Diabetes Technology:

What do we need to know in primary care?

David Miller

General Practice Pharmacist

East Yorkshire

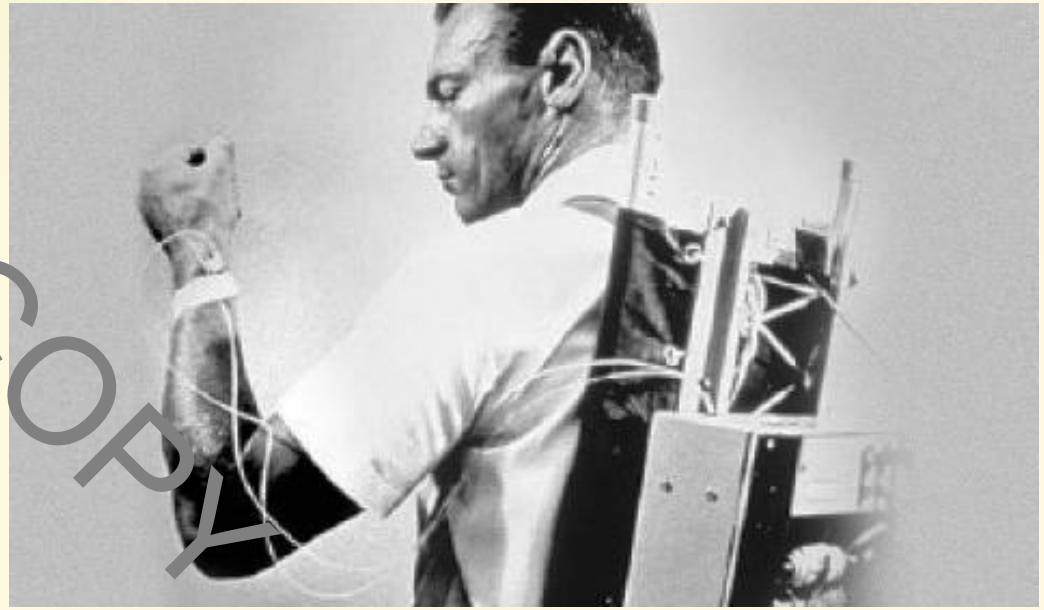


Image from Diabetes Australia website
https://www.diabetesaustralia.com.au/100years/1963-first-prototype-of-a-pump

Disclosures:

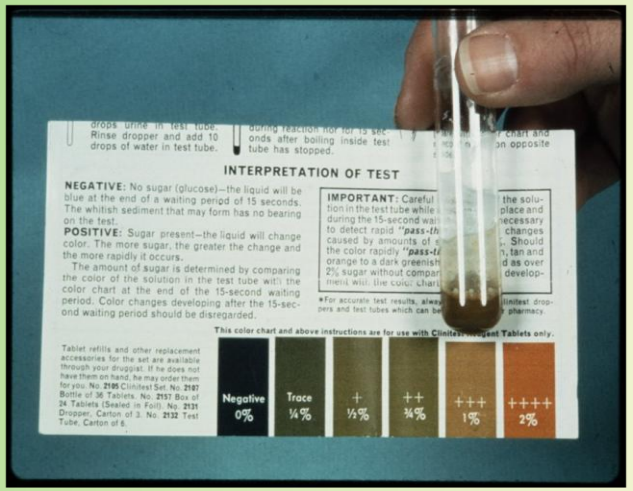
Employed by Greengates Medical Group

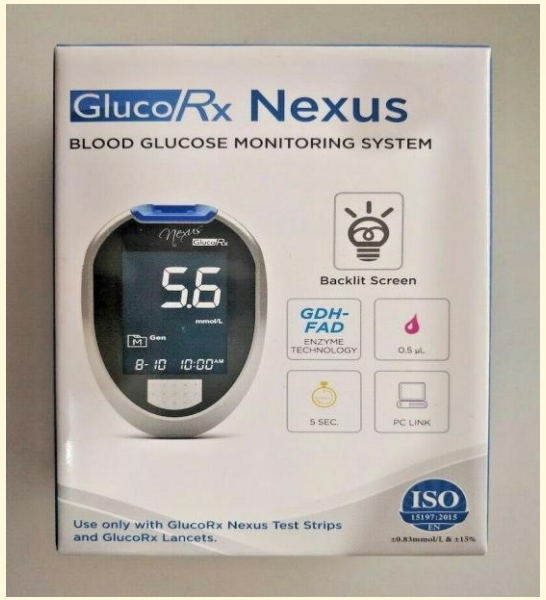
PCDO society committee member

Speaker fees and sponsorship received from:
Abbott, Astra Zeneca, Lily, Novo Nordisk

- Continuous glucose monitoring: What, who and when?
- Essentials of data interpretation
- Hybrid-closed-loop systems
- Smart Insulin Pens
- Data privacy, driving and other medicolegal issues

The evolution of glucose monitoring





Continuous Glucose Monitoring

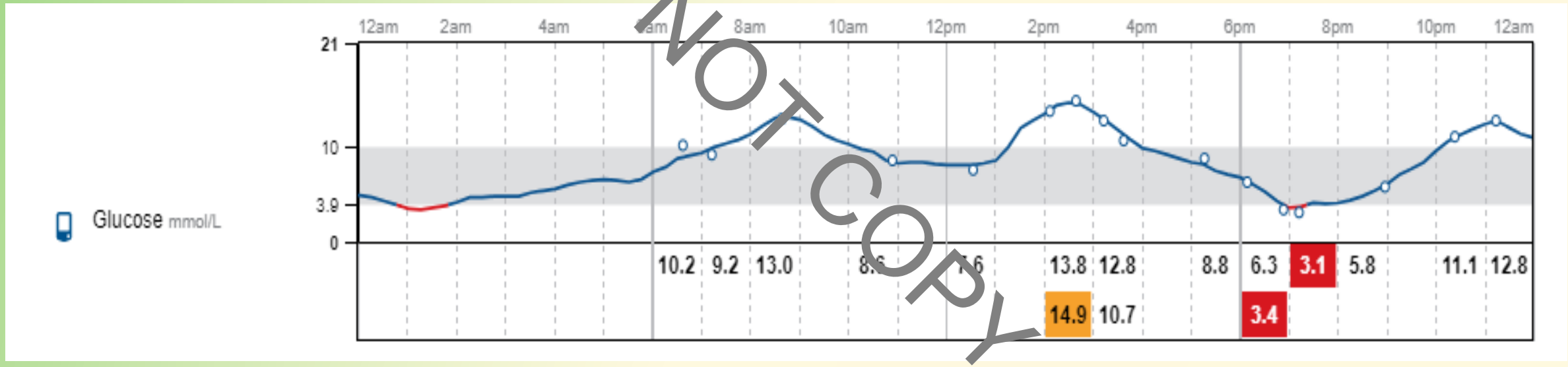
- Measures glucose in interstitial fluid every few minutes, giving real-time data and trends.

- Transmits glucose data by Bluetooth to a reader or a mobile phone app.
- Glucose data can be reviewed on a reader device or on mobile phone which can also share data with an online portal.

Capillary Blood Glucose readings for a random day in January 2025

Time	Blood Glucose (mmol/l)
10pm (night before)	8.9
6.30am	10.2
12.30pm	7.6
6.00pm	6.3
9pm	5.8

Continuous glucose monitoring data for the same random day in January 2025



NHS England Eligibility Criteria

Type 1 diabetes

Type 2 diabetes using two or more daily insulin injections **and**:

- Recurrent or severe hypos.
- Impaired hypo awareness.
- Disability would make finger prick glucose monitoring difficult.
- Advised to finger prick test at least 8 times a day.
- Pregnancy

Or:

- Type 2 diabetes using insulin and would otherwise need help from a care worker or healthcare professional to monitor blood glucose.

(NICE NG28)

NHS Scotland Eligibility Criteria

People with diabetes using two or more daily insulin injections or insulin pump therapy.*

*Guidance specifically recommends flash glucose monitoring, which has largely been superseded by continuous glucose monitoring

Scottish Health Technologies Group advice statement 009-18 (2018)

NHS Wales

People with diabetes who require treatment with insulin.

*Guidance specifically recommends flash glucose monitoring, which has largely been superseded by continuous glucose monitoring.

