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IPN Annual Meeting

Belfast

10th May 2017

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The sponsoring pharmaceutical companies have not had any editorial input into the agenda or material being presented, with the exception of the sponsored symposium

Derby Teaching Hospitals NHS
NHS Foundation Trust

A Practical Approach to Flash Glucose Monitoring

Dr Emma Wilmot

Consultant Diabetologist

Disclosures

Previous recipient of speaker fees,

research & educational grants from

Abbott, Boehringer Ingelheim, Dexcom, Diasend, GSK, Eli Lilly, Medtronic, Roche, Sanofi Aventis.

Overview

- Evidence for Flash Glucose Monitoring in T1DM: IMPACT study
- A practical approach to use in clinic
- Case discussions

Freestyle Libre Flash Glucose Sensor

The FreeStyle Libre reader

The FreeStyle Libre sensor

Freestyle Libre Flash Glucose Sensor

- Senses interstitial glucose
- 4.5 +/- 4.8 minute lag
- Factory calibrated
- No alarms
- £96 per month

The FreeStyle Libre reader

The FreeStyle Libre sensor

Bailey et al 2015 Diabetes Technology & Therapeutics

Libre vs. CGM

	Freestyle Libre	Dexcom G5 CGM	Medtronic Enlite CGM
MARD	**11.4%**	9%	13.6%
Sensor duration	**14 days**	7 days	6 days
Calibration needed	**No**	Yes, 2x/day	Yes
Alarms on high	**No**	Yes	Yes
Alarms on low	**No**	Yes	Yes
Predictive low glucose suspend	**No**	No	Yes
Ease of use	**+++**	++	++

Impact Study

- RCT of Freestyle Libre vs SMBG in 239 well controlled patients with T1DM

Novel glucose-sensing technology and hypoglycaemia in type 1 diabetes: a multicentre, non-masked, randomised controlled trial

Jan Bolinder, Ramiro Antuna, Petronella Geelhoed-Duijvestijn, Jens Kröger, Raimund Weitgasser

Summary

Background Tight control of blood glucose in type 1 diabetes delays onset of macrovascular and microvascular diabetic complications; however, glucose levels need to be closely monitored to prevent hypoglycaemia. We aimed to assess whether a factory-calibrated, sensor-based, flash glucose-monitoring system compared with self-monitored glucose testing reduced exposure to hypoglycaemia in patients with type 1 diabetes.

Method In this multicentre, prospective, non-masked, randomised controlled trial, we enrolled adult patients with well controlled type 1 diabetes (HbA_{1c} ≤58 mmol/mol [7·5%]) from 23 European diabetes centres. After 2 weeks of all participants wearing the blinded sensor, those with readings for at least 50% of the period were randomly assigned (1:1) to flash sensor-based glucose monitoring (intervention group) or to self-monitoring of blood glucose with capillary strips (control group). Randomisation was done centrally using the biased-coin minimisation method dependent on study centre and type of insulin administration. Participants, investigators, and study staff were not masked to group allocation. The primary outcome was change in time in hypoglycaemia (<3·9 mmol/L [70 mg/dL]) between baseline and 6 months in the full analysis set (all participants randomised; excluding those who had a positive pregnancy test during the study). This trial was registered with ClinicalTrials.gov, number NCT02232698.

Bolinder et al. Lancet Sept 2016

Impact Study

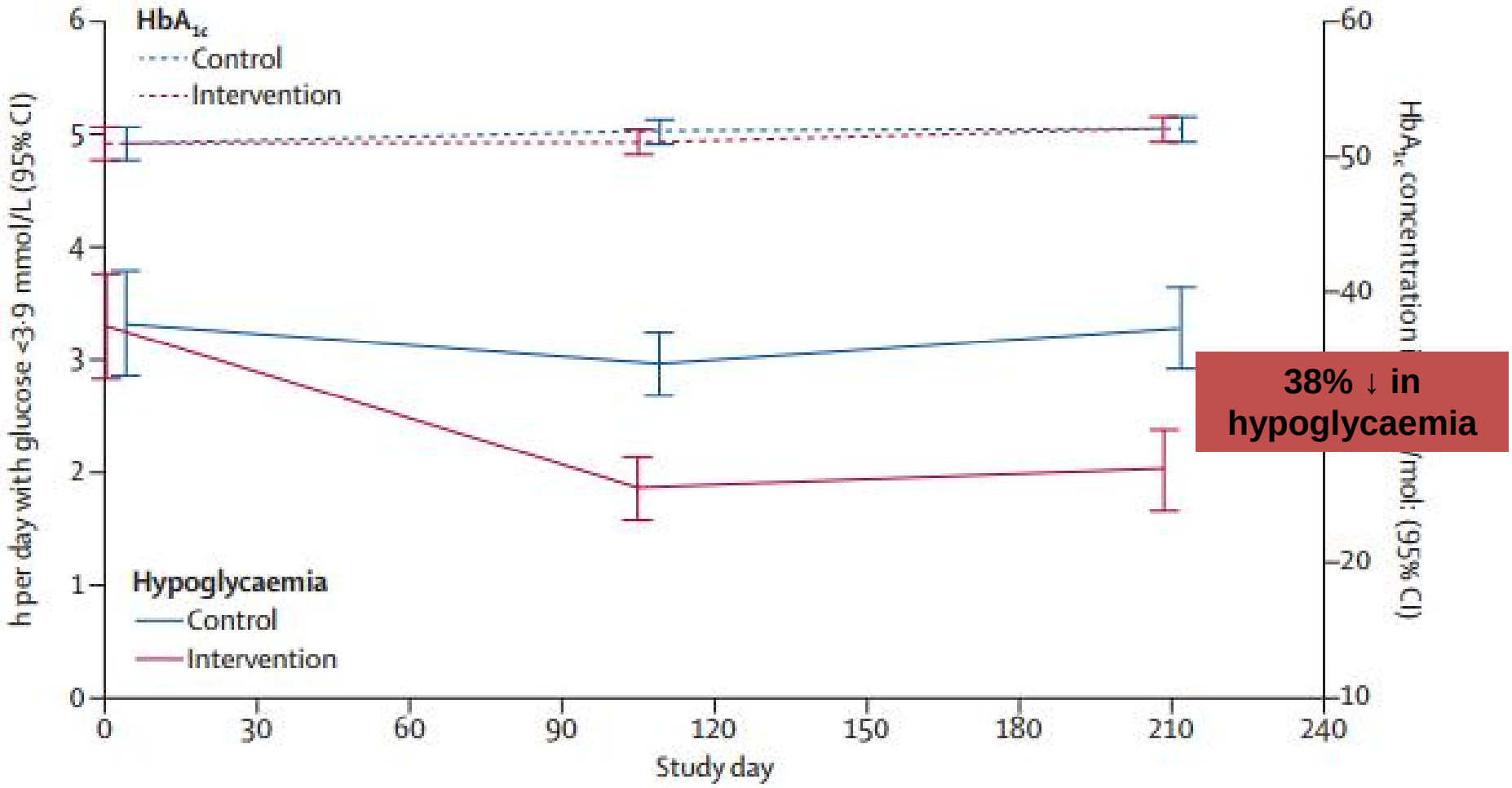
	Intervention (n=119)	Control (n=120)
Men	77 (65%)*	59 (49%)*
Women	42 (35%)	61 (51%)
Race		
White	119 (100%)	119 (99%)
Black	0	1 (1%)
Age (years)	42 (33–51)	45 (33–57)
BMI (kg/m²)	25·2 (3·6)	24·8 (3·5)
Duration of diabetes (years)	20 (13–27)	20 (12–32)
Screening HbA_{1c} (%; mmol/mol)	6·7 (0·5); 50·1 (5·7)	6·7(0·6); 50·2 (6·5)
Self-reported blood glucose frequency per day	5·4 (2·0)	5·6 (2·3)
Insulin administration method		
Multiple daily injections	81 (68%)	80 (67%)
Continuous subcutaneous insulin infusion	38 (32%)	40 (33%)
Insulin, total daily dose		
Basal (units)	25·7 (13·9)	20·9 (10·0)
Bolus (units)	24·2 (13·5)	22·2 (13·4)
Continuous subcutaneous insulin infusion (units)	41·4 (17·1)	35·9 (15·6)

Data are n (%), median (IQR), or mean (SD). *p=0·0153.

Table 1: Baseline characteristics

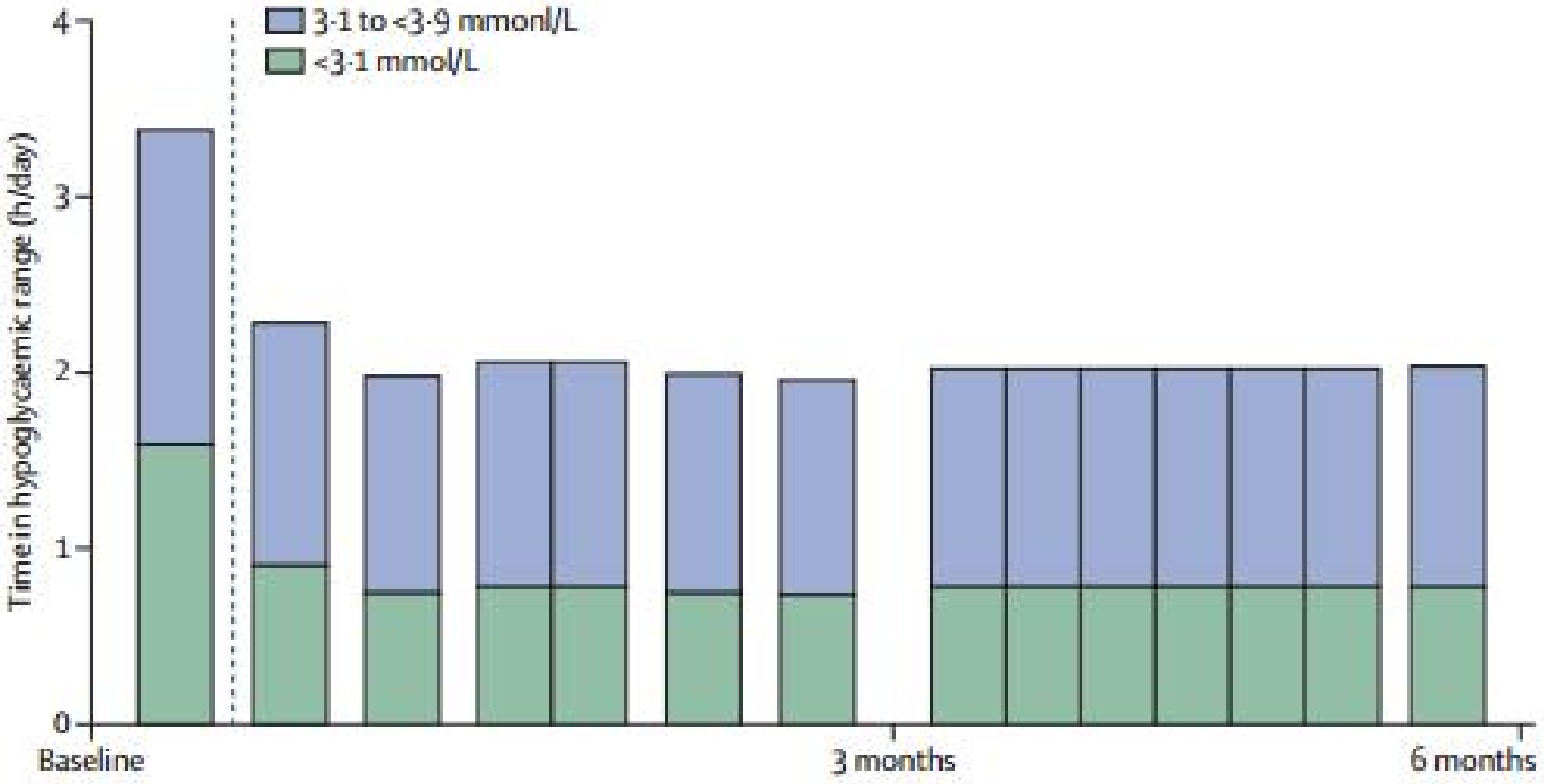
Bolinder et al. Lancet Sept 2016

Results: HbA1c and Hypoglycaemia



Bolinder et al. Lancet Sept 2016

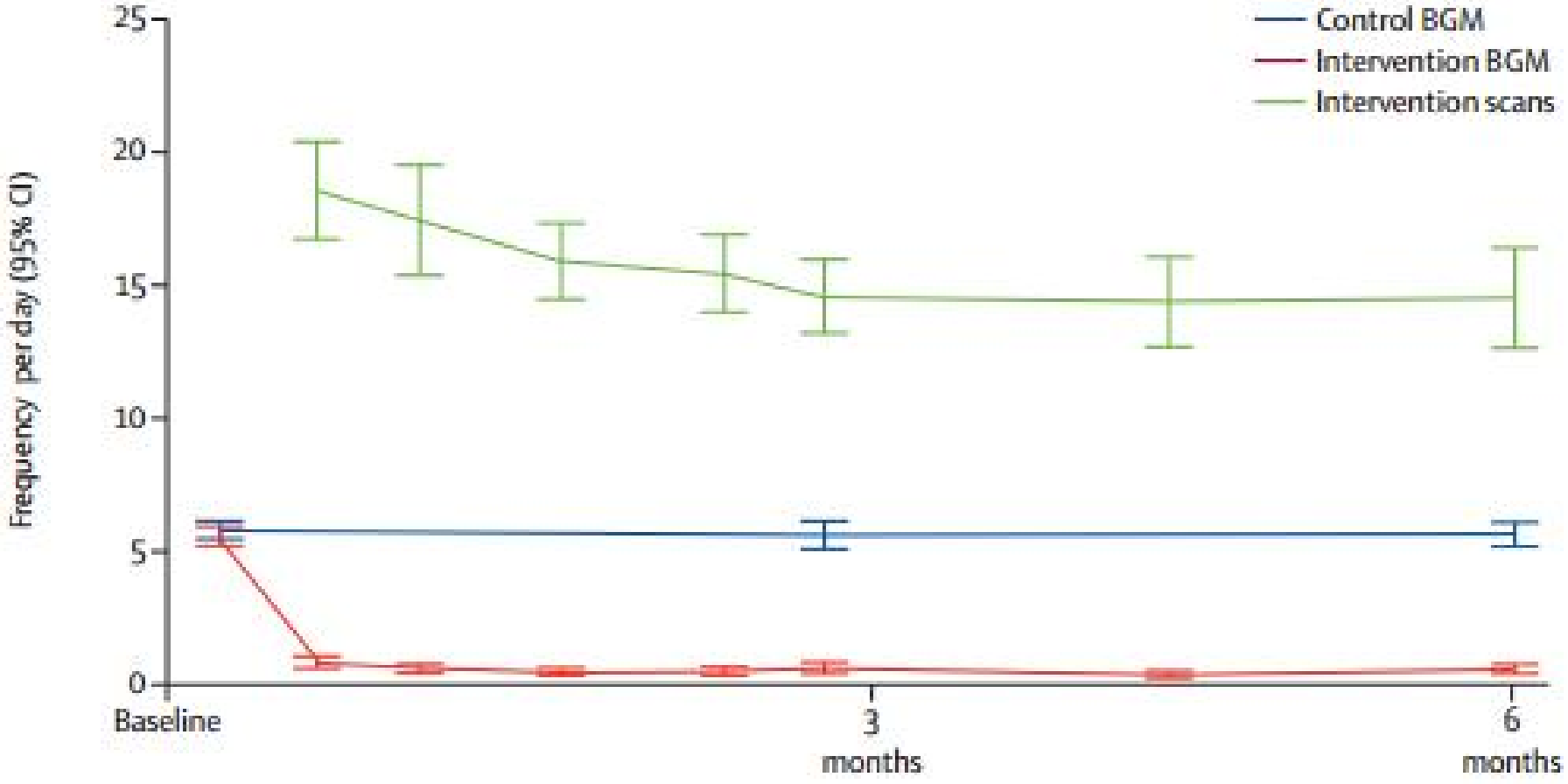
Improvement within 2/52



Bolinder et al. Lancet Sept 2016

- You do not need a degree to realise that this means you are at risk of impending hypoglycaemia

Mean of 15 scans per day SMBG fell from 5.5 to 0.5 tests/day



Bolinder et al. Lancet Sept 2016

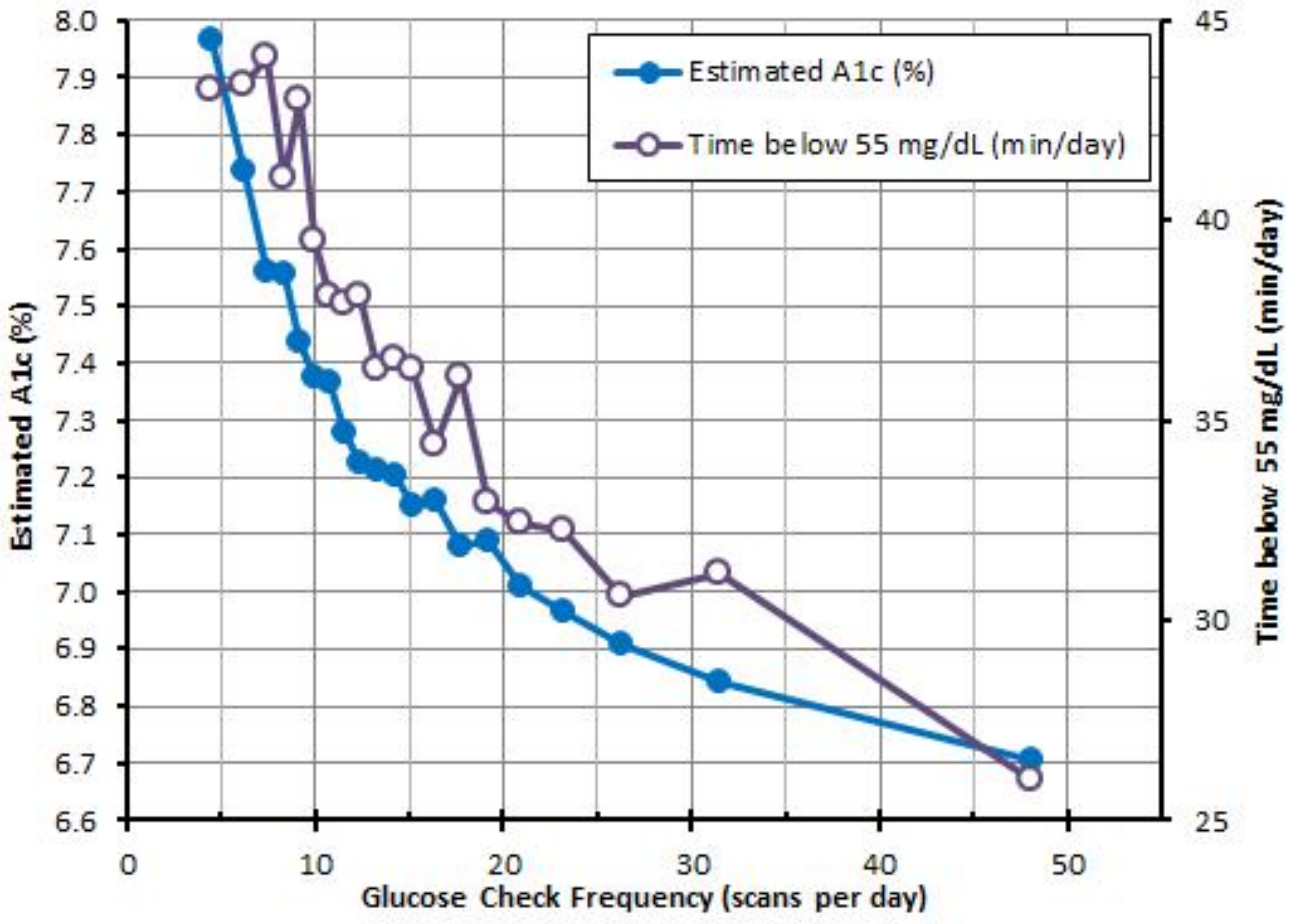
Monthly Summary

December 2016

FreeStyle Libre

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average Glucose				1 **10.3** mmol/L	2 **11.6** mmol/L	3 **8.6** mmol/L	4 **9.9** mmol/L
Scans/Day				16	24	15	24
Low-Glucose Events							
	5 **7.3** mmol/L 13	6 **8.3** mmol/L 15	7 **9.4** mmol/L 16	8 **9.6** mmol/L 19	9 **7.1** mmol/L 26	10 **10.8** mmol/L 16	11 **7.8** mmol/L 15
	12 **7.8** mmol/L 17	13 **9.5** mmol/L 24	14 **8.0** mmol/L 15	15 **8.0** mmol/L 21	16 **7.5** mmol/L 20	17 **8.2** mmol/L 21	18 **8.3** mmol/L 10
	19 **10.0** mmol/L 12	20 **9.5** mmol/L 18	21 **7.4** mmol/L 15	22 **9.5** mmol/L 24	23 **9.0** mmol/L 22	24 **8.8** mmol/L 12	25 **11.6** mmol/L 18
	26 **9.4** mmol/L 17	27 **9.5** mmol/L 21	28 **9.6** mmol/L 21	29 **8.5** mmol/L 18	30 **9.6** mmol/L 31	31 **9.0** mmol/L 21	

Real world Libre data



- **51K readers, worldwide**
- **Average 16 scans/day**

T. Dunn, Y. Xu, G. Hayter, Abbott Diabetes Care, ATTD 2017

Lots of scans = good DM control

Libre adverse events

	Intervention group (n=120)	Control group (n=121)
Participants with adverse or serious adverse events	63 (53%)	61 (50%)
Number of adverse or serious adverse events	138	138
Participants with serious adverse events	5 (4%)	4 (3%)
Number of serious adverse events	5	5
Participants with hypoglycaemic serious adverse events*	2 (2%)	3 (2%)
Number of hypoglycaemic serious adverse events*	2	4
Participants with hypoglycaemic adverse events	0	2 (2%)
Number of hypoglycaemic adverse events	0	3
Participants with device-related adverse events†	10 (8%)	0
Number of device-related adverse events	13	0
Participants who discontinued due to adverse events	6 (5%)	1 (<1%)‡

Table includes the full analysis set and two participants that became pregnant. *A hypoglycaemic serious adverse event was reported during the baseline phase. †Device-related adverse events were all related to wearing the sensor: four participants with allergy (one severe, three moderate); one with itching (mild); one with rash (mild); four with insertion-site symptom (severe); two with erythema (one severe, one mild); and one with oedema (moderate); all resolved. ‡Due to severe hypoglycaemia.

Table 3: Adverse events

Bolinder et al. Lancet Sept 2016

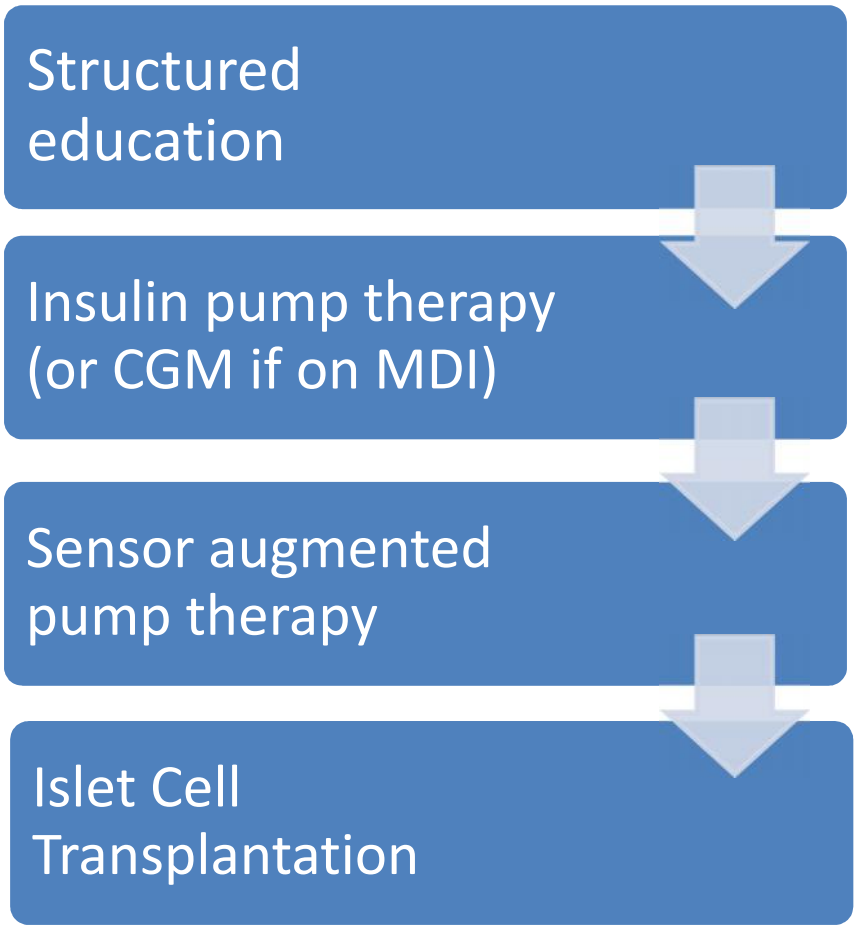
Impact overall

- Freestyle Libre use
  - Reduced hypoglycaemia (<3.9mmol/l) by 38%
  - Reduced hyperglycaemia (>13.3mmol/l) by 19%
  - No significant change in HbA1c
  - Greater treatment satisfaction ($p<0.05$)
- In a well controlled group with T1DM
  - No training was required
  - 15 scans/day

Where does Libre lie in our treatment pathways?

