

WELCOME TO THE PUMP AND CGM TECHNOLOGY ELECTIVE!



Session Objectives

This session will use 2 patient cases to demonstrate:

1. Exercise concerns faced by patients with type 1 diabetes
2. Use of insulin pumps to help manage glucose changes with exercise in people with type 1 diabetes
3. Use of CGM to help manage glucose changes with exercise in people with type 1 diabetes



REVIEW OF CLINICAL CASES

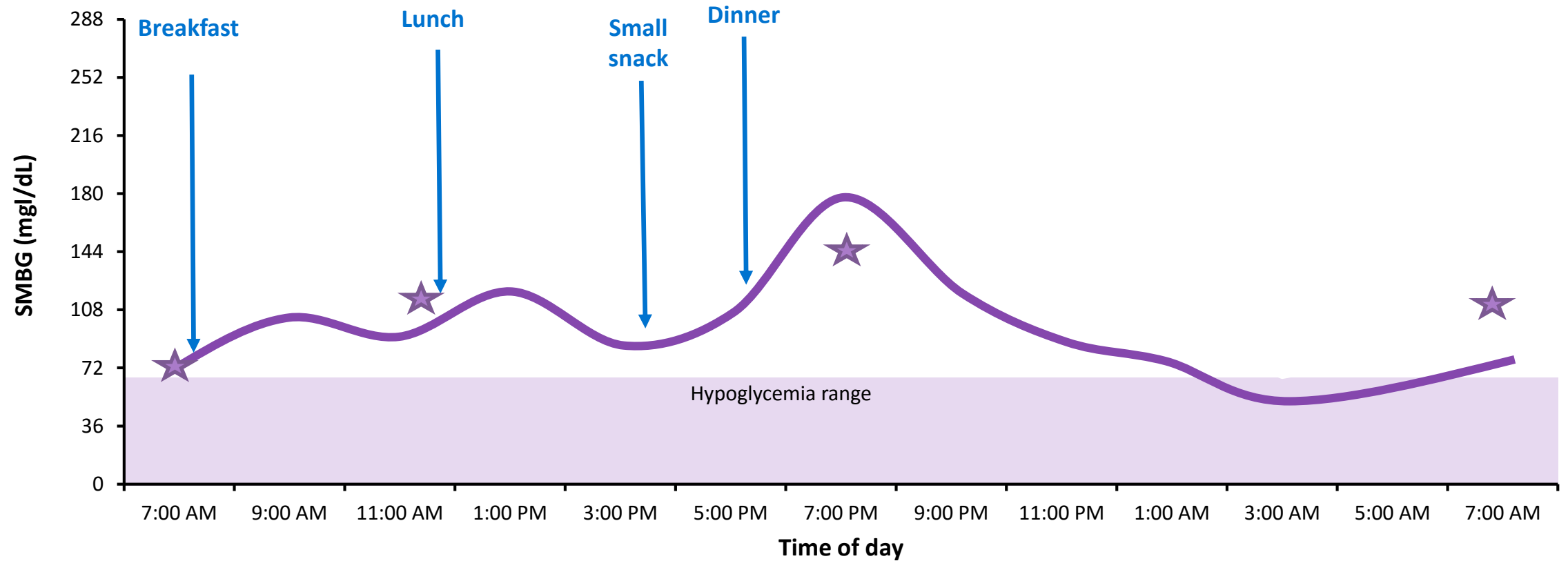
Clinical Case 1: Gavin with hypoglycemia unawareness

- Age: 22-year-old male
- Duration of diabetes: 8 years, currently on CSII (occasional CGM)
- BMI: 25 kg/m² (weight stable); fit
- Impaired awareness of hypoglycemia



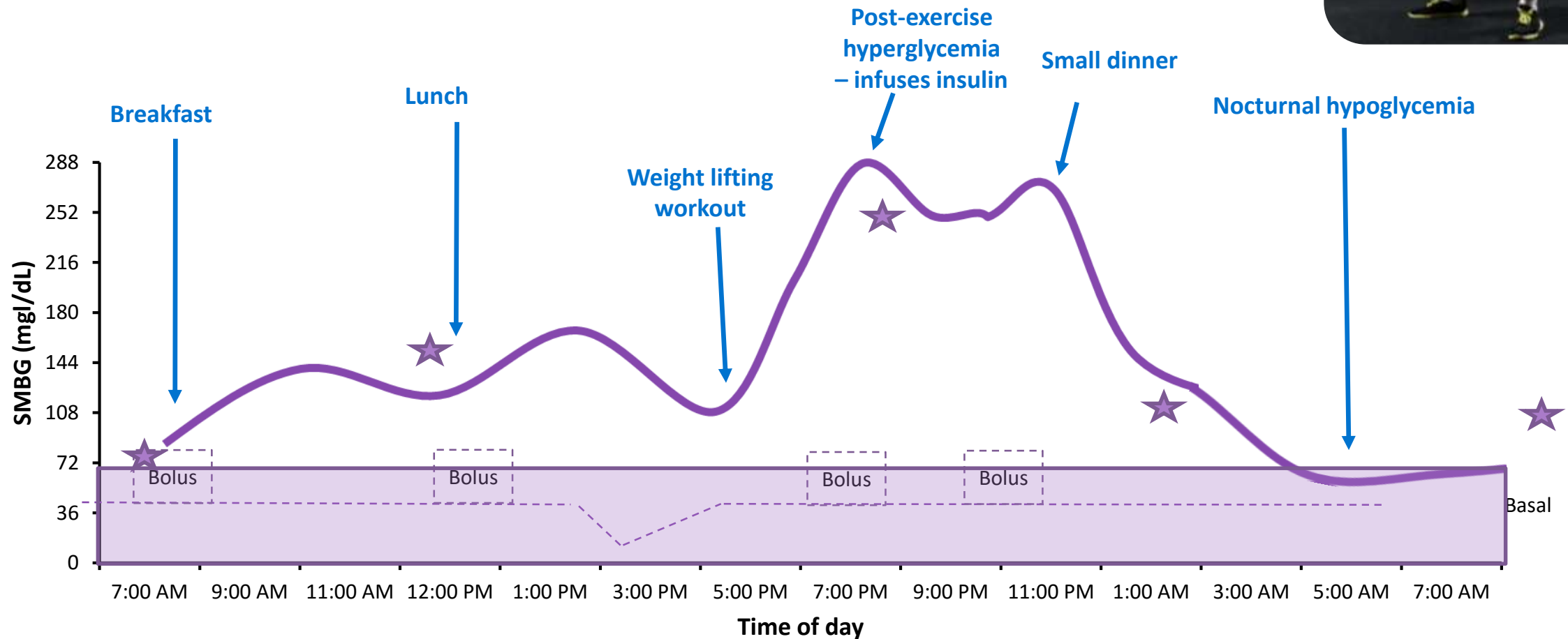
History	Current treatment	Exercise regimen
<ul style="list-style-type: none">■ MDI until 2 years ago then switched CSII■ HbA_{1c} 7% 53% mmol/ mol	<ul style="list-style-type: none">■ Continuous Subcutaneous Insulin Infusion	<ul style="list-style-type: none">■ Intermittent exercise, cycling and some swimming during the week■ Longer cycle rides on the weekend (more than 2 hours)