Health Technology Wales (2021)

Key Metrics

- Time in Range (TIR): Percentage of time glucose is in target range. Usual goal is >70% time in range.
- Time Below Range (TBR): Percentage of time glucose is below range (<3.9mmol/l).
- Glucose variability (calculated from standard deviation of glucose levels): Aim for variability <36%

How to Interpret Data

Case Study: Louise

57 years old
Type 2 diabetes since 2013
Atorvastatin 20mg daily
Metformin 1g twice daily
Empagliflozin 25mg daily
Basal-Bolus regime with Tresiba & Humalog

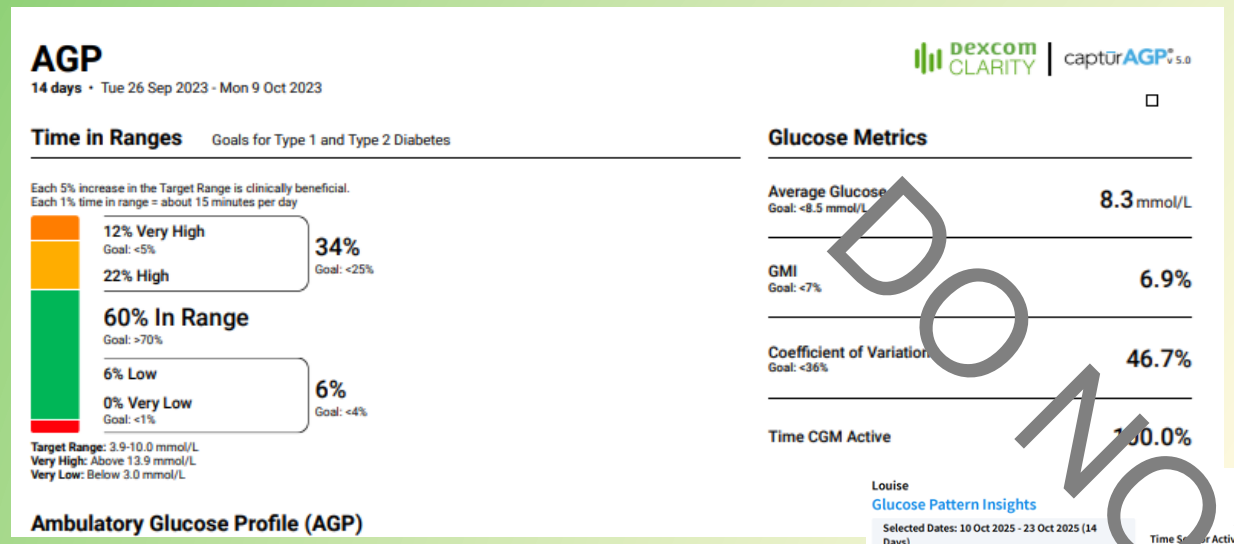
October 2025 annual review:

- BMI 34kg/m^2
- HbA1c: 49mmol/mol

Library photo

“I have the odd hypo now and then.”

How to Interpret Data



AGP

14 days • Tue 26 Sep 2023 - Mon 9 Oct 2023

dexcom CLARITY | captūrAGP v5.0

Time in Ranges

Goals for Type 1 and Type 2 Diabetes

Each 5% increase in the Target Range is clinically beneficial.
Each 1% time in range = about 15 minutes per day

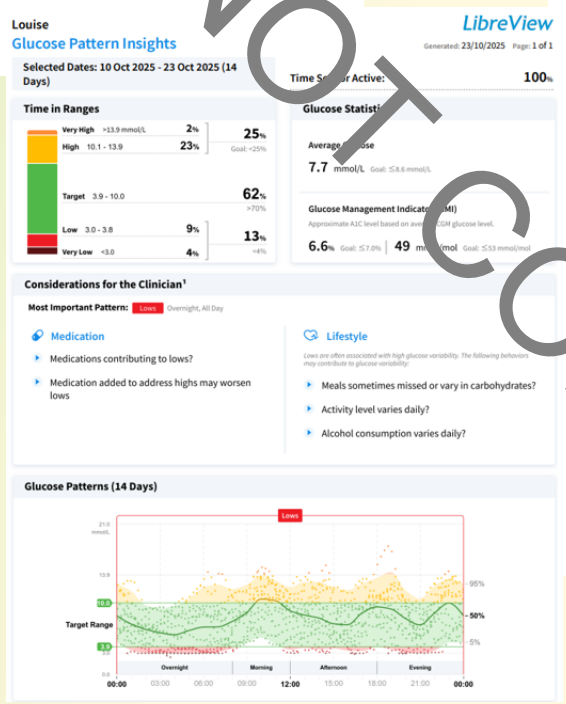
- 12% Very High — Goal: <5%
- 22% High
- **34%** — Goal: <25%
- 60% In Range — Goal: >70%
- 6% Low
- 0% Very Low — Goal: <1%
- **6%** — Goal: <4%

Target Range: 3.9-10.0 mmol/L
Very High: Above 13.9 mmol/L
Very Low: Below 3.0 mmol/L

Glucose Metrics

Average Glucose — Goal: <8.5 mmol/L	8.3 mmol/L
GMI — Goal: <7%	6.9%
Coefficient of Variation — Goal: <36%	46.7%
Time CGM Active	100.0%

Ambulatory Glucose Profile (AGP)



Louise

LibreView

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Glucose Pattern Insights

Selected Dates: 10 Oct 2025 - 23 Oct 2025 (14 Days)

Time Sensor Active: 100%

Time in Ranges

Very High >13.9 mmol/L	2%	25% (Goal: <25%)
High 10.1 - 13.9	23%	
Target 3.9 - 10.0	62%	>70%
Low 3.0 - 3.8	9%	13% (<4%)
Very Low <3.0	4%	

Glucose Statistics

Average Glucose: 7.7 mmol/L Goal: ≤8.6 mmol/L

Glucose Management Indicator (GMI)

Approximate A1C level based on average CGM glucose level.

6.6% Goal: ≤7.0% | 49 mmol/mol Goal: ≤53 mmol/mol

Considerations for the Clinician[1]

Most Important Pattern: Lows Overnight, All Day

Medication

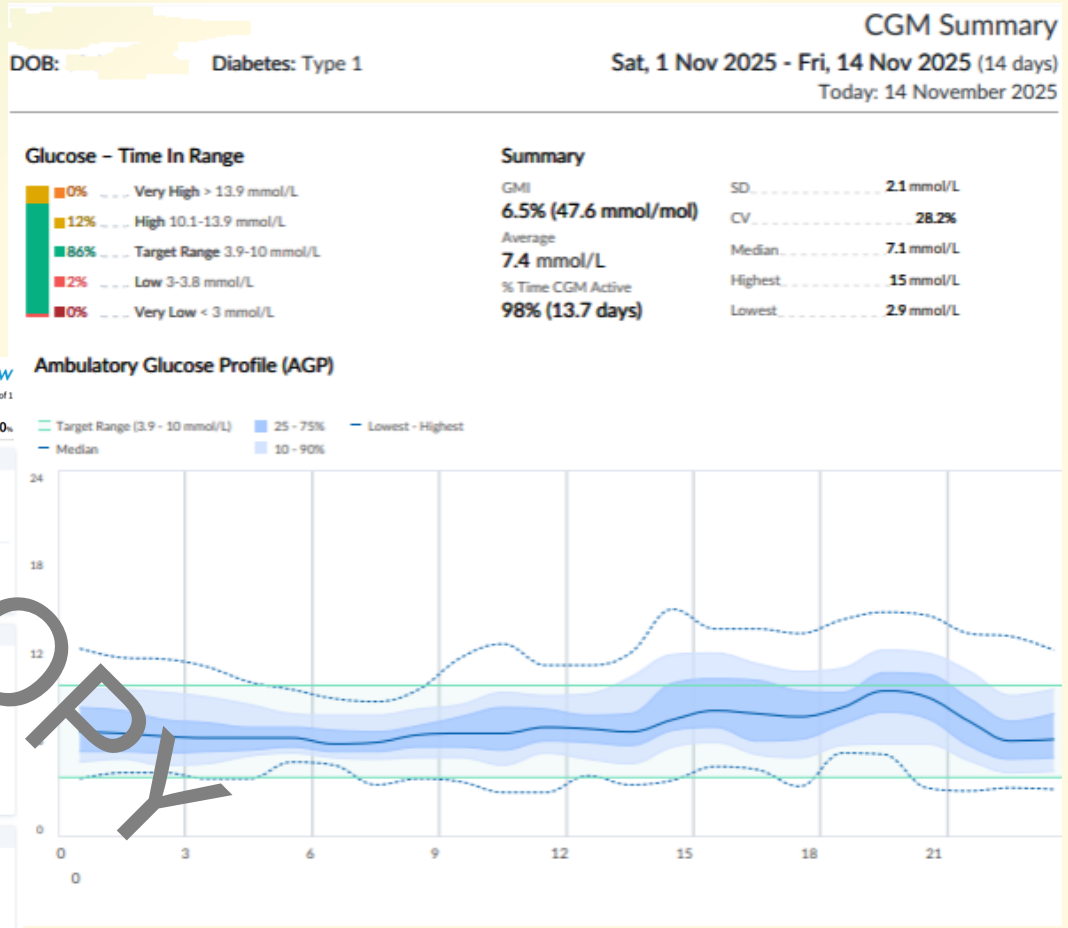
- Medications contributing to lows?
- Medication added to address highs may worsen lows

