Workshop: Adjusting insulin and carbohydrate for exercise in patients with Type 1 Diabetes

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Dates to remember

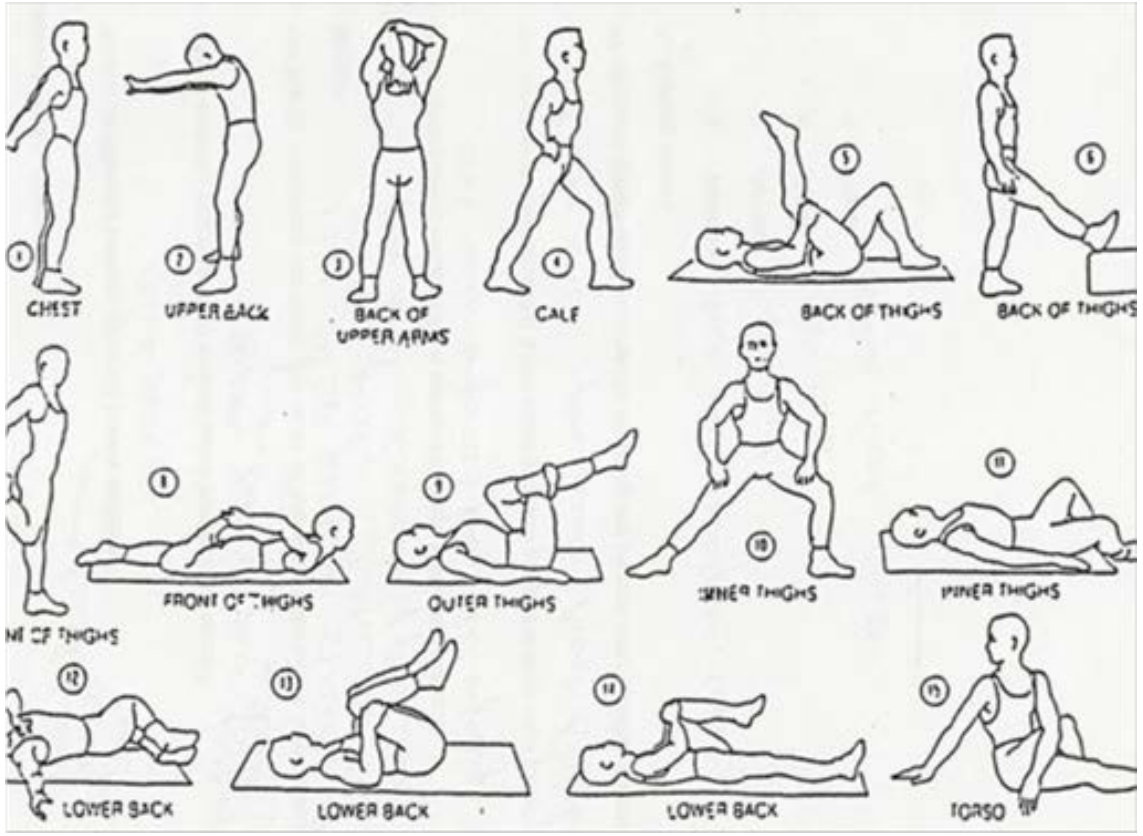
- EXTOD JDRF HCP Exercise and Type 1 conference in Glasgow 18/10/2019
- EXTOD JDRF Patient Exercise and Type 1 conference in Glasgow 19/10/19
- See ABCD website

A BIT OF PHYSIOLOGY

The physiology of exercise– the rule of three’s

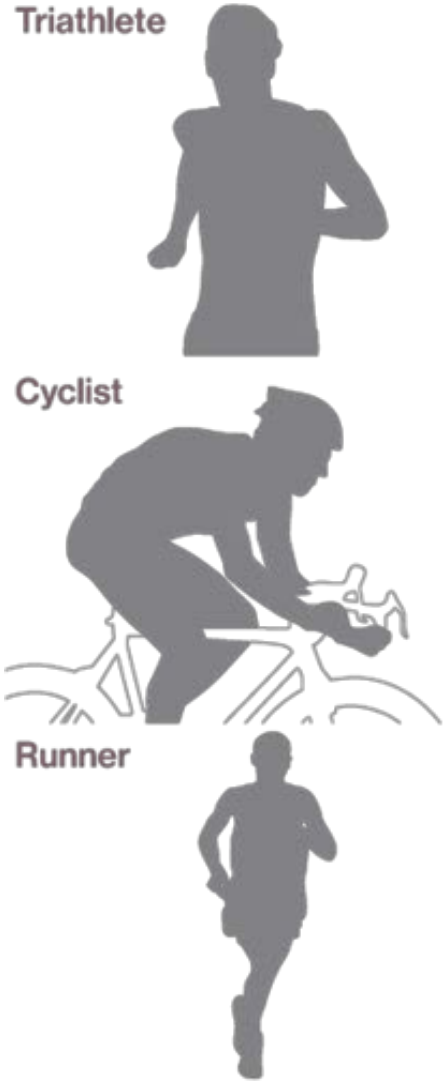
- ***Three different types of exercise***
- Three hormones involved with exercise
- Glucose response is different for the three types of exercise

Flexibility exercises



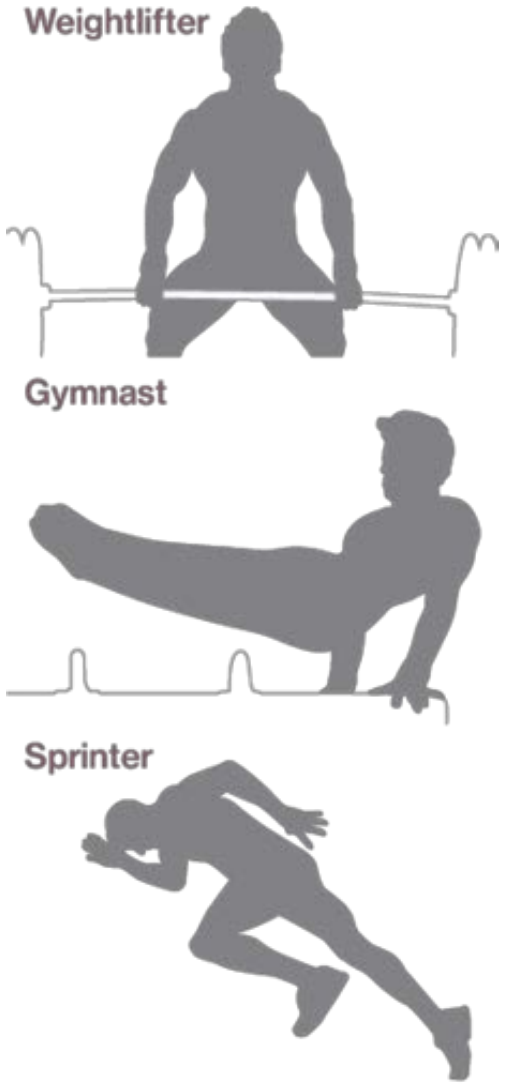
- Improve flexibility and balance
- Low intensity
- Burns small amount of glucose
- Help protect against injury
- Can be used to calm nerves before event
- Recommended to do before and after exercise
- Examples – Yoga

Aerobic exercise



- Uses oxygen
- Normally continuous
- Last longer than 2 minutes
- Low to moderate intensity
- Makes muscles more toned
- Small force used

Anaerobic exercise

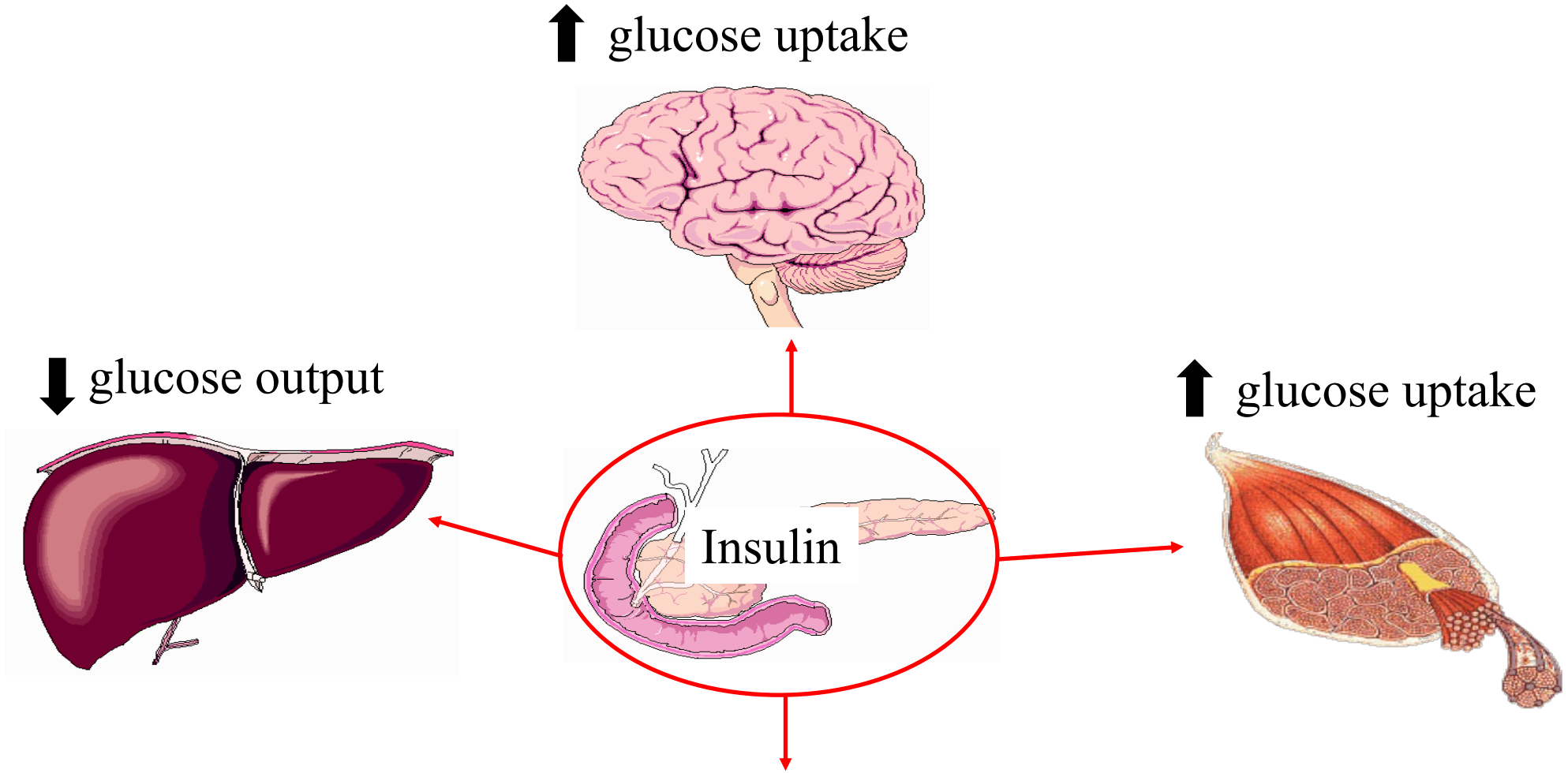


- Does not use oxygen
- Normally intermittent
- Each bit last less than 2 minutes
- High intensity
- Makes muscles bigger
- Large force used

The physiology of exercise– the rule of three's

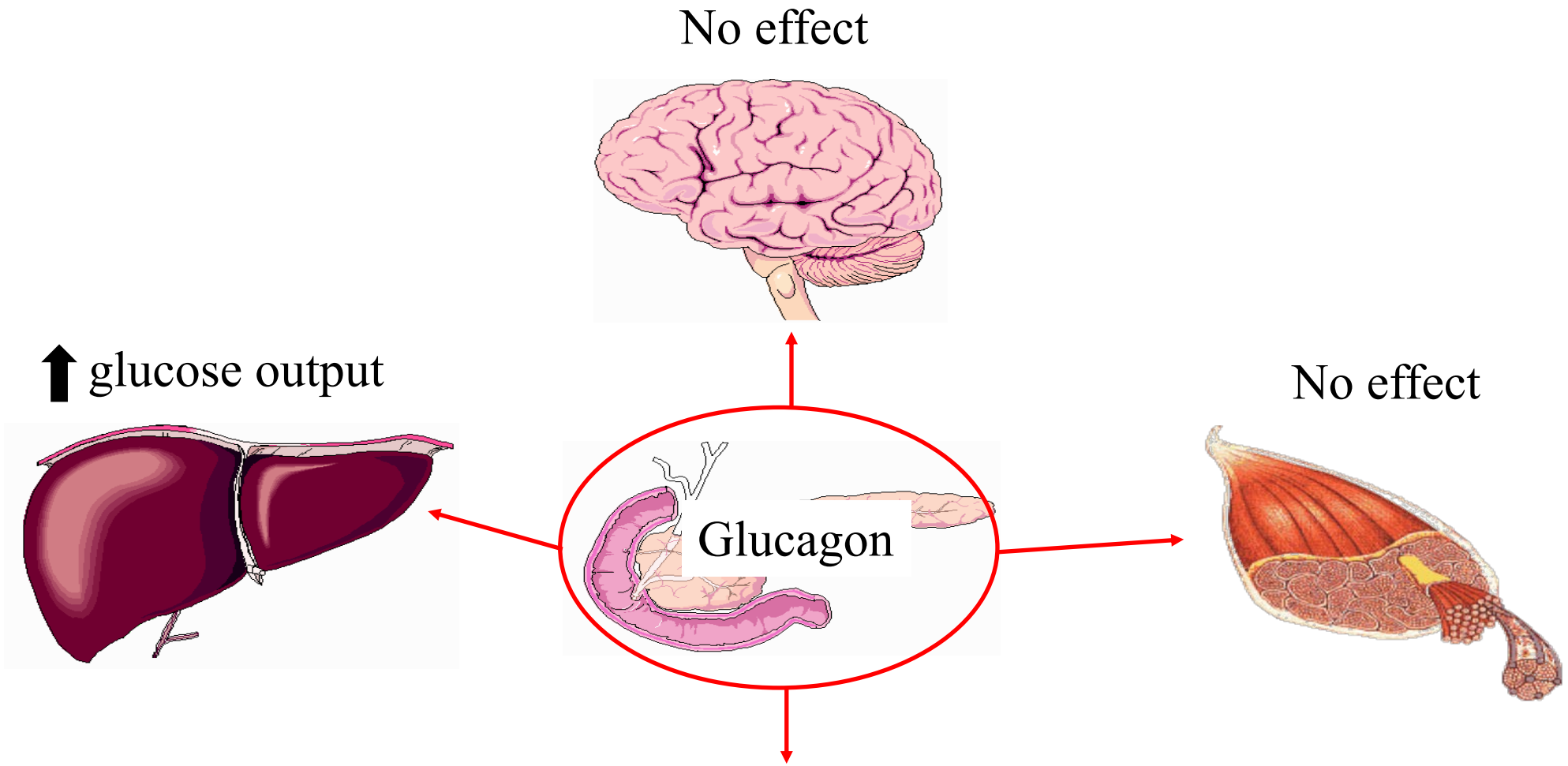
- **Three different types of exercise – flexibility, aerobic & anaerobic**
- ***Three hormones involved with exercise***
- Glucose response is different for the three types of exercise

Insulin – hormone 1

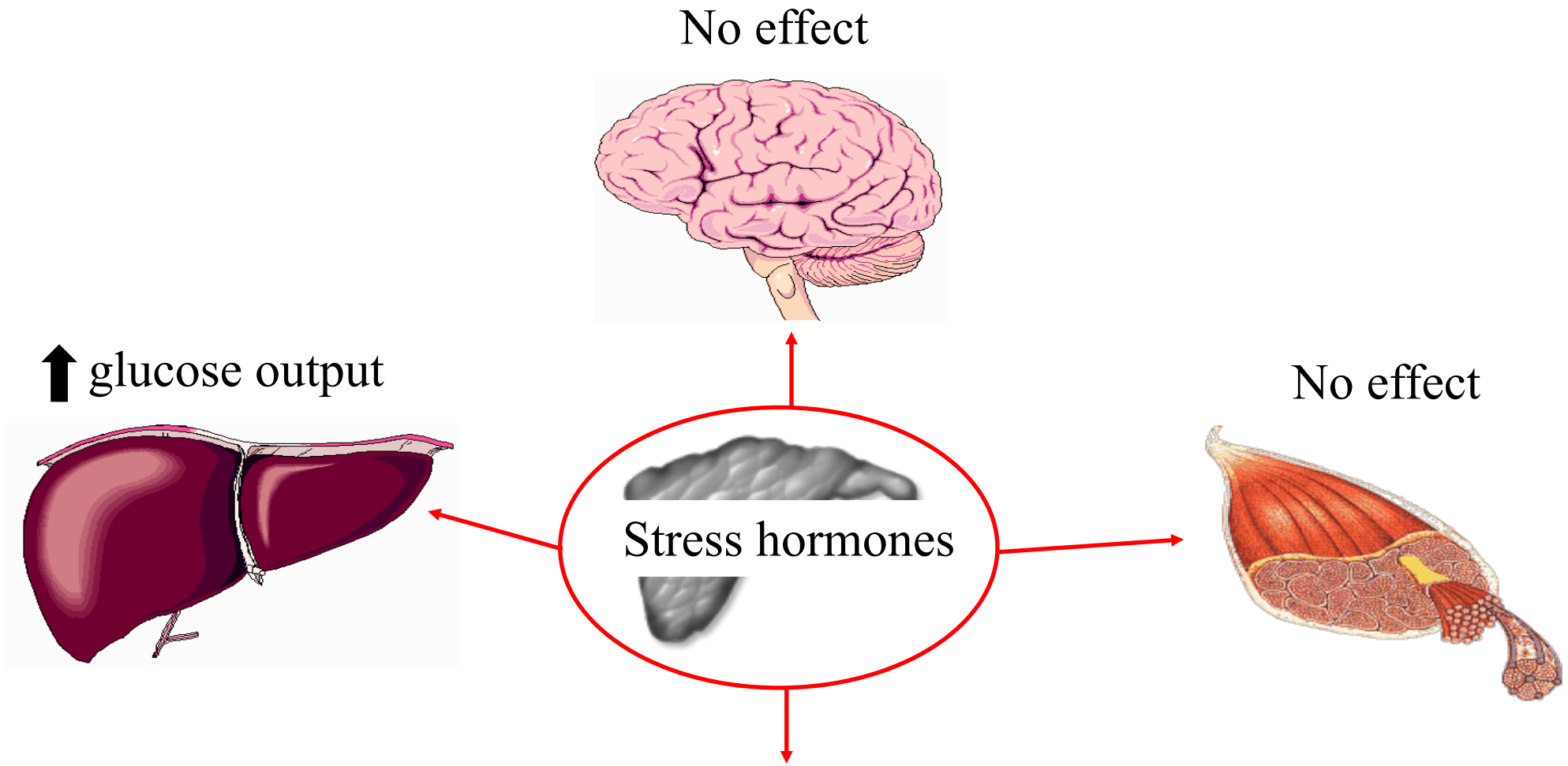


So lowers blood glucose

Glucagon – hormone 2



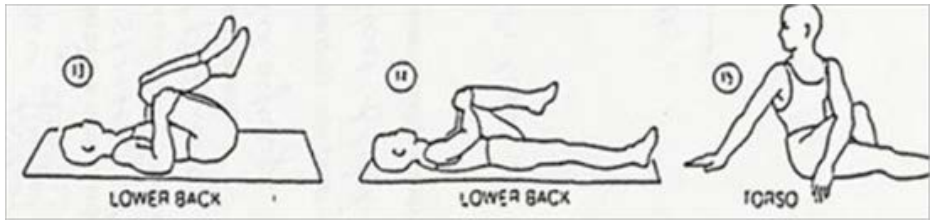
Three Hormones involved in exercise



The physiology of exercise– the rule of three's

- Three different types of exercise – flexibility, aerobic & anaerobic
- **Three hormones involved with exercise – Insulin, glucagon and stress hormones**
- ***Glucose response is different for the three types of exercise***

