WELCOME TO THE RECREATIONAL, ENDURANCE/COMPETITIVE, AND ELITE ATHLETE ELECTIVE!

JDRF PEAK
TID Performance in Exercise and Knowledge

Session Agenda

1. Introduction (20 minutes)
2. Case studies and discussion (40 minutes)

Session Objectives

In this session, you will learn:

1. The physiological mechanisms that operate during exercise in athletes with type 1 diabetes
2. What to consider before initiating an exercise program for the athlete with type 1 diabetes
3. How to adapt an exercise program in recreational and competitive/endurance athletes

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Key Points

- As you train your insulin sensitivity and your fuel utilization will change
- Emotional stress will bring blood sugar up before a race

Before We Begin…

In your opinion, what are the key differences between recreational and competitive/endurance athletes with type 1 diabetes?

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Key Differences Between Recreational and Competitive/Endurance Athletes with Type 1 Diabetes

1. Same metabolic challenges
2. As result of training and fitness:
   - Most competitive/endurance athletes may have higher muscle insulin sensitivity and thus have lower insulin to carbohydrate ratio
     - Insulin dose may increase if carbohydrate intake increases
3. Derive a higher percentage of fuel from fat sources at lower exercise intensities
4. Higher training volume
5. Ritualized daily training routine
6. Lack of flexibility for training and competition

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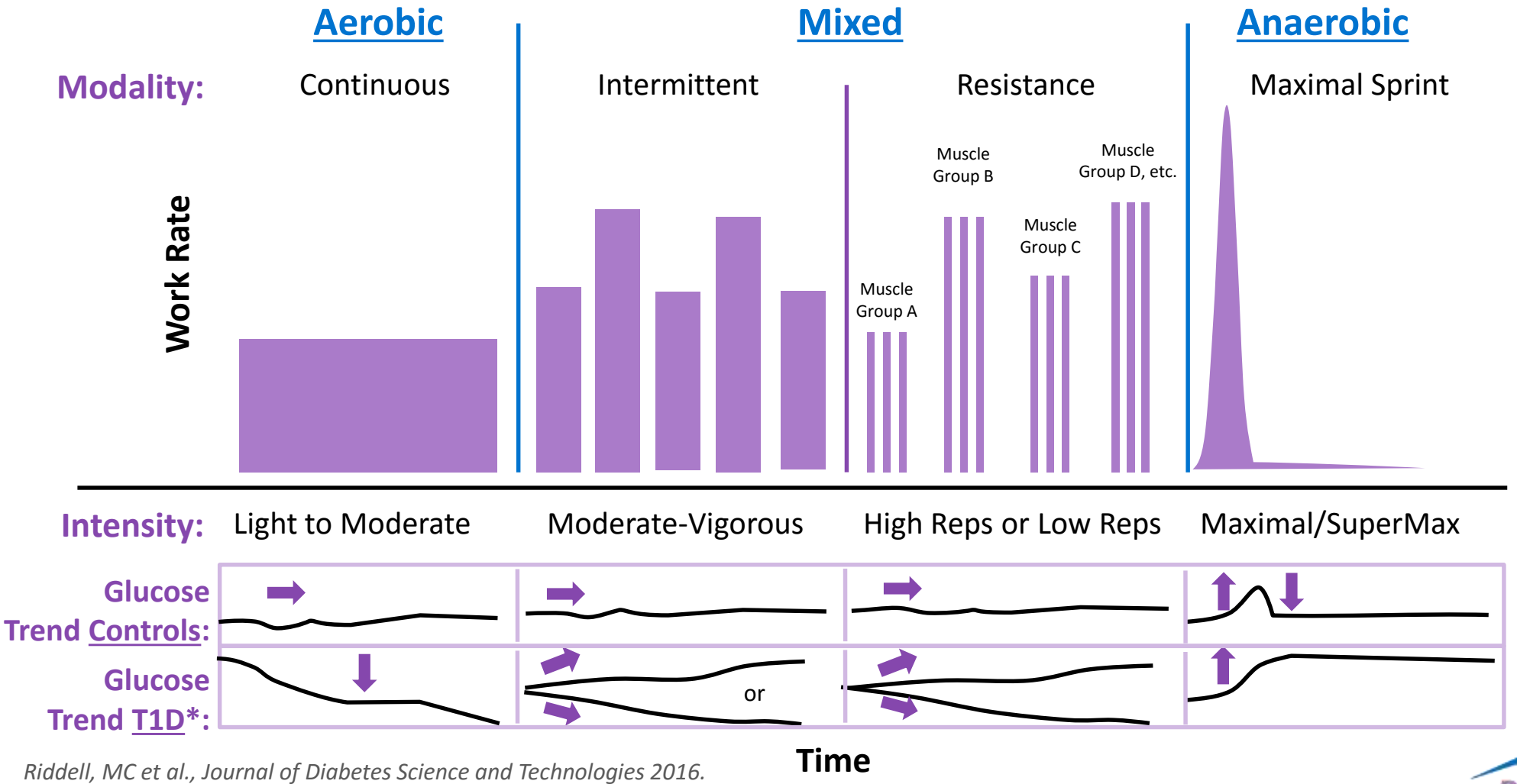
Riddell, MC, *et al. Journal of Diabetes Science and Technologies* 2016: DOI: 10.1177/1932296815609370

Exercise Comes in Several Different Forms, Each with Different Effects on Glucose Levels



Riddell, MC et al., Journal of Diabetes Science and Technologies 2016.