Lifestyle

Lows are often associated with high glucose variability. The following behaviors may contribute to glucose variability:

- Meals sometimes missed or vary in carbohydrates?
- Activity level varies daily?
- Alcohol consumption varies daily?

Glucose Patterns (14 Days)



CGM Summary

DOB: [redacted] Diabetes: Type 1

Sat, 1 Nov 2025 - Fri, 14 Nov 2025 (14 days)
Today: 14 November 2025

Glucose – Time In Range

0%	Very High > 13.9 mmol/L
12%	High 10.1-13.9 mmol/L
86%	Target Range 3.9-10 mmol/L
2%	Low 3-3.8 mmol/L
0%	Very Low < 3 mmol/L

Summary

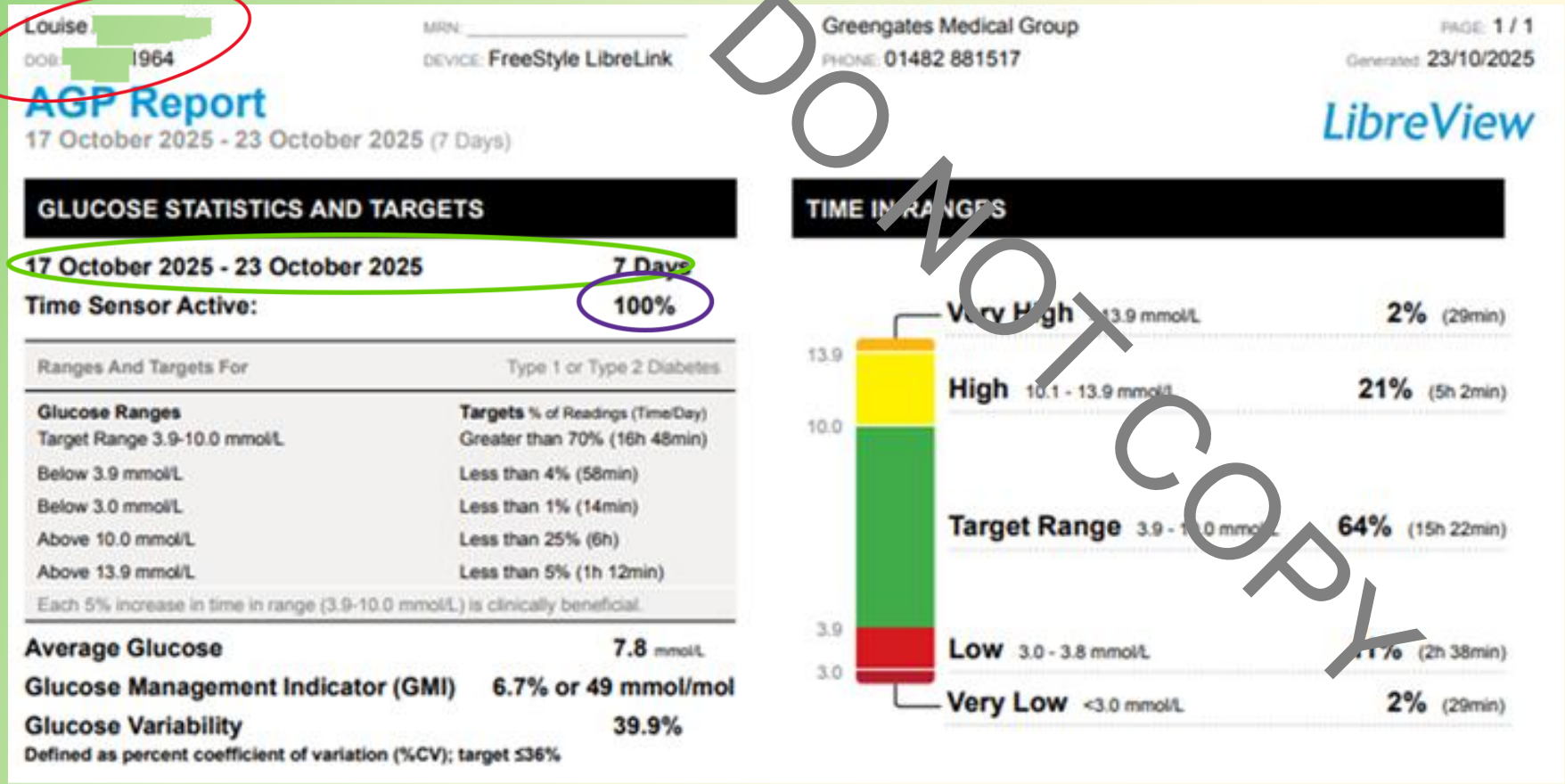
GMI
6.5% (47.6 mmol/mol)
Average
7.4 mmol/L
% Time CGM Active
98% (13.7 days)

SD	2.1 mmol/L
CV	28.2%
Median	7.1 mmol/L
Highest	15 mmol/L
Lowest	2.9 mmol/L

Ambulatory Glucose Profile (AGP)

Target Range (3.9 - 10 mmol/L) — 25 - 75% — Lowest - Highest
Median — 10 - 90%

Case Study: Louise



Louise [redacted]
DOB [redacted]1964
MRN: _____
DEVICE: FreeStyle LibreLink

Greengates Medical Group
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AGP Report

17 October 2025 - 23 October 2025 (7 Days)

LibreView

GLUCOSE STATISTICS AND TARGETS

17 October 2025 - 23 October 2025	7 Days
Time Sensor Active:	100%

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	**7.8** mmol/L
Glucose Management Indicator (GMI)	**6.7% or 49 mmol/mol**
Glucose Variability	**39.9%**