Where in the pathway??

Problematic hypoglycaemia



- Currently **no** evidence of benefit in those with IAH/recurrent severe hypoglycaemia
- Use NICE recommended hypoglycaemia pathways (ie pump/CGM)
- Freestyle Libre is an alternative to SMBG, not CGM

Starting on the Libre

One of your patients mentions

that they are going to buy the Libre system.

What advice would you give

them for using the system safely?

Discuss

Starting advice

- DVLA: Use blood glucose for driving
- Be aware of 5 minute lag, check blood glucose if feel high/low
- Don’t correct glucose within ~2.5hrs of a bolus
- Avoid post prandial spikes by giving the bolus 20 mins before meals
- Try to check blood glucose at least once per day to ensure sensor reliable

Driving and Libre: useful adjunct

- Scenario:

- About to leave drive to school to pick up the kids…check blood glucose which is 5.3mmol/l
- By DVLA regulations, safe to drive

Must check BLOOD GLUCOSE for driving

Impact on decision making

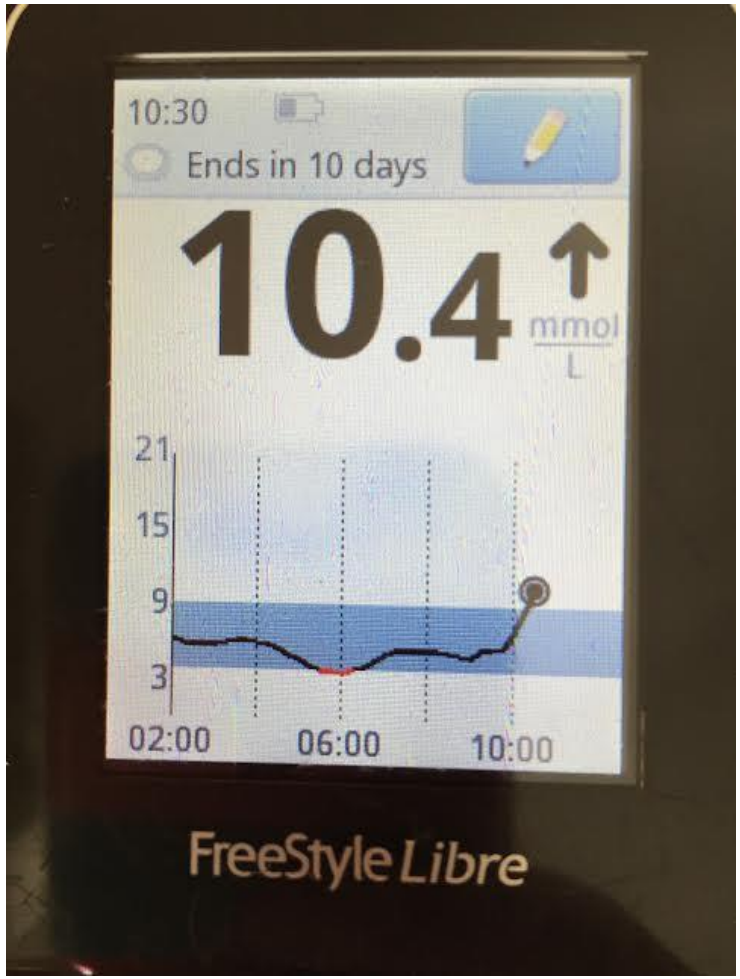
- Response to this….

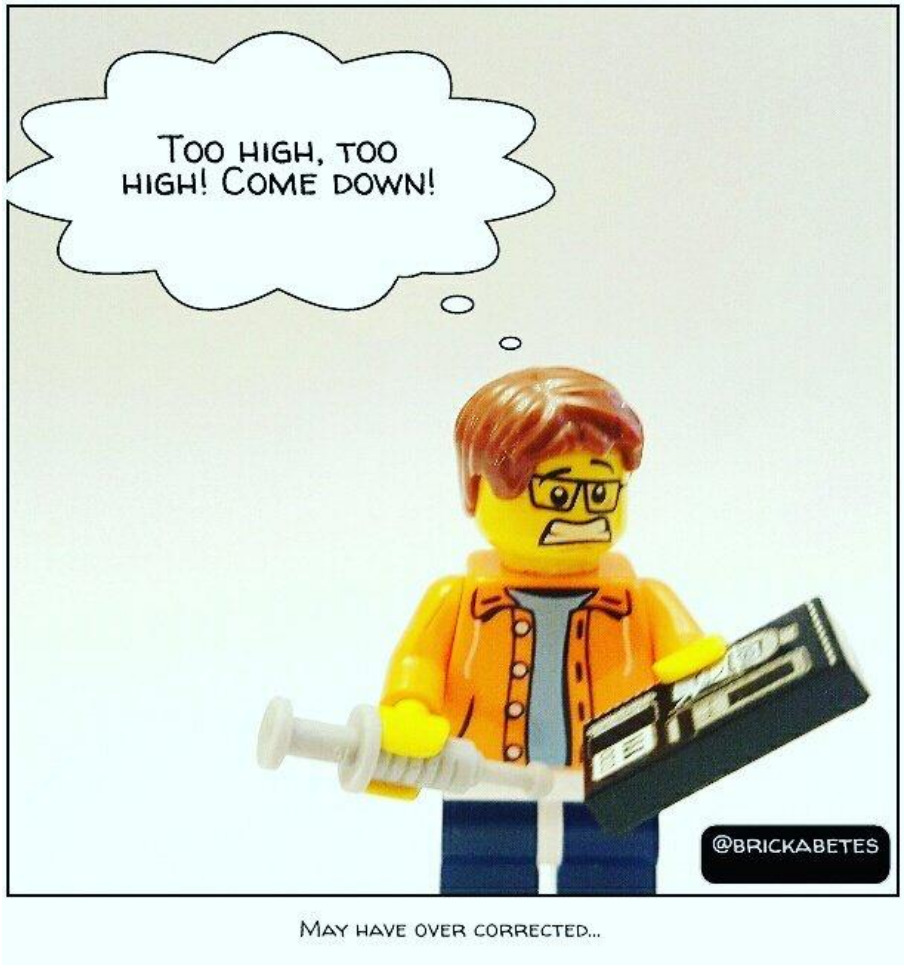
Impact on decision making

- Response to this….

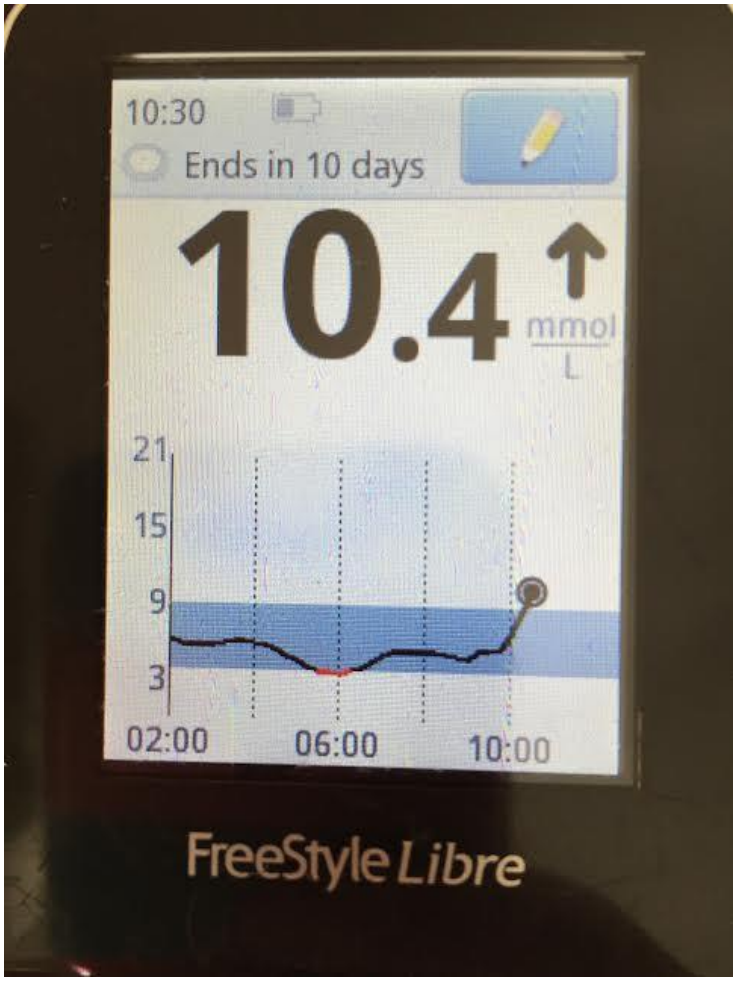
….very different to….

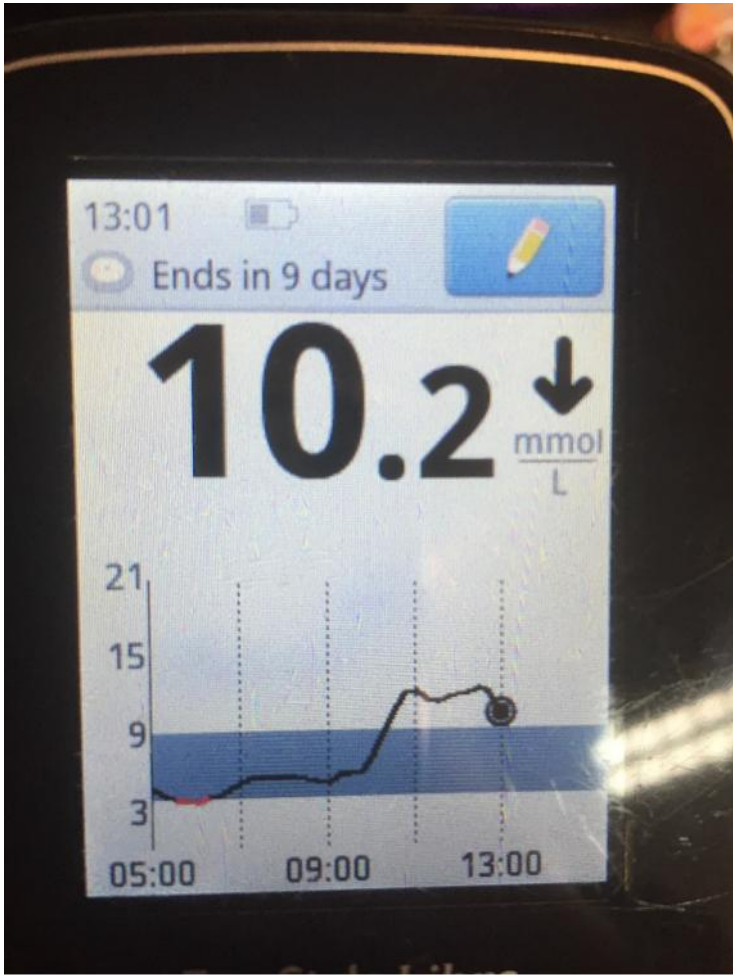
The post prandial spike & the temptation to correct…



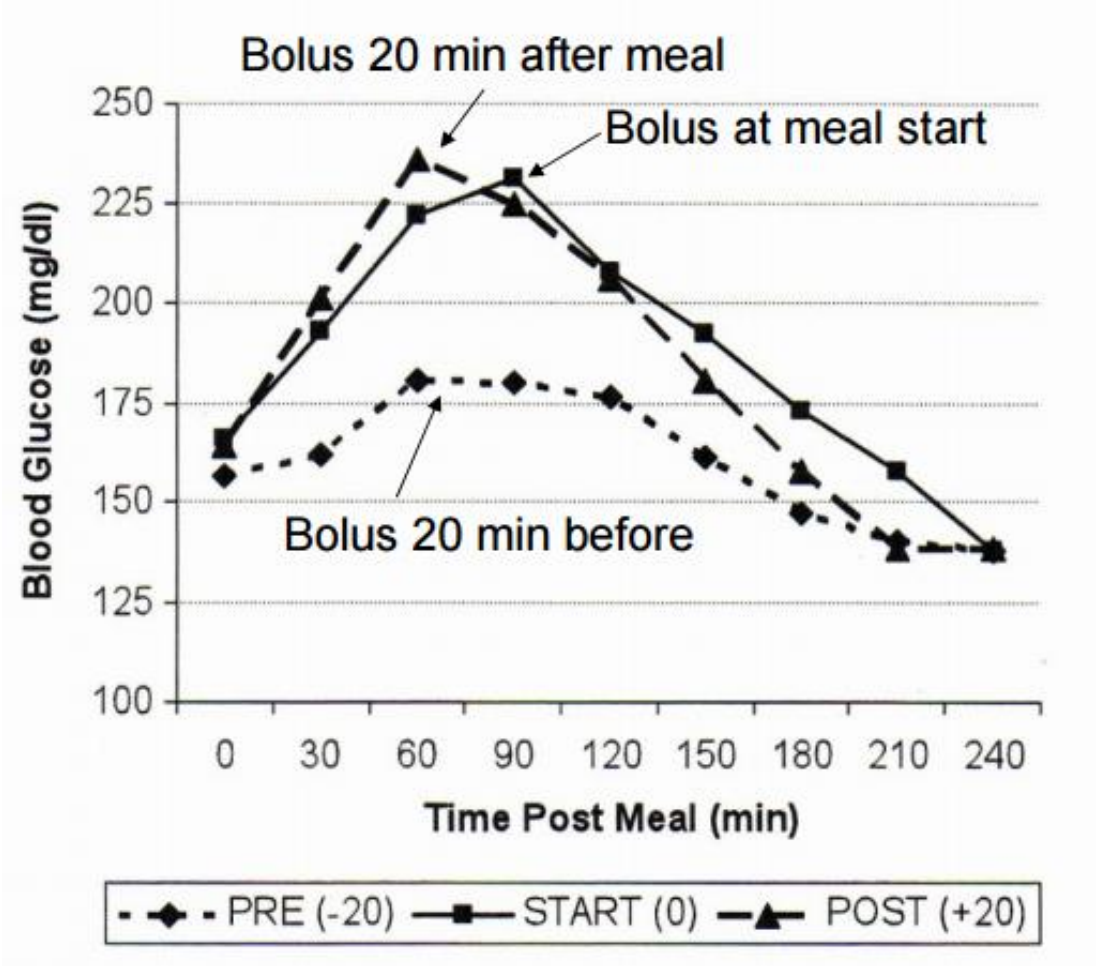


3 hours later with no correction…



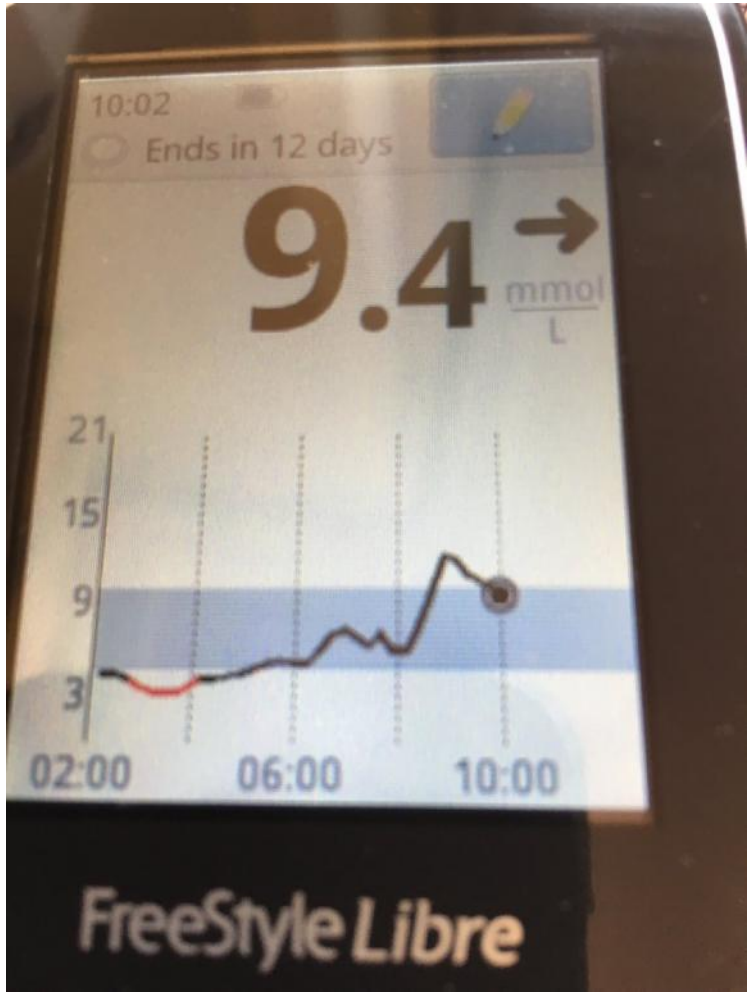


Timing is everything…
Bolus 20 minutes before meals



Cobry et al Diabetes Technol Ther 2010; 12: 173-177

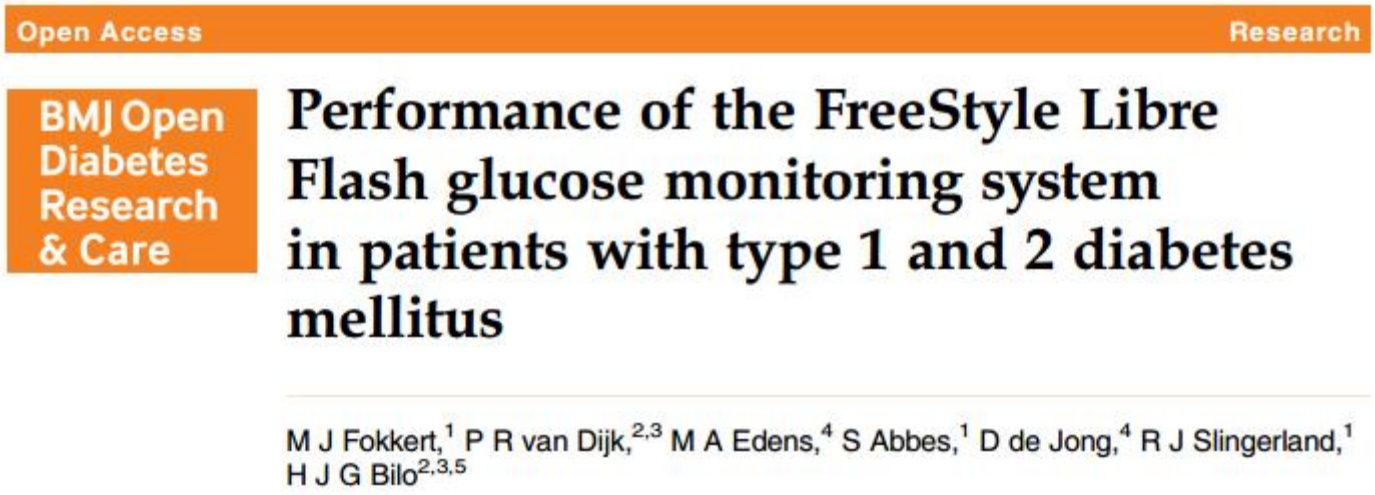
Nocturnal Hypoglycaemia



- A surprise finding for many
- Allows for basal optimisation
- Leads to a reduction in nocturnal hypos

Hypo over treatment

May underestimate post prandial rise….



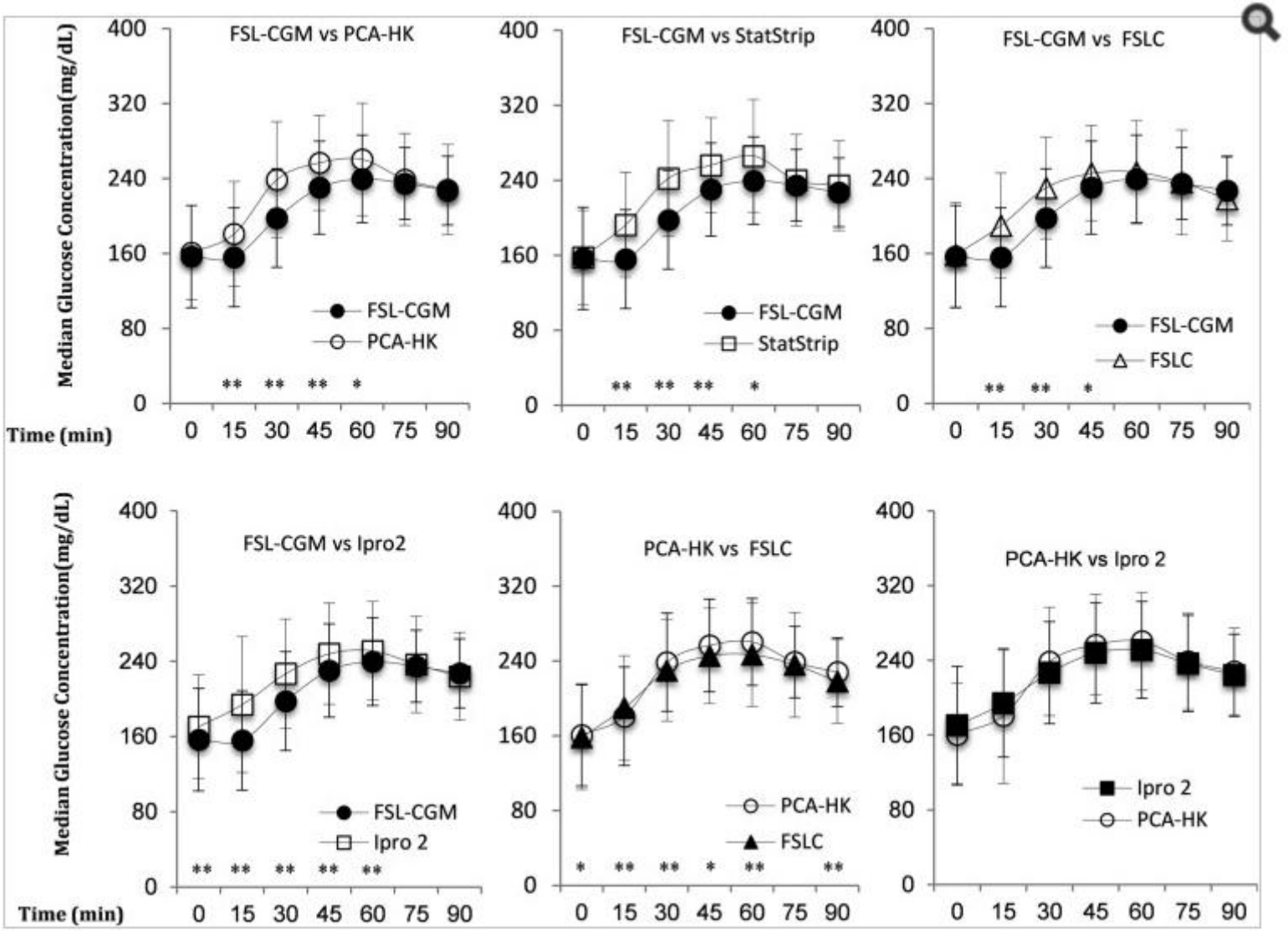
Open Access Research

BMJ Open Diabetes Research & Care

Performance of the FreeStyle Libre Flash glucose monitoring system in patients with type 1 and 2 diabetes mellitus

M J Fokkert,[1] P R van Dijk,[2,3] M A Edens,[4] S Abbes,[1] D de Jong,[4] R J Slingerland,[1] H J G Bilo[2,3,5]

Fokkert et al. BMJ Open Diabetes Res care 2017 Feb 17;5(1):



Slower rise and generally lower values: may underestimate the effect of a meal on the glucose response

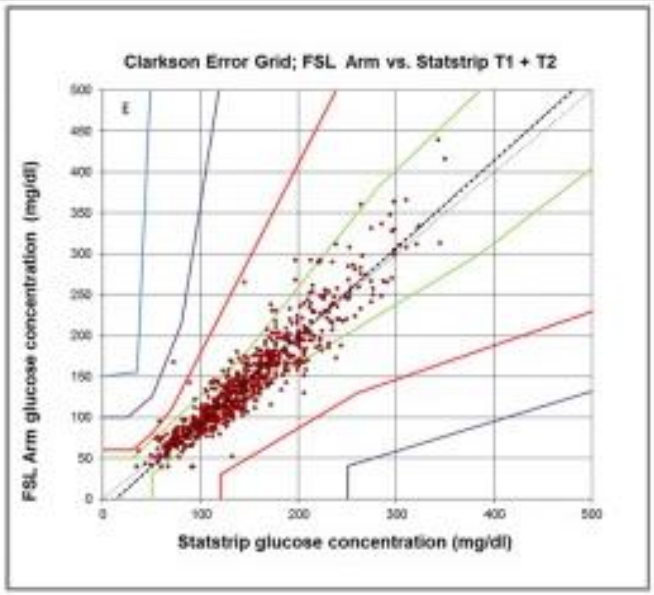
Fokkert et al. BMJ Open Diabetes Res care 2017 Feb 17;5(1):

Fokkert conclusions

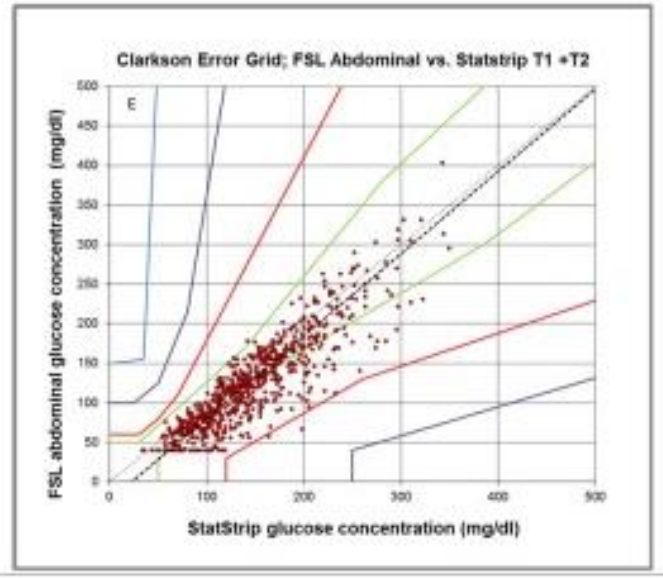
- Lower than expected glucose values were observed in the lower glucose ranges for the FSL-CGM compared with reference method
  - When a user is alert and sees a low reading in the absence of clinical signs of hypoglycaemia, check blood glucose
- May underestimate effect of a meal on glucose

Where to wear?