*Blood glucose levels may increase after continuous aerobic exercise of long duration

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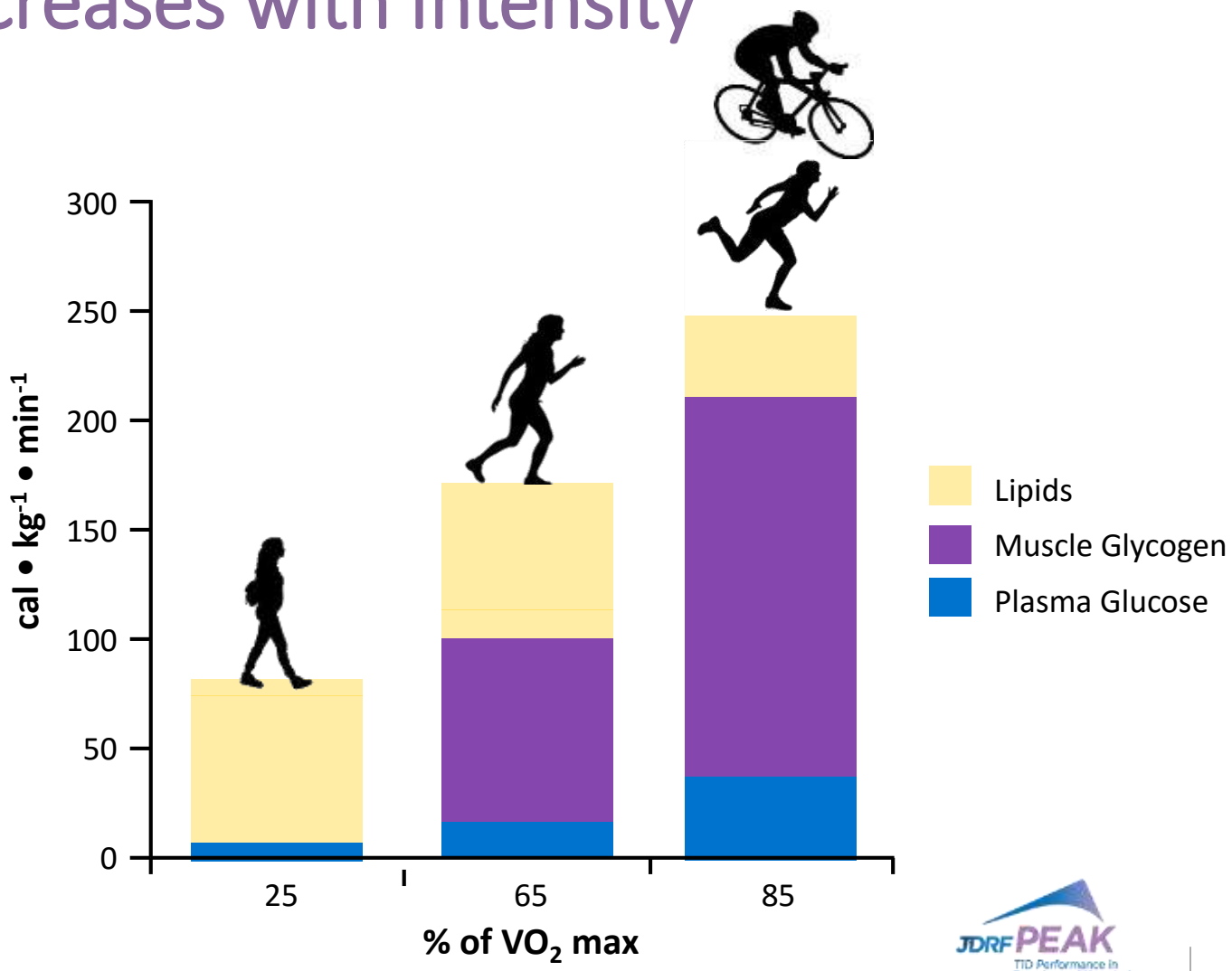
Fuel Utilization:
Plasma Glucose Uptake Increases with Intensity

- Lower intensity exercise
  - High lipid utilization
- Higher intensity exercise
  - High muscle glycogen use



Romijn et al., Am J Physiol 1993; Van Loon et al., J Physiol 2001

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As exercise intensity increases from moderate to vigorous activity:

A. Fat utilization increases and glucose utilization decreases

B. Fat utilization decreases and glucose utilization increases

C. Both fat and glucose utilization increase

D. Glucose increases just until reaching lactate threshold, then fat utilization increases

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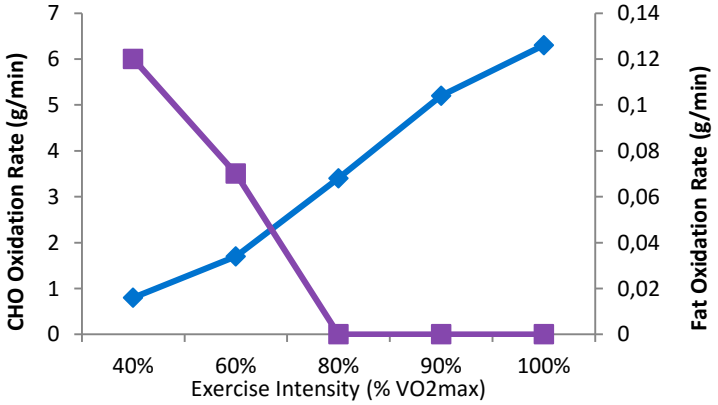
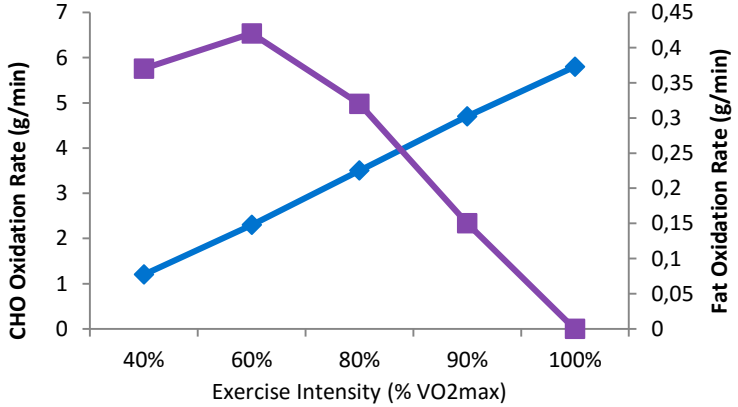
Trained vs. Untrained Athletes and Pattern of Fuel Utilization

