Managing T1D for Exercise

Rob Andrews – University of Exeter

Parth Narendran – University of Birmingham

Help Mark cycle LEJOG

The Challenge

Help Mark cycle from Lands End to John O'Groats

An unsupported ride with his friends

Mark is a 26 yr old man, diagnosed with TYPE 1 DIABETES at age 12

HbA1c 7.5%
He has no diabetes complications
He is on MDI insulin injections and tests regularly
He has good hypoglycaemia awareness
He is otherwise fit and healthy

Sun July 7th	Land’s End YH, 5, 90m
Mon July 8th	Perranporth, 41, 857m
Tues July 9th	Launceston, 53, 1200m
Wed July 10th	Exeter, 52, 1094m
Thurs July 11th	Churchill, Somerset, 90, 1350m
Fri July 12th	Coleford, 50, 916m
Sat July 13th	Shropshire, 85, 1440m
Sun July 14th	Warrington, 82, 900m
Mon July 15th	Lancs, 80, 773m
Tues July 16th	Ambleside, 28, 503m
Wed July 17th	Carlisle, 49, 997m
Thurs July 18th	Sanquhar, 82, 958m
Fri July 19th	Lochranza, 67, 840m
Sat July 20th	Oban, 66, 840m
Sun July 21st	Fort William, 45, 755m
Mon July 22nd	Dingwall, 83, 1421m
Tues July 23rd	Golspie, 46, 464m
Wed July 24th	John O’Groats, 68, 1095m

Pre - exercise

Guidelines on starting glucose values

During and after exercise

Alter insulin dose

Increase carbohydrate intake

Alter exercise type

(ICE)

Pre - exercise

Starting glucose values

Question 1

Adam, age 25, was diagnosed with T1DM 6 years ago. Adam used to exercise regularly and he would like to resume this.

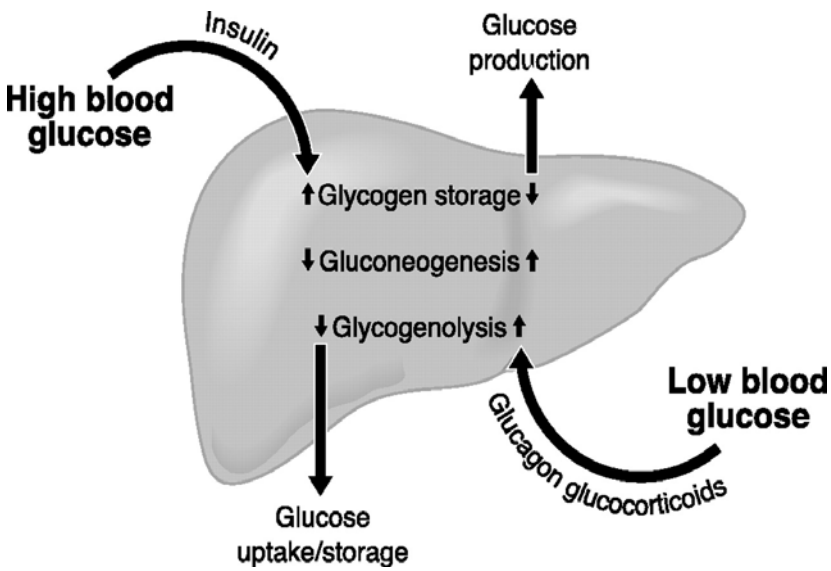
He would like to cycle at moderate intensity for 60 minutes

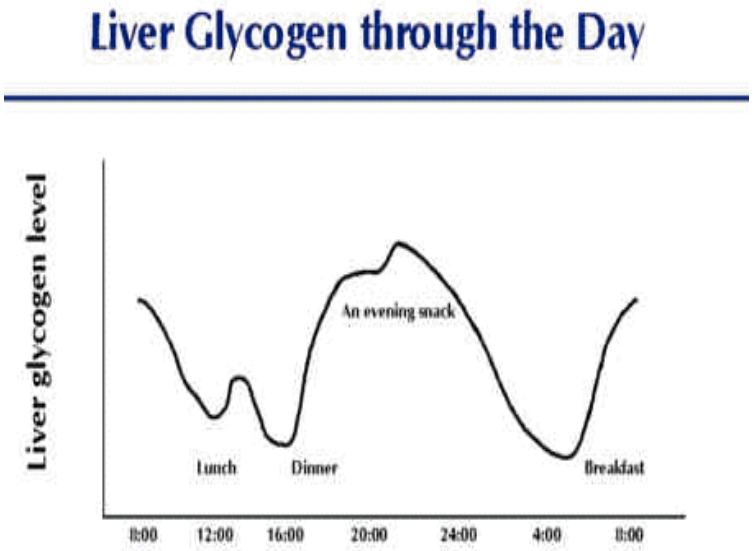
What action should he take based on the following pre-exercise glucose readings?

5mmol/L (2mmol/L previous day needing 3rd party help)

Question 1 options

a) Take carbohydrate, then retest glucose
b) Take carbohydrate, then proceed to exercise
c) Proceed straight to exercise
d) Do not exercise





Liver is a major glucose store and is important in exercise

Low blood glucose depletes liver glycogen

It takes 24hrs for glycogen to be replaced to safe levels after a severe hypo

Question 1 options

a) Take carbohydrate, then retest glucose
b) Take carbohydrate, then proceed to exercise
c) Proceed straight to exercise
d) Do not exercise

Question 2

Adam, age 25, was diagnosed with T1DM 6 years ago. Adam used to exercise regularly and he would like to resume this.

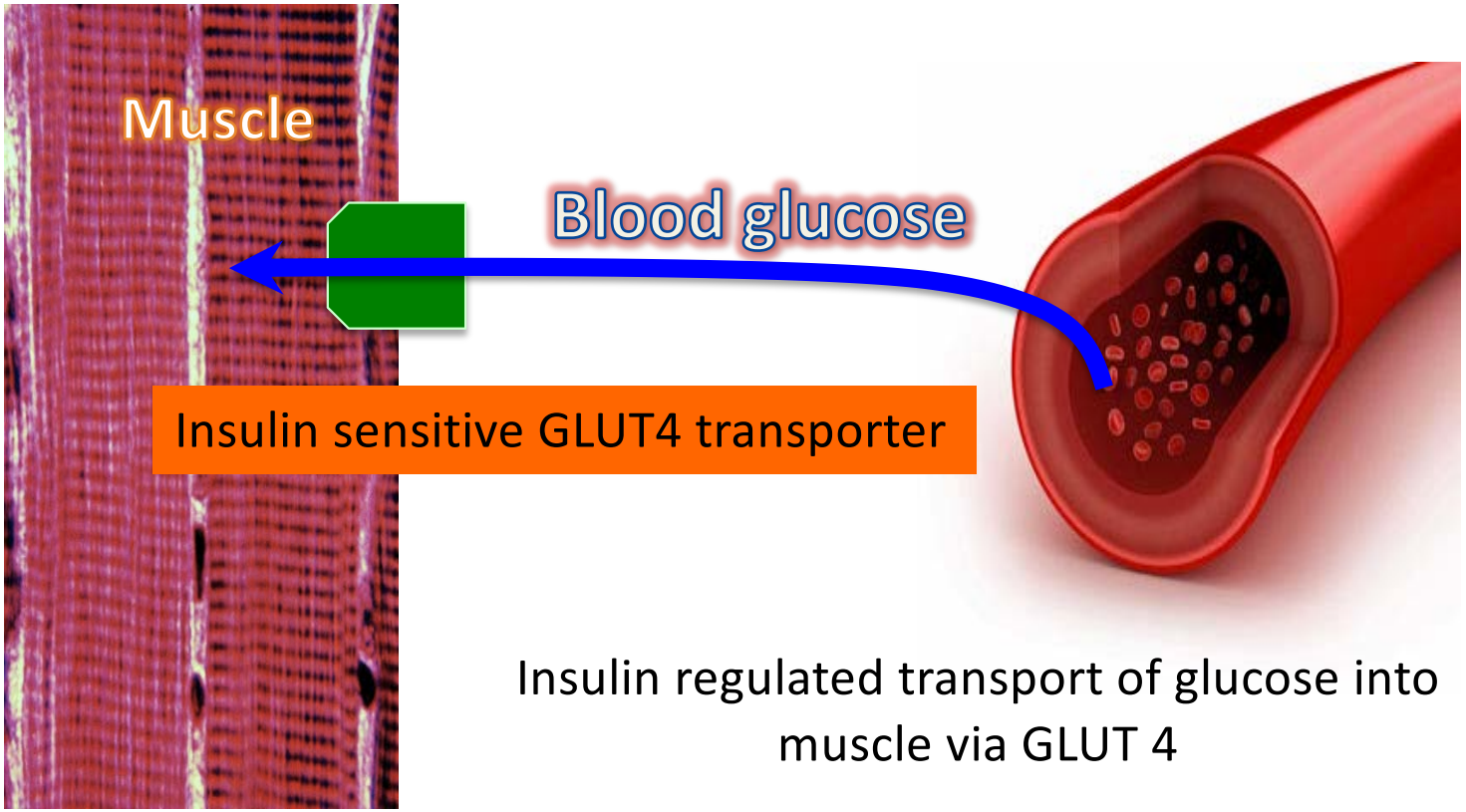
He would like to cycle at moderate intensity for 60 minutes

What action should he take based on the following pre-exercise glucose readings?

