The role of Flash Glucose Monitoring (FGM) in diabetes education to manage hypoglycaemia unawareness

Melissa Lee Kar Yan

Admiralty Medical Centre

Ms. LBH

48 years old/Female/Malay
Wt: 59kg, BMI: 31.6 kg/m²

Type 1 DM (Brittle) - 27 yrs
- Cx Gastroparesis & Hypo Unaware
- Late mother had DM

Primary Hypothyroidism
- (Hashimoto) for 19 years

HbE Heterozygous
- Fe Deficiency Anemia (Hb 7.4-9.5)

HTN & HLD - 12 yrs

***Multiple admissions to A&E due to Severe hypogly & DKA requiring ICU*

Supportive family
- Lives with sister
- 7 siblings

Unemployed
- Clinic assistant until 2012, Cashier 2013, NLB 2014-March 2018, Clinic assistant Jan-March 2019

Non-smoker, non-drinker

***Observes Ramadan until 2017*

Chronology

SMBG
Insulin Pump
CGMS
Carb Count

Libre 1.0
Libre 1.1

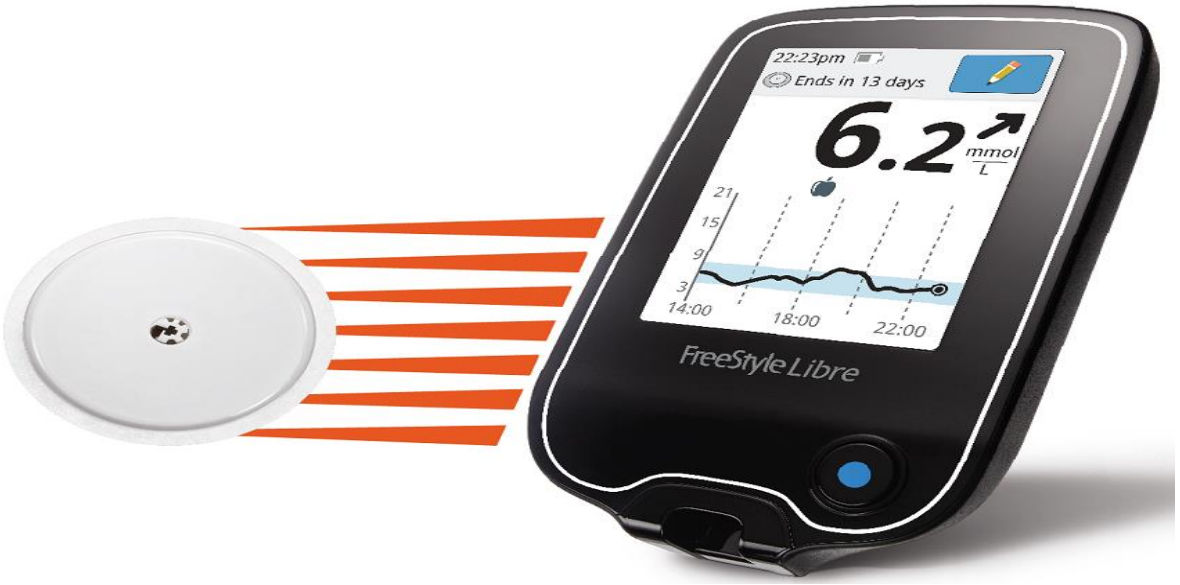
Libre 2

Libre 3

Libre 4

Feb18 : DKA
May18 : Hyperglycaemia
May18 : Severe Hypoglycaemia

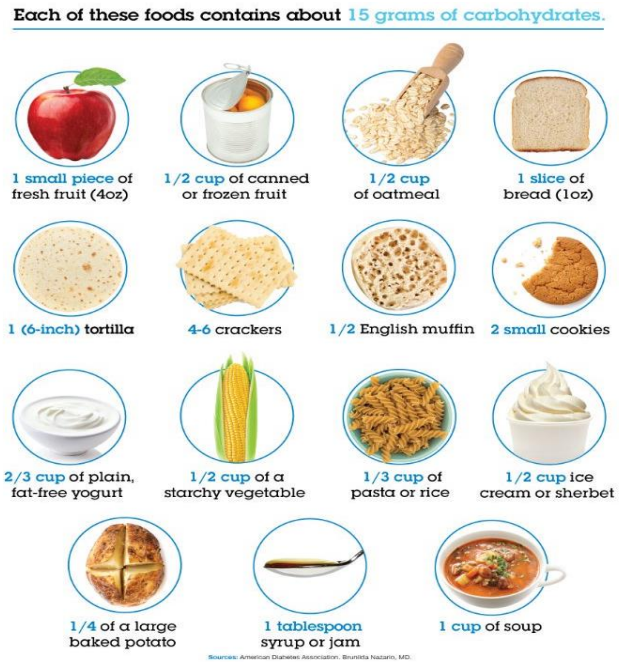
Before 2018 → **June 2018** → **August 2018** → **October 2018** → **January 2019**



Challenges before 2018

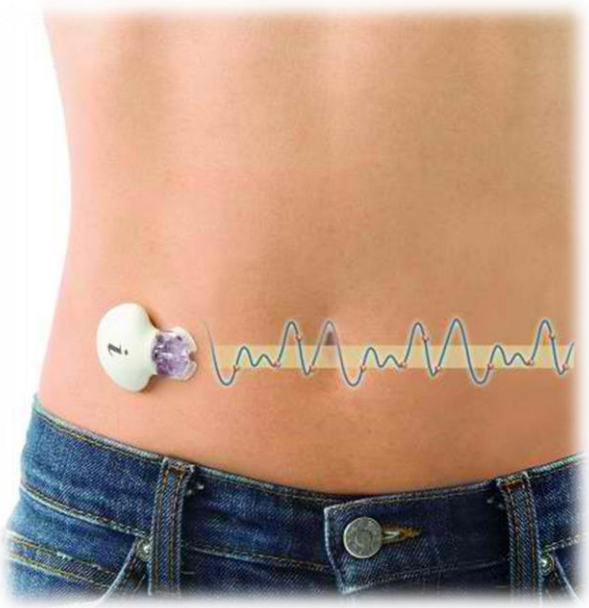
Insulin pump > 10 years ago

- unable to manipulate the pump settings



Carbohydrate counting by dietitian in 2013

- CHO portion suggestion 2/3/1/3
- Sample meal planning



CGMS in 2014

- incomplete data and difficult in handling device

Start Date: _____ End Date: _____

Day	Breakfast	Lunch	Dinner	Bedtime
Sunday				
Monday				
Tuesday				
Wednesday				

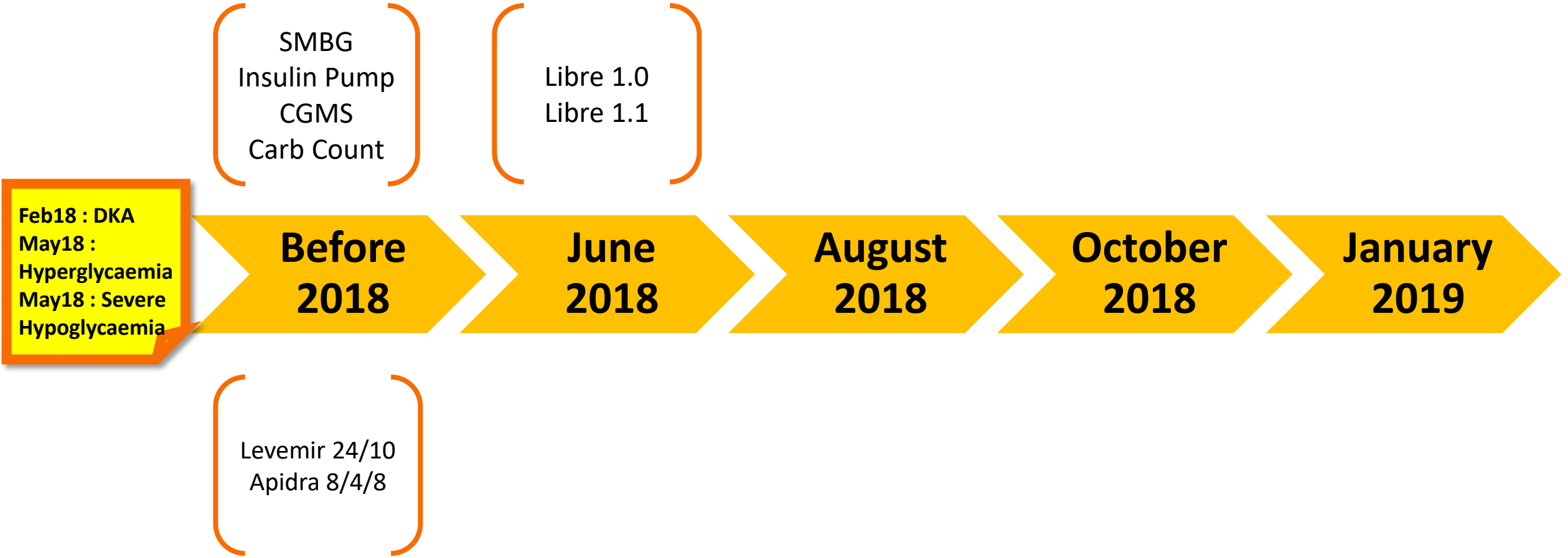
SMB[illegible]t BF 4[illegible]l/L,
Pos[illegible]/L

