

Continuous Glucose Monitoring made simple

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Disclosures



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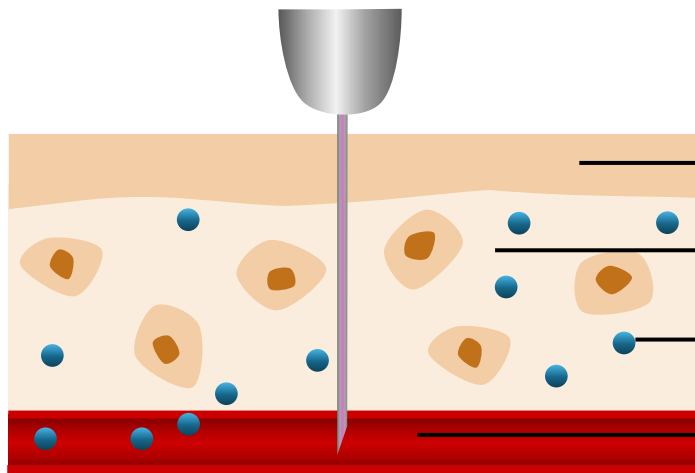
Agenda

- Who is eligible?
- What do we need to know when prescribing
- Data analysis made easy

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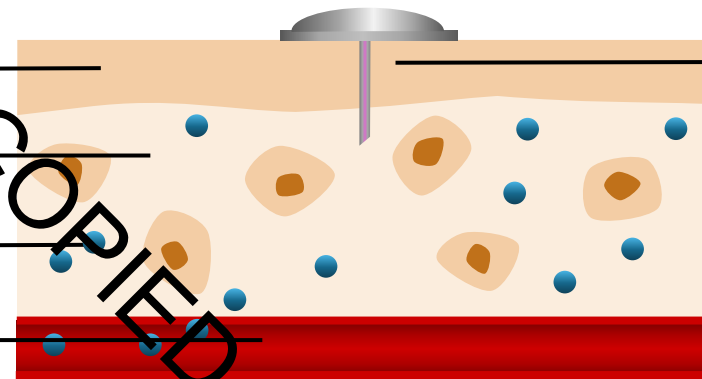
What is Continuous Glucose Monitoring (CGM)?

CLASSIC CAPILLARY BLOOD GLUCOSE METER



Skin
Interstitial fluid
Glucose
Capillary

CGM SYSTEM

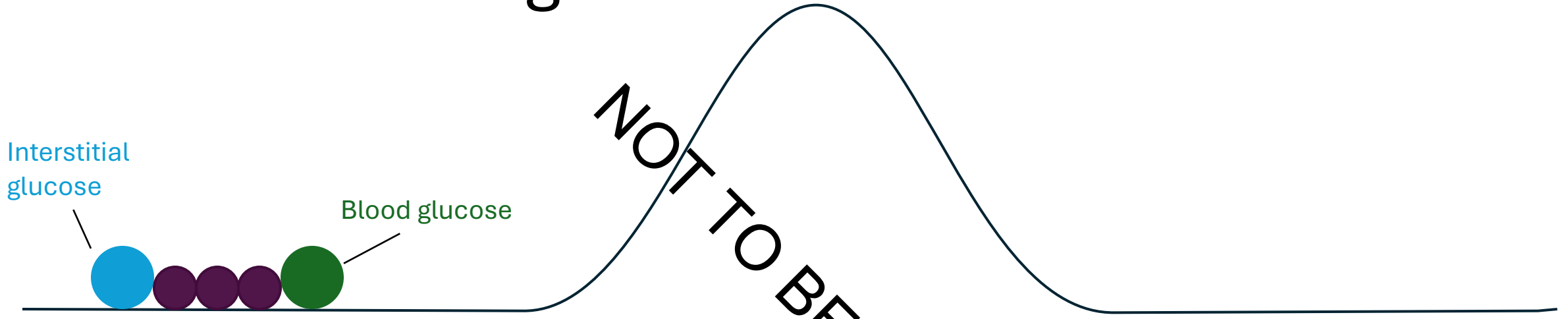


Microfilament

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Understanding interstitial fluid measurement

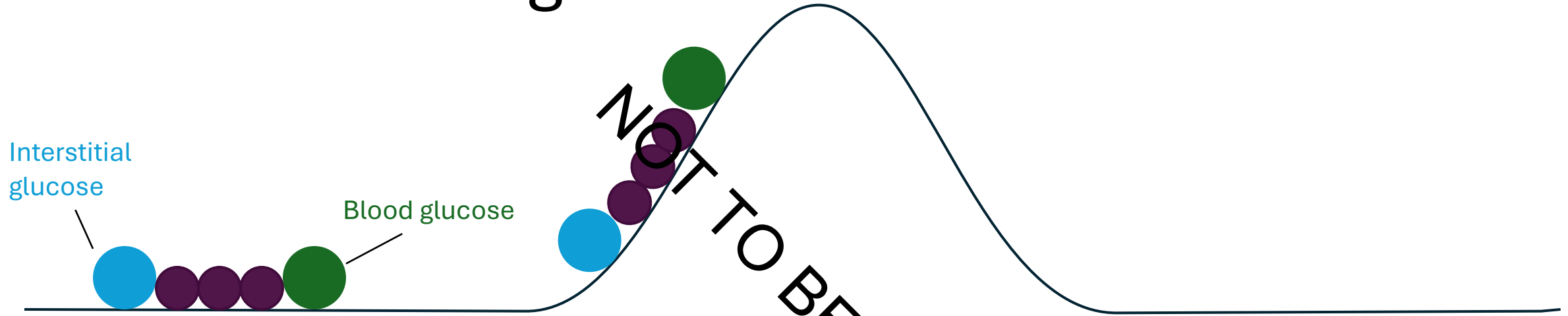


Blood glucose levels	Stable
Interstitial glucose levels	Similar to blood glucose

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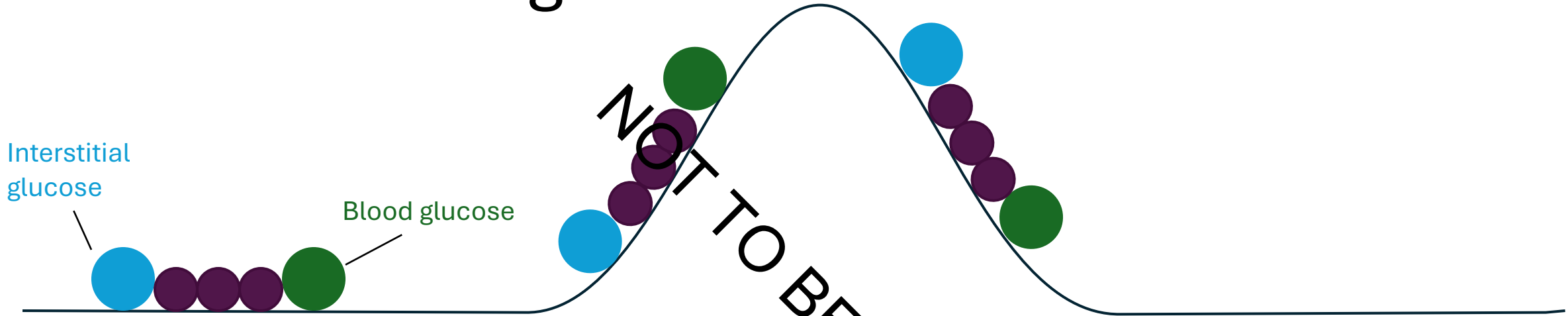


Understanding interstitial fluid measurement



Blood glucose levels	Stable	Increasing
Interstitial glucose levels	Similar to blood glucose	May be lower than blood glucose

Understanding interstitial fluid measurement



Blood glucose levels	Stable	Increasing	Decreasing
Interstitial glucose levels	Similar to blood glucose	May be lower than blood glucose	May be higher than blood glucose

Who is eligible for CGM in Scotland?

- Offer adults with type 1 diabetes a choice of CGM based on their individual preferences, needs, characteristics, and the functionality of the devices available¹
- Offer rtCGM to all children and young people with type 1 diabetes, alongside education to support children and young people and their families and carers to use it¹
- Adults with type 2 diabetes who are on multiple daily insulin injections or insulin pump therapy should have access to flash glucose monitoring²
 - There is no guidance currently on use of CGM or flash glucose monitoring in children or young people with type 2 diabetes²
- Ensure pregnant women with type 1 diabetes have access to CGM; consider CGM for pregnant women with type 2 diabetes³
 - CGM is not currently routinely recommended in women with gestational diabetes³

1. Healthcare Improvement Scotland. Optimising glycaemic control in people with Type 1 diabetes (SIGN 170). Available at: <https://rightdecisions.scot.nhs.uk/optimising-glycaemic-control-in-people-with-type-1-diabetes-sign-170/>; 2. Scottish Health Technologies Group. Freestyle Libre Flash Glucose Monitoring Advice Statement. Available at: <https://shtg.scot/our-advice/freestyle-libre-flash-glucose-monitoring>; 3. Healthcare Improvement Scotland. Management of diabetes in pregnancy (SIGN 171). Available at: <https://www.sign.ac.uk/media/2205/sign-171-management-of-diabetes-in-pregnancy.pdf>

Systems currently available on the NHS

	FreeStyle Libre 2 and Libre 2 plus systems	Dexcom ONE+	GlucoRx AiDEX	GlucoMen Day
Type of CGM	Libre 2: isCGM/rtCGM*	rtCGM	rtCGM	rtCGM
Sensor life	15 days (Libre 2 Plus) 14 days (Libre 2)	10 days	14 days	14 days
Transmitter life	n/a	n/a	4 years	5 years
Warm-up time	1 hour	30 minutes	1 hour	55 minutes
Calibration required?	No	No	No	Every 48 hours

Adapted from: Diabetes Specialist Nurse Forum UK. CGM comparison chart. Available at:

<https://static1.squarespace.com/static/636e507501d1fa72da31dd2d/t/65ef1cb36a8d092d4cda16b8/1710169268149/CGM+overview+V6.pdf>

* The FreeStyle Libre 2 system functions as rtCGM when paired with the LibreLink app on a smartphone and as isCGM (requiring manual scanning) when used with the Libre Reader device

What needs to be prescribed?