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

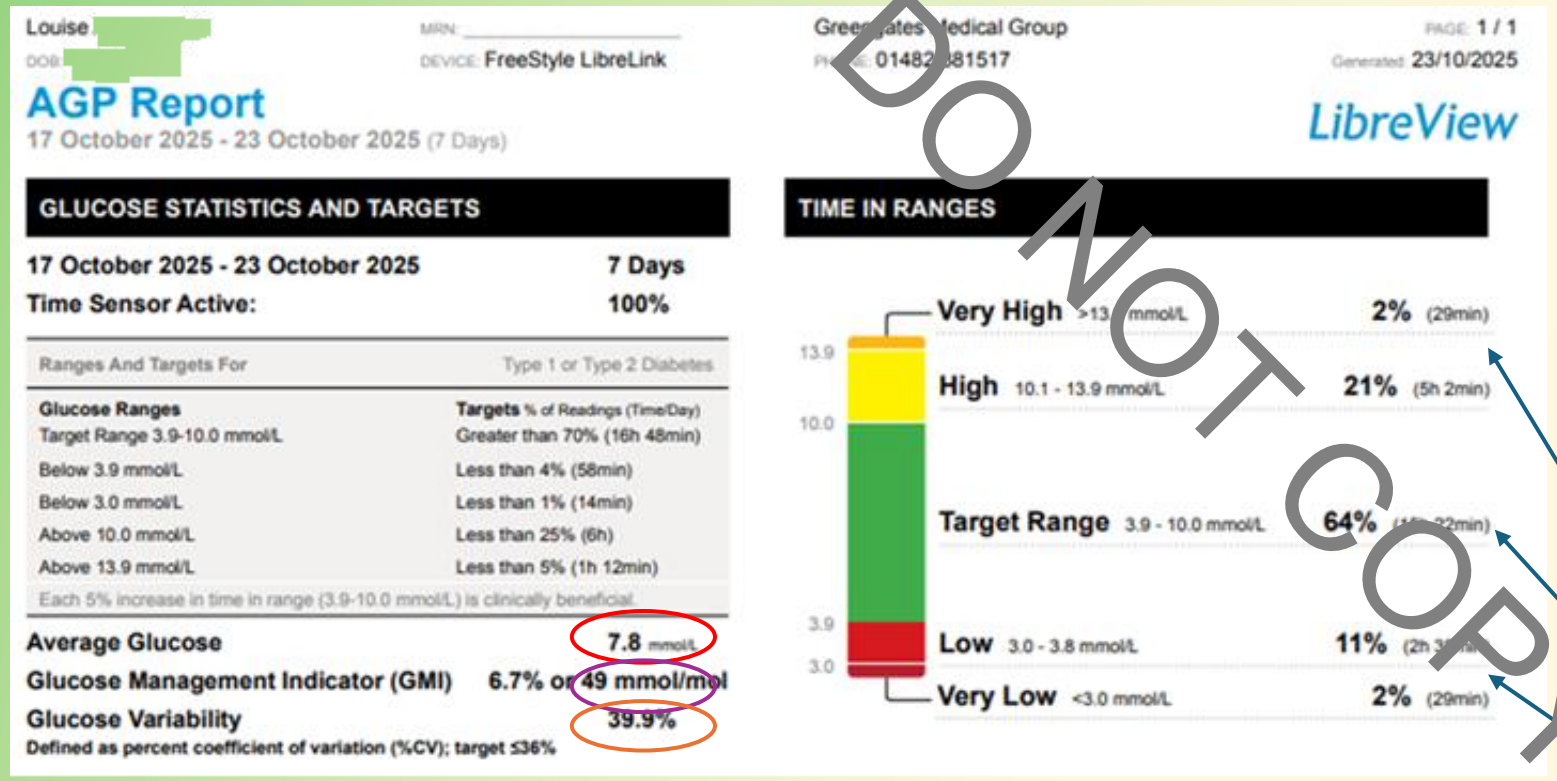
TIME IN RANGES

13.9
10.0
3.9
3.0

Very High	>13.9 mmol/L	2% (29min)
High	10.1 - 13.9 mmol/L	21% (5h 2min)
Target Range	3.9 - 10.0 mmol/L	64% (15h 22min)
Low	3.0 - 3.8 mmol/L	11% (2h 38min)
Very Low	<3.0 mmol/L	2% (29min)

1. Validate data:
   - Correct patient?
   - Right date?
   - Sensor active?

Case Study: Louise



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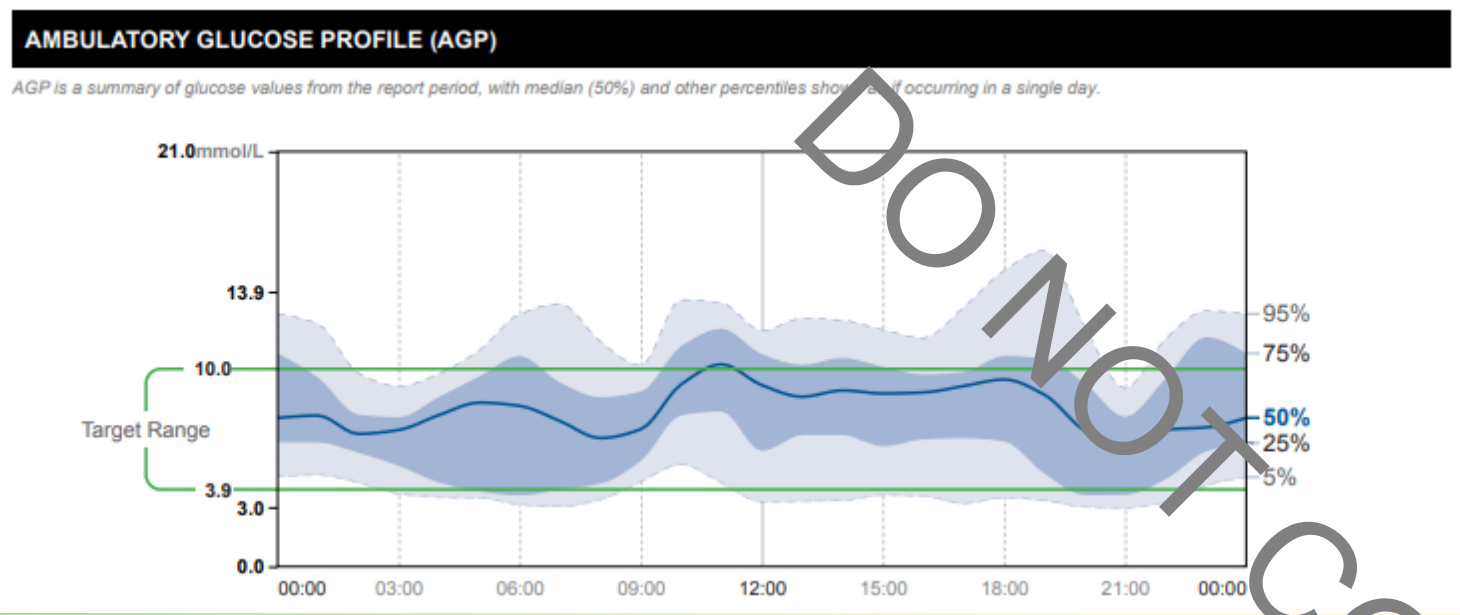
Target Range 3.9 - 10.0 mmol/L — **64%** (15h 22min)
Low 3.0 - 3.8 mmol/L — **11%** (2h 3[redacted])
Very Low <3.0 mmol/L — **2%** (29min)

2. Glucose metrics:

- Mean glucose
- Glucose management indicator
- Glycaemic variability (s.d./mean)
- Time Above Range
- Time In Range
- Time Below Range

Case Study 2: Louise



3: Ambulatory Glucose Profile (AGP):

- Time In Range:
  - Targets
- Time Below Range:
  - When? Patterns?
  - How low?
- Time Above Range.

Table 1. Time In Range targets for continuous glucose monitoring (Battelino et al, 2019).

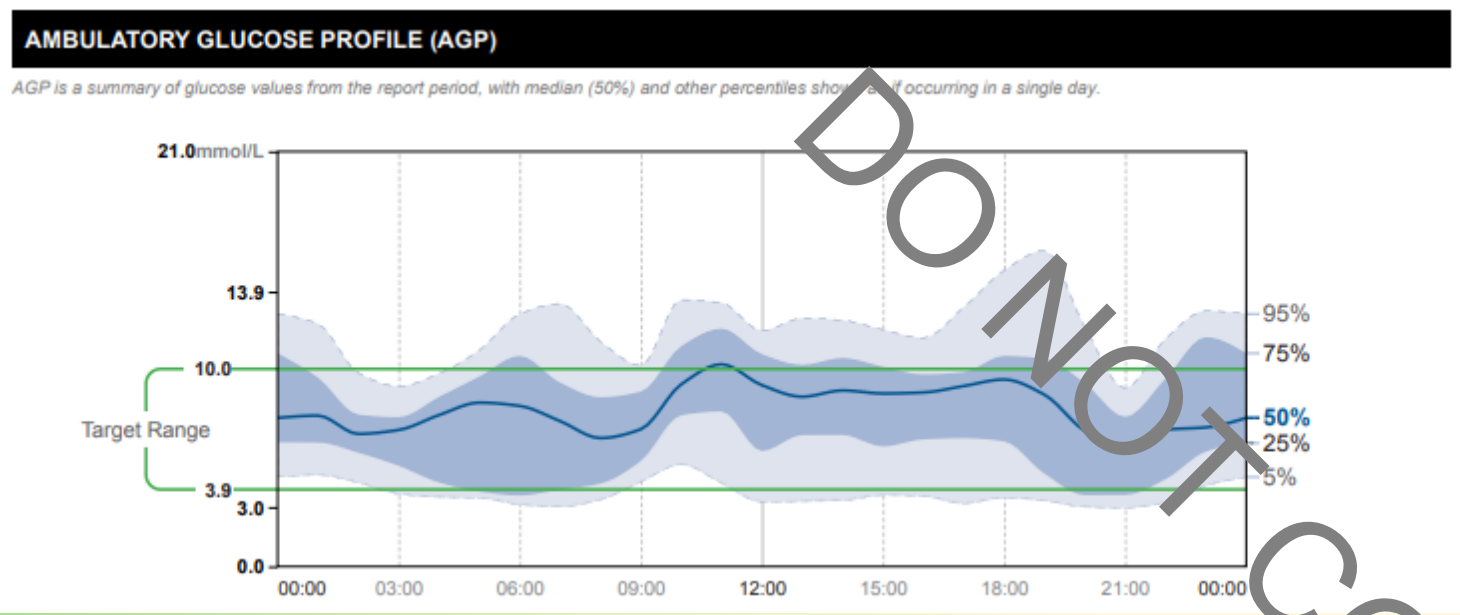
Patient group	Target range	TIR target (% of readings)	TBR target (% of readings)	TAR target (% of readings)
Type 1 diabetes*	3.9–10.0 mmol/L	>70%	<4% (<1% for <3.0 mmol/L)	<25% (<5% for >13.9 mmol/L)
Type 2 diabetes	3.9–10.0 mmol/L	>70%	<4% (<1% for <3.0 mmol/L)	<25% (<5% for >13.9 mmol/L)
Pregnancy (T1D)	3.5–7.8 mmol/L	>70%	<4% (<1% for <3.0 mmol/L)	<25%
Pregnancy (T2D and GDM)	3.5–7.8 mmol/L	Not specified, but >90% achievable	Not specified, but <4% (<1% for <3.0 mmol/L)	Not specified, but <5% achievable
Older/high-risk (T1D or T2D)	3.9–10.0 mmol/L	>50%	<1%	<50% (<10% for >13.9 mmol/L)