- The pattern of fuel utilization in trained and untrained is based on:
  - Central (brain & nervous system) adaptations to exercise
  - Local adaptations to exercise
  - Changes in skeletal muscle fibers
  - Training adaptations at the cellular level and substrate utilization

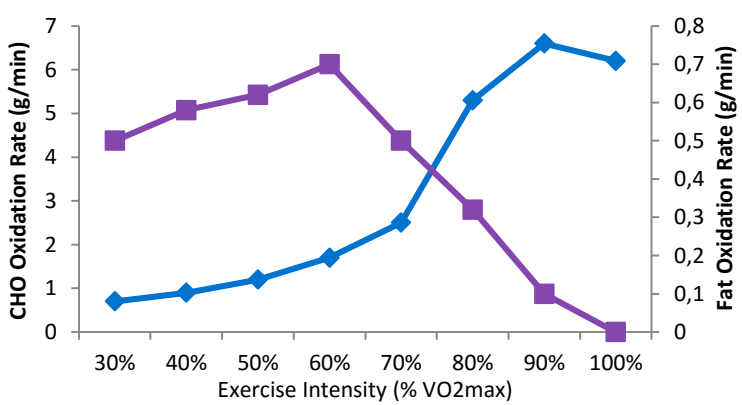
Sedentary



Recreational



World Class



Carbohydrate FAT

San Millan, I and Brooks, GA. 2015 Unpublished data (Submitted)

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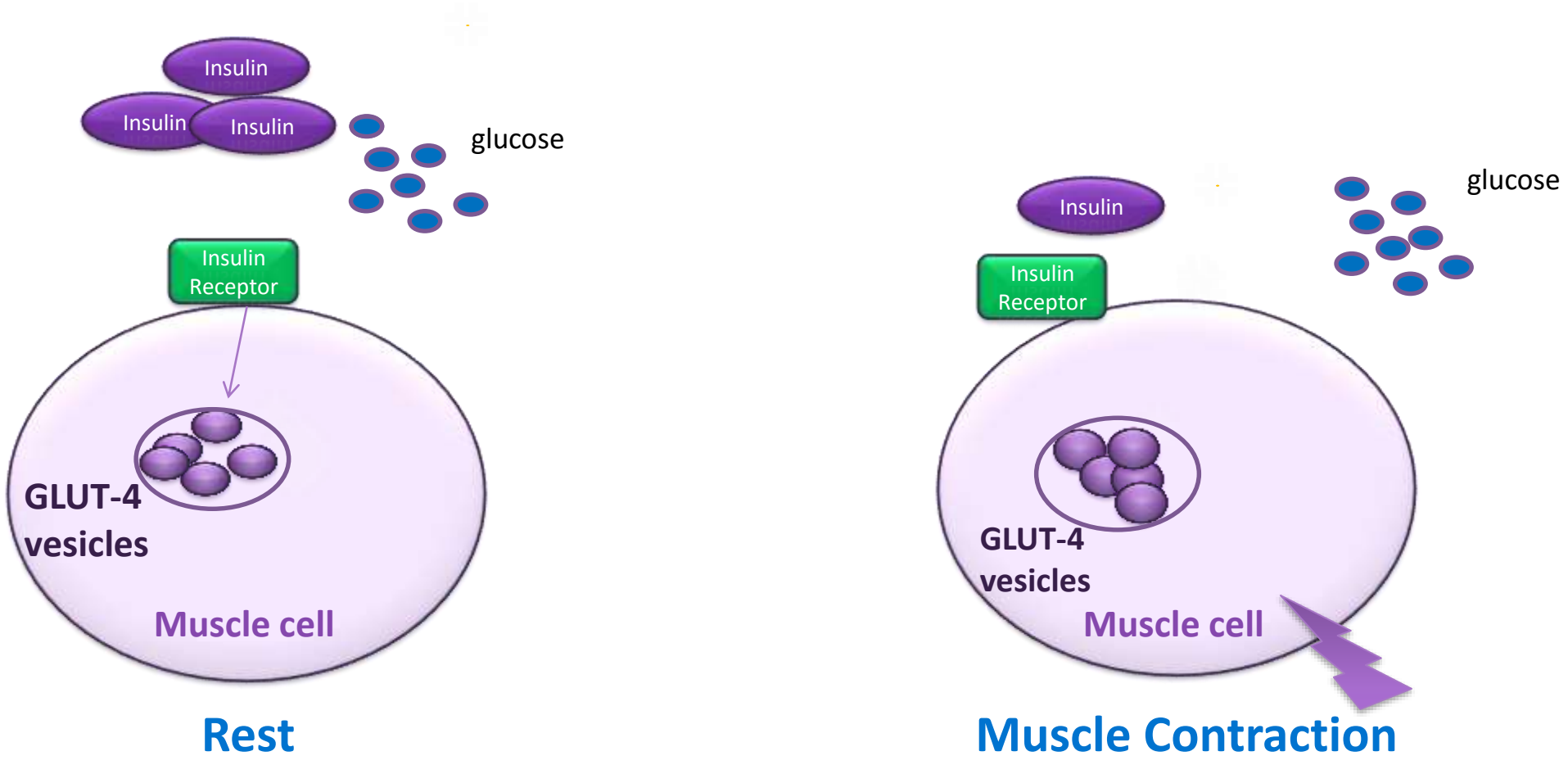
During Exercise, 2 Simultaneous Mechanisms Act on Glucose Uptake by Skeletal Muscle Cells: Insulin and Muscle Contraction