- H[illegible]
- A[illegible]ed

re[illegible]itive

UNRELIABLE

Chronology


SMBG
Insulin Pump
CGMS
Carb Count
Libre 1.0
Libre 1.1
Feb18 : DKA
May18 : Hyperglycaemia
May18 : Severe Hypoglycaemia
Before 2018
June 2018
August 2018
October 2018
January 2019
Levemir 24/10
Apidra 8/4/8

Snapshot

6 June 2018 - 20 June 2018 (15 days)

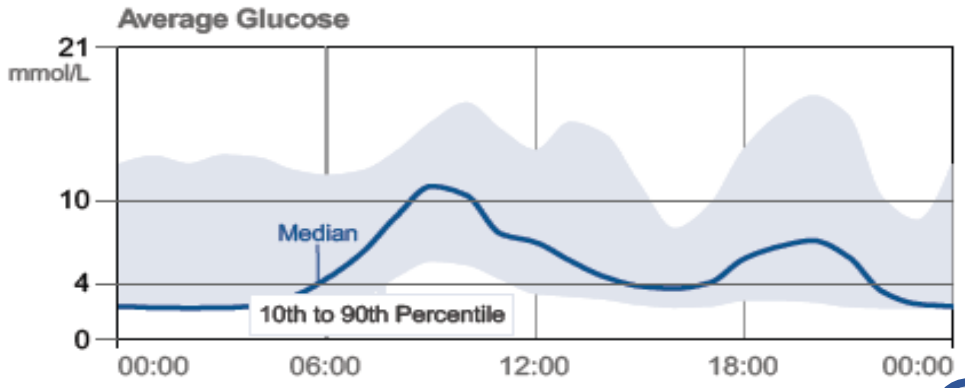
FreeStyle Libre

(Apr18) HbA1c: 11.7%

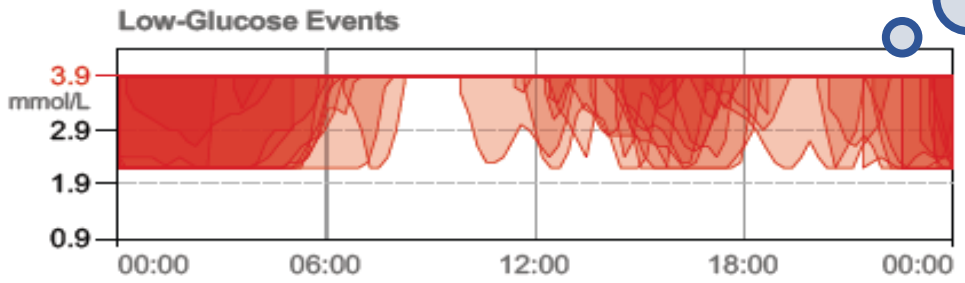
Glucose

Estimated A1c 6.0% or 42 mmol/mol

AVERAGE GLUCOSE	6.9	mmol/L
% above target	25	%
% in target	33	%
% below target	42	%