2x FreeStyle Libre 2 sensors per 28 days

or

2x FreeStyle Libre 2 plus sensors per 30 days

3x Dexcom ONE+ applicators with built-in sensor every 30 days

Sharps disposal unit (with instructions on local collection policy)

Appropriate quantity of capillary blood glucose test strips and lancets

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Dexcom ONE+



Smart devices sold separately

- Sensor life: 10 days

• Provides real-time and predictive glucose data

- A small sensor on the arm or abdomen (or, for children 2–6 years, on the upper buttocks) sends glucose data continually via Bluetooth to a compatible mobile app or reader

• The reader or device shows:

- current glucose reading
- option to view 3, 6, 12 or 24 hours of glucose data
- trend arrow

FreeStyle Libre 2 system



- Sensor life: 15 days (Libre 2 Plus sensor)
- *With a reader:*
 - Sensor needs to be scanned at least every 8 hours
 - Data is enhanced from 6 scans per day or more
 - Shows data from the last time the sensor was scanned
- *With a smart device:*
 - Sensor transmits glucose data every minute continuously
 - Shows current data
- The reader or device shows:
 - glucose reading
 - graph showing latest 8 hours of glucose data
 - trend arrow

Resources

- FreeStyle Libre Academy

<https://pro.freestyle.abbott/uk-en/scientific-resources-education/libre-academy.html>

- Dexcom Patient Education

<https://www.dexcom.com/en-gb/learn>

- Dexcom Education Hub

<https://educationhub.dexcom.com>

- Diabetes Technology Network (DTN-UK)

<https://abcd.care/dtn-uk/resource-taxonomy/diabetes-technology-network>



FreeStyle
Libre

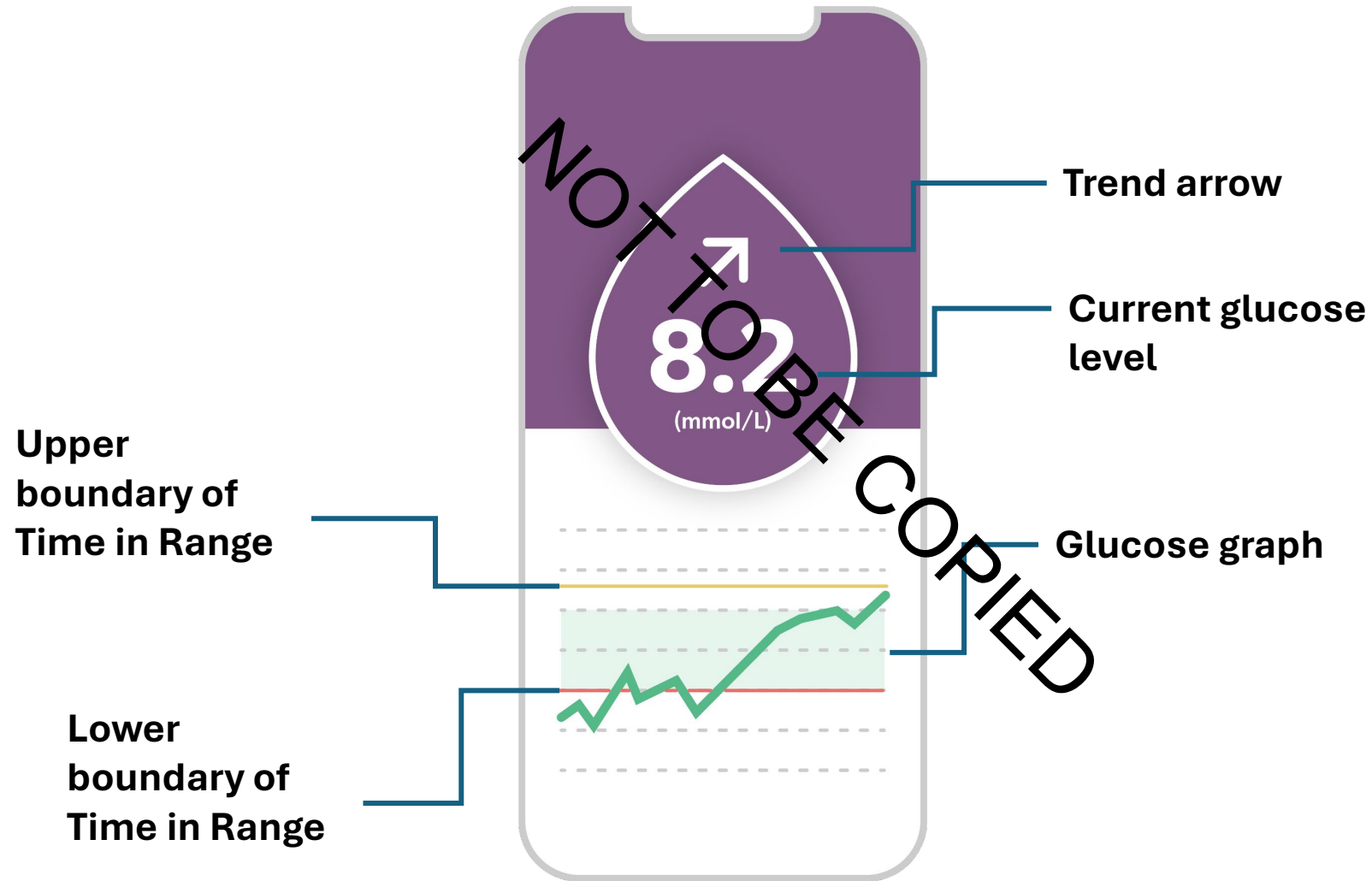
dexcom one⁺

dexcom
education hub

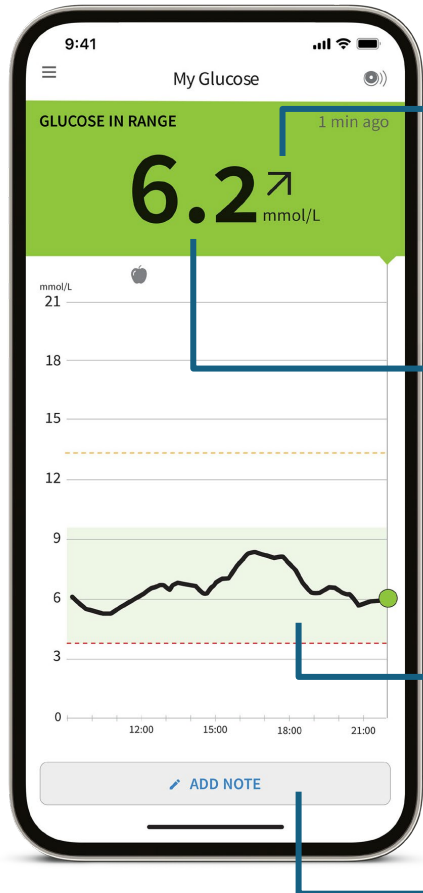
DTN UK
collaborate • evolve • support

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What data can the person see instantly?



How glucose values appear on smartphone



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).

Add notes

to record relevant events.



Rising quickly



Rising



Changing slowly



Falling

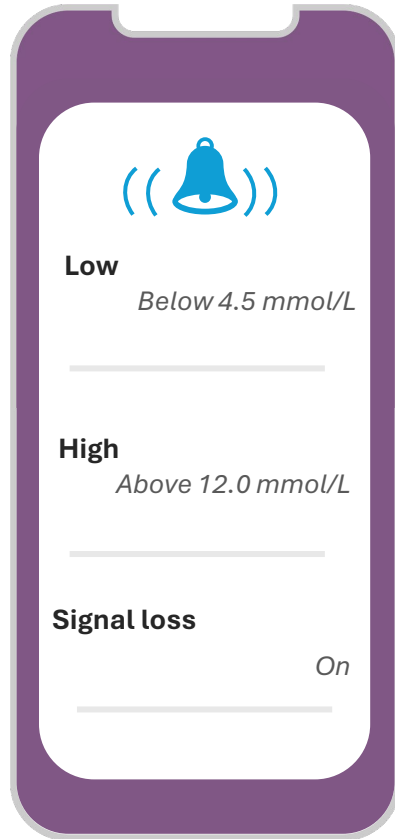


Falling quickly

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.

