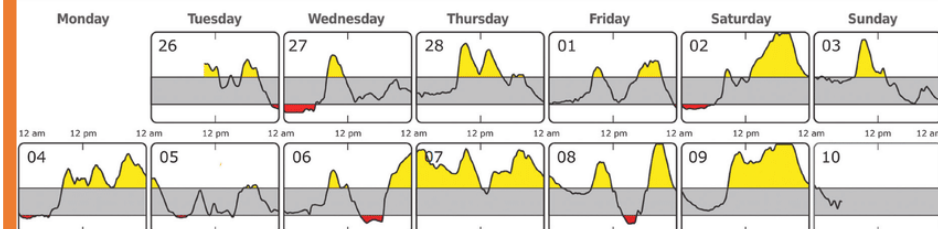


AMBULATORY GLUCOSE PROFILE (AGP)

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.



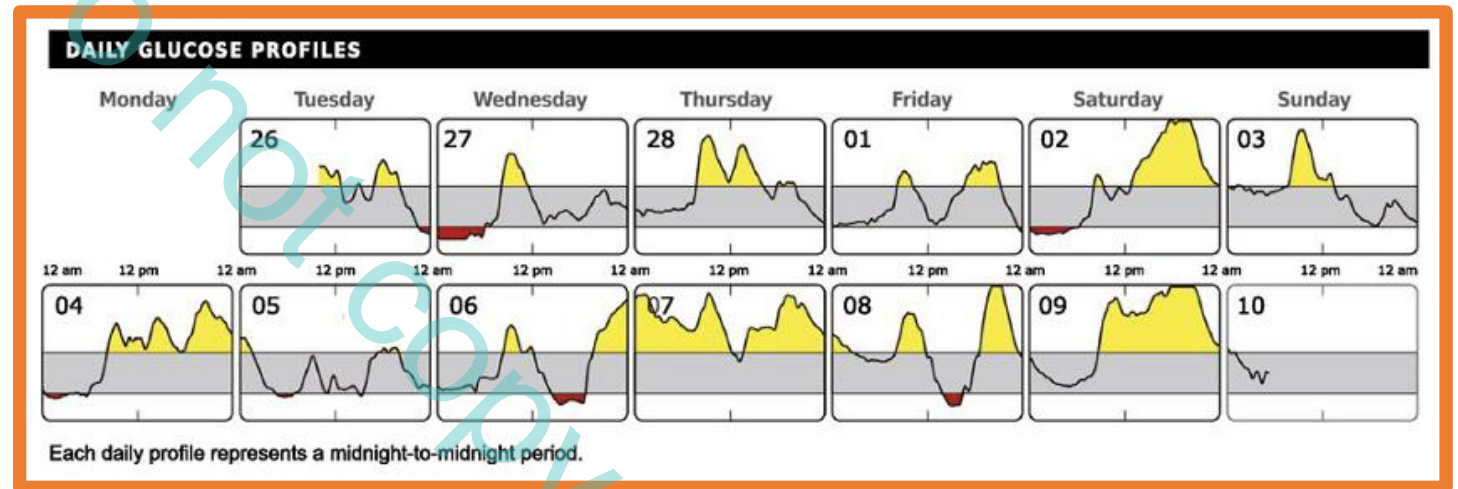
DAILY GLUCOSE PROFILES



Each daily profile represents a midnight-to-midnight period.