Normal glucose control during flexibility exercises



ADRENALS

PANCREAS

↓ **insulin**
↑ **glucagon**

Small amount glucose released from liver

Normal Glucose

Blood

Small amount glucose used by muscle

LIVER

MUSCLE

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Normal glucose control during aerobic exercise

ADRENALS

PANCREAS

↑ Stress hormones

↓ insulin
↑ glucagon

If exercise intense
And prolonged then
Glucose may fall below
3.5 mmol/l

Moderate amount of glucose released from liver

Small fall in Glucose

Moderate amount of glucose used by muscles

LIVER

Blood

MUSCLE

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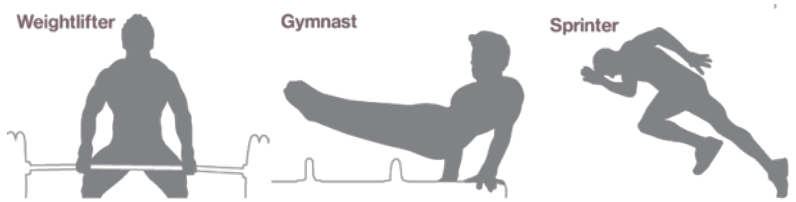
Normal glucose control during anaerobic exercise



ADRENALS

↑↑↑↑↑↑↑↑
Stress hormones

PANCREAS

↑ **insulin**
↓ **insulin**
↓ **glucagon**
↑ **glucagon**

Large amount of glucose released from liver

Normal Glucose

Moderate amount of glucose used by muscles

LIVER

Blood

MUSCLE

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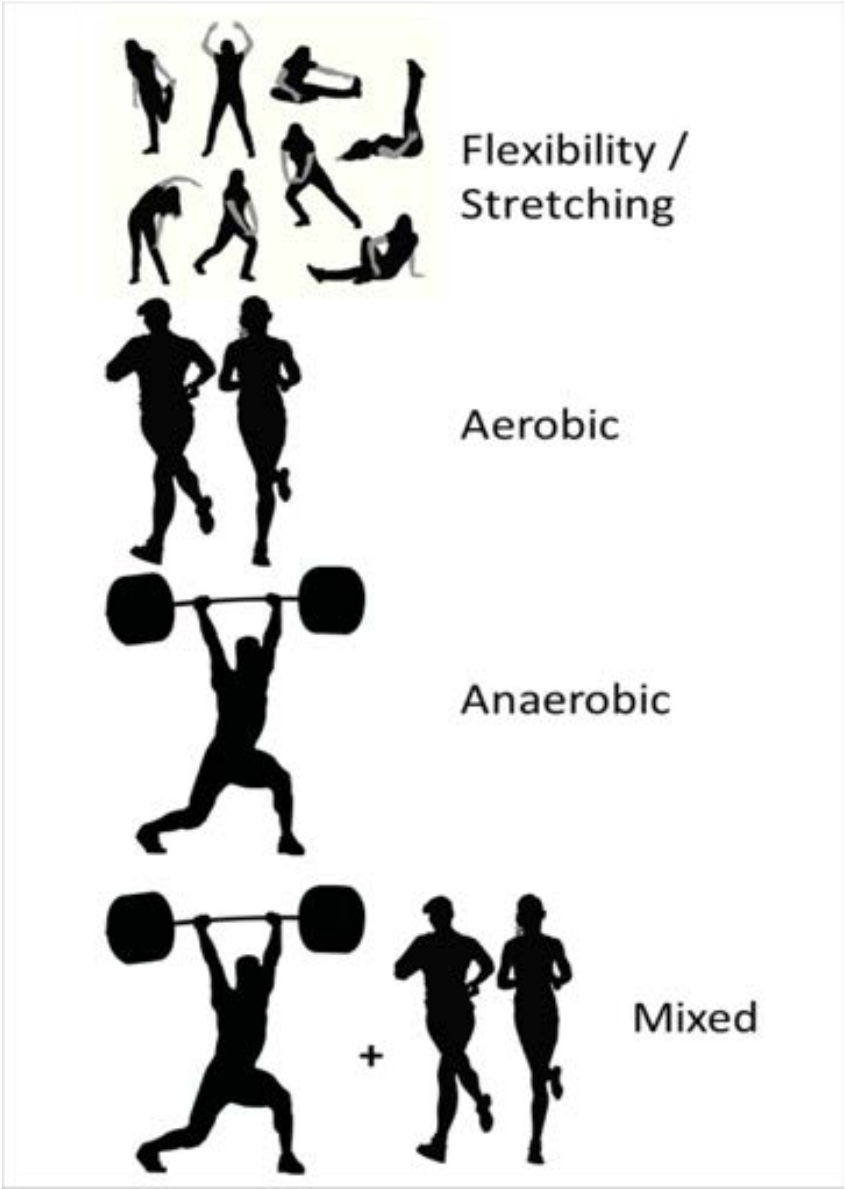
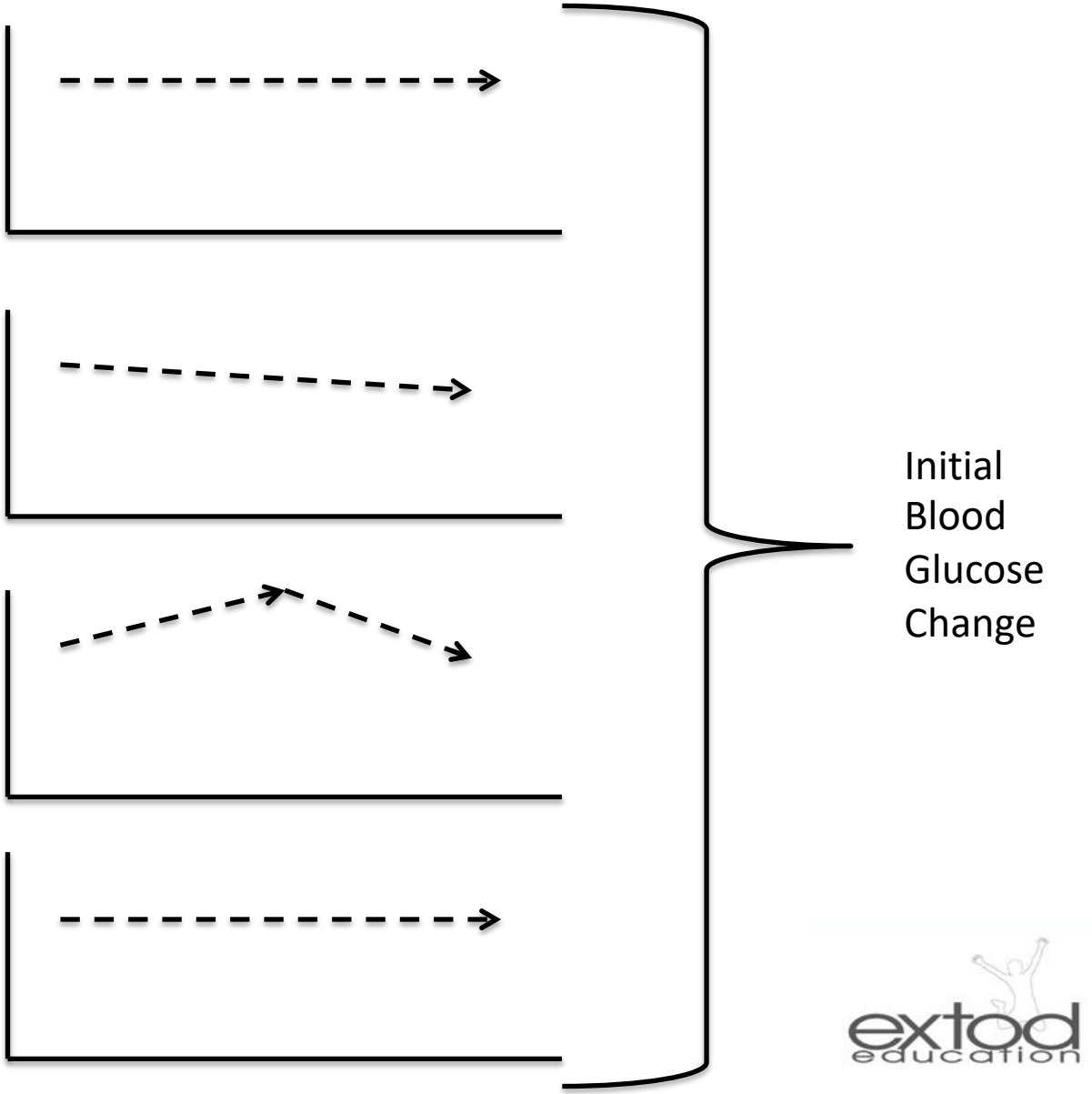
Glucose responses to different exercises in NORM





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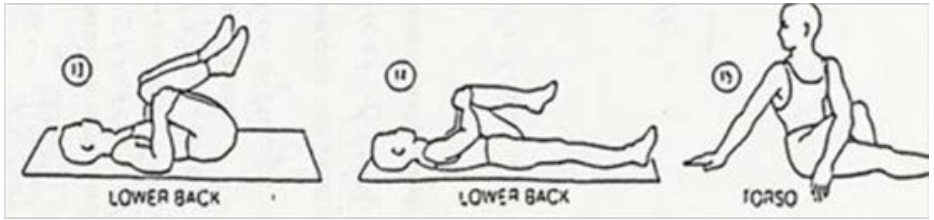
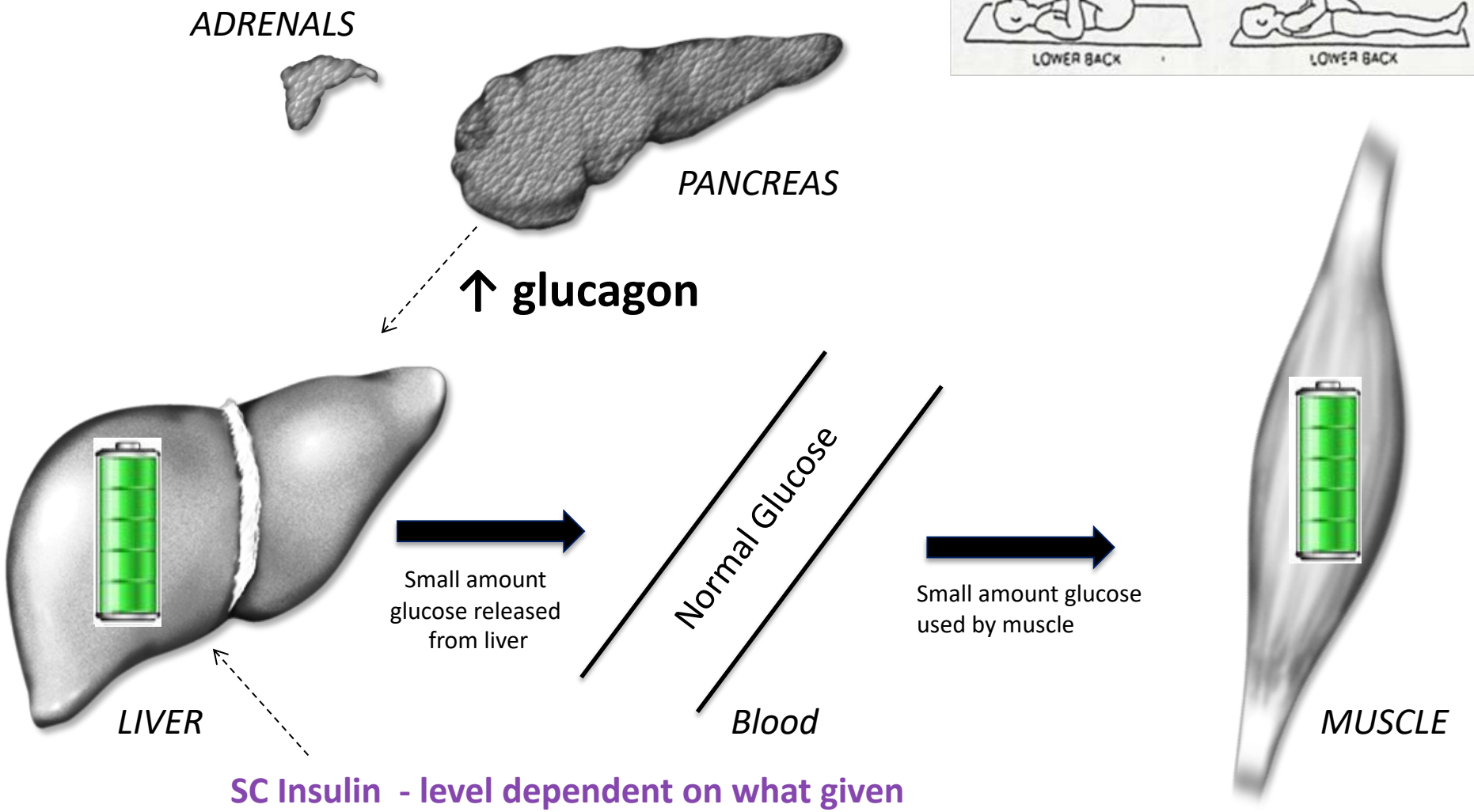
The physiology of exercise– the rule of three's

- Three different types of exercise – flexibility, aerobic & anaerobic
- Three hormones involved with exercise – Insulin, glucagon and stress hormones
- **Glucose response is different for the three types of exercise- Stays same with flexibility, slight fall with aerobic and rise and then normalisation with anaerobic**

Glucose control during flexibility exercises in type 1 diabetes





SC Insulin - level dependent on what given

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Glucose control during aerobic exercise in type 1 diabetes

ADRENALS

↑ Stress hormones

PANCREAS

↑ glucagon

Food may be Needed

LIVER

Moderate amount of glucose released from liver

Varied Glucose

Blood

Moderate amount of glucose used by muscles

MUSCLE

SC Insulin - level dependent on what given

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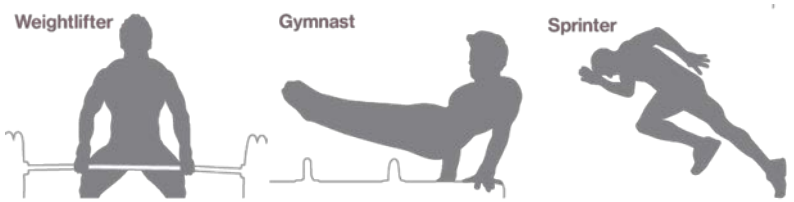
Glucose control during anaerobic exercise in type 1 diabetes