15mmol/L (with 2+ ketones in urine)

Question 2 options

a) Take correction dose insulin, then retest glucose
b) Take a third of the standard insulin correction dose, then proceed to exercise
c) Proceed straight to exercise
d) Do not exercise



Insulin regulated transport of glucose into muscle via GLUT 4

Insulin is required for glucose entry into muscle, therefore muscles will not exercise in the absence of insulin

Question 2 options

a) Take correction dose insulin, then retest glucose
b) Take a third of the standard insulin correction dose, then proceed to exercise
c) Proceed straight to exercise
d) Do not exercise

Blood glucose levels that say “No”

Low blood glucose

- Blood glucose < 3.5 mmol/L
- Severe hypoglycaemia (needed help)
  - Don’t exercise for 24 hours
- Self treated hypoglycaemia
  - Be careful for 24 hours
  - If it occurs before exercise – treat and have stable glucose for 60 minutes before starting
  - If it occurs during exercise – stop, treat, recommence after stable for 45 minutes

High blood glucose

- Blood glucose >15 mmol/L
- Ketone greater than 1.5 mmol/L
  - Take insulin wait until ketones have gone before exercise
- Ketones less than or equal to 1.5 mmol/L
  - Eaten <2 hours: just monitor
  - Eaten >2 hours: take extra insulin
  - Can do low to moderate intensity exercise

If you cannot measure your blood ketones we suggest you take a 1/3 of your normal correction dose and then wait until your blood glucose is below 15 before exercising and ensure that you do not do anaerobic exercise on that day

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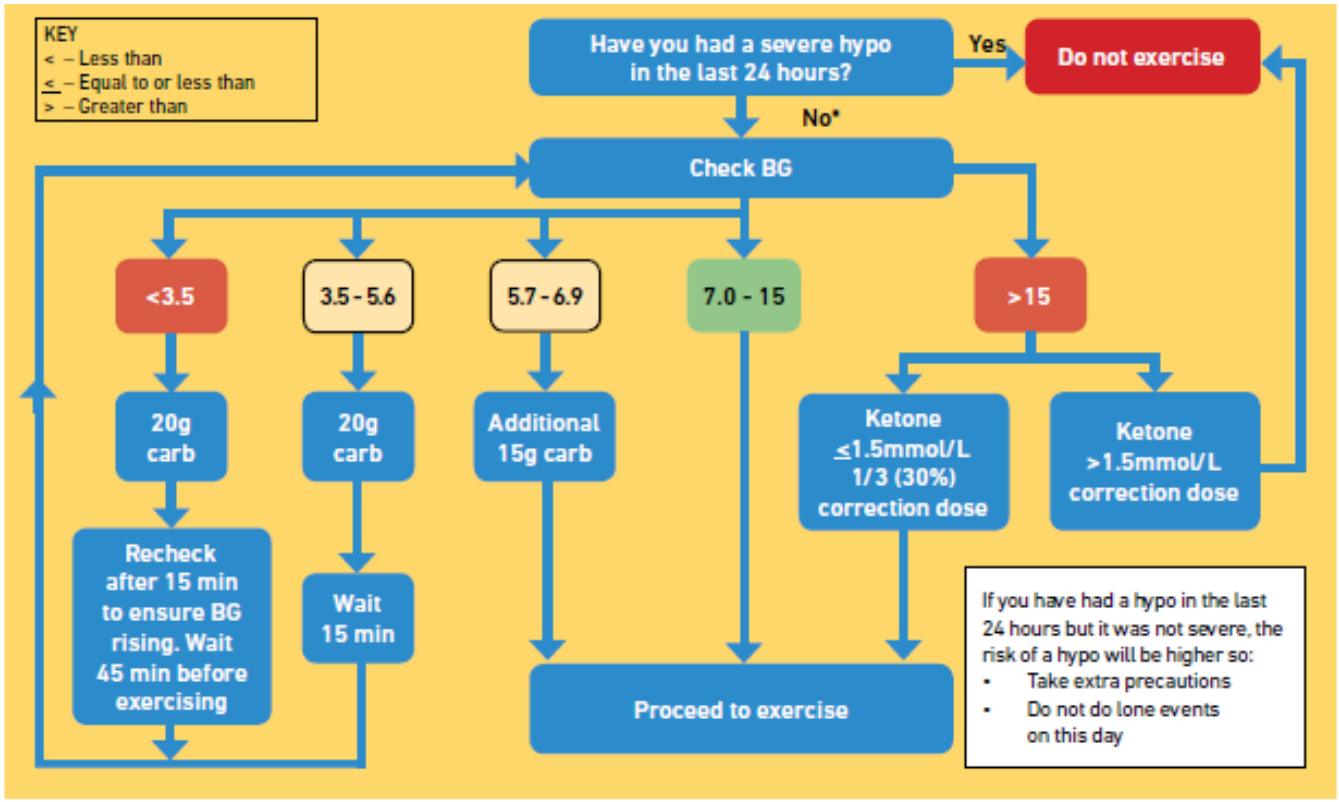
Simple flowchart for glucose and exercise



Addition information for CGM/Libre

Confirm with BG reading if

- Glucose <6.0
- Glucose >15

If ⬆ and glucose 5.7-6.9: no need for extra carbs, proceed to exercise. Stick to advice if in any other range

If ⬇ and glucose 5.7-6.9: take twice as much carbs at 20 and 40 minutes into exercise

If ⬇ and glucose 7.0-9.0: take 15 grams of carbs at start of exercise

During and after exercise

Potential approaches to controlling glucose

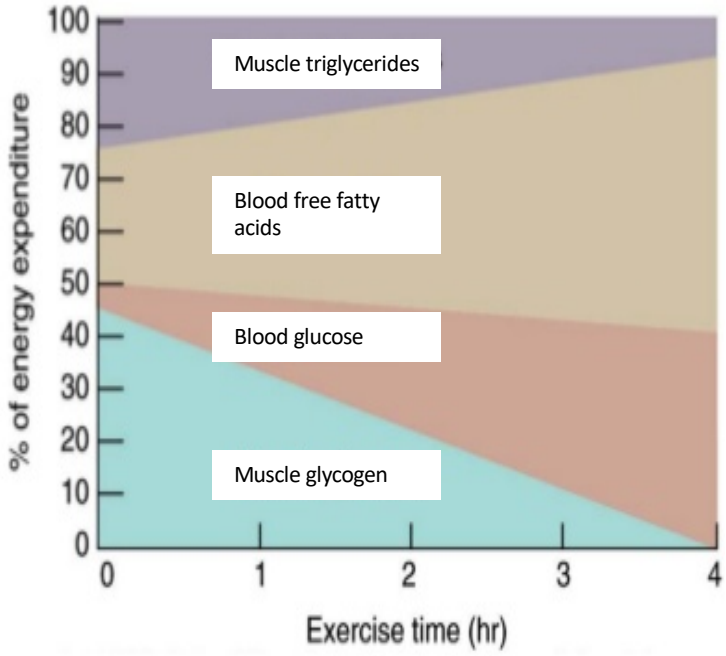
Alter insulin dose

Increase carbohydrate intake

Alter exercise type

(ICE)

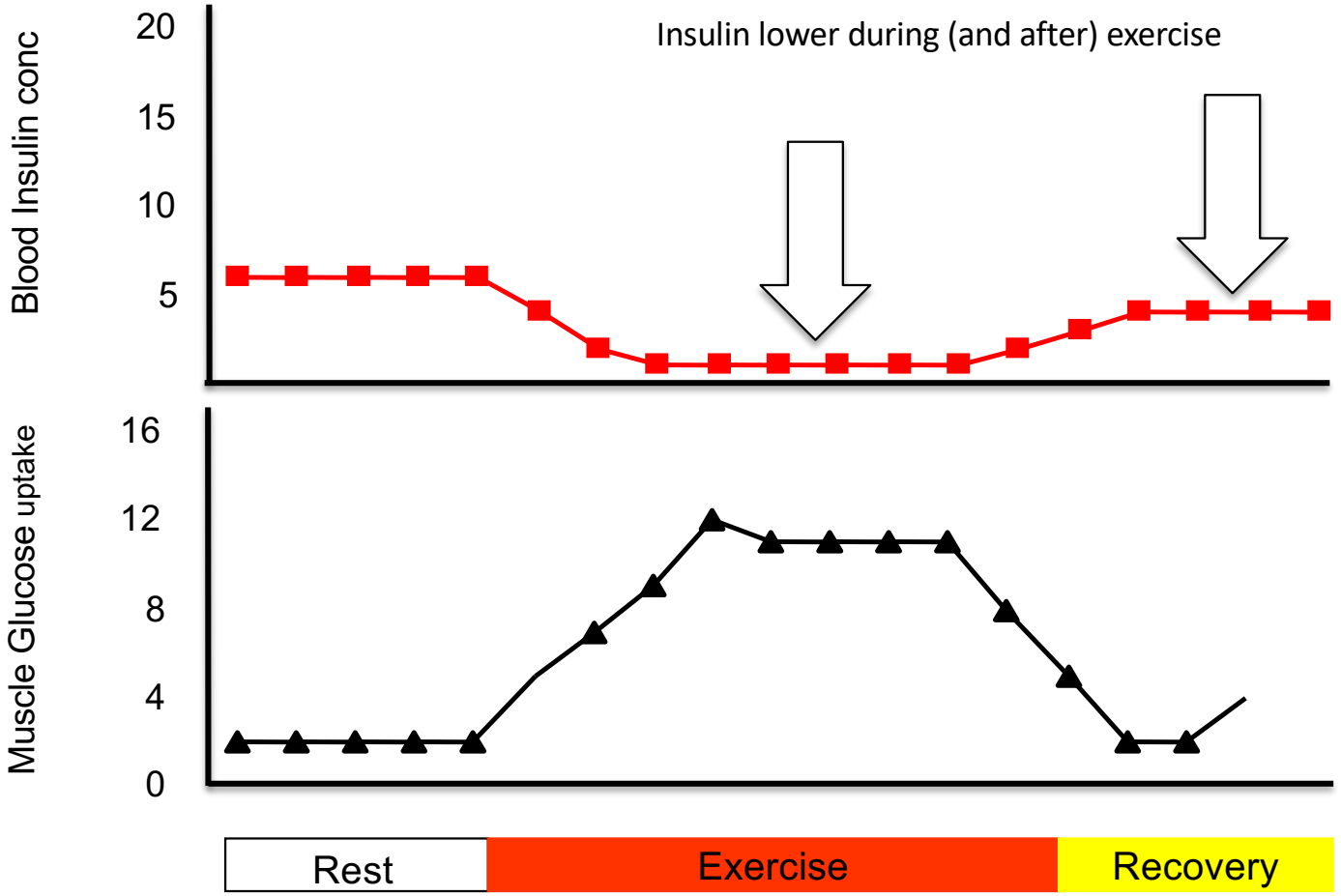
Fuels used with increasing duration of exercise



