WELCOME TO THE CHILD/ADOLESCENT ATHLETE ELECTIVE!

JDRF PEAK
TID Performance in Exercise and Knowledge

Session Objectives

This session will use 3 patient cases to demonstrate:

1. Exercise concerns faced by children and adolescents with type 1 diabetes (and their parents)
2. Effects of exercise on BG in children and adolescents with type 1 diabetes
3. Exercise-related nutritional needs in children and adolescents with type 1 diabetes

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INTRODUCTION

Children and Exercise

- Physical activity is important for childhood development (physical, social, emotional)
- In young children, exercise is often unplanned and can vary day-to-day
- Type of exercise varies more than in adults
- Responsibility for T1D care changes as the child ages and achieves more independence
- Insulin sensitivity varies through childhood
- Fear of hypoglycemia among caregivers can lead to less physical activity, especially in younger children

Some Key Facts About Children with Type 1 Diabetes

1. Aerobic fitness may be lower in children with type 1 diabetes[1]
2. 1 in 3 children with type 1 diabetes are overweight or obese [2,3]
   - The youngest children (<6 years) are the most overweight/obese
3. Diabetes treatment responsibilities change through childhood
   - Until age ~10, parent(s)/other adults are responsible for diabetes management
   - After age ~10, responsibility for care becomes shared between parents and youth as the child acquires more self-care tasks

1. *Williams BK et al., Diabetic medicine*
2. *Kappellen T et al., Pediatr Endocr Met 2014*
3. *Islam et al, Diabetic Med 2014*

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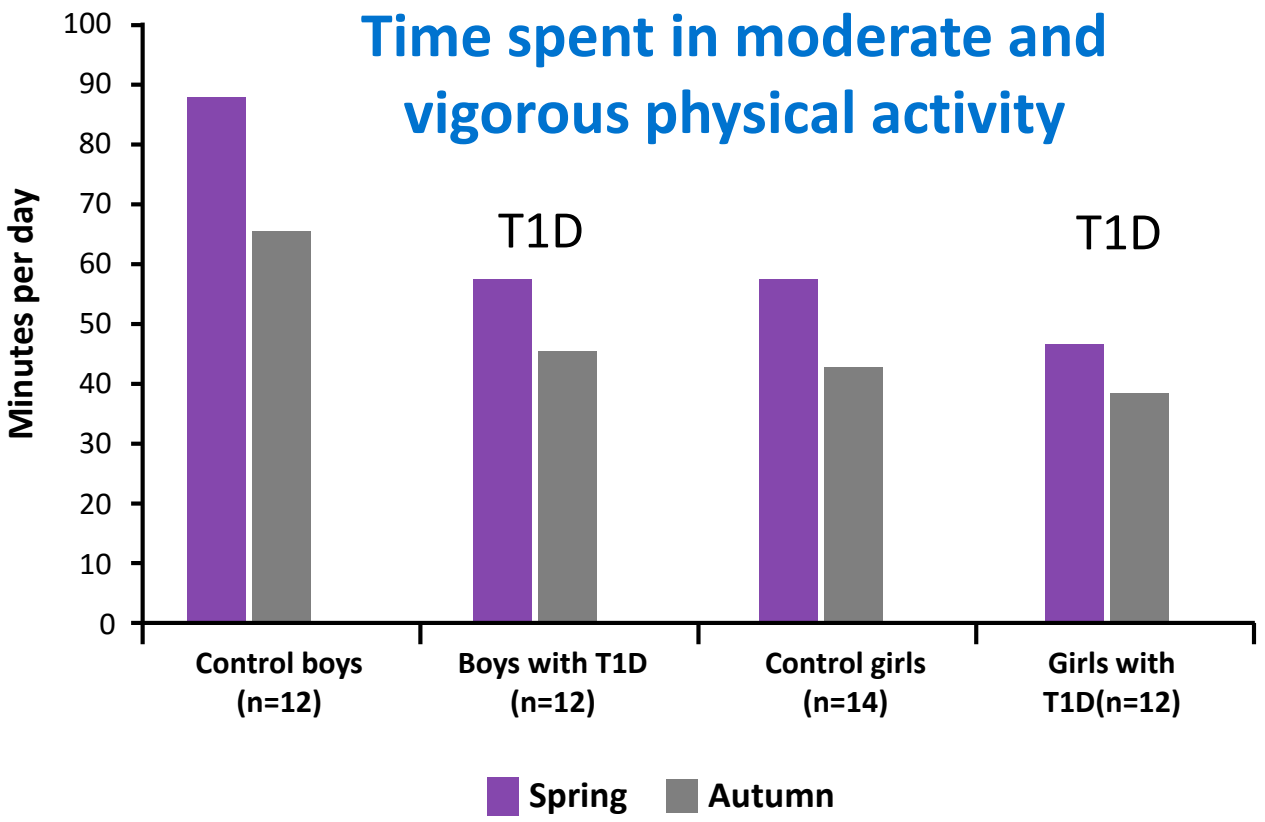
Children <7 Years of Age: Amount of Physical Activity

- Children with T1D were **less active overall** (p=0.010) and spent 16 min less in moderate-to-vigorous physical activity than age-matched control children (p=0.006)
- Overall physical activity per day (p=0.004) and time in moderate and vigorous physical activity (p=0.002) were **significantly higher in boys than in girls**



Sundberg F, Forsander G, Fasth A, Ekelund U. Acta Paediatr 2012 Nov;101(11):1164-9.

Physical Activity: Performance

- Some studies have shown reduced physical performance in children with diabetes compared to healthy controls[1,2]
- Other studies have shown normal physical capacity in children with type 1 diabetes[3,4]

The differences in outcomes may be due to selection bias, as less physical activity during early childhood could predispose to lower performance later in childhood (i.e. in youth diagnosed with T1D at very young ages)

1. *Maggio AB et al. Eur J Pediatr 2010: 169: 1187–1193*
2. *Komatsu WR et al. Pediatr Diabetes 2005: 6: 145–149*
3. *Heyman E et al. Acta Paediatr 2005: 94: 1389–1394*
4. *Adolfsson P et al. Pediatric Diabetes 2012: 13: 587–596*

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Children and Exercise: Recommendations

1. From diagnosis, promote exercise
2. Deal with barriers, such as hypoglycemia

Note: Diagnosis is a time when life & lifestyle are changed within the entire family – T1D in childhood is a 'family disease'

JDRF PEAK Expert Panel Recommendation

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Benefits of Exercise in Type 1 Diabetes

General benefits:

- Physiologic and metabolic health – cardiovascular risk factor reduction
- Psychosocial and emotional health
- Weight control, strength & conditioning

Benefits in children:

- Improved risk factor profile for CAD
- Decreased risk of overweight / obesity
- Improved skeletal density
- Improved body composition (↑muscles)
- Better school performance

Bunkeflo project: Daily physical exercise in school compared with exercise 2 times a week between age of 9 and 15

Here's a question for you!