Setting alarms



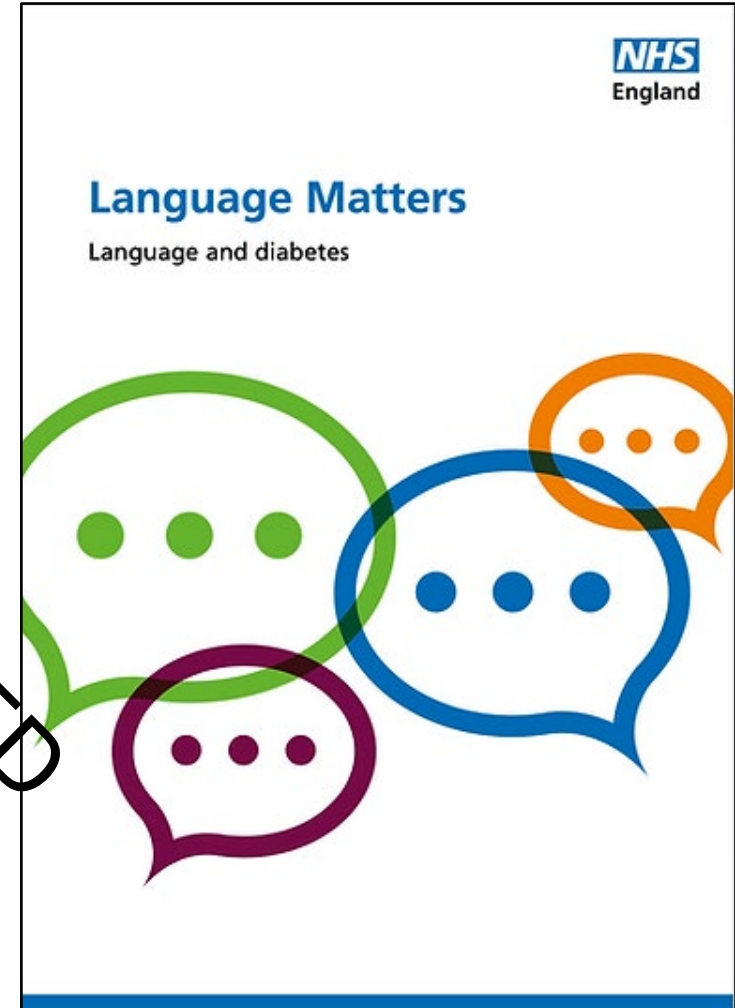
- Individualise the alarms
- Consider a higher “low alarm” for a person with frailty to provide for greater reaction time

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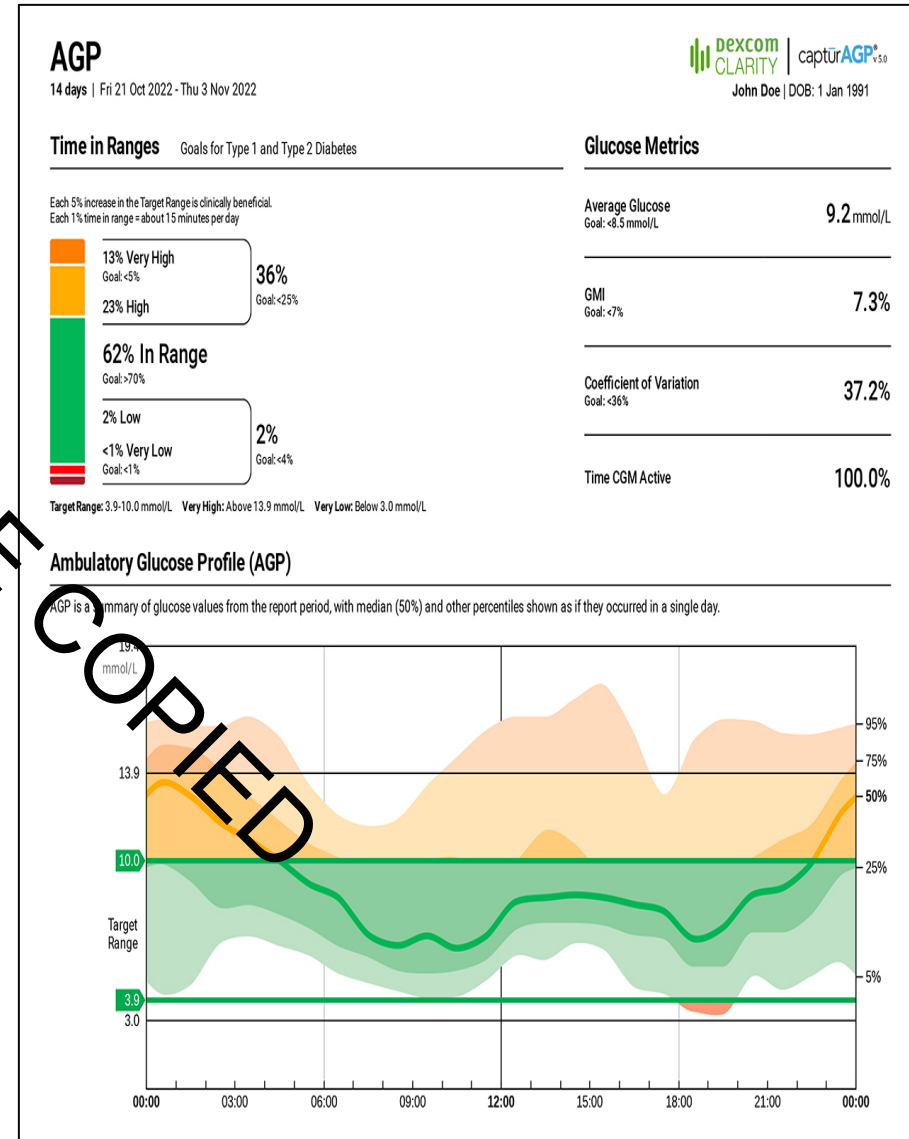
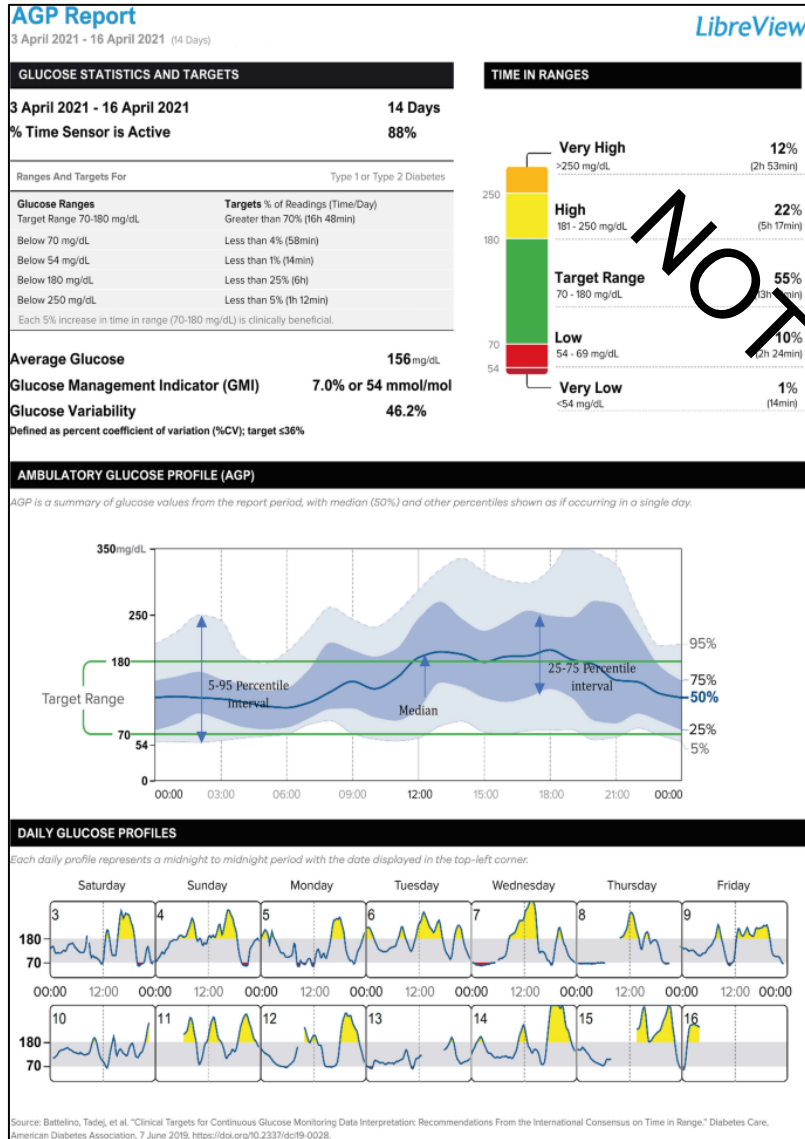
When looking at someone's data:

- ✓ Ask permission first
- ✓ Avoid judgement
- ✓ Shared process; empower the person with diabetes to share what they see
- ✓ Look to the positives first

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Ambulatory Glucose Reports



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

Resources

ARTICLE

How to analyse CGM data: A structured and practical approach

Victoria Millson, Peter Hammond

Adoption of continuous glucose monitoring (CGM), including flash glucose monitoring, is increasing rapidly in the UK; however, there is a shortage of skills related to diabetes technology amongst healthcare professionals. The benefits of CGM cannot be fully realised if healthcare professionals and users do not know how to interpret the vast amount of data produced, and to set appropriate glycaemic targets. This quick reference guide is an accompaniment to the article by Millson and Hammond (2020) and offers a brief summary of the structured approach to interpreting CGM data contained therein.

Victoria Millson, Peter Hammond

Adoption of continuous glucose monitoring (CGM), including flash glucose monitoring, is increasing rapidly in the UK; however, there is a shortage of skills related to diabetes technology amongst healthcare professionals. The benefits of CGM cannot be fully realised if healthcare professionals and users do not know how to interpret the vast amount of data produced, and to set appropriate glycaemic targets. This article offers a structured approach to interpreting CGM data, and acting on it, based on recent international consensus recommendations.

Managing blood glucose levels is the cornerstone of diabetes care, and it presents a long-term challenge for people with diabetes and healthcare professionals alike. There is a wealth of studies confirming the relationship between glycaemic control and adverse outcomes for people with diabetes.

Adoption of continuous glucose monitoring (CGM), including flash glucose monitoring, is increasing rapidly, both globally and in the UK, albeit UK growth is not uniform or linear. Within the diabetes professional community there is a definite shortage of skills related to diabetes technology, with varied uptake of both CGM and insulin pump therapy across the UK. CGM and the diabetes technology surrounding it have become increasingly sophisticated in recent years, and it is easy to see how healthcare professionals could have been left behind if they were not early adopters of the initial systems, creating a culture of those with tech knowledge and those without.

A standardised approach in this emerging field is much needed, so that we can focus on how best to interpret blood glucose data and realise the benefits in the real world.

Towards a standardised approach

It is no surprise that, with all the new technology and a limited evidence base, even those in the know – the experts, so to speak – cannot always reach universal agreement on how best to use CGM in the real world. However, there are now consensus recommendations for use of key CGM metrics that have been presented in three separate peer-reviewed articles (Danne et al, 2017; Perie et al, 2017; Bartelino et al, 2019), although formal adoption by diabetes professional organisations and official guidance has been absent for some time.