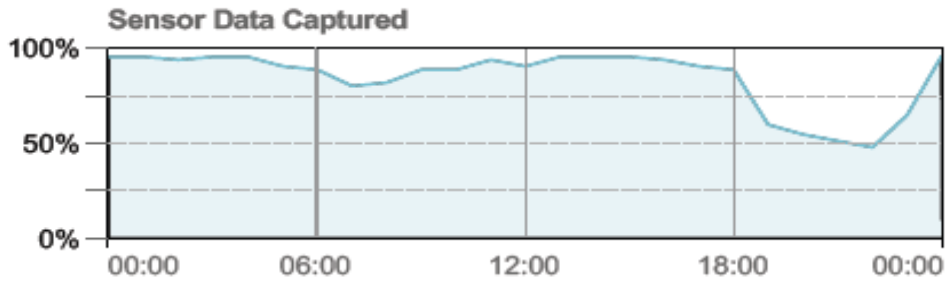


LOW-GLUCOSE EVENTS	27	
Average duration	293	Min



Sensor Usage

SENSOR DATA CAPTURED	85	%
Daily scans	5	

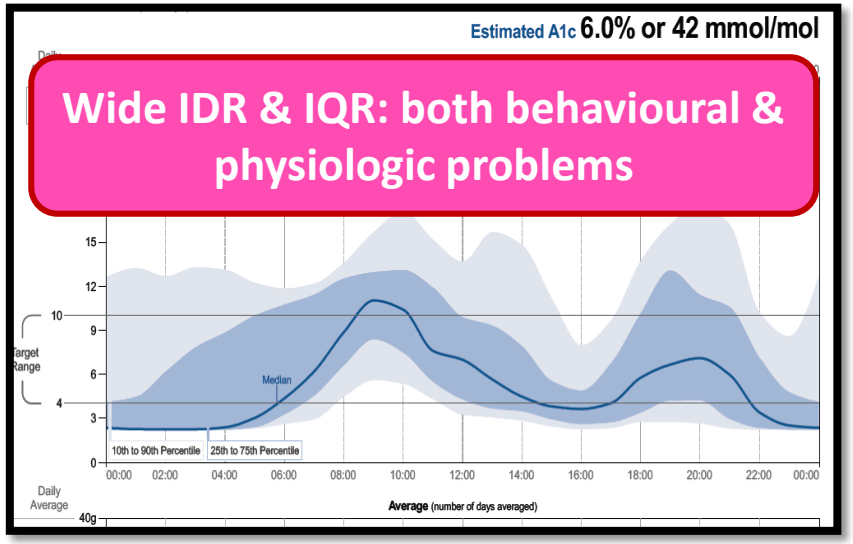


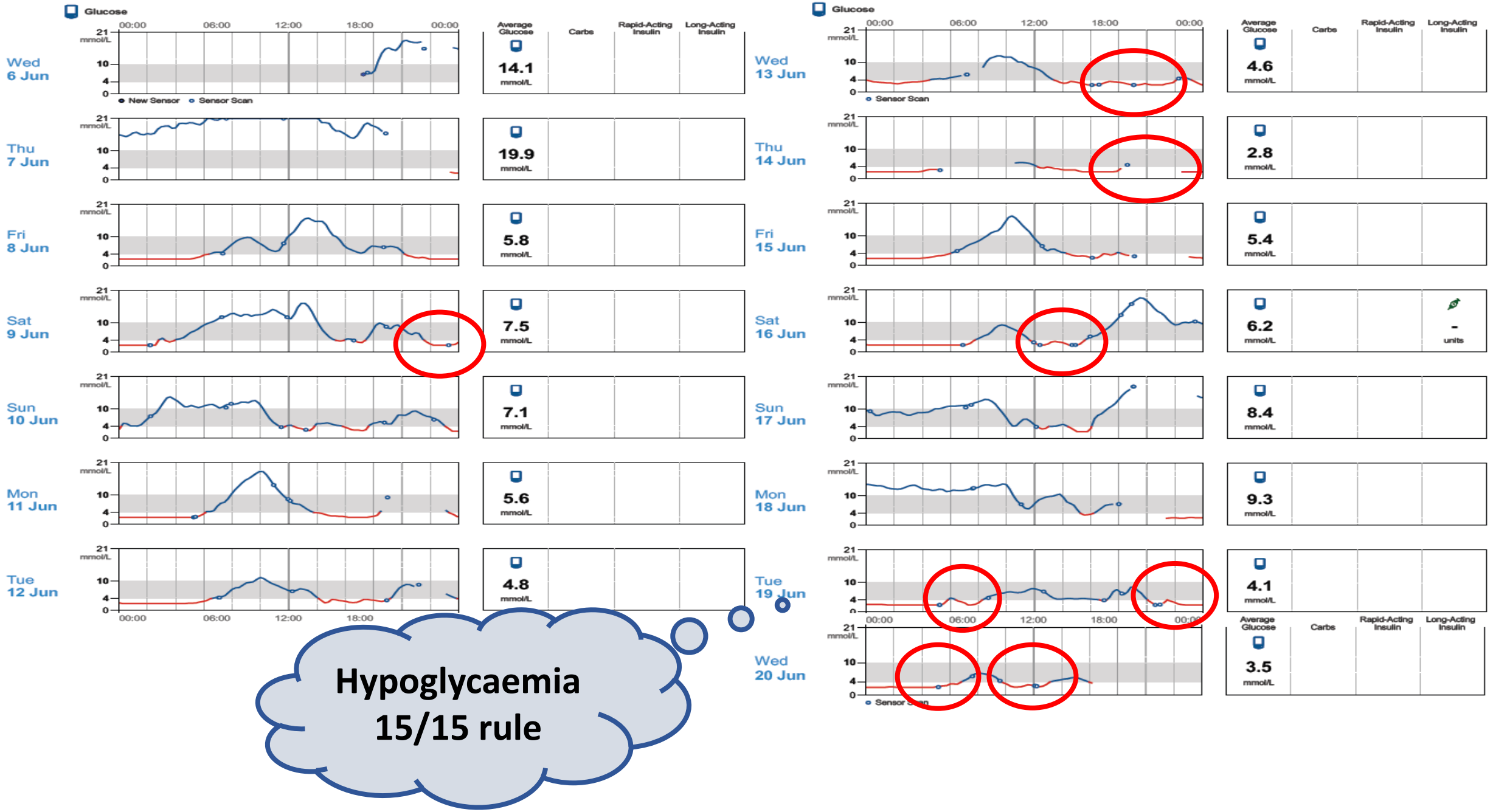
Levemir

- 24/10 → 20/6

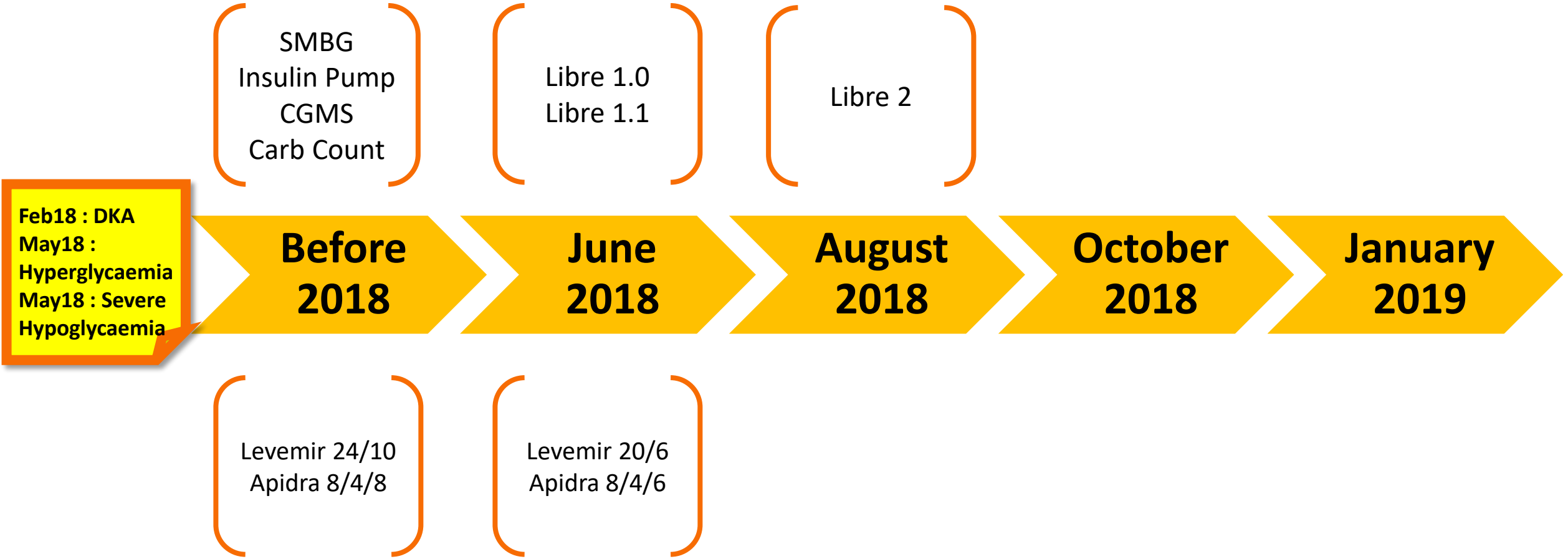
Apidra

- 8/4/8 → 8/4/6




Glucose
00:00
06:00
12:00
18:00
00:00
21
mmol/L
10
4
0
New Sensor
Sensor Scan
Average Glucose
Carbs
Rapid-Acting Insulin
Long-Acting Insulin
Wed 6 Jun
14.1 mmol/L
Thu 7 Jun
19.9 mmol/L
Fri 8 Jun
5.8 mmol/L
Sat 9 Jun
7.5 mmol/L
Sun 10 Jun
7.1 mmol/L
Mon 11 Jun
5.6 mmol/L
Tue 12 Jun
4.8 mmol/L
Wed 13 Jun
4.6 mmol/L
Thu 14 Jun
2.8 mmol/L
Fri 15 Jun
5.4 mmol/L
Sat 16 Jun
6.2 mmol/L
-
units
Sun 17 Jun
8.4 mmol/L
Mon 18 Jun
9.3 mmol/L
Tue 19 Jun
4.1 mmol/L
Wed 20 Jun
3.5 mmol/L
Hypoglycaemia
15/15 rule

Chronology


SMBG
Insulin Pump
CGMS
Carb Count
Libre 1.0
Libre 1.1
Libre 2
Feb18 : DKA
May18 : Hyperglycaemia
May18 : Severe Hypoglycaemia
Before 2018
June 2018
August 2018
October 2018
January 2019
Levemir 24/10
Apidra 8/4/8
Levemir 20/6
Apidra 8/4/6

Snapshot

6 August 2018 - 20 August 2018 (15 days)

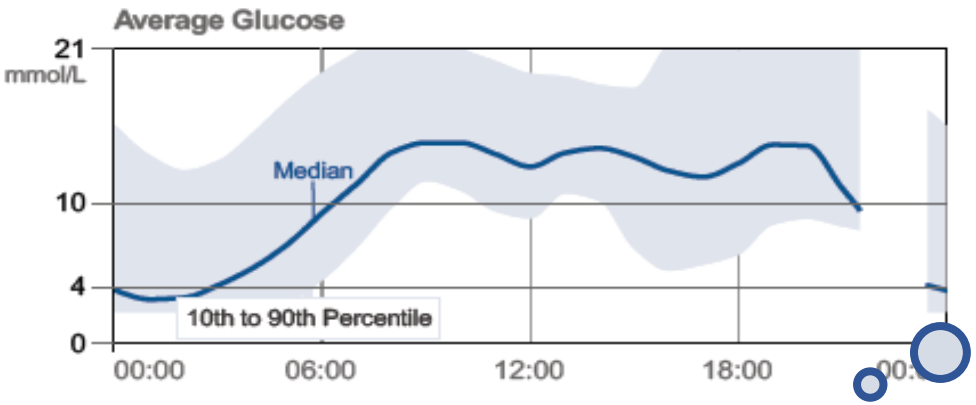
FreeStyle Libre

(July18) HbA1c: 7.1%

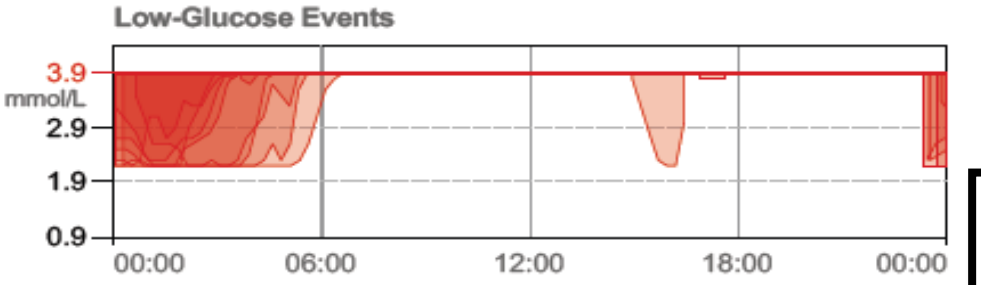
Glucose

Estimated A1c 9.0% or 75 mmol/mol

AVERAGE GLUCOSE	11.7	mmol/L
% above target	60	%
% in target	25	%
% below target	15	%