ADRENALS

PANCREAS

↑↑↑↑↑↑↑
Stress hormones

↑ glucagon

May finish with High Blood glucose

High Glucose

Large amount of glucose released from liver

Moderate amount of glucose used by muscles

LIVER

Blood

MUSCLE

SC Insulin - level dependent on what given

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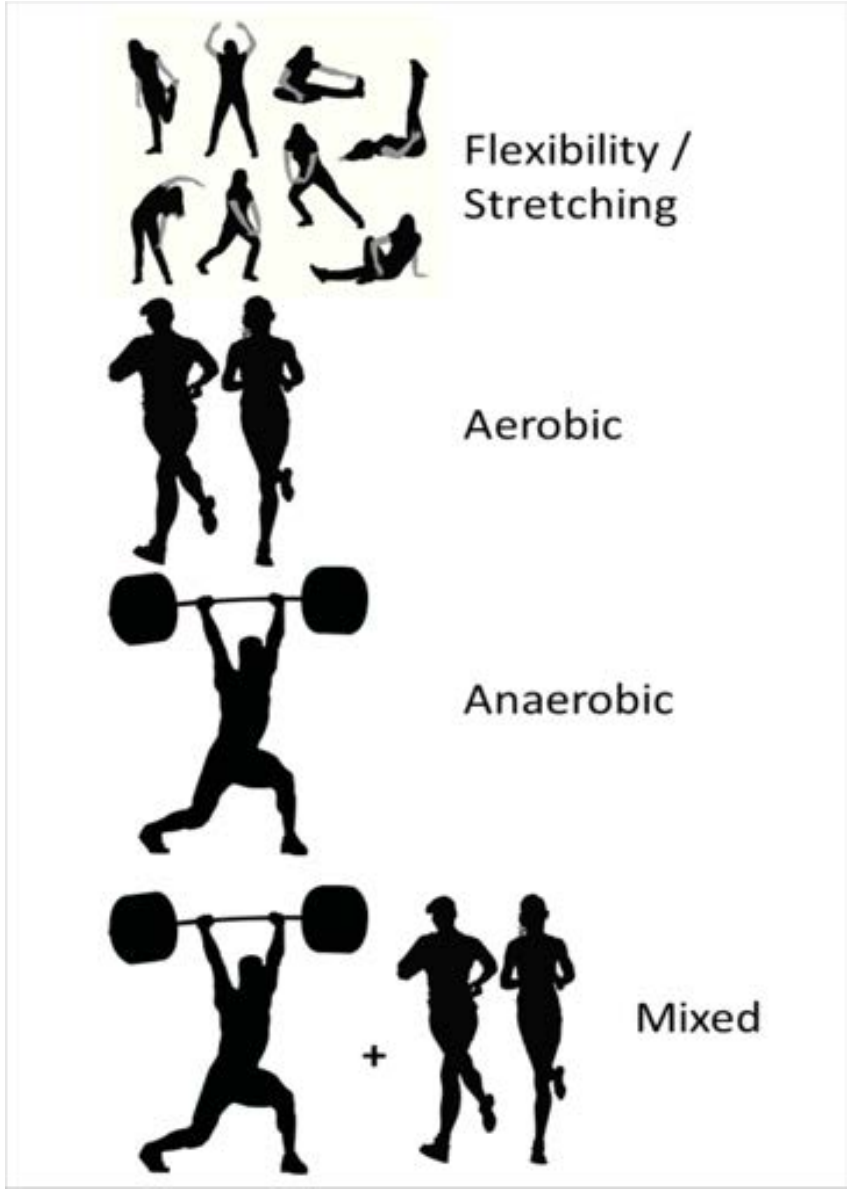
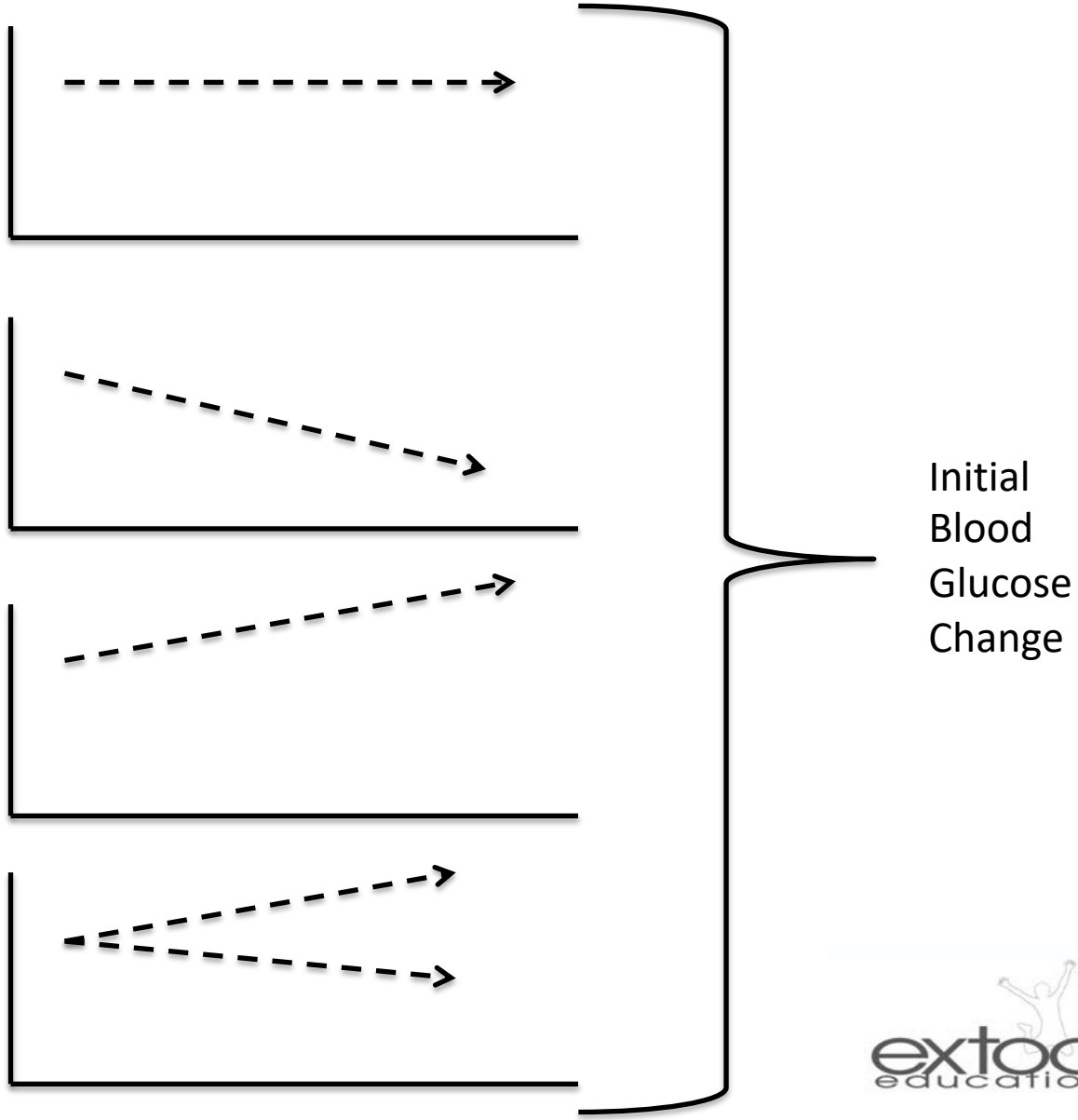
Glucose responses to different exercises in TOD





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The physiology of exercise– the rule of three’s

- Three different types of exercise – flexibility, aerobic & anaerobic
- Three hormones involved with exercise – Insulin, glucagon and stress hormones
- Glucose response is different for the three types of exercise- Stays same with flexibility, slight fall with aerobic and rise and then normalisation with anaerobic. **This glucose response is more diverse in patients with Type 1 Diabetes**.

CASES

Case 1

Charlie is a 56 year old accountant
Diagnosed with T1DM 25 years ago

Current treatment

- Lispro 1:15 (B'fast), 1:10 (lunch), 1:10 (dinner)
- Tresiba 38 units nocte
- Atorvastatin 20 mg od. Ramipril 10 mg od, Nifedipine (Adalat LA 30 mg od)

Other medical problems

- Hypertension
- Retinopathy previously requiring laser therapy a year ago.
- Microalbuminurea
- Peripheral neuropathy with loss of sensation of both feet
- Hypoglycaemic aware

Case 1 - continued

Measures

- Weight 97Kg, BMI 29
- HbA1c 68mmol/mol. BP 140/85

Target

- New to running
- Wants to run a 10K in 8 months time

Case 1 - continued

Questions from patient

- Am I safe to do the 10 k run?
- Do I need to make any changes to my medication?
- What is a good starting blood glucose for exercise?
- Is there a simple way to keep my glucose stable during exercise?
- Is there anything I should specifically do to stay safe?

Additional questions

- Would your advice change if she had
  - Proteinuria?
  - Severe nonproliferative retinopathy?
  - Autonomic neuropathy?

Learning goals for case 1

- How to assess someone with Type 1 new to exercise
- Risks associated with different diabetes complications
- Starting advice on staying safe with exercise

Assessment – keys things to look at

Current approaches to managing T1DM - Check glucose regularly, carbohydrate counting and as good control as can get.

Insulin regime - MDI or Pump best, Ultralong insulins can be problem

Insulin injection techniques and site - The aim to reduce day-to-day variation in insulin absorption and to avoid accelerated absorption of insulin when exercising.

Hypoglycemia frequency and awareness - History of how often and whether aware

Diabetes complications - Some diabetes complications restrict what people with T1DM can do, others suggest that further investigations should be done before exercise is started

Review of calorie intake - Ensuring adequate fuel and fluid replacements is **one of the most important** components in ensuring safe and effective training in people with T1D.

A detailed history of exercise program - The type, duration and intensity of exercise will determine blood glucose fluxes both during and after exercise and advice given.

History of performance in training and competition - The approach to glucose management (for example the starting blood glucose) may need to be different in training and competitive events

Exercise and Macrovascular complications

Complications	Advice
Stable known Coronary heart disease	• All activities fine
Known exertional angina	• All activities okay, but heart rate should be kept >10 bpm below onset of exercise-related angina
New chest pain	• Needs to be assessed by Doctor before starting exercise
Hypertension	• Both aerobic and resistance training may lower resting blood pressure. • Some blood pressure medications can cause exercise-related hypotension • Ensure adequate hydration during exercise
Recent MI	• Restart exercise after myocardial infarction in a supervised cardiac rehabilitation program. • Start at a low intensity and progress and increase intensity slowly • Both aerobic and resistance exercise are okay
Recent stroke	• Restart exercise after stroke in a supervised environment/ program. • Start at a low intensity and progress and increase intensity slowly • Both aerobic and resistance exercise are okay
Congestive heart disease	• Check symptoms are not worsening • Low or moderate intense activity best • Avoid activities that cause an excessive rise in heart rate
Peripheral artery disease	• All Activities ok. • Resistance training of affected limbs can improve functional performance (McDermott MM 2009) • Low intensity walking also improves symptoms (Pena KE 2009).

Exercise and Microvascular complications

Nerve diseases	
Complications	**Advice**
Peripheral neuropathy	• All forms of activity fine. • Regular aerobic exercise may prevent the onset or delay the progression of peripheral neuropathy (Balducci S 2006) • Check feet regularly • Wear appropriate shoes and keep feet dry • Do not do weight bearing exercises if have active Charcot
Local foot deformities	• All forms of activity fine but focus more on non-weight bearing exercises to reduce plantar pressure • Check feet regularly • Wear appropriate shoes and keep feet dry
Foot ulcers/ amputations	• All forms of activity fine • Exercise does not increase risk of foot ulcers or reulceration with peripheral neuropathy (Lemaster JW 2008). • Avoid weight-bearing activity with unhealed ulcer • Check feet/amputation site regularly
Autonomic neuropathy	• Cardiac investigations should be carried out before beginning exercise of greater intensity than normal • Addition care taken as high risk of hypoglycaemia • Avoid exercising in extreme heat • With blunted heart rate response, use heart rate reserve and ratings of perceived exertion to monitor exercise intensity (Colberg SR 2003) • With postural hypotension, avoid activities with rapid postural or directional changes to avoid fainting or falling.

Exercise and Microvascular complications

Eyes diseases	
Complications	**Advice**
Mild to moderate nonproliferative retinopathy	• Little risk of eye damage from physical activity • Ensure annual eye exam
Severe nonproliferative and unstable proliferative retinopathy	• Individuals with unstable diabetic retinopathy are at risk for vitreous haemorrhage and retinal detachment • Avoid vigorous intense activity or doing powerlifting (very heavy weights)
Vitreous haemorrhage	• Do not exercise • Only exercise when given clearance by ophthalmologist
Cataracts	• Cataracts do not limit ability to exercise • But may affect safety due to limited vision
Kidney disease	
Complications	**Advice**
Microalbuminuria	• All forms of activities fine • Regular aerobic exercise may also prevent the onset or delay the progression of diabetic nephropathy (Robinson-Cohen C 2014 and Waden J 2015).
Overt nephropathy	• All forms of activities fine • Both aerobic and resistance training improve physical function and quality of life in individuals with kidney disease
End-stage renal disease	• All forms of activities fine but start at low intensity • Electrolytes should be monitored when activity done during dialysis sessions. • Doing supervised, moderate aerobic physical activity undertaken during dialysis sessions may be beneficial and increase compliance (Koh KP 2010)

Checklist for exercising safely

Checklist	Person with out T1DM	Person with T1DM
Carb supplements – drinks, snacks	✔	✔
Mobile phone if exercising alone	✔	✔
Water or isotonic (calorie free) sports drinks to maintain hydration	✔	✔
Appropriate footwear and clothing for the exercise you plan to do	✔	✔
Suitable hypo treatment	✖	✔
Medical card and/or bracelet/necklace	✖	✔

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 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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Starting blood glucose

Blood glucose concentrations	Recommendations (rule of thumb)
<5.6 mmol/L	▪ Ingest 20g of glucose before exercise ▪ Delay exercise until blood glucose >5.6 mmol/L
5.7 – 6.9 mmol/L	▪ Ingest 15g of glucose ▪ Exercise can be started
7 – 14 mmol/L	▪ exercise can be started
>15 mmol/L	Check blood ketones ▪ If greater than 1.5 mmol/L take normal corrective dose of insulin and do not exercise until have gone. ▪ If less than or equal to 1.5 mmol/L take 1/3 of normal corrective dose of insulin if not eaten in last 2 hours and start to exercise, keeping eye on blood glucose and only do low to moderate intense 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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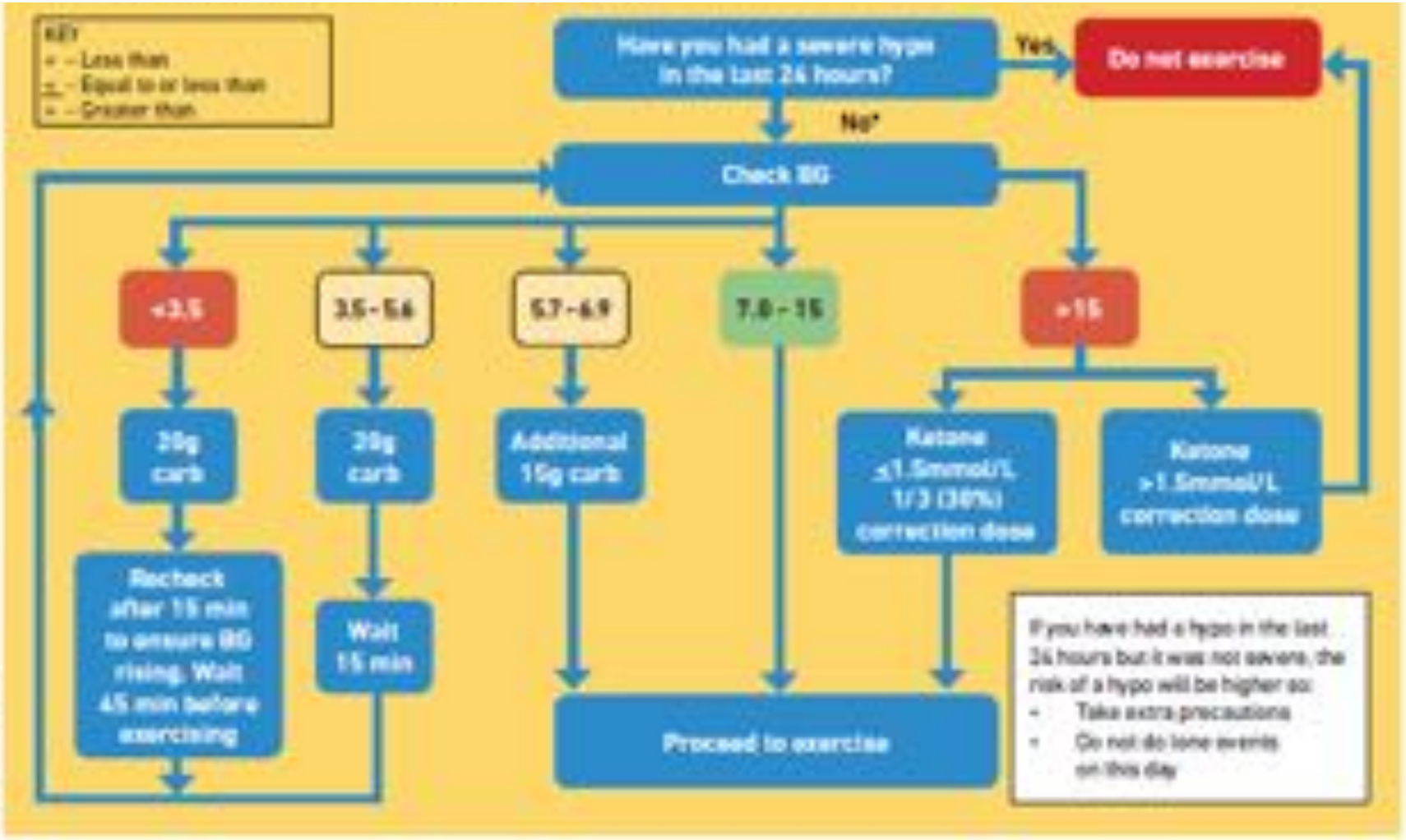
Simple flowchart for glucose and exercise



Addition information for 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

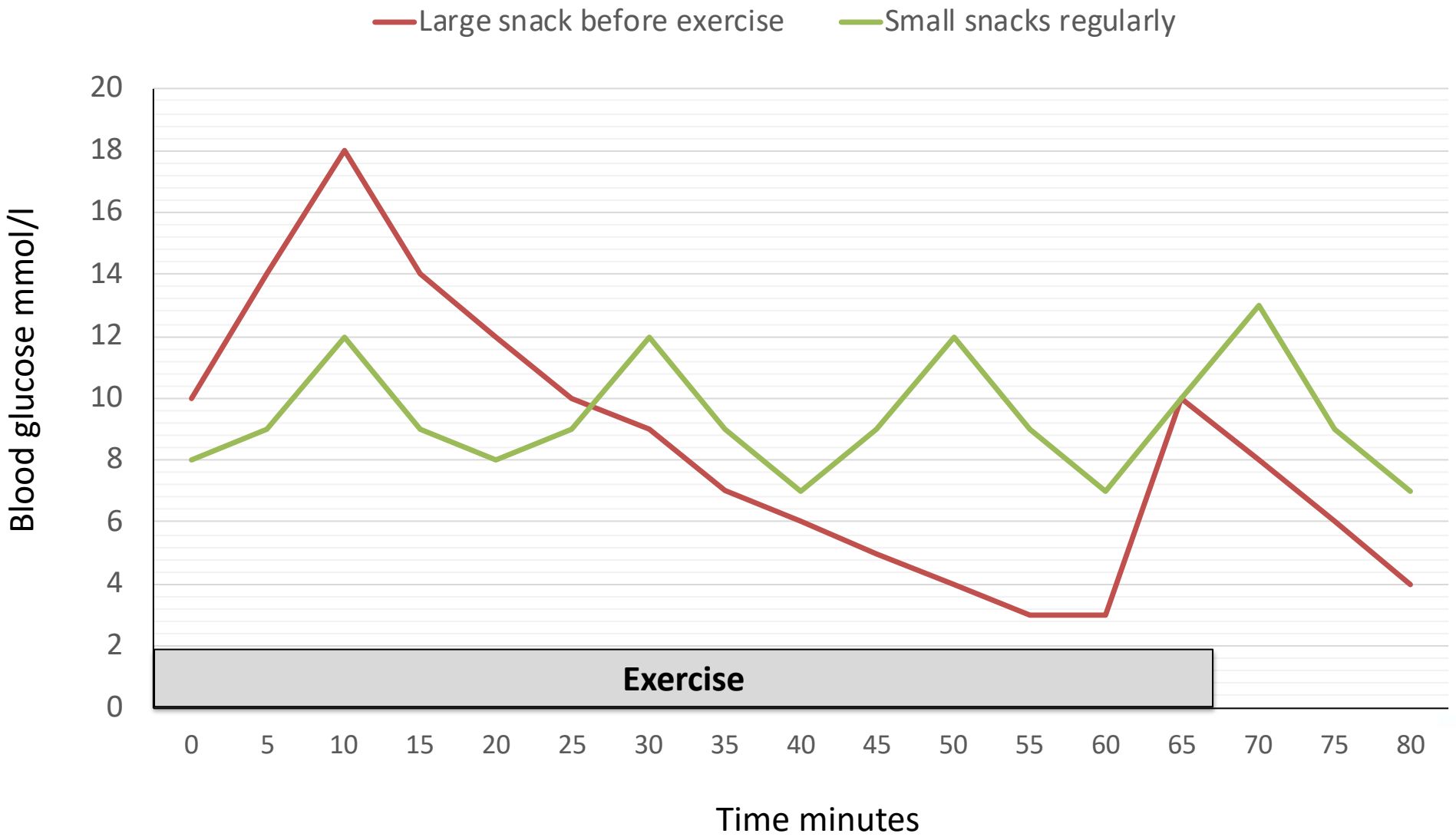
Simple carbohydrate regime

- 30 grams/ hr

Examples of carbohydrates you could try

Carbohydrate source	10 grams	15 grams	30 grams
Jelly Babies (large)	2	3	6
Jelly Beans	6	9	18
Cola	100 ml	150ml (mini can)	300ml
Lucozade Body Fuel Energy Gel	1/3 X 45g tube	½ X 45g tube	1 X 45g tube
Apple Juice	80 ml	120ml	240ml
Lucozade Sport Body Fuel	167 ml	250ml	500ml
Powerade Isotonic	133 ml	200ml	400ml
Gatorade	167 ml	250ml	500ml