This article looks to outline a clinical strategy for CGM use and interpretation of the resulting data, and to provide accessible, practical tips for both healthcare professionals and CGM users.

Metrics of glucose control

In order to predict and shape future strategies, it is illuminating to look at both past and current practice and metrics. HbA_{1c} has long been the main focus and target metric employed by clinicians and in CGM studies, and people with diabetes are also conditioned by such behaviours, after years of using HbA_{1c} to monitor how well their blood glucose is

Citation: Millson V, Hammond P (2020) How to analyse CGM data: A structured and practical approach. *Journal of Diabetes Nursing* 24: JDN135

Article points

1. Time In Range is a valuable new metric for users of continuous glucose monitoring, and is linked to both HbA_{1c} levels and clinical outcomes.
2. The ambulatory glucose profile streamlines multiple days of blood glucose data, allowing identification of regular glycaemic trends and variation.
3. Deeper, individual-day analysis can then be used to identify anomalous glycaemic variability and underlying issues.

Key words

- Ambulatory glucose profile
- Continuous glucose monitoring
- Time In Range

Authors

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Journal of Diabetes Nursing Volume 24 No 3 2020

<https://diabetesonthenet.com/journal-diabetes-nursing/how-analyse-cgm-data-structured-and-practical-approach/>



Quick guide: Interpreting CGM data

QUICK GUIDE: INTERPRETING CGM DATA

Adoption of continuous glucose monitoring (CGM), including flash glucose monitoring, is increasing rapidly in the UK; however, there is a shortage of skills related to diabetes technology amongst healthcare professionals. The benefits of CGM cannot be fully realised if healthcare professionals and users do not know how to interpret the vast amount of data produced, and to set appropriate glycaemic targets. This quick reference guide is an accompaniment to the article by Millson and Hammond (2020) and offers a brief summary of the structured approach to interpreting CGM data contained therein.

Citation: Quick guide: Interpreting CGM data. *Journal of Diabetes Nursing* 24: JDN143

Step 1: Assess user history

1. Quality of data
 - Number of days worn (aim for 14)
 - Percentage of time CGM is active (aim for >70% of the time)
2. Insulin therapy
 - What insulin
 - MDI or insulin pump
 - Basal and bolus doses
3. Physical activity
 - Working or non-working days
5. Illness – any additional therapy (e.g. steroid treatment)

Step 2: Assess Time In Range (TIR)

Overall goal (type 1 and 2 diabetes):
Aim for >70% of the day with blood glucose 3.9–10.0 mmol/L

Priority 1:
Minimise Time Below Range (<3.9 mmol/L)

Priority 2:
Then minimise Time Above Range (>10.0 mmol/L)

Note: A TIR of 70% reflects an average of 53 mmol/mol, which is a 10% increase in the reported HbA_{1c} reduction of 5 mmol/mol (0.5%).

Time In Range (TIR) targets for other patient groups

Group	Blood glucose range	Target (percentage of day)
Older/high-risk patients (Type 1 and type 2 diabetes)	>13.9 mmol/L	<10%
	>10.0 mmol/L	<30%
Pregnancy: Type 1 diabetes (note more narrow glucose ranges)	>7.8 mmol/L	<25%
	3.5–7.8 mmol/L	>70%
Pregnancy: Type 2 diabetes and GDM (note more narrow glucose ranges)	>8 mmol/L	<5%
	3.5–7.8 mmol/L	>70%

Note: no specific recommendations for these groups, but these targets are advised.

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<https://diabetesonthenet.com/journal-diabetes-nursing/quick-guide-interpreting-cgm-data/>



How to initiate and support continuous glucose monitoring

by Nicola Milne, DIAS Nurse Lead, Brooklands and Northenden Primary Care Network

What and why

- Eligibility for the use of continuous glucose monitoring (CGM), which includes both real-time and intermittently scanned, is increasing as national organisations such as NICE update their guidelines.

- This is based on the evidence of significant benefits of CGM use in people with diabetes, including increased time spent in target glucose range, improved quality of life and reduced risk of hospital admissions for severe hypoglycaemia and diabetic ketoacidosis.^{1,2}

- Accessibility to CGM is now widening to include persons who may have all their diabetes reviews delivered in primary care. As clinicians, it is important that we seek to enable timely and appropriate initiation of CGM, offer support to those in our care and try to mitigate inequitable access.

Citation: Milne N (2023) How to initiate and support continuous glucose monitoring. *Diabetes & Primary Care* 25: 117-9

What is CGM?

- Both real-time CGM (rtCGM) and intermittently scanned CGM (isCGM) are methods of measuring glucose levels via interstitial fluid (fluid between cells), without the need for routine capillary blood glucose testing.
- rtCGM records glucose levels continuously throughout the day and night, providing both real-time and predictive glucose data. A small sensor is worn, usually on the arm or abdomen, which inputs interstitial glucose data continually via a transmitter or via bluetooth to the wearer's smartphone.
- People using a reader without their device linked to a transmitter (e.g. isCGM not linked to a smartphone) will still need to scan their sensor. To obtain sufficient data for a complete glucose profile, the sensor must be scanned at least every 8 hours although data is enhanced from six scans a day or more.
- There are various CGM systems available, some of which work with insulin pumps or enable closed-loop systems and which are only available via the NHS supply chain through specialist secondary care services. However, as of August 2023, three devices are available via NHS prescription (FPI0): see Table 1.

Table 1. CGM systems available via NHS prescription.³

	FreeStyle Libre 2	Descorm ONE	Glucose's AIDEX
Type of CGM	isCGM/rtCGM*	rtCGM	rtCGM
Sensor life	14 days	10 days	14 days
Transmitter life	n/a	3 months	4 years
New sensor warm up time	1 hour	2 hours	1 hour
Calibration required	No	No	No

*The FreeStyle Libre 2 functions as rtCGM when paired with the LibreLink app on a smartphone and as isCGM (requiring manual scanning) when used with the Libre Reader device.

Potential benefits

- Reduction in fingerprick testing.
- Trend arrows can aid safe and effective adjustments in treatment to avoid hypo- and hyperglycaemia.
- Alarms can be set to alert the user to potential hypo- and hyperglycaemic events.
- Patterns in glucose variation can be identified.
- Easier and less invasive identification of night-time hypo.
- Can enhance self-management and user engagement.
- Carers and parents can access readings and data.
- Generates a full 24-hour glycaemic picture (for isCGM, sensor must be scanned at least every 8 hours to achieve this).
- Studies show increased time in glucose target range, and potentially improved HbA_{1c}, reducing the risk of long-term diabetes complications.¹
- Positive impact on quality of life.¹
- Data can be uploaded to share online with healthcare professionals through compatible systems (subject to local data-sharing agreements), enabling potentially more effective consultations and also remote reviews.

- Apps enable the sensors to be scanned with smartphones/smartwatches.
- Studies in people with type 1 diabetes show cost-effectiveness compared with fingerprick testing.¹
- Larger text displays and spoken glucose readings are possible for those with visual impairment.

Possible disadvantages

- Data overload can confuse or worry some users.
- Interstitial fluid glucose time lag; thus, a fingerprick test is required in periods of rapidly changing glucose levels.
- CGM should not be prescribed without an individual being able to use capillary blood glucose monitoring when needed (See Need to Know section).
- Possible sensor problems relating to skin irritation or adhesive failure.
- Group 2 drivers still need to check capillary blood glucose levels for driving.⁴

References can be found in the online version of this article.

Diabetes & Primary Care Vol 25 No 4 2023

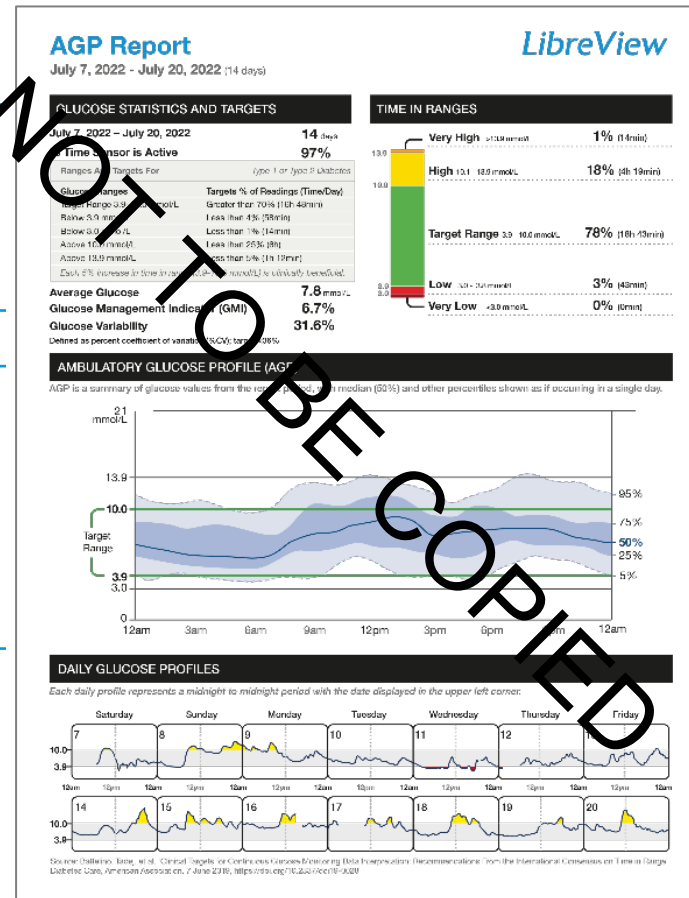
<https://diabetesonthenet.com/diabetes-primary-care/how-to-cgm-aug23/>



The AGP report – what are we looking at?

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.