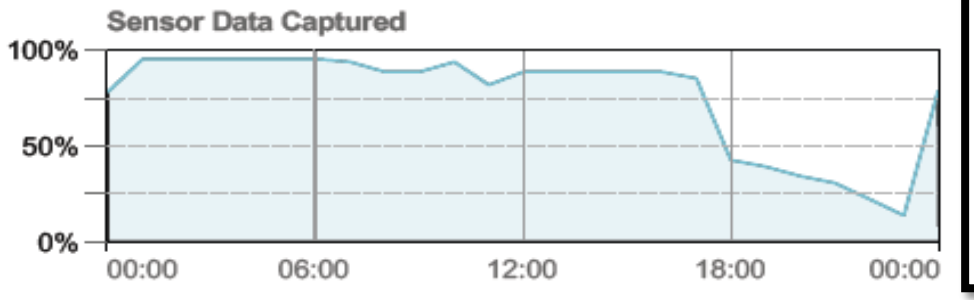


LOW-GLUCOSE EVENTS	11	
Average duration	236	Min



Sensor Usage

SENSOR DATA CAPTURED	76	%
Daily scans	4	



Logged

TOTAL DAILY INSULIN

units/day

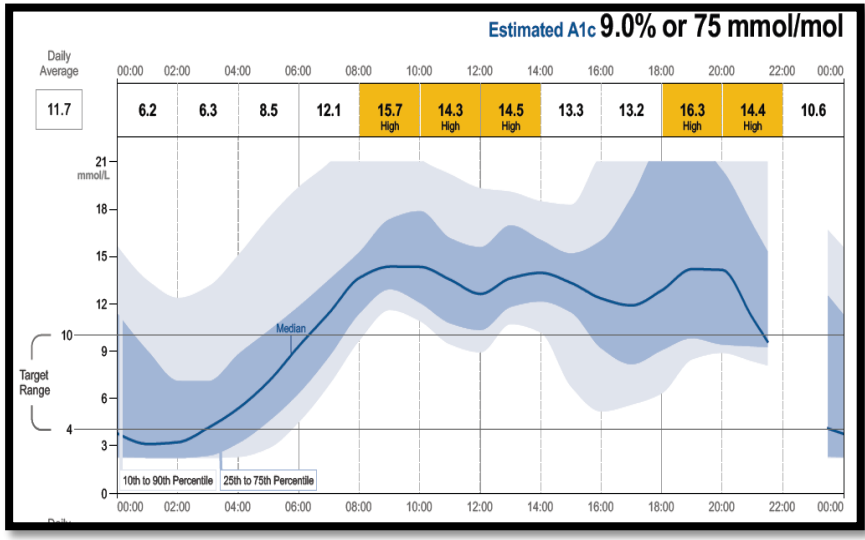
units/day

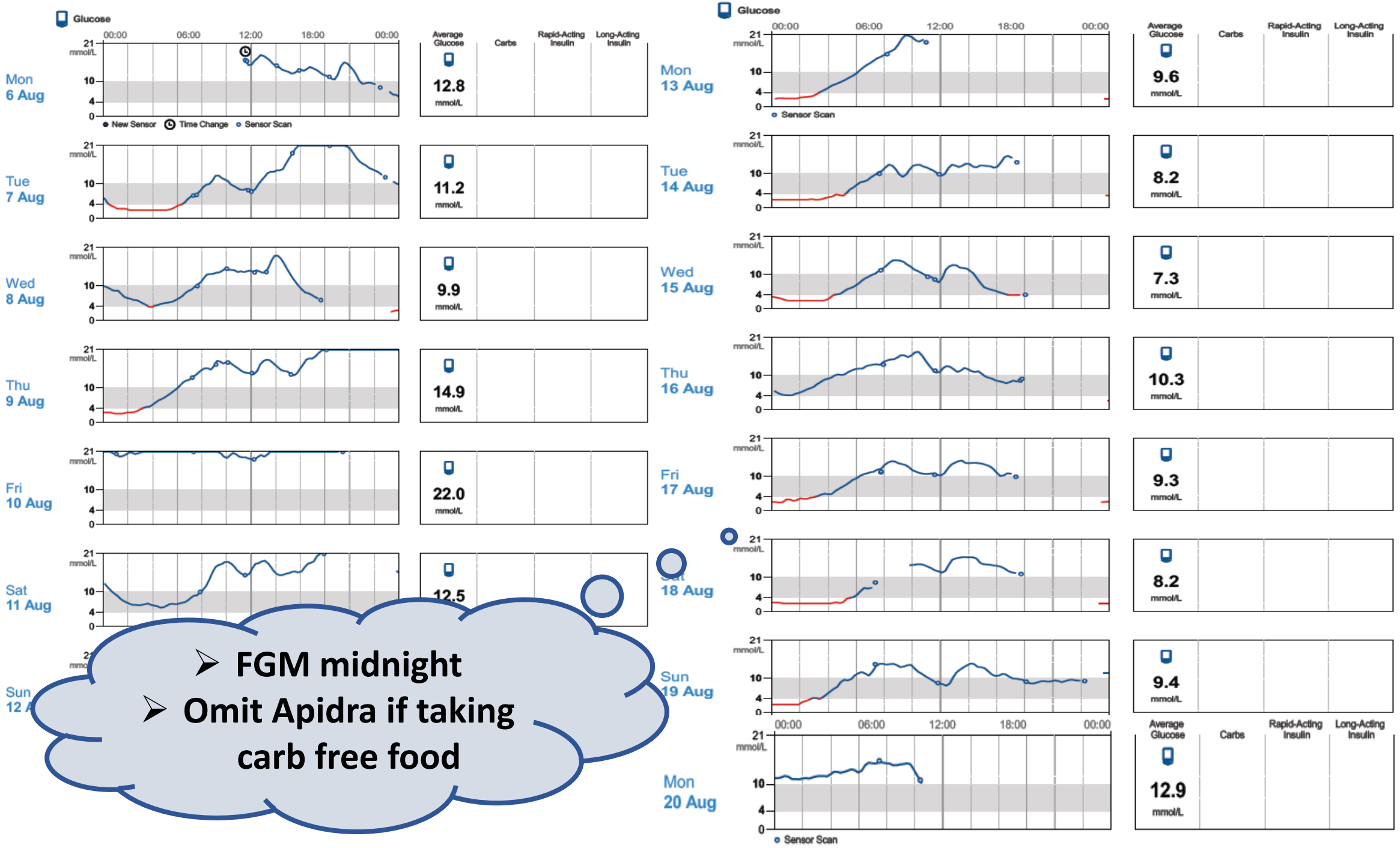
Levemir

- 20/6 → 20/4

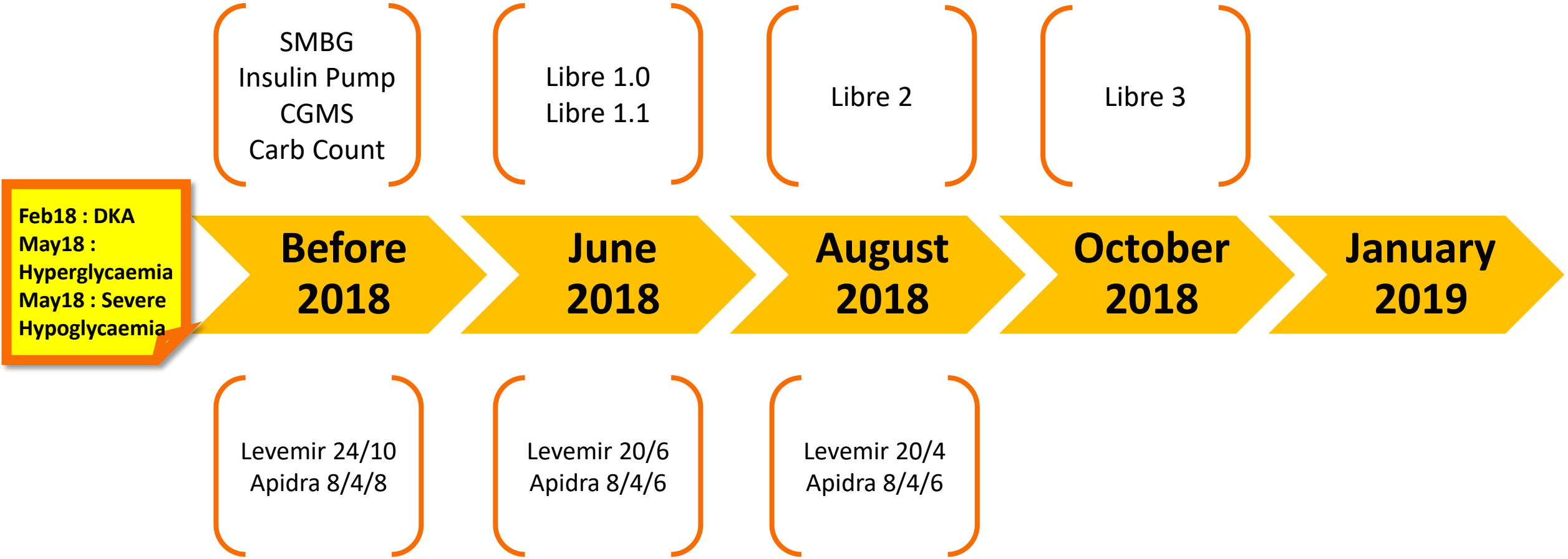
Apidra

- 8/4/8 → 8/4/6




Glucose
00:00
06:00
12:00
18:00
00:00
21
mmol/L
10
4
0
New Sensor
Time Change
Sensor Scan
Average Glucose
Carbs
Rapid-Acting Insulin
Long-Acting Insulin
Mon 6 Aug
12.8 mmol/L
Tue 7 Aug
11.2 mmol/L
Wed 8 Aug
9.9 mmol/L
Thu 9 Aug
14.9 mmol/L
Fri 10 Aug
22.0 mmol/L
Sat 11 Aug
12.5
Sun 12 A
Mon 13 Aug
9.6 mmol/L
Tue 14 Aug
8.2 mmol/L
Wed 15 Aug
7.3 mmol/L
Thu 16 Aug
10.3 mmol/L
Fri 17 Aug
9.3 mmol/L
Sat 18 Aug
8.2 mmol/L
Sun 19 Aug
9.4 mmol/L
Mon 20 Aug
12.9 mmol/L
➢ FGM midnight
➢ Omit Apidra if taking carb free food

Chronology


SMBG
Insulin Pump
CGMS
Carb Count
Libre 1.0
Libre 1.1
Libre 2
Libre 3
Feb18 : DKA
May18 : Hyperglycaemia
May18 : Severe Hypoglycaemia
Before 2018
June 2018
August 2018
October 2018
January 2019
Levemir 24/10
Apidra 8/4/8
Levemir 20/6
Apidra 8/4/6
Levemir 20/4
Apidra 8/4/6

Snapshot

5 October 2018 - 18 October 2018 (14 days)

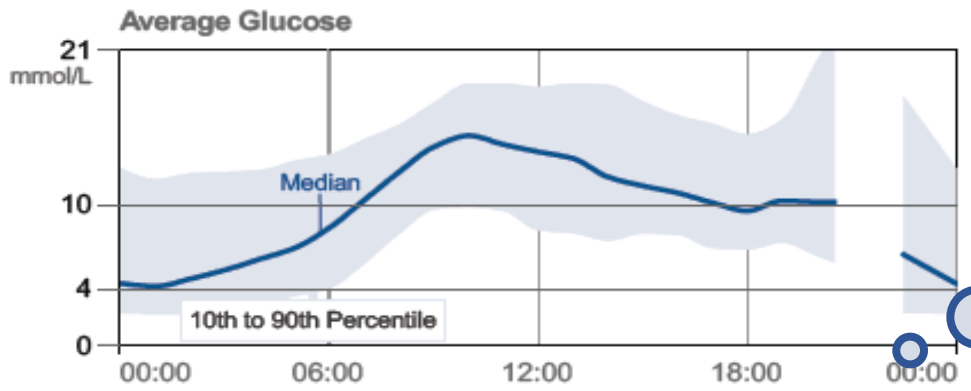
FreeStyle Libre

(Oct18) HbA1c: 8.9%

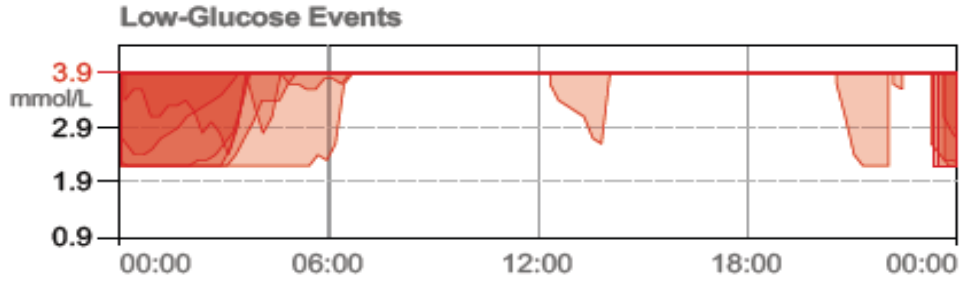
Glucose

Estimated A1c 7.9% or 63 mmol/mol

AVERAGE GLUCOSE	9.9	mmol/L
% above target	47	%
% in target	38	%
% below target	15	%