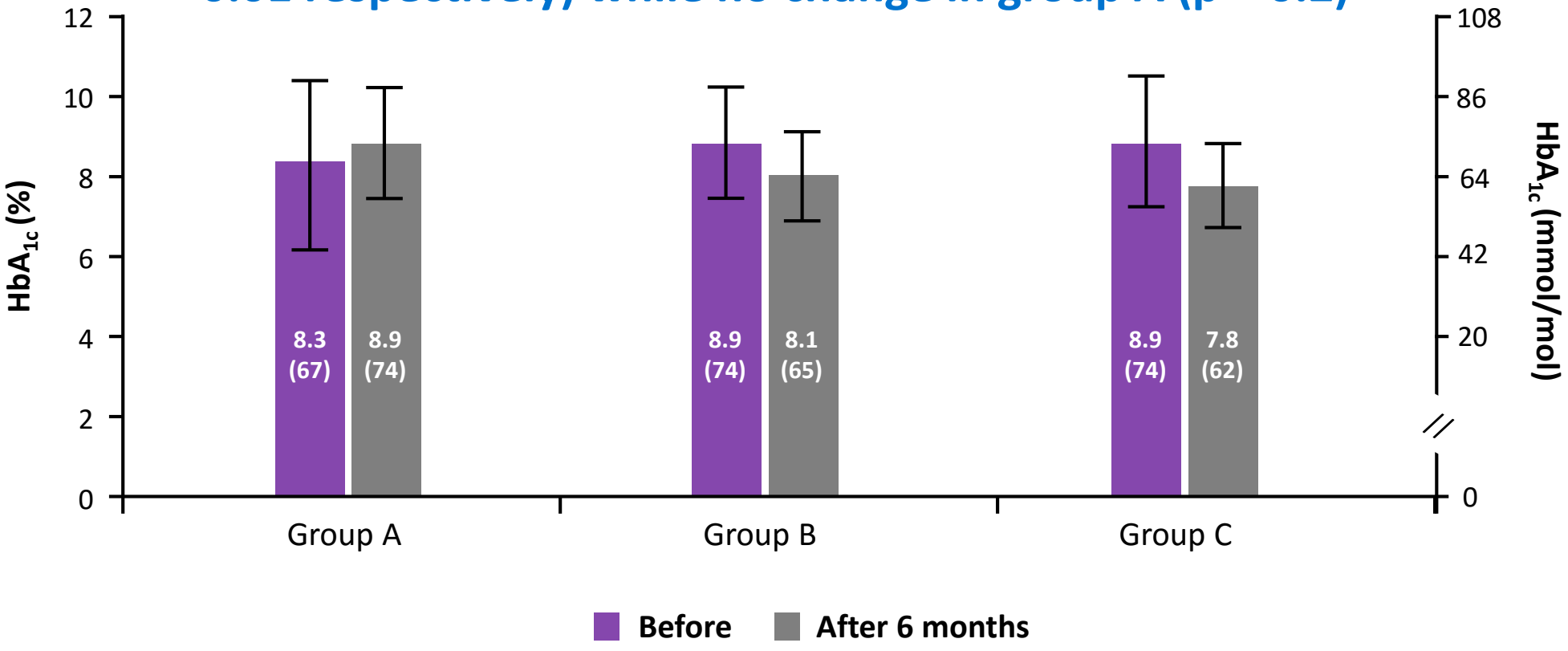
Does physical activity improve glycemic control?

a) Yes
b) No

Salem M et al., 2010, Diabetology and Metabolic syndrome

Does Exercise Improve Glycaemic Control?

A reduction in mean HbA_{1C} in both groups B & C (p = 0.03, 0.01 respectively) while no change in group A (p = 0.2)



A = Control

Exercise
B = 1x/week
C = 3x/week

N=196
13-18 y/o
T1D ≥3 yrs
HbA_{1c} ≥7.5%

Numbers in brackets are in mmol/mol

Salem M et al., 2010, Diabetology and Metabolic syndrome

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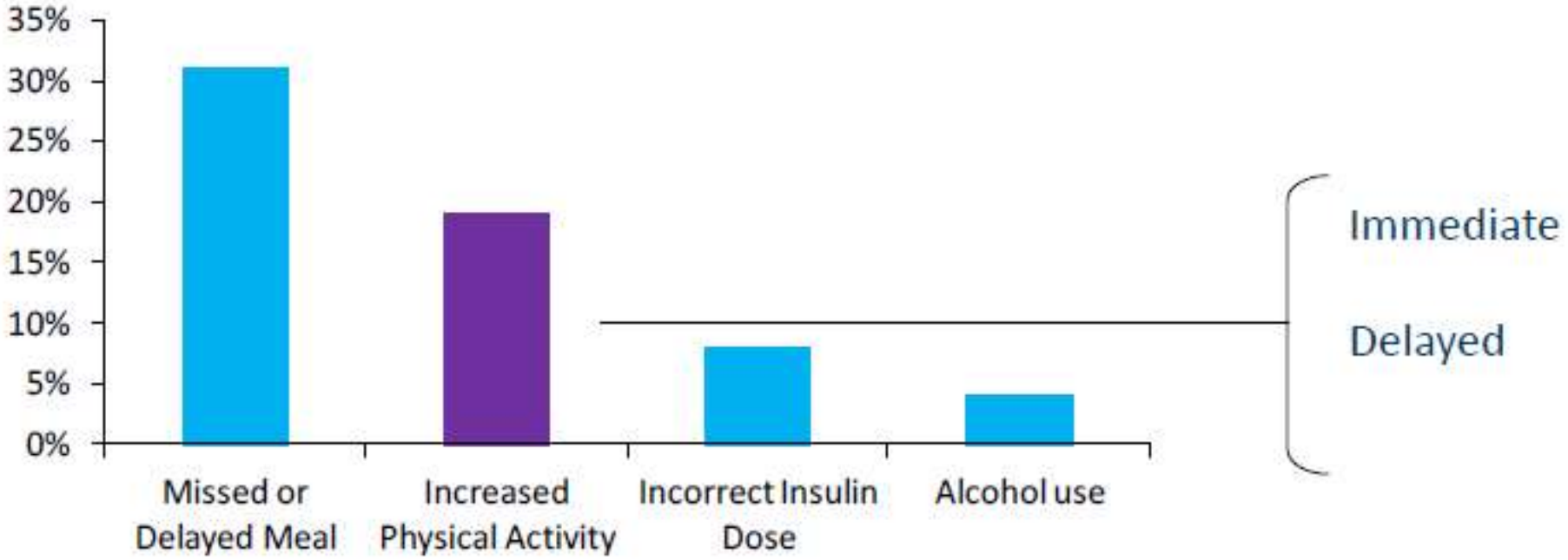
Exercise and Hypoglycemia: Clinical Observations

Precipitating factors for severe hypoglycemia



Davis et al., Diabetes Care 1997

Effect of Aerobic Exercise in Children With Type 1 Diabetes

Study overview:

- 50 youth w/ type 1 diabetes, 11–17 y/o
- Afternoon treadmill exercise vs none
- Hypoglycemia <61.2 mg/dL/ 3.4 mmol/L

Results:

1. During exercise: 22% had hypoglycemia
2. Overnight:
   - Post-exercise: 48% hypoglycemic
   - Post-rest: 28% hypoglycemic