*For age <25 years, if aiming for HbA_{1c} ≤58 mmol/mol (7.5%), set TIR target at approximately 60%.

GDM=gestational diabetes; T1D=type 1 diabetes; T2D=type 2 diabetes; TAR=Time Above Range; TBR=Time Below Range; TIR=Time In Range.

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

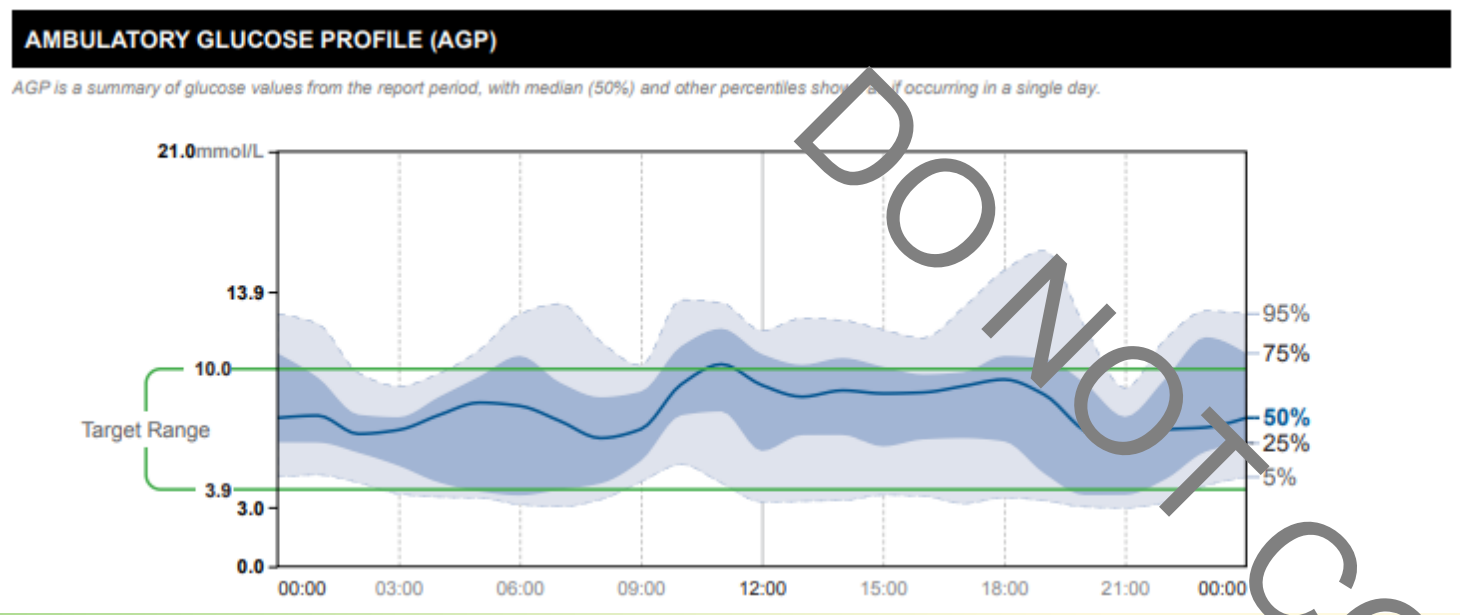
Case Study 2: Louise



4: Review AGP for each part of the day:

- Overnight.
- Meals: Is glucose returning to baseline after food?
- Physical Activity.

Case Study 2: Louise



5: Assess Variability:

- Different activity on some days?
- Alcohol?
- Look at individual day-to day analysis.

Closing the consultation:

- Highlight the positives
- Summarise main points from AGP:
- Reinforce one key message:
  - Prioritise addressing hypoglycaemia.
  - Next, focus on addressing Time Above Range.
  - Then review variability: Carb counting? Pre-bolousing? Exercise? Stress?
- Avoid making changes without a clear pattern. More data may be needed.

Driving: Group 1 (Cars) AND Group 2 (lorry and bus)

Updated 7 Nov 2025

- Continuous Glucose Monitoring (CGM)*
  or
- Finger prick glucose monitoring

- Carry monitoring equipment at all times

- Check glucose level at least twice a day, even on non-driving days

- Check glucose level just before driving and at least every 2 hours during your journey

- Pull over safely before checking glucose

- Keep a finger-prick monitor as backup and to confirm glucose level if CGM device or sensor isn't working, or doesn't reflect symptoms

- Carry ID showing you have diabetes managed with insulin in case of an accident

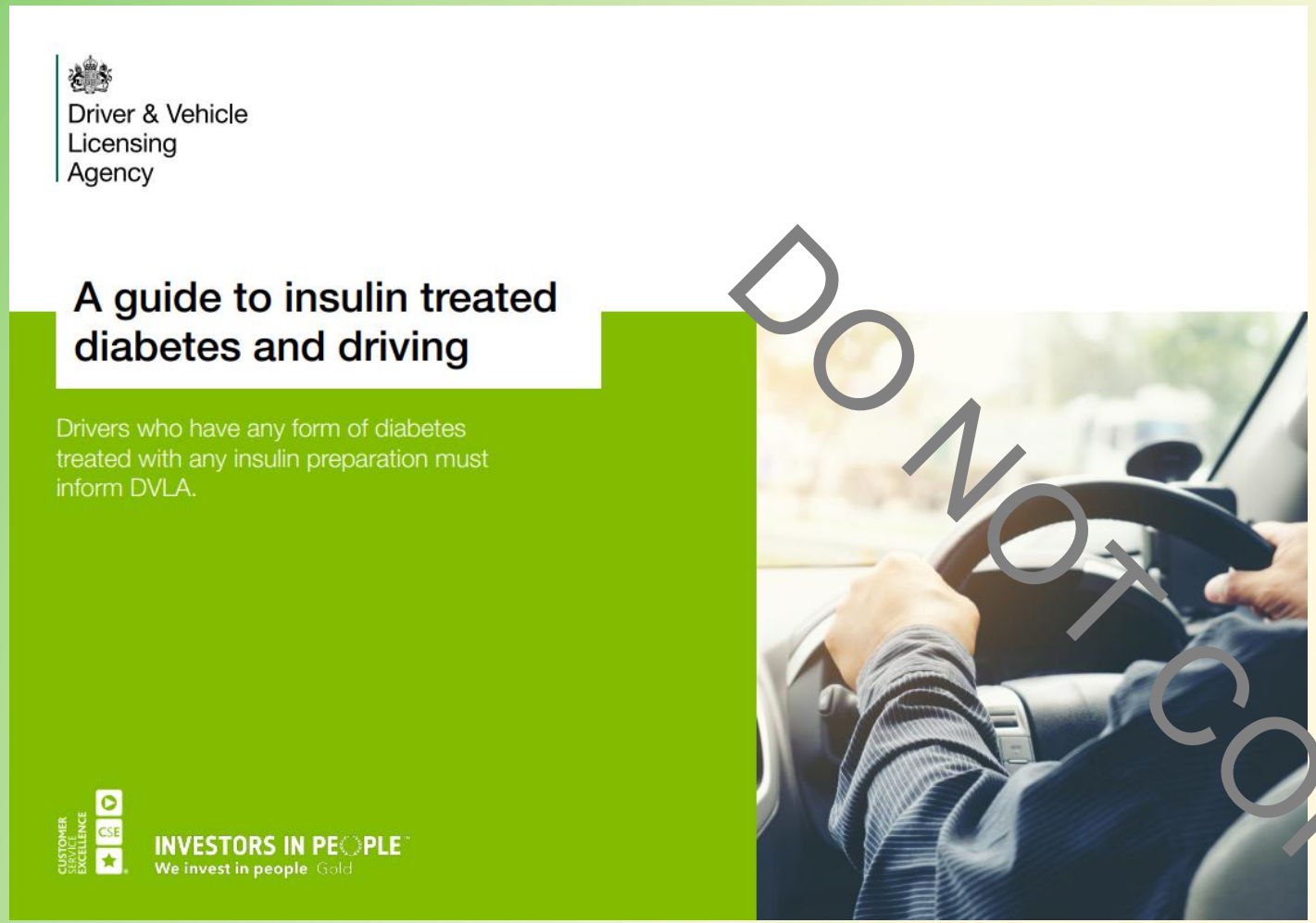
- Don't drive if glucose is 4.0mmol/L or below.