Hayashi, T., Wojtaszewski, J. F., & Goodyear, L. J. *American Journal of Physiology-Endocrinology And Metabolism*, 1997
Rose, A. J., & Richter, E. A. *Physiology*, *2015*

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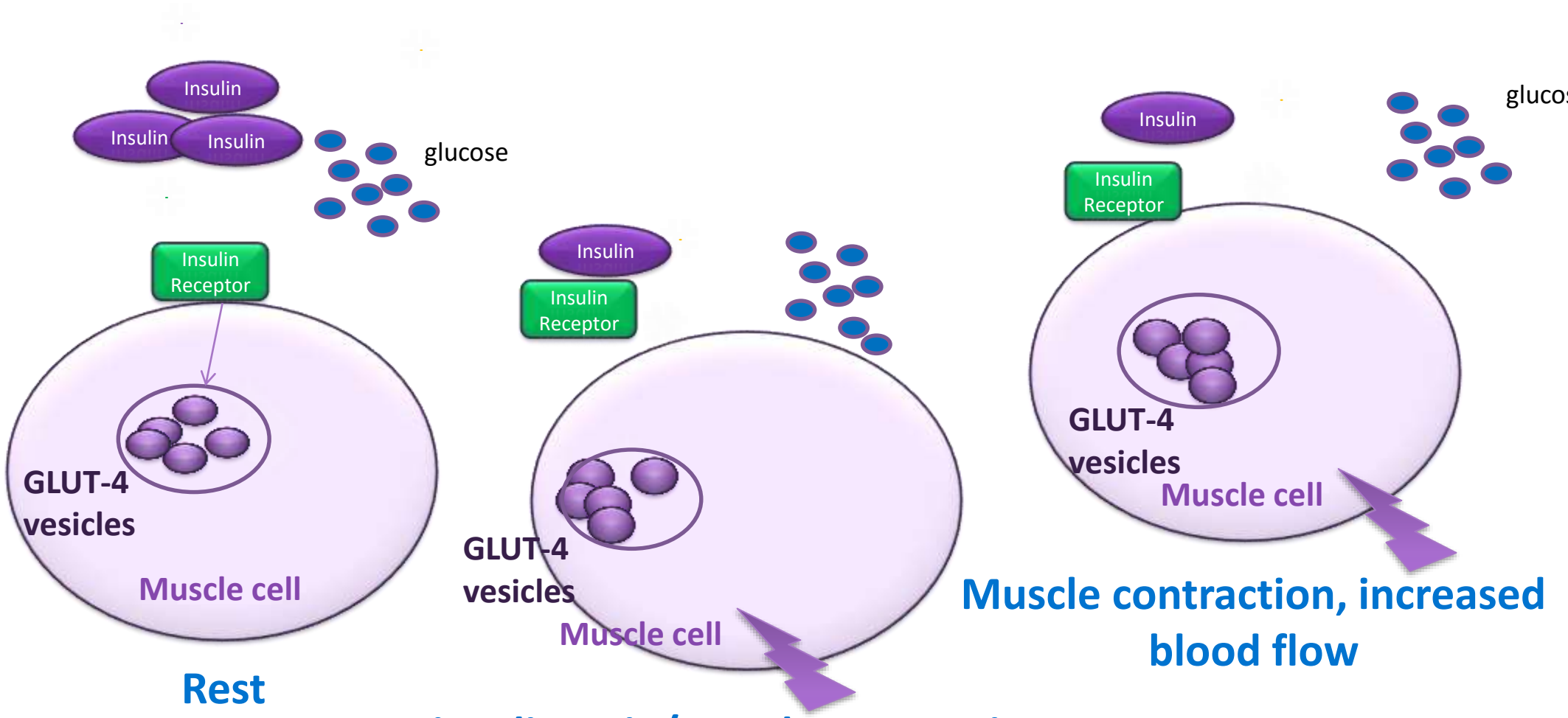

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Essential Considerations Before Initiating an Exercise Program for the Athlete with Diabetes

1. Perform a physical examination with emphasis on neuropathies, blood pressure, pulse, cardiac exam, and stress test if necessary
2. Get educated in basic metabolic and glucose responses to exercise
3. Be aware that as fitness improves, insulin needs can decrease due to increased insulin sensitivity

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Insulin Regulation During Exercise in People With or Without Type 1 Diabetes

People without diabetes

- The pancreas in people without diabetes decreases insulin production by ~50% in order to avoid hypoglycemia
  - Carbohydrate intake will moderate this effect
- Hypoglycemia is extremely rare in people without diabetes

Patients with type 1 diabetes

- Patients with type 1 diabetes ***cannot*** decrease existing plasma insulin levels
- 2 mechanisms (increased muscle glucose uptake) working full force may increase hypoglycemia risk regardless of the duration of exercise

- It is essential to correctly plan insulin dose and meals before a competition, and consider reducing short-acting insulin before a meal close to the activity[1]
- Very close glucose monitoring before competition and especially during warm up is essential[1]

1. Hornsby WG and Chetlin RD. Diabetes Spectrum 2005 Apr; 18(2): 102-107

Recreational and Competitive/Endurance Athletes: Appropriate Nutrition Before, During, and After Competition

Practical nutritional advice

- Consume a meal or snack 2-3 hours before exercise
- Always monitor glucose before exercise. Insulin dose reduction may be needed to avoid hypoglycemia
- Individualize snack before starting exercise
- Consume carbohydrate during strenuous exercise or activity lasting 60 minutes or longer (or shorter, depending on glucose response)
- 30-40 g of carbohydrate per hour is typical , but up to 80 g carbohydrate per hour is possible with insulin administration as needed
- Spread carbohydrate across exercise to match glucose uptake by muscles e.g. 10-20 g every 20-30 minutes
- Some athletes have difficulty ingesting enough carbohydrate during a race
- Practice using the carbohydrate of choice as it can be a challenge for the digestive system