Direcnet Study Group: J Peds 2005

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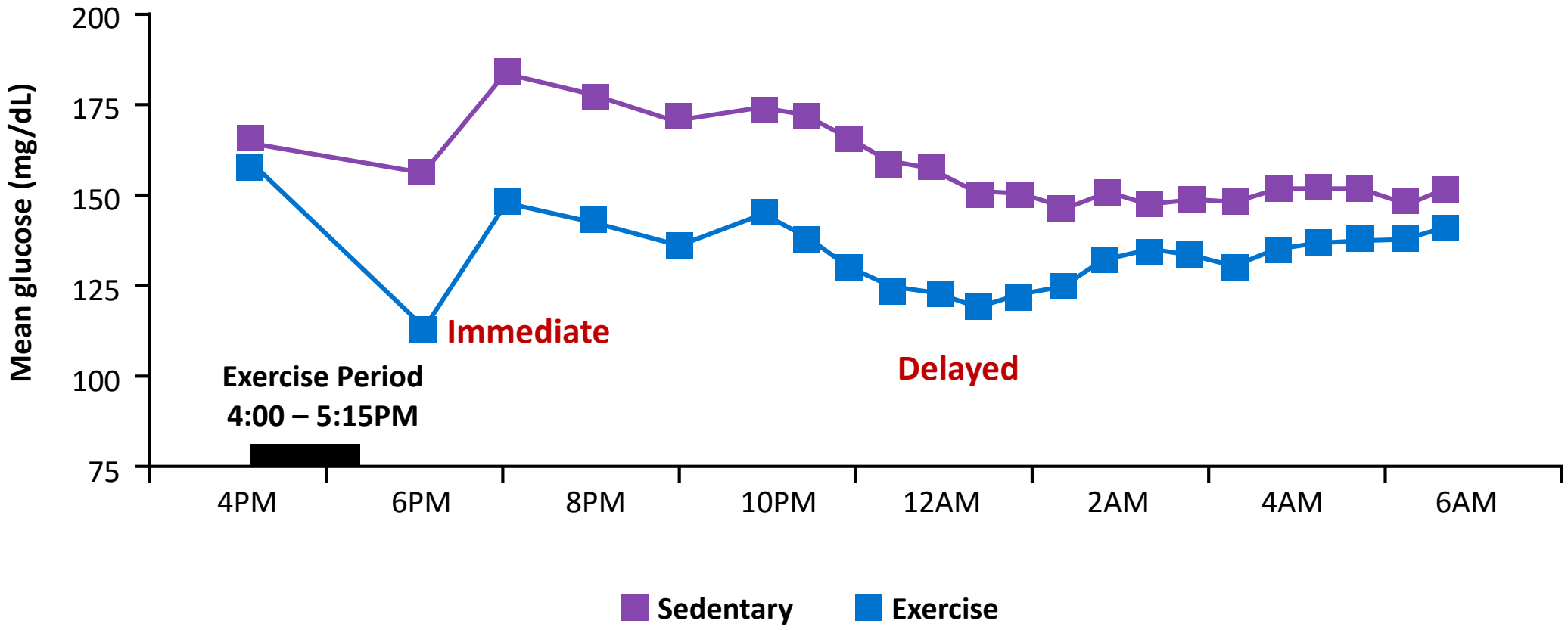
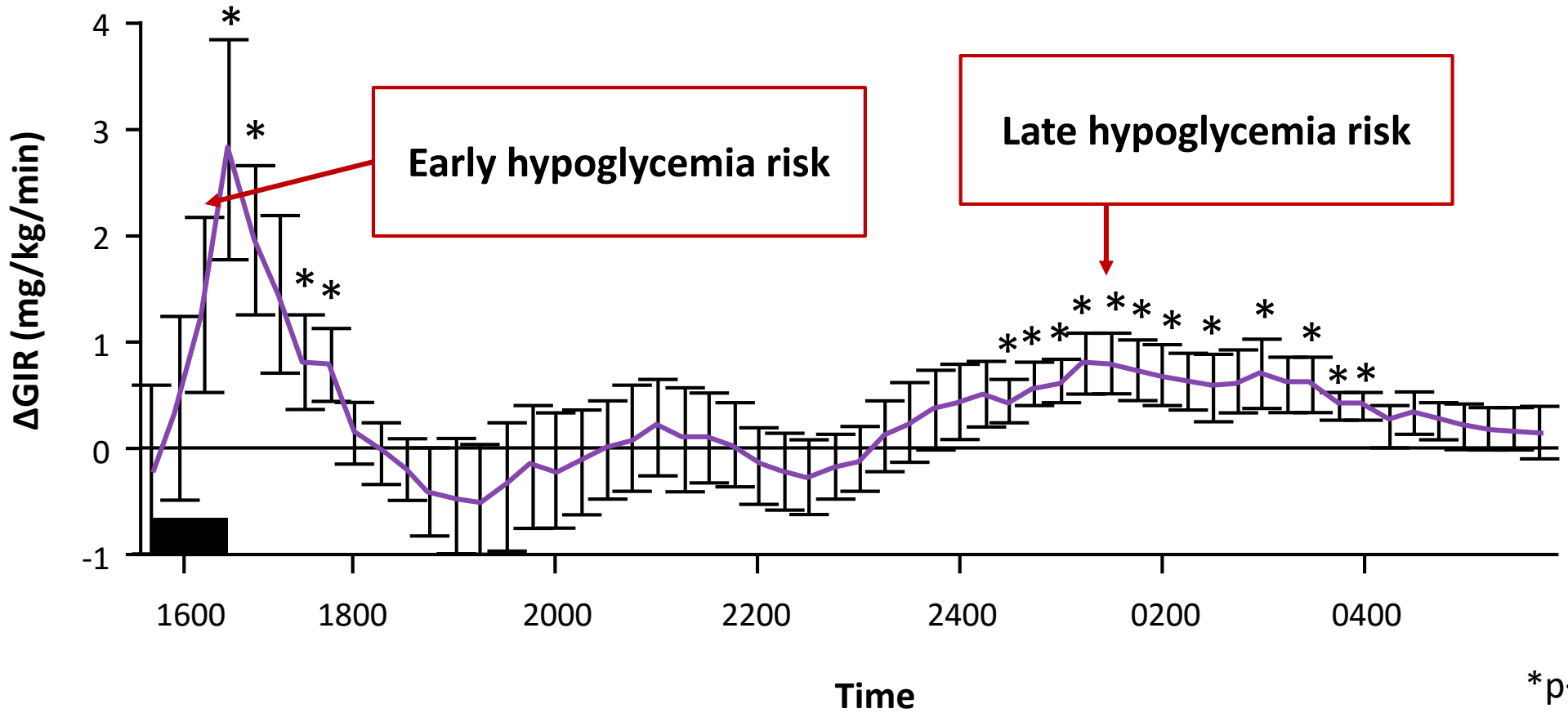
Effect of Aerobic Exercise in Children With Type 1 Diabetes (Cont'd)



Direcnet Study Group: J Peds 2005

Difference Between Glucose Infusion Rates (GIR) to Maintain Euglycemia on Exercise and Rest Days: Biphasic Glucose Requirements



Mcmahon et al., JCEM 2007

Exercise-Related Hypoglycemia

- Absolute or relative excess of insulin
- Increased insulin sensitivity
- Deficient glycogen repletion
- Blunted counter-regulatory responses

Shetty et al., IDF poster 0917

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Triple Threat

During sleep and after exercise, children with type 1 diabetes have:

1. Increased glucose requirements
    - Increased insulin sensitivity
    - Glycogen restoration
2. Impaired counter-regulation
3. Excessive circulating insulin