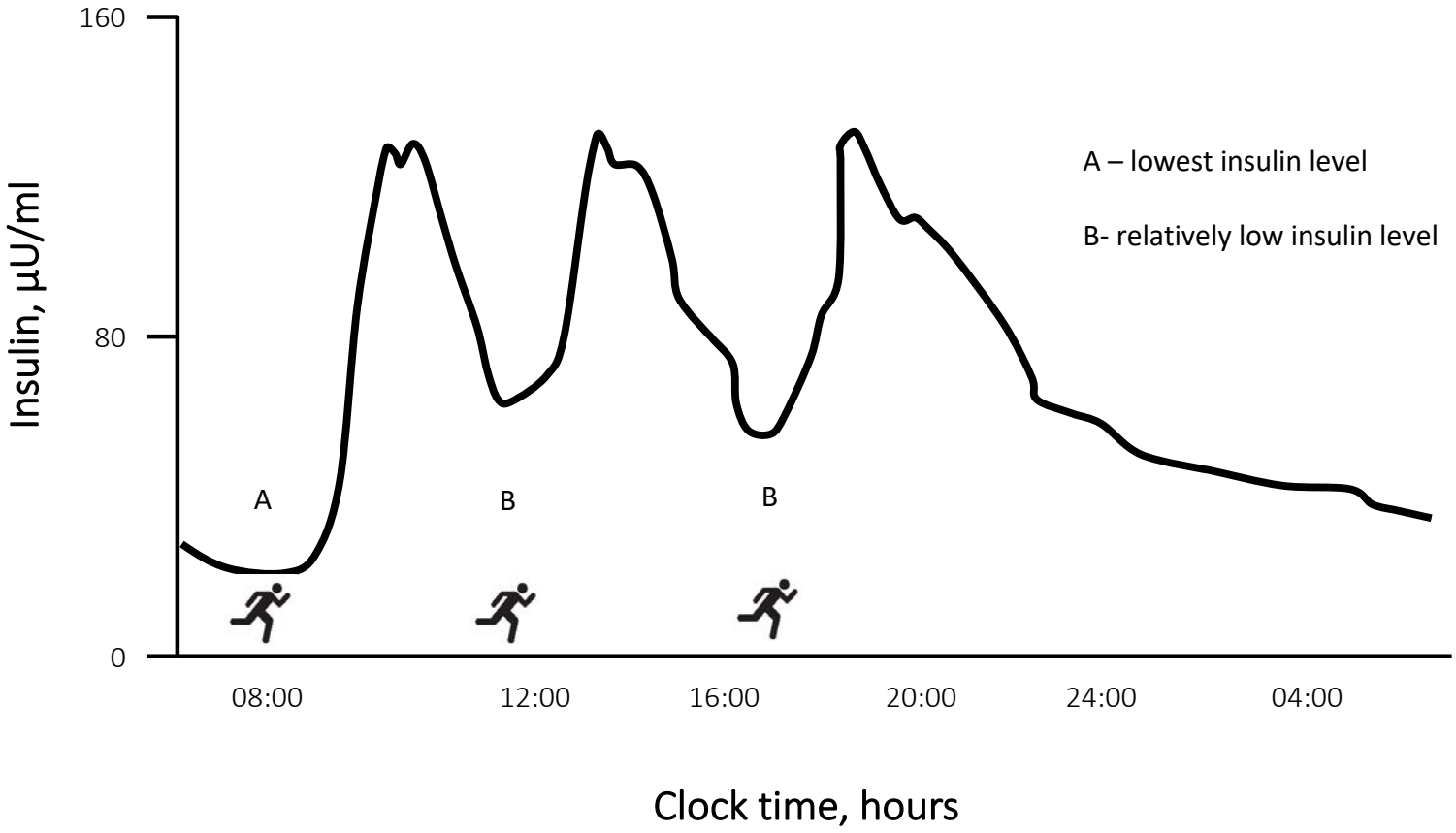
- Little blood glucose used during first 30mins of exercise
- More blood glucose used with longer duration exercise

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

Normal response to exercise



Prevailing insulin levels



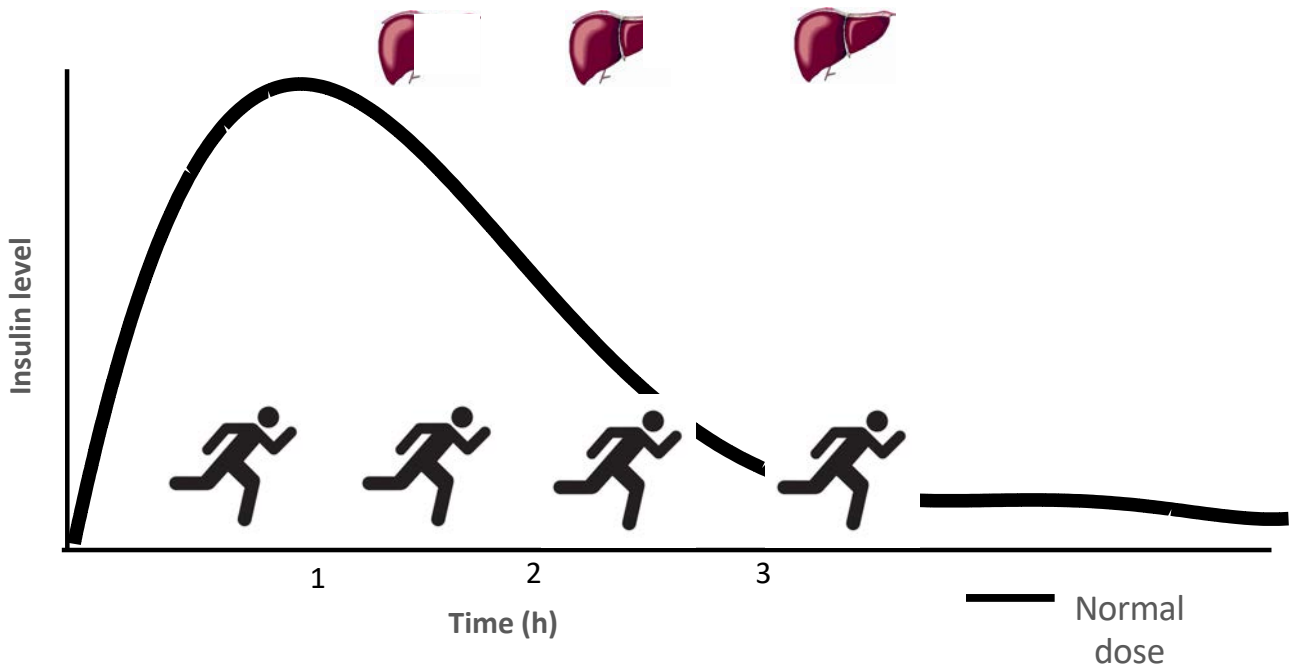
Morning or afternoon exercise?