Take Carbohydrate every 20 minute



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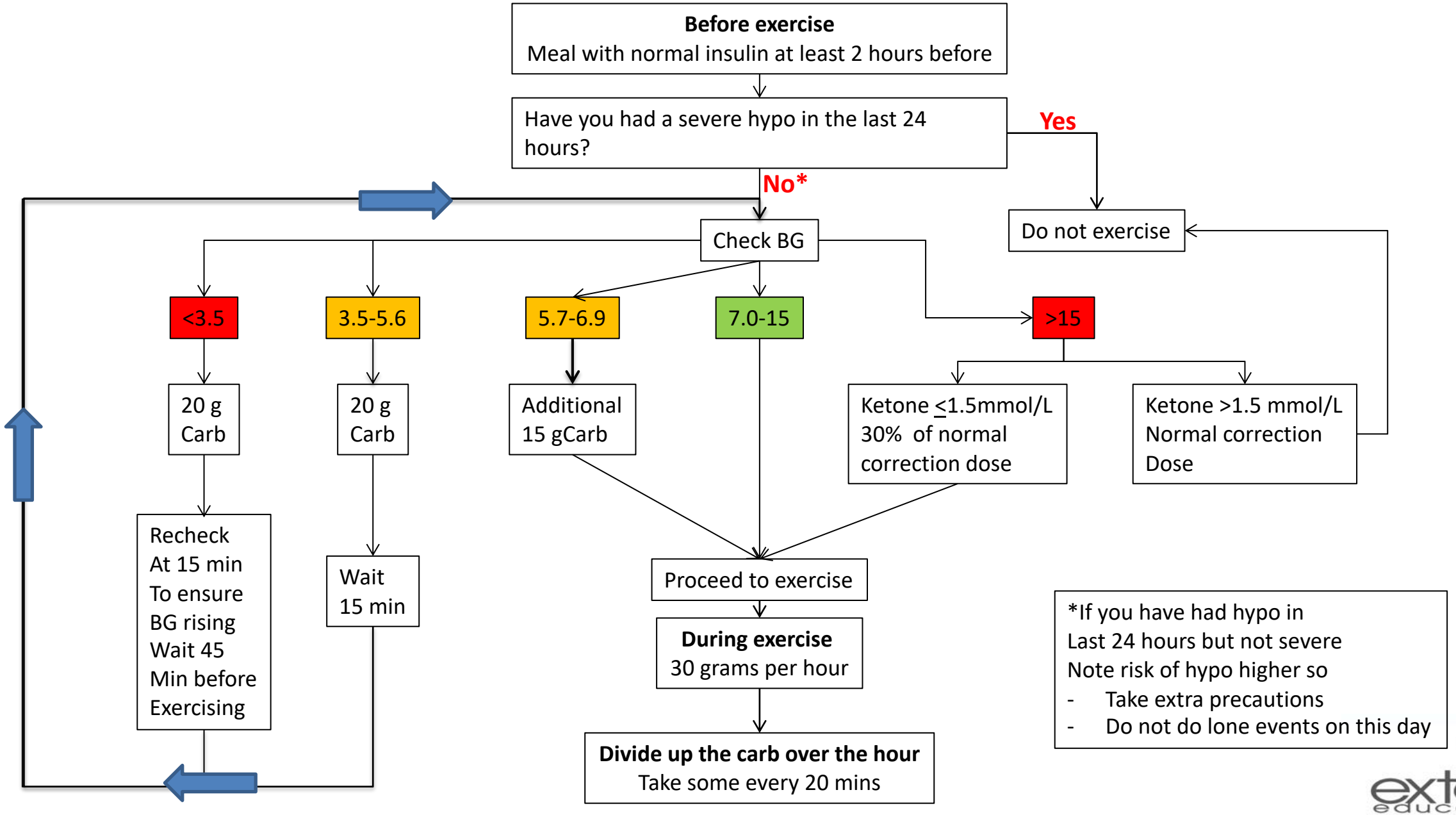
Simple Flowchart for Carbohydrate replacement during exercise



Semi-quantitative method

- In this an estimate of carbohydrate requirements based on body weight. For moderate activity 0.5mg/kg/hr is used and for intense activity 1mg/kg/hr is used.

- For example: Rob wishes to exercise at intense activity for 60 minutes. He weighs 90 kg so will take 30 grams at the start, 30 grams at 20 minutes and 30 grams at 40 minutes.

Quantitative method

- To account for the variable fuel requirements of different types of exercise, standardised tables have been devised to help athletes estimate ExCarbs for many different activities with varying intensities according to body weight.

- This activity-specific approach to estimating ExCarbs, although not tested in a clinical trial setting, is a popular resource among active patients with Type 1 Diabetes

Quantitative method

- For example: Rob wishes to cycle for 1 hour at ~ 16 km per hour. Using table below this requires 61 g, so will take 20 grams at the start, 20 grams at 20 minutes and 21 grams at 40 minutes.

Activity	Weight (mass in kg)		
	45 kg	68 kg	90 kg
Baseball	25	38	50
Basketball			
moderate	35	48	61
vigorous	59	88	117
Bicycling			
10 km/h	20	27	34
16 km/h	35	48	61
22 km/h	60	83	105
29 km/h	95	130	165
32 km/h	122	168	214

Using the Borg scale to calculate glucose requirements

- The Borg scale can be used to calculate how much glucose is required for an exercise. This uses the intensity of the exercise.

Pulse	VO_2 max	Borg scale	
60		6	No exertion at all
70		7	Extremely easy
80		8	
90		9	Very easy → 0.5 g/kg/hour
100		10	
110	(65%) 44%	11	Light exertion
120		12	
130		13	Moderate exertion → 1 g/kg/hour
140	(75%) 60%	14	
150		15	Exhausting → 1.5 g/kg/hour
160	(85%) 75%	16	
170		17	Very exhausting → >2 g/kg/hour
180	(92%) 86%	18	
190		19	Extremely exhausting
200	(100%)	20	Maximal exhaustion

Case 1 - continued

Questions from patient

- Am I safe to do the 10 k run? ***Yes, needs to keep close eye on feet***
- Do I need to make any changes to my medication? ***Not immediate but might consider changing tresiba***
- What is a good starting blood glucose for exercise? ***See –flow diagram***
- Is there a simple way to keep my glucose stable during exercise? - ***See flow Diagram***
- Is there anything I should specifically do to stay safe? ***See what to take to stay safe and glucose and exercise slides***

Additional questions

- Would your advice change if she had
  - Proteinuria? ***No***
  - Severe nonproliferative retinopathy? ***Start off less intense , not to do heavy weights***
  - Autonomic neuropathy? ***Yes, investigate for heart disease***

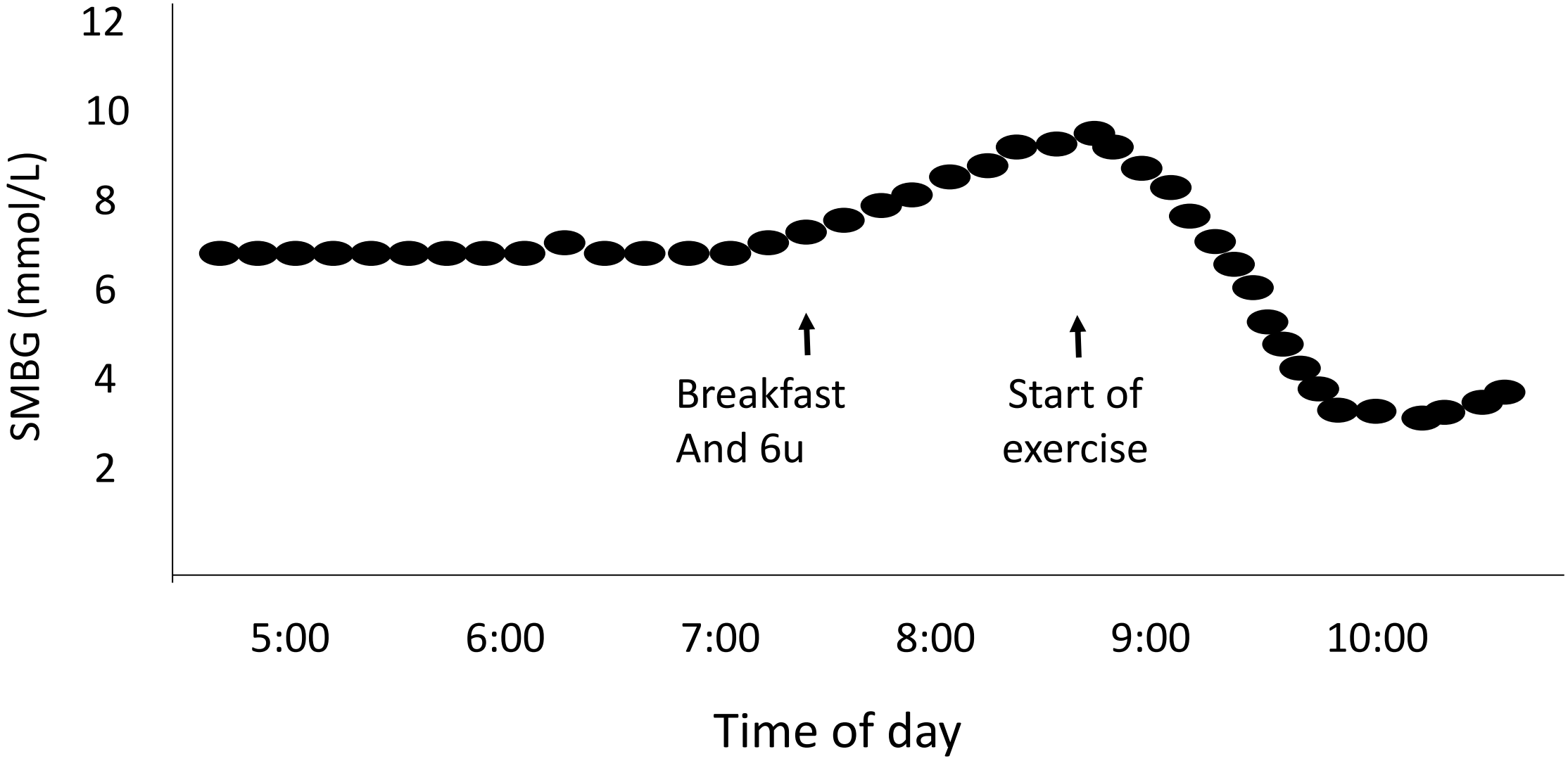
Case 2 - Mark

- 32 year-old cyclist
- Type 1 diabetes since age 15
- Last HbA1 54
- On Humalog 1:10 /1:8/1:8 and Levemir 15
- During training he has been having low blood sugars that stop him training
- What further information do you want?

Case 2- Mark

- He exercises with an hour of breakfast for 2 hours
- For breakfast he takes his normal insulin
- He is trying to lose weight so is not keen to take extra carbohydrates if possible

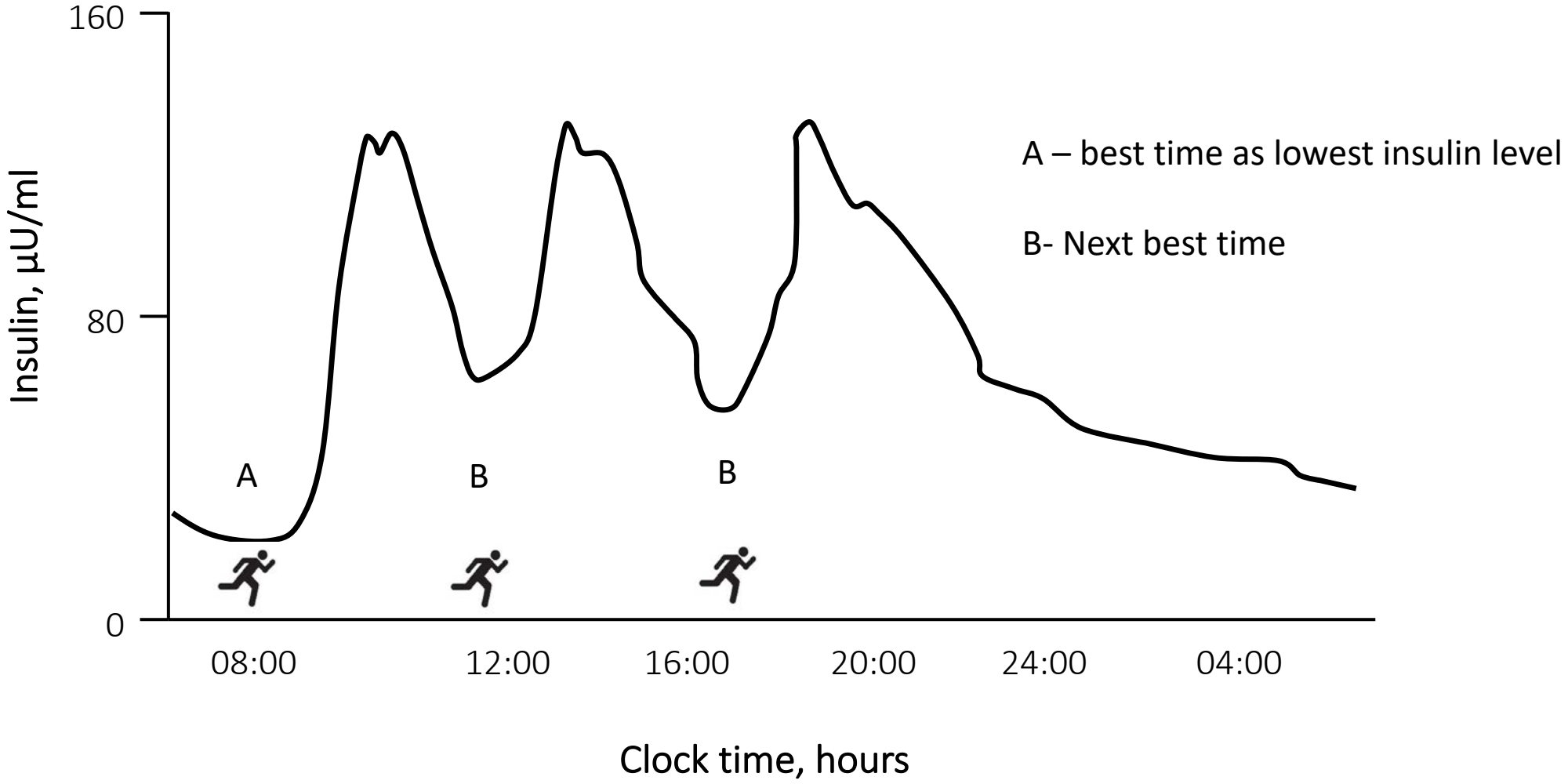
Training day blood glucoses



Case 2 - Mark

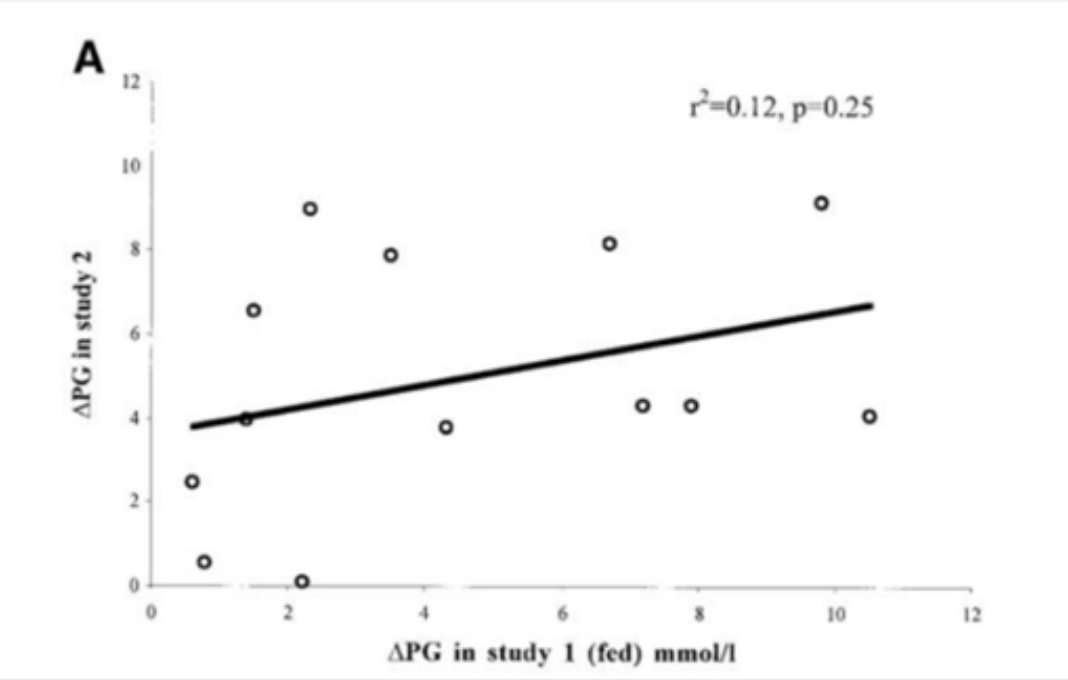
- What would you advise?