Not all Exercises are the Same and Physical Activity in Children is Different

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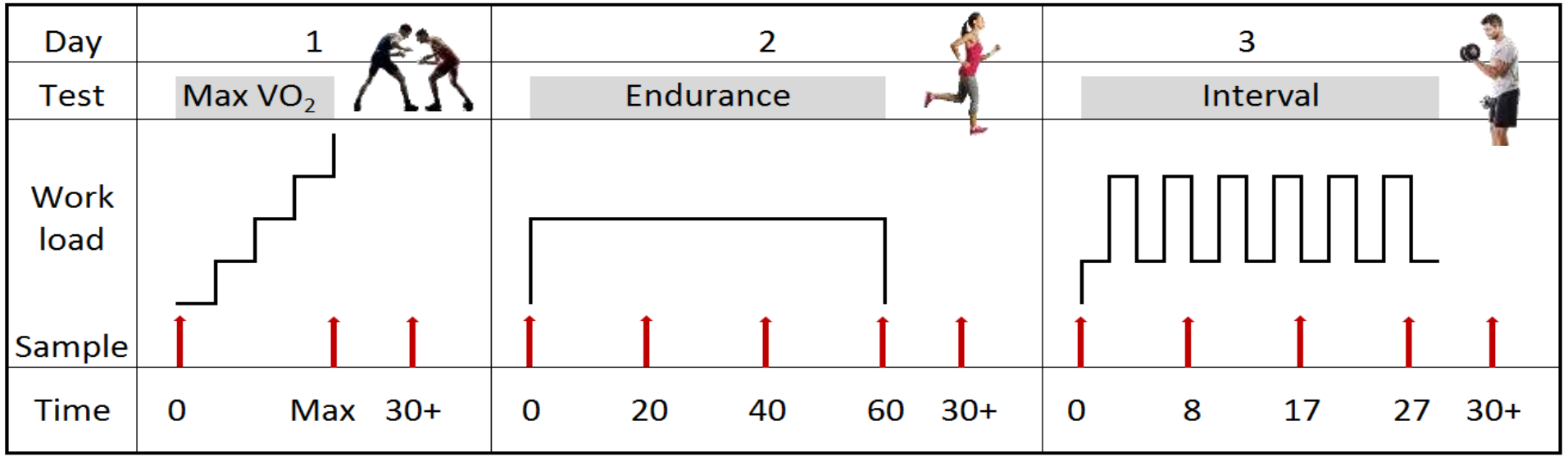
Hormonal Response During Exercise of Different Intensities



Test overview:

- 12 adolescents with type 1 diabetes and 12 healthy controls (age, sex, BMI, and activity matched)
- 3 different work loads over 3 days; CGM was used to assess glucose levels and to monitor for hypoglycemia (avoided pre-exercise)

Adolfsson P., et al. Paediatric Diabetes. 2012 Dec; 13(8): 587–96

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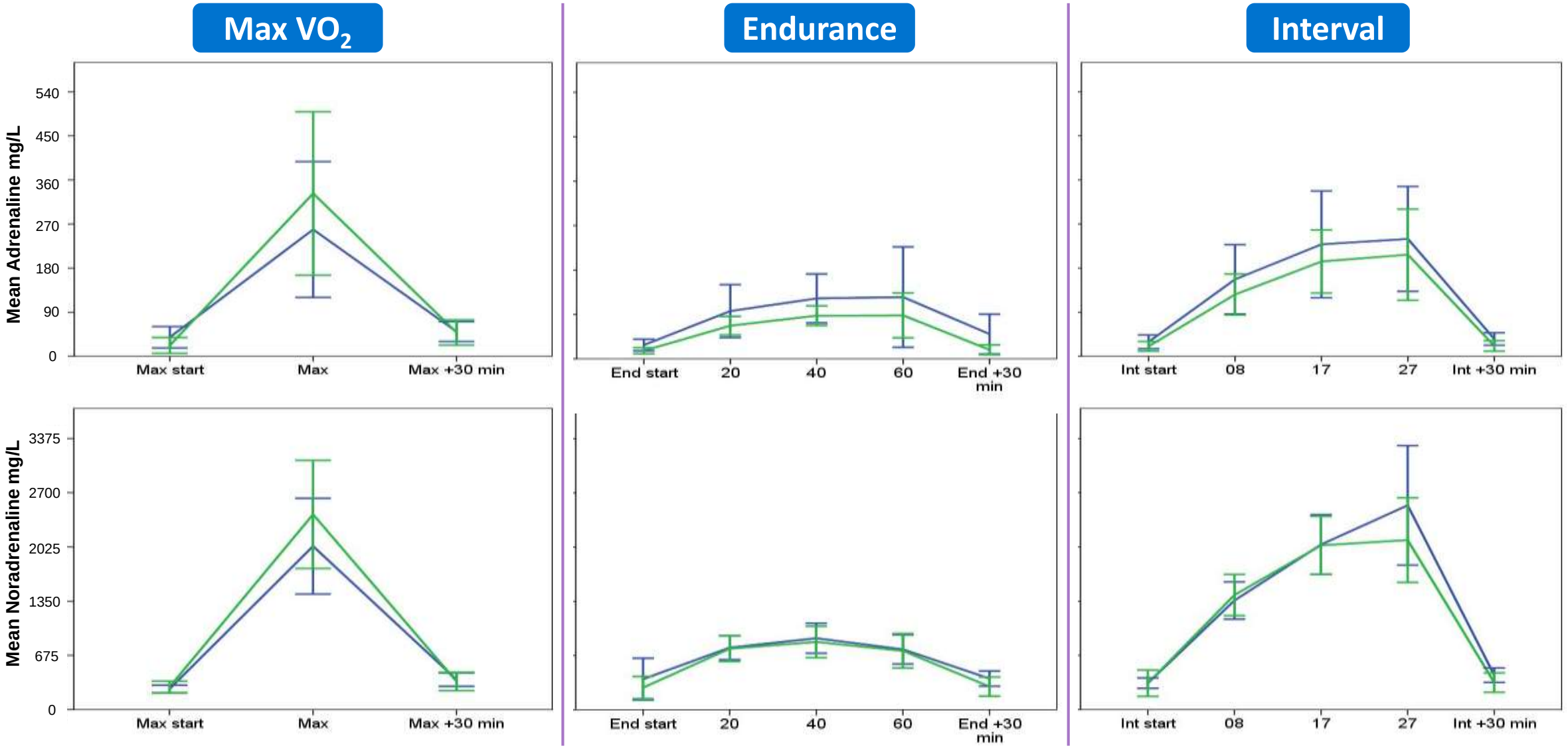
Adrenaline and Noradrenaline Responses During Exercise of Different Intensities



Adolfsson P., et al. Paediatric Diabetes. 2012 Dec; 13(8): 587–96

Hormonal Response During Exercise of Different Intensities

Results:

- When hypoglycemia is avoided prior to activity, then the hormonal response is normalized in youth with type 1 diabetes
- The physical performance is not different from that in healthy subjects!

Ages 14–19
T4-5
T1D 6.3 yrs
HbA_{1c} 7.9%

Adolfsson P., et al. Paediatric Diabetes. 2012 Dec; 13(8): 587–96

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CLINICAL CASES

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Clinical Problem 1: Pete, 15 Years Old

- Trying to get back on the school football team, started to train late afternoons
- Severe hypoglycemia last week at 2 am, wanted to train the next day, felt awful
- Diabetes: 10 yrs
- BMI: 95th percentile
- HbA_{1c}: 8.5% (69 mmol/mol)
- MDI total daily dose: 1.9 U/kg
- Eating a lot to train

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Clinical Problem 1: Pete, 15 Years Old

What are the problems for Pete?

1. Delayed hypoglycemia
2. Insulin resistance
   - Overweight
   - Adolescence
   - Poor diabetes control
3. Poor baseline fitness

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Clinical Problem 1: Pete, 15 Years Old

Pete's questions:

1. Should I give up the idea of improving my fitness and exercising regularly?
2. Why did I have hypoglycemia overnight?
3. How can I prevent it from happening?

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Pete: Questions

- Why did Pete experience nocturnal hypoglycemia?
- How can Pete prevent future episodes of nocturnal hypoglycemia?
- What recommendations do you have for Pete, to help him exercise safely and achieve his fitness goals?