Greater risk of hypo if exercise undertaken after 4pm

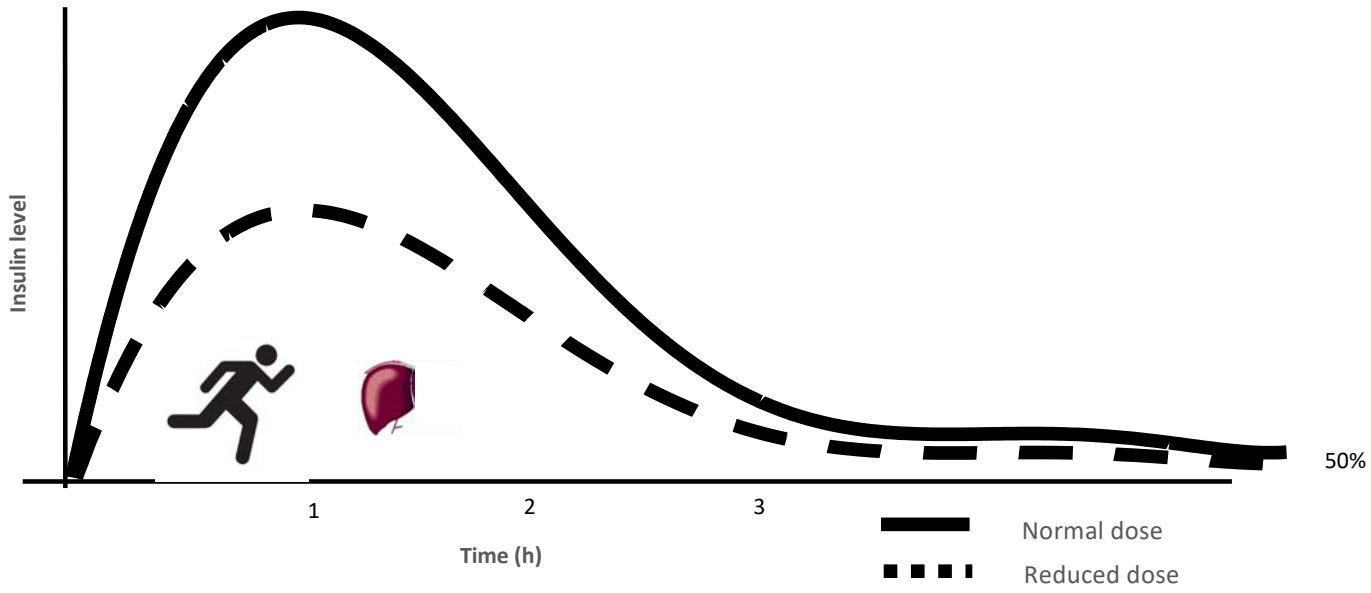
Insulin resistance

Wakefulness

Liver glucose release and timing of BOLUS insulin



Effect of lowering fasting acting insulin by 50%



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Simple Insulin regime

Exercise fasted

or

Reduce pre-exercise quick acting (QA) insulin by 50%

if exercising within 2 hours of injection

Or

Delay exercise till 2 hours have passed after meal

All this works for pumps as well

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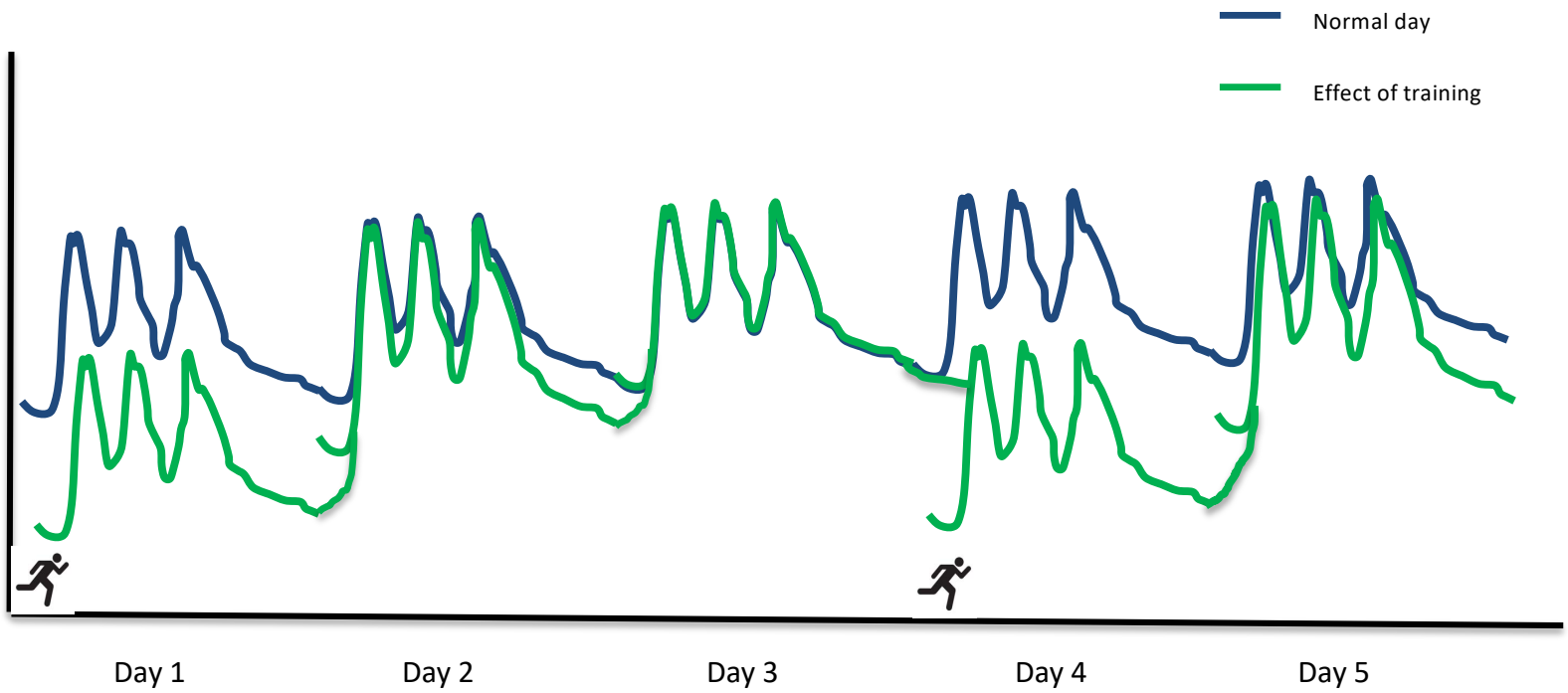
Effect of exercise on subsequent insulin sensitivity
Exercise undertaken every few days



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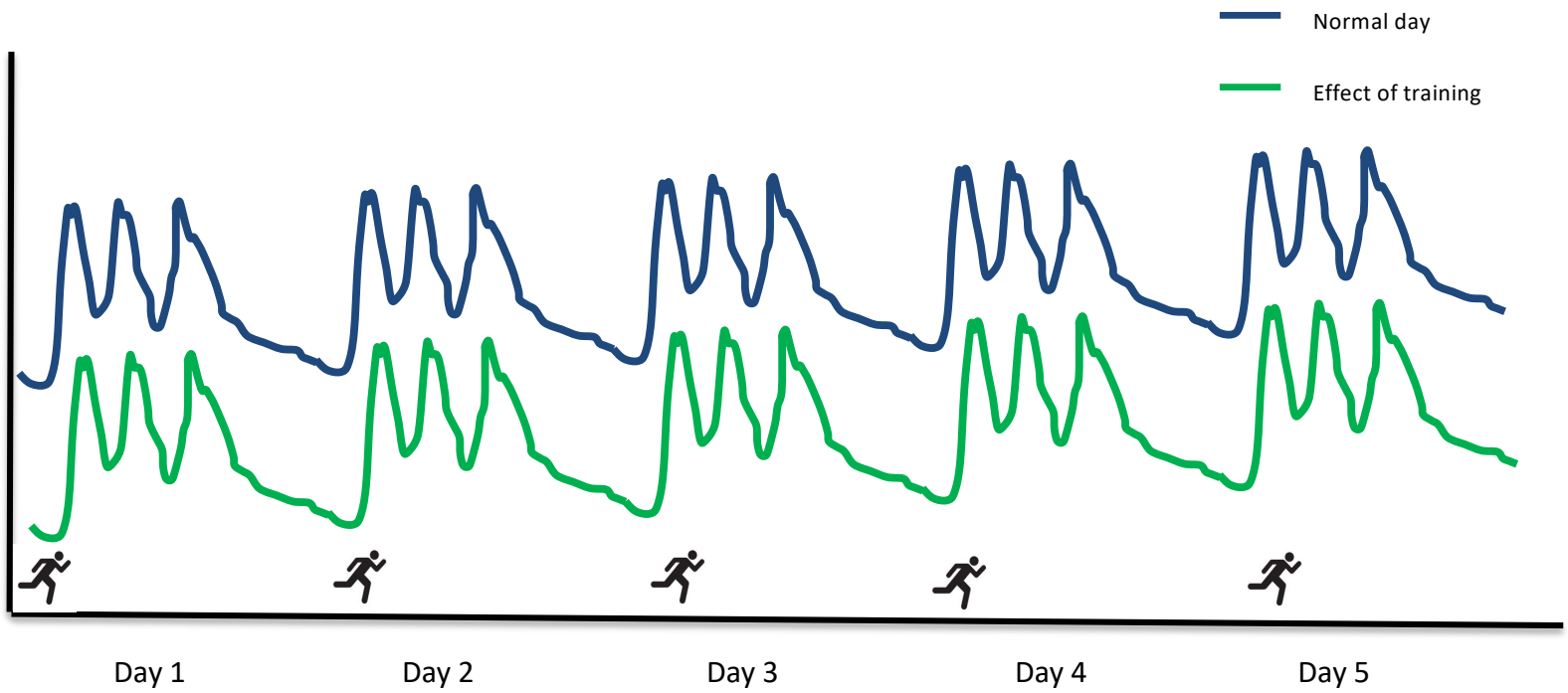
Effect of exercise on subsequent insulin sensitivity
Exercise undertaken every day