Gavin: Non-Exercise Day Glucose Profile (CGM)

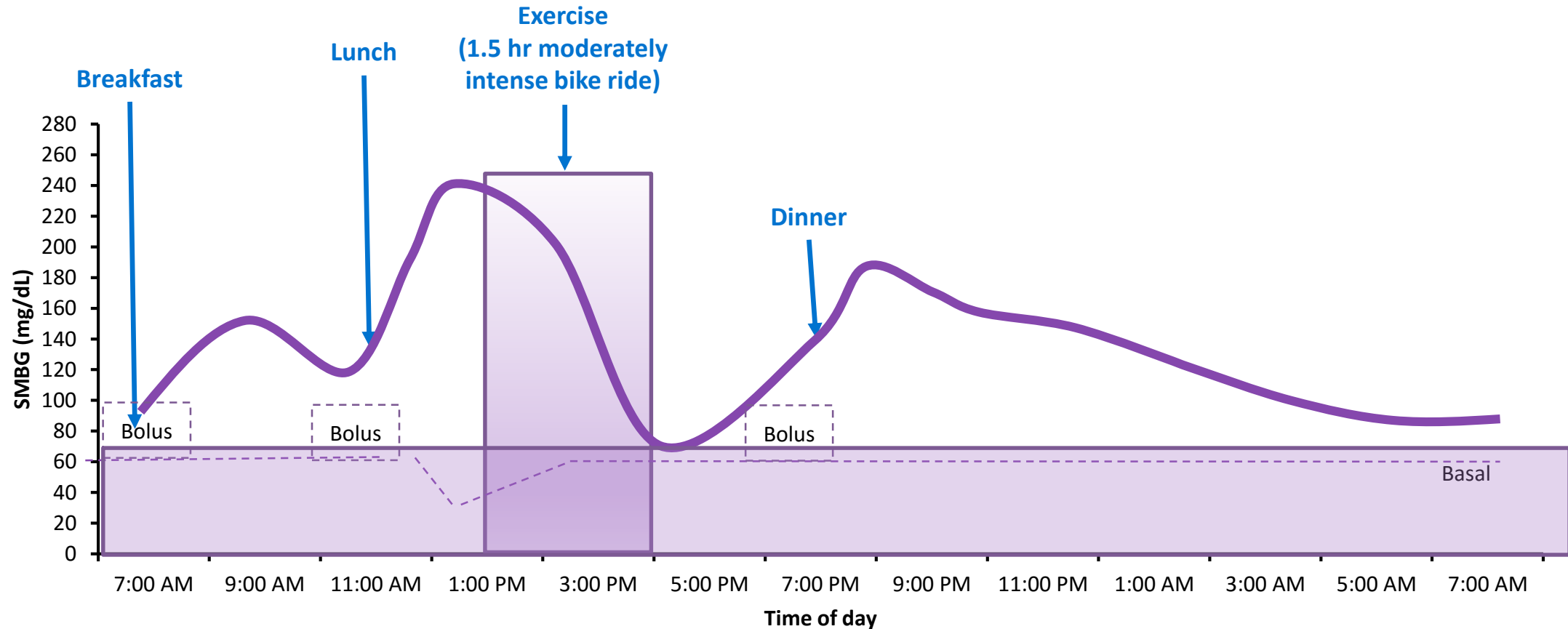


★ SMBG measurement

Gavin: Exercise Day Glucose Profile 1 (CGM)



Gavin: Exercise Day Glucose Profile 2 (CGM)

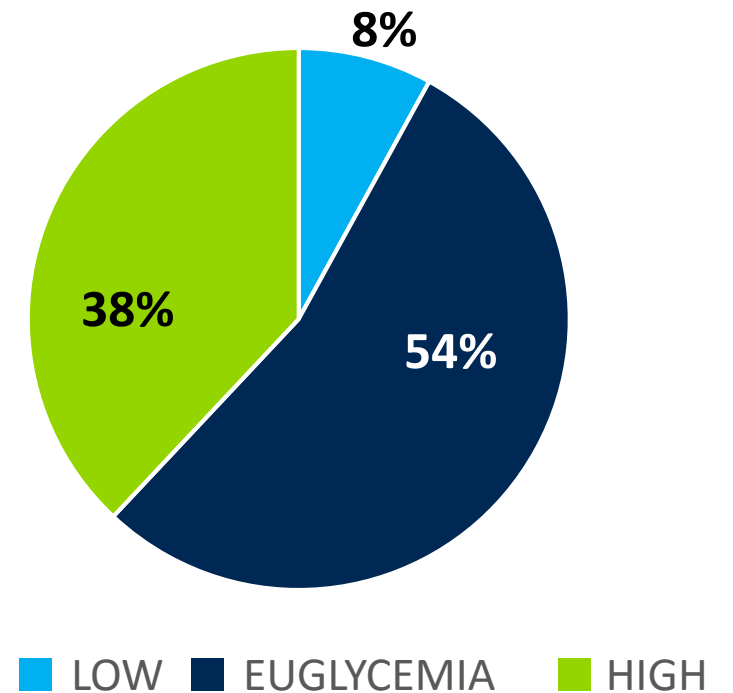


Pump Data: Gavin



Average daily totals
Carbohydrates: 72 g
Insulin: 25.05 U <ul style="list-style-type: none">Basal: 16.2 U (65%)Bolus: 8.8 U (35%)
Food only: 5.2 U
Corrections: 1.08 U <ul style="list-style-type: none">Number of corrections: 1.1
Manual: 3.75 U <ul style="list-style-type: none">Number of manual boluses: 2.8

7-day glycemia AUC



Gavin: Advice on Exercise Management

1. Can basal bolus doses be improved for sedentary and exercise days?
2. Are the bolus doses fitting?
3. Consider advice on carbohydrate intake for Cross-Fit vs. cycling
4. Consider advising patient on post-training insulin correction factor and food intake
5. Consider advising patient on nocturnal basal rates after training