Best time to exercise - 1



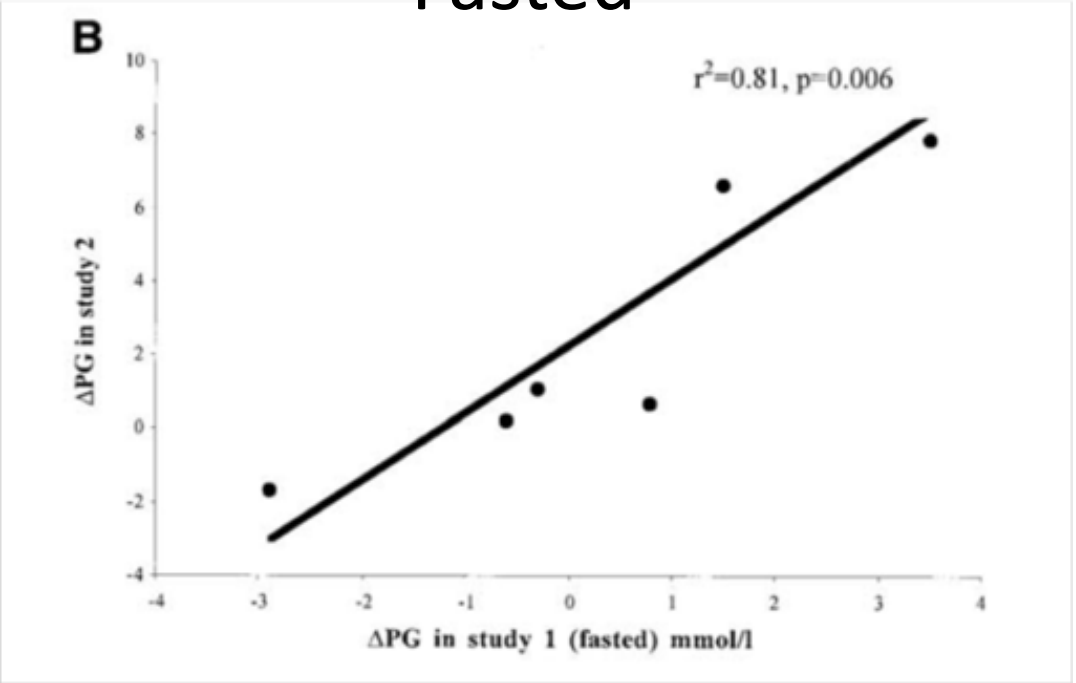
Best time to exercise - 2

Fed



Poor reproducibility in the blood glucose response to aerobic exercise in individuals with T1D in the post meal state

Fasted

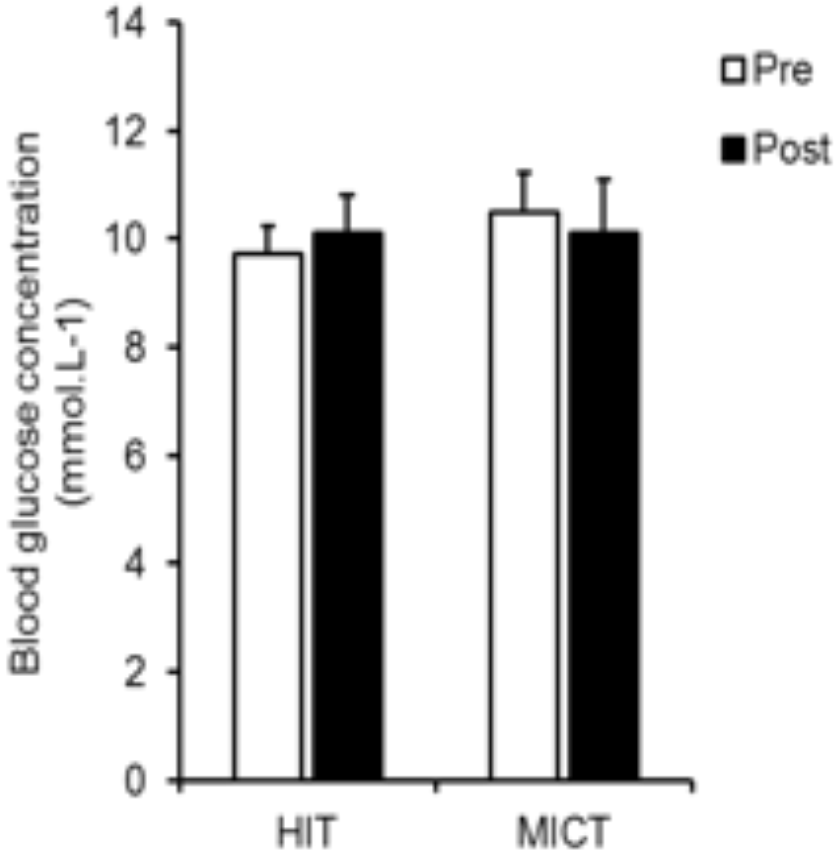


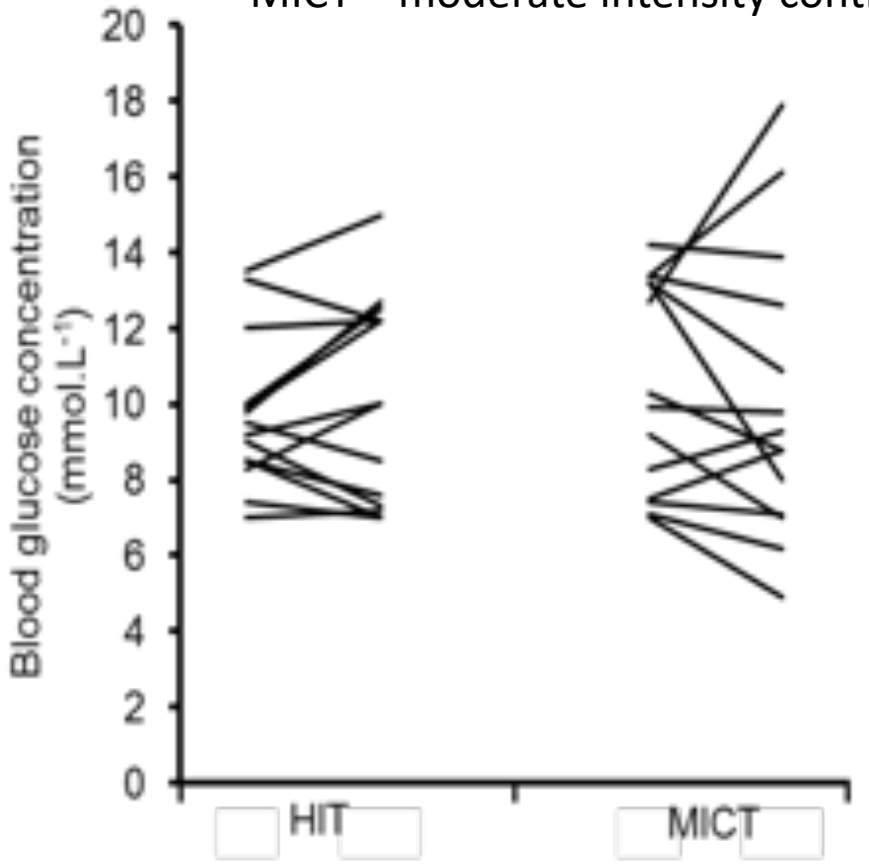
Good reproducibility in the blood glucose response to aerobic exercise in individuals with T1D in the fasted state

Biankin et al., Diabetes Care 2003

Best time to exercise - 3

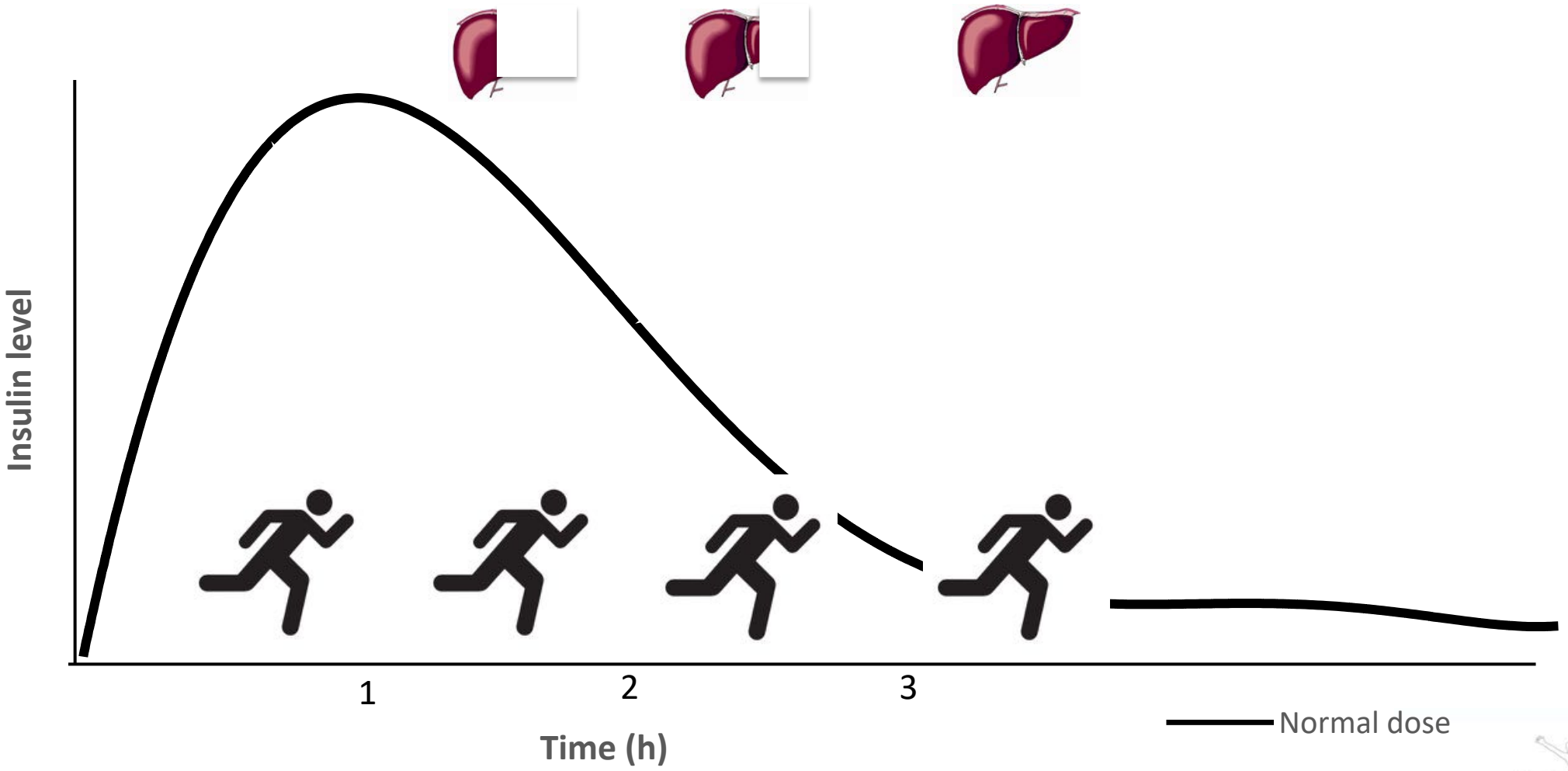
HIT = High intensity exercise
MICT – moderate intensity continuous exercise



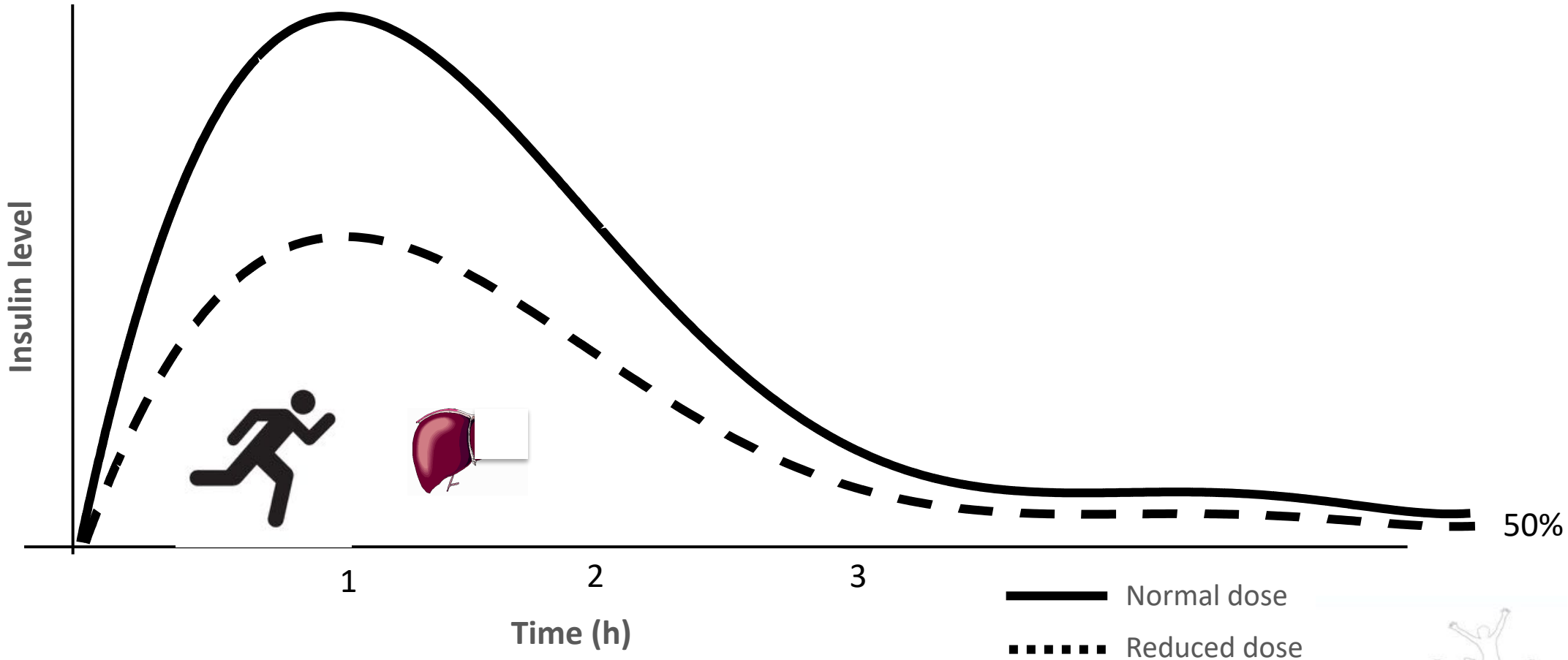


Scott SN et al 2018 - based on 14 people

Liver glucose release and timing of insulin



Affect of lowering fasting acting insulin by 50%

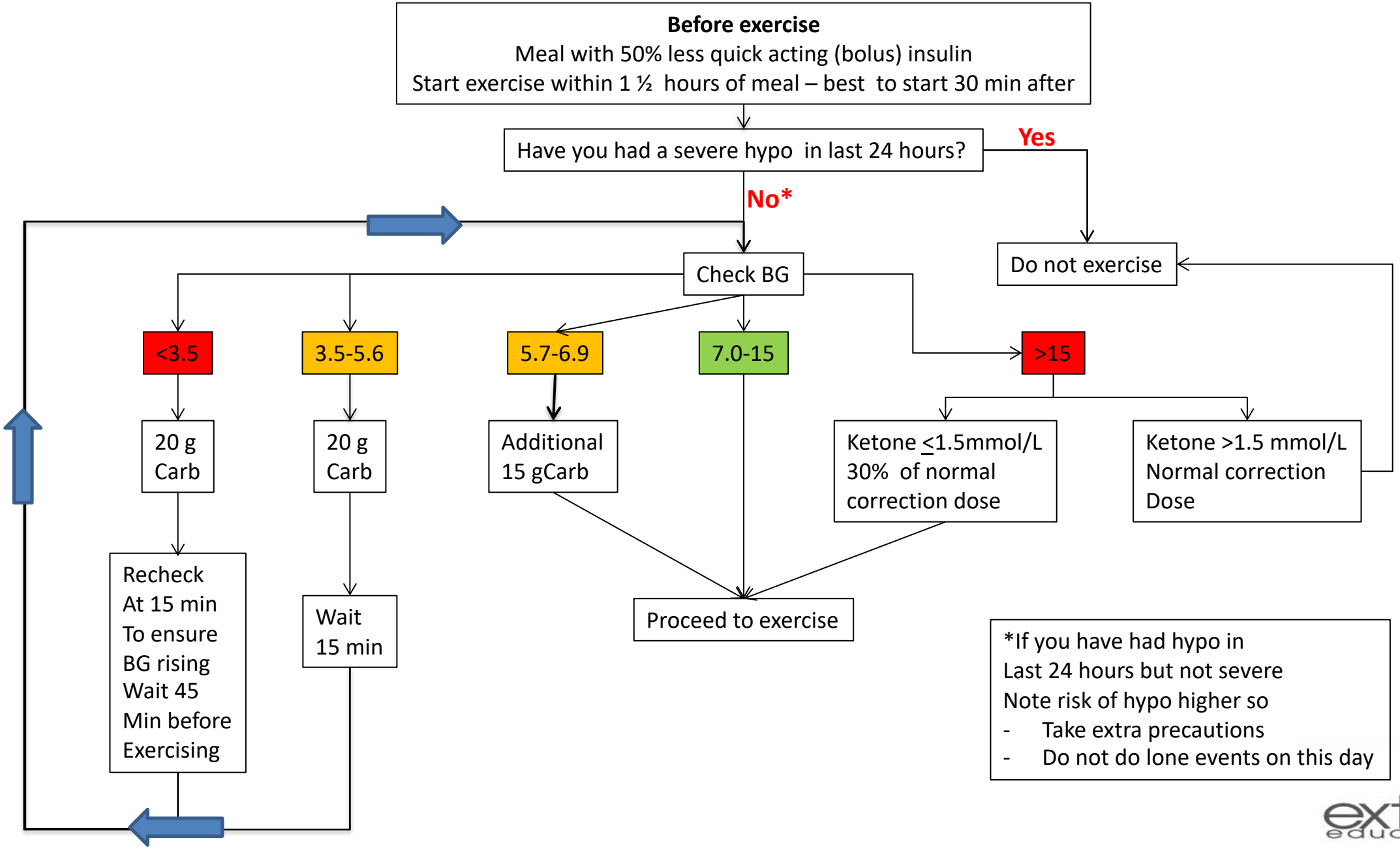


Simple Insulin regime

If exercising within 2 hours of quick acting (bolus) insulin

- Reduce pre-exercise fast acting (bolus) insulin by 50%

Flowchart to for simple Insulin Strategy pre exercise



Case 2 - Mark

Options are

- Exercise fasted
- Eat earlier
- Eat later with greater reduction in insulin

Semi-quantitative method

- Insulin reduction is made dependent on the intensity of the exercise that is going to be preformed. To gain the best advantages from this reduction, exercise is best-performed 30 minutes after eating

	% Dose reduction	
Exercise	**30 min of exercise**	**60 min of exercise**
Low (*<50% MHR or RPE <10)*	25	50
Medium (51-74 MHR or RPE 10-15)	50	75
High (>75 MHR or RPE >15)	75	100

Quantitative method

- For this you will need to know; how much energy will be burnt during exercise, and your insulin carbohydrate ratio. The energy burnt can be based on previous glucose need for that exercise or from one of the carbohydrate tables.

Example 1

- Mark wants to cycle for one hour after breakfast at 16km/hr. He normally takes insulin in ratio 1 unit for 6 grams. For breakfast he has 90 grams of carbohydrate. On his ride he will burn 60 grams of carbohydrate (see table 1 “Exercise carbohydrate” section) above. So the Difference is 90-60 = 30 grams. So he needs to take insulin to cover 30 grams – 5 units, as opposed to his normal 15 units.