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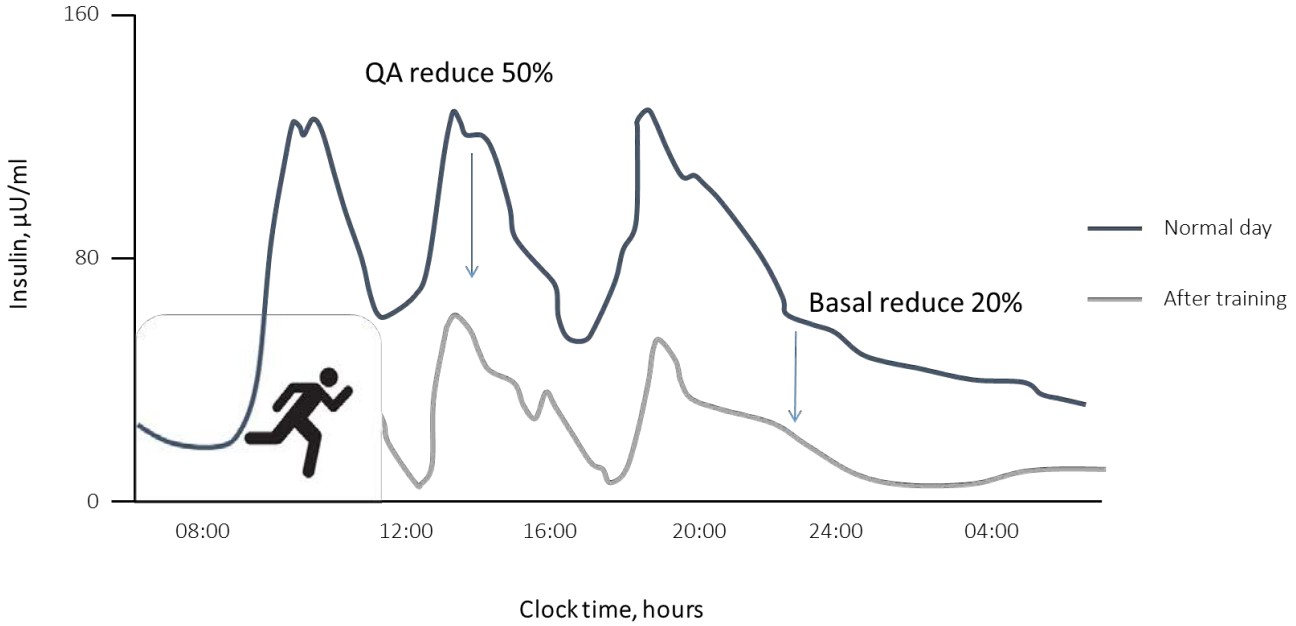
Effect of exercise on Insulin sensitivity



O/N basal reduction if 1) >2hrs exercise 2) after 4pm or 3) new exercise

Managing QA and BI insulin AFTER exercise

(The 50:50:20 rule)

- 50% (1/2) normal quick acting insulin dose for first two meals after exercise
- 50% (1/2) normal correction dose for 12 hours after exercise
- 80% (4/5) normal night time background insulin dose (or 20% reduction for 6 hours after go to bed) if
  - exercised after 4pm
  - more than 2 hours of exercise
  - new exercise

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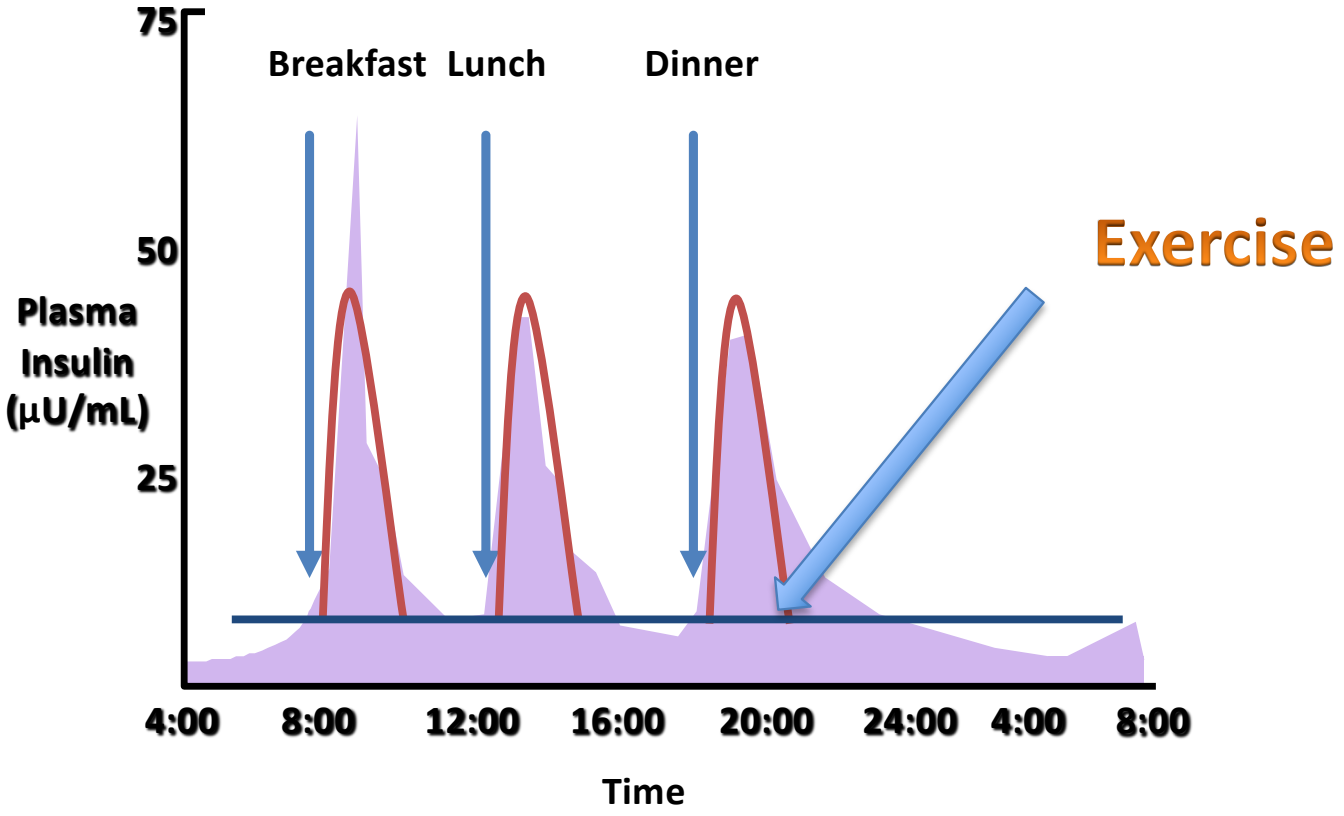
Question 3

Adam would like to cycle at moderate intensity for 60 minutes

He is on an MDI regime with meal time rapid acting insulin, and once a day basal insulin at night.

What should he do with his insulin if wants to **cycle after dinner?**



Adapted from White JR, Campbell RK, Hirsch I. Postgraduate Medicine. June 2003;113(6):30-36.

Question 3 options

a) Reduce bolus insulin for dinner
b) Reduce bolus insulin for dinner as well as evening basal insulin
c) Reduce basal insulin in the evening
d) No change

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Managing QA and BI insulin AFTER exercise

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  - exercised after 4pm
  - more than 2 hours of exercise
  - new exercise

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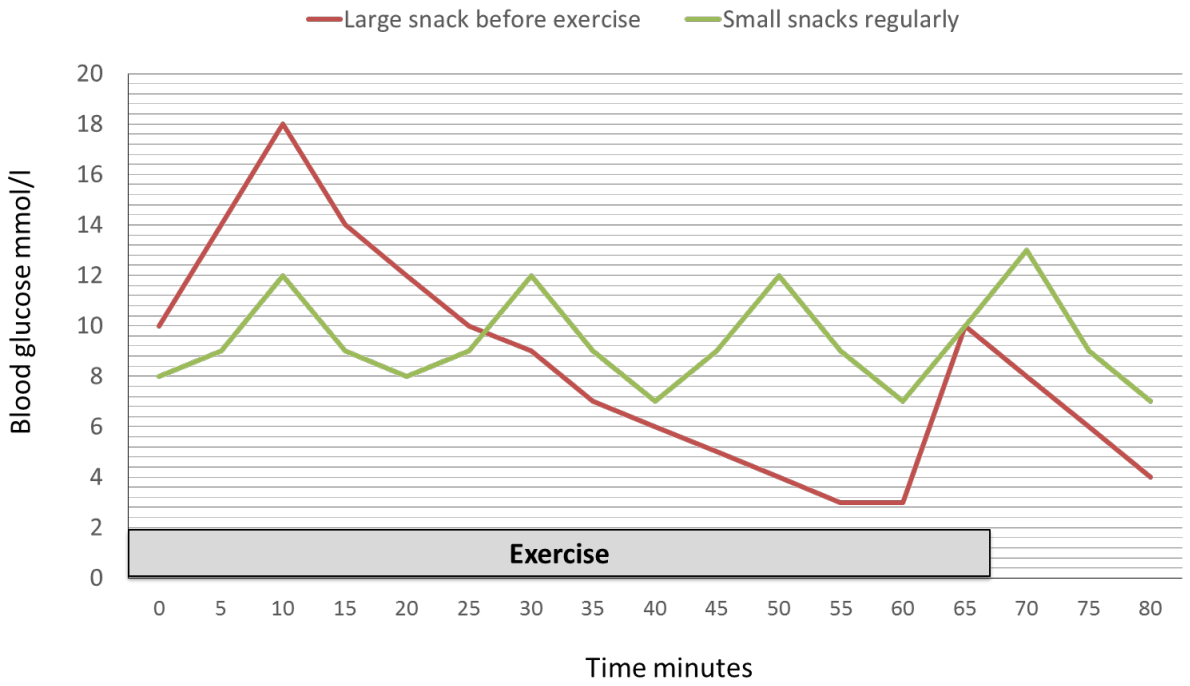
…often exercise is not planned and insulin cannot be adjusted