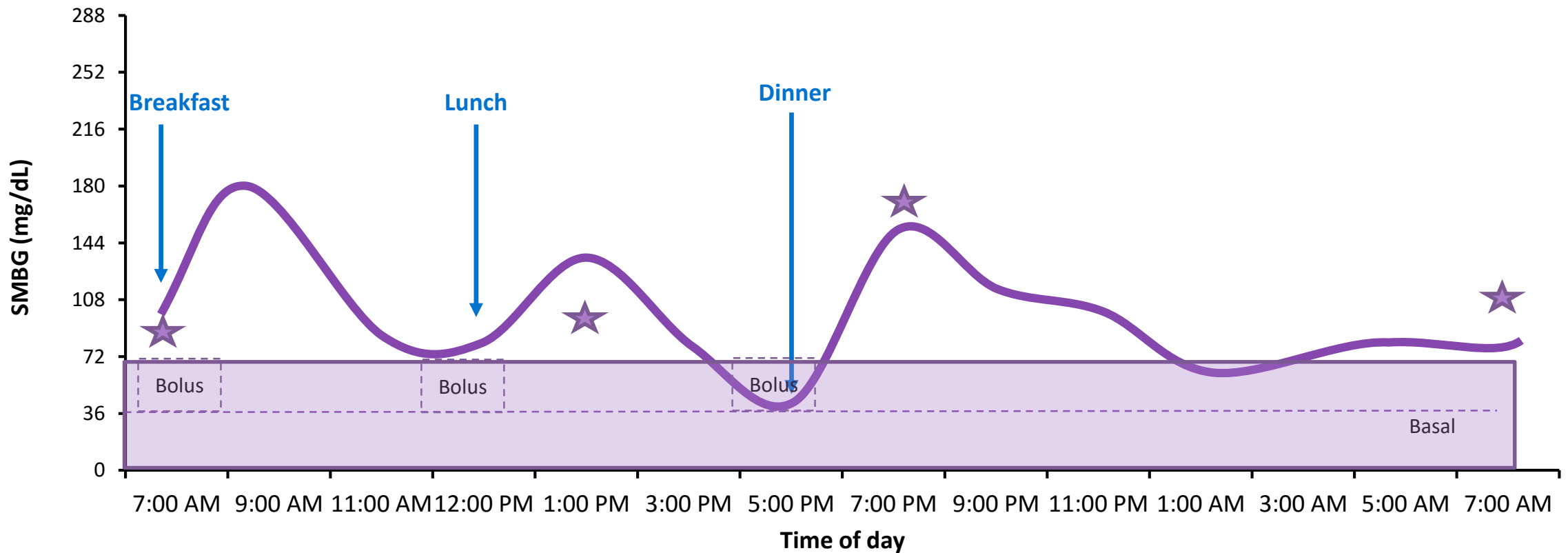
Clinical Case 2: Sally

- Pump patient with post-exercise hypoglycemia
- 38-year-old female
- Duration of diabetes: 7 years
- BMI: 28 kg/m²
- Exercise goal: to lose weight and improve fitness

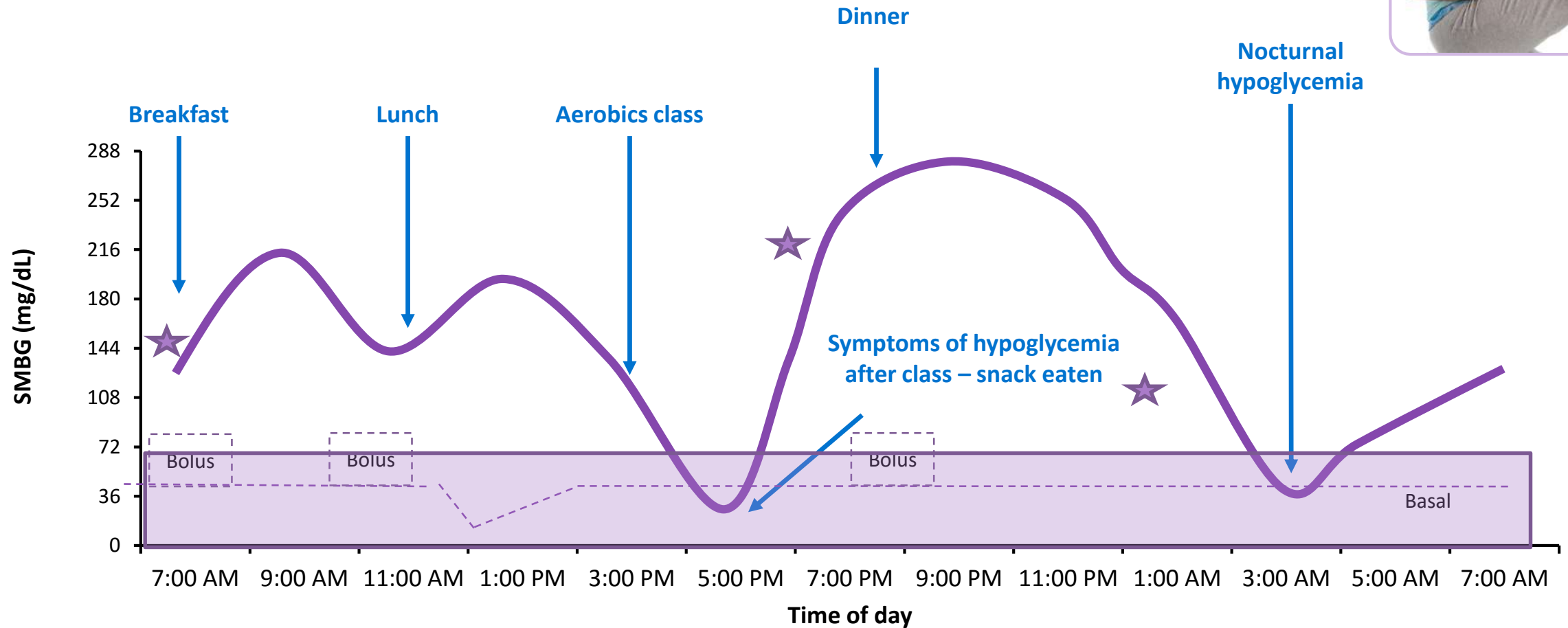


History	Exercise routine	Patient concerns
<ul style="list-style-type: none">■ Uncomplicated diabetes■ Was on MDI, now on CSII and intermittent use of CGM■ HbA_{1c} 7.6% 60 mmol/ mol	<ul style="list-style-type: none">■ New exercise programme to lose weight and improve fitness (aerobics class 2x per week, brisk walking)	<ul style="list-style-type: none">■ Has been experiencing hypoglycemic events during, and sometimes after, exercise