Zone	N	%
A	611	85,5
B	102	14,3
C	2	0,3
D	0	0
E	0	0



Zone	N	%
A	418	62,9
B	245	36,8
C	2	0,3
D	0	0
E	0	0



Clarke Error Grid Zone A

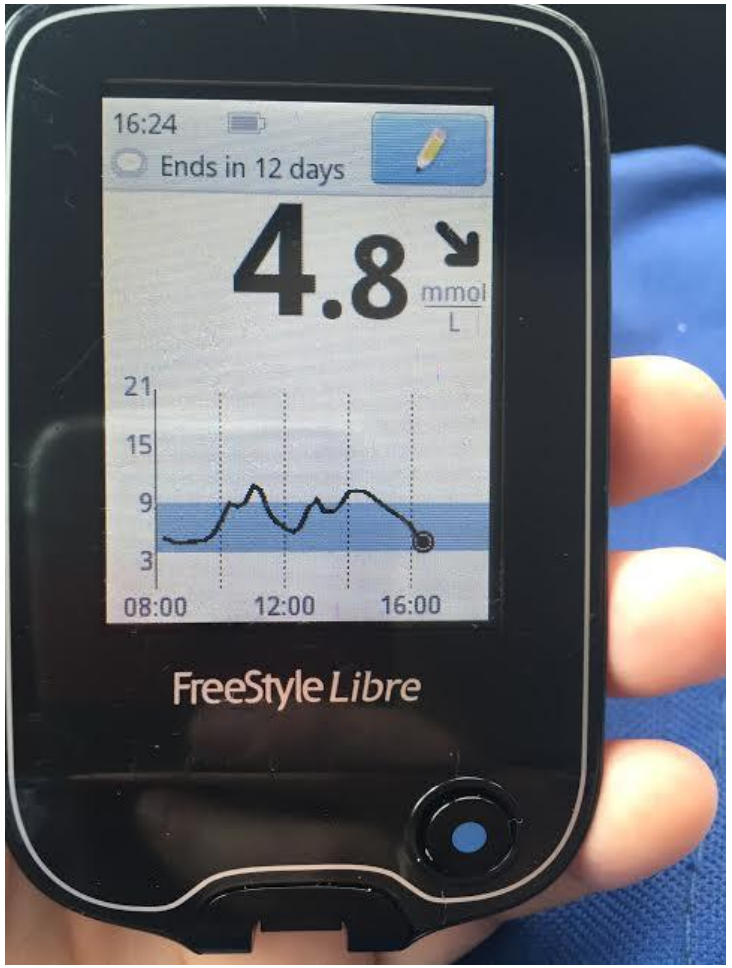
- Arm 85%
- Abdomen 64%

Abdominal use NOT recommended

Fokkert et al. BMJ Open Diabetes Res care 2017 Feb 17;5(1)

Question

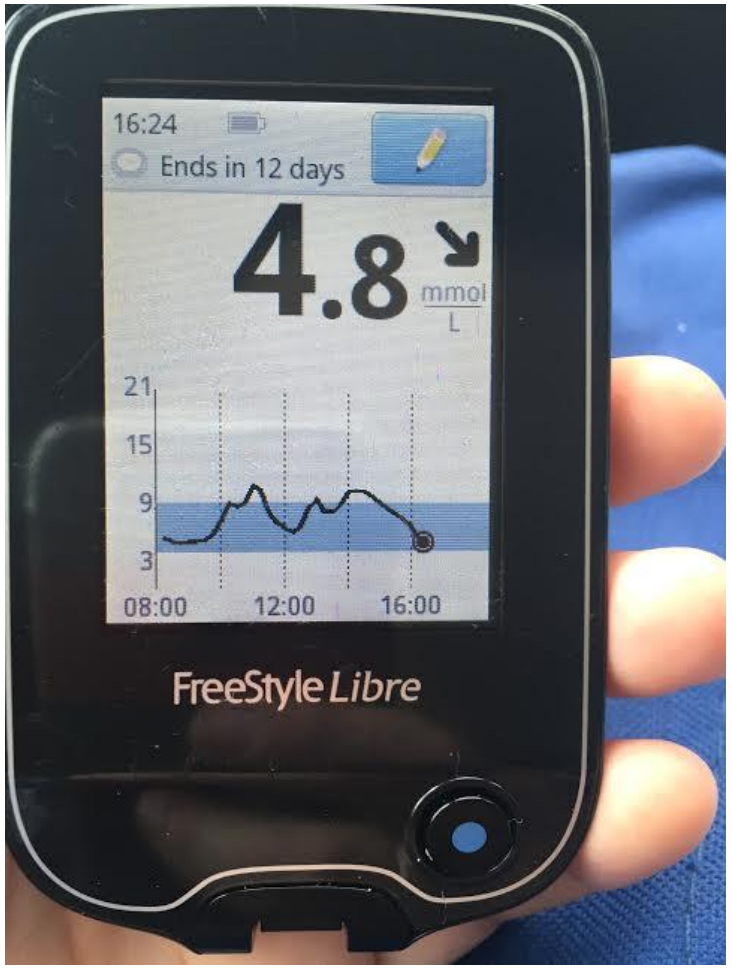
What would you advise this patient to do?



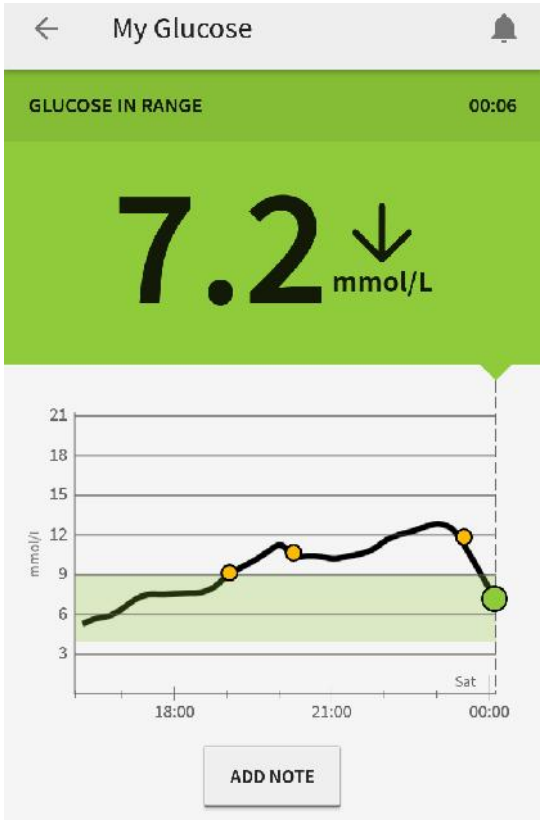
Question

What would you advise this patient to do?

- **Check blood glucose**
- **Take extra carbohydrate**
- **Rescan**
- **Be aware of 5 minute lag in recovery phase**



Impact on behaviour



- Pre bed blood glucose of 7.2mmol/l, reassuring
- How might patient respond to this Libre image?

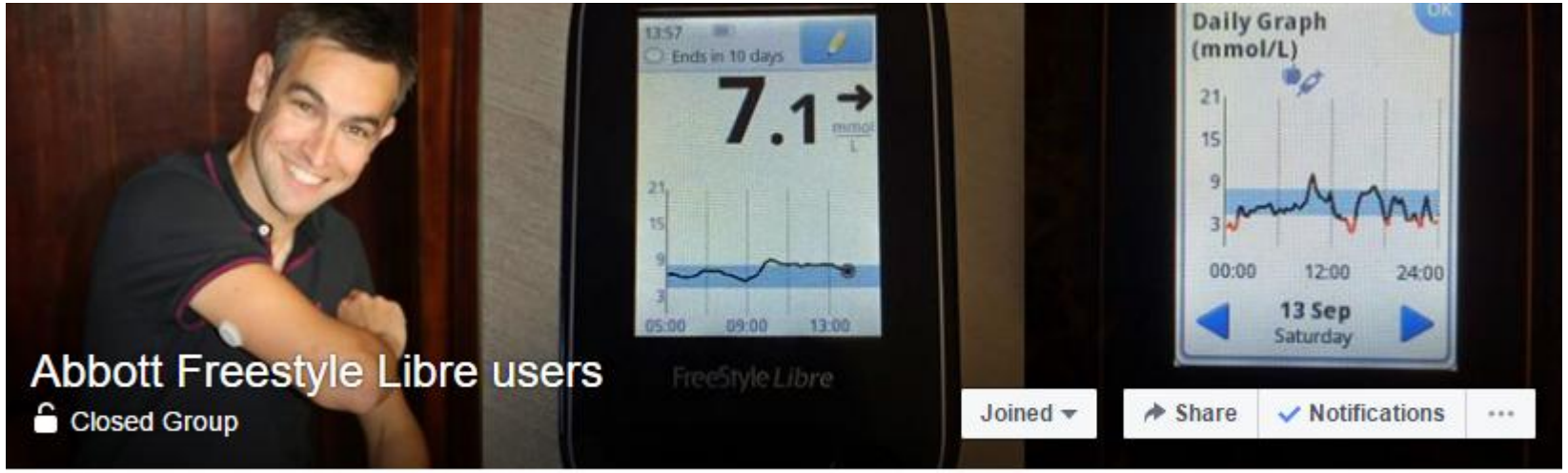
Avoiding hypoglycaemia

- Take action if glucose <7 with arrow pointing down (glucose falling)
- Degree of correction depends on insulin on board, activity levels etc
- What is the cause of the drop?
- Micro carb and/or pump suspension allow for hypo avoidance

Changes patients have made

- Reduced overnight & daytime hypoglycaemia
- Avoid over tx of hypos
- Started to bolus before meals
- Early correction of carb errors
- Accuracy of I:C & ISF
- Many say they have learned a lot more about their diabetes

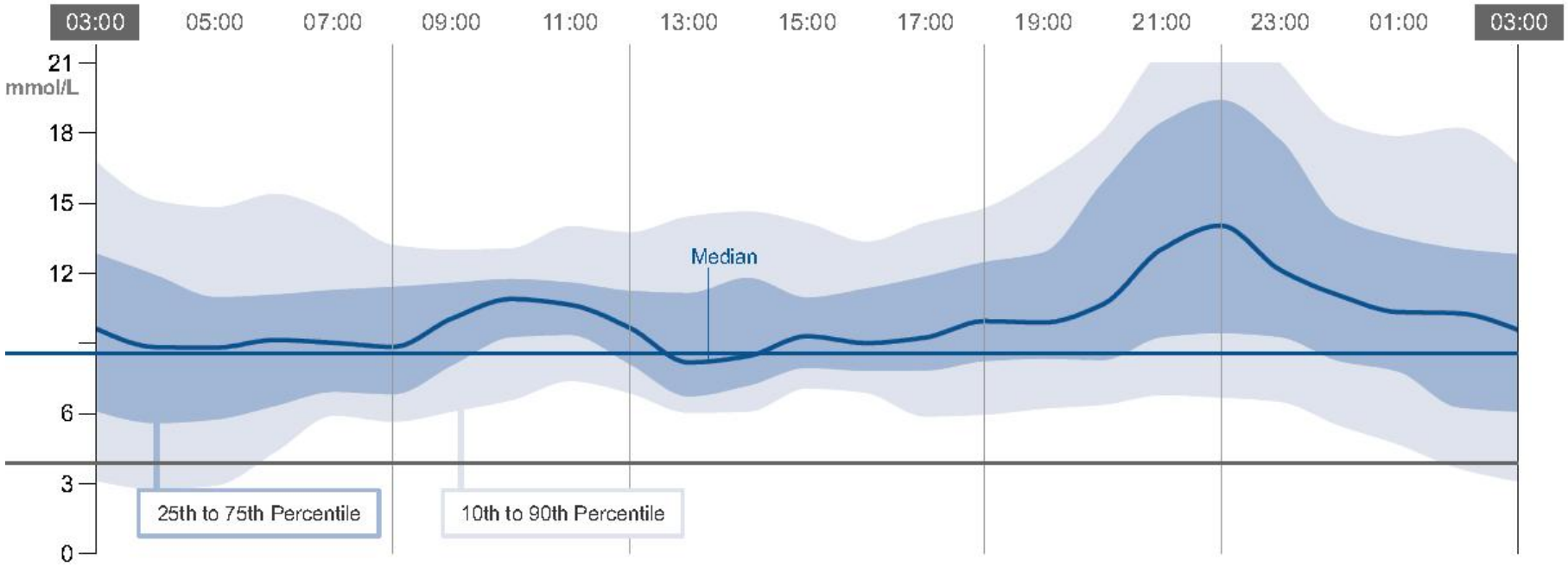
Facebook peer support



Data interpretation

Ambulatory Glucose Profile

Hourly percentile curves: 10th, 25th, Median (50th), 75th, 90th

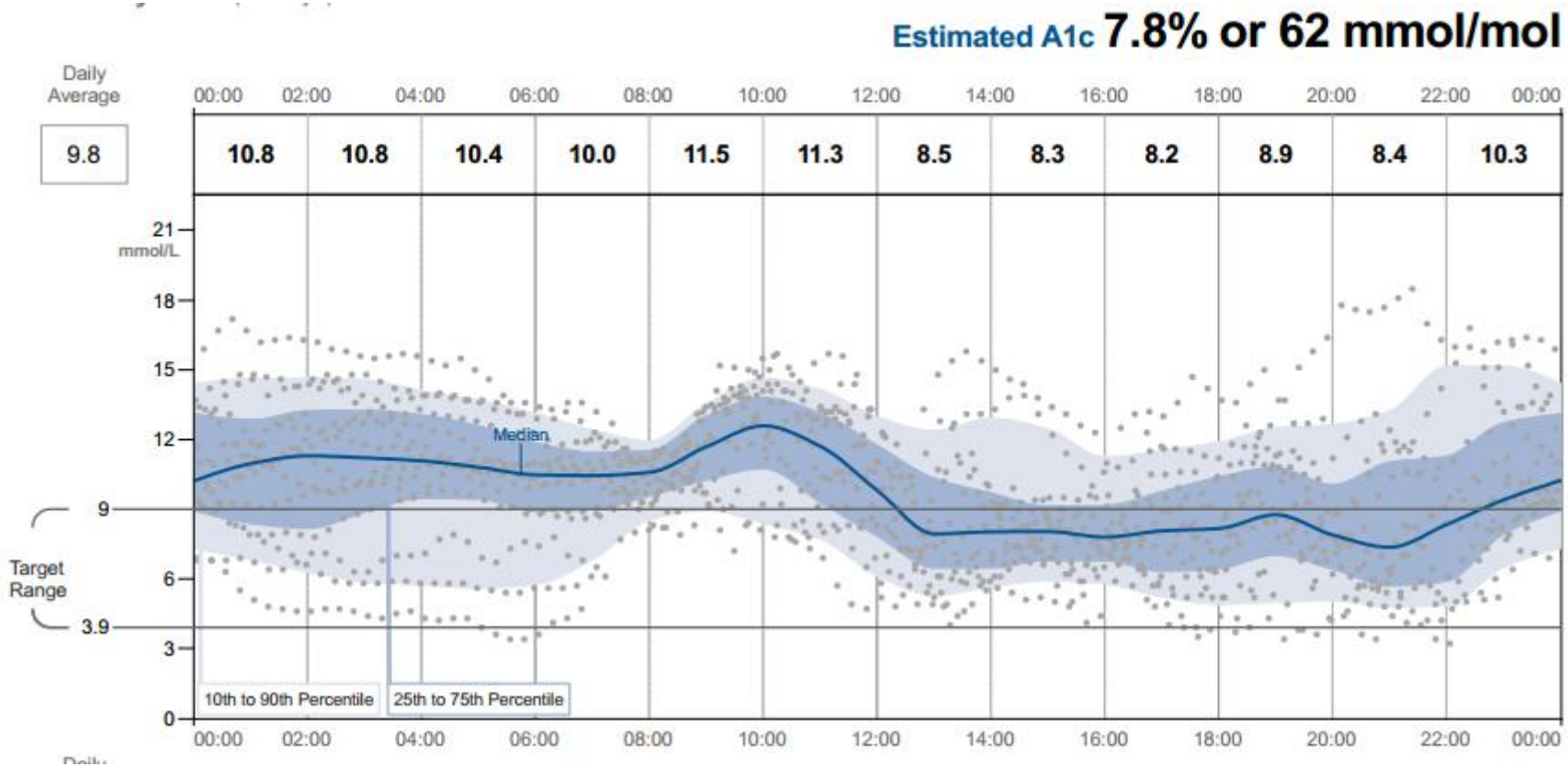


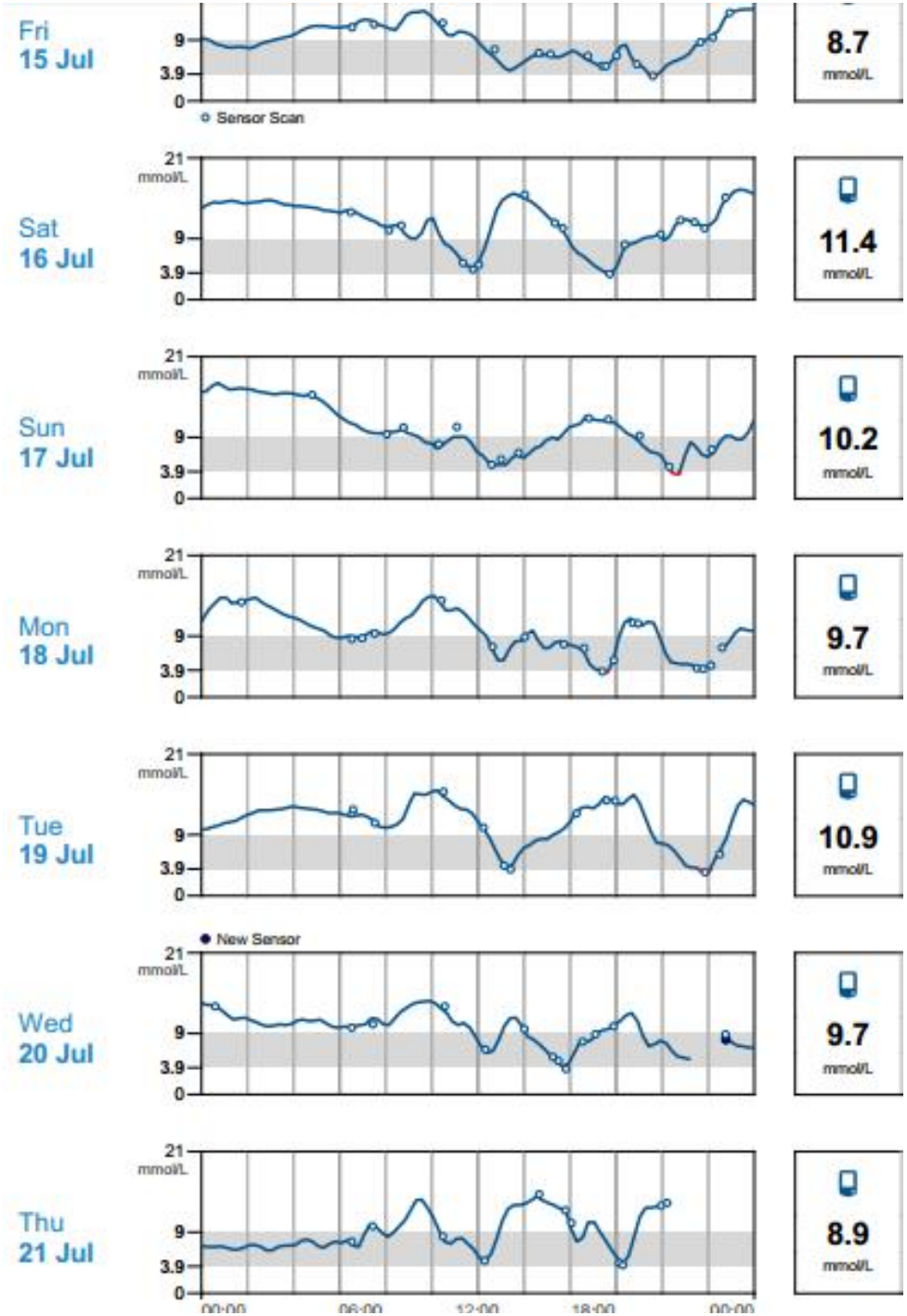
Data for illustrative purposes only – not real patient data

The AGP is for **hypothesis generation**

Day by day analysis can confirm/refute your hypotheses

NL What would you do with the basal overnight?

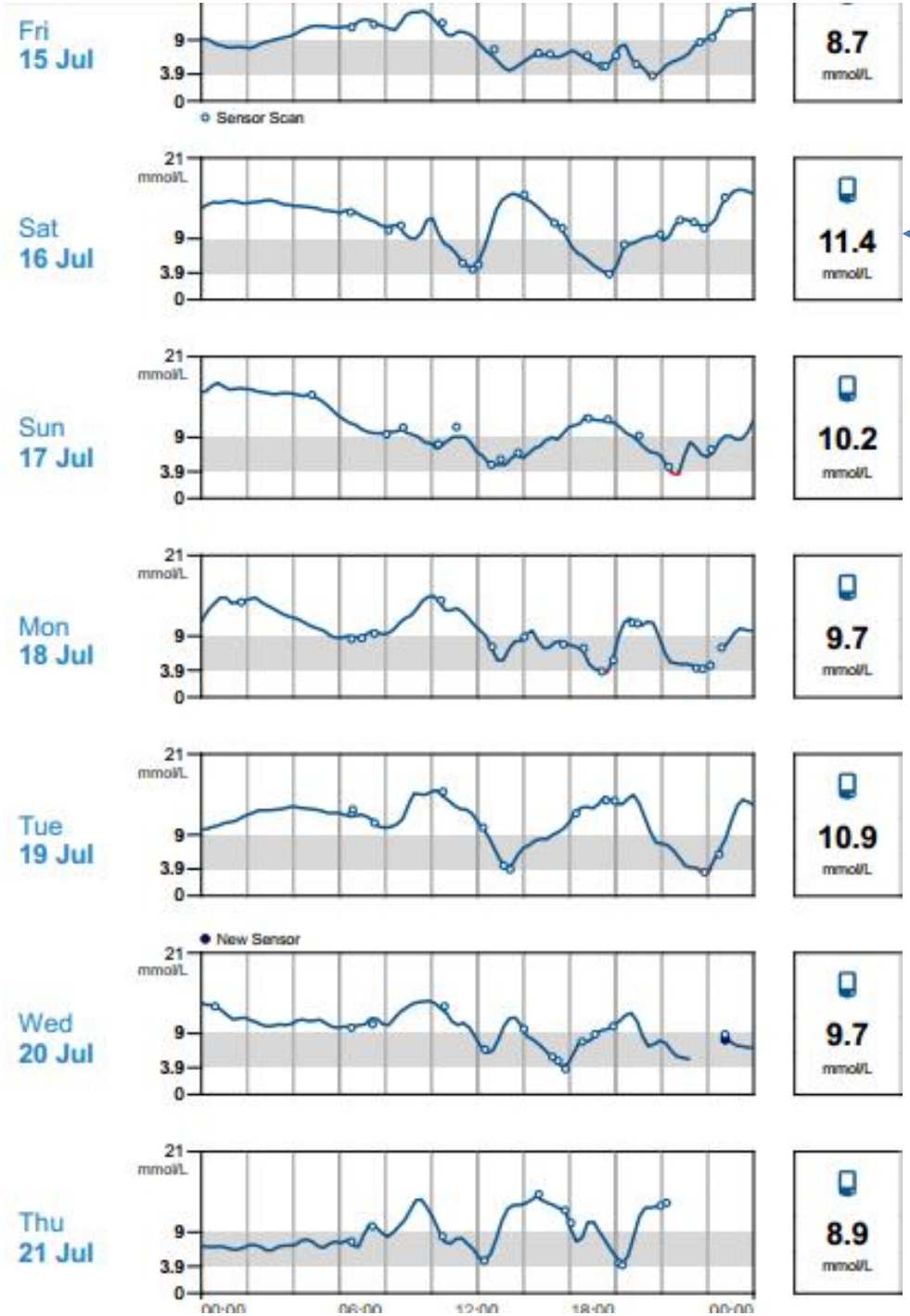




Question

What would you do with the basal insulin?

1. Increase
2. Decrease
3. Stay the same



Alcohol

Alcohol

Question

What would you do with the basal insulin?