Use of Carbohydrate

Use of Exercise

Simple carbohydrate regime

Start with 30g/hour



Taking something every 20 minutes will keep blood glucose stable

Carbohydrate intake DURING exercise – further titration with CGM/Libre

CGM Glucose level	Trend arrow(s)	Action	Comments
<5.0 mmol/L	None or downward trending ↘	15-20g CHO 	Stop exercise if blood glucose < 4.0 mmol/L
5.0-6.1 mmol/L	↓ Libre	15g CHO 	
5.0-6.1 mmol/L	↘ ↓ Libre	20g CHO 	
6.1-6.9 mmol/L	or Libre	8g CHO 	
>7.0 mmol/l		No action	

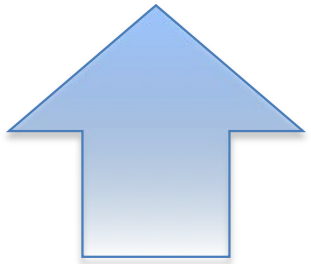
Semi-quantitative method

- Estimate of carbohydrate requirements based on body weight.
  - For moderate activity 0.5g/kg/hr
  - For intense activity 1g/kg/hr is used
  - **Use the latter for starting advice**

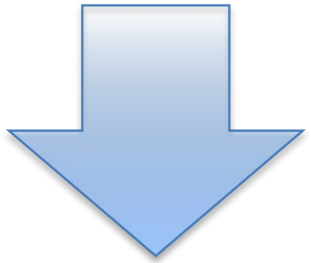
For example: Mark wishes to exercise at moderate intensity for 60 minutes. He weighs 42 kg so will take 7 grams at the start, 7 grams at 20 minutes and 7 grams at 40 minutes.

Effect of different exercises on blood glucose

Glucagon
Adrenaline
Noradrenaline
Cortisol

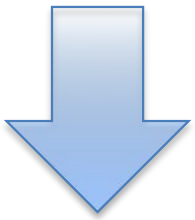


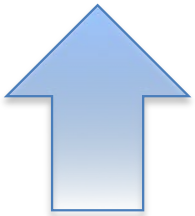
Blood glucose



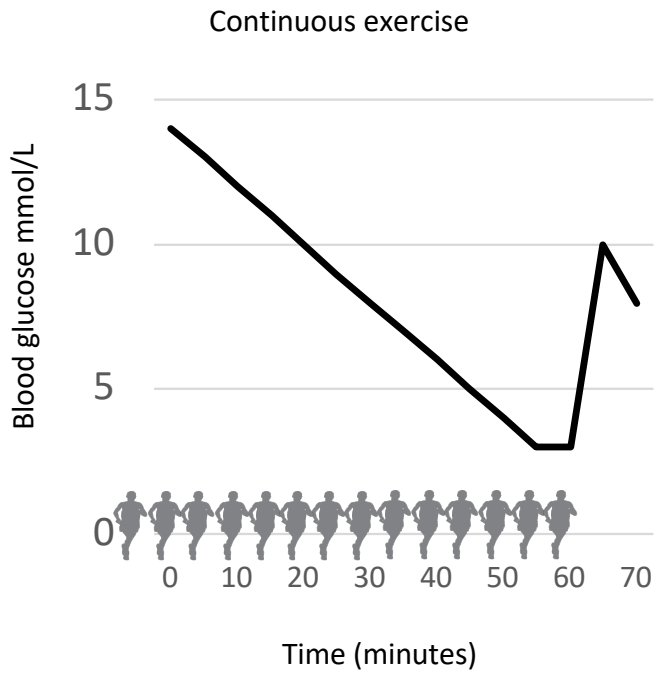
Insulin

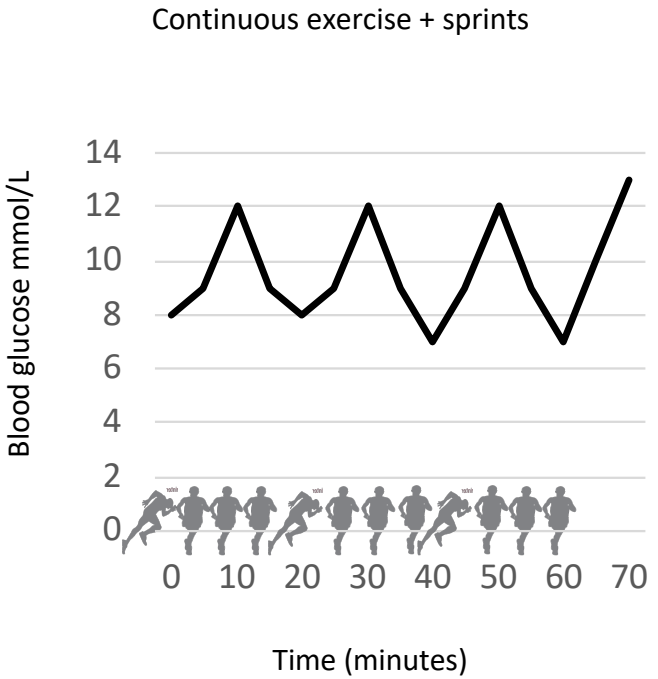
ENDURANCE	ANAEROBIC	INTERMITTENT
Hiking	Weight lifting	Childs play
Golf	Body Building	Soccer
Road cycling	Dressage	Team sports
Cycle tour	Fencing	
Mountain biking	Track and field events	
Distance running	Sprinting	
Distance swimming	Archery	
Marathon	Wrestling	





Using intensity of exercise to control glucose





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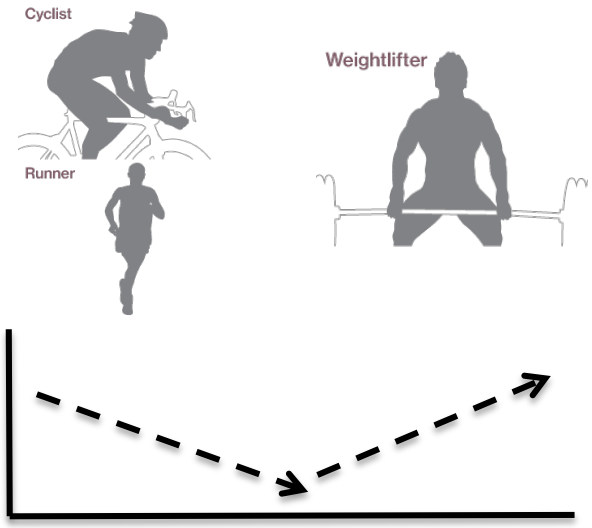
…in the gym

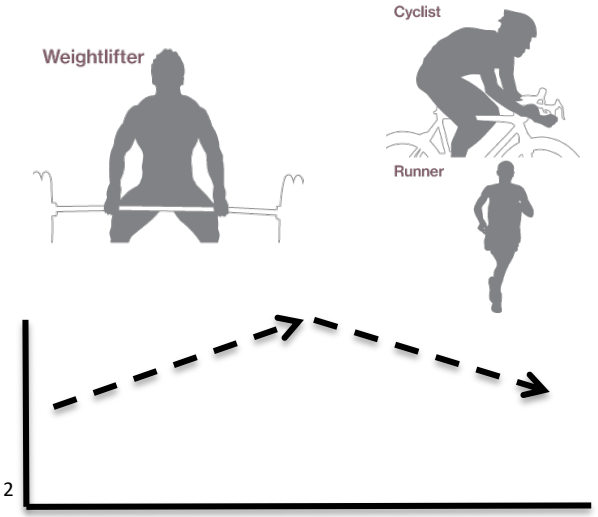
Order 1

Aerobic then Anaerobic



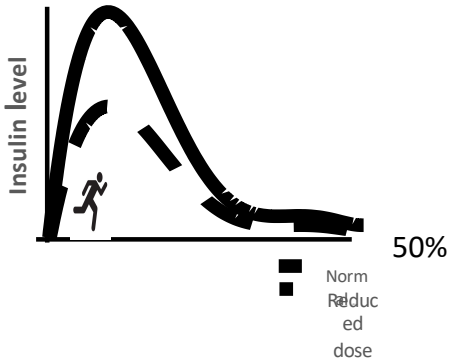
Order 2

Anaerobic then Aerobic



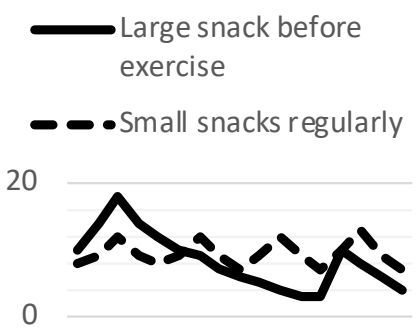
Three options for managing glucose during exercise

Insulin



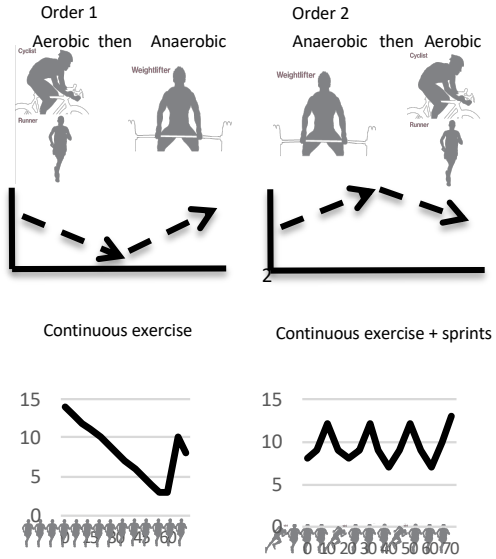
Reduce quick acting by 50% if exercising within 2 hrs of meal

Carbohydrate



30 gram per hour
Divide carbohydrate over hour
Take some every 20 minutes

Exercise type and intensity



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Question 4

24yr old student. Diagnosed T1D 10yrs.