Sally: Non-Exercise Day Glucose Profile



Sally: Exercise Day Glucose Profile



Pump Data: Sally



Average daily totals

Carbohydrates: 150 g

Insulin: 50. U

- Basal: 25 U (50%)
- Bolus: 25 U (50%)

Food only: 10.2 U

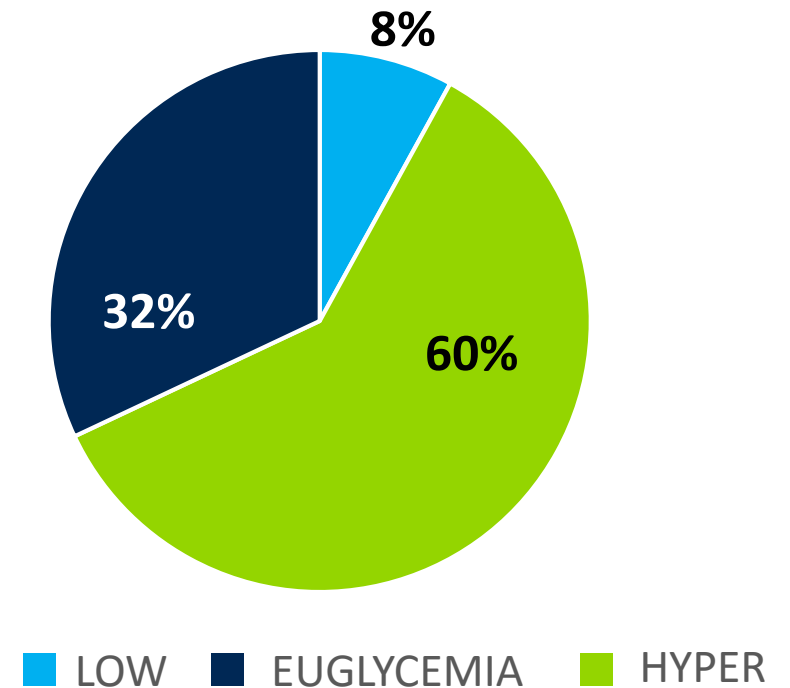
Corrections: 0.5 U

- Number of corrections: .75

Manual: 0.5 U

- Number of manual boluses: 1.7

7-day glycemia AUC

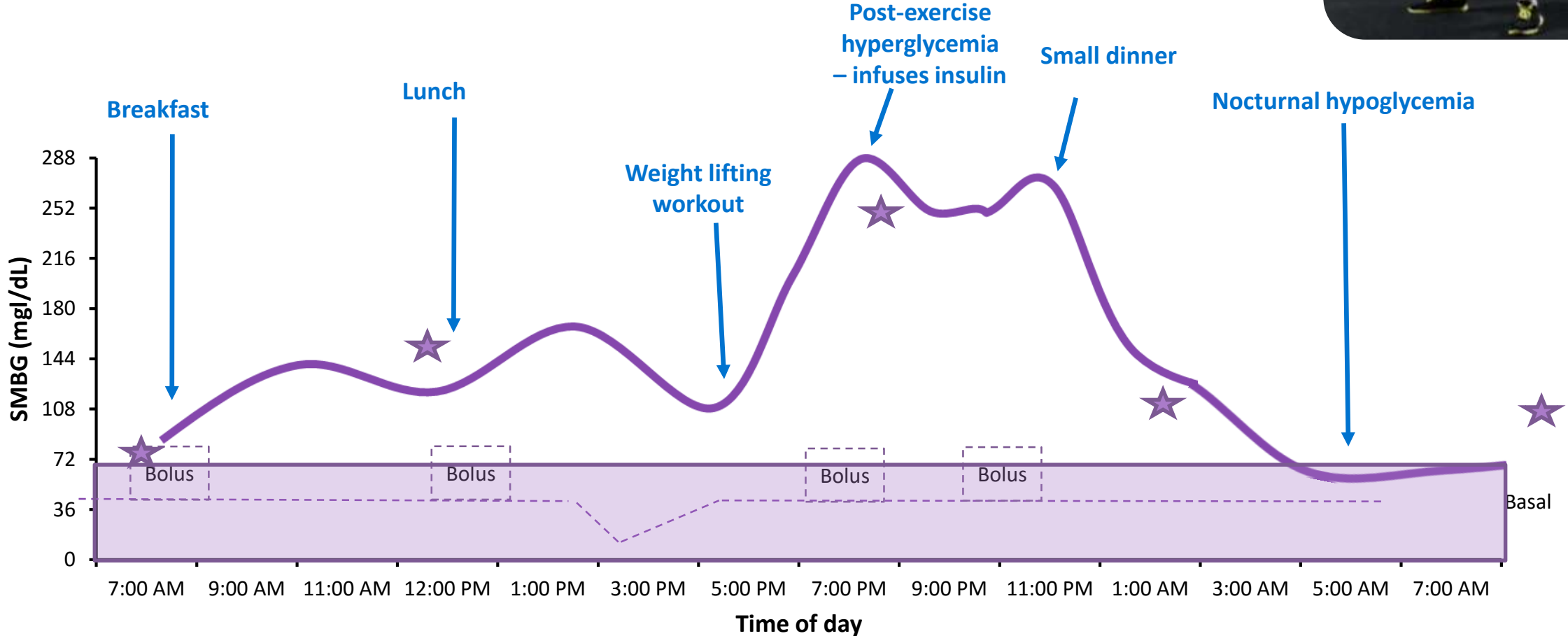


Discussion about Sally

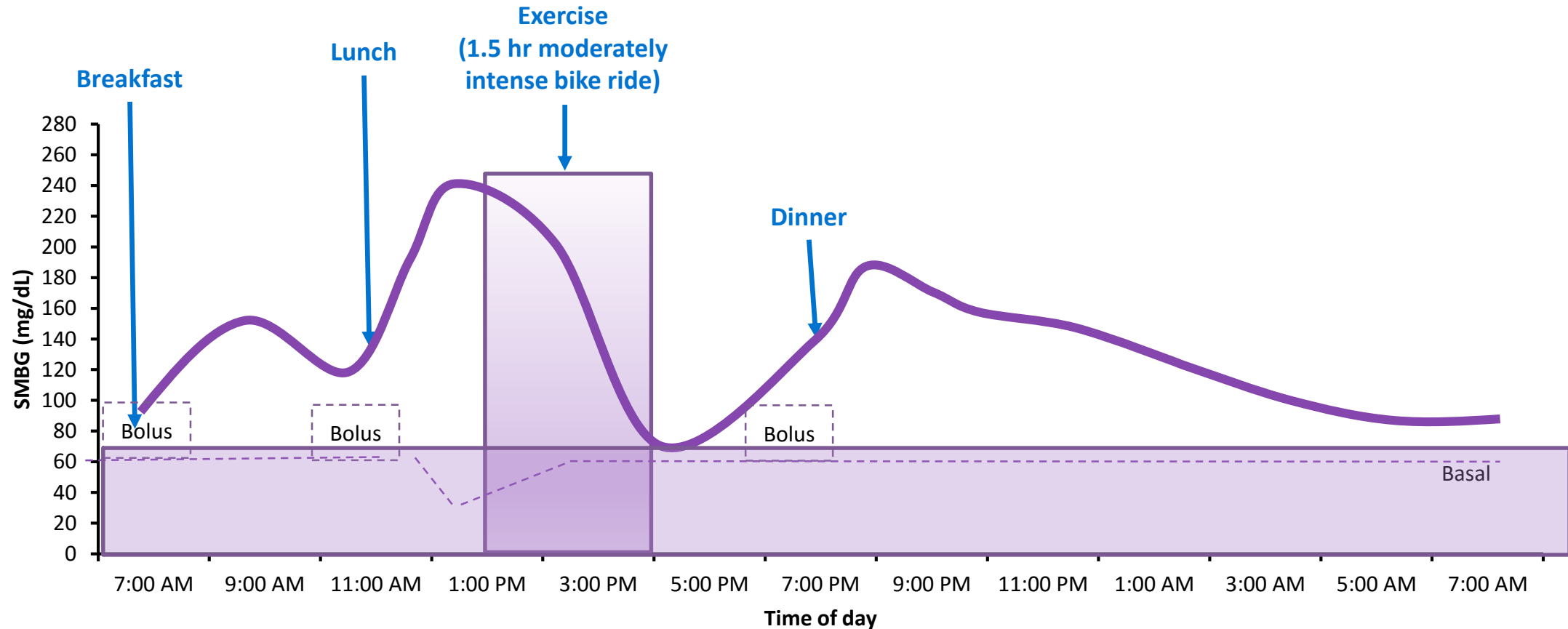