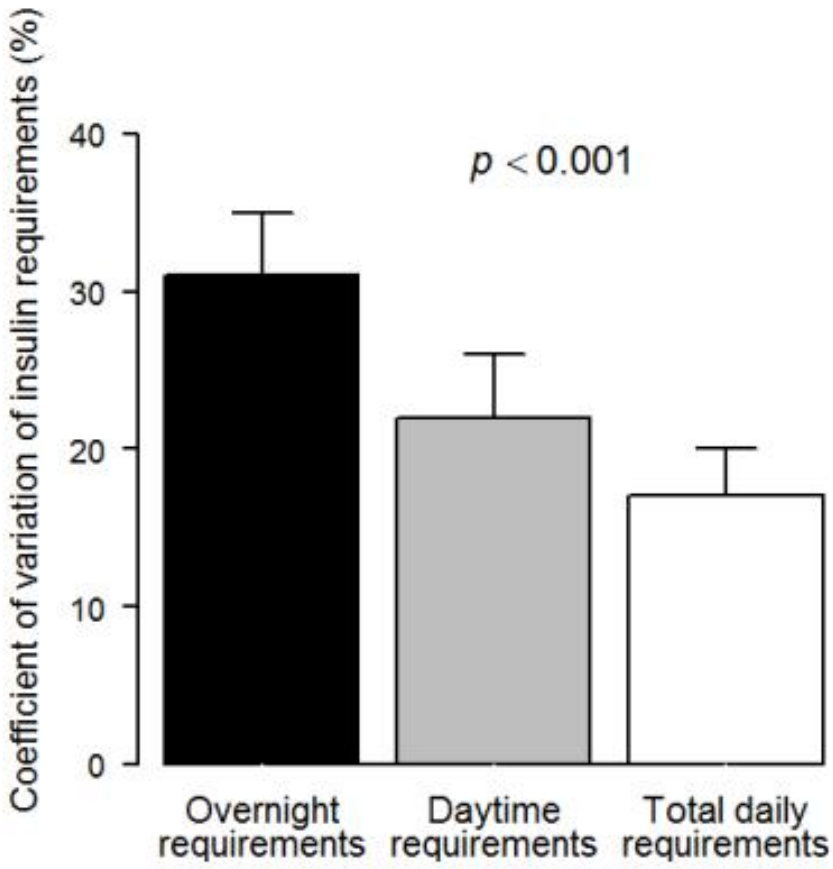
1. Increase
2. Decrease
3. **Stay the same**

When in target pre bed basal is perfect

Basal rate:
cruising at the desired altitude

Variability in overnight requirements

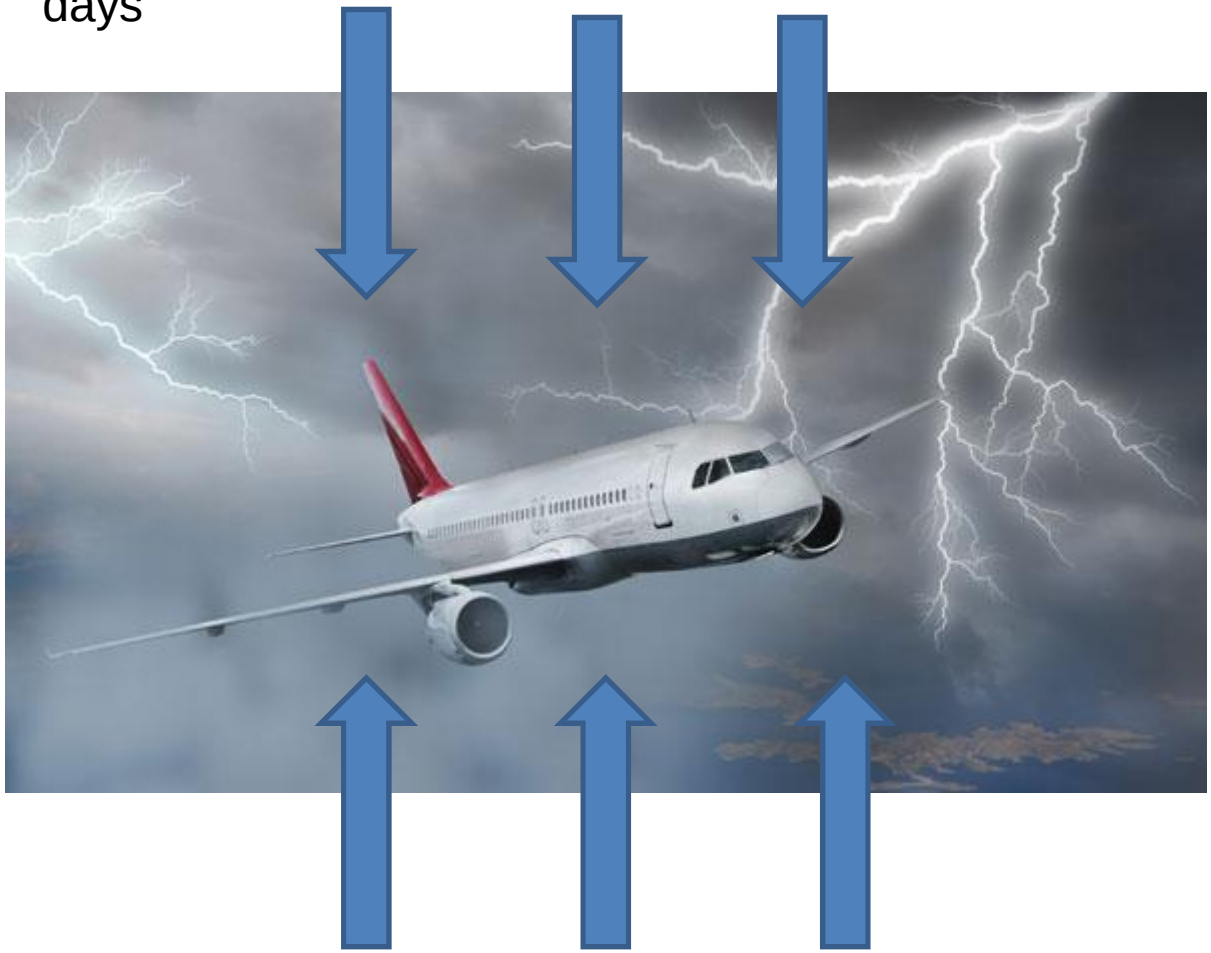
Supplementary Figure S1. Coefficient of variation of overnight (23:00 to 07:00), daytime (07:00 to 23:00) and total daily (midnight to midnight) insulin requirements [mean(SD), N=32].



Yue R et al. Diabetes Care 2016 Mar

Turbulence in basal requirements

Exercise, standing, alcohol, relaxation, non-work days



Dawn phenomenon, stress, illness, sitting, work days, pre-menstruation

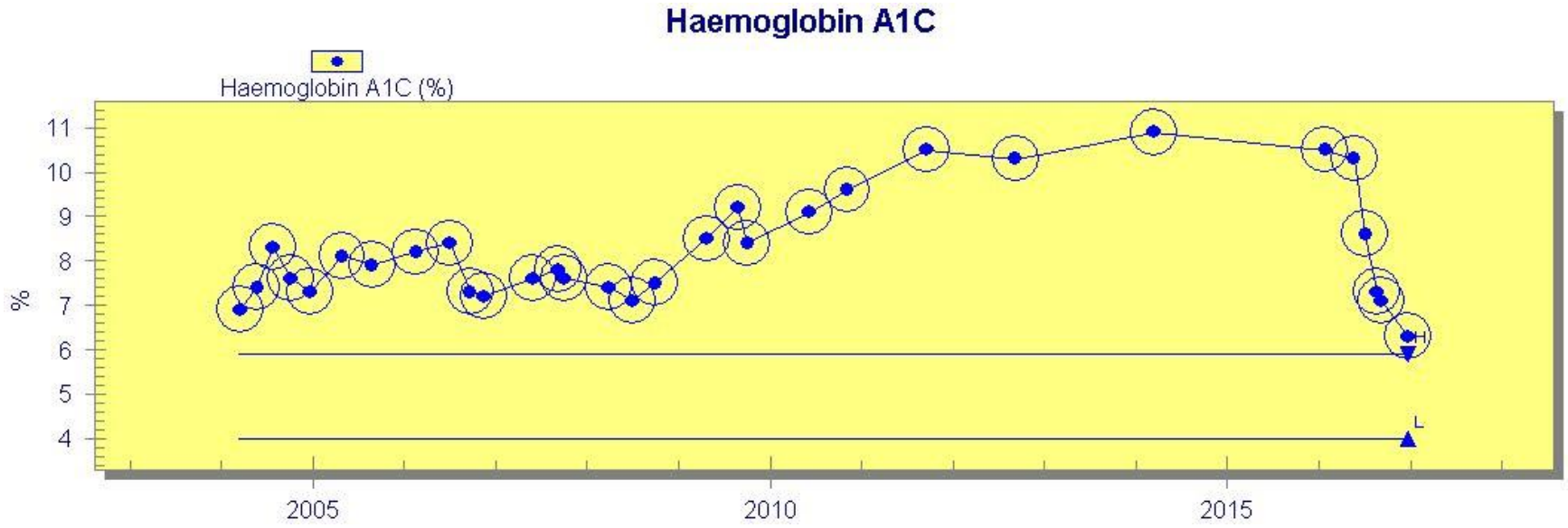
Basal control

- This is ideal
- Reality is insulin requirements vary greatly overnight
- This is not possible every night

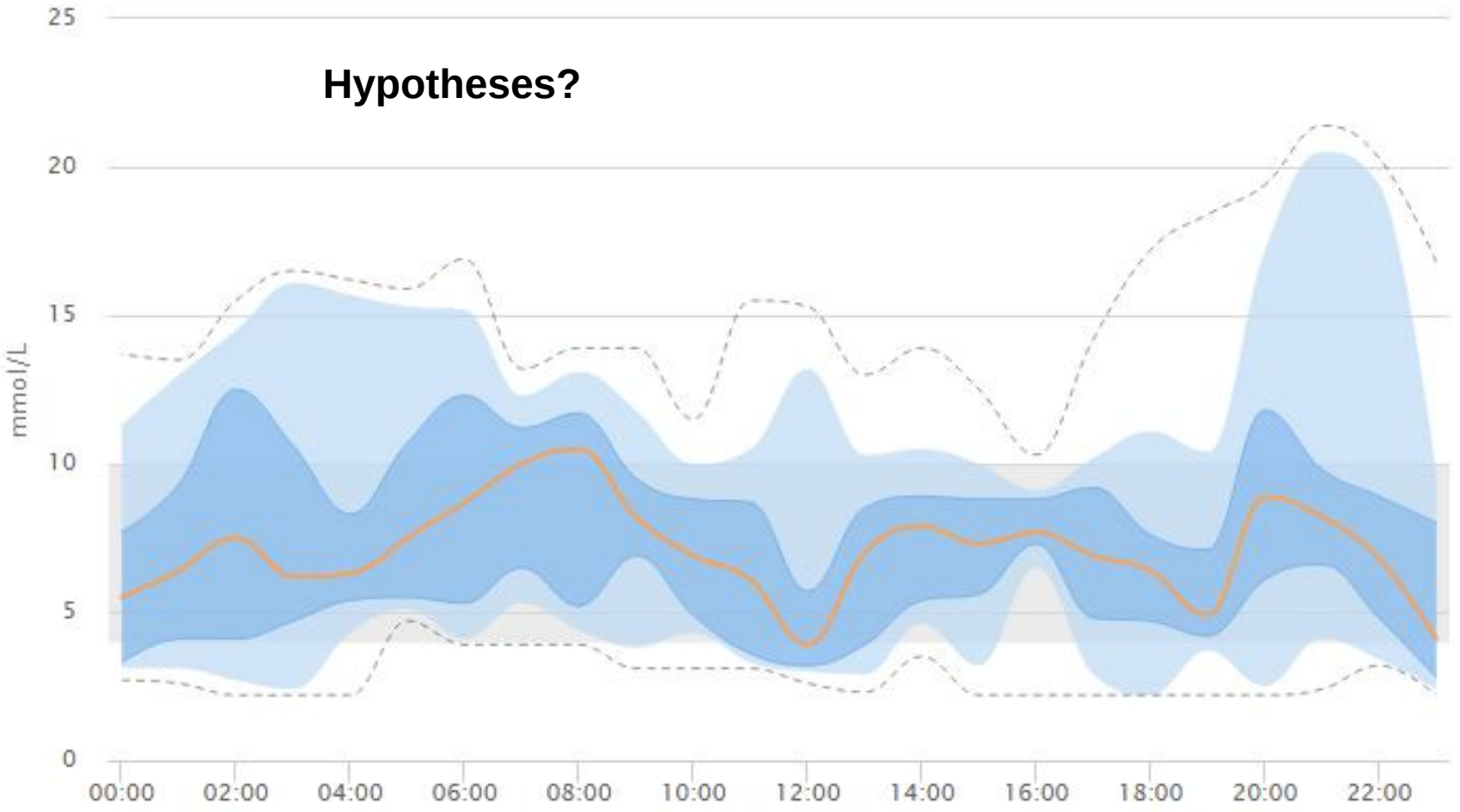
JB: Flash Glucose

- Previously disengaged with his diabetes
- HbA1c >10% for past 5 years despite CSII
- Foot ulcers, charcot, retinopathy
- Met at DUK meeting early 2016
- Keen to engage in his care, rebuilding confidence
- May 2016: HbA1c 10.3%, not monitoring, not keen to download/share data
- Between clinics started to self fund Freestyle Libre….seen in Sept

JB HbA1c

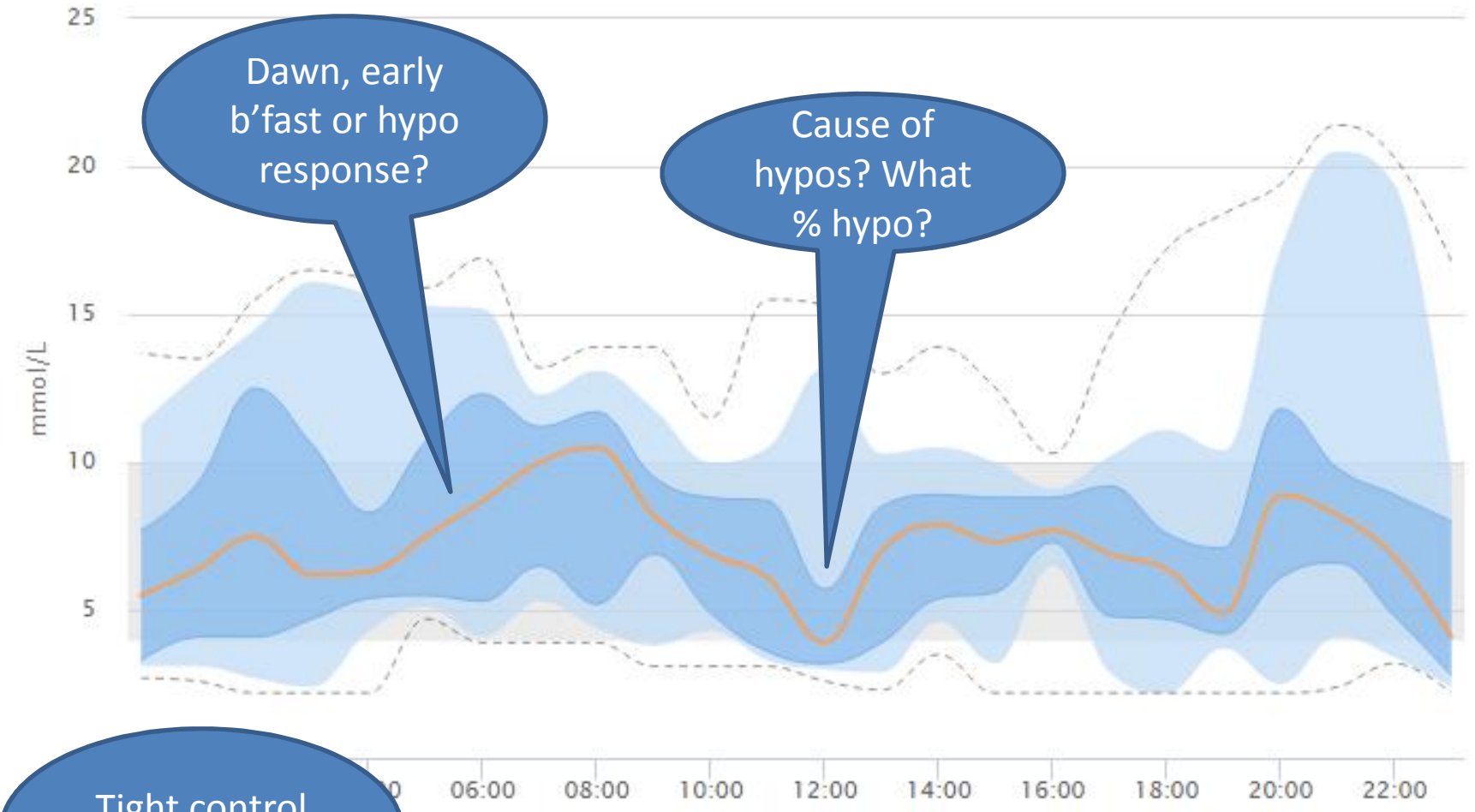

Haemoglobin A1C
Haemoglobin A1C (%)
%
11
10
9
8
7
6
5
4
H
L
2005
2010
2015

Hypotheses?



Show active basal profile

Number of values:	**982**	Values above goal (10 mmol/L):	**221**	Highest value (mmol/L):	**21.4** (25/08/2016 21:20)
Values per day:	**122.8**	Values within goal (4-10 mmol/L):	**597**	Lowest value (mmol/L):	**Lo** (23/08/2016 18:48)
Period average (mmol/L):	**7.6**	Values below goal (4 mmol/L):	**164**	Standard deviation:	**3.7**



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Period average (mmol/L):	**7.6**	Values below goal (4 mmol/L):	**164**	Standard deviation:	**3.7**

Compilation

Glucose	CGM	Insulin	Carbs	Activity	
Average	Average	Average daily dose	Average carbs / day	Avg steps / day	Avg kcal / day
0 mmo / L	7.3 mmol/L	38.2 U	122 g	0 steps	0 kcal
SD = 0 | # = 0	SD = 3.3 | # =	SD = 8 | # days = 14	SD = 52 | # = 34	0% of 10000 (target)	0% of 2500 (target)
Avg # / day = 0	Avg # / day = 10	Avg # bolus doses/day = 9.4	Avg # / day = 2.4		

Low av glucose/SD

I:C 1:13 and ISF 1:3

Glucose (mmol/L)

No values

CGM (mmol/L)

CGM readings summary	
Average (mmol/L)	7.3
Median (mmol/L)	6.7
AUC high > 10 mmol/L	0.5
AUC low < 4 mmol/L	0.1
Highest value (mmol/L)	16.4
Lowest value (mmol/L)	Lo
Standard deviation (SD)	3.3
Values per day	105.9
Number of values	1482
Values above goal (10 mmol/L)	333
Values within goal (4-10 mmol/L)	912
Values below goal (4 mmol/L)	237
Average daily CGM sensor duration	26:30 (110%)
Total CGM sensor duration	15 days 10:30

Interval	*Avg*	*#*	*SD*
00:00-06:00	7.2	321	3.6
06:00-08:00	7.9	136	3
08:00-10:00	8.4	141	3.5
10:00-12:00	7.4	138	3.3
12:00-14:00	5.8	129	2.8
14:00-16:00	5.7	122	1.9
16:00-18:00	6.5	119	2.3
18:00-20:00	6.7	121	3.1
20:00-22:00	8.4	130	2.9
22:00-24:00	8.5	125	4.1

Insulin

Insulin doses summary	
Average daily insulin (U)	38.2
Standard deviation (SD)	7.8
Average daily basal (U)	17
Average daily bolus (U)	21.2
Average bolus doses/day	9.4
Average days between cannula fills	2.5
Average days between primes	2

Bolus calculation summary	
Avg # ezBG Boluses/day	0 (0%)
Avg # ezCarb Boluses/day	2.4 (25%)
Avg # Combo Boluses/day	1.9 (20%)
Avg # Normal Boluses/day	6.1 (64%)
Bolus overrides/total boluses	7%
Avg # bolus overrides/day	0.6
Avg # bolus ezBG overrides/day	0
Avg # bolus ezCarb overrides/day	0.6
Avg # carbs/ezCarb Bolus	51 g
Avg # Insulin Units/ezCarb Bolus	4

Carb summary	
Avg # carbs/day	122 g
Standard deviation (SD)	52

Basal seems appropriate

Compilation

Glucose		CGM		Insulin	Carbs	Activity	
Average		Average		Average daily dose	Average carbs / day	Avg steps / day	Avg kcal / day
0		7.3		38.2 U	122 g	0	
mmo / L		mmol/L				steps	
SD = 0	# = 0	SD = 3.3	# = 1482	SD = 8 # days = 14	SD = 52 # = 34	0% of 1000	
Avg # / day = 0		Avg # / day = 105.9		Avg # bolus doses/day = 9.4	Avg # / day = 2.4		

Behavioural?

Behavioural

16% hypo, after b'fast

Glucose (mmol/L)

No values

CGM (mmol/L)

CGM readings summary	
Average (mmol/L)	7.3
Median (mmol/L)	6.7
AUC high > 10 mmol/L	0.5
AUC low < 4 mmol/L	0.1
Highest value (mmol/L)	16.4
Lowest value (mmol/L)	Lo
Standard deviation (SD)	3.3
Values per day	105.9
Number of values	1482
Values above goal (10 mmol/L)	333
Values within goal (4-10 mmol/L)	912
Values below goal (4 mmol/L)	237
Average daily CGM sensor duration	26:30 (110%)
Total CGM sensor duration	15 days 10:30

Interval	*Avg*	*#*	*SD*
00:00-06:00	7.2	321	3.6
06:00-08:00	7.9	136	3
08:00-10:00	8.4	141	3.5
10:00-12:00	7.4	138	3.3
12:00-14:00	5.8	129	2.8
14:00-16:00	5.7	122	1.9
16:00-18:00	6.5	119	2.3
18:00-20:00	6.7	121	3.1
20:00-22:00	8.4	130	2.9
22:00-24:00	8.5	125	4.1

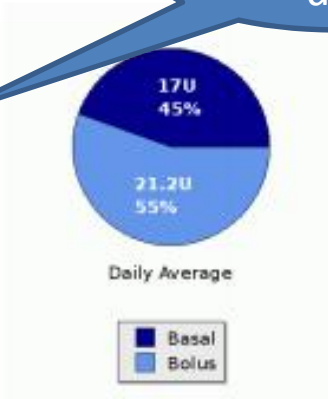
Insulin

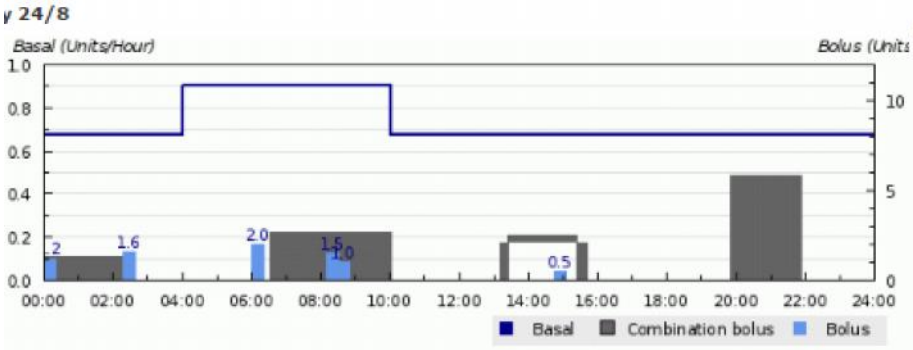
Insulin doses summary	
Average daily insulin (U)	38.2
Standard deviation (SD)	7.8
Average daily basal (U)	17
Average daily bolus (U)	21.2
Average bolus doses/day	9.4
Average days between cannula fills	2.5
Average days between primes	2

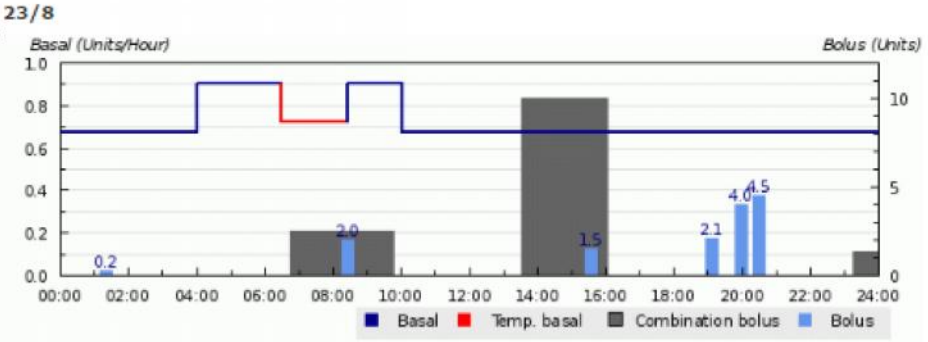
Carb summary	
Avg # carbs/day	122 g
Standard deviation (SD)	52