Glucose Statistics and Time in Target

GLUCOSE STATISTICS AND TARGETS

July 7, 2022 – July 20, 2022

14 days

% Time Sensor is Active

97%

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% (18h 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

7.8 mmol/L

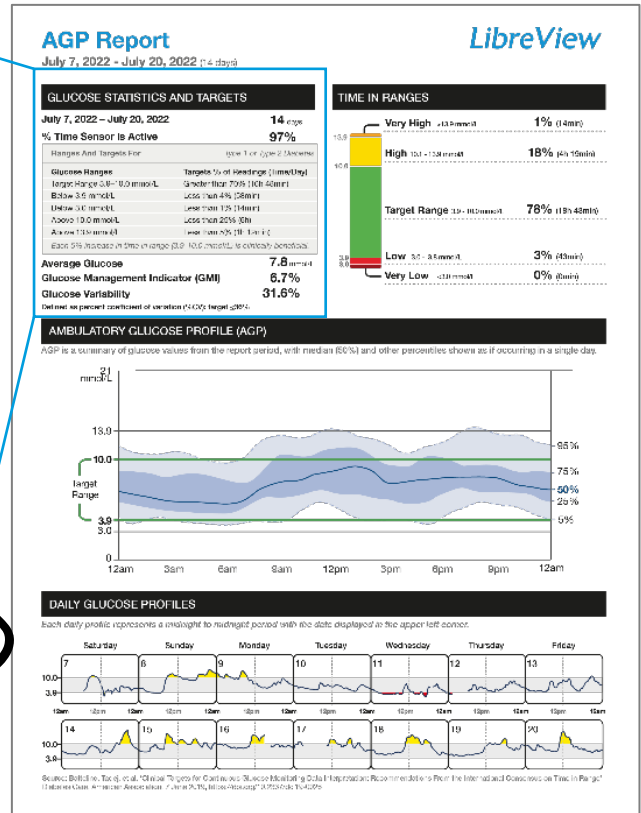
Glucose Management Indicator (GMI)

6.7%

Glucose Variability

31.6%

Defined as percent coefficient of variation (%CV); target $\leq 36\%$

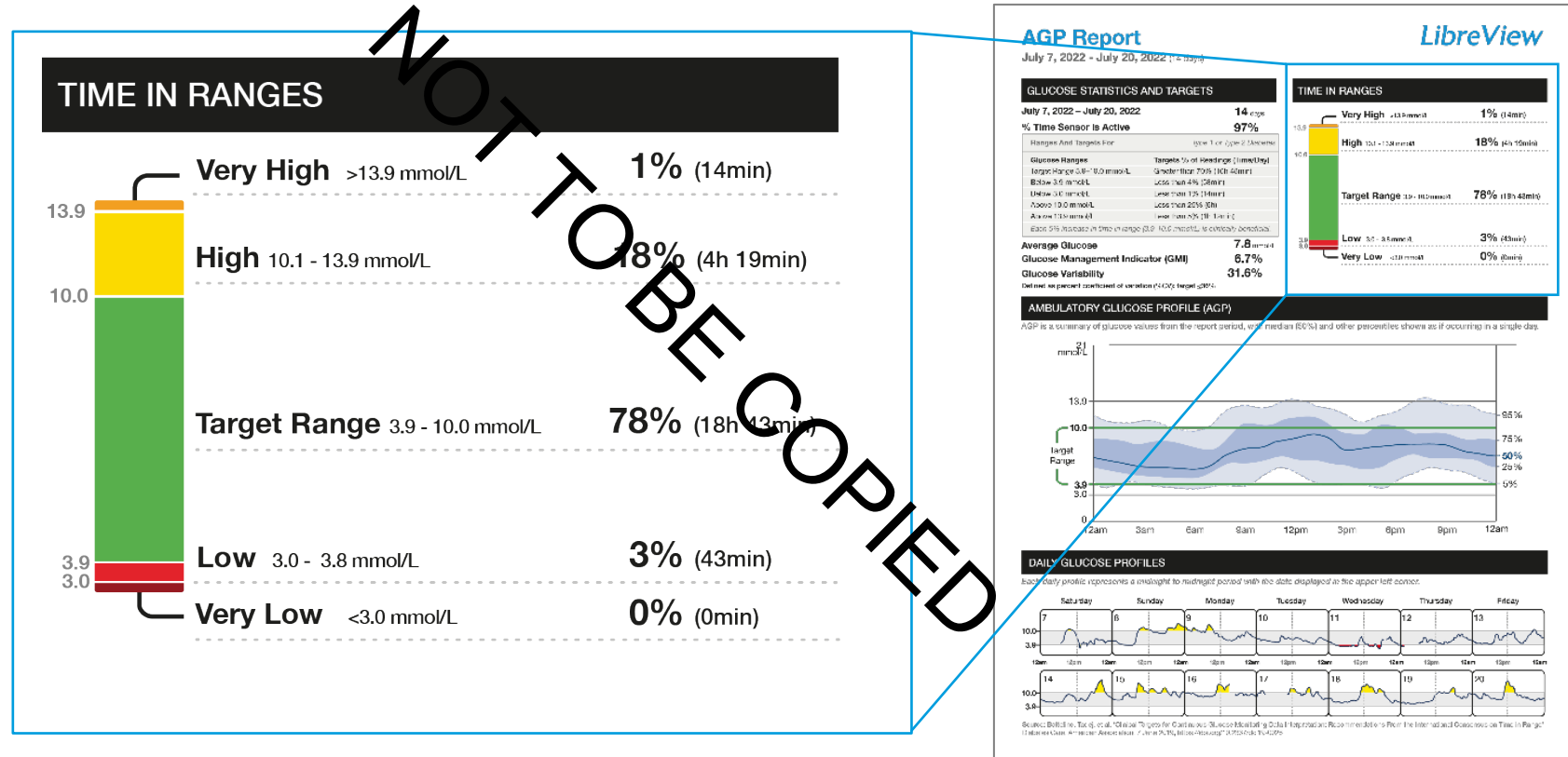


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1. Battelino T, Danne T, Bergenstal RM, et al. Clinical targets for continuous glucose monitoring data interpretation: recommendations from the international consensus on time in range. Diabetes Care. (2019);42(8):1593-1603.

Assess time in range, time below and time above range

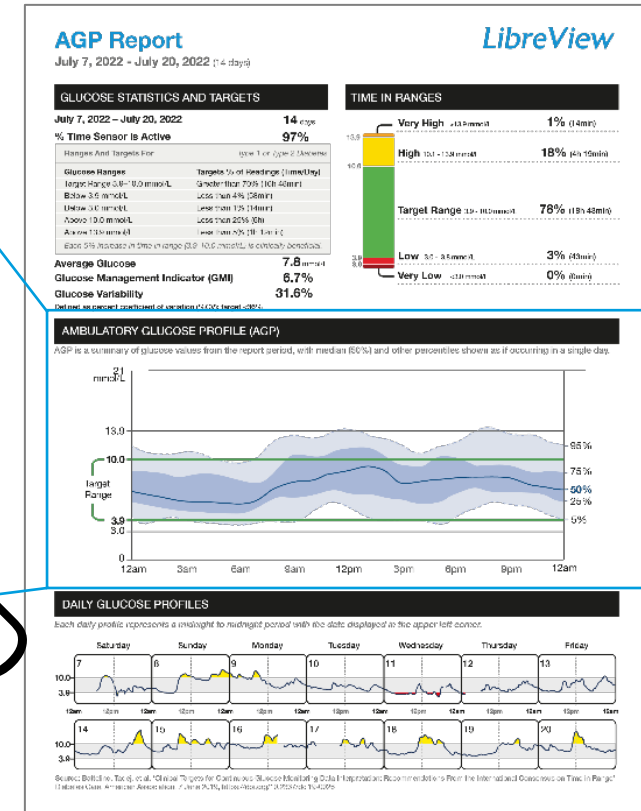
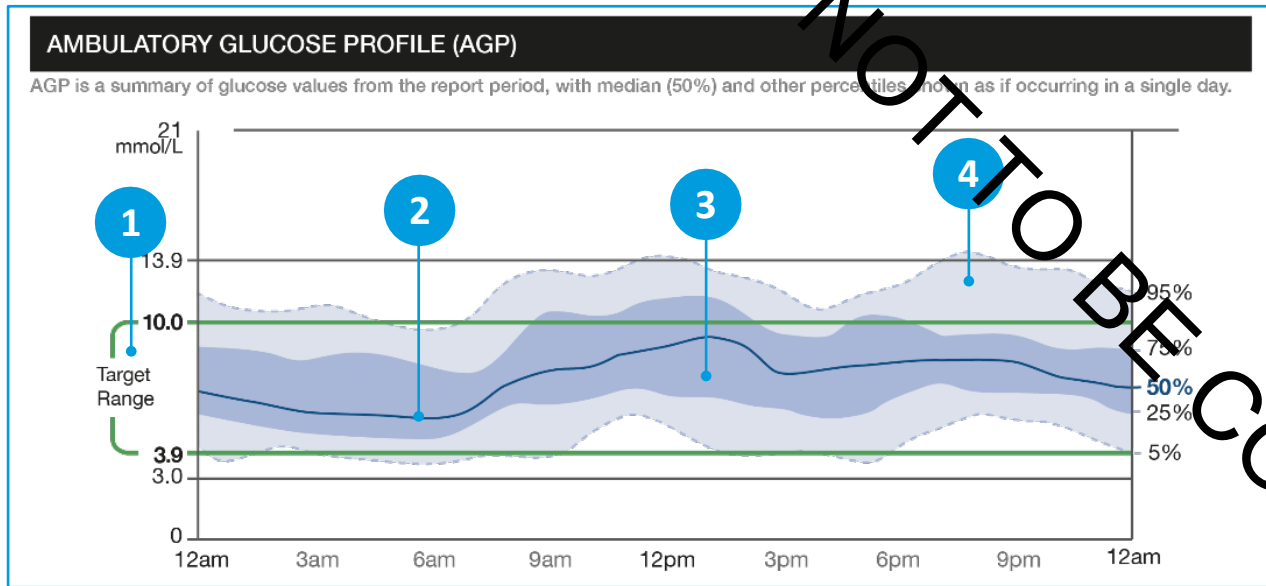
Objective:
More green
Less red



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.