1. What do you think about Sally's diabetes management on non-exercise days? What changes might you recommend?
2. What would you recommend for Sally's exercise days?
3. Why might Sally's advice differ from Gavin's?
4. Note any advantages/limitations of the technologies (e.g. pumps, CGM) that Sally may use to manage glycemia during exercise



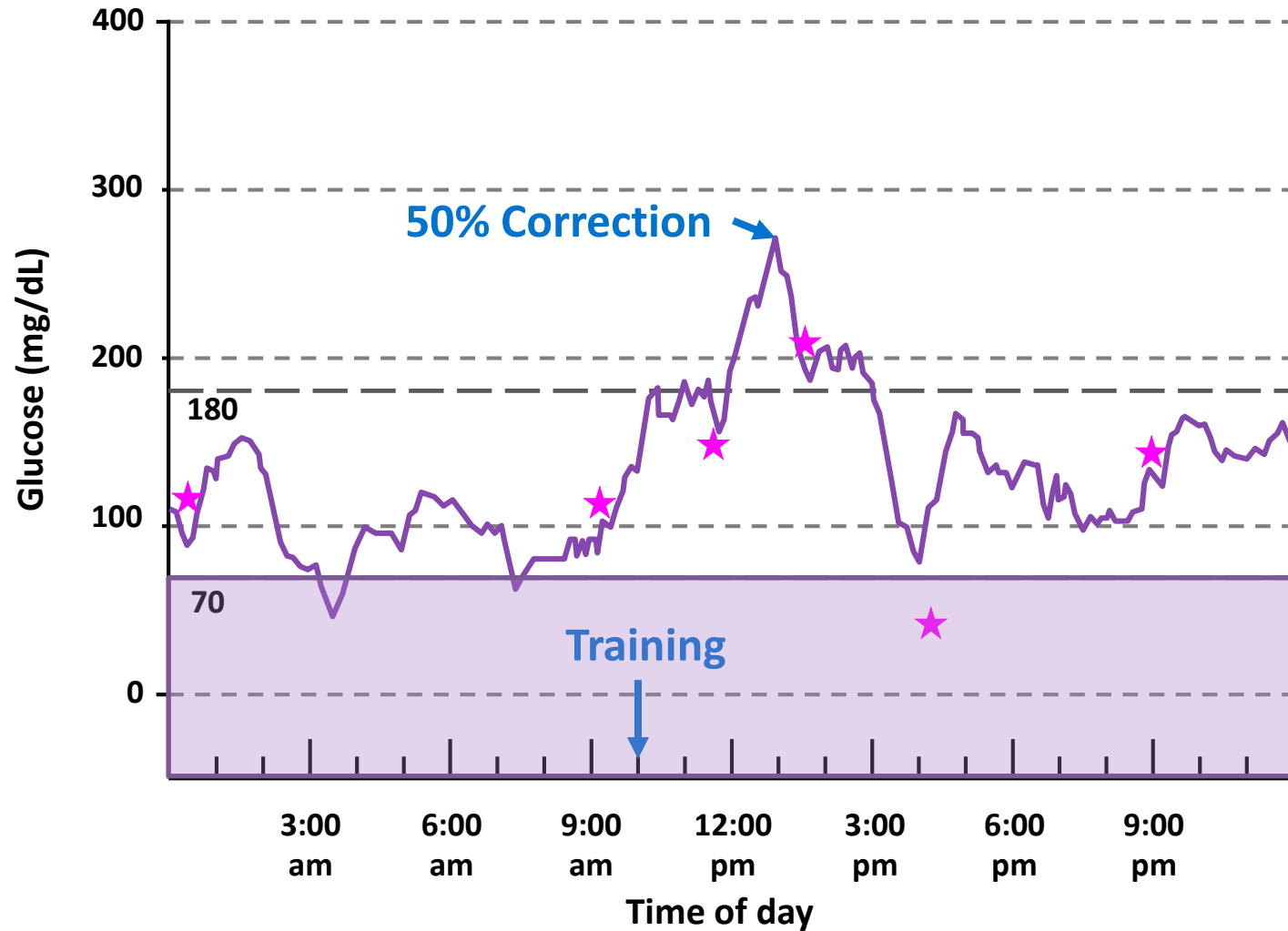
Mismatching insulin on board and exercise type



Gavin: Exercise Day Glucose Profile 2 (CGM)