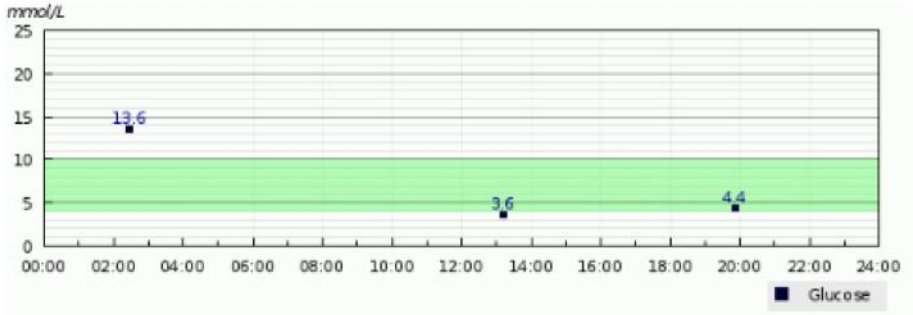
Bolus calculation summary	
Avg # ezBG Boluses/day	0 (0%)
Avg # ezCarb Boluses/day	2.4 (25%)
Avg # Combo Boluses/day	1.9 (20%)
Avg # Normal Boluses/day	6.1 (64%)
Bolus overrides/total boluses	7%
Avg # bolus overrides/day	0.6
Avg # bolus ezBG overrides/day	0
Avg # bolus ezCarb overrides/day	0.6
Avg # carbs/ezCarb Bolus	51 g
Avg # Insulin Units/ezCarb Bolus	4

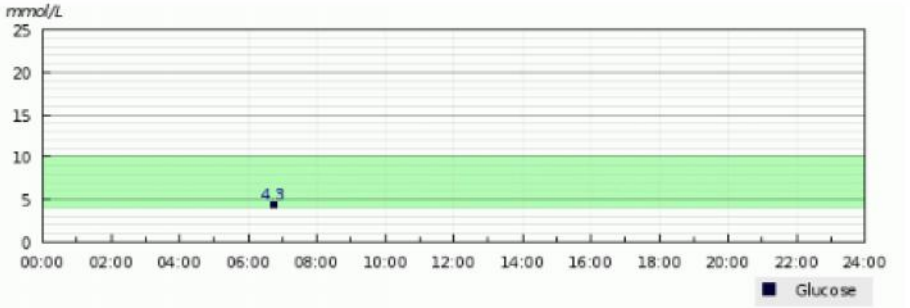
Bolus calc use

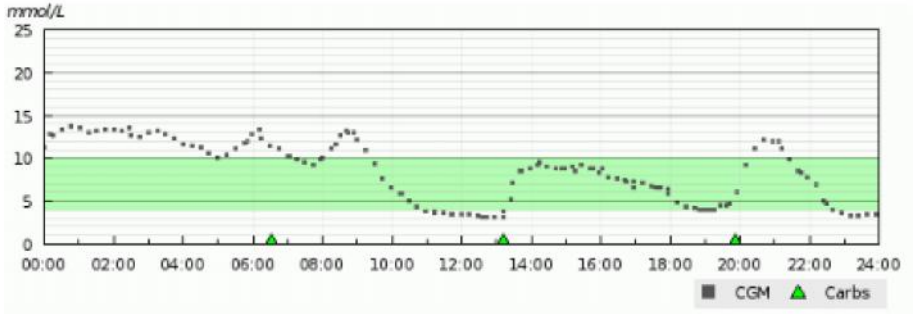


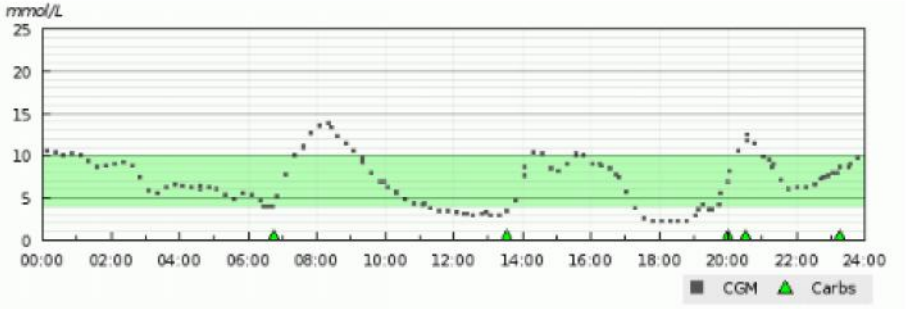

24/8
Basal (Units/Hour)
Bolus (Units)
Basal
Combination bolus
Bolus

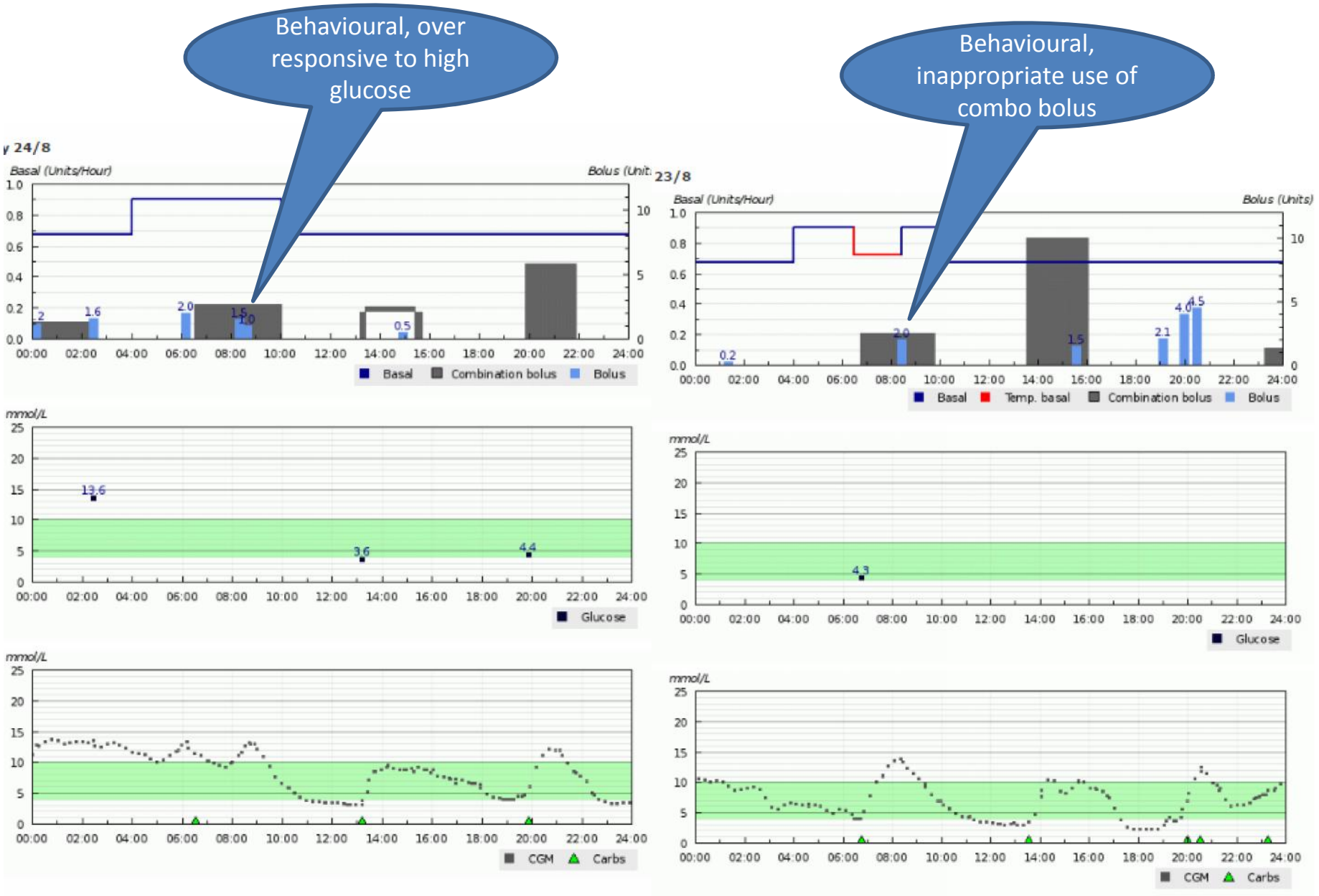

23/8
Basal (Units/Hour)
Bolus (Units)
Basal
Temp. basal
Combination bolus
Bolus


mmol/L
Glucose

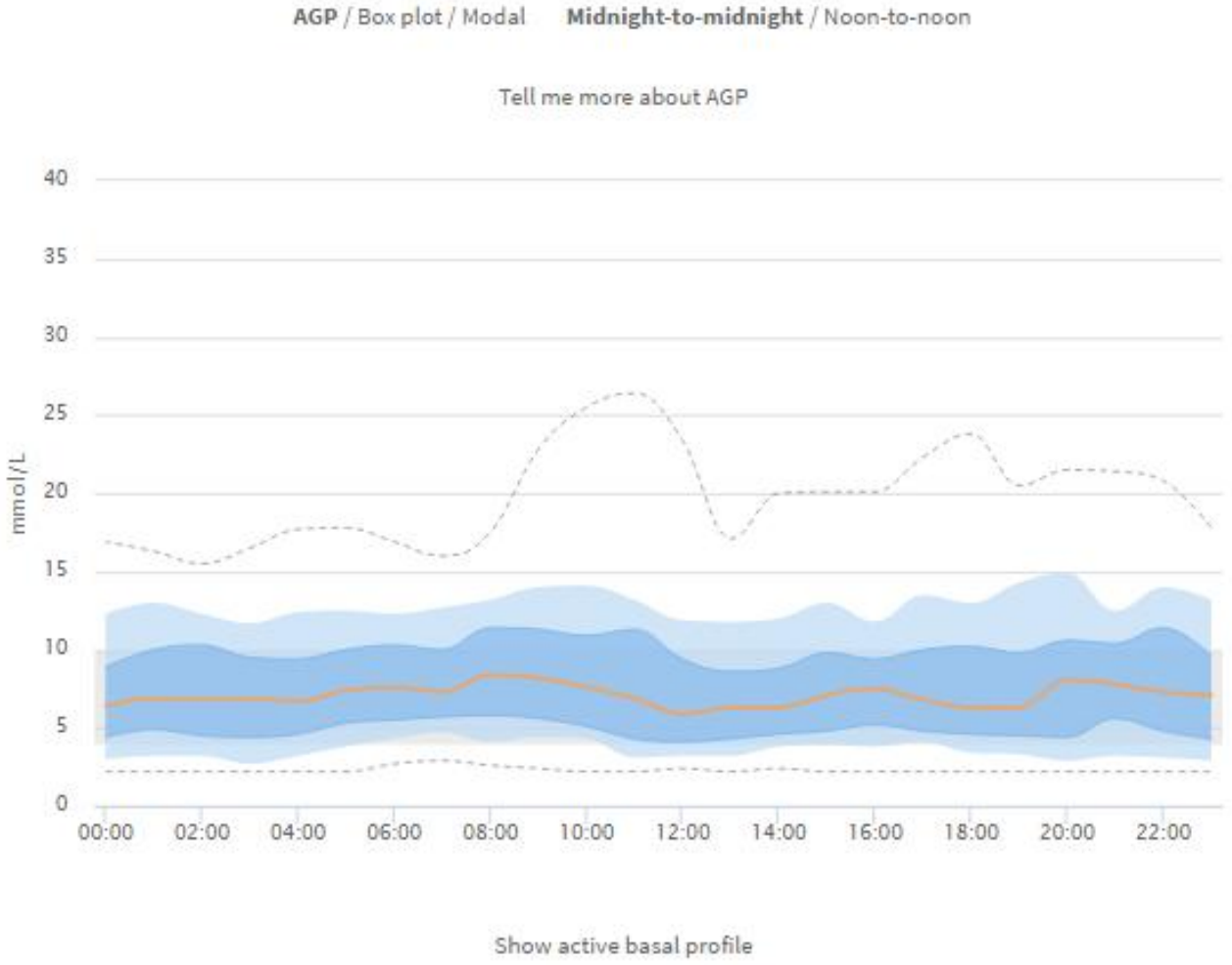

mmol/L
Glucose


mmol/L
CGM
Carbs

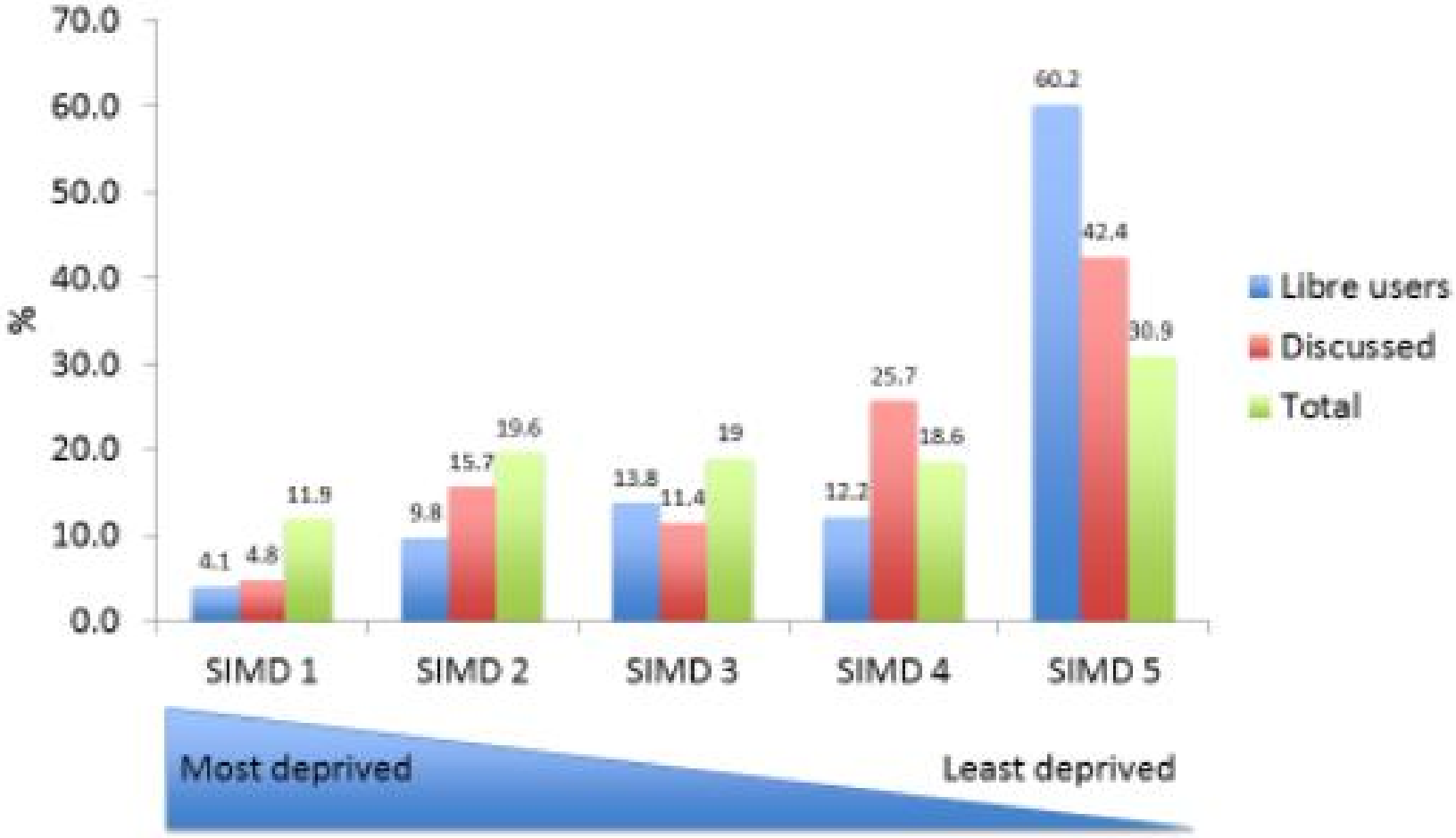

mmol/L
CGM
Carbs


Behavioural, over responsive to high glucose
Behavioural, inappropriate use of combo bolus
24/8
23/8
Basal (Units/Hour)
Bolus (Units)
Basal
Combination bolus
Bolus
Temp. basal
mmol/L
Glucose
CGM
Carbs

Started 2nd job doing a paper round to allow him to achieve this…



Do not make assumptions



McKnight, Gibb Diabetic Medicine 2017

WC

- 50 year male, Type 1 Diabetes 2007
- DAFNE graduate 2008
- Insulin pump therapy 2012, pre pump 12.9%
- Recent episode of severe nocturnal hypoglycaemia
- Gold score 3

Compilation

Glucose		CGM		Insulin		Carbs		Activity	
Average		Average		Average daily dose		Average carbs / day		Avg steps / day	Avg kcal / day
8.7 mmol/L		0 mmol/L		18.3 U		61 g		0 steps	0 kcal
SD = 6.6	# = 104	SD = 0	# = 0	SD = 12	# days = 14	SD = 54	# = 20	0% of 10000 (target)	0% of 2500 (target)
Avg # / day = 7.4		Avg # / day = 0		Avg # bolus doses/day = 0.9		Avg # / day = 1.4			

Glucose (mmol/L)

Glucose values summary	
Average (mmol/L)	8.7
Median (mmol/L)	6.6
Highest value (mmol/L)	27.2
Lowest value (mmol/L)	1.8
Standard deviation (SD)	6.6
Values per day	7.4
Number of values	104
Values above goal (10 mmol/L)	31
Values within goal (4-10 mmol/L)	41
Values below goal (4 mmol/L)	32

Interval	*Avg BG*	*# BG*	*SD*
00:00-06:00	7.5	29	5.9
06:00-08:00	11.3	7	8.4
08:00-10:00	6.3	9	3.7
10:00-12:00	10.7	10	7.8
12:00-14:00	17.3	6	6.5
14:00-16:00	10.3	13	7.2
16:00-18:00	8.2	7	4.3
18:00-20:00	7	7	1.7
20:00-22:00	5	9	4.9
22:00-24:00	7.8	7	5.2

CGM (mmol/L)

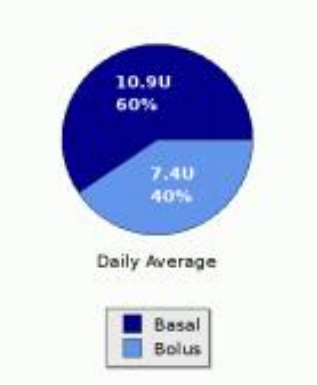
No values

Insulin

Insulin doses summary	
Average daily insulin (U)	18.3
Standard deviation (SD)	12
Average daily basal (U)	10.9
Average daily bolus (U)	7.4
Average bolus doses/day	0.9
Average days between cannula fills	-
Average days between primes	-

Bolus calculation summary	
Avg # Normal Boluses/day	0.6 (67%)

Carb summary	
Avg # carbs/day	61 g
Standard deviation (SD)	54



Compilation

Glucose		CGM		Insulin		Carbs		Activity	
Average		Average		Average daily dose		Average carbs / day		Avg steps / day	Avg kcal / day
8.7		0		18.3 U		61 g		0	0
mmol/L		mmol/L						steps	kcal
SD = 6.6	# = 104	SD = 0	# = 0	SD = 12	# days = 14	SD = 54	# = 20	0% of 10000 (target)	0% of 2500 (target)
Avg # / day = 7.4		Avg # / day = 0		Avg # bolus doses/day = 0.9		Avg # / day = 1.4			

Average good, SD high

0.9 bolus/ day

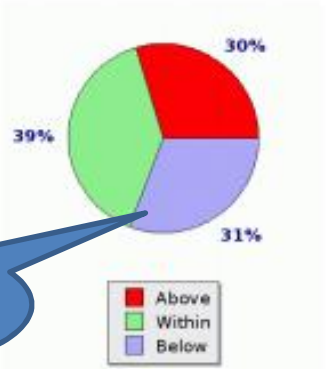
Lots of hypos

Low % basal

Glucose (mmol/L)

Glucose summary	
	8.7
	6.6
	27.2
	1.8
	6.6
	7.4
Number of values	104
Values above goal (10 mmol/L)	31
Values within goal (4-10 mmol/L)	41
Values below goal (4 mmol/L)	32

Interval	Avg BG	# BG	SD
00:00-06:00	7.5	29	5.9
06:00-08:00		7	8.4
08:00-10:00		9	3.7
10:00-12:00		10	7.8
12:00-14:00		6	6.5
14:00-16:00		13	7.2
16:00-18:00	8.2	7	4.3
18:00-20:00	7	7	1.7
20:00-22:00	5		
22:00-24:00	7.8		



CGM (mmol/L)

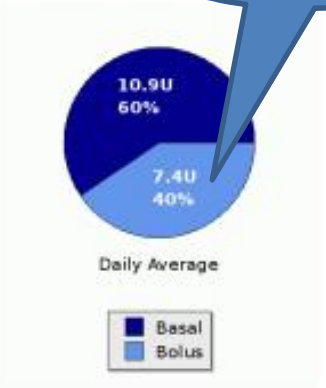
No values

Insulin

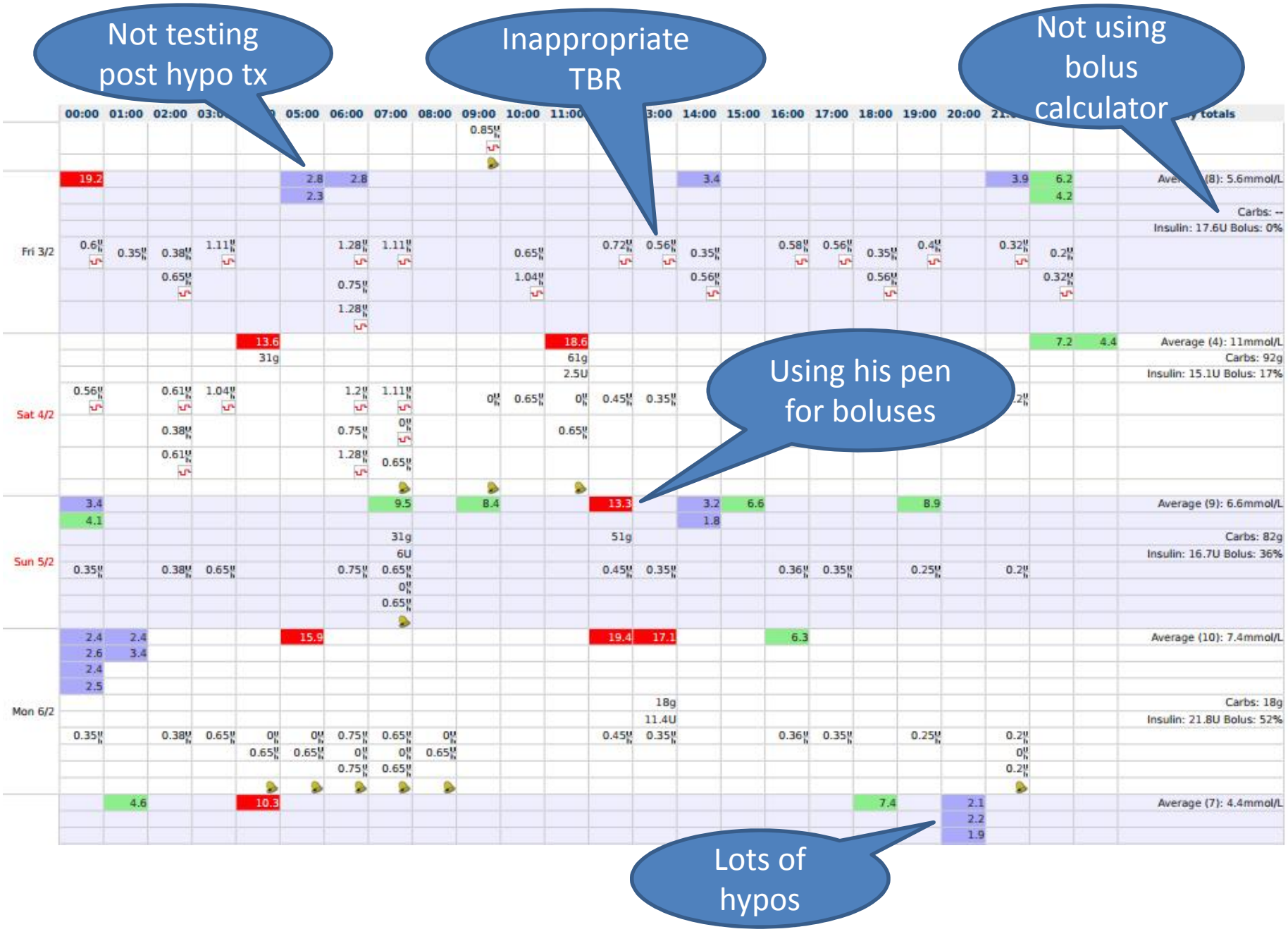
Insulin doses summary	
Average daily insulin (U)	18.3
Standard deviation (SD)	12
Average daily basal (U)	10.9
Average daily bolus (U)	7.4
Average bolus doses/day	0.9
Average days between cannula fills	-
Average days between primes	-

Bolus calculation summary	
Avg # Normal Boluses/day	0.6 (67%)

Carb summary	
Avg # carbs/day	61 g
Standard deviation (SD)	54




00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 Daily totals
Fri 3/2
Sat 4/2
Sun 5/2
Mon 6/2
Average (8): 5.6mmol/L
Carbs: --
Insulin: 17.6U Bolus: 0%
Average (4): 11mmol/L
Carbs: 92g
Insulin: 15.1U Bolus: 17%
Average (9): 6.6mmol/L
Carbs: 82g
Insulin: 16.7U Bolus: 36%
Average (10): 7.4mmol/L
Carbs: 18g
Insulin: 21.8U Bolus: 52%
Average (7): 4.4mmol/L