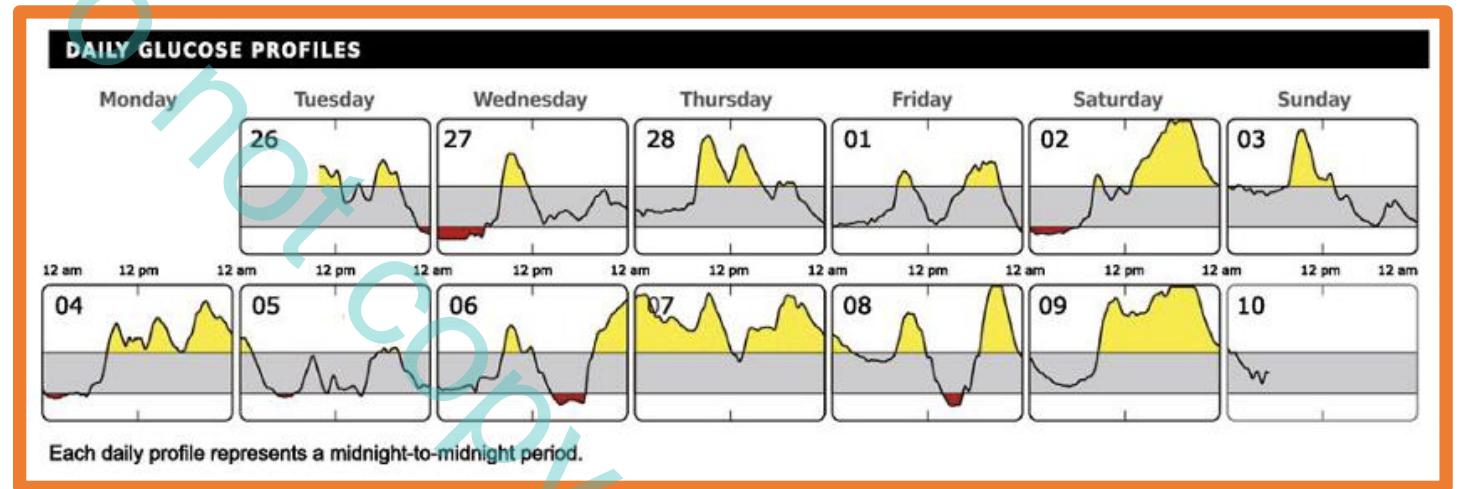
The main concerns here are...