Glucose Tracing: Gavin



- Breakfast at 8 am: Bagel, yoghurt, and coffee
- 50% less bolus insulin in anticipation of training
- **Intense** training for 30 minutes at 10 am performed with pump suspension (in water training)
- Reconnection with documented hyperglycemia and 50% correction given

Pump Data: Gavin



Average daily totals

Carbohydrates: 72 g

Insulin: 25.05 U

- Basal: 16.2 U (65%)
- Bolus: 8.8 U (35%)

Food only: 5.2 U

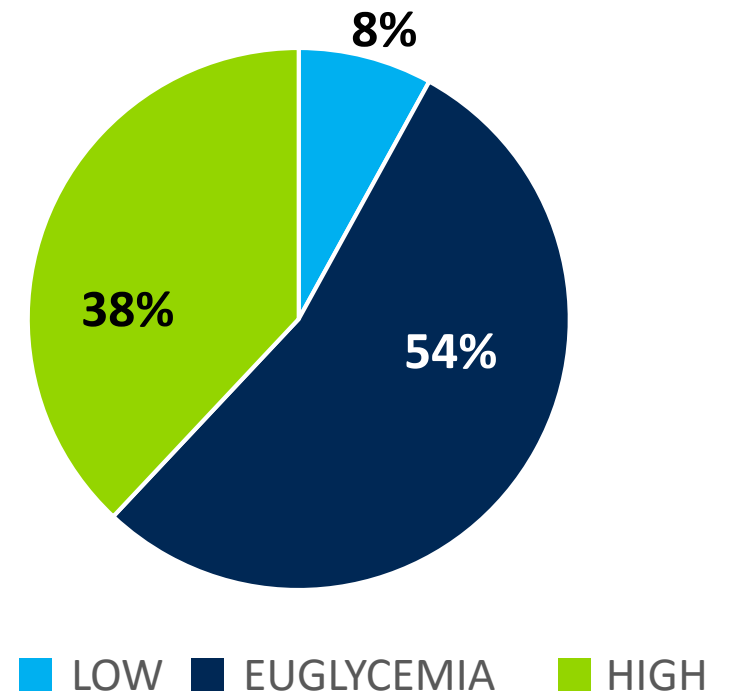
Corrections: 1.08 U

- Number of corrections: 1.1

Manual: 3.75 U

- Number of manual boluses: 2.8

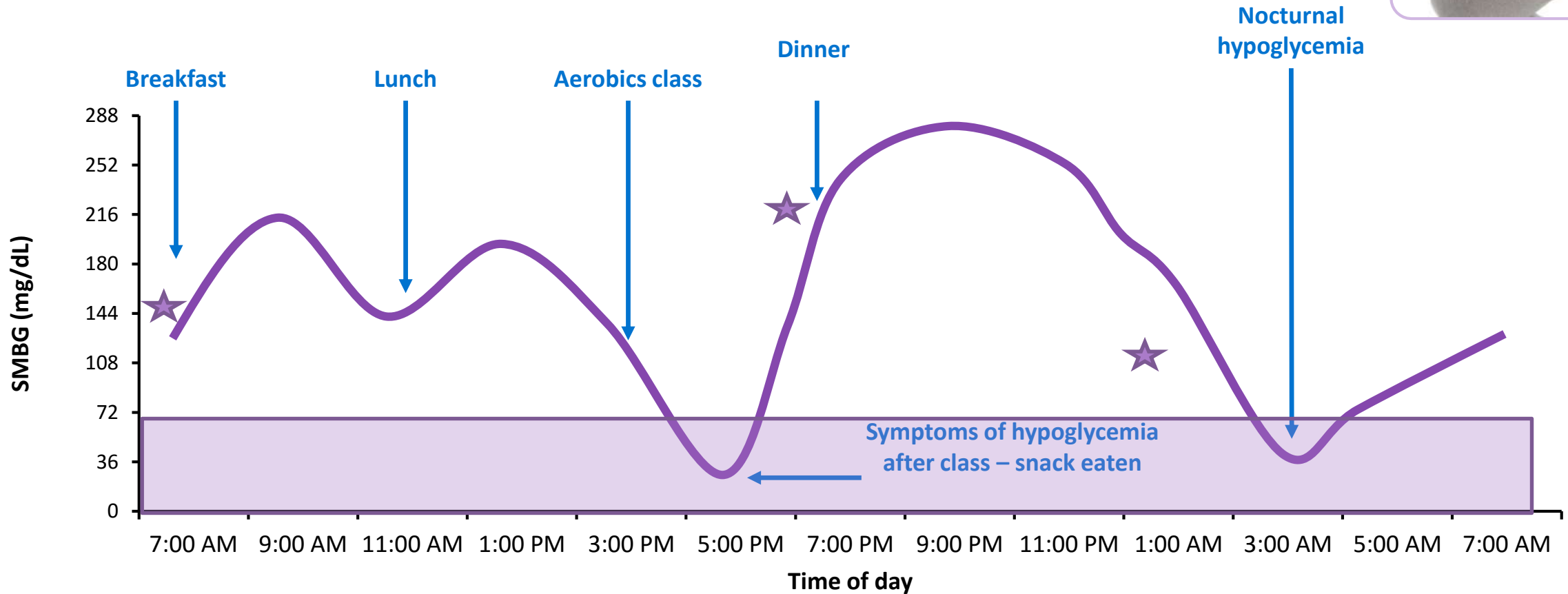
7-day glycemia AUC



Sally: Advice on Management

1. Are basal bolus doses correct for sedentary and exercise days?
2. Consider your advice on temporary basal rates during and after each form of exercise
3. Consider advice on carbohydrate intake and total energy requirements
4. Advise patient on post-training insulin rates and food intake
5. Advise patient on nocturnal risk and management strategies after training

Sally: Exercise Day Glucose Profile



Pump Data: Sally



Average daily totals

Carbohydrates: 150 g

Insulin: 50. U

- Basal: 25 U (50%)
- Bolus: 25 U (50%)