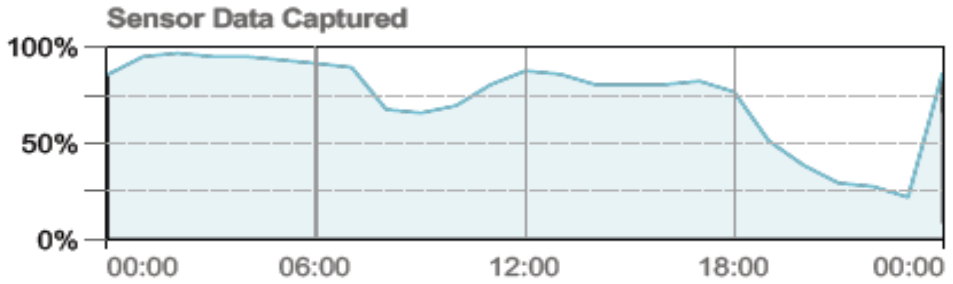


LOW-GLUCOSE EVENTS	9	
Average duration	258	Min



Sensor Usage

SENSOR DATA CAPTURED	74	%
Daily scans	4	



Levemir

- 20/6 → 20/2

Apidra

- 8/4/8 → 8/5/5

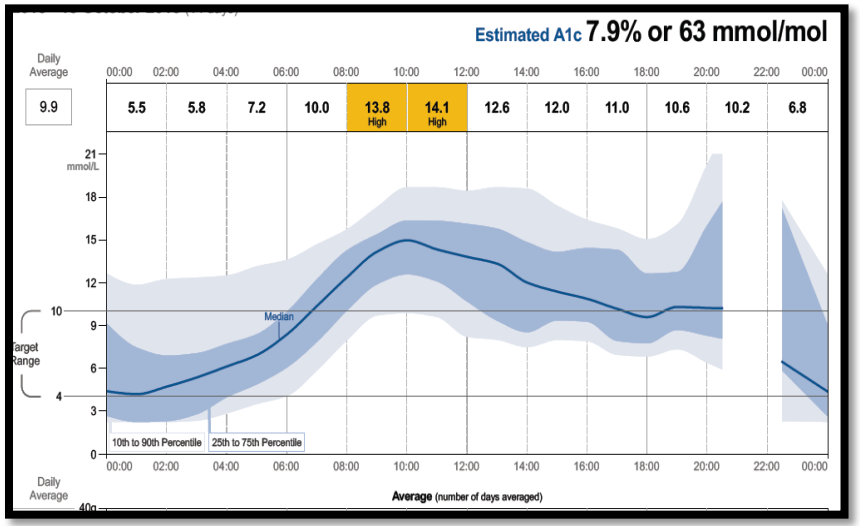
Long-A… …di…

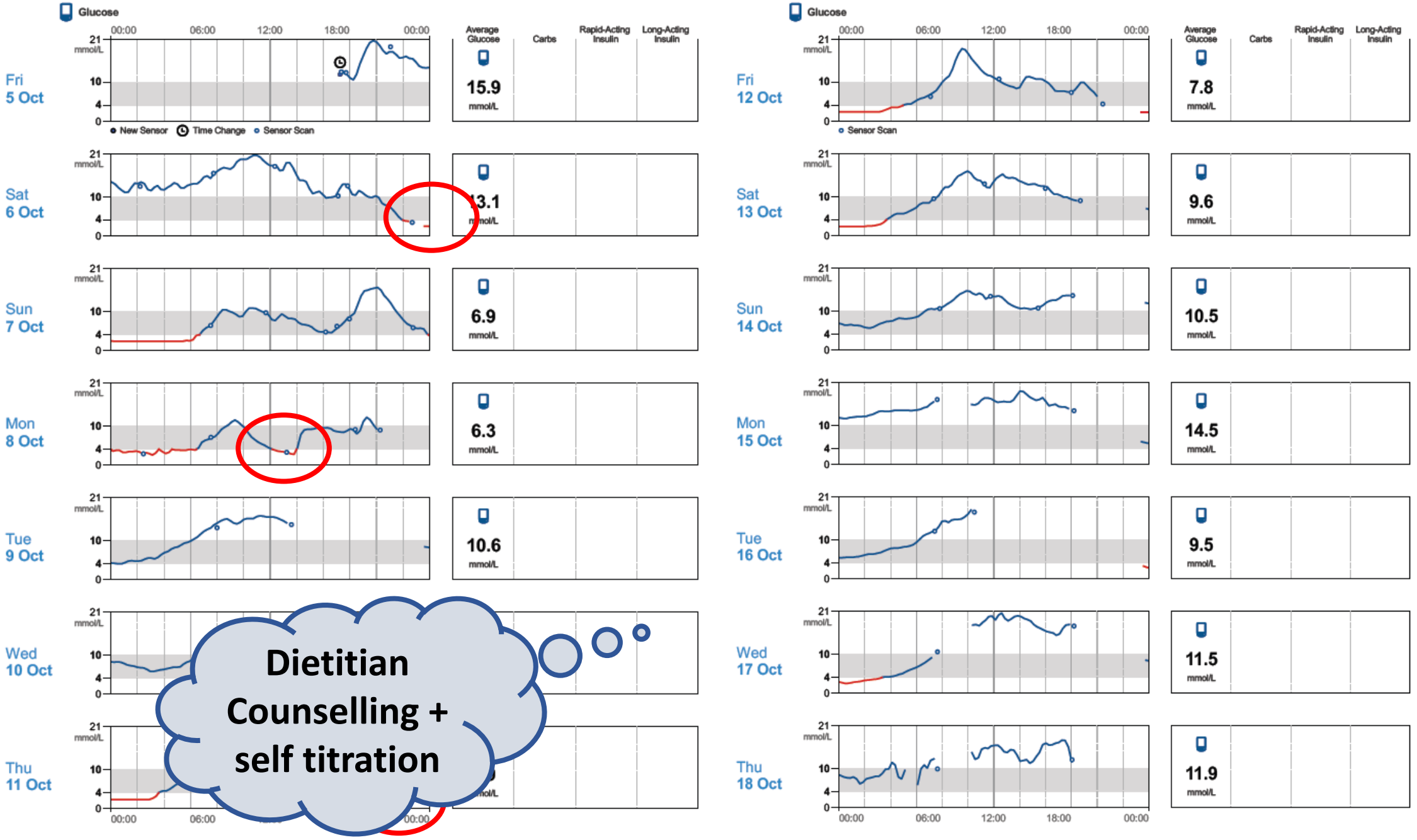
…s/day

units/day

TOTAL DAILY INSULIN

units/day




Glucose
00:00
06:00
12:00
18:00
00:00
21
mmol/L
10
4
0
New Sensor
Time Change
Sensor Scan
Average Glucose
Carbs
Rapid-Acting Insulin
Long-Acting Insulin
Fri 5 Oct
15.9
mmol/L
Sat 6 Oct
13.1
mmol/L
Sun 7 Oct
6.9
mmol/L
Mon 8 Oct
6.3
mmol/L
Tue 9 Oct
10.6
mmol/L
Wed 10 Oct
Thu 11 Oct
Dietitian
Counselling +
self titration
Fri 12 Oct
7.8
mmol/L
Sat 13 Oct
9.6
mmol/L
Sun 14 Oct
10.5
mmol/L
Mon 15 Oct
14.5
mmol/L
Tue 16 Oct
9.5
mmol/L
Wed 17 Oct
11.5
mmol/L
Thu 18 Oct
11.9
mmol/L

Chronology

Feb18 : DKA
May18 : Hyperglycaemia
May18 : Severe Hypoglycaemia

Before 2018	June 2018	August 2018	October 2018	January 2019
SMBG Insulin Pump CGMS Carb Count	Libre 1.0 Libre 1.1	Libre 2	Libre 3	Libre 4
Levemir 24/10 Apidra 8/4/8	Levemir 20/6 Apidra 8/4/6	Levemir 20/4 Apidra 8/4/6	Levemir 20/2 Apidra 8/5/5	