Not testing post hypo tx
Inappropriate TBR
Not using bolus calculator
Using his pen for boluses
Lots of hypos
00:00
01:00
02:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
totals
Fri 3/2
Carbs: --
Insulin: 17.6U Bolus: 0%
Sat 4/2
Average (4): 11mmol/L
Carbs: 92g
Insulin: 15.1U Bolus: 17%
Sun 5/2
Average (9): 6.6mmol/L
Carbs: 82g
Insulin: 16.7U Bolus: 36%
Mon 6/2
Average (10): 7.4mmol/L
Carbs: 18g
Insulin: 21.8U Bolus: 52%
Average (7): 4.4mmol/L

Plan

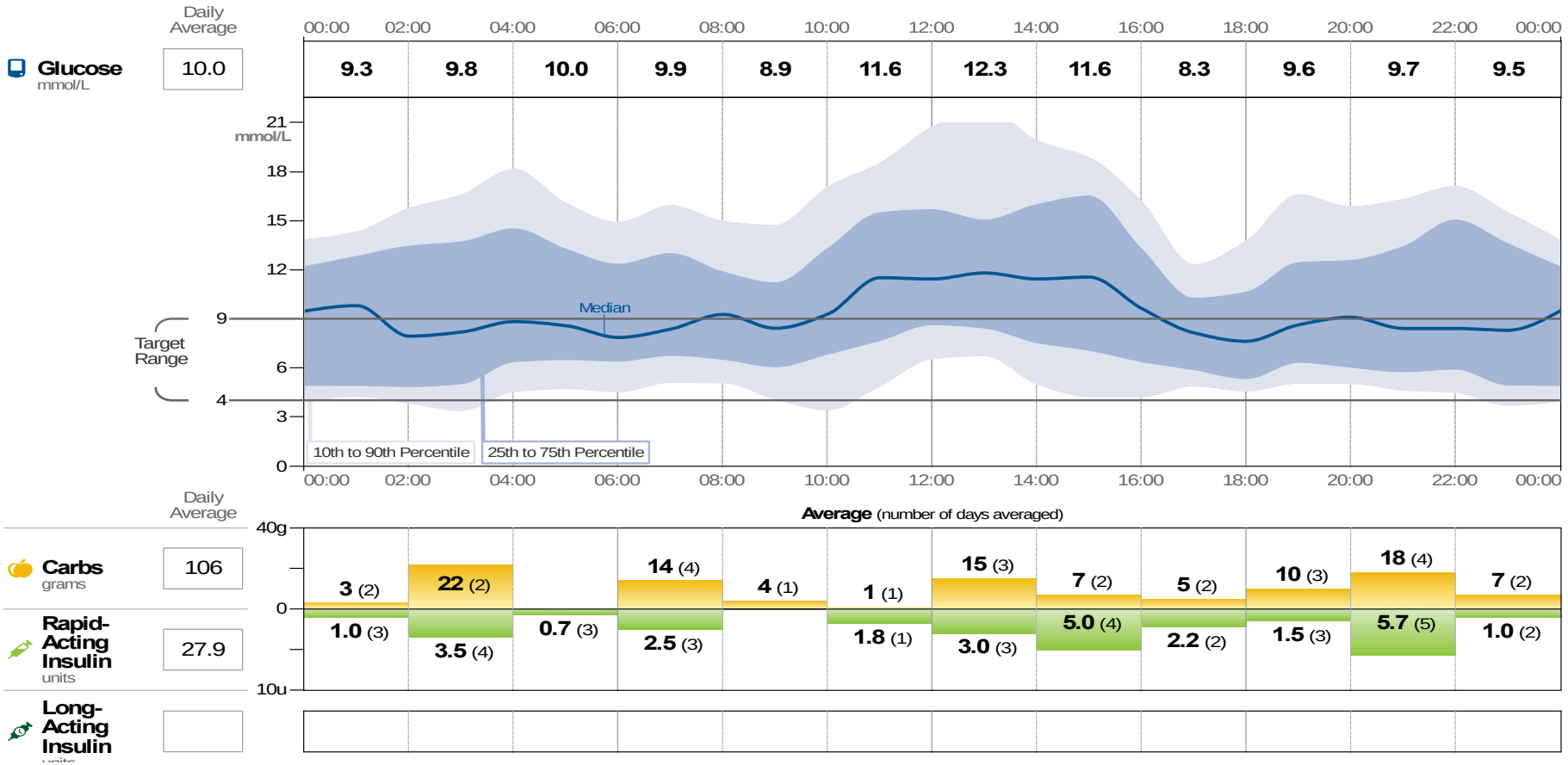
- Use the pump bolus calculator consistently
- No injections via pen (unless he suspects pump failure)
- Avoid temporary basal rate use
- Work to increase his basal and reduce bolus % of the total daily dose
- Avoid >10 unit boluses of novorapid at a time
- Freestyle Libre attached in clinic

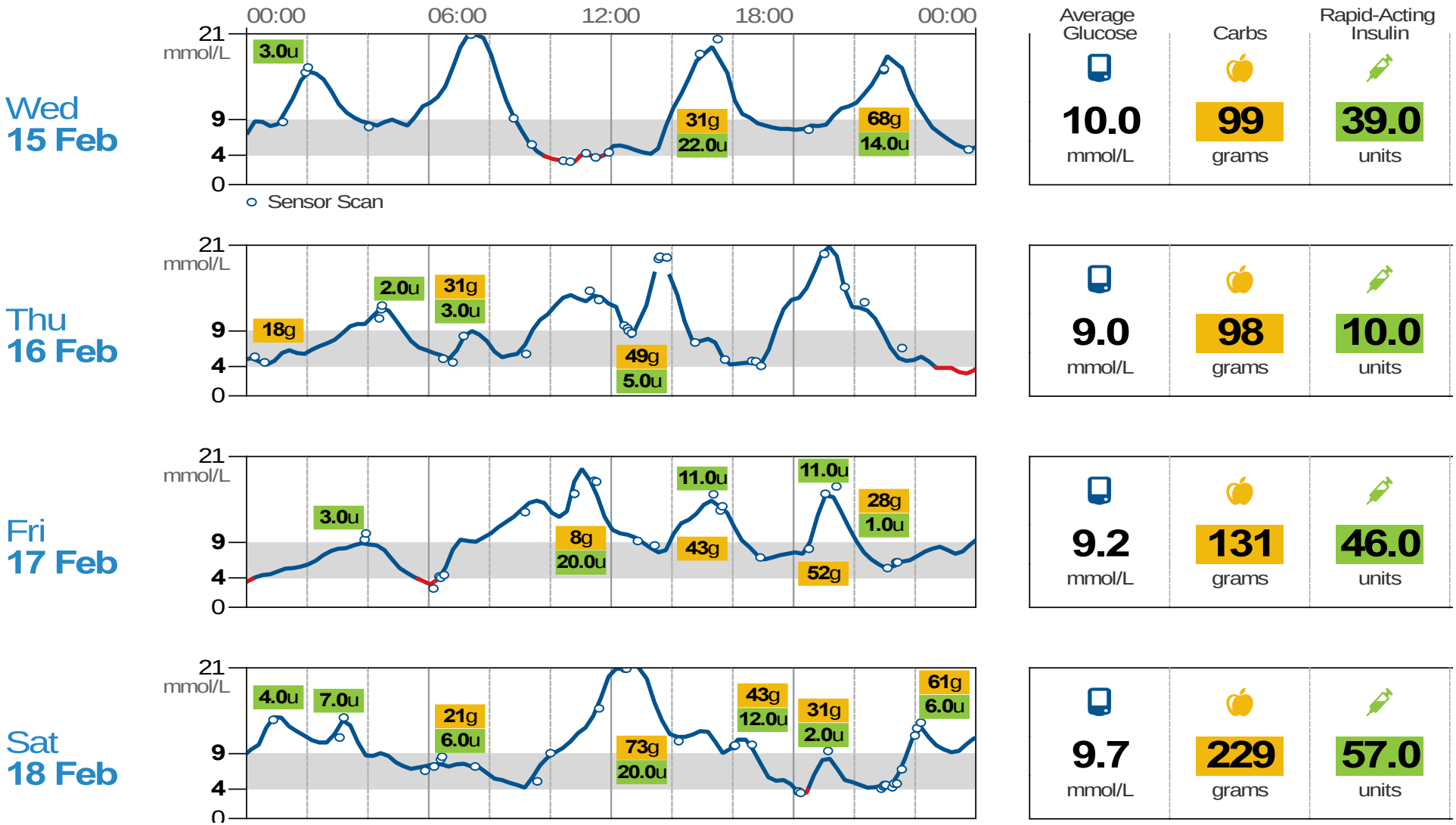
Daily Patterns (with Ambulatory Glucose Profile)

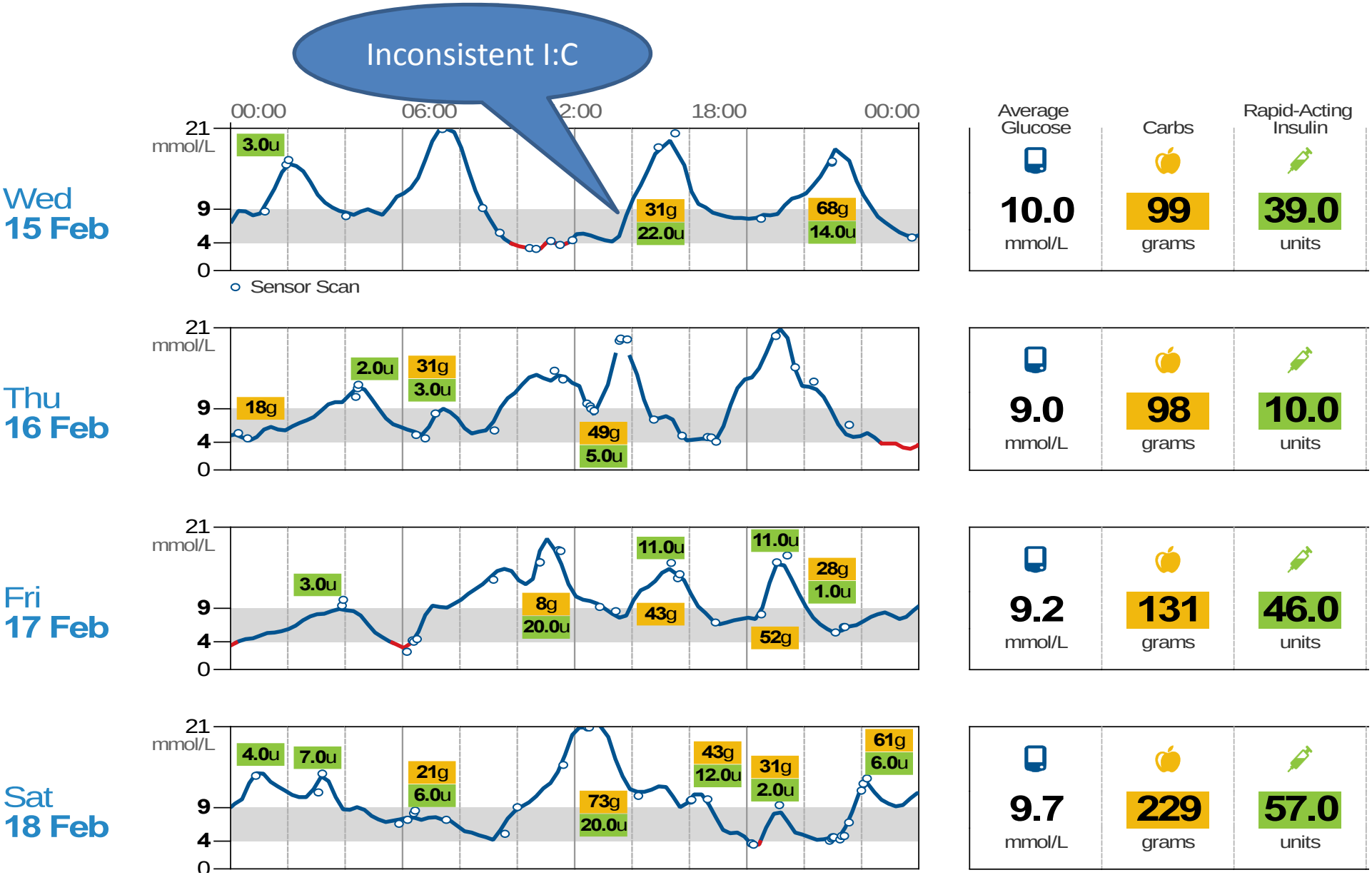
8 February 2017 - 21 February 2017 (14 days)

FreeStyle Libre

Estimated A1c 7.9% or 63 mmol/mol




00:00
06:00
12:00
18:00
00:00
21
mmol/L
9
4
0
Sensor Scan
Wed
15 Feb
3.0u
31g
22.0u
68g
14.0u
Thu
16 Feb
18g
2.0u
31g
3.0u
49g
5.0u
Fri
17 Feb
3.0u
8g
20.0u
11.0u
43g
11.0u
52g
28g
1.0u
Sat
18 Feb
4.0u
7.0u
21g
6.0u
73g
20.0u
43g
12.0u
31g
2.0u
61g
6.0u
Average Glucose
Carbs
Rapid-Acting Insulin
10.0
mmol/L
99
grams
39.0
units
9.0
mmol/L
98
grams
10.0
units
9.2
mmol/L
131
grams
46.0
units
9.7
mmol/L
229
grams
57.0
units


Inconsistent I:C
00:00
06:00
2:00
18:00
00:00
21
mmol/L
9
4
0
Sensor Scan
Wed
15 Feb
3.0u
31g
22.0u
68g
14.0u
Thu
16 Feb
18g
2.0u
31g
3.0u
49g
5.0u
Fri
17 Feb
3.0u
8g
20.0u
11.0u
43g
11.0u
52g
28g
1.0u
Sat
18 Feb
4.0u
7.0u
21g
6.0u
73g
20.0u
43g
12.0u
31g
2.0u
61g
6.0u
Average Glucose
Carbs
Rapid-Acting Insulin
10.0
mmol/L
99
grams
39.0
units
9.0
mmol/L
98
grams
10.0
units
9.2
mmol/L
131
grams
46.0
units
9.7
mmol/L
229
grams
57.0
units

Issues

- **Structural issues**
- Basal too low
- I:C/ISF not used
- Working towards increasing basal and reducing boluses

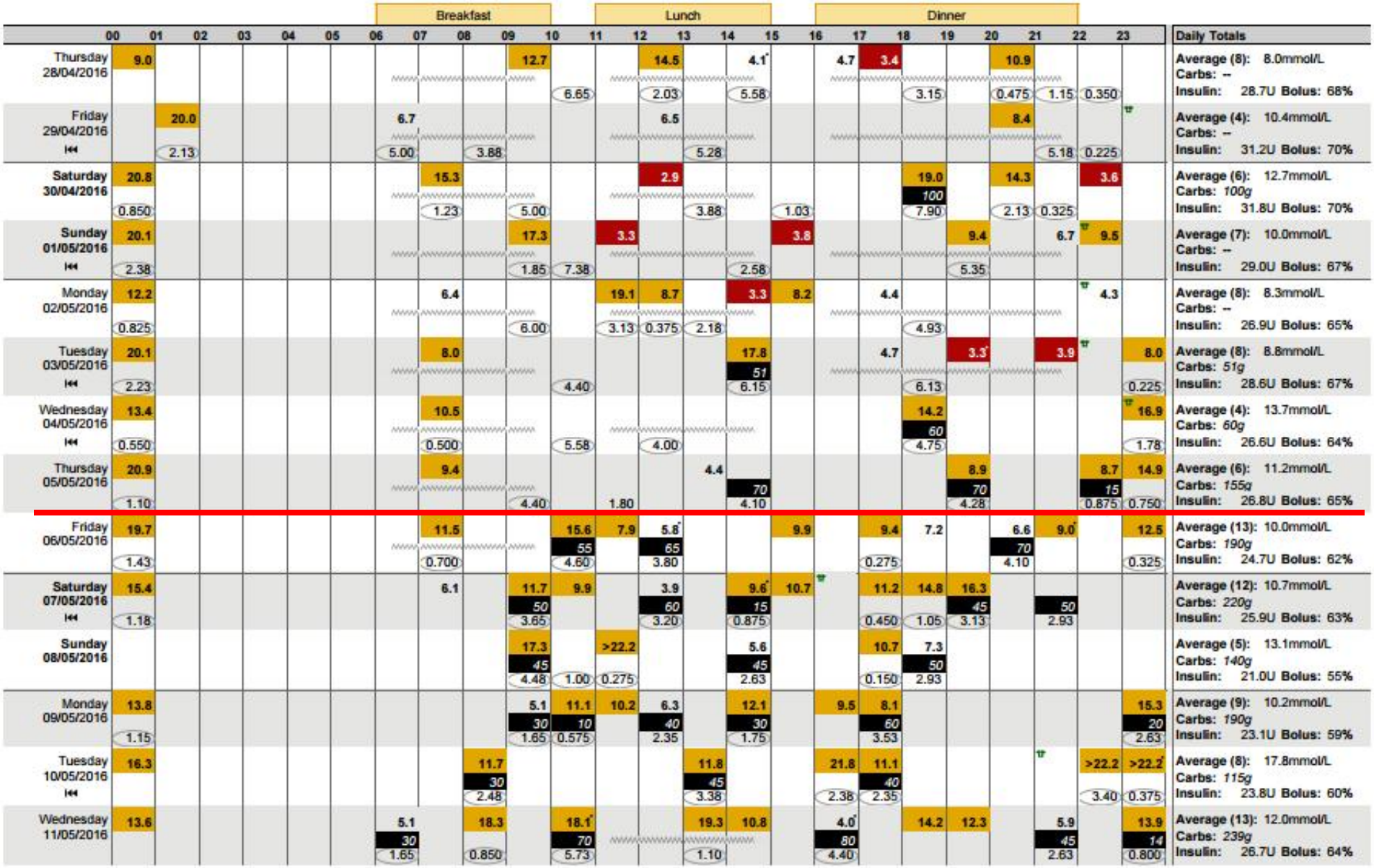
- **Behavioural issues**
- Inconsistent I:C and ISF
- Habit of large boluses via pen
- Trying to encourage bolus calculator use and consistent I:C
- Avoid large boluses of NR

Despite significant challenges, Libre has helped him avoid hypos

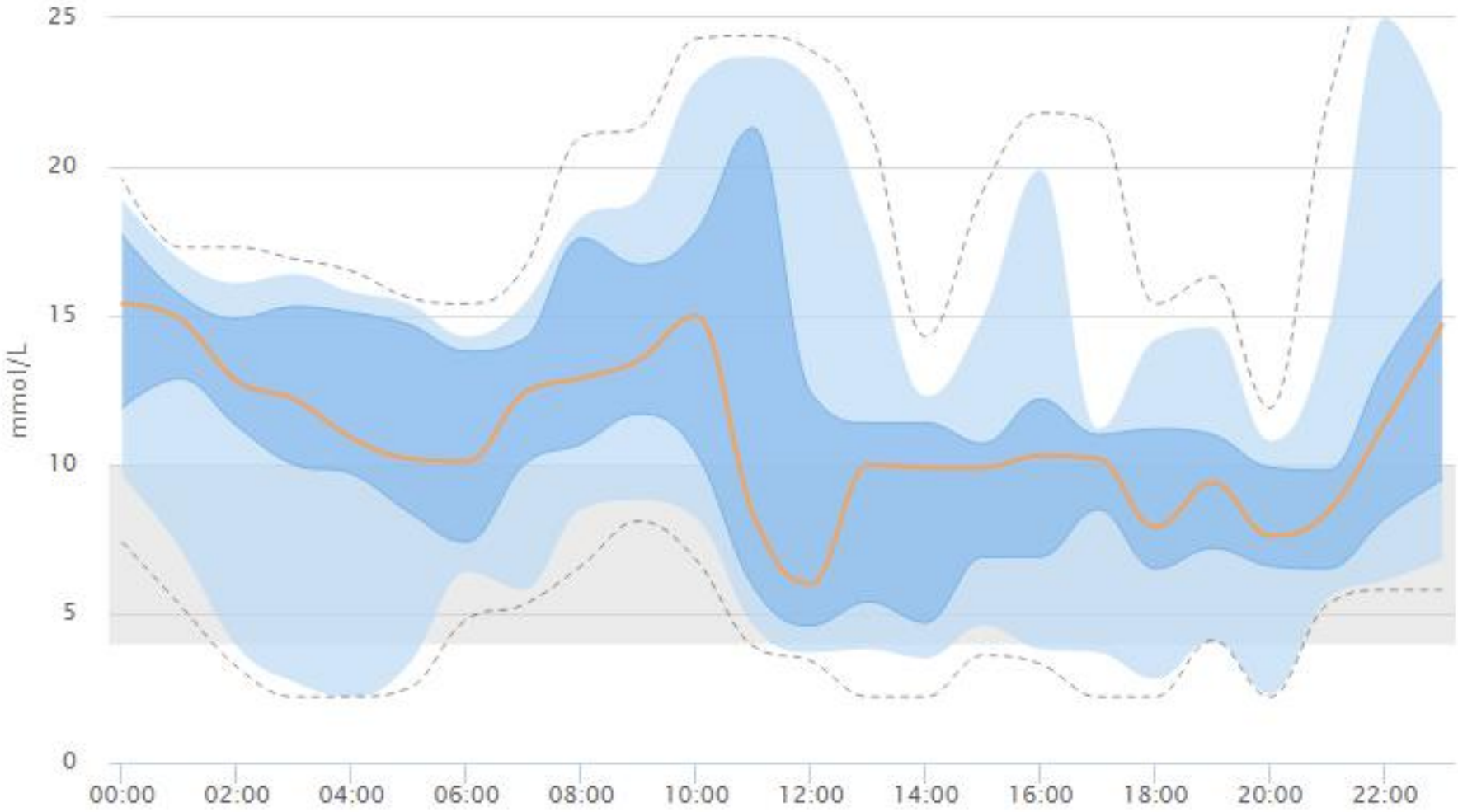
Hypos and the Libre

- Mum of 2
- Frequent hypoglycaemia
- 1 severe hypo – 4 year old had to treat severe hypo
- Seen in clinic, libre sensor inserted
- Advised to use bolus calculator consistently

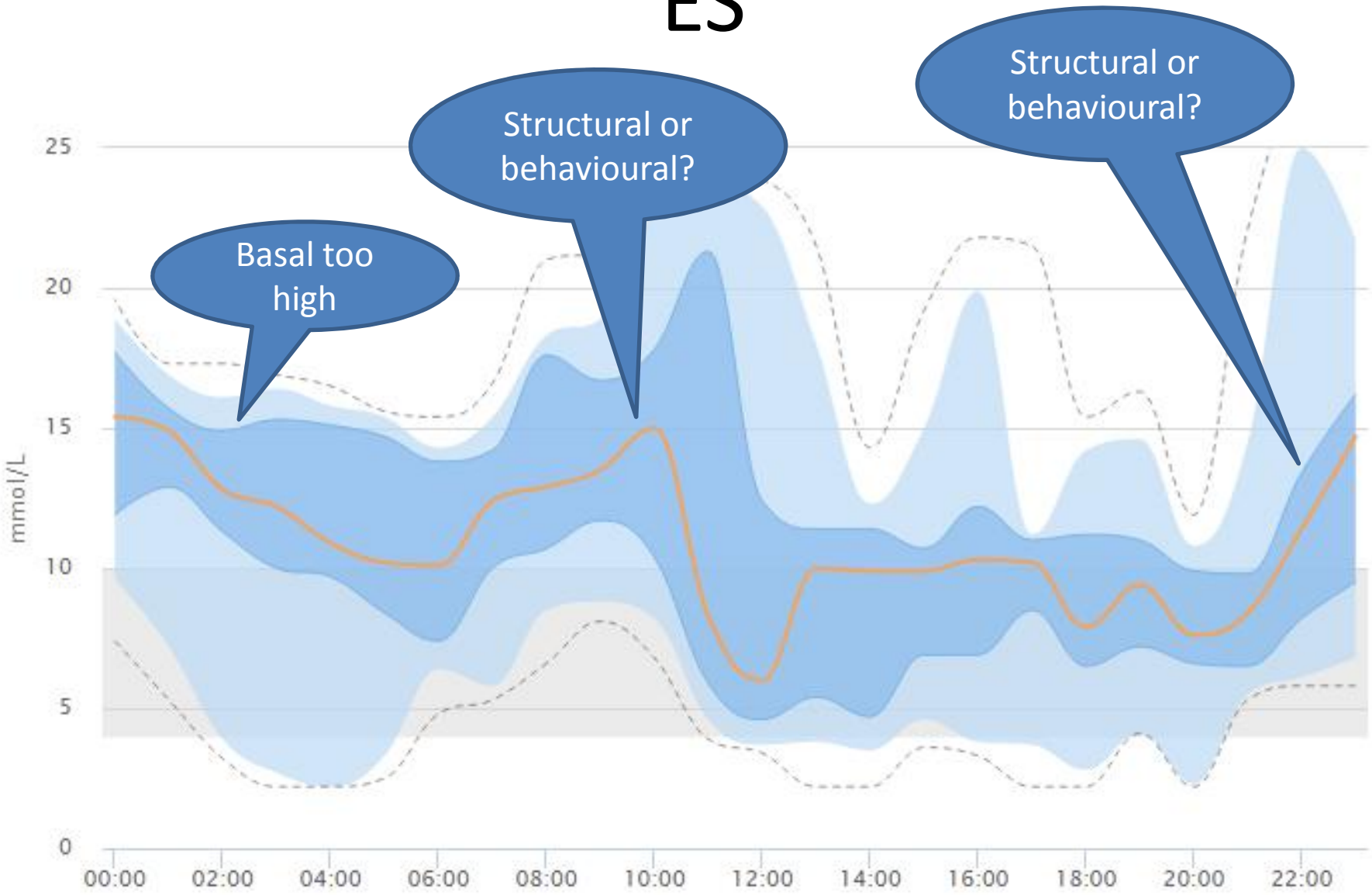
ES


Breakfast
Lunch
Dinner
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Daily Totals
Thursday 28/04/2016
Average (8): 8.0mmol/L
Carbs: --
Insulin: 28.7U Bolus: 68%
Friday 29/04/2016
Average (4): 10.4mmol/L
Carbs: --
Insulin: 31.2U Bolus: 70%
Saturday 30/04/2016
Average (6): 12.7mmol/L
Carbs: 100g
Insulin: 31.8U Bolus: 70%
Sunday 01/05/2016
Average (7): 10.0mmol/L
Carbs: --
Insulin: 29.0U Bolus: 67%
Monday 02/05/2016
Average (8): 8.3mmol/L
Carbs: --
Insulin: 26.9U Bolus: 65%
Tuesday 03/05/2016
Average (8): 8.8mmol/L
Carbs: 51g
Insulin: 28.6U Bolus: 67%
Wednesday 04/05/2016
Average (4): 13.7mmol/L
Carbs: 60g
Insulin: 26.6U Bolus: 64%
Thursday 05/05/2016
Average (6): 11.2mmol/L
Carbs: 155g
Insulin: 26.8U Bolus: 65%
Friday 06/05/2016
Average (13): 10.0mmol/L
Carbs: 190g
Insulin: 24.7U Bolus: 62%
Saturday 07/05/2016
Average (12): 10.7mmol/L
Carbs: 220g
Insulin: 25.9U Bolus: 63%
Sunday 08/05/2016
Average (5): 13.1mmol/L
Carbs: 140g
Insulin: 21.0U Bolus: 55%
Monday 09/05/2016
Average (9): 10.2mmol/L
Carbs: 190g
Insulin: 23.1U Bolus: 59%
Tuesday 10/05/2016
Average (8): 17.8mmol/L
Carbs: 115g
Insulin: 23.8U Bolus: 60%
Wednesday 11/05/2016
Average (13): 12.0mmol/L
Carbs: 239g
Insulin: 26.7U Bolus: 64%

ES, hypothesis?