Food only: 10.2 U

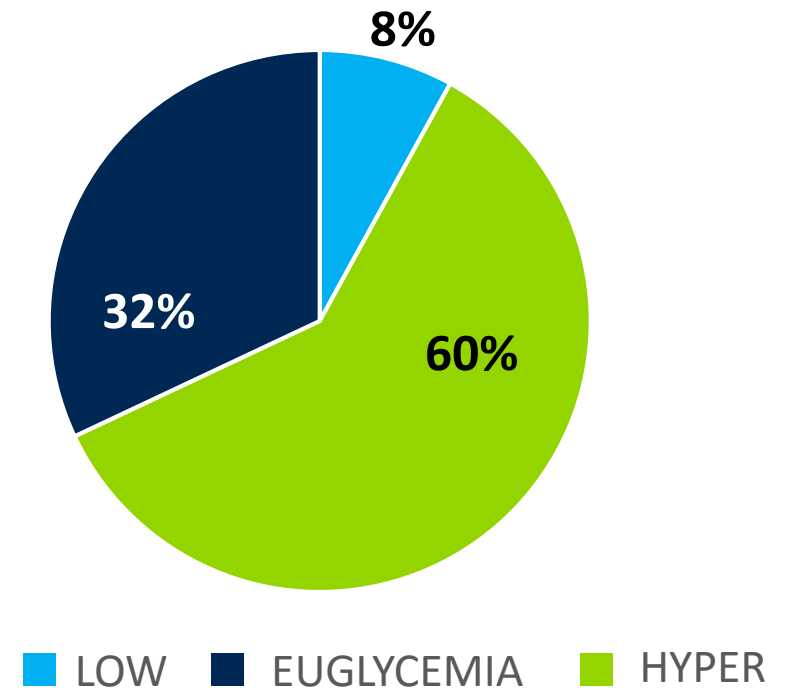
Corrections: 0.5 U

- Number of corrections: .75

Manual: 0.5 U

- Number of manual boluses: 1.7

7-day glycemia AUC



Data to be Considered for Sally

Average daily totals	Data to be considered for Sally
Carbohydrates: 150 g	Carbohydrate ratio: e.g. 12 g/unit of insulin
Insulin: 50. U <ul style="list-style-type: none">▪ Basal: 25 U (50%)▪ Bolus: 25 U (50%)	Active insulin time: 5 hours
Food only: 10.2 U	Blood glucose targets: e.g. 90–129.6 mg/dL
Corrections: 0.5 U <ul style="list-style-type: none">▪ Number of corrections: .75	Insulin Sensitivity: e.g. 50.4 mg/dL drop per unit
Manual: 0.5 U <ul style="list-style-type: none">▪ Number of manual boluses: 1.7	

CGM and CSII: Avoidance of Hypoglycemia

Device	Suggested uses and recommendations
Continuous subcutaneous insulin infusion (CSII)*	<ul style="list-style-type: none">Recommended for basal rate adjustments<ul style="list-style-type: none">To avoid hypoglycemia:<ul style="list-style-type: none">Reduce basal insulin infusion rate up to 90 minutes before exerciseContinue infusion at reduced level until exercise is completedConsider reduced basal for up to 12 hours in recovery (i.e. 20% reduction)
Continuous glucose monitoring (CGM)	<ul style="list-style-type: none">Recommended for hypoglycemia avoidance<ul style="list-style-type: none">Helpful to wear during exercise to track glucose and to learn optimal preparationOffers optimal adjustment of both basal and meal insulin doses with or without exercise

Note: The use of CSII helps to limit post-exercise hyperglycemia compared with multiple dose insulin (MDI) therapy, and is not associated with increased risk of post-exercise late-onset hypoglycemia¹.

1. Yardley et al. 2013. *Diabetes Technology & Therapeutics* 15(1):84-8

Trend Arrows – Velocity of Glucose Change Per 10 Min

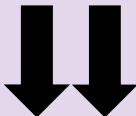






Product	Velocity	Trend arrow	Velocity	Trend arrow	Velocity	Trend arrow
Dexcom	>30.6 mg/dL >1.69 mmol/L	↓ ↓	19.8 – 30.6 mg/dL 1.09 -1.69 mmol/L	↓	9.0 – 19.8 mg/dL .5 - 1.09 mmol/mol	↘
Abbott FreeStyle Libre			>18 mg/dL >.99 mmol/L	↓	10.8-18 mg/dL .6 - .99 mmol/L	↘
Medtronic			> 19.8 mg/dL >1.09 mmol/L	↓ ↓	10.8 – 19.8 mg/dL .6 - .99 mmol/L	↓

CGM and Carbohydrate Intake Algorithm to Reduce/Avoid Hypoglycemia While Exercising

CGM Glucose level	Trend arrow(s)	Action	Comments
<90 mg/dL <5 mmol/L	None or downward trending	16-20 g CHO	Stop exercise if plasma glucose ≤ 70.2 mg/dL/ 3.8 mmol/L
90–109.8 mg/dL 5 – 6 mmol/L	↓ Medtronic ↘ Dexcom	16 g CHO	
90–109.8 mg/dL 5 – 6 mmol/L	↓↓ Medtronic ↓ or ↓↓ Dexcom	20 g CHO	
>109.8, <124.2 mg/dL >6, <6.8 mmol/L	Any downward trending arrows (both manufacturers)	8 g CHO	

Note: Treatment of hypo or hyperglycemia should not be based solely on CGM. Self monitoring of blood glucose level is recommended. Carbohydrate (CHO) intake is generally recommended for long duration aerobic exercise for performance reasons (~1 g/kg body mass per hour).

Watch Out for Hypoglycemia!

Product	Interval	Trend arrow	Interval	Trend arrow	Interval	Trend arrow
Dexcom	>117 mg/dL >6.5 mmol/L		102.6 – 117 mg/dL 5.6 - 6.5 mmol/L		86.4 – 102.6 mg/dL 4.7 - 5.7 mmol/L	
Freestyle Navigator or Libre			>102.6 mg/d 5.6 mmol/L		86.4 – 102.6 mg/dL 4.7 - 5.7 mmol/L	
Medtronic			>102.6 mg/dL 5.6 mmol/L		86.4 – 102.6 mg/dL 4.7 - 5.7 mmol/L	

Trend Arrows – Velocity of Glucose Change Per 10 Min!

Product	Velocity	Trend arrow	Velocity	Trend arrow	Velocity	Trend arrow
Dexcom	>30.6 mg/dL 1.69 mmol/L	↑↑	19.8 – 30.6 mg/dL 1.09 -1.69 mmol/L	↑	9.0 – 19.8 mg/dL .5 - 1.09 mmol/mol	↗
Freestyle Navigator or Libre			>19.8 mg/dL 1.09 mmol/L	↑	9.0 – 19.8 mg/dL .5 - 1.09 mmol/mo	↗
Medtronic			>19.8 mg/dL 1.09 mmol/L	↑↑	10.8 – 19.8 mg/dL .6 - .99 mmol/LI	↑

Watch Out for Hyperglycemia!