Snapshot

17 January 2019 - 30 January 2019 (14 days)

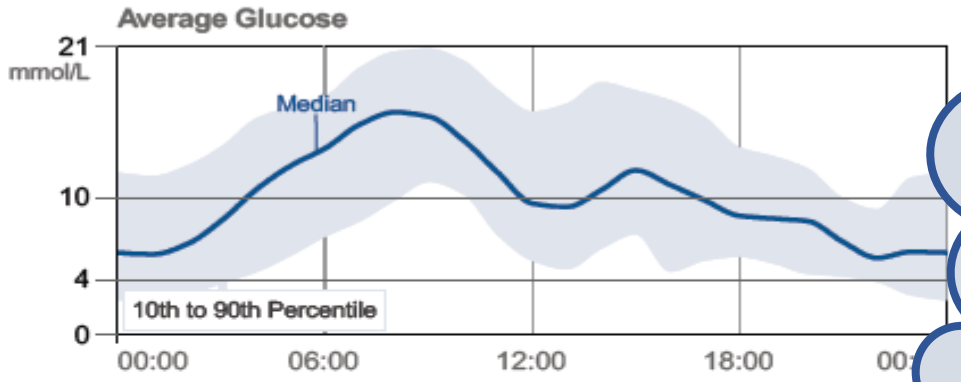
FreeStyle Libre

(Feb19) HbA1c: 8.7%

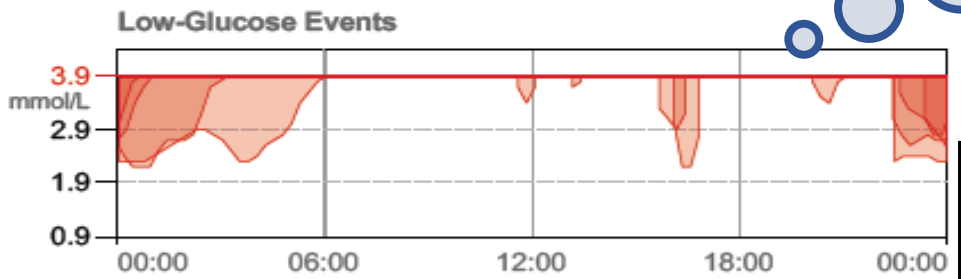
Glucose

Estimated A1c 8.3% or 67 mmol/mol

AVERAGE GLUCOSE	**10.6**	mmol/L
% above target	51	%
% in target	42	%
% below target	7	%

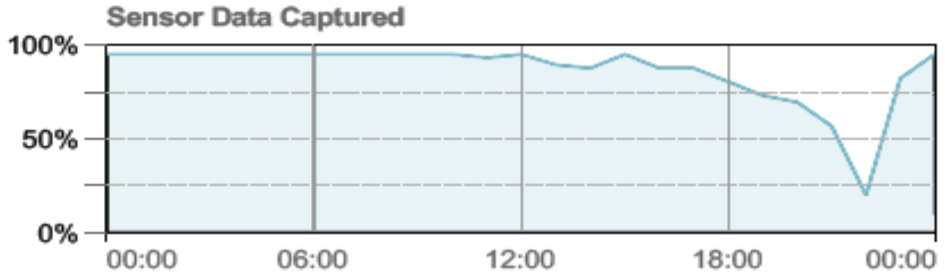


LOW-GLUCOSE EVENTS	**9**	
Average duration	152	Min



Sensor Usage

SENSOR DATA CAPTURED	**87**	%
Daily scans	8	



Logged ... s/day

units/day

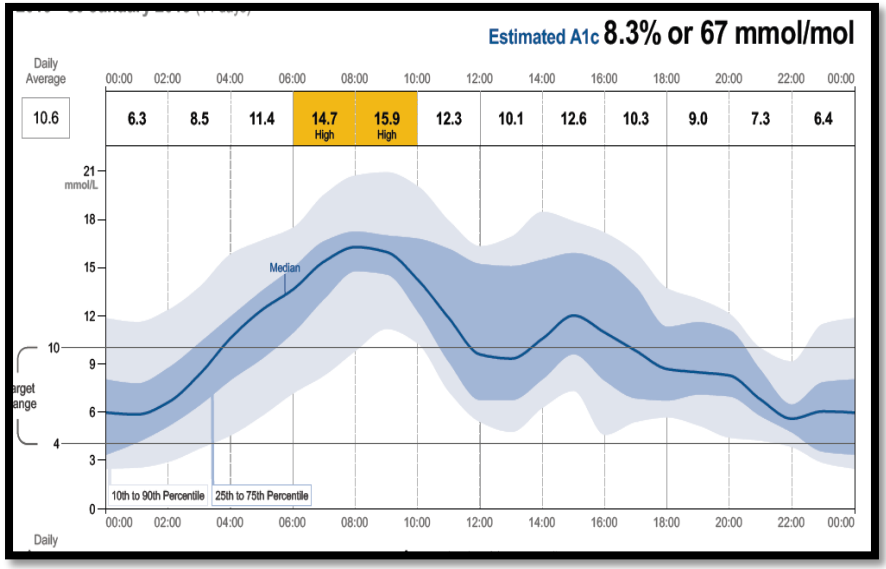
Levemir

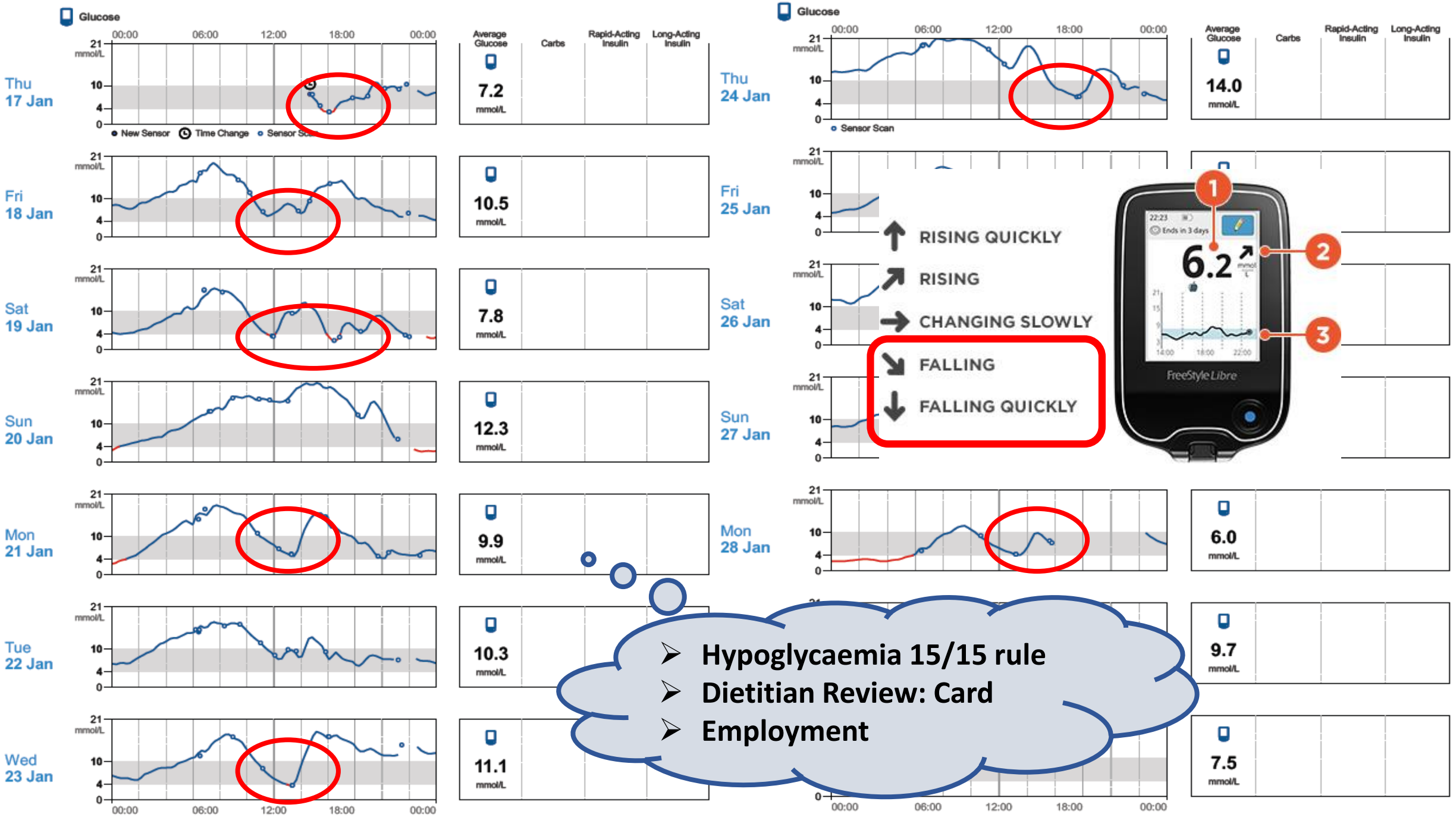
- 20/2 → 20/0

Apidra

- 8/6/6 → 8/6/4

+ Empagliflozin 5mg EOD



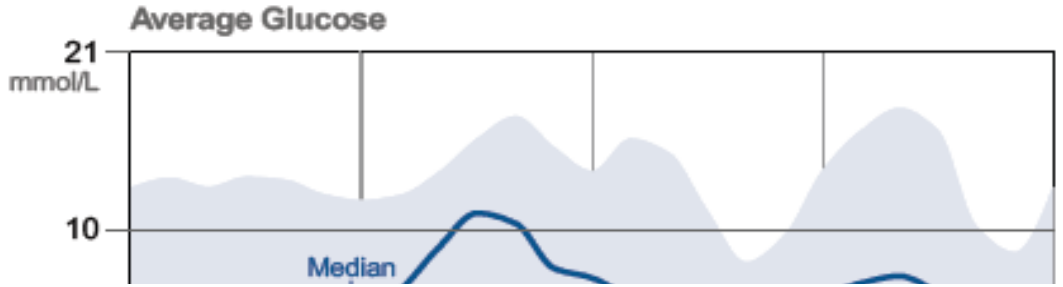

Glucose
00:00
06:00
12:00
18:00
00:00
21
mmol/L
10
4
0
New Sensor
Time Change
Sensor Scan
Average Glucose
Carbs
Rapid-Acting Insulin
Long-Acting Insulin
Thu 17 Jan
7.2 mmol/L
Fri 18 Jan
10.5 mmol/L
Sat 19 Jan
7.8 mmol/L
Sun 20 Jan
12.3 mmol/L
Mon 21 Jan
9.9 mmol/L
Tue 22 Jan
10.3 mmol/L
Wed 23 Jan
11.1 mmol/L
Thu 24 Jan
14.0 mmol/L
Fri 25 Jan
Sat 26 Jan
Sun 27 Jan
Mon 28 Jan
6.0 mmol/L
9.7 mmol/L
7.5 mmol/L
RISING QUICKLY
RISING
CHANGING SLOWLY
FALLING
FALLING QUICKLY
22:23
Ends in 3 days
6.2
mmol/L
FreeStyle Libre
1
2
3
Hypoglycaemia 15/15 rule
Dietitian Review: Card
Employment