Food consumed during exercise should be easy to digest, low in fat & fiber, and may be high or low GI depending on the duration of the exercise

Adapted from Scheiner G, Diabetes Self Management, Integrated Diabetes Services LLC, 2006, 1-5

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Professional Cycling Team – All Individuals with T1D

- First professional team in history composed of athletes with type 1 diabetes

- Mission:

1. To raise awareness and inspire people with type 1 diabetes
    - With proper management it is not only possible to live a normal life, but it is even possible to become a professional athlete

DIALOGUE: SOME CASE STUDIES

Case 1: Competitive Cyclist

- 27-year-old competitive cyclist with type 1 diabetes since age 12
  - HbA_{1c} ranges from 7 to 8% (53-64 mmol/mol)
  - Currently on MDI: Basal at 15U; 18U if recovery
  - Bolus ~8U after breakfast day of race
- 71 kg; Height 70.5”
- Targets for ~100.8-149.4 mg/dL/ 5.5 - 8.3 mmol/L blood glucose levels before the race
- Complains about significant hypoglycemia at the start of race which makes him quit the race

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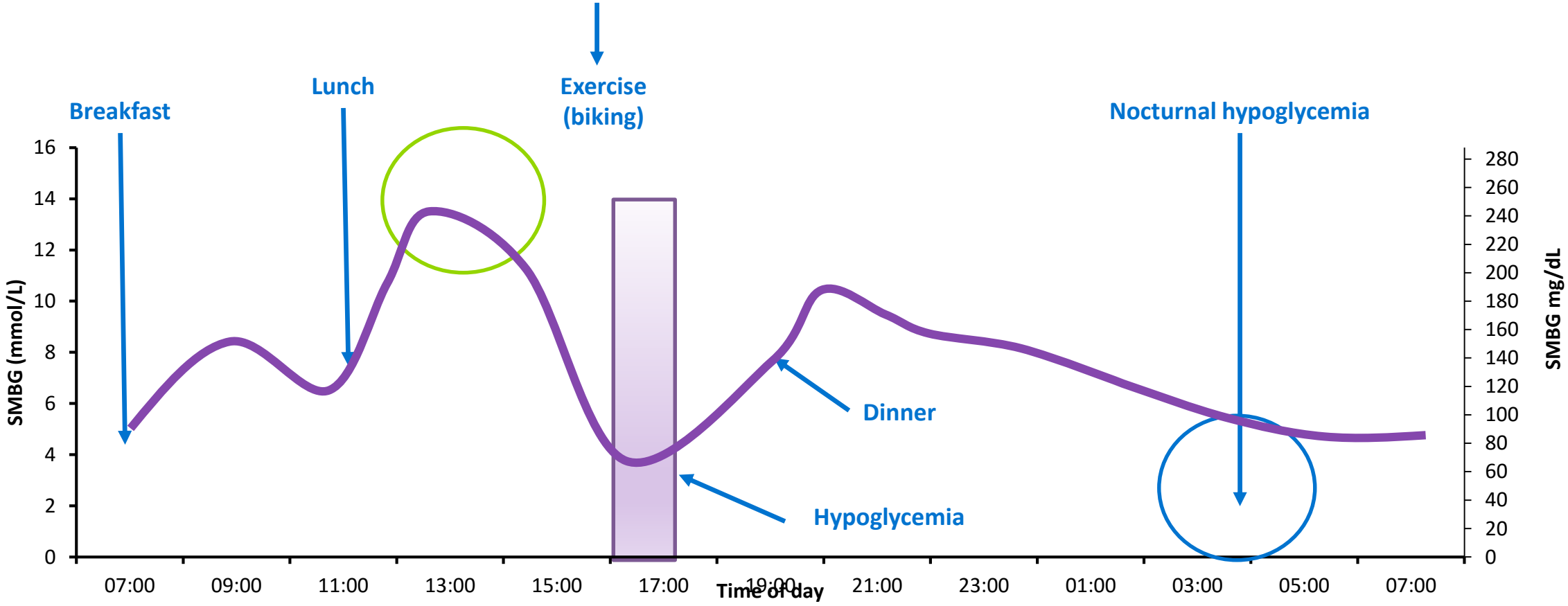
CGM Tracing



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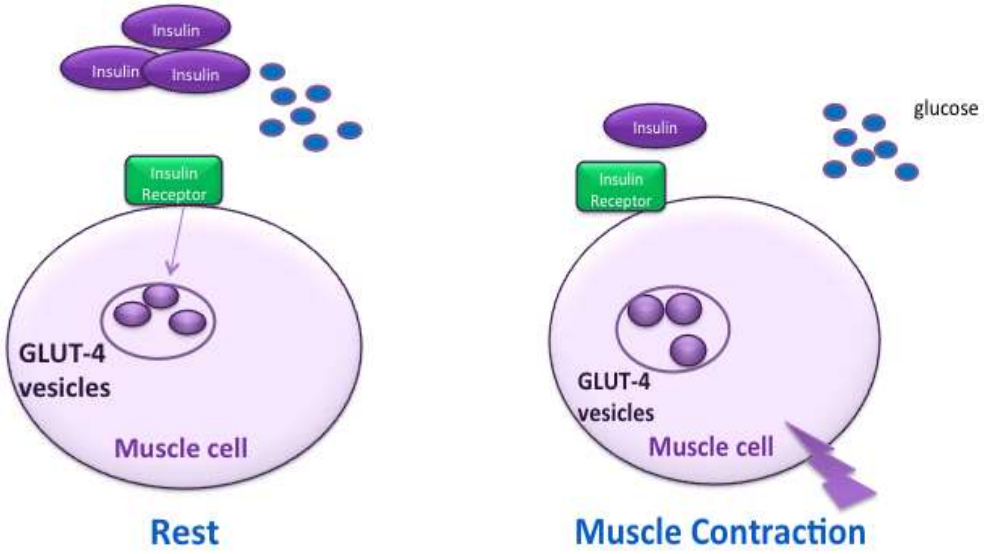
Case 1: Competitive Cyclist

What would you recommend?