Assess 24-hour glucose profile



- 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.

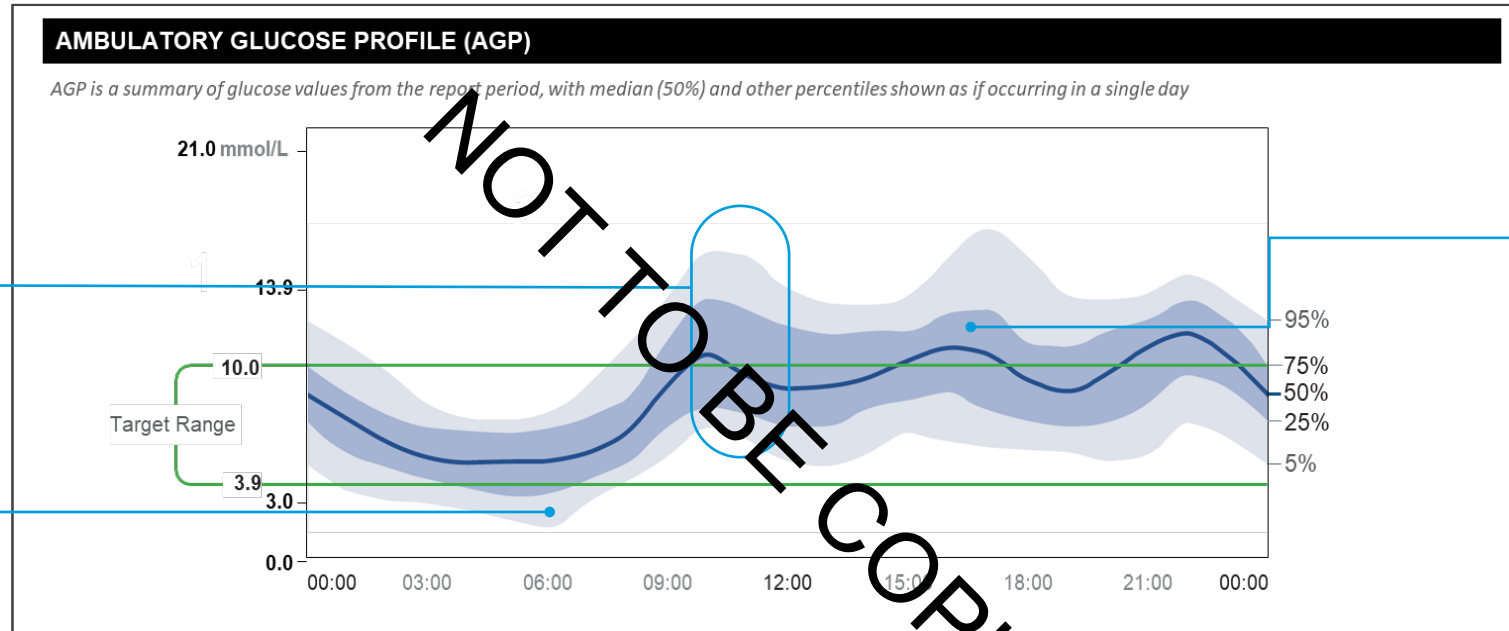
Uncover patterns of hyper- and hypoglycaemia and glycaemic variability

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)

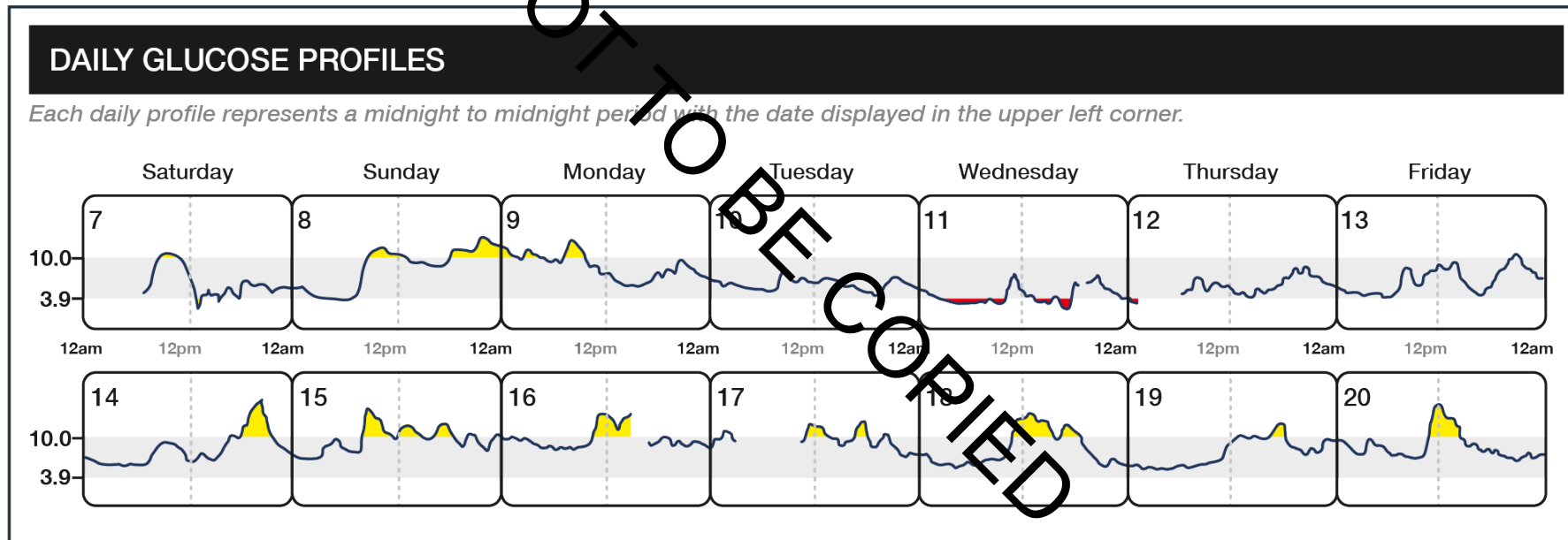
Images are for illustrative purposes only. Not real patient data.

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



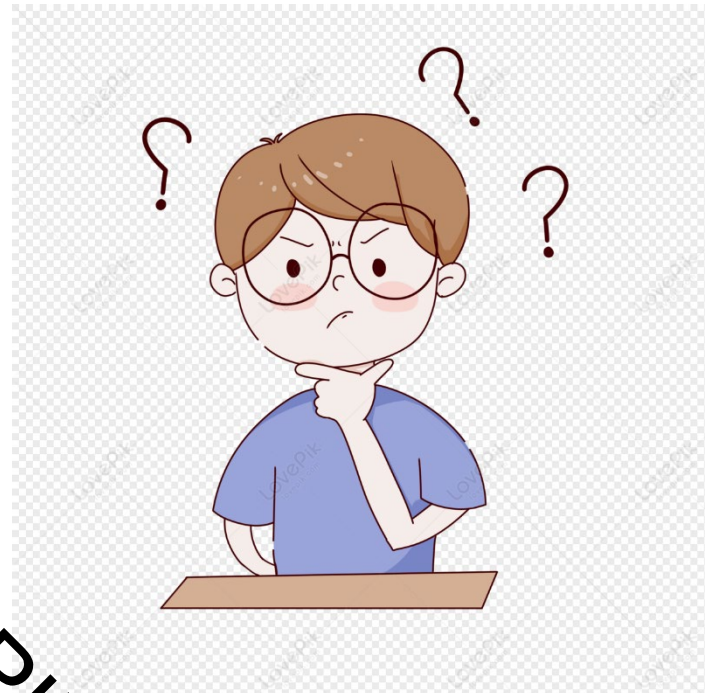
Use these daily glucose values profiles to help guide your patients through a clinical and engaging dialogue