Case 2 - Mark

- If Mark was on a pump what initial advice would you give him about reducing his insulin?

Case 2 - Mark

- Reduced bolus by 30- 50% with no change to background if exercising with 2 hours of meal.

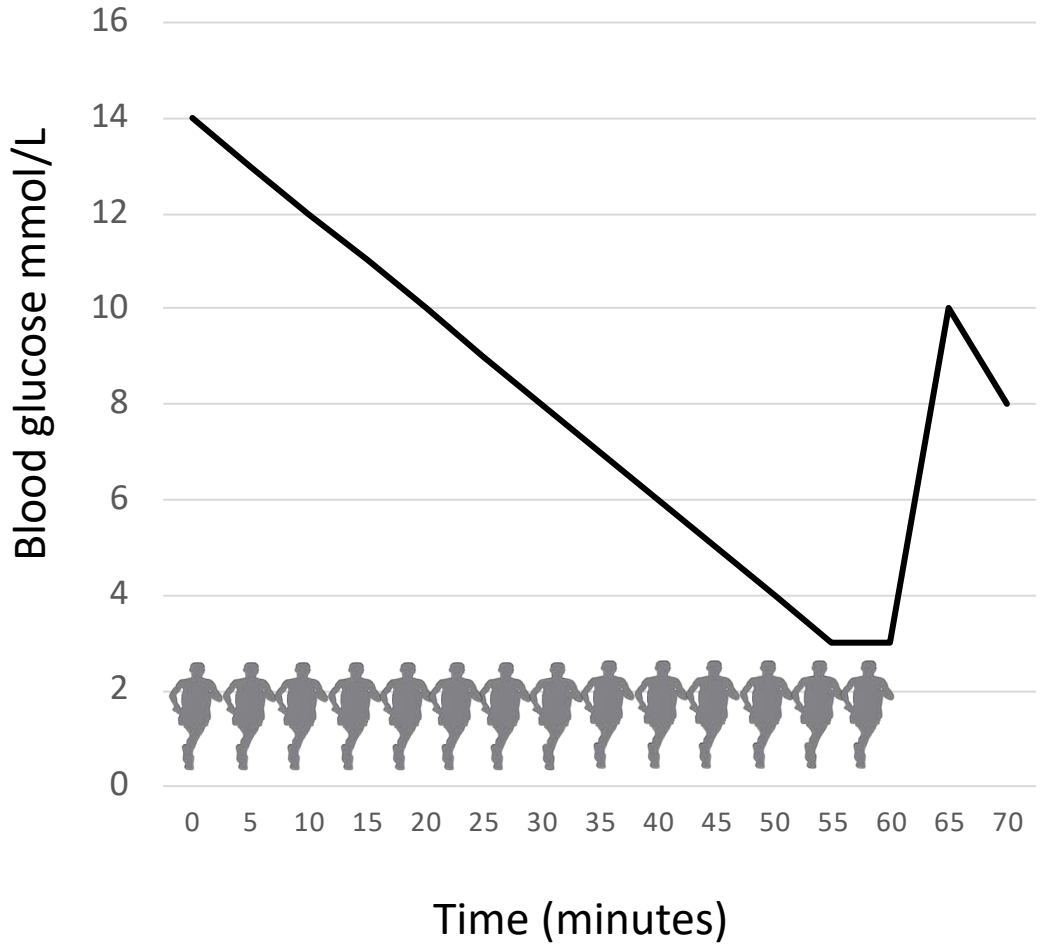
- Reduce background by 80% from 60 minutes before until end of exercise if exercising 2 hours after eating.

Case 2 - Mark

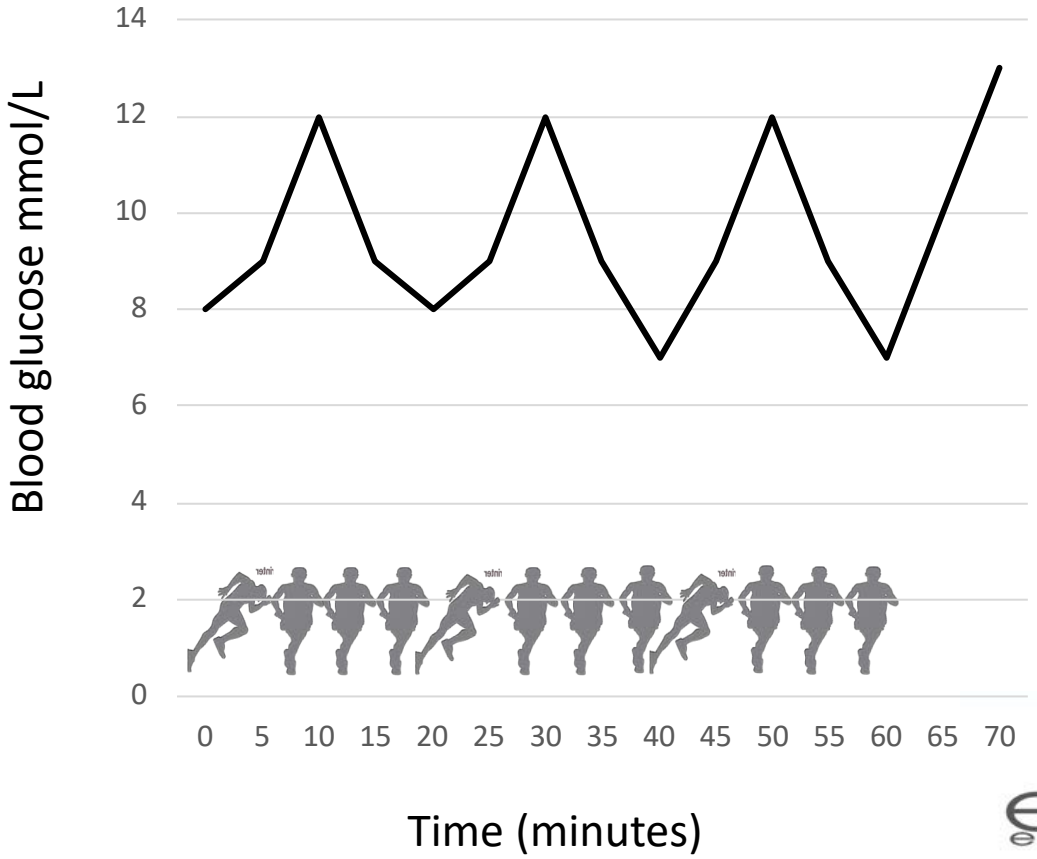
- Is there anything that Mark could do to his exercise regime to help with his blood glucose?

Using intensity of exercise to control glucose

Continuous exercise



Continuous exercise + sprints



extod education

Case 3 - Sally

- 42 year-old
- Type 1 diabetes since age 6
- Last HbA1 84
- On Humalog 1:10/1:10/ 1:8 and Levemir 8 am 12 pm
- She is keen to lose weight and has started going to the gym three times a week
- Half way through her sessions she is having problems with low glucoses
- What further information do you want?

Case 3 - Sally

- At the gym after a warm up she does 20 minutes of cycling , 20 minutes of running and then 30 minutes of weights.

- Her blood sugars starts at 8 falls to 3-4 halfway through run and then finishes at 16 after the weights.

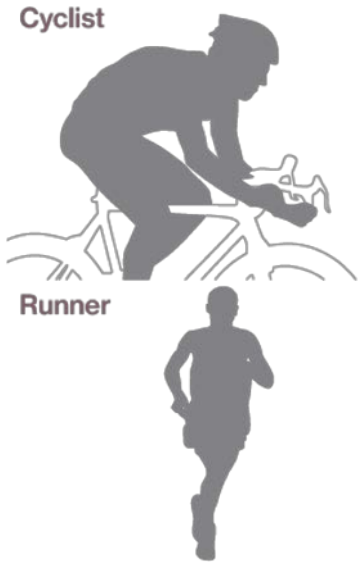
Case 3 - Sally

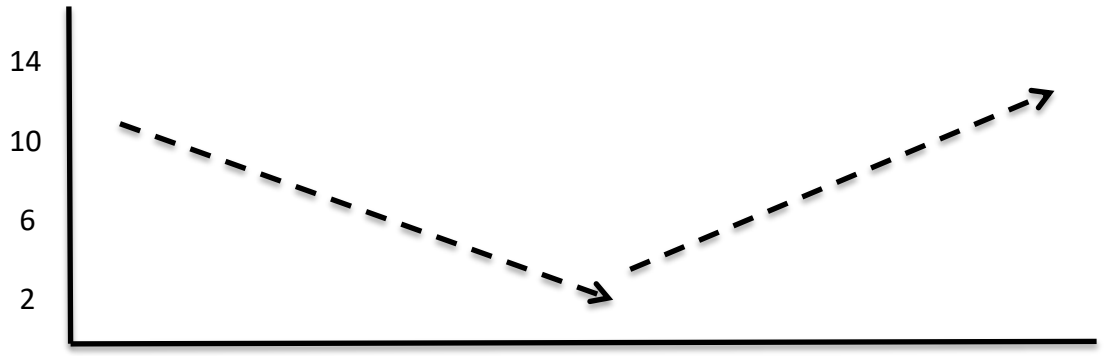
- What advice would you give her?

Order of gym events

Order 1

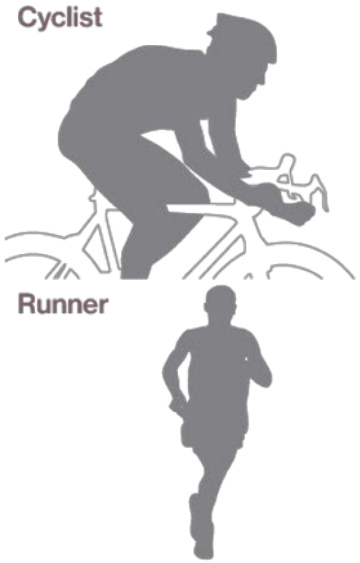
Aerobic then Anaerobic

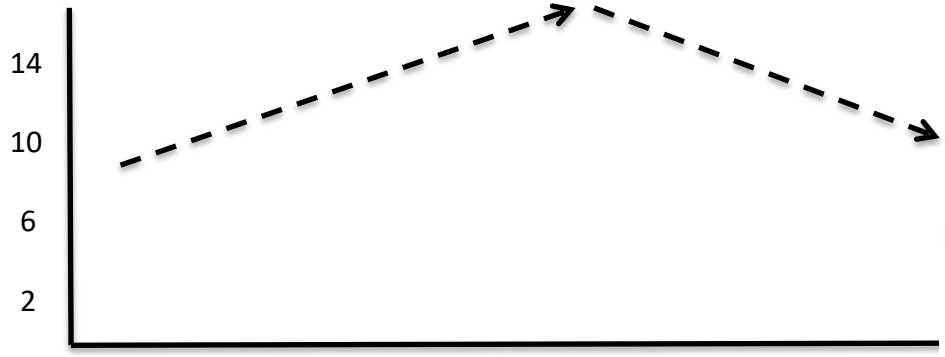




Order 2

Anaerobic then Aerobic





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Case 3 - Sally

- If Sally had a pump and did not want to change the order of her exercise what could she do?

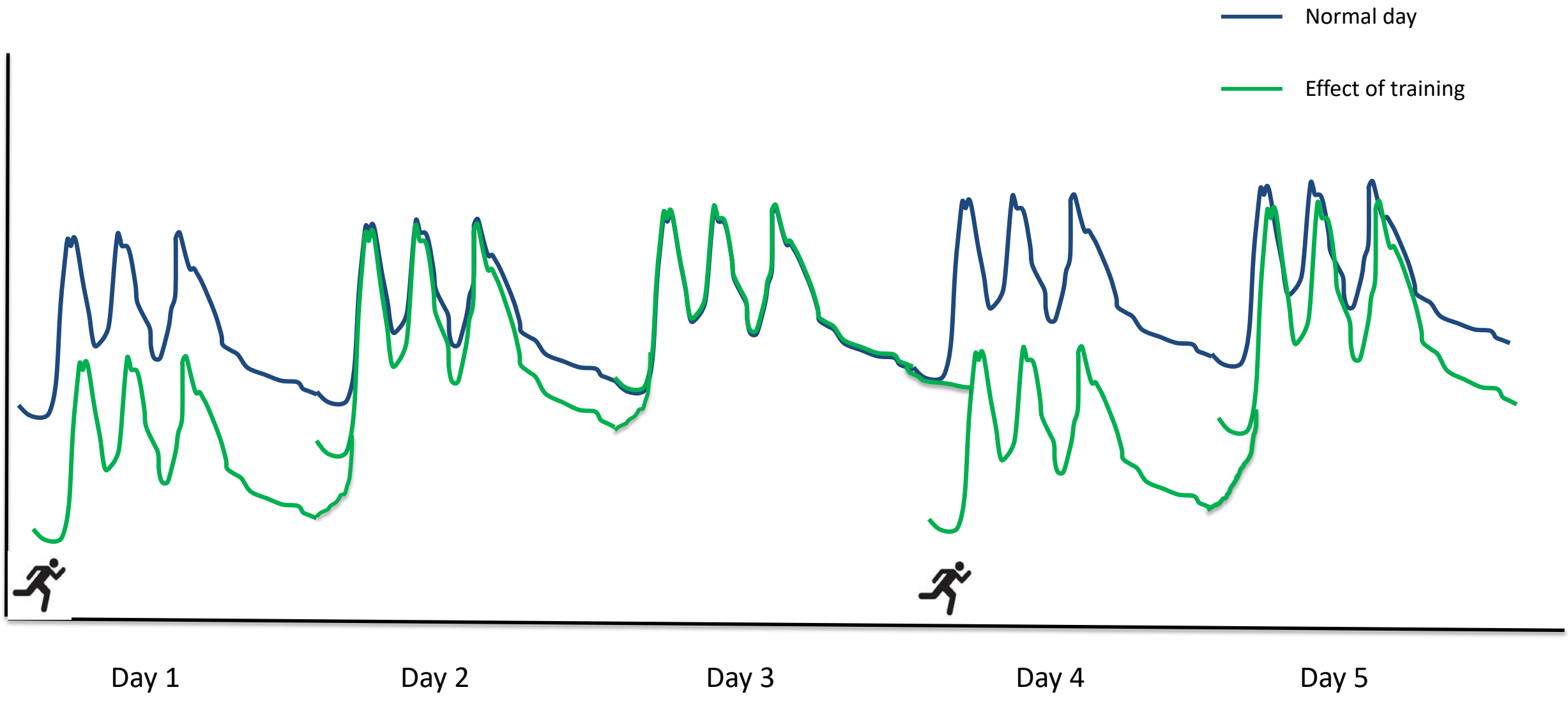
Case 3 - Sally

- Changing the order of her gym session has helped control her blood sugars.

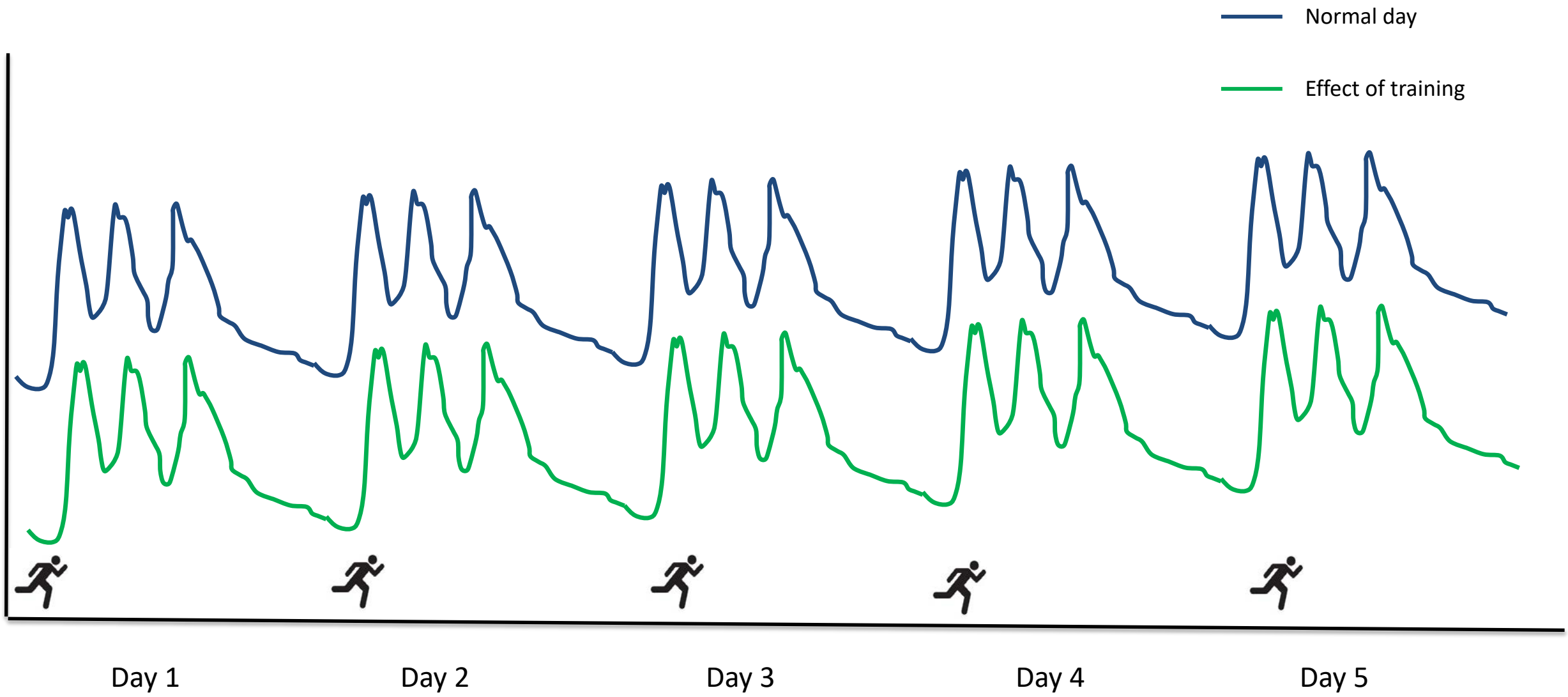
- But for 36 hour after exercising she has to reduce her insulin to stop going low and then she has to increase her insulin for the next 24 hours until she exercises.

- Is there anything she can do to help with this?