Mechanisms of Hypoglycemia Developed by Athletes

1. Too much insulin on board
2. Individuals without diabetes can regulate endogenous insulin production as needed to avoid hypoglycemia
3. Two metabolic mechanisms function at the same time:
   - Insulin-mediated GLUT-4 translocation to sarcolemma
   - Muscle-contraction GLUT-4 translocation to sarcolemma



Case 1: Debrief

- Rider was educated on why hypoglycemia happens at onset of exercise
- He reduced basal dose by 10% and pre-exercise meal bolus by 50%
- Recommended to maintain glucose levels in the 150-175 mg/dL (5.6-8.3 mmol/L) range right before the race
- This solved the problem

Case 2: Competitive Soccer Player

- 21-year-old competitive soccer player with type 1 diabetes since age 7
- HbA_{1c} ranges from 7 to 8% (53-64 mmol/mol)
  - Currently on MDI: Basal at 16 U
  - 8 U post-exercise correction
- Complains about significant hyperglycemia post game followed by important hypoglycemia in the hours after game, with 2 severe nocturnal hypoglycemic events

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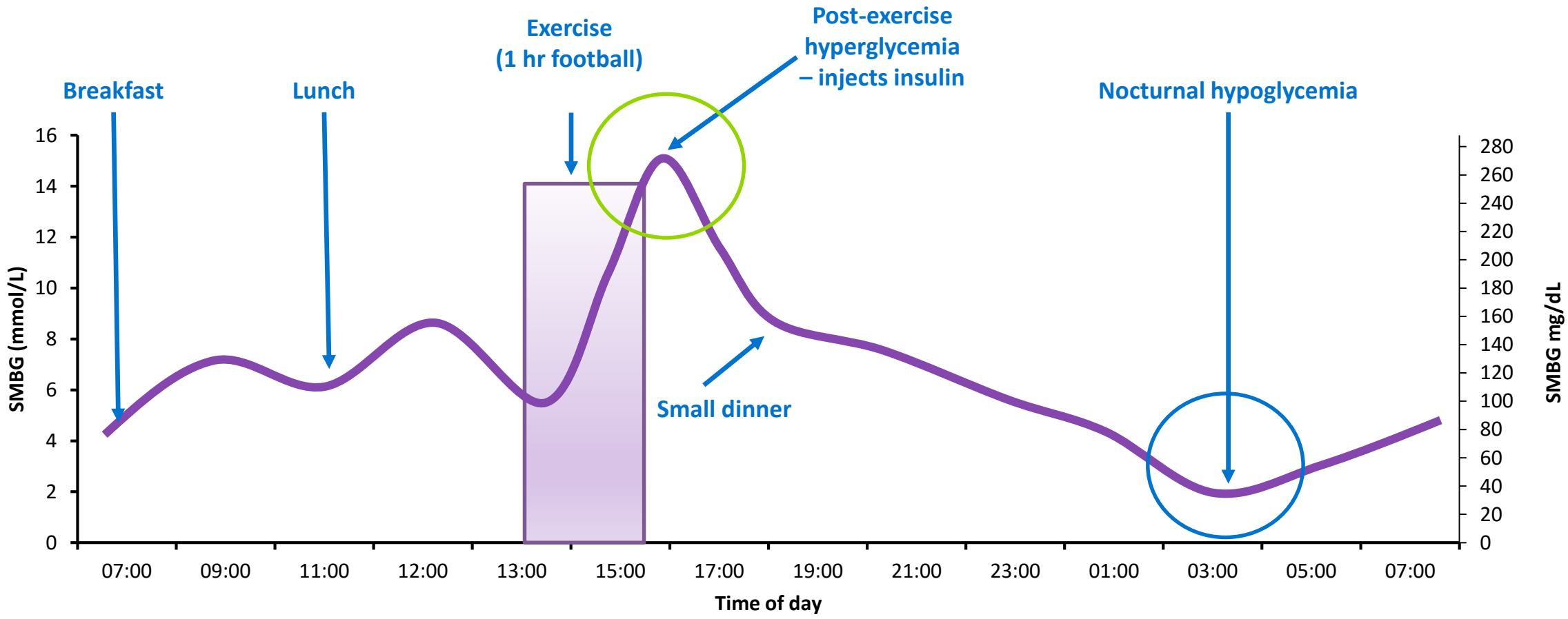

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Case 2: Competitive Soccer Player

What would you recommend?