Recommendations for Pete

1. Planning
2. Glucose monitoring: check during, after and overnight
3. Reduction in basal insulin overnight
4. Consider bedtime snack if active and blood glucose <126 mg/dL/ 7.0 mmol/L
5. Mealtime routines and snacking
6. Close monitoring as fitness improves
7. Consider CGM ± pump

Clinical Problem 2: Matt, 15 Years Old

- Type 1 diabetes for 6 years
- CSII, HbA_{1c}: 7.1% (54 mmol/mol)
- Several sports
- Overnight OK; reduces basal rates to ~60% on active days

Matt's problems:

- With exercise, blood glucose levels vary from high to low: hard to predict
- He finds that his performance is affected when glucose levels too elevated

Clinical Problem 2: Matt, 15 Years Old

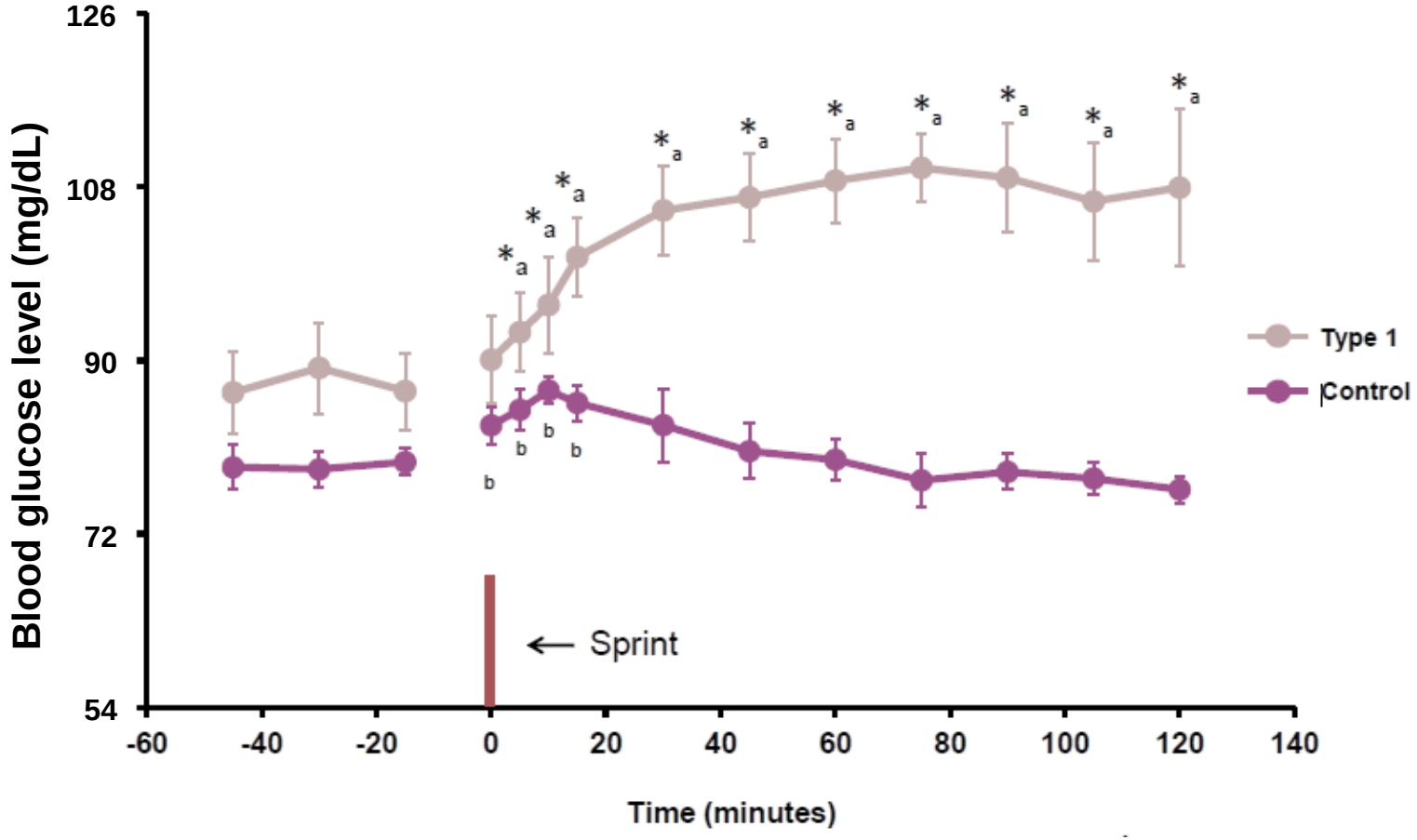
What information do we need from Matt?

1. What activities does he participate in?
   - Cycling in morning usually
   - Swimming (60–90 min) after school
2. When does he do them?
   - Relationship to food
   - Relationship to insulin dose
3. How much does he bolus and where is his usual infusion site?

Matt: Questions

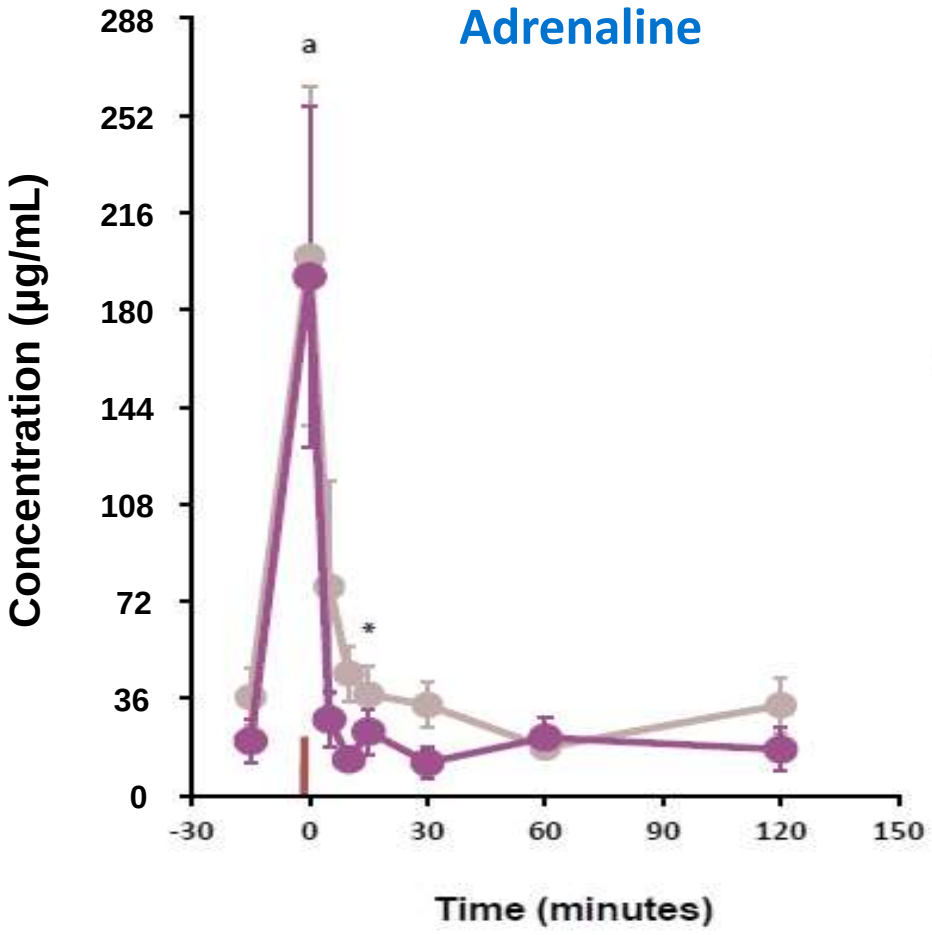
- Why do Matt's glucose levels fluctuate during exercise?
- What do you recommend for Matt to maintain stable blood glucose levels during:
  - Cycling in the morning?
  - Swimming and sprints in the evening?