Exercise 2-3 times per week

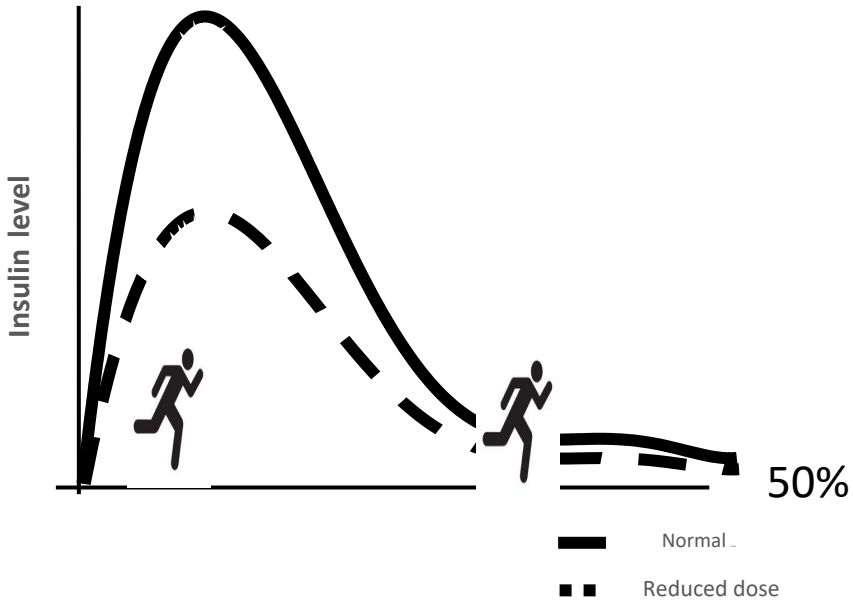


Exercise every day of week



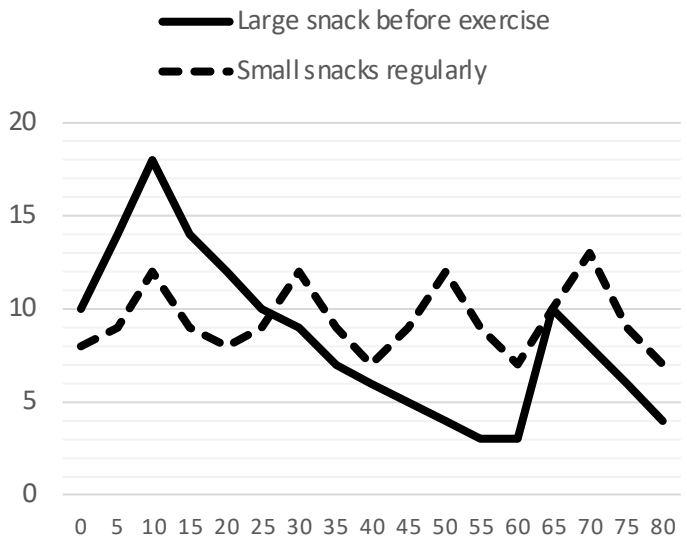
Three options for managing glucose during exercise - ICE

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



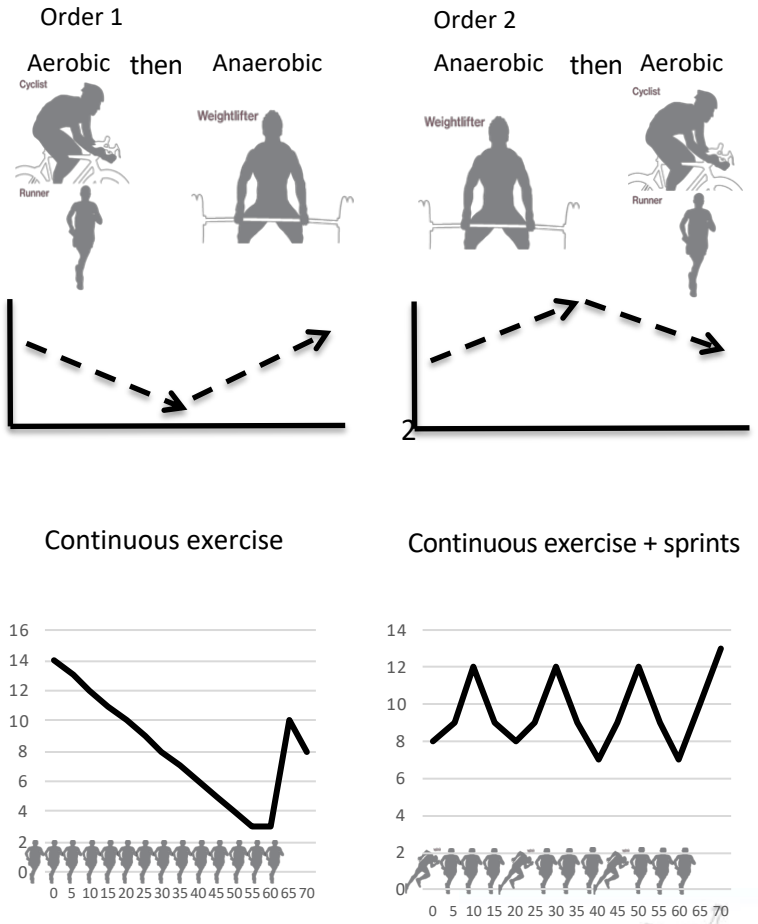
Reduce quick acting by 50% if exercising
Within 2 hrs of meal
Or
Exercise 2 hours after meal

Carbohydrate for exercise



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

Exercise type and intensity



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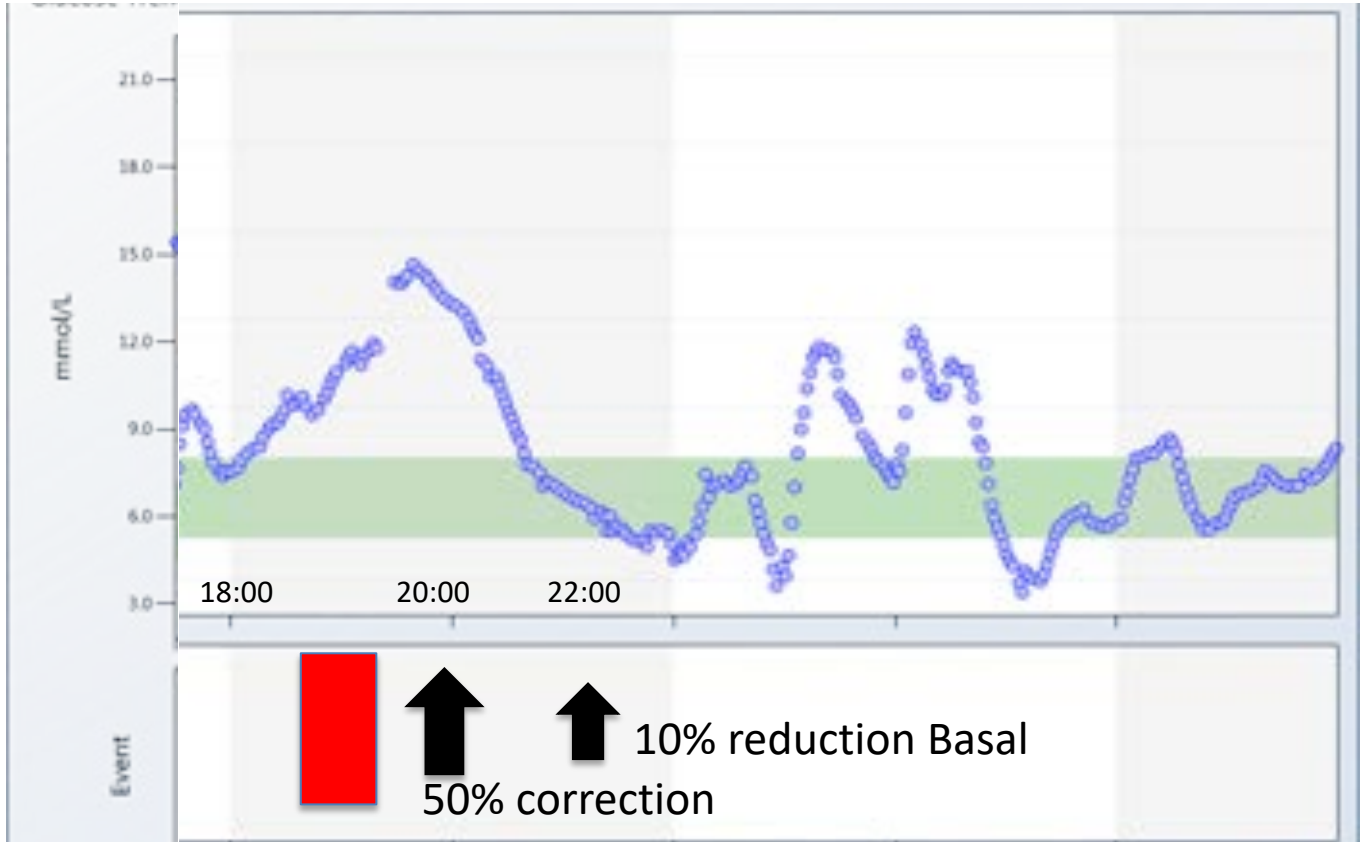
Summary table 1

Strategy	Pros	Cons
Reducing pre-exercise fast acting insulin	Reduces hypoglycaemia during and following exercise, reduces carbohydrate requirement	Needs planning Not helpful for spontaneous exercise, or for exercise more than 2 hours after taking fast acting insulin
Exercise carbohydrate	Useful for unplanned exercise	May not be possible with some exercises. Not helpful where weight control important. May over-replace so blood glucose goes too high.
Altering order or make of exercise	Useful for unplanned exercise	May not be possible with some exercises. May not always have desired effect, lowering glucose or raising glucose more than wish.

Case 4 - Paul

- 22 year-old footballer
- Type 1 diabetes since age 7
- Last HbA1 60
- On Novorapid 1:10/1:10/1:8 and Glargine 16
- Complains about significant hyperglycaemia post games and then hypos after.
- What further information do you want?

Case 4 - paul

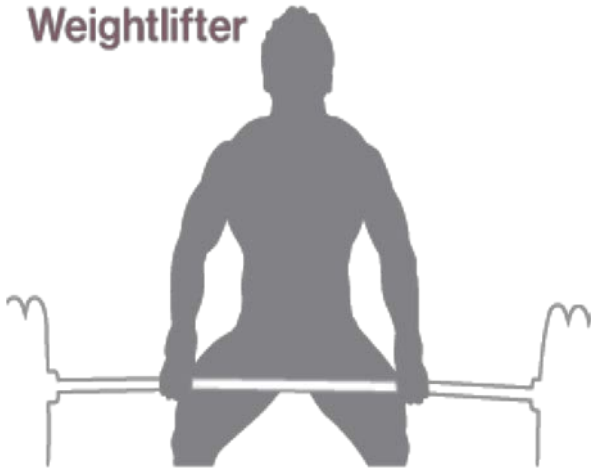

21.0
18.0
15.0
12.0
9.0
6.0
3.0
mmol/L
18:00
20:00
22:00
Event
10% reduction Basal
50% correction

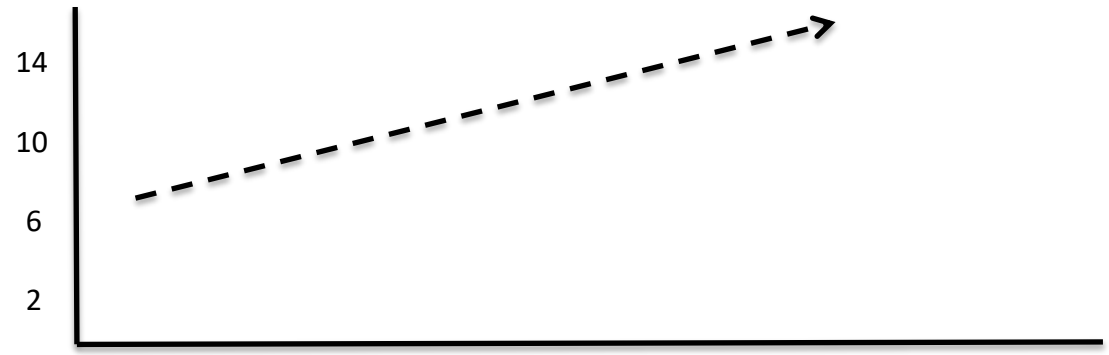
Case 4 - Paul

- What would you advise?

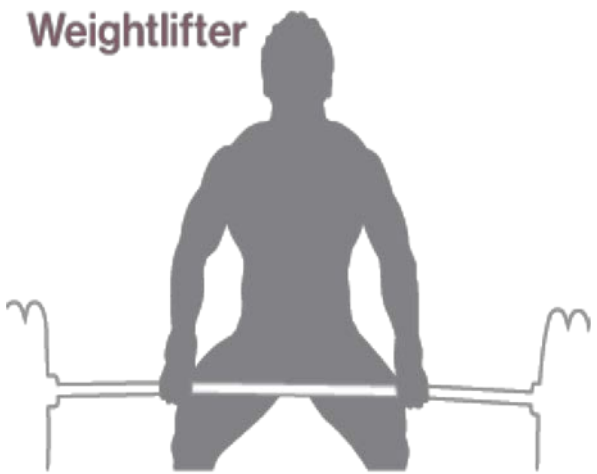
Warm down – stretches/ low intensity aerobic

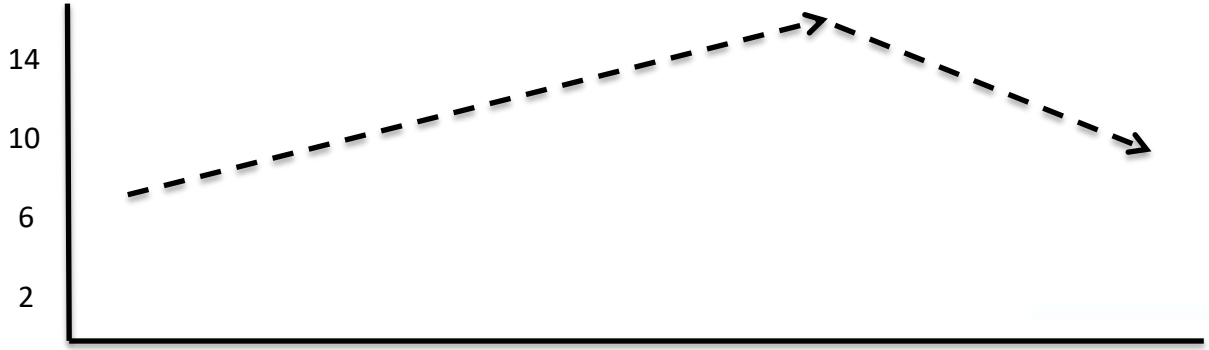
Anaerobic





Anaerobic



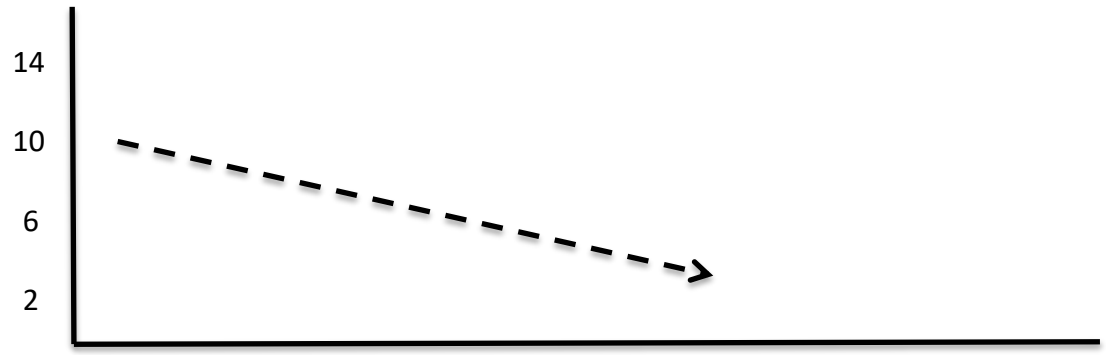


or

Add

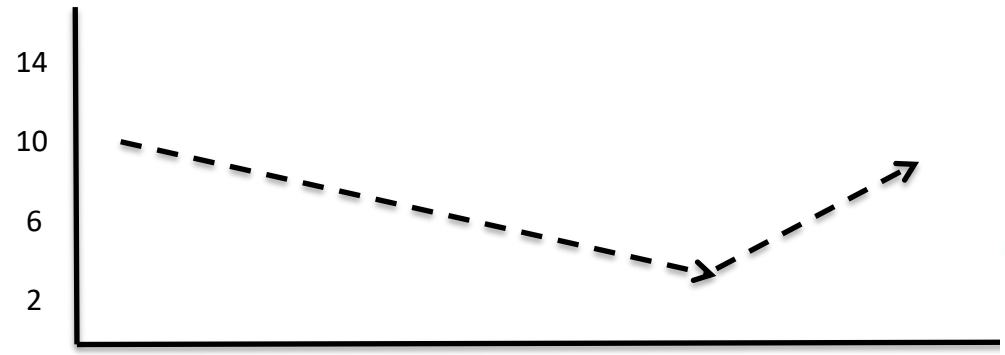
Warm down – sprint

Aerobic



Aerobic

Add



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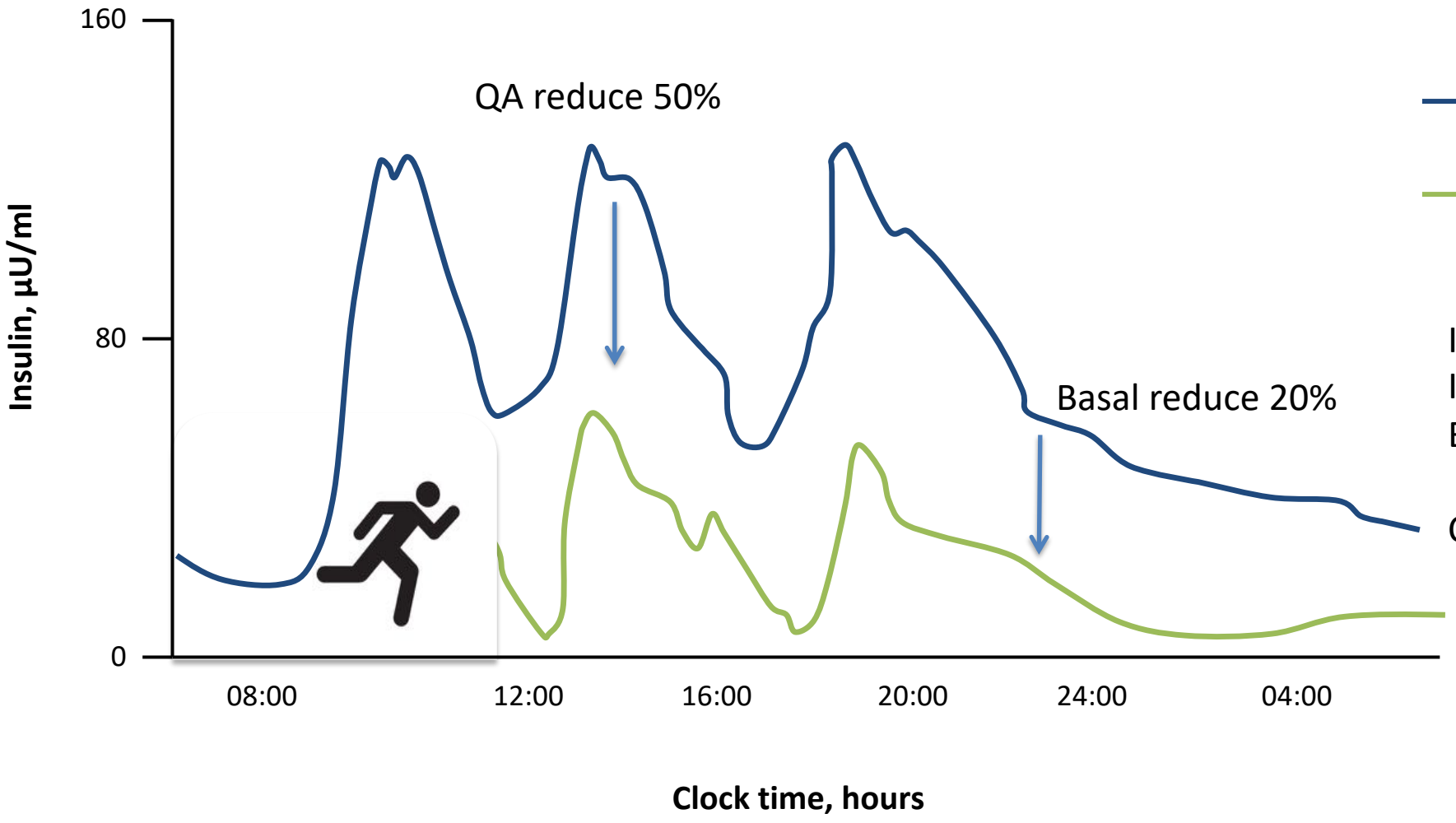
Case 4- Paul

- The correction bolus is most likely the cause of the night time hypo.