Case 2: Debrief

- Player was advised to cool down for 20 min with a light jog
- He reduced post exercise bolus by 50%
- He had tight glucose control until bedtime
- Now, he barely has post-exercise hyperglycemia and evening hypoglycemic events

Prevention of Post-Exercise Hyperglycemia

- It is important to be aware that high intensity exercise will increase chances of post-exercise hyperglycemia
  - Low, aerobic exercise intensities always decrease chances of post-exercise hyperglycemia
  - 15-30 min cooldown is always recommended especially after high intensity exercise

Case 3: Professional Cyclist

- 23-year-old professional cyclist with type 1 diabetes since age 14 in 2006 (9 years duration)
- Switches on and off MDI to pump therapy
  - HbA_{1c} ranges from 7 to 8%
  - Currently on MDI: Basal 12U if cycling; 15U if recovery
  - Bolus based on 1U/15gm: average dosing 10U, 7U, 5U giving 20 min before meals
- Concerned about weight gain (67 kg; Height 65”; BMI 24.6 kg/m^2)
- Complains about significant hyperglycemia at the start of cycling and during the first hour or more

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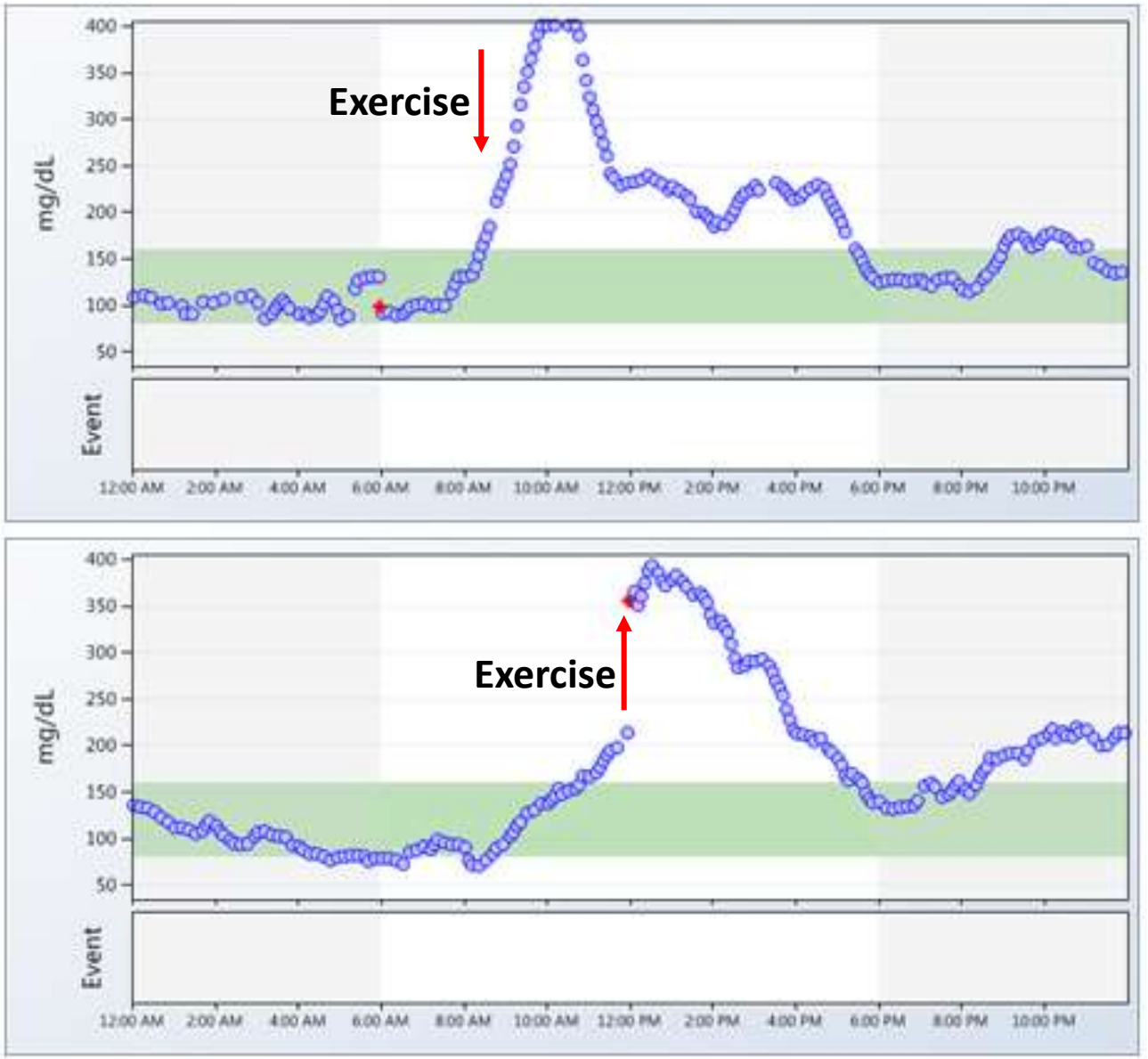
CGM Tracing



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Case 3: Professional Cyclist

What would you recommend?

Summary

- Based on CGM download, rider was deliberately trying to start cycling at 180 mg/dL (10 mmol/L) or higher, which resulted in further hyperglycemia during his training
  - Very high intensity
- Recommended to start his cycling at 120.6–160.2 mg/dL (6.7–8.9 mmol/L)
  - If above target, consider giving an additional bolus (0.5-3 units) closer to the start of the race or if on a pump, increase basal by 20-50% for 1 hour
- He decided to return to the pump
  - Basal 0.8 units per hour
  - Bolus the same; average 1 unit per 15 g consumed

Case 3: Debrief

- Glucose readings have improved at the start of training and during cycling
- Still has minor hyperglycemia around 12 am to 6 am but at other times, he is normal
- Discussed with him his eating at night and how he covers it
- Had significant hyperglycemia one day due to a bad pump site which he troubleshooted
- Continue to upload weekly

Case 4: Competitive Runner

- 31-year-old Competitive runner with type 1 diabetes since age 7
  - HbA_{1c} ranges from 7 to 8% (53-64 mmol/mol)
  - Currently on MDI: Basal at 10U
  - Bolus average dosing 7U
  - She tapers and carbo-loads 3-4 days before races and needs to increase TDD by 50%
- Complains about “blocked” legs and very poor performance the day of the race
  - She can run at a 3min 45s/km pace during training but day of the race she can’t…
- Normal glucose levels during the race