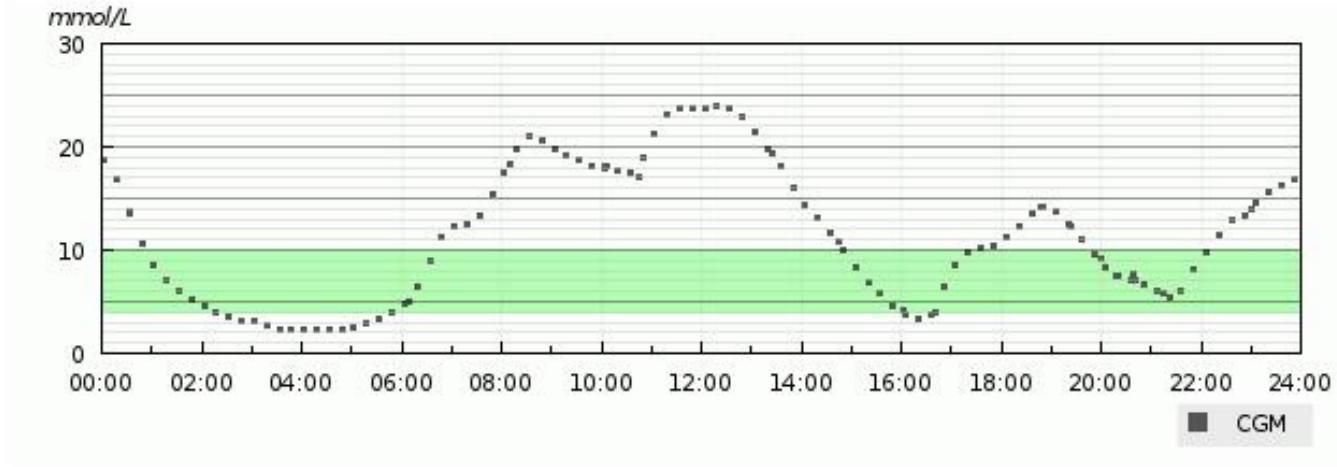


ES

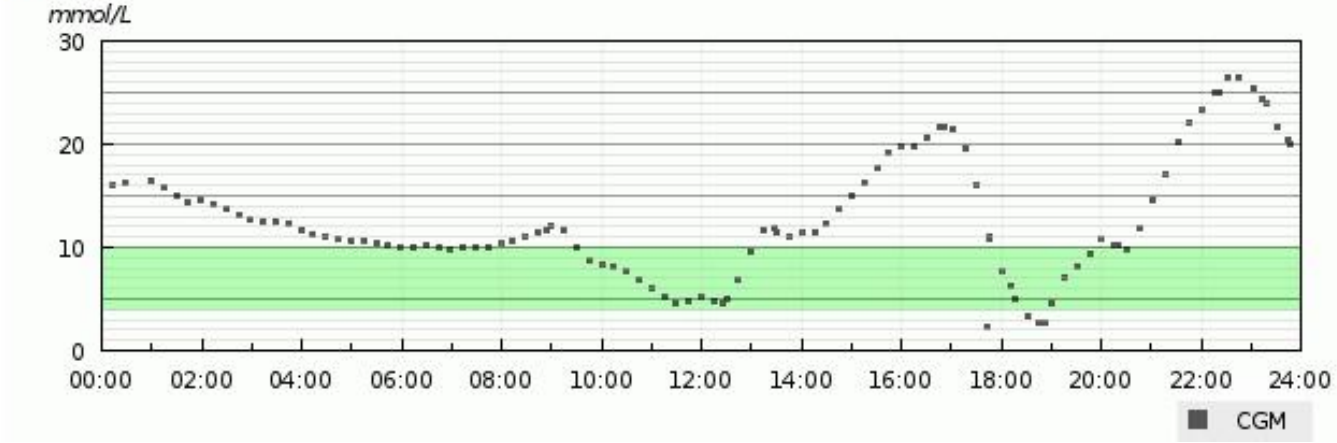

Basal too high
Structural or behavioural?
Structural or behavioural?
mmol/L
25
20
15
10
5
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00

ES – thoughts?

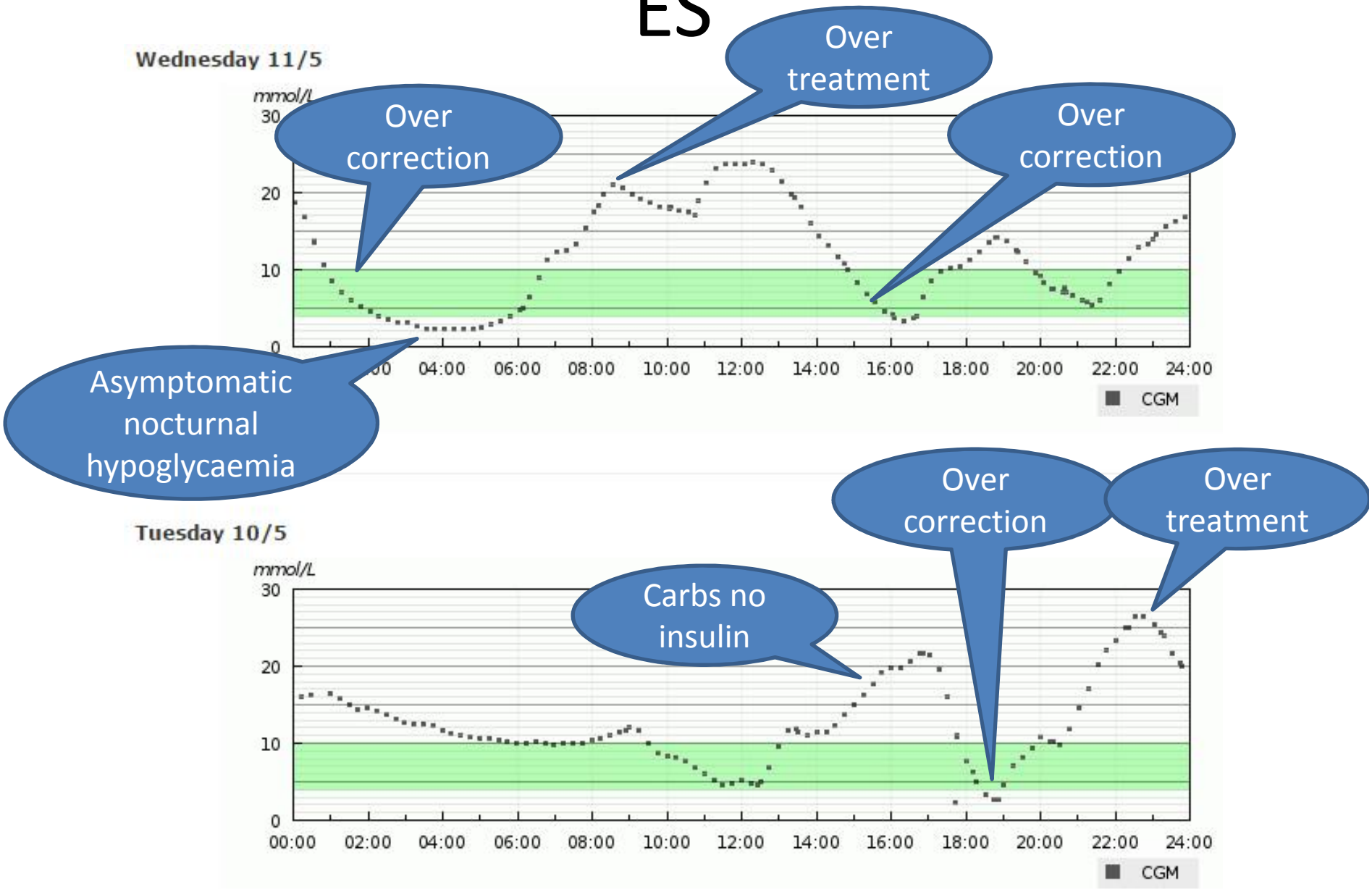
Wednesday 11/5



Tuesday 10/5



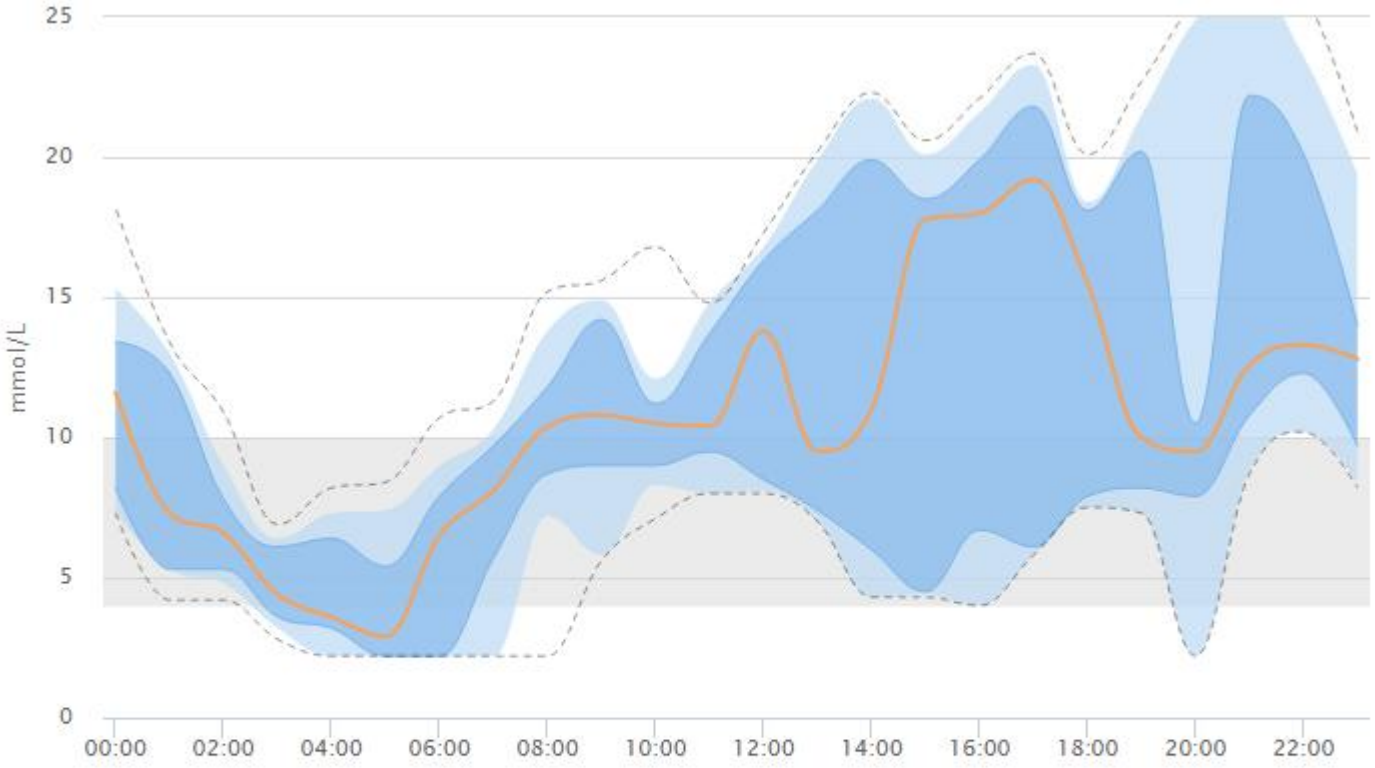
ES


Wednesday 11/5
mmol/L
30
20
10
0
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
24:00
CGM
Over correction
Over treatment
Over correction
Asymptomatic nocturnal hypoglycaemia
Tuesday 10/5
mmol/L
30
20
10
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
24:00
CGM
Carbs no insulin
Over correction
Over treatment

EP case discussion

- 28 yrs
- T1DM dx age 12yrs
- Teacher in reception
- HbA1c 9.4%
- Keen to conceive

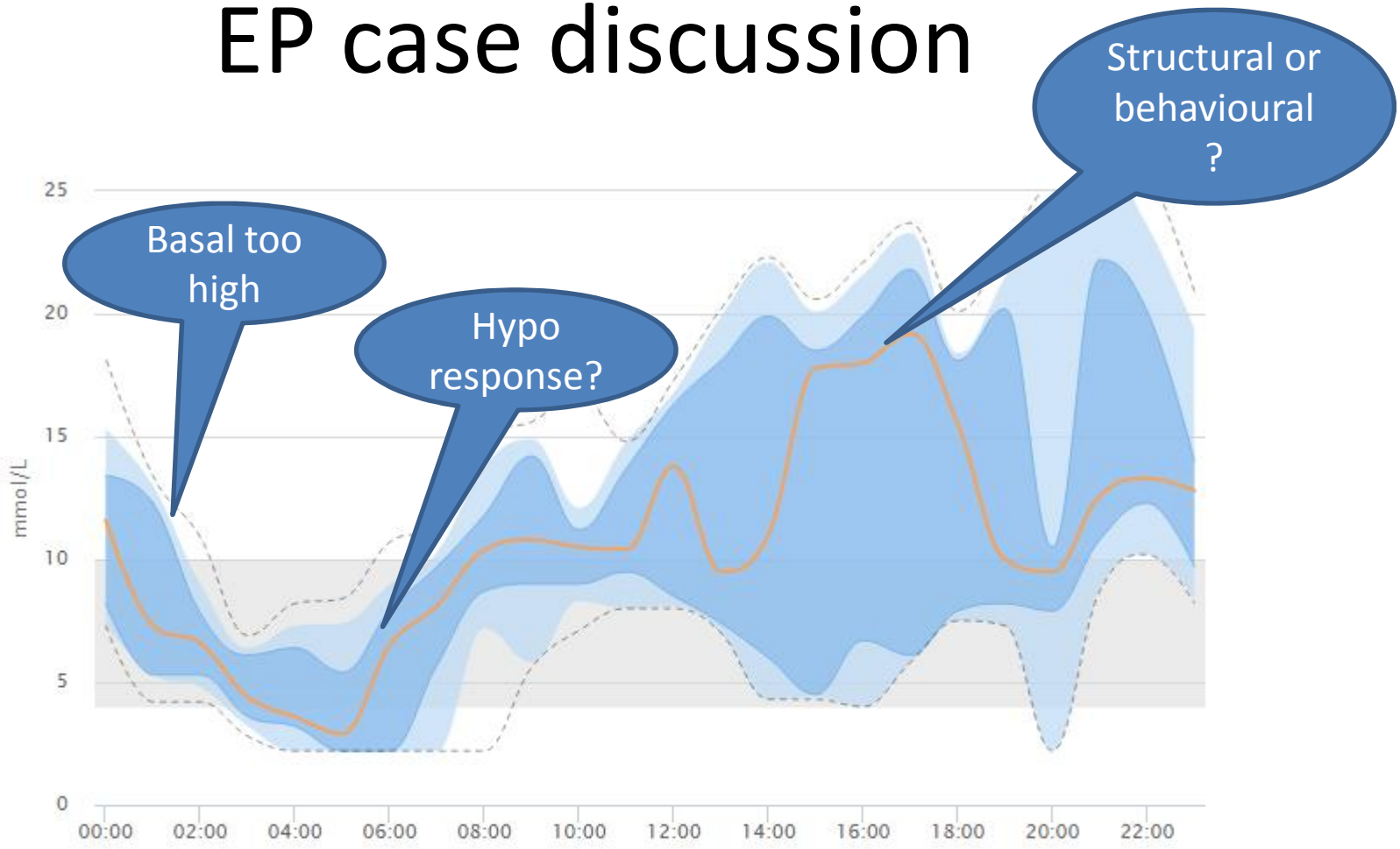
EP case discussion



Show active basal profile

Number of values:	**396**	Values above goal (10 mmol/L):	**184**	Highest value (mmol/L):	**Hi** (16/08/2016 21:46)
Values per day:	**28.3**	Values within goal (4-10 mmol/L):	**170**	Lowest value (mmol/L):	**Lo** (18/08/2016 05:57)
Period average (mmol/L):	**10.7**	Values below goal (4 mmol/L):	**42**	Standard deviation:	**5.7**

EP case discussion



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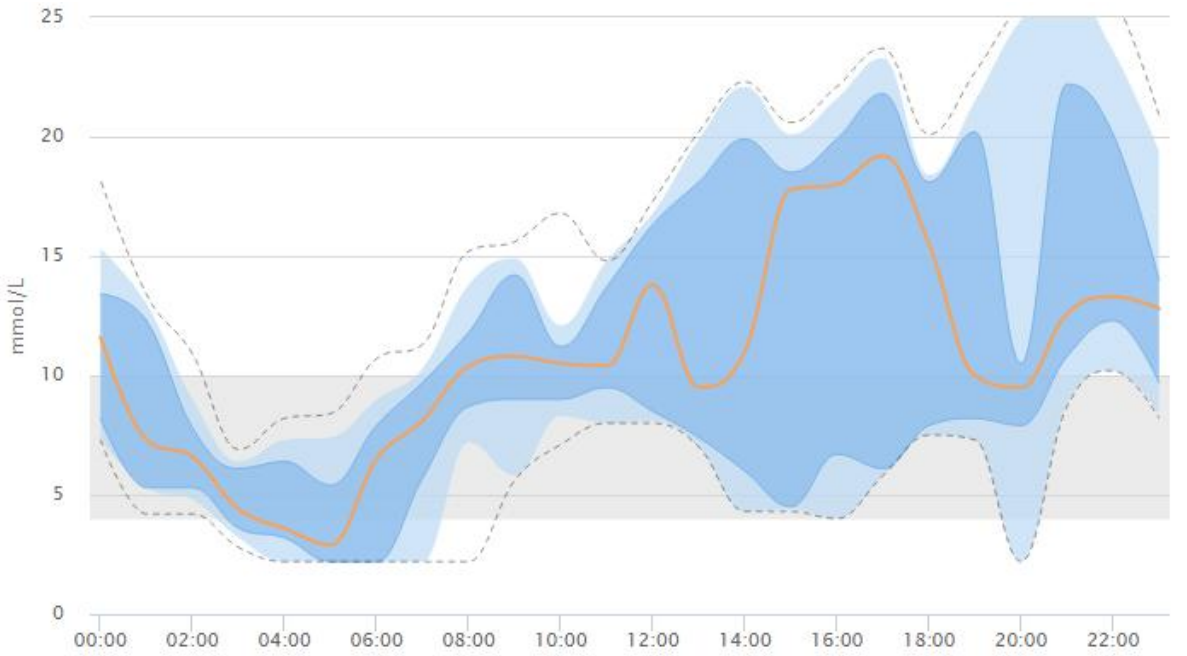

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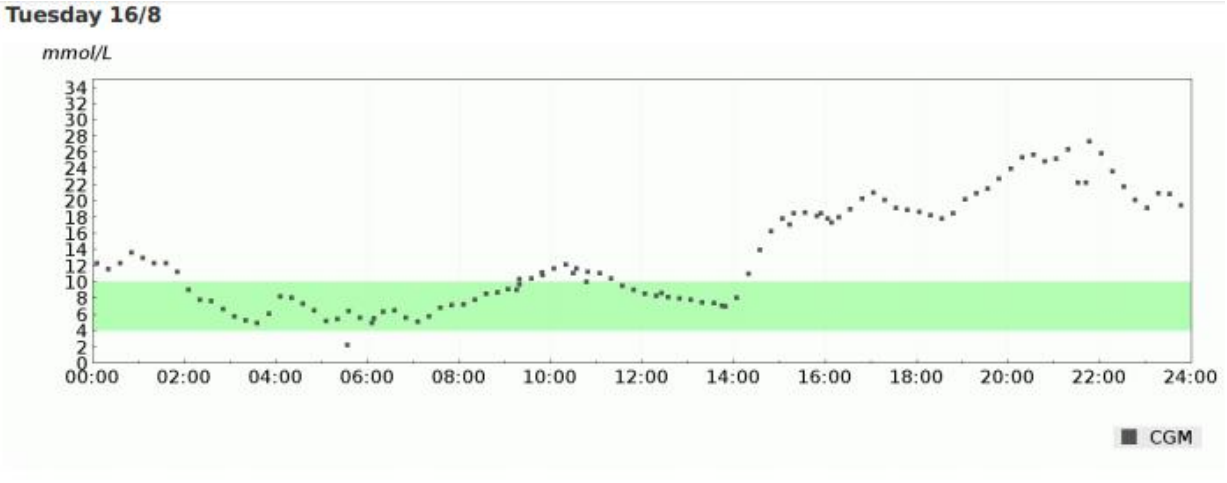
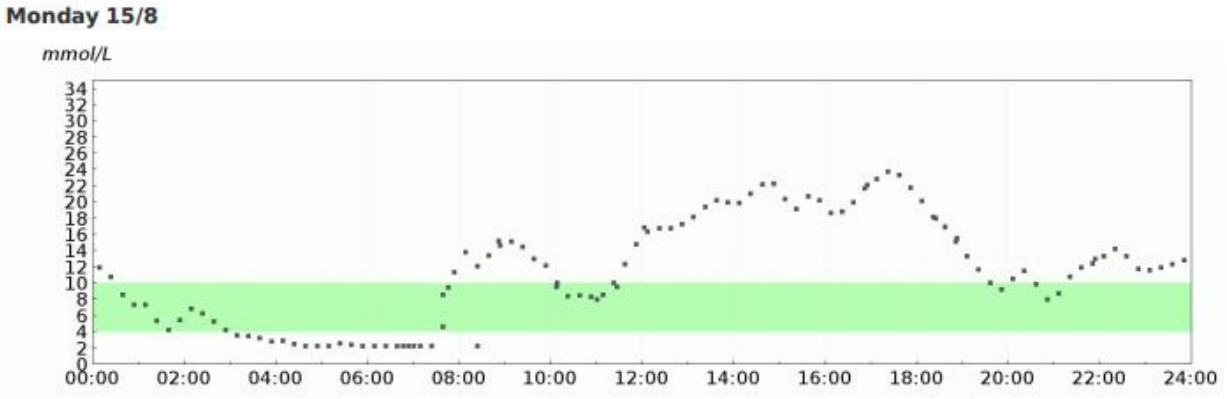
What would you do with the basal overnight?