- If glucose is between 4.0 mmol/L and 5.0mmol/L, eat a fast-acting carbohydrate snack before driving

- Low glucose levels while driving:
  - Stop the vehicle safely as soon as possible
  - Switch off engine and remove the keys from ignition
  - Wait at least 45 minutes after glucose levels have return to at least 5.0mmol/L or above before driving again

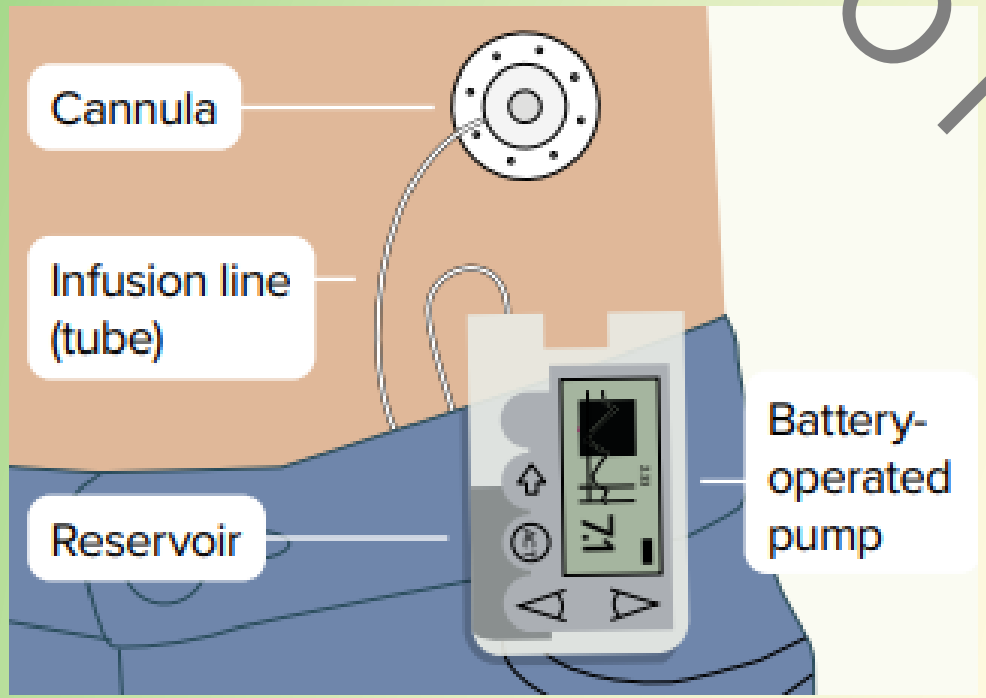
- Eat regular meals or snacks and take breaks on long journeys

* Use an approved CGM device that's non-adjunctive



https://tinyurl.com/3kh6eyps

Continuous Subcutaneous Insulin Infusion (CSII or 'Insulin Pump') for type 1 diabetes

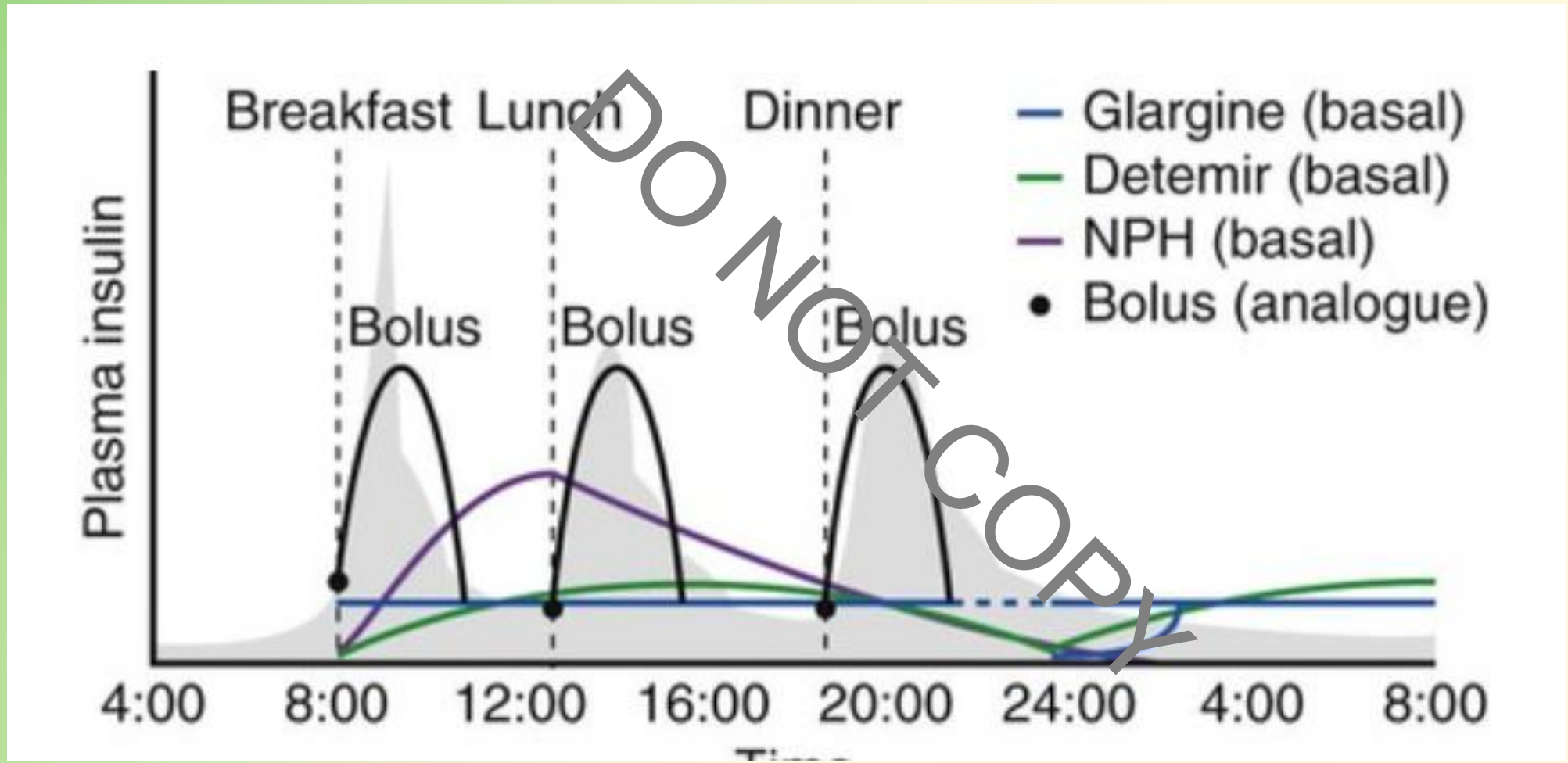


Graphic from NHS England leaflet: Making a decision about managing type 1 diabetes. (2024)