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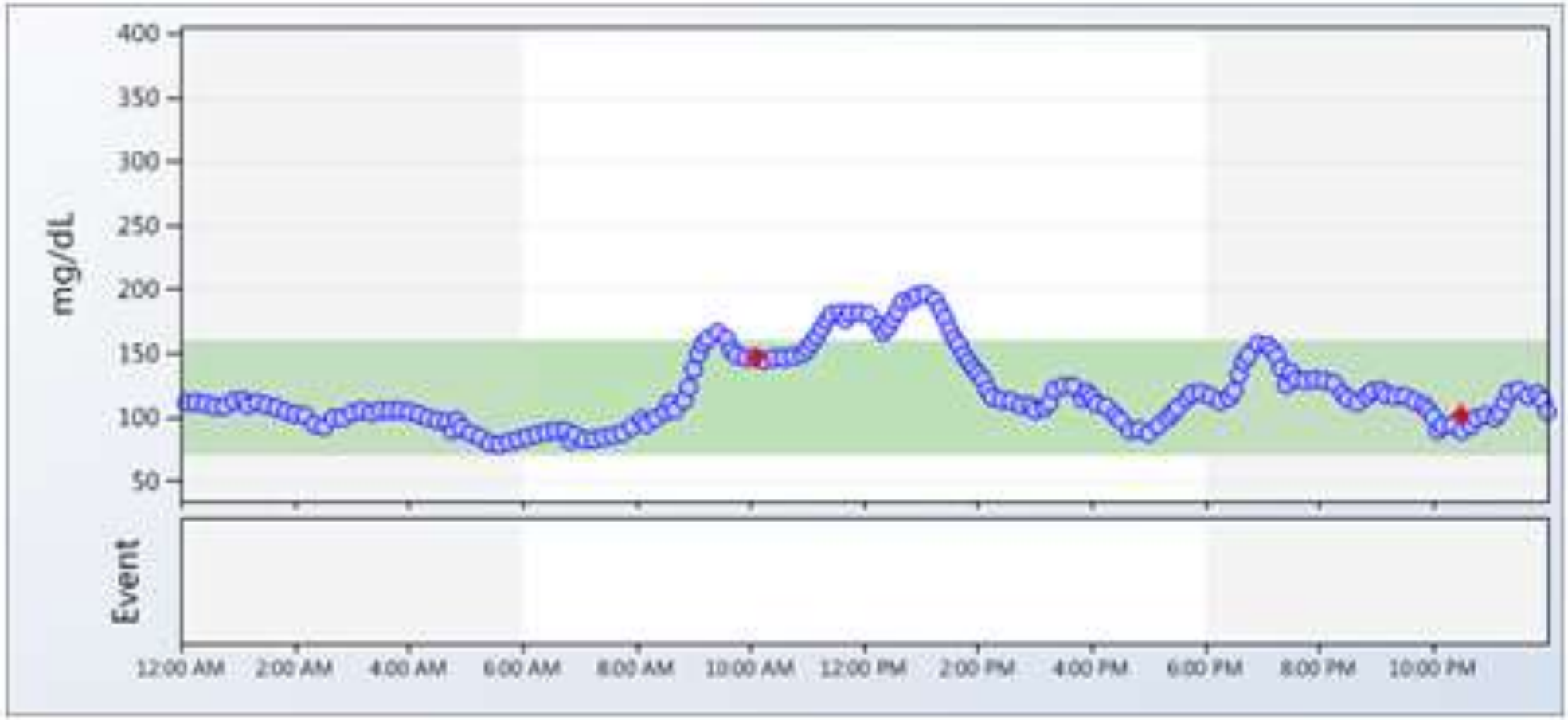
CGM Tracing



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Case 4: Competitive Runner

What would you recommend?

Case 4: Debrief

- She was advised not to carbo-load the days before the race and just have a normal carbohydrate diet
- Day before the race she does a 1h easy run with one to two 5-min “openers”
- She didn’t need an increase in insulin TDD
- Her performance improved and she achieved PR in a ½ marathon

Case 5: Recreational Athlete

- 42-year-old mother of 1, part-time RN, type 1 diabetes since age 12, 1985 (30 years duration)
- Hypo unawareness and history of severe lows
- On pump since 1990; on SAP since 2014
  - Control excellent (A1C 6% to 7% since onset)
  - No severe hypo in past year
- Current weight 65 kg; height 66”; BMI 23.5 kg/m^2
- TDD 24.5 U; Basal 9.7 U (40%); ICR 18; ISF 79.2 mg/dL; target 99 mg/dL
- BG average 142.2 mg/dL SD 3.3 on 4t/d; CGM 8.2 SD 3.1, 7 days a week

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Case 5: Recreational Athlete

- For past year, exercises 2 to 4 times a week at a gym
  - 20 minutes weight training followed by 40 minutes aerobic exercise
- Frustrated with having to eat to prevent low blood glucose levels
- Has tried suspending pump at exercise but has post-exercise highs to 180 mg/dL/ 10 mmol/L
- Wants advice on what to do

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Case 5: Recreational Athlete

What would you recommend?

Based on Our Experience With Susan…

1. Try doing aerobic, followed by resistance exercise
2. Counsel on use of trend arrows
3. Try 50% temporary basal with exercise up to 90 mins
4. Encourage her to use the bolus wizard and mark exercise times
5. Congratulate her on starting an exercise program and no severe lows

   - She has lost 5 pounds (3.5% of her body weight) since initiating her program

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Adapting Exercise Programs for Elite and Recreational Athletes: SUMMARY

- Rules for exercise in T1D are not the same as for people without diabetes
- Monitor glucose levels before, during, and after exercise as you may need less insulin to avoid hypoglycemia
- Always advise to cool down after intensive exercise or hyperglycemia
- Individualization of each athlete's needs is key

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Questions?

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THANK YOU!

www.TypeOneNation.org/PEAK

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