Chronology

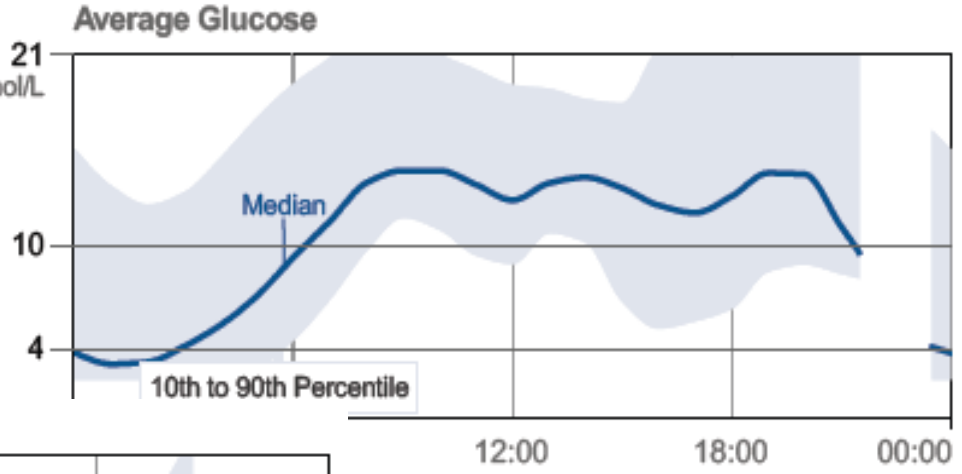
Feb18 : DKA
May18 : Hyperglycaemia
May18 : Severe Hypoglycaemia

Before 2018	June 2018	August 2018	October 2018	January 2019
SMBG Insulin Pump CGMS Carb Count	Libre 1.0 Libre 1.1	Libre 2	Libre 3	Libre 4
Levemir 24/10 Apidra 8/4/8	Levemir 20/6 Apidra 8/4/6	Levemir 20/4 Apidra 8/4/6	Levemir 20/2 Apidra 8/5/5	Levemir 22/0 Apidra 8/6/4 Empa 5mg EOD

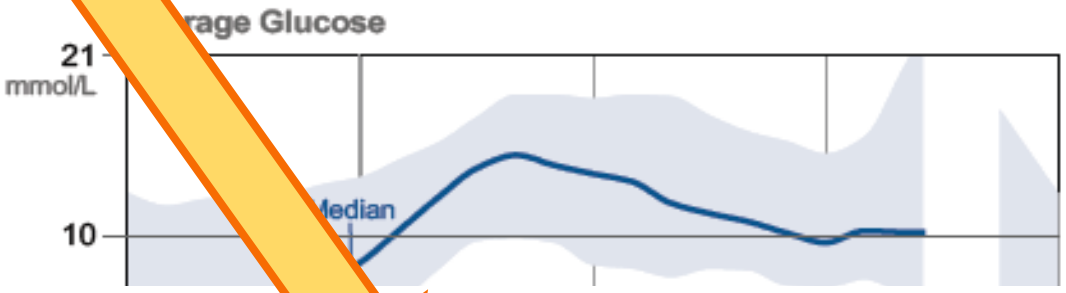
AVERAGE GLUCOSE	6.9 mmol/L
% above target	25 %
% in target	33 %
% below target	42 %



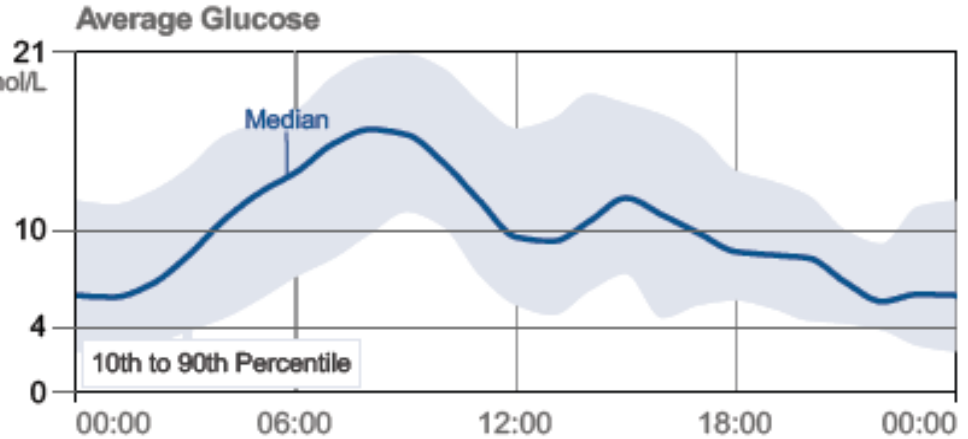
AVERAGE GLUCOSE	11.7 mmol/L
above target	60 %
get	25 %
% bel et	15 %



AVERAGE GLUCOSE	9.9 mmol/L
% above target	47 %
% in target	38 %
% below target	15 %



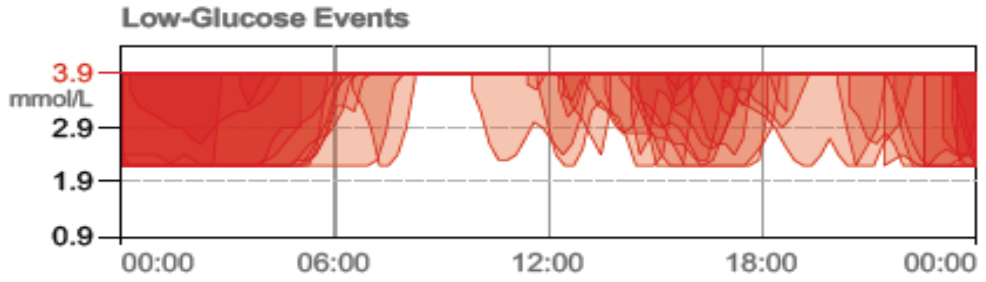
AVERAGE GLUCOSE	10.6 mmol/L
% above target	51 %
% in target	42 %
% below target	7 %



June 2018

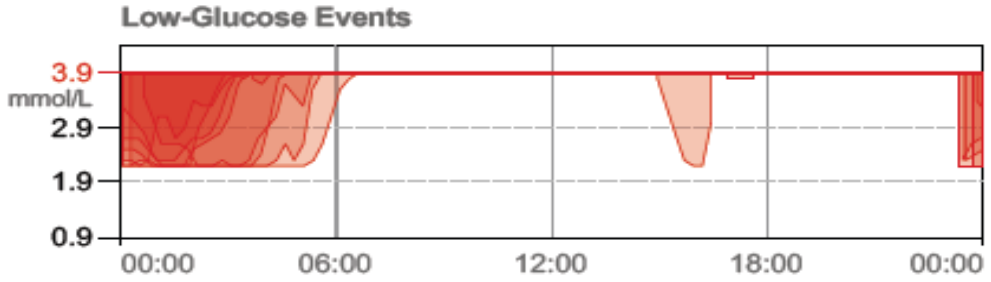
LOW-GLUCOSE EVENTS	27
Average duration	293 Min

4.9 hours



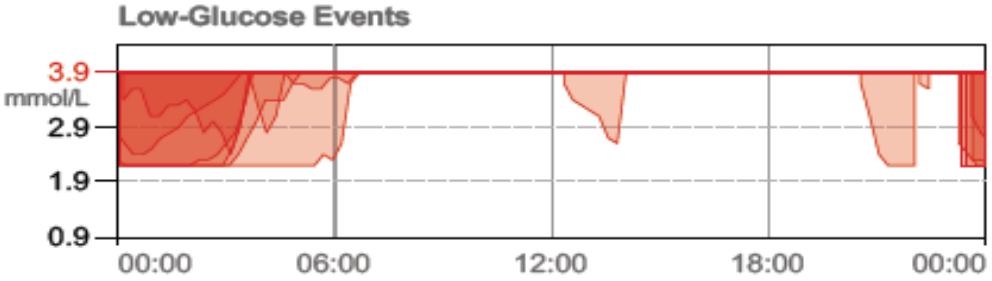
Aug 2018

LOW-GLUCOSE EVENTS	11
Average duration	236 Min



Oct 2018

LOW-GLUCOSE EVENTS	9
Average duration	258 Min



Jan 2019

LOW-GLUCOSE EVENTS	9
Average duration	152 Min

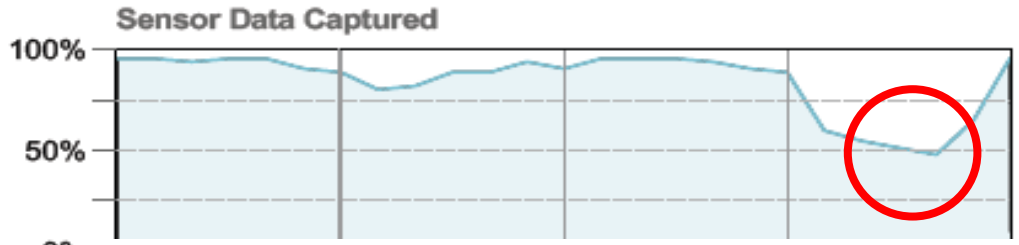
2.5 hours

↓ Hypo episodes by 3x

↓ Hypo duration by 48% (141mins)