CSII/Insulin pumps

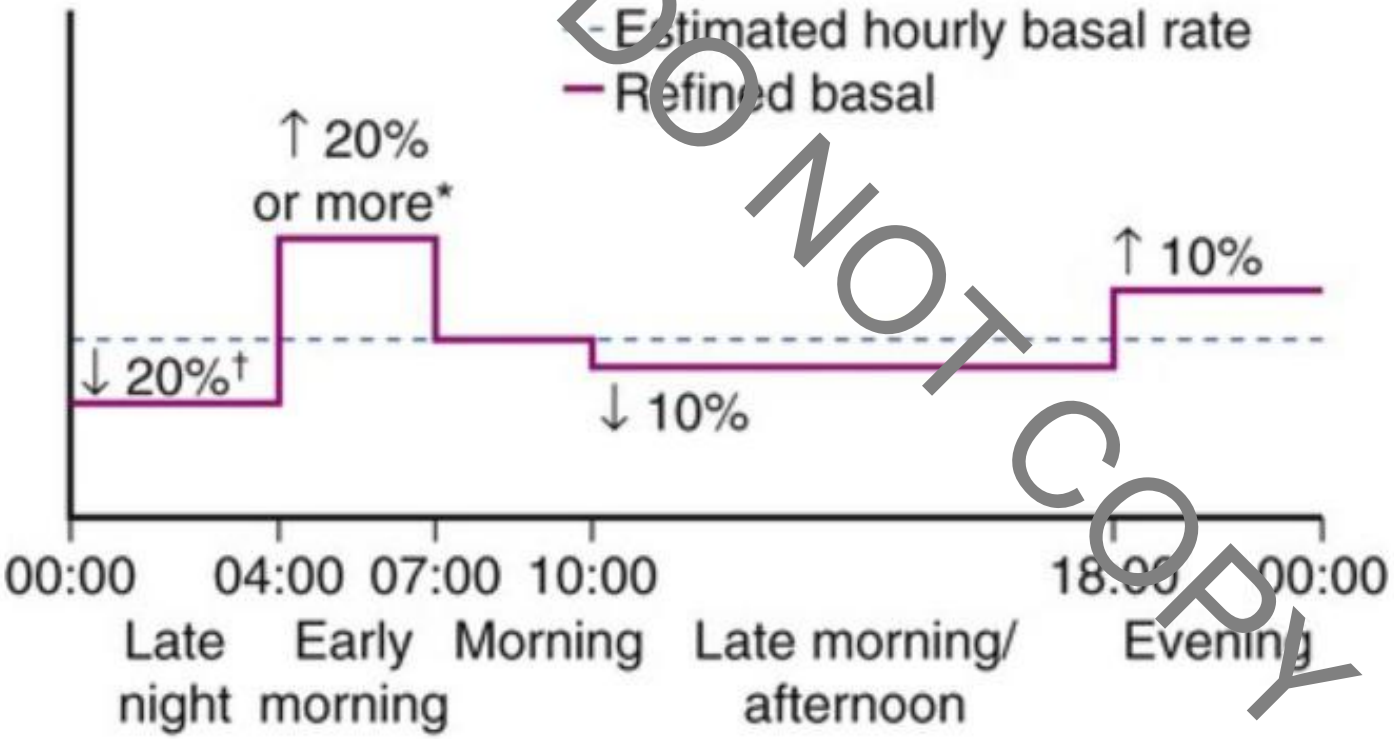
- Battery powered pump delivers short-acting insulin via subcutaneous cannula.
- Continuous background insulin over 24 hours.
- Extra bolus doses administered as required for meals and/or correcting doses.
- Can be tethered or 'patch pump'.

MDI Basal-Bolus Regime



Graph from Insulin Pumps and Continuous Glucose Monitoring Made Easy, Hussain & Oliver, 2016

Pump basal profile set up for usual circadian rhythm

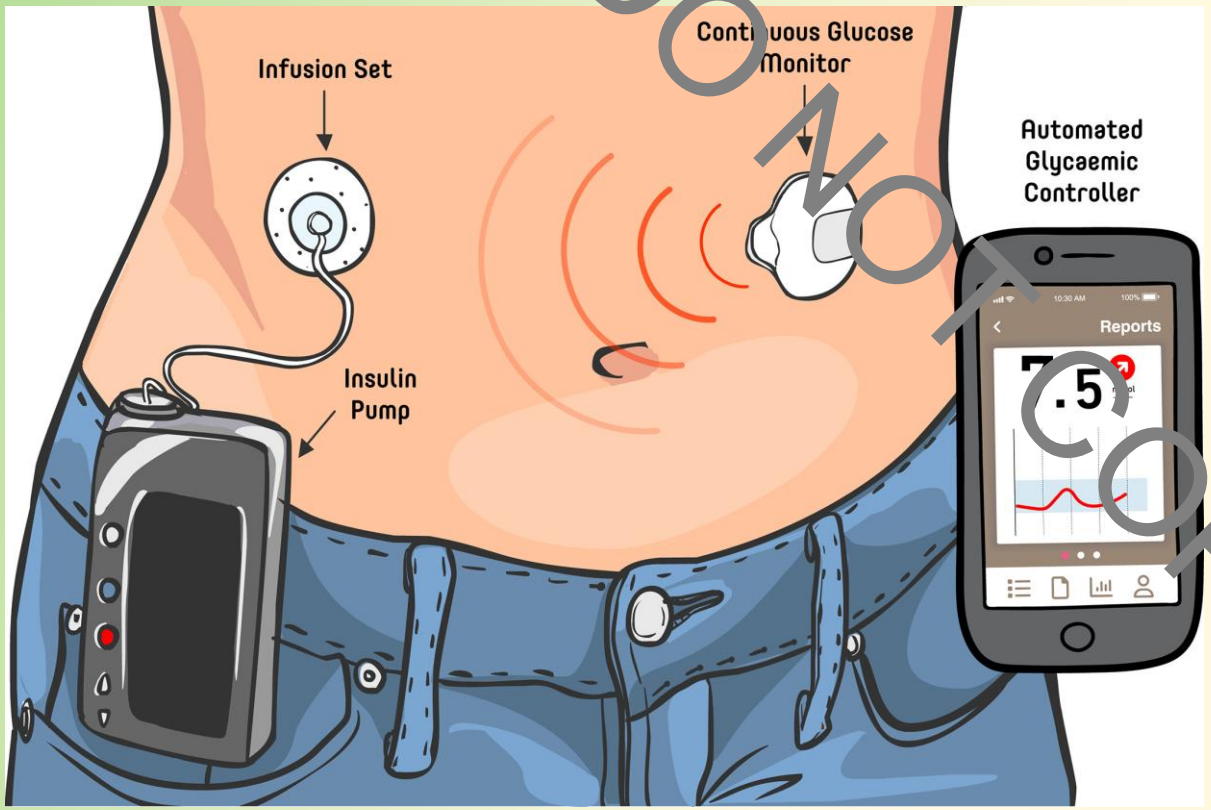


Graph from Insulin Pumps and Continuous Glucose Monitoring Made Easy, Hussain & Oliver, 2016

Considerations for primary care:

- Insulin pens for multiple daily injections back-up is essential.
- Ketone testing equipment must always be available.
- Ensure patient knows pump-specific ‘Sick Day Rules’.
- MDI dosages should be recorded in case needed in future.
- Insurance for insulin pump.

Hybrid Closed Looping for type 1 diabetes (‘Articial Pancreas System’)



Graphic from: UK's Association of British Clinical Diabetologist's Diabetes Technology Network (ABCD-DTN): Best practice guide for hybrid closed-loop therapy

Hybrid Closed Loop

- Insulin pump connects to CGM via Bluetooth
- Basal insulin delivery is managed by algorithm, informed by CGM, to keep glucose in range.
- Extra bolus doses still need to be administered as required for meals.
- Need to set algorithm for exercise (‘ease-off’ mode) or illness/stress (‘boost mode’).

England, Wales & Northern Ireland: Eligibility Criteria for Hybrid Closed Loop (NICE TA 943, December 2023)

HbA1c of 58 mmol/mol or more, or have disabling hypoglycaemia, despite best possible management with at least 1 of the following:

- continuous subcutaneous insulin infusion (CSII)
- real-time continuous glucose monitoring
- intermittently scanned continuous glucose monitoring.