Moderate glycaemic control. HbA1c 8%.
Basal bolus insulin regime.
Has recently taken up squash in evenings after dinner.
Troubled by **hyperglycaemia** following squash.

How would you manage him?

Question 4 options

a) Take extra insulin with dinner before squash
b) Take correction insulin after game
c) Prolonged cool down after game
d) Switch sports

Managing QA and BI insulin <u>AFTER</u> exercise

(The 50:50:20 rule)

- 50% (1/2) normal quick acting insulin dose for first two meals after exercise
- 50% (1/2) normal correction dose for 12 hours after exercise
- 80% (4/5) normal night time background insulin dose (or 20% reduction for 6 hours after go to bed) if
  - exercised after 4pm
  - more than 2 hours of exercise
  - Blood sugar <126 before bed

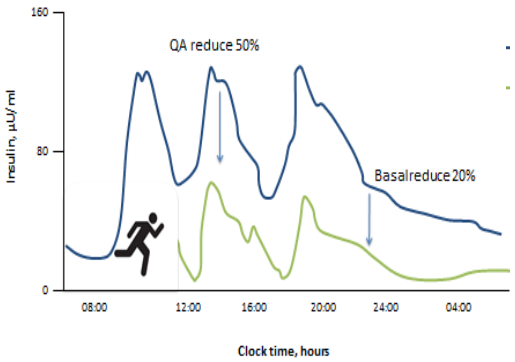
Diet Strategies for nocturnal hypoglycaemia

Consider bedtime snack with protein and complex carbohydrate if:

- exercised after 4 pm
- exercised more than 2 hours
- new exercise

Three options for managing glucose after exercise

Insulin – how much on board / how do you alter it



50% of normal quick acting with meal prior to exercise if exercising within 2 hours of meal

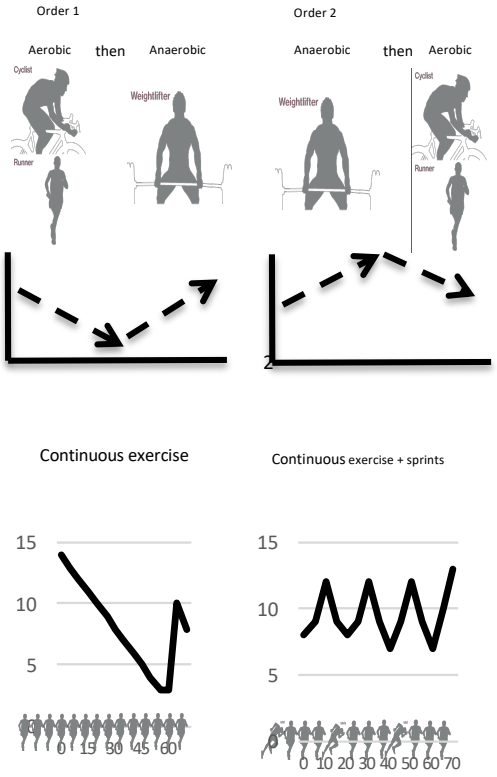
50% of normal quick acting insulin for first 2 meals/snacks after

20% reduction night time background insulin If exercise after 4 pm or longer than 2 hours

Carbohydrate for exercise

Recovery	1 -1.2g/kg during the first hour
Before bed	Slow release carbohydrate

Exercise type and intensity



The Challenge!


LAND'S END

Day 1

Mark arrives at Lands End and tells you he had a hypo yesterday that required help from his partner

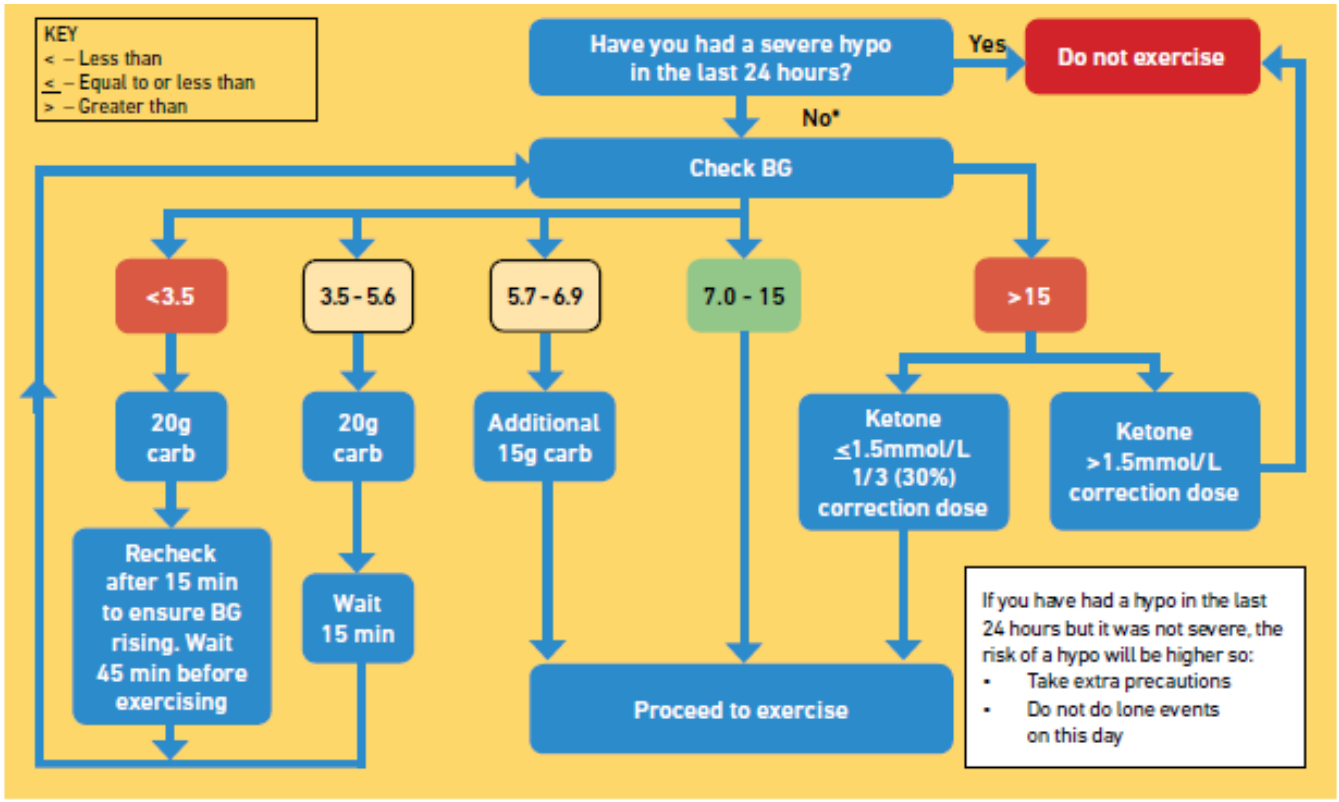
What should he do?

What if Mark is about to start cycling

His BG is 6.0 mmol/L

What should he do?

Simple flowchart for glucose and exercise



Addition information for CGM/Libre

Confirm with BG reading if

- Glucose <6.0
- Glucose >15

If ⬆ and glucose 5.7-6.9: no need for extra carbs, proceed to exercise. Stick to advice if in any other range

If ⬇ and glucose 5.7-6.9: take twice as much carbs at 20 and 40 minutes into exercise

If ⬇ and glucose 7.0-9.0: take 15 grams of carbs at start of exercise

Day 1

5 miles to Lands End Youth Hostel

Mark finishes safely

His BG is now 14 mmol/L

Why has his BG gone up from 6mmol/L?

Day 2
LE to Perranporth, 41 miles

Mark has breakfast a 7am
Wishes to start cycling at
9am

Expects to get to
Perranporth at 5pm after
lunch stop

What bolus insulin doses? (RAI)

1) BF: 100%, Lunch: 50%, Dinner: 50%

2) BF: 50%, Lunch: 50%, Dinner: 50%

3) BF: 50%, Lunch: no insulin, Dinner: 50%

What bolus insulin doses? (RAI)

1) BF: 100%, Lunch: 50%, Dinner: 50%

2) BF: 50%, Lunch: 50%, Dinner: 50%

3) BF: 50%, Lunch: no insulin, Dinner: 50%

What basal insulin doses? (BD Levermir)