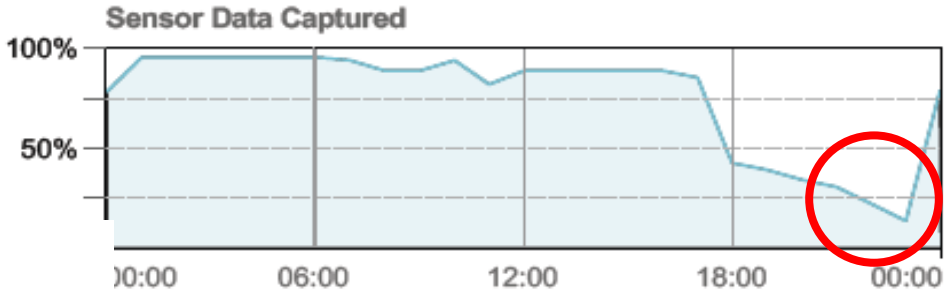
Sensor Usage

SENSOR DATA CAPTURED	85 %
Daily scans	5



Sensor Usage

SENSOR DATA CAPTURED	76 %
scans	4

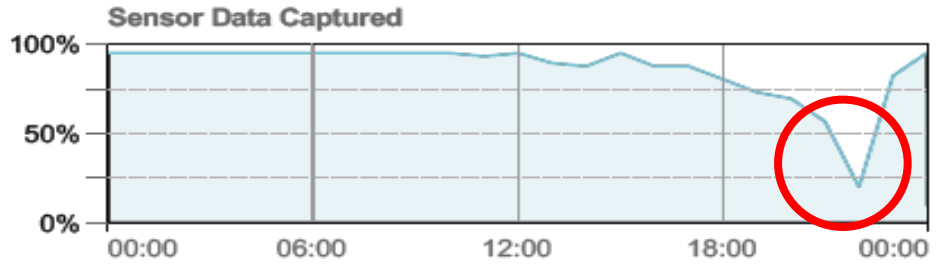


Sensor Usage

SENSOR DATA CAPTURED	74 %
Daily scans	4

Sensor Usage

SENSOR DATA CAPTURED	87 %
Daily scans	8



Learning Points

- **Rate-of-change Trend Arrows in decision making**
- FGM as a Supplement to HbA1c in DM patients

Optimising use of rate-of-change trend arrows for insulin dosing decisions using the FreeStyle Libre flash glucose monitoring system

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SAGE

**Ramzi A Ajjan[1], Michael H
Lalantha Leelarathna[4,5], G**

Abstract

Continuous glucose monitoring and
multiple daily injections of insulin an
glucose levels, these technologies a
glucose. Two systems, the Dexcom
for adjunct capillary blood glucose,
of change in the insulin dosing algo
into daily glucose management, inclu
monitoring system, we also review
conjunction with current glucose re

Table 1. Rate of change and anticipated glucose calculation for 15 and 30 min following the current scan.[a]

Trend arrow	Rate and direction of glucose change	Anticipated change in glucose from current reading	
		15 min	30 min
↑	Glucose rising rapidly >0.1 mmol/L/min	>+1.5 mmol/L	>+3.0 mmol/L
↗	Glucose rising 0.06–0.1 mmol/L/min	+0.9 to 1.5 mmol/L	+1.8 to 3.0 mmol/L
→	Glucose changing slowly <0.06 mmol/L/min	<±0.9 mmol/L	<±1.8 mmol/L
↘	Glucose falling 0.06–0.1 mmol/L/min	−0.9 to −1.5 mmol/L	−1.8 to −3.0 mmol/L
↓	Glucose falling rapidly >0.1 mmol/L/min	>−1.5 mmol/L	>−3.0 mmol/L

RoC: rate of change.
[a]Note that the RoC trend arrows are not always concurrent with a laboratory reference measurement of blood glucose change when measured at the same time.[13]

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REVIEW

Hypoglycaemia in type 1 diabetes: technological treatments, their limitations and the place of psychology

Pratik Choudhary [1,2] · Stephanie A. Amiel [1,2]

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Abstract

Advances in technology allowing improved insulin delivery and glucose monitoring can significantly reduce the burden of hypoglycaemia when used appropriately. However, limitations of the current technology, and the skills, commitment and motivation required to use them, mean that it does not work for all people. Education and informed professional support are key to success. In the context of problematic hypoglycaemia, data suggest that newer technology has lower efficacy and uptake in those with most need. Identifying the causes of hypoglycaemia and understanding some of the underlying behavioural drivers may prove useful and psycho-educational strategies may be effective in selected individuals. Ultimately, as in many spheres of medicine, successful management of problematic hypoglycaemia depends upon matching the right treatment to the right individual.

Keywords Continuous glucose monitoring · Continuous subcutaneous insulin infusion · Diabetes technologies · Hypoglycaemia · Insulin analogues · Insulin pumps · Psychology · Review

Learning Points

- Rate-of-change Trend Arrows in decision making
- **FGM as a Supplement to HbA1c in DM patients**

Limitations of HbA1c and SMBG

	HbA1c	SMBG
Limitations	• Does not reflect intra- and inter-day glycaemic excursions • Only provides an average of glucose levels over the previous 2-3 months • Does not detect hypoglycaemia or hyperglycaemia on a daily basis • Unreliable measure in patients with anaemia, iron deficiency • Does not reflect rapid changes in daily glucose • Does not provide data as how to adjust treatment regimen	• Provides a single "point-in-time" measurement • No indication of the direction or rate of change of glucose levels • Fails to detect nocturnal and asymptomatic hypoglycaemia • Unreliability of patient recorded data as it depends on the individual to self monitor • Can result in inappropriate treatment decisions

(Evan, Cranston, & Bailey, 2017)
(Mazze & Cranston, 2018)

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CLINICAL FOCUS: CARDIOMETABOLIC CONDITIONS
REVIEW

Professional flash continuous glucose monitoring as a supplement to A1C in primary care

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ABSTRACT

Decreasing glycated hemoglobin (A1C) is the primary goal of current diabetes management due to intervention studies in type 1 and type 2 diabetes associating levels <7.0% (53 mmol/mol) with lower complication risk. Strategic self-monitoring of blood glucose (SMBG) is also recommended to achieve greater time in range, with fewer extremes of hypo- or hyperglycemia. Unlike A1C, SMBG can distinguish among fasting, prandial, and postprandial hyperglycemia; uncover glycemic variability, including potentially dangerous hypoglycemia; and provide feedback to patients about the effects of behavior and medication on glycemic control. However, it has the drawback of capturing only static glucose readings and users are often dependent on time-pressed clinicians to interpret numerous data points. A novel flash continuous glucose monitoring (FCGM) device used for a single 2-week period with a readily interpretable data report know as the ambulatory glucose profile (AGP) has the potential to overcome limitations of conventional technologies, with less cost and greater convenience. This review summarizes the rationale for using intermittent FCGM as a supplement to A1C in primary care, and provides a stepwise approach to interpreting the AGP visual display for efficient individualized therapy.

ARTICLE HISTORY
Received 16 August 2017
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KEYWORDS
Diabetes; self-monitoring of blood glucose; flash continuous glucose monitoring; hyperglycemia; hypoglycemia; glycemic variability

Closing the Gap…

	Libre 1.1	Libre 2.0	Libre 3.0	Libre 4.0
HbA1c (Laboratory)	**11.7%**	**7.1%**	**8.9%**	**8.7%**
Estimated A1c (Libre)	**6.0%**	**9.0%**	**7.9%**	**8.3%**


ALL IN A
NUTSHELL

Chronology

TDD: 54u

TDD: 40u

Before 2018	June 2018	August 2018	October 2018	January 2019
SMBG Insulin Pump CGMS Carb Count	Libre 1.0 Libre 1.1	Libre 2	Libre 3	Libre 4
Levemir 24/10 Apidra 8/4/8	Levemir 20/6 Apidra 8/4/6	Levemir 20/4 Apidra 8/4/6	Levemir 20/2 Apidra 8/5/5	Levemir 22/0 Apidra 8/6/4 Empa 5mg EOD

HbA1c: 11.7%

HbA1c: 8.7%

Feb18 : DKA
May18 : Hyperglycaemia
May18 : Severe Hypoglycaemia

Jan19: No admission

SUMMARY FINDINGS

- ↓ HbA1c by 3.0%
- ↓26% TDD
- ↓ Admission rate
- Target ranges improved
  - % in target
  - % below target
- ↓ Hypoglycaemia Episodes (3x)
- ↓ Hypoglycaemia Duration (48%)
- Sensor Data Captured improved and maintaining above 70%
- ↑ patient satisfaction & quality of life (employment)

Reference

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thank
you