1. Increase
2. Decrease
3. Stay the same
4. Not sure

EP case discussion

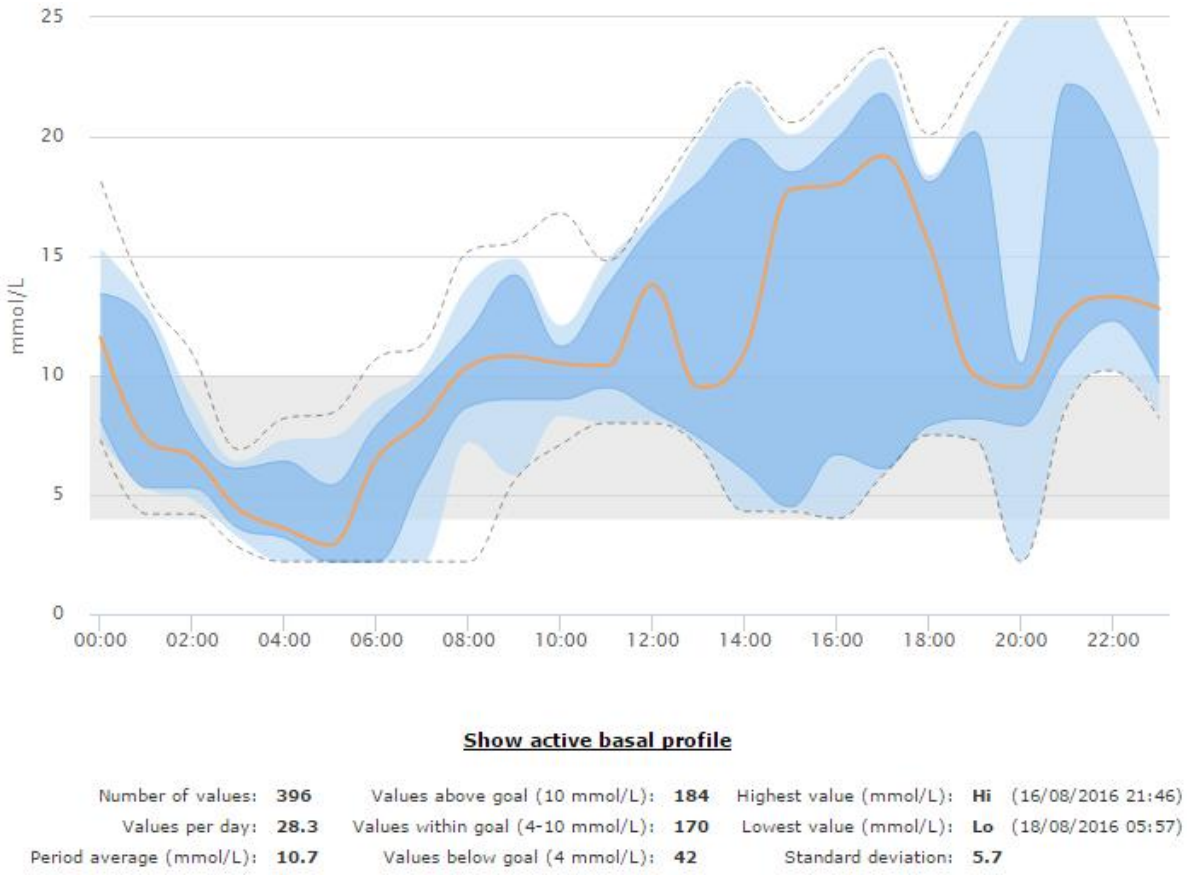




What would you do with the basal overnight?

1. Increase
2. **Decrease**
3. Stay the same
4. Not sure

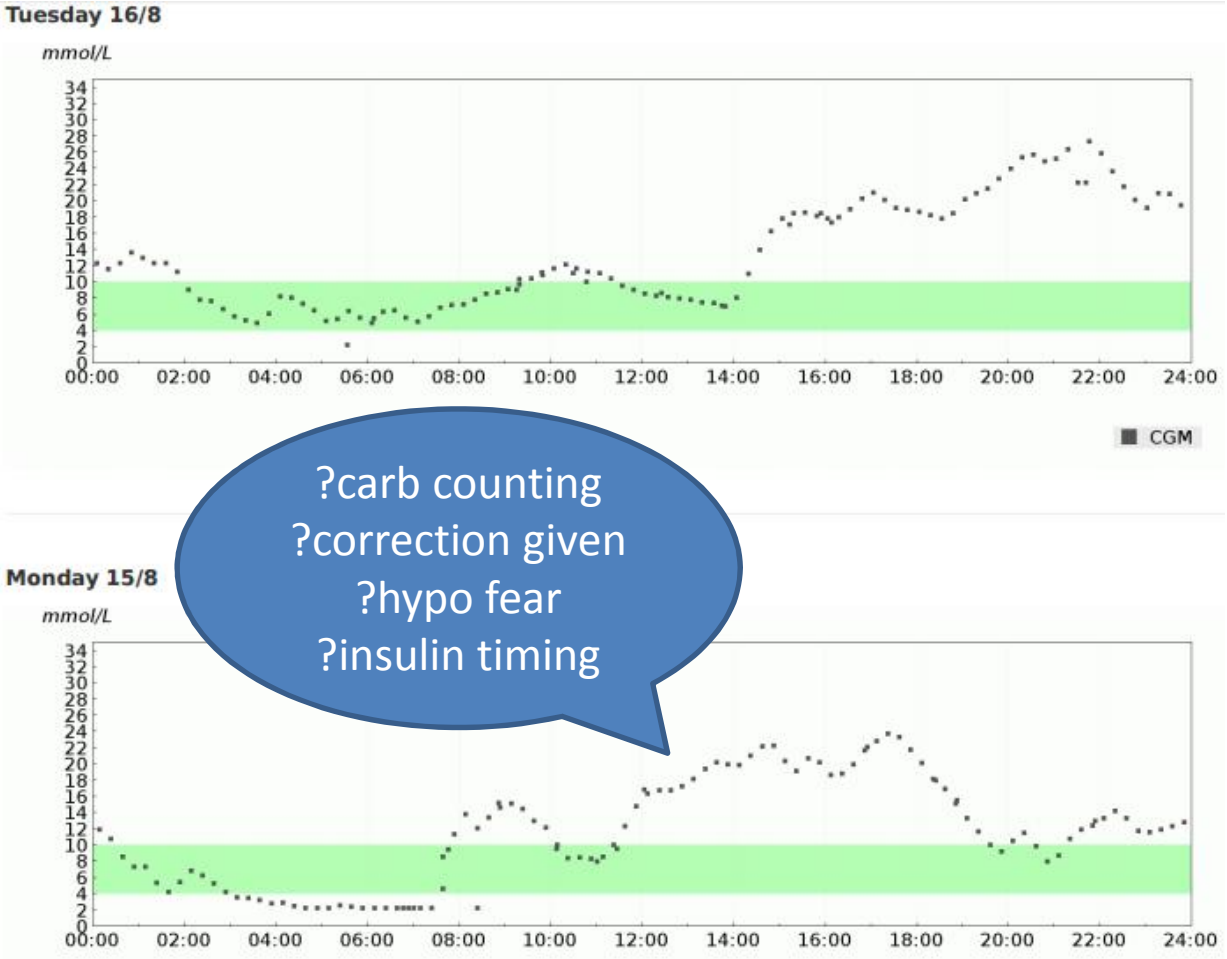
EP case discussion



What would you do with the lunch I:C ratio?

1. Increase
2. Decrease
3. Stay the same
4. Not sure

EP case discussion



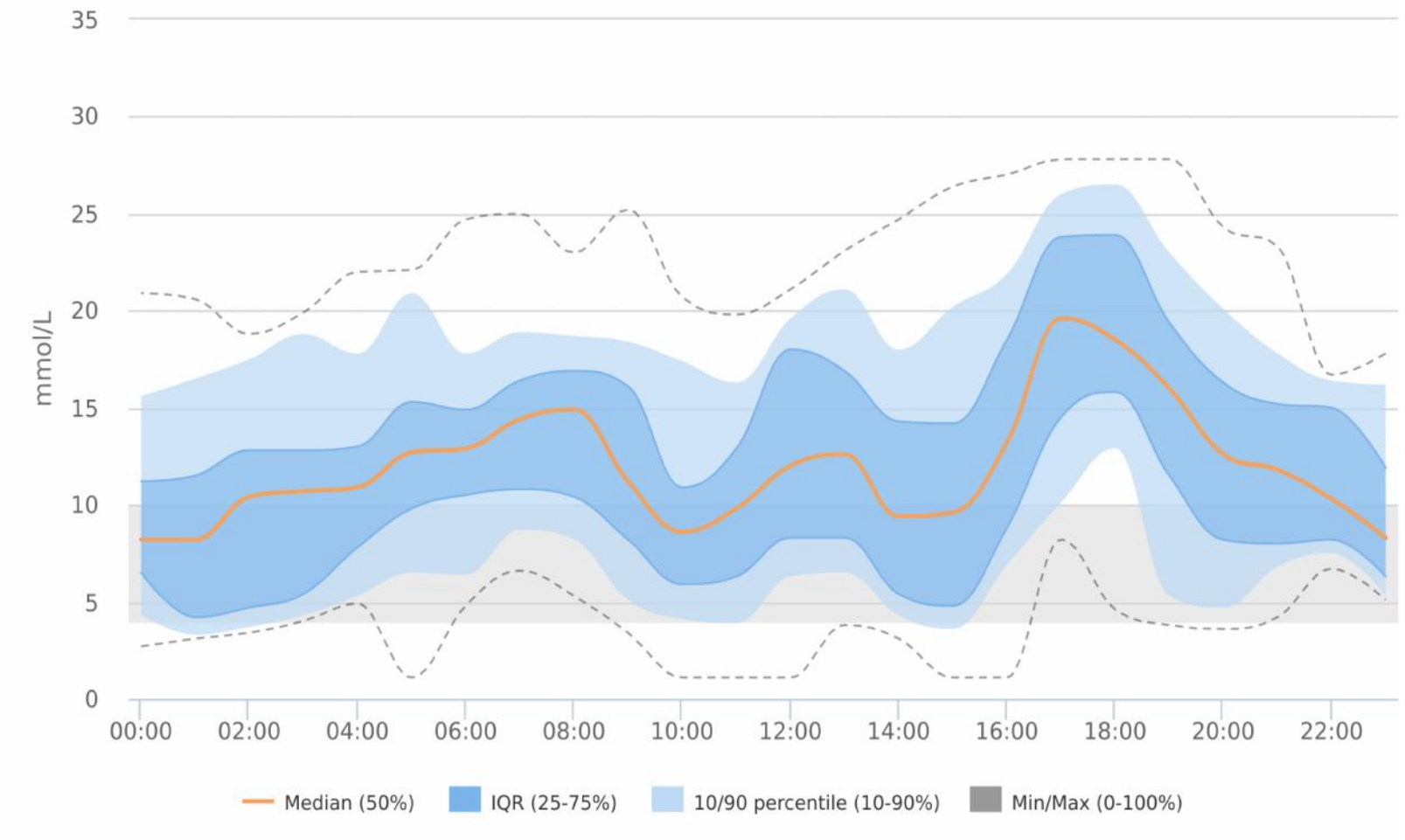
What would you do with the lunch I:C ratio?

1. Increase
2. Decrease
3. Stay the same
4. **Not sure**

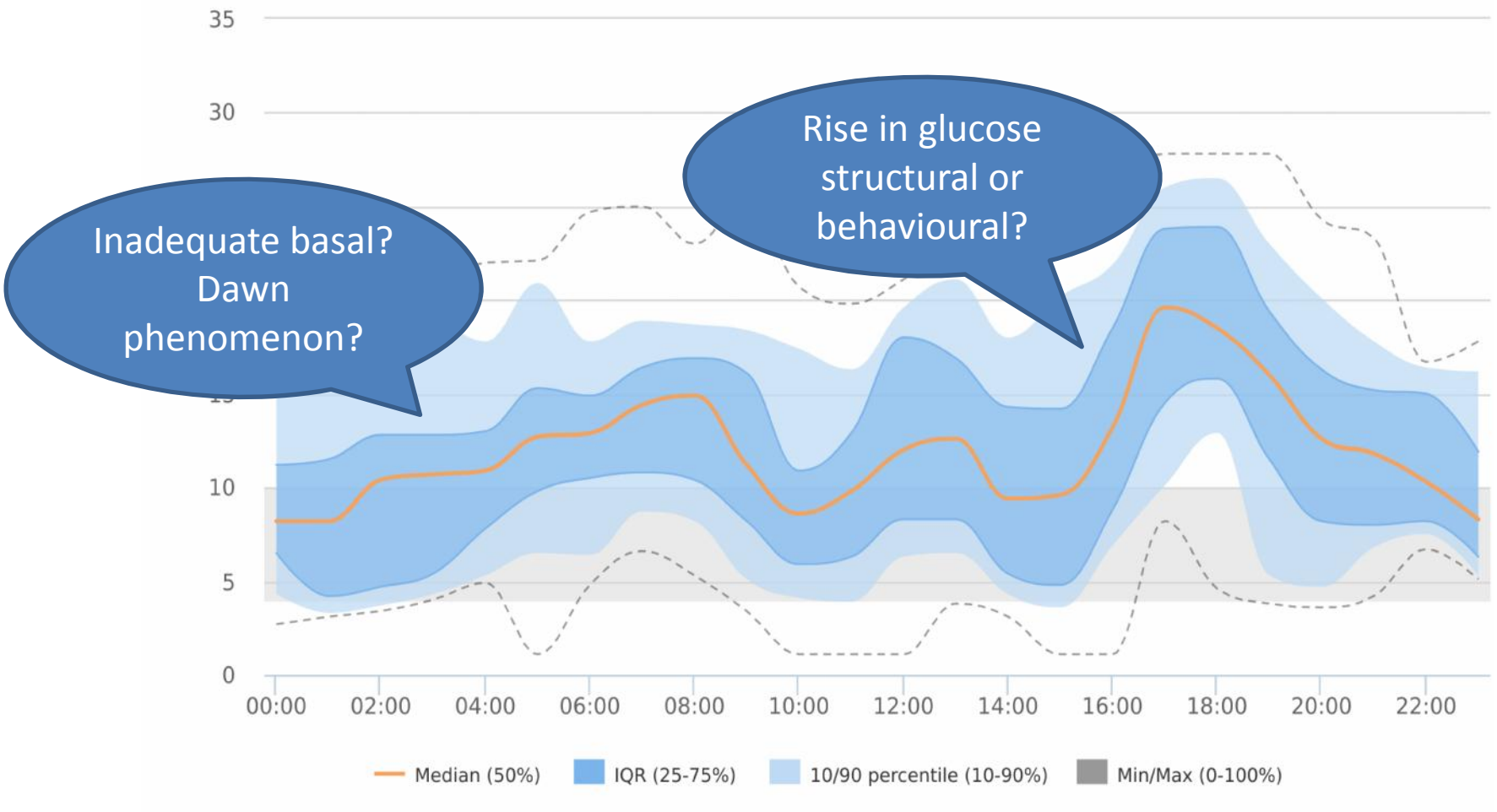
Case: SD

- 28 year old female, Type 1 Diabetes since 10 years old
- One child (5 years old)
- Hx Proliferative Retinopathy & Neuropathy
- DAFNE Graduate
- Desperate for CSII
- Currently on Levemir and Novorapid

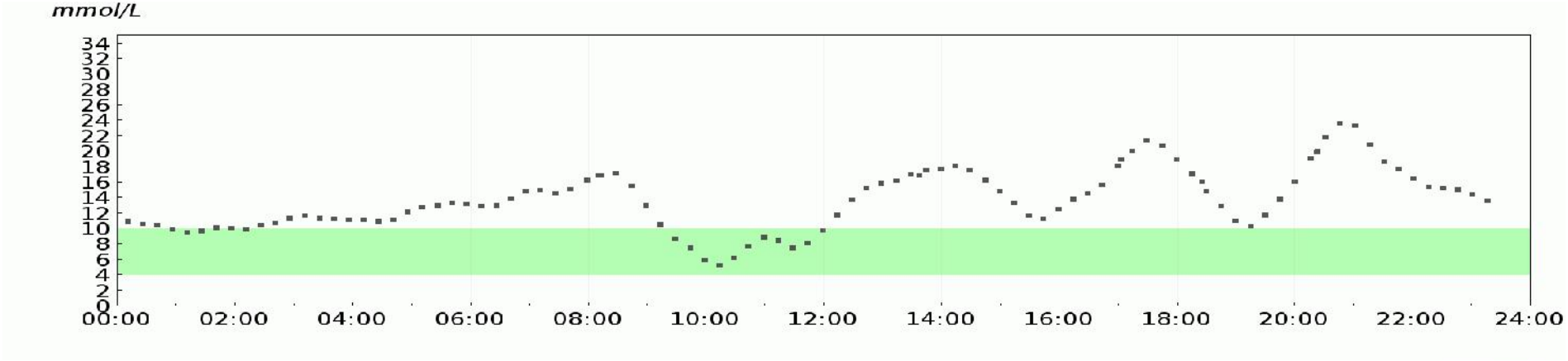
CGM: Standard day



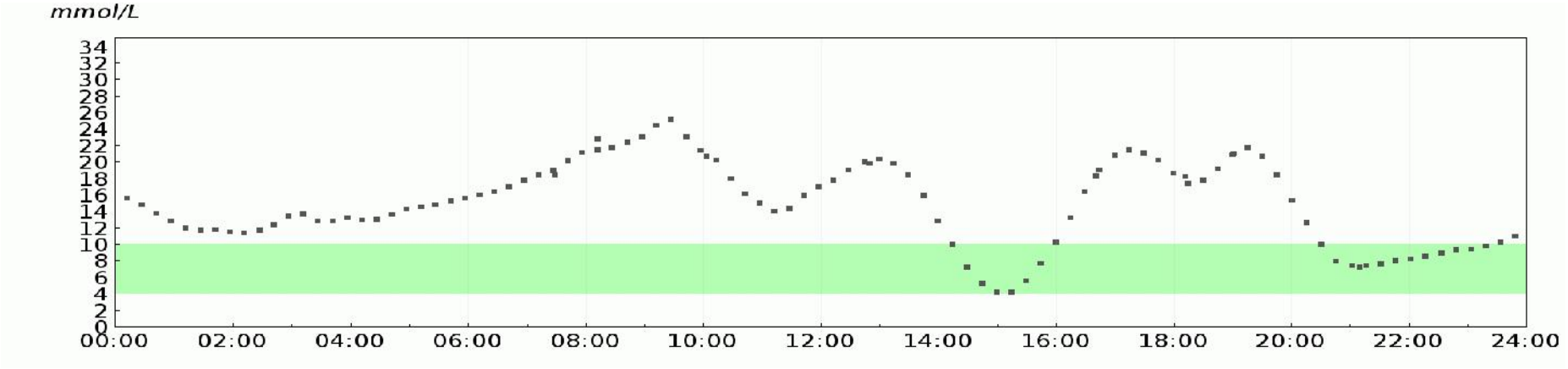
CGM: Standard day



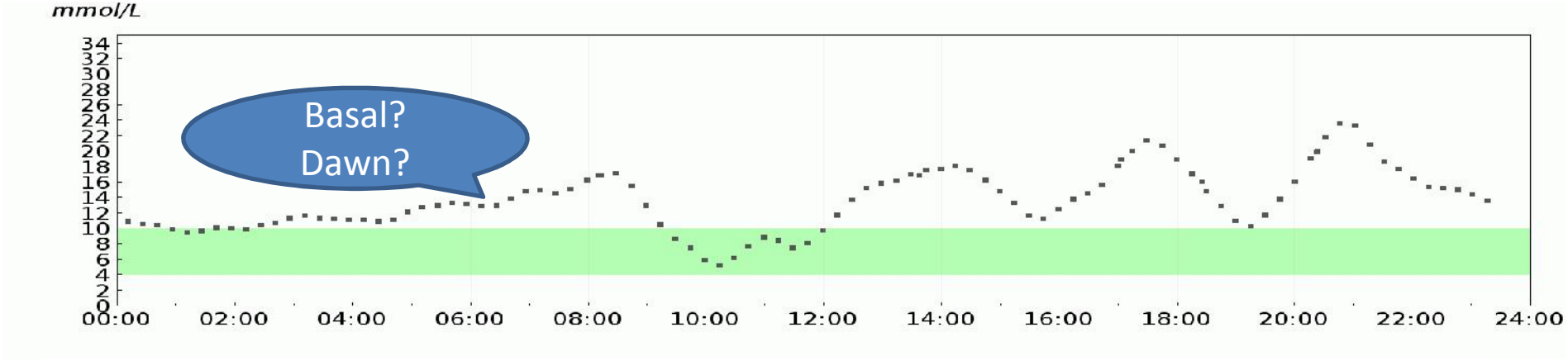
Thursday 26/1



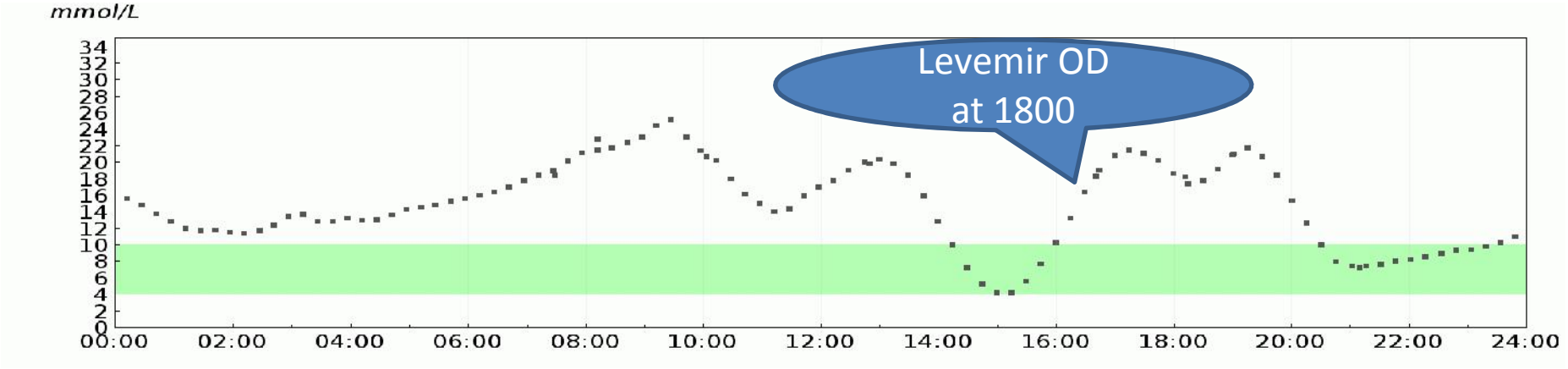
Monday 30/1



Thursday 26/1



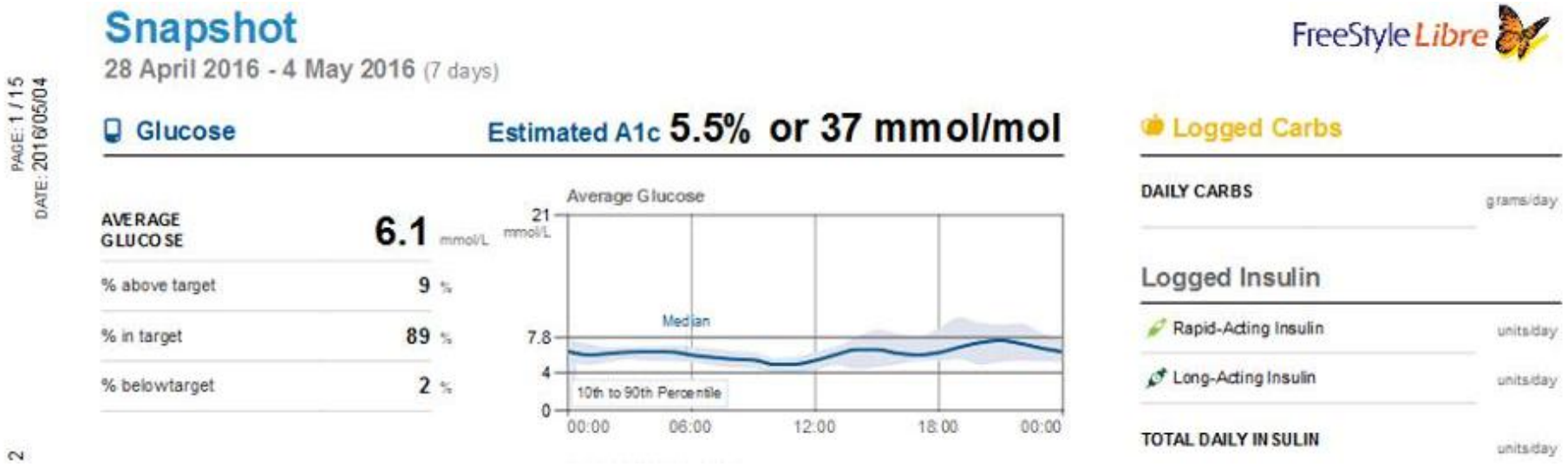
Monday 30/1



Success story

“A few years ago, I was under GP care, drifting along with an HbA1c of 9. What has changed? My healthcare team, a pump, me understanding a lot more …… finally the Libre. It's made me think differently, I've been experimenting with lower carb intake and pre-bolus….

The resulting flat line and complete lack of accompanying mind-fog is wonderful as is the rarity of hypos. Reason I'm sharing this - to say **'I was as rough as a box of spanners and I've been able to get here. It's possible**'.”



Top tips

- Main benefits
  - Hypo avoidance
  - Timing of mealtime insulin
  - Ease of use
- Embrace the data
  - Let the patient guide you
  - Do not be afraid to learn from your patients, they are (or should be) the experts

Conclusions

- Patients find it useful, we have a role in supporting them
- The data is complex!
- Let the patient identify the positives and areas for improvement and develop the management plan
- You don’t need to sort everything in one go, let the patient identify their realistic targets

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Derby Teaching Hospitals NHS
NHS Foundation Trust

Thank you

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