1) AM: 100%, PM 80%

2) AM: 50%, PM 80%

3) AM: 50%, PM 100%

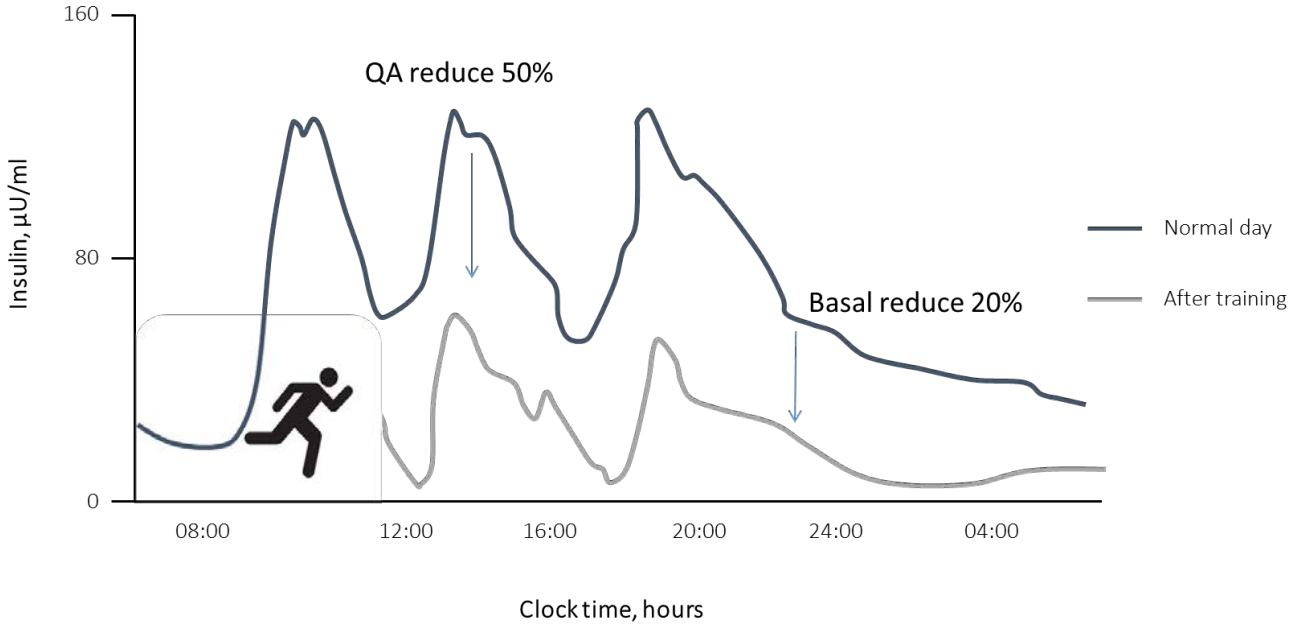
What basal insulin doses? (BD Levermir)

1) AM: 100%, PM 80%

2) AM: 50%, PM 80%

3) AM: 50%, PM 50%

Effect of exercise on Insulin sensitivity



Reduce basal O/N, and bolus for dinner and Bfast the next day

Managing QA and BI insulin AFTER exercise

(The 50:50:20 rule)

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  - exercised after 4pm
  - more than 2 hours of exercise
  - new exercise

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Recovery food

Did you do more than 60 minutes moderate intensity exercise or more than 30 high intensity exercise?

No → No recovery food needed

Yes → Have food with carbohydrate and protein in Ratio 4:1. For example

Ham sandwich.

Milkshake

Cereal and milk

Day 3
Perranporth to
Launceston, 53 miles

Mark has breakfast a 7am
Wishes to start cycling at
9am

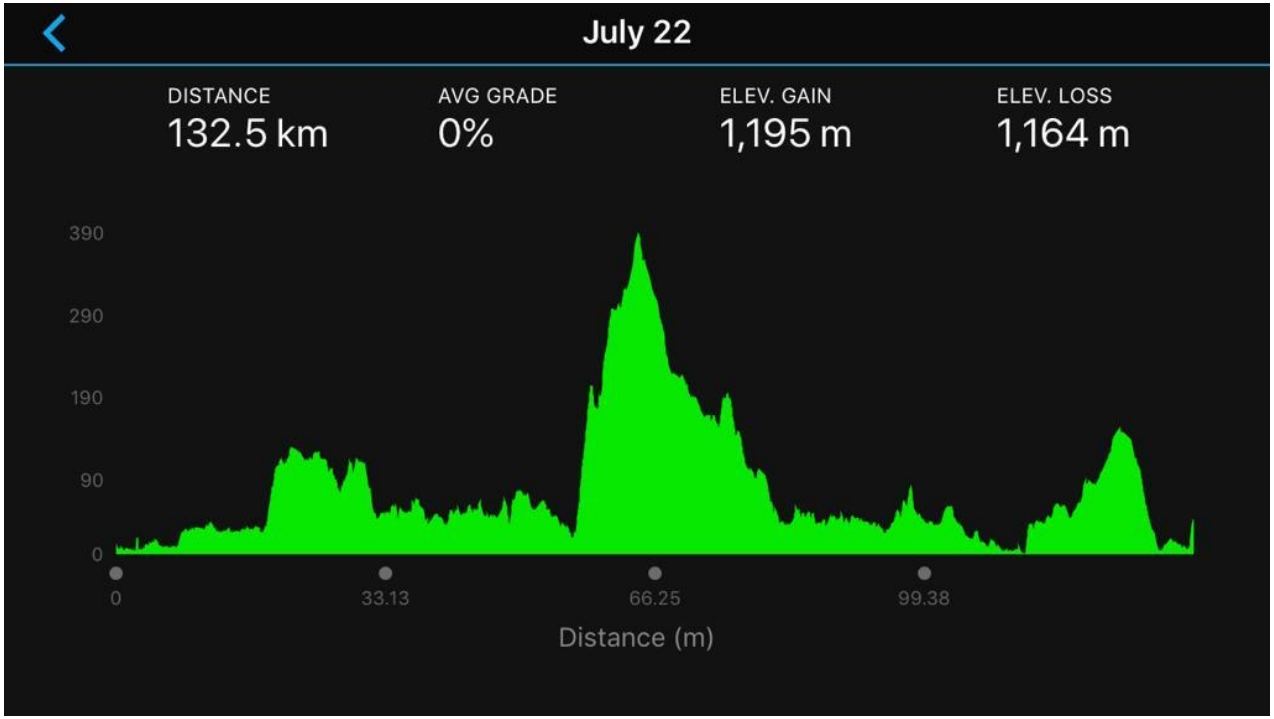
Expects to get to
Launceston late afternoon
after lunch stop

What should he do with insulin doses for today

1) Bolus: 50%, 50%, 50%. Basal 50%, 80%
2) Bolus: 100%, 50%, 50%. Basal 100%, 80%
3) Bolus: 100%, 50%, 50%. Basal 50%, 80%

What should he do with insulin doses for today

1) **Bolus: 50%, 50%, 50%. Basal 50%, 80%**
2) Bolus: 100%, 50%, 50%. Basal 100%, 80%
3) Bolus: 100%, 50%, 50%. Basal 50%, 80%


July 22
DISTANCE
132.5 km
AVG GRADE
0%
ELEV. GAIN
1,195 m
ELEV. LOSS
1,164 m
390
290
190
90
0
0
33.13
66.25
99.38
Distance (m)

Day 6
Somerset to Coleford 50miles

Mark finds he is having hypos and needing to take significant extra carbs despite reducing insulin as suggested

What is happening?


ALTURA


GRETNA GREEN
SINCE 1754

Day 16

Fort William to Dingwall

Marks glucose has fallen from 7 to 5 in the past hour

He is 2 miles from his lunch stop

He is all out of food/snacks

What can he do?

What can he do?

- Phone a friend
- Phone Uber
- Sprint
- Wait for colleagues to catch up and help

What can he do?

- Phone a friend
- Phone Uber
- **Sprint**
- Wait for colleagues to catch up and help

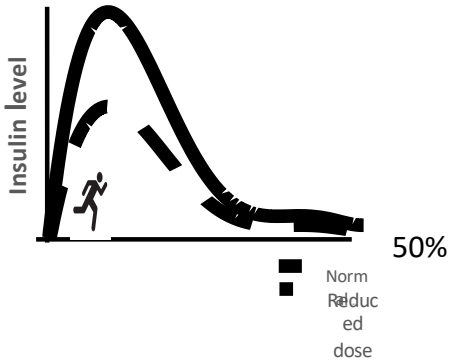
John O’Groats

Summary

- Severe hypoglycaemia in the past 24hours is an absolute contra-indication to exercise
- Hyperglycaemia with ketones >1.5 is an absolute contra-indication to exercise
- Hypoglycaemia can occur during and immediately after exercise, as well as in the night that follows
- Different exercises affect blood glucose in different ways
- People with T1D find simple starting rules helpful

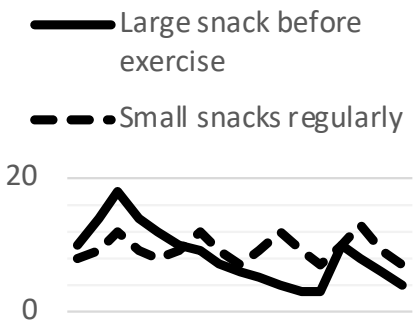
Three options for managing glucose during exercise

Insulin



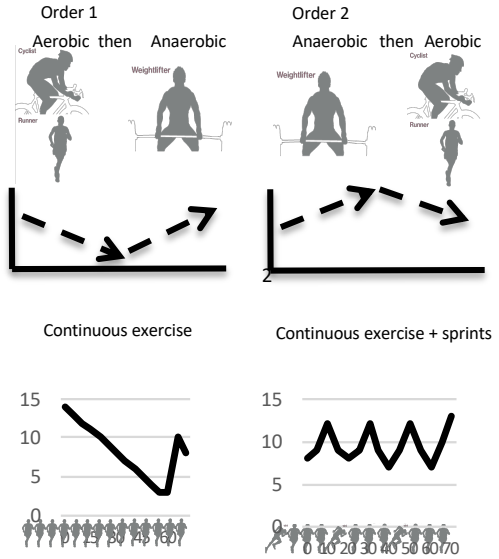
Reduce quick acting by 50% if exercising within 2 hrs of meal

Carbohydrate



30 gram per hour
Divide carbohydrate over hour
Take some every 20 minutes

Exercise type and intensity



extod education

With advice and support people with T1D can (and want to) undertake physical activity safely and at the highest level

Support websites

www.extod.org

www.runsweet.com

www.excarbs.com

r.c.andrews@exeter.ac.uk
p.narendran@bham.ac.uk