- HCL systems are recommended as an option for managing blood glucose levels in type 1 diabetes for children and young people.

- HCL systems are recommended as an option for managing blood glucose levels in type 1 diabetes for women, trans men and non-binary people who are pregnant or planning to become pregnant.

(Plan for roll-out varies from country to country)

Scotland: Eligibility Criteria for Hybrid Closed Loop (SIGN 170, March 2024)

Closed-loop systems should be available to people with type 1 diabetes (paediatric and adult) who:

- Under their current diabetes care plan continue to have suboptimal glycaemic control, a high risk of severe hypoglycaemia, or impaired awareness of hypoglycaemia.

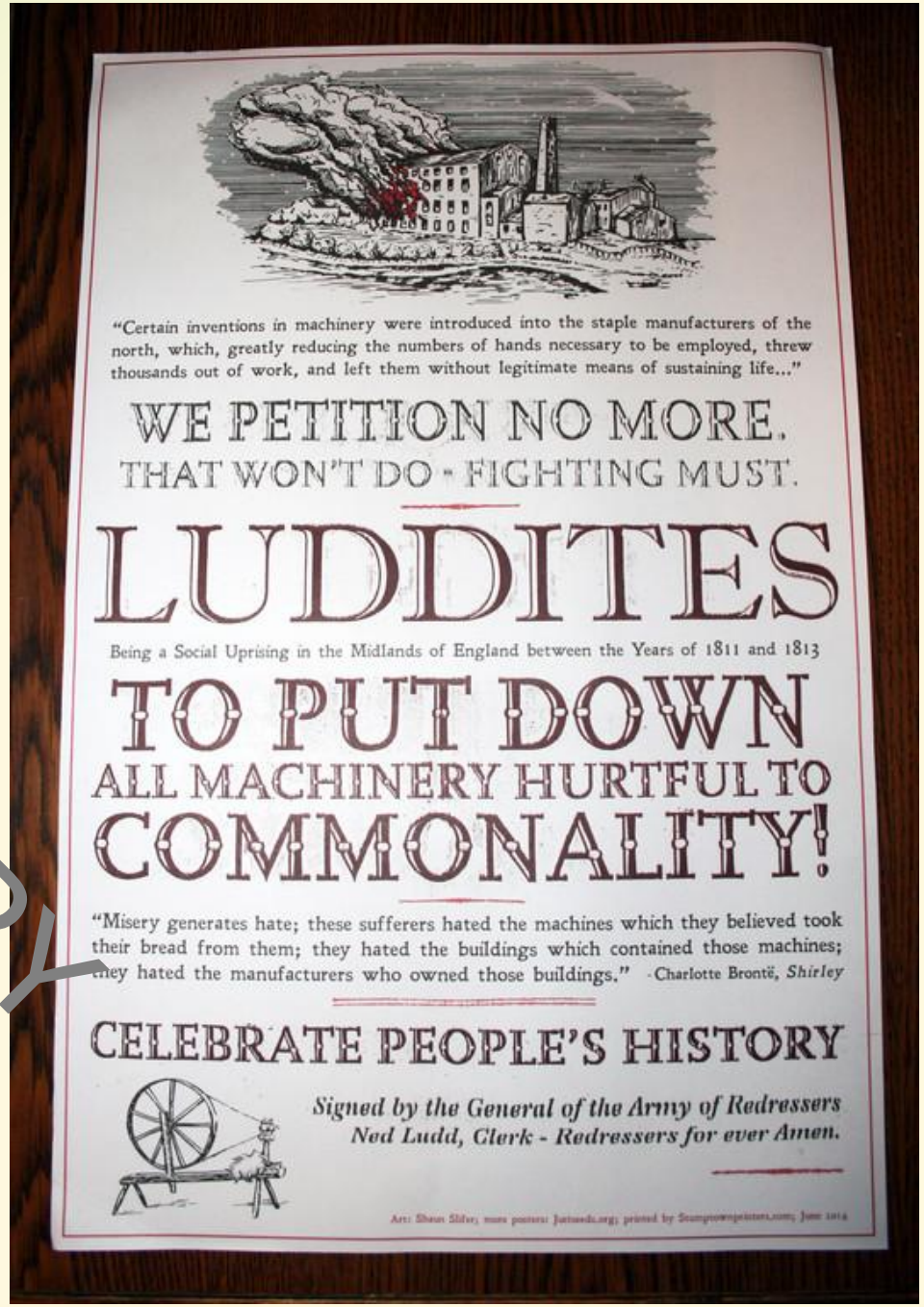
or

- Experience diabetes-related distress, measured using a validated tool, that adversely affects quality of life or their ability to manage diabetes, and which is likely to be improved by moving to a closed-loop system.

Considerations for primary care:

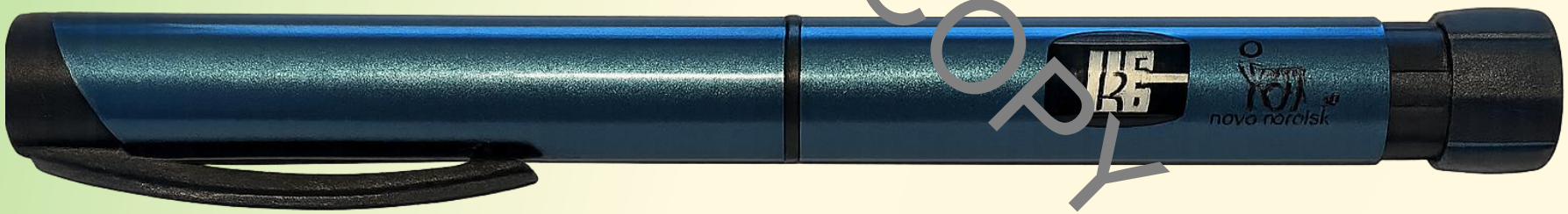
- Equipment for multiple daily injection back-up is essential.
- MDI dosages should be recorded in case needed in future.
- Ketone testing equipment must always be available.
- Ensure patient knows pump-specific ‘Sick Day Rules’.
- Insurance for insulin pump.

But not everyone likes technology…



Smart Insulin Pens

- Ordinary looking insulin pens



Smart Insulin Pens

Log dose, time and date of insulin administration

Smart Insulin Pens

Can transfer data to Librelink or Glooko apps.

Smart pen compatibility

Fiasp Levemir* Novomix 30 Novorapid Tresiba 100 units/ml *RIP late 2026	Novopen 6 Novopen Echo Plus	Units Half-units	1 to 60 units 0.5 to 30 units	Blue Silver Teal Red

Compatible with LibreLink and Glooko mobile apps

(Also Medtronic InPen, links with Simplera CGM system. Not available on FP10)

NHS

Making a decision about **managing type 1 diabetes**

What is this leaflet?

This leaflet is for people with type 1 diabetes.

It can help you decide between the different technology available to manage diabetes.
There are some parts for you to fill in.
You should go through this leaflet and then talk to your diabetes team.

Measuring glucose

Insulin and insulin pens

Insulin pumps

Hybrid closed loop systems

https://tinyurl.com/3bcnscwa

Data Protection

- **Know the Legal Frameworks**

CGM data is *special category health data* under **UK GDPR** and the **Data Protection Act 2018**.
Common Law Duty of Confidentiality also applies.

- **Use the Right Lawful Basis**

Patient consent must be freely given and withdrawable. **Public task** (NHS care provision), **Legitimate interest** (clinical management) and **Legal obligation** (e.g. safeguarding) must also be considered.

- **Be 'App-Savvy'**

Patients must be made aware that CGM platforms (e.g. LibreView, Dexcom Clarity, Glooko) share data via the via cloud. They should be told who sees their data, and how it's stored and shared
Apps and cloud portals must meet **NHS Digital Standards**

- **Keep Data Secure**

CGM data must be stored using encrypted systems, with access limited to authorised personnel.
CGM data should not be stored longer than needed.

- **Support Patient Rights**

Patients must be able to access their CGM data, request corrections and understand how their data is used.
Clear **privacy notices** should be used.

Summary:

- CGM is no longer a secondary care thing.
- Pump use is only going to increase. We need to increase our familiarity and know how to keep our patients safe.
- Smart pens are a good option for people who don’t like technology.