- A. High variability
- B. Hypoglycaemia
- C. Hyperglycaemia
- D. All the above

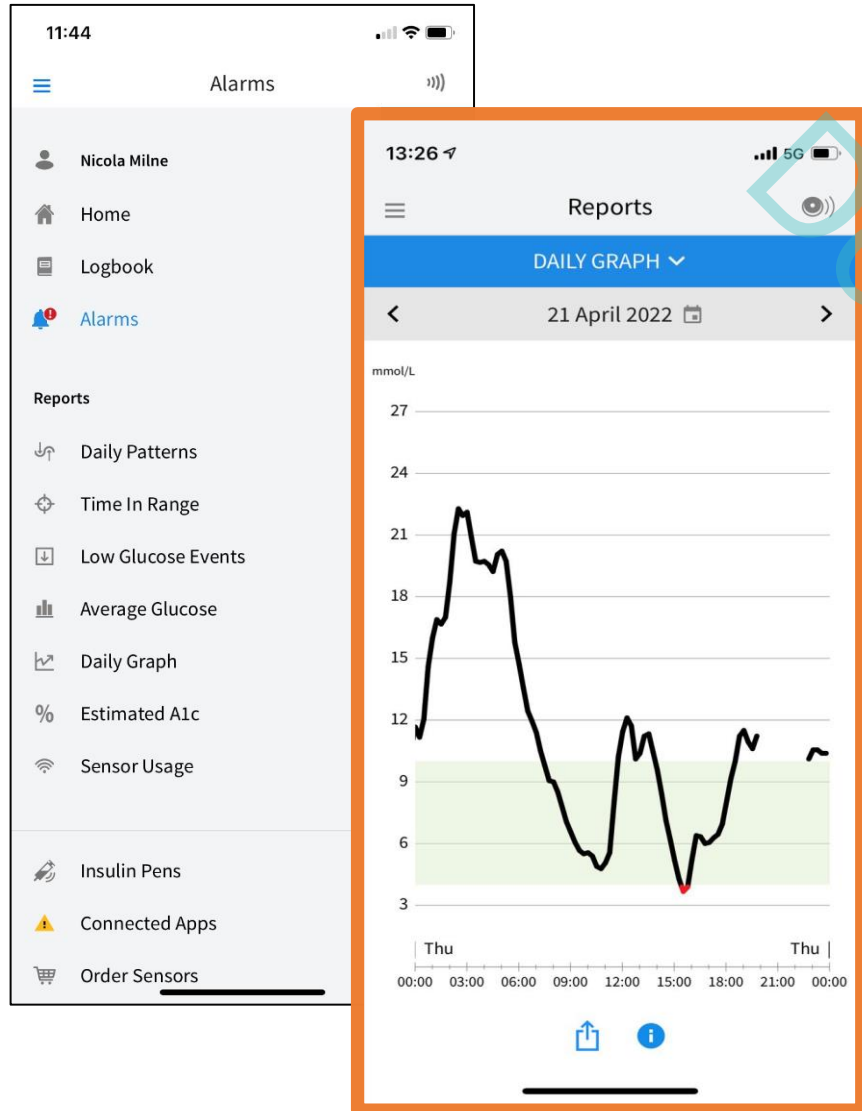


The main concerns here are...

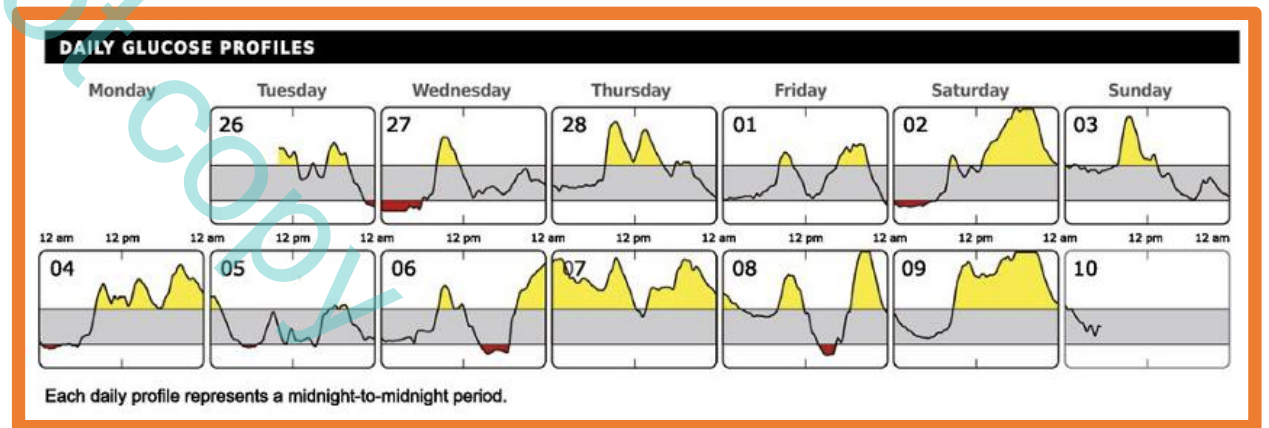
- A. High variability
- B. Hypoglycaemia
- C. Hyperglycaemia
- D. All the above



High variability



How can we help Bill?

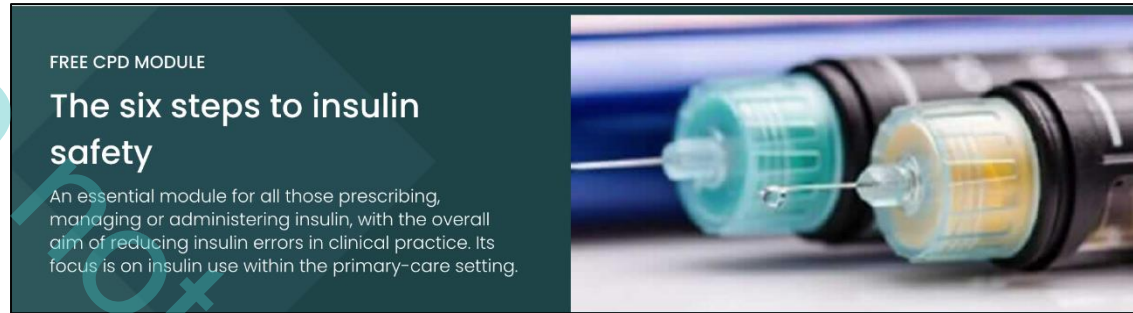


Common reasons for high variability and/or reduced time in range

- Incorrect/inconsistent timing of insulin injections
- Incorrect insulin doses for lifestyle
- Under-reacting to glucose levels
- Over-reacting to glucose levels
- Overtreating hypoglycaemia
- Poor injection technique to include injecting into areas of lypohypertrophy

Resources

- For information on appropriate insulin management, see *The Six Steps to Insulin Safety* e-Learning module



<https://diabetesonthenet.com/cpd-modules/the-six-steps-to-insulin-safety>

- For information on appropriate injection technique, visit *Injection Technique Matters*

<https://trenddiabetes.online/injection-technique-matters/>



Important to remember!