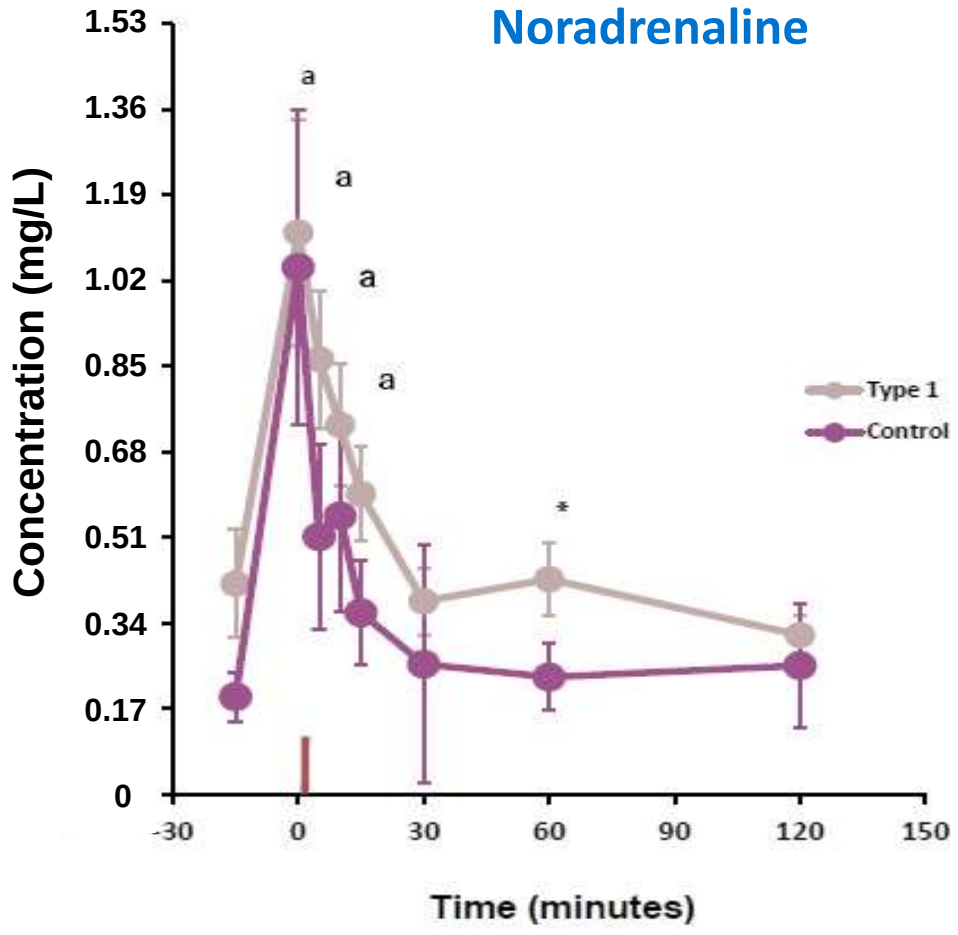
Blood Glucose Response to a 10-Second Sprint in Type 1 Diabetic and Healthy Individuals



Fahey et al., 2012. JCEM 97(11):4193-4200

Blood Glucose Response to a 10-Second Sprint in Type 1 Diabetic and Healthy Individuals (Cont'd)





Fahey et al., 2012. JCEM 97(11):4193-4200

Recommendations for Matt

Cycling (am)	Swimming, sprints (pm)
▪ Monitor glucose – Trial, need to record and review	▪ Monitor glucose – Trial, needs to record and review
▪ Have breakfast ▪ Reduce breakfast insulin bolus	▪ May need half correction if blood glucose >252 mg/dL/ 14.0 mmol/L; monitor for ketones
▪ Sports drinks (6-8% CHO) – Suggested 0.5-1 g CHO/kg/hr*	▪ Focus on prevention of delayed hypoglycemia
	▪ Consume food after swimming and reduce bolus insulin

The total energy expenditure during exercise in children and adolescence is usually in the range of 1.0–1.5 g/kg/hour. However this should be individualised.

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Clinical Problem 3: Emma, 13 Years Old

- Type 1 diabetes for 4 years
- CSII, HbA_{1c} 6.6% (49 mmol/mol)
- Several sports
- Different outcomes depending on day

Emma's problem:

- Hypoglycemia
  - Some days without hypoglycemia, some with hypoglycemia

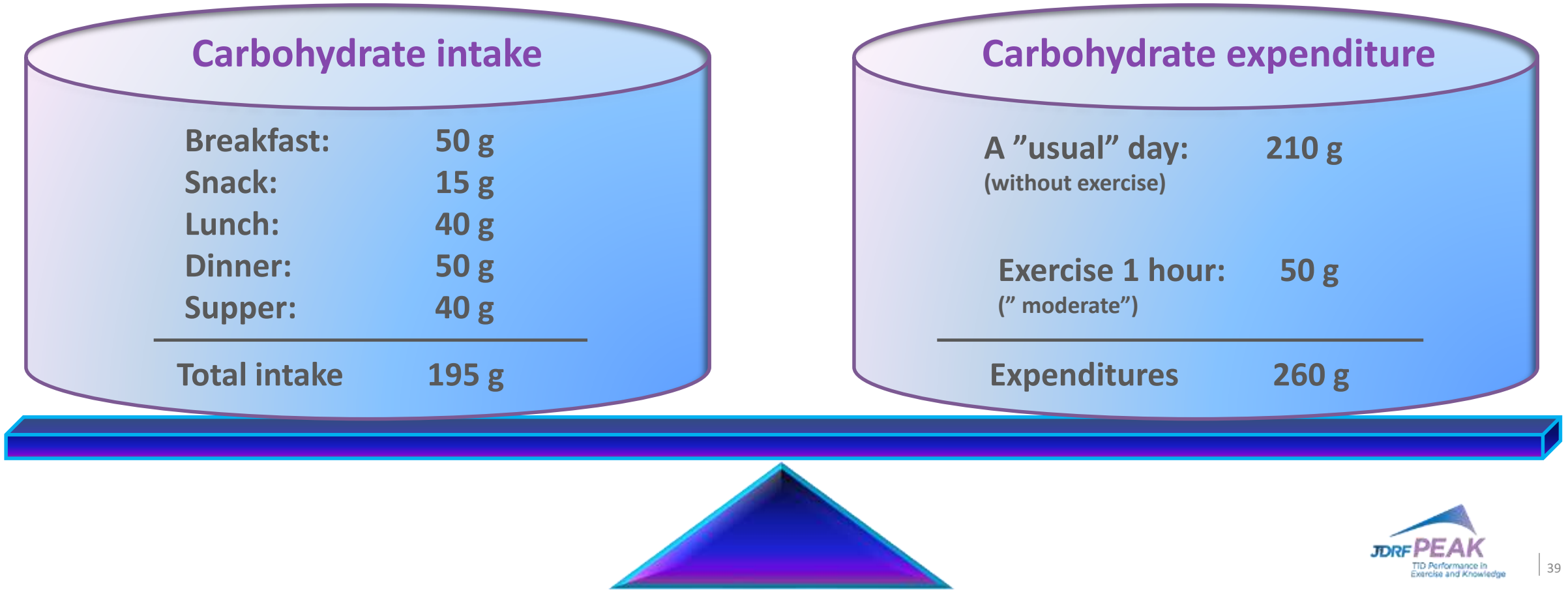
Clinical Problem 3: Emma, 13 Years Old

Information at visit:

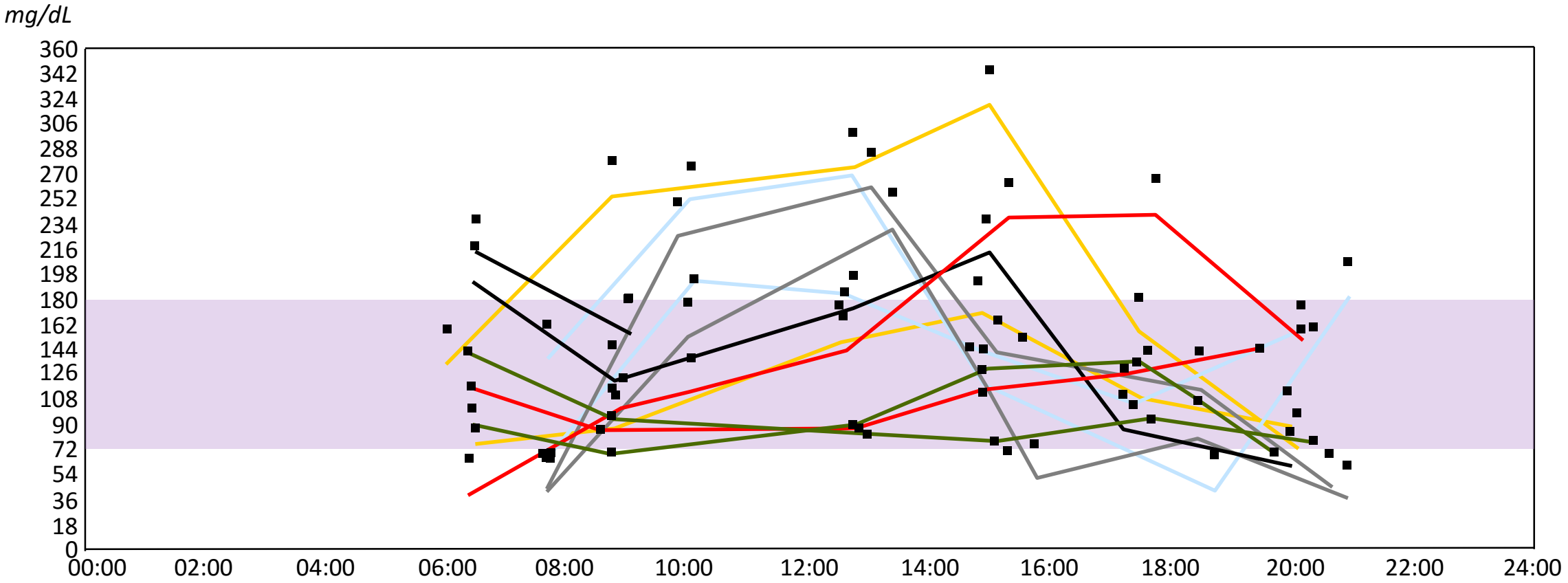
1. Glucose variability – insertion sites for CSII
2. Hypoglycemia – depending on days of physical activity?
3. Should this be balanced by CSII strategies or food strategies?
4. Using technology to detect problems and identify strategies

Analyzing the ”Balance”: Diet

Checking the balance between intake and expenditure



Standard Day at Start – Plasma Glucose



Differences between days!

Emma: Question

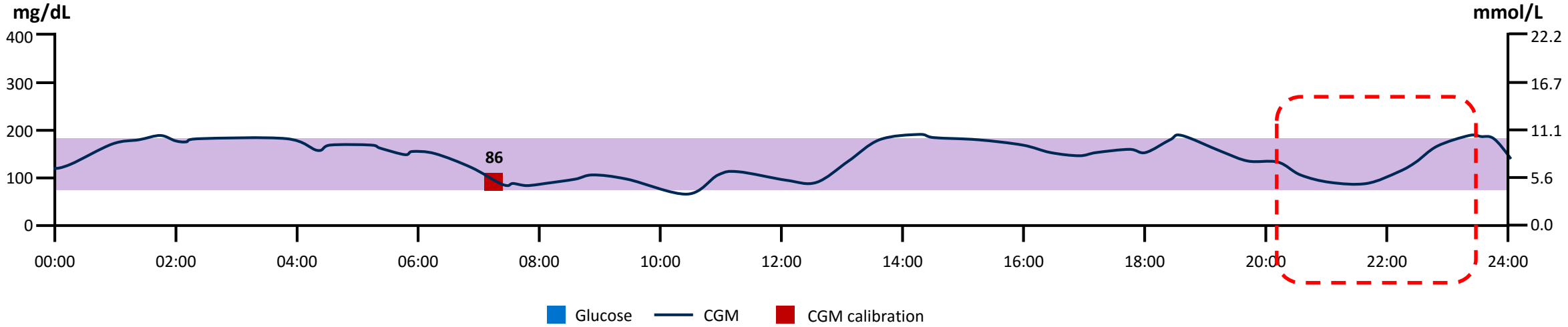
What can Emma do to avoid hypoglycemia?

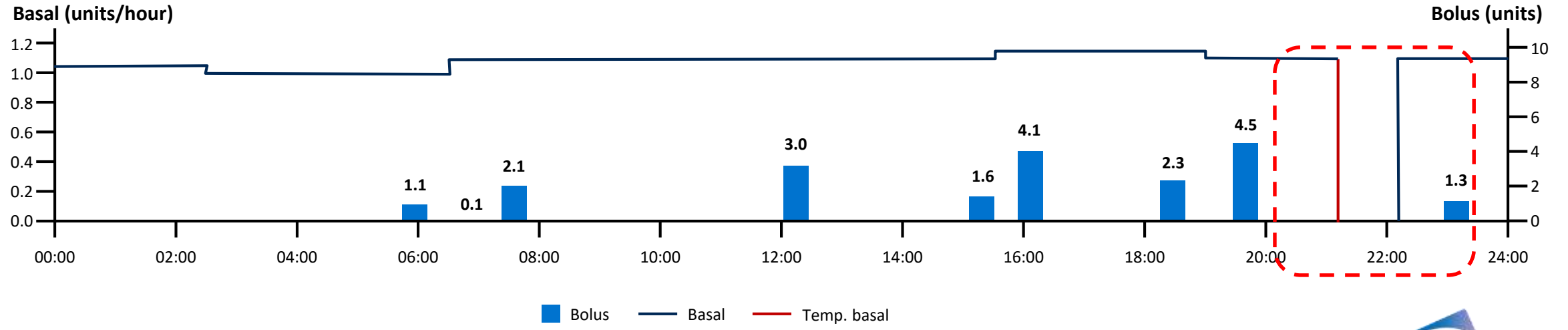
Strategies for Emma

1. Replacement of infusion set – optimal site
2. Learning the principles of adequate carbohydrate intake depending on type and duration of exercise
3. Learning how to reduce the risk of hypoglycemia, or to prevent this by using CGM