If your blood glucose value is above 144 mg/dL/ 8 mmol/L:

1. Check for trend arrow pointing upwards
2. Discuss possible actions depending on the cause of upcoming hyperglycemia
3. Consider additional insulin where appropriate – doses likely to be very small

Adaptation of CSII Where pump is removed

- Some exercise may require pump removal (swimming, combat sports, intense competition)
 - No more than 60 minutes without mandatory SMBG testing and reconnect with CSII, if necessary, for insulin administration (basal insulin can also be given by needles for active days with pump off)
 - Missed basal insulin (full or partial) can be given either before pump removal or after pump reconnect depending on exercise plans
- If post exercise hyperglycemia is observed, a 50% bolus insulin correction can be administered safely¹
- Reducing the basal rate of pump by 60-80% before exercise has been found helpful in reducing the hypoglycemic risk²

1. Turner et al., *Diabet Med.* 2015 Jul 29

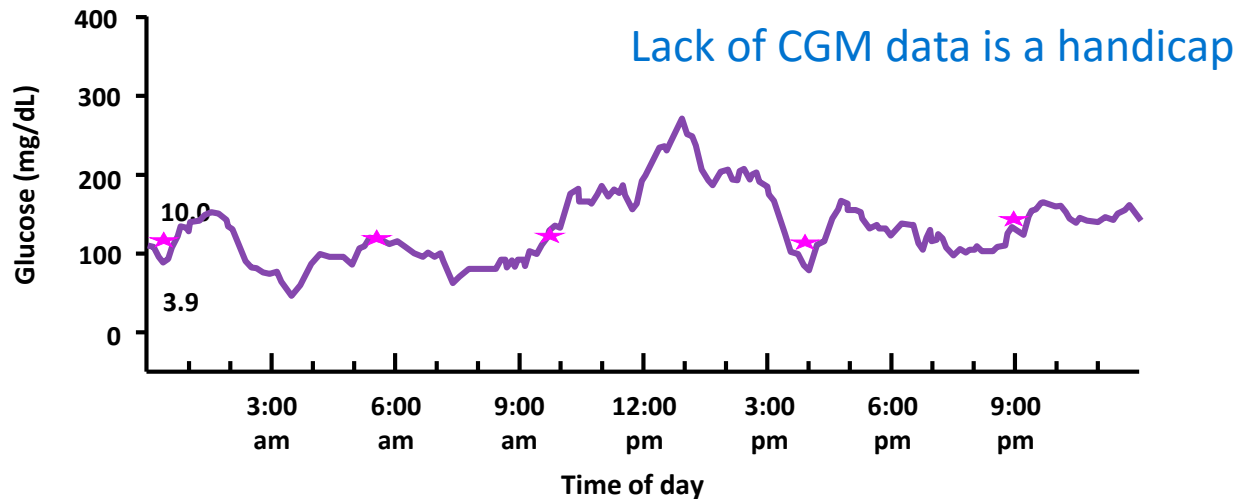
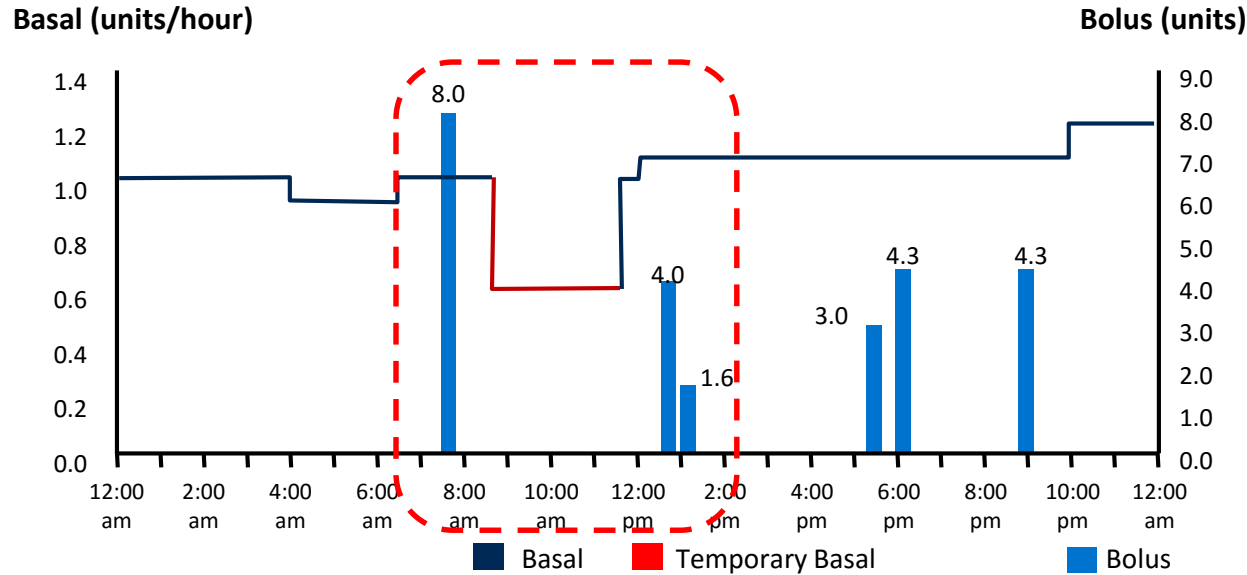
2. Franc S et al. *Diabetes Obes Metab.* 2015 Dec;17(12):1150-7

DATA MANAGEMENT

Diabetes Management Software

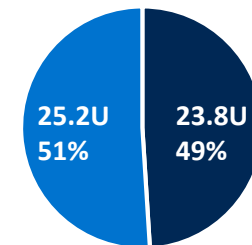


Download – Feedback



Patient example: A bolus quite close to exercise so they reduced basal

Basal		Bolus	
Time	U/h	Time	U/h
12:00 am	1.000	7:37 am	8.00
4:00 am	0.925	Override (Proposed: 14.70) (Corr: 3.22) (Meals: 11.50)	
6:30 am	1.000	12:40 pm	4.00
8:39 am	0.600	1:12 pm	1.55
11:39 am	1.000	5:26 pm	3.00
12:00 pm	1.075	6:10 pm (Corr: 0.92) (Meals: 4.28) (IOB: 2.35)	
10:00 pm	1.200	8:57 pm (Meals: 4.28)	



Key Points

- Technology can improve exercise management
- Diabetes management using technology can be done in steps:
 - 1) Sedentary day analysis (correct insulin doses, ISF, CF, etc.)
 - 2) Use CGM for exercise assessment
 - 3) Manage pre exercise, during and post exercise insulin and/or carbohydrate needs
 - 4) Educate and reassess
 - 5) Additional taping of the material at least 24 hours before exercising
 - 6) Reminder about hydration and have carbohydrates readily available



Teamwork with the patient

Questions?



THANK YOU!

www.TypeOneNation.org/PEAK