My target pre-meal blood glucose range (mmol/l) ... 4-7

My target post-meal blood glucose range (mmol/l) ... 6.5-8.9

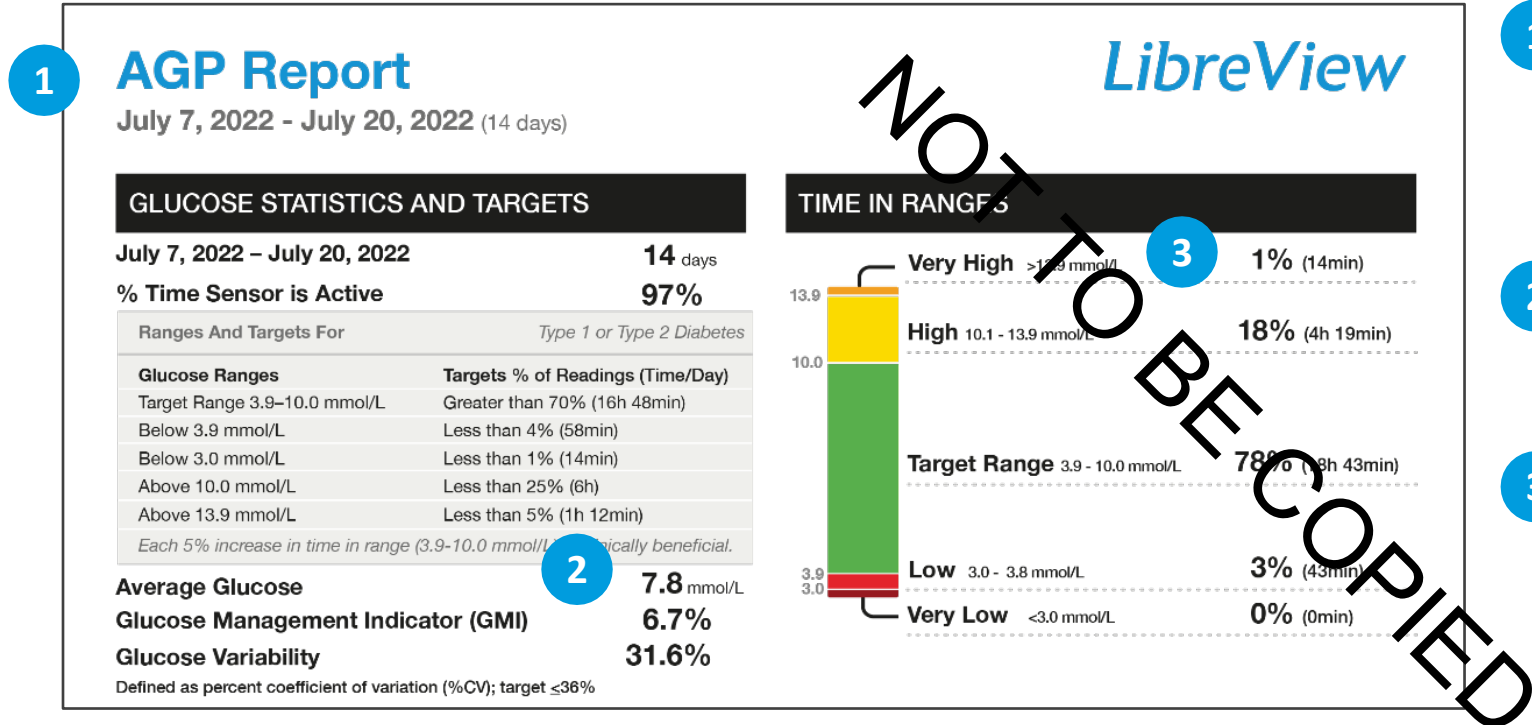
Date	Name of insulin, the insulin dose and injection time		Blood glucose level (mmol/l)							Key points/Notes
			Before breakfast	2 hours after breakfast	Before midday meal	2 hours after midday meal	Before evening meal	2 hours after evening meal	Before bed	
2/3			7.1		9.3		9.0		12.0	
3/3			5.8		5.6		11.0		8.0	
4			9.8		9.0		8.5		5.6	
5			6.9						3.8	
6			4.9		5.5		10		8.0	
7/3			11.2	3.9	8.2		8.5		13.0	
8/3			11.7		9.8		7.9		8.7	
9			6.3	3.4					7.8	
10/3			8.4		7.5		9.8		7.0	

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It's like driving in a strange place without SatNav

Step 1: validate the data, assess TIR and 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 Talk to the patient**

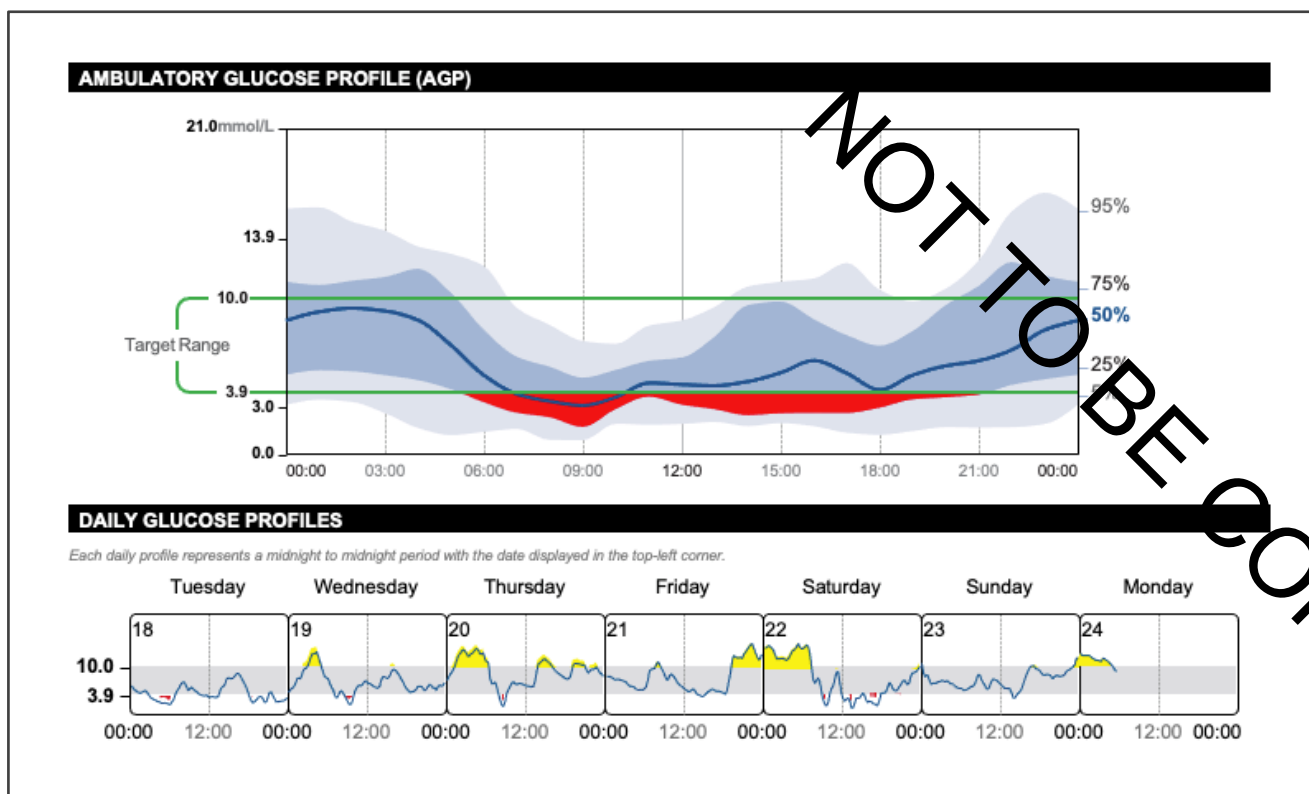
Reinforce positive achievements before focusing on areas for attention.

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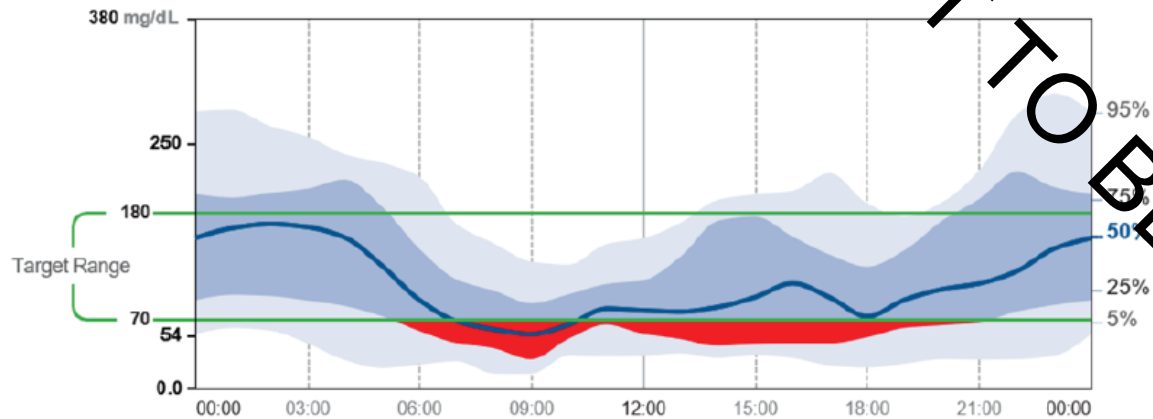
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1. Battelino T, et al. Diabetes Care 2019; 42:1593-1603 doi:10.2337/dci19-0028.



(a) Identify patterns of hypoglycaemia

AMBULATORY GLUCOSE PROFILE (AGP)



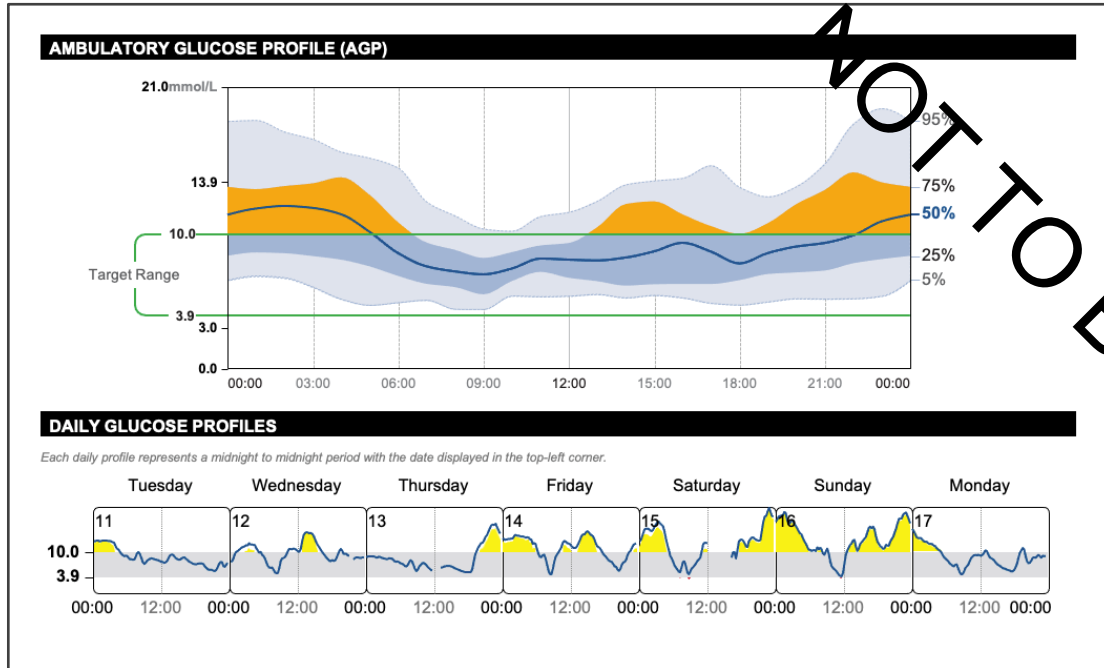
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Possible causes of hypoglycaemia

- Basal insulin dose too high (early-morning hypoglycaemia)
- Prandial insulin dose too high (lunchtime hypoglycaemia)
- Insufficient lunchtime carbohydrate
- Unplanned exercise (early morning run)
- Prandial insulin timing (too far ahead of mealtimes)
- Alcohol consumption before bedtime
- Impaired awareness of hypoglycaemia

Step 3: look for patterns of hyperglycaemia

IS ANY OF THE IQR BAND ABOVE THE TARGET RANGE?