Avoiding Hypoglycemia

Manual pump stop based on CGM information – value + trend





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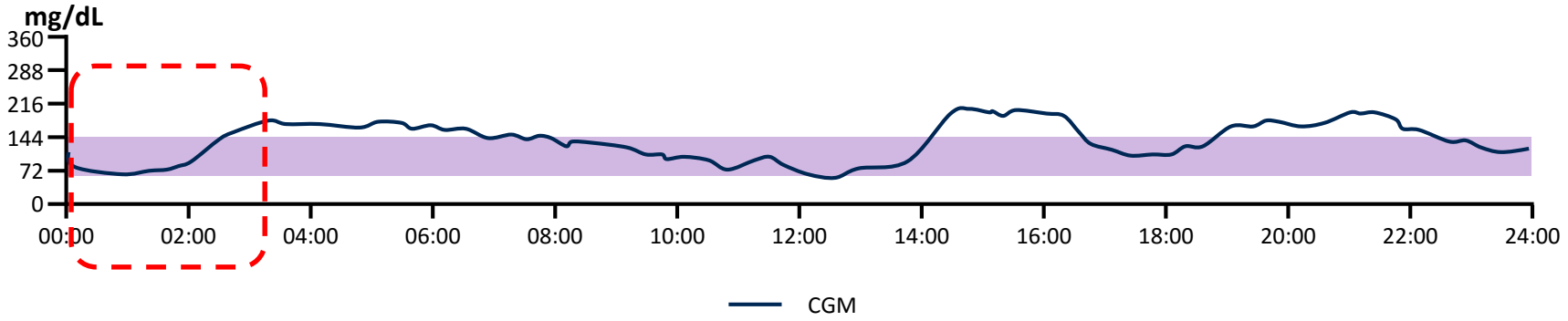
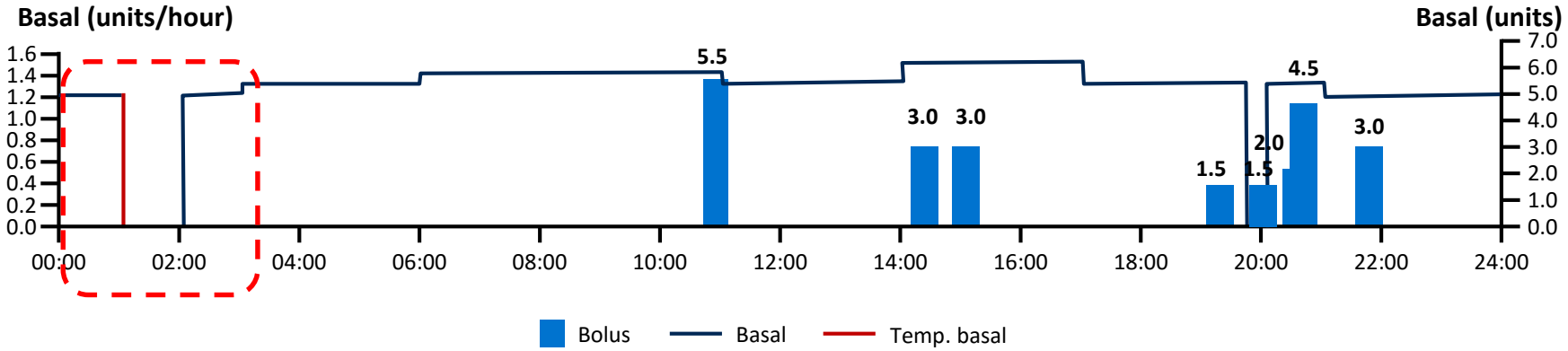
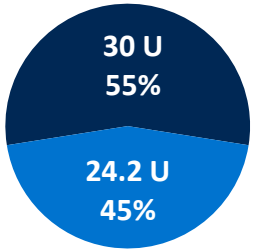
Avoiding Hypoglycemia at Night







Basal		Bolus	
Time	U/h	Time	U
01:05	0.000	10:54	5.50
02:05	1.200	14:22	3.00
03:02	1.300	Interrupted	-
06:02	1.400	15:06	3.00
11:02	1.300	19:18	1.50
14:02	1.500	20:02	1.50
17:02	1.300	20:33	2.25
19:44	0.000	20:46	4.50
20:05	1.300	21:48	3.00
21:02	1.200		

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Key Points

In order to approach target glucose control during and after exercise, adjustment of both carbohydrate intake and insulin doses are necessary

Carbohydrates

Adjustments of carbohydrate intake before, during, and after exercise

Insulin

Adjustments of insulin doses before, during, and after exercise

- Intensity of exercise
- Individual habit of exercise
- Duration of exercise
- Previous “hypo”
- Time of exercise

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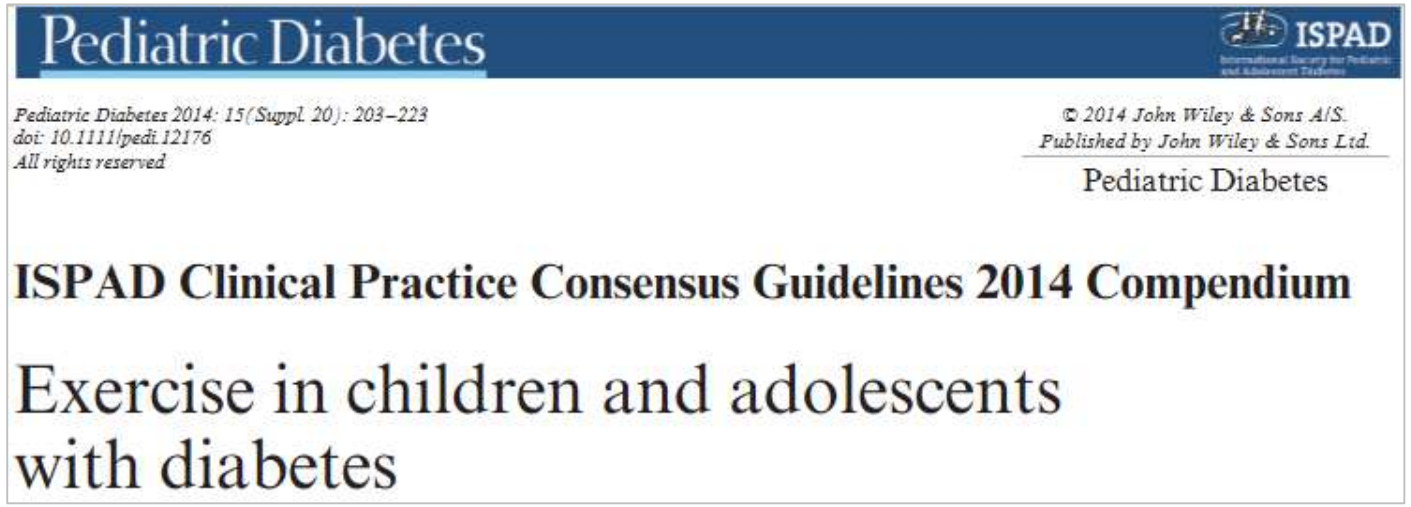
2014 ISPAD Consensus Guidelines



Pediatric Diabetes

ISPAD

Pediatric Diabetes 2014: 15(Suppl. 20): 203–223
doi: 10.1111/pedi.12176

Pediatric Diabetes

ISPAD Clinical Practice Consensus Guidelines 2014 Compendium

Exercise in children and adolescents with diabetes

Executive summary and recommendations at the start of the article:

- Factors affecting glucose response to exercise
- Normal day-to-day exercise/training
- Insulin regimens
- What to eat and drink
- Hypoglycemia – during and after exercise

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Questions?

THANK YOU!

www.TypeOneNation.org/PEAK

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