Ask permission to view a person's data

Avoid judgement

Shared process; empower the person with diabetes to share what they see.

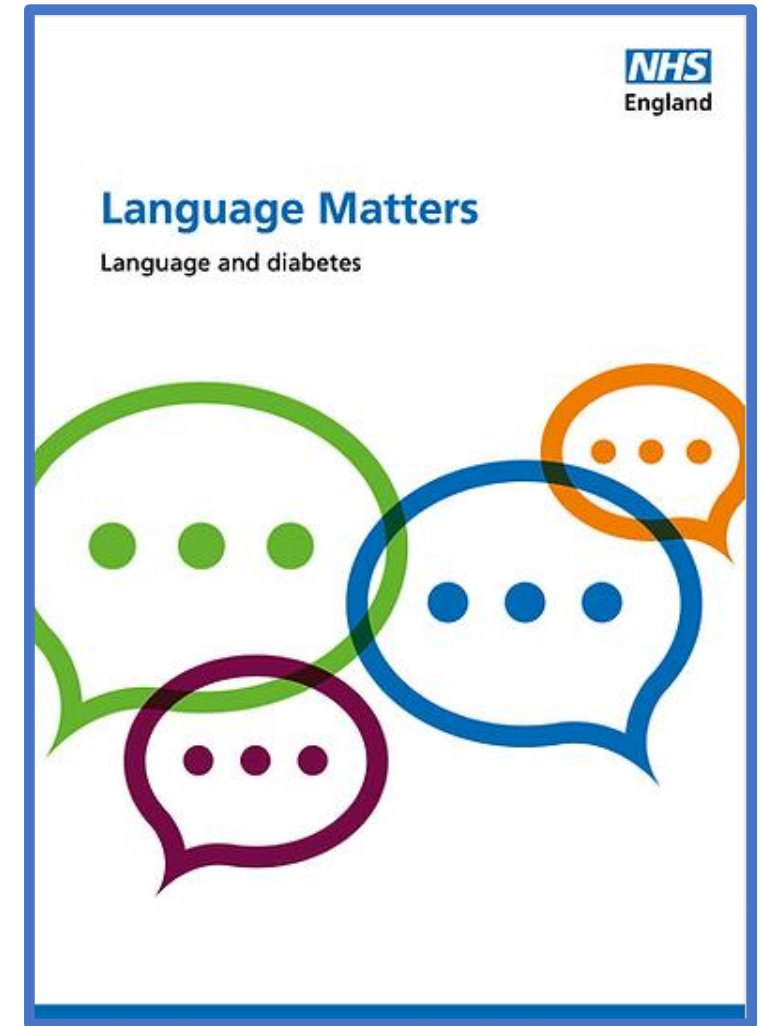
Look to the positives first

Look at

- Time in range
- Time below range
- Time above range

Review for variability/manage any causes for same

Shared decision making with SMART Goal setting



Resources

- Diabetes technology Network

<https://abcd.care/dtn>



- Leicester Diabetes Centre/ EDEN: *Implementing Glucose Sensing in Primary Care* e-Learning modules

<https://www.edendiabetes.com/education-blog/2022/11/9/implementing-glucose-sensing-in-primry-care>



- How to initiate and support continuous glucose monitoring

<https://diabetesonthenet.com/diabetes-primary-care/how-to-cgm/>

- FreeStyle Libre Tutorials & Downloads

<https://www.freestyle.abbott/uk-en/support/tutorialsanddownloads>



- Dexcom One HCP Educational Resources

<https://uk.provider.dexcom.com/products/dexcom-one/training-and-resources>