WHAT TIME OF DAY IS HYPERGLYCAEMIA OCCURING?

- 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 hypoglycemia

Medication/insulin

- Timing and Dose
- Missed insulin or diabetes medication

Lifestyle and behaviour's

- Illness/stress
- Activity/daily routine

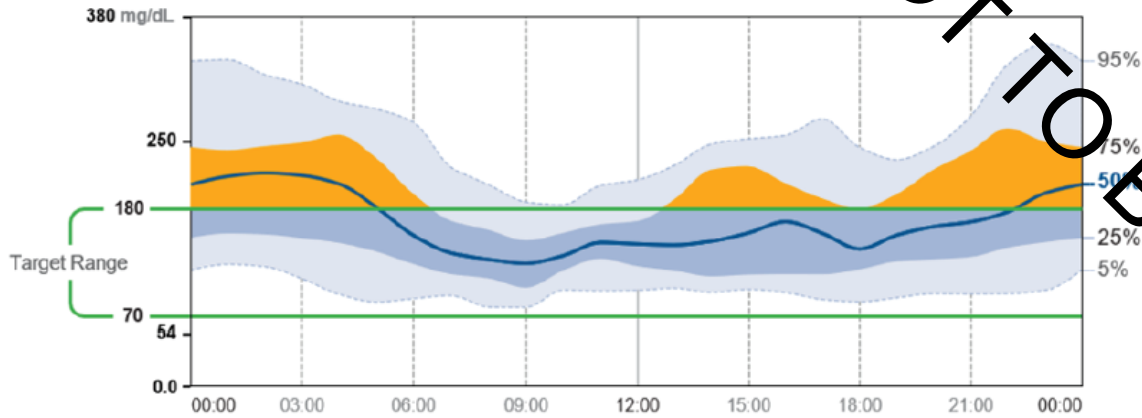
CONFIRM WITH THE DAILY GLUCOSE PROFILES

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



(b) Identify patterns of hyperglycaemia

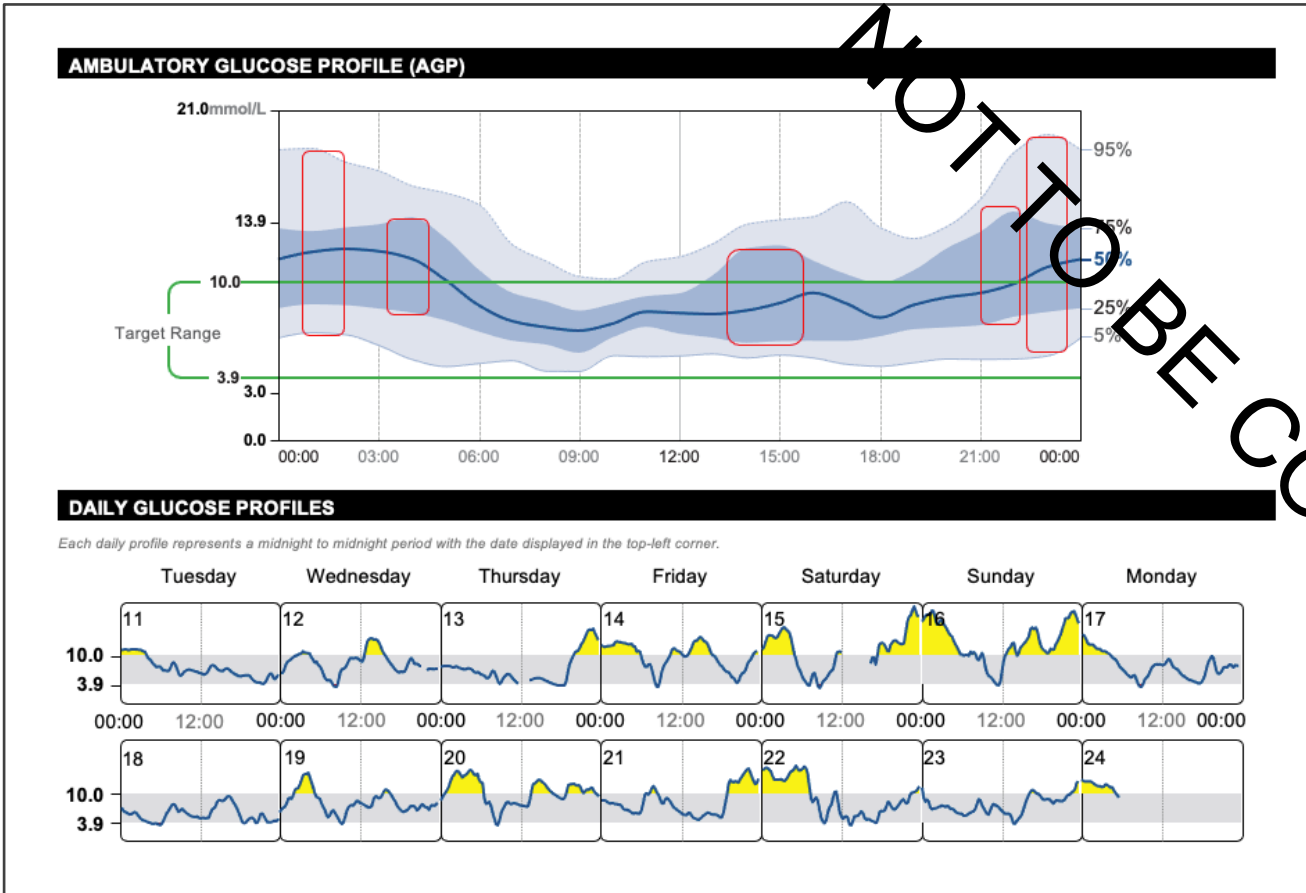
AMBULATORY GLUCOSE PROFILE (AGP)



- Possible causes of hyperglycaemia
- Basal insulin dose too low (overnight hyperglycaemia)
 - Prandial insulin dose too low (after lunch or evening meal)
 - Missed basal or bolus doses
 - Lipodystrophy and insulin malabsorption
 - Large mealtime carbohydrate portion
 - High-fat/protein meals
 - Prandial insulin timing (close to or following mealtimes).
 - Concurrent medication – e.g. steroids

Step 4: look for glucose variability

LOOK FOR A WIDER DARK BLUE AND GREY OUTER BAND



**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

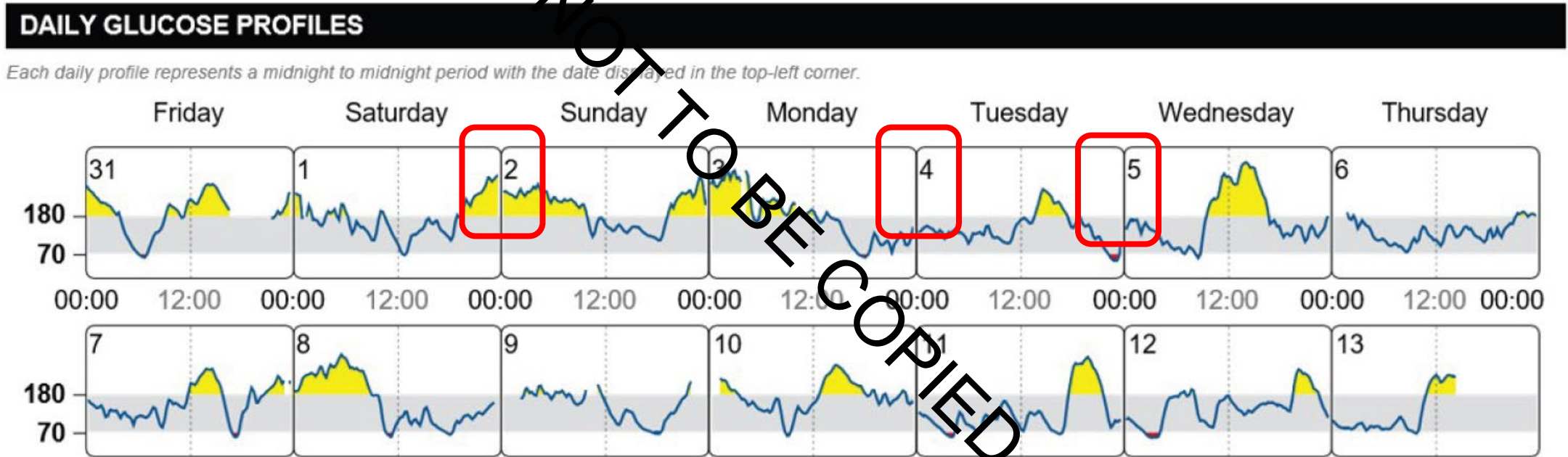
Lifestyle related

• 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?

If glucose variability happens on some days but not others look at the Daily Glucose Profiles



summary

CGM is now available to a wider cohort, many of which are cared for in primary care



depending on sensor type 2-3 sensor will need prescribing monthly, in addition to CBGM strips.



Although the data is presented differently, we still need to focus on:

- reduction of hypoglycaemia
- reduction of hyperglycaemia
- minimising variation

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Thank you for
listening and
any questions?