- Options are
  - Do 20-30 minutes warm down
  - Reduce bolus more + snack before bed

Affect of exercise on Insulins sensitivity



Insulin to carb ratio and
Insulin sensitivity factor
Both increase

Can last up to 36 hours

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*If you have had hypo in
Last 24 hours but not severe
Note risk of hypo higher so
- Take extra precautions
- Do not do lone events on this day

Before exercise
Meal with 50% less quick acting insulin.
Start exercise within 1 ½ hours of meal – best to start 30 min after

Have you had a severe hypo in last 24 hours?

Yes

Do not exercise

No

Check BG

<3.5

20 g Carb

Recheck At 15 min To ensure BG rising Wait 45 Min before Exercising

3.5-5.6

20 g Carb

Wait 15 min

5.7-6.9

Additional 15 gCarb

7.0-15

>15

Ketone ≤1.5mmol/L
30% of normal correction dose

Ketone >1.5 mmol/L
Normal correction Dose

Proceed to exercise

After Exercise
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 if exercised after 4pm or more than 2 hours of exercise or high intensity exercise at any time of day.

Case 4- Paul

- Is there anything else that might help to lower his glucose post exercise?

Summary table 2

Glucose level post exercise	Action
Low blood sugar after exercise	Treat as normally would. Note may need more glucose than normal due to depletion of stores
Low blood sugar over night	Take long acting carbohydrate before going to bed
High glucose after exercise	Dehydration can push glucose up so rehydration will help to lower glucose

Case 4- Paul

- How could Paul manage this if he was on a pump?

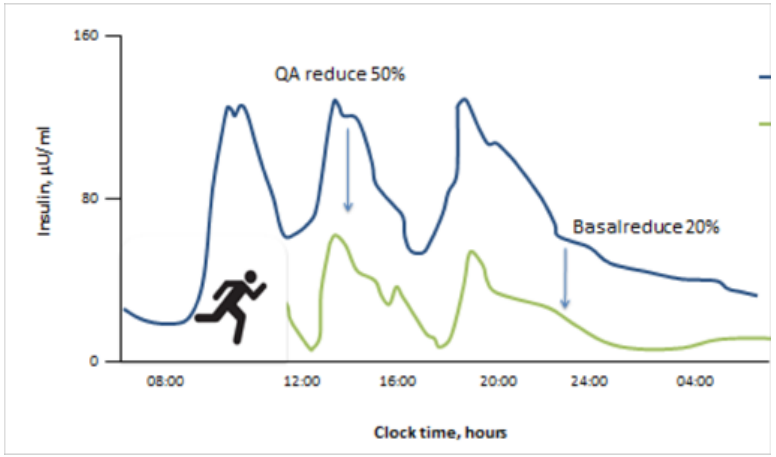
Case 4 - Paul

- Reduced bolus by 30- 50% with no change to background if exercising with 2 hours of meal.

- Reduce background by 80% from 60 minutes before until 30 minutes before the end of exercise.

Three options for managing glucose after exercise - ICE

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

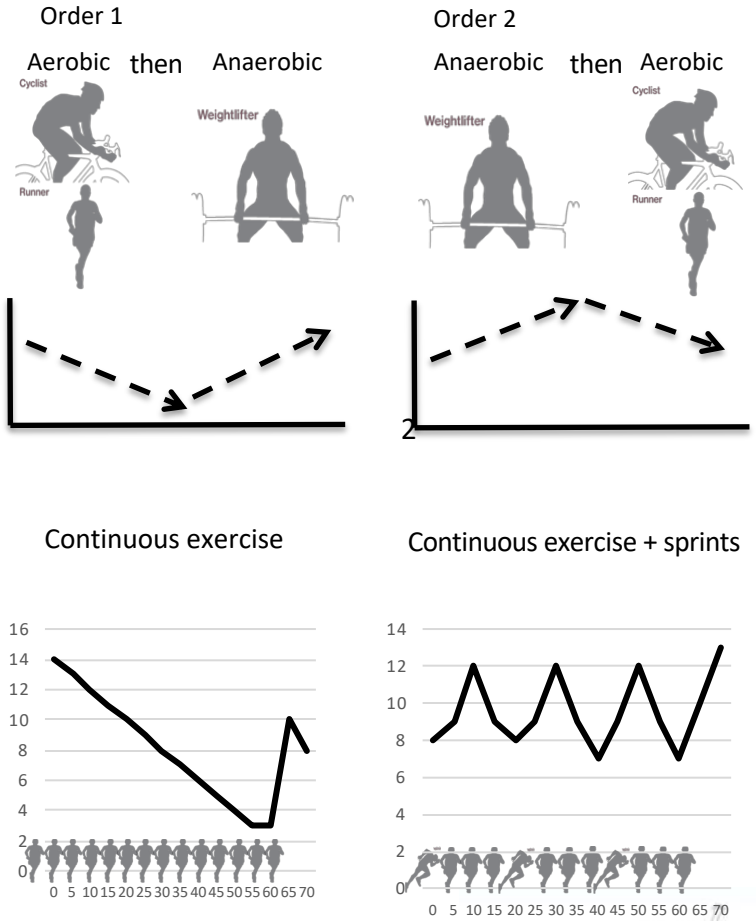
50% of normal quick acting insulin for first 2 meals/snacks after

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



extod education

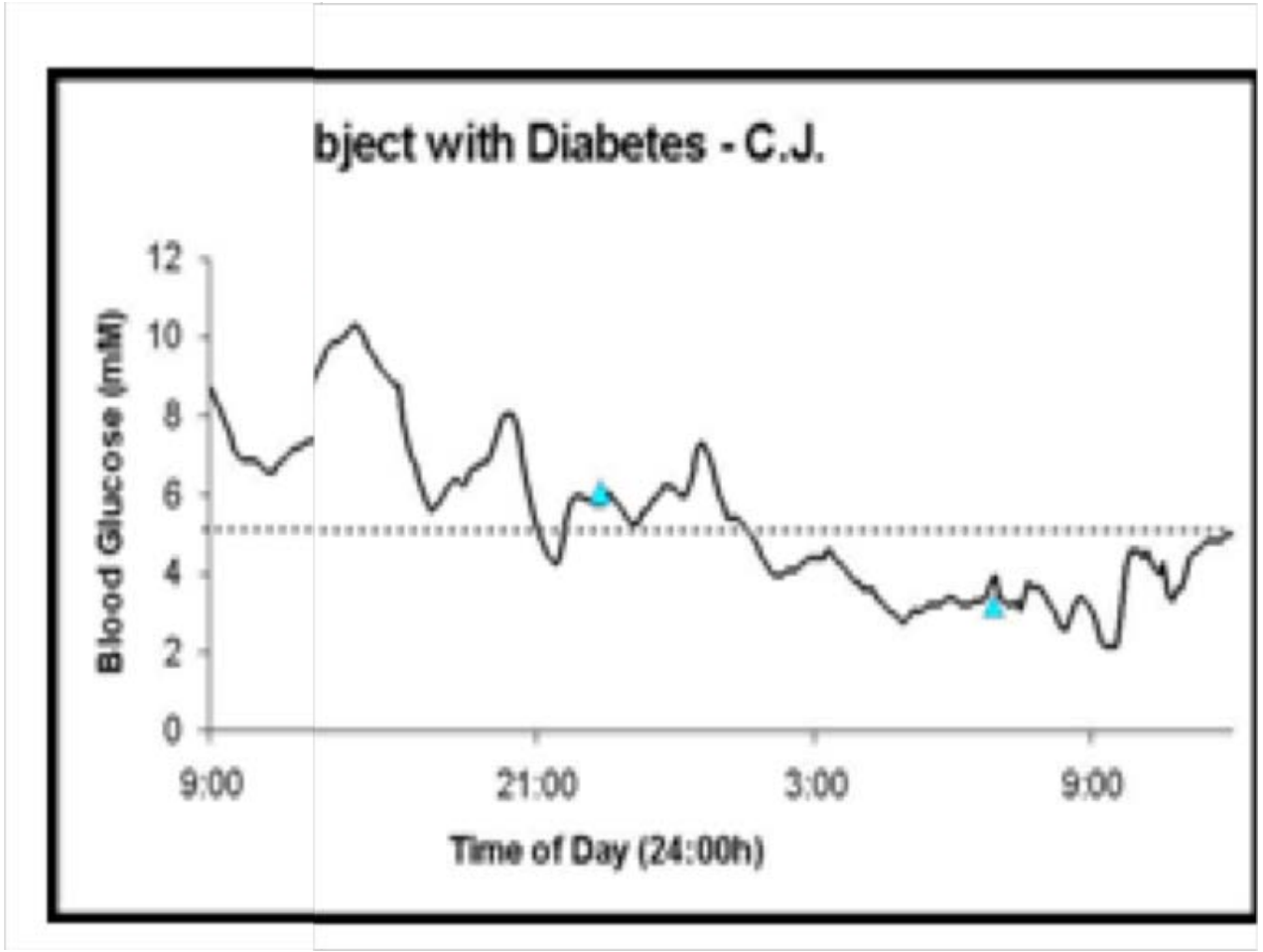
Case 5 - Jane

- Jane is 32 years old, T1DM for 15 years
- HbA1 45
- She uses insulin pump therapy and makes reductions in her basal rate to manage her BG when running, she rarely adjusts her mealtime bolus insulin doses.
- She is training for a half marathon, and struggling with fatigue and late night hypos.
- She is running 4 times a week, 3 evenings after her evening meal and on Sunday mornings before breakfast. Evening runs average 60 mins and the Sunday run is longer ~90 mins

Case 5- Jane

- Where would you start?

Bit more info



Case 5- Jane

- What does Jane need to know about nutrition and exercise?

- What are the time points she needs to think about?

Carbohydrate requirements body mass, exercise intensity & duration

Training Load	CHO Recommendations
Very light training (low intensity exercise or skill-based exercise)	3-5 g.kg-1.day-1
Moderate intensity exercise for 1 hr/day	5-7 g.kg-1.day-1
Moderate to high intensity exercise for 1-3 hrs/day	6-10 g.kg-1.day-1
Moderate to high intensity exercise for 4-5 hrs/day	8-12 g.kg-1.day-1

2010 International Olympic Committee (IOC)
Concensus statement on Sports Nutrition
*Burke, L.M., (2010)

Protein recommendations

Training type and load	Protein recommendations	Training type and load
Sedentary men & women	0.8 – 1.0g/kg/day	Sedentary men & women
Endurance athletes	0.8 – 1.2g/kg/day	Endurance athletes
Resistance (strength) athletes	1.0 – 1.7g/kg/day	Resistance (strength) athletes

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

Recovery

- Protein and carbohydrate together improve glycogen storage 2 hours post exercise
- 4 carb : 1 protein
- 1g/kg/hr carb
- 0.2g/kg/hr protein




Strategies for nocturnal hypoglycemia

MDI

1. Bedtime snack with protein and starch (Kalergis M et al. Diabetes Care 2003; Campbell et al., Diabetes Care 2014)
2. Basal insulin adjustment?
   - NPH reduce by 20%?
   - Split glargine dose could be reduced by 20%?

CSII

1. Bedtime snack (complex carbs, protein, fat)
2. Lower nocturnal basal rate by 20% for 6 hours after go to bed (Taplin et al. J Pediatr 2010)

Semi-quantitative method basal insulin MDI

- Insulin reduction is made dependent on the intensity and type of the exercise that has been preformed.

	Single exercise bout (up to 60 minutes)	Unusually active day (>90 minutes accumulated) or new exercise
Aerobic	No reduction	20-30% reduction
Resistance (anaerobic)	No reduction	10-20% reduction
High intensity interval training	No reduction	No reduction
Mixed (aerobic and anaerobic)	No reduction	20-30% reduction

This only applies to Long acting (glargine and determir) and intermediate acting insulin

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Semi-quantitative method basal insulin pump

- Insulin reduction is made dependent on the intensity and type of the exercise that has been preformed. Reduction with exercise only if exercising 3 hours after meal.

	Exercise ~ 30 minutes	Exercise ~ 60 minutes	After exercise
Aerobic	50% basal reduction, performed 90 min before exercise or 100% reduction at exercise onset	50%-80% basal reduction, performed 90 min before exercise or 100% reduction at exercise onset	20% basal reduction overnight from bedtime for 6 hours
Resistance (anaerobic)	No reduction	50% basal reduction, performed 90 min before exercise	20% basal reduction overnight from bedtime for 6 hours
High intensity interval training	No reduction	No reduction	No reduction
Mixed (aerobic and anaerobic)	100% reduction at exercise onset	50% basal reduction, performed 90 min before exercise or 100% reduction at exercise onset 20-30% reduction	20% basal reduction overnight from bedtime for 6 hours

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Case 5- Jane

- First step is to see the dietitian to
  - To access carbohydrate need
  - To provide information about what should eat post training.

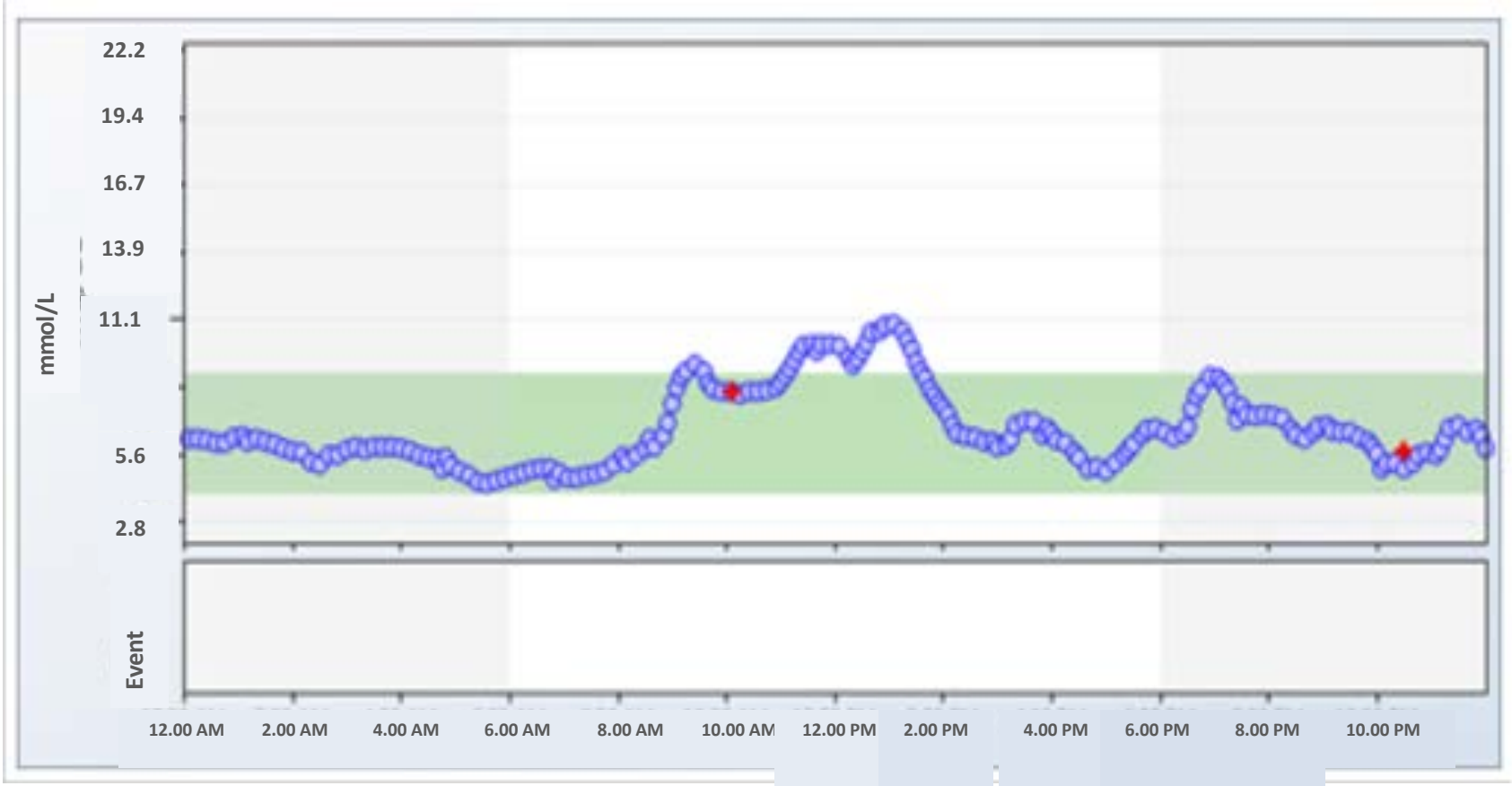
- Second step consider reducing background over night on training days
  - Reduce insulin by 20% for 6 hours after go to bed

Case 5- Jane

- Jane is doing very well.
- Fatigue and hypos gone, but
- Complains about “blocked” legs and very poor performance the day of the race
- She can run at a 6 min mile pace during training but day of the race she can’t…
- What further information do you need?

Case 5 – further information

- She tapers and carb-loads 3-4 days before races and needs to increase total daily insulin by 50%.



Case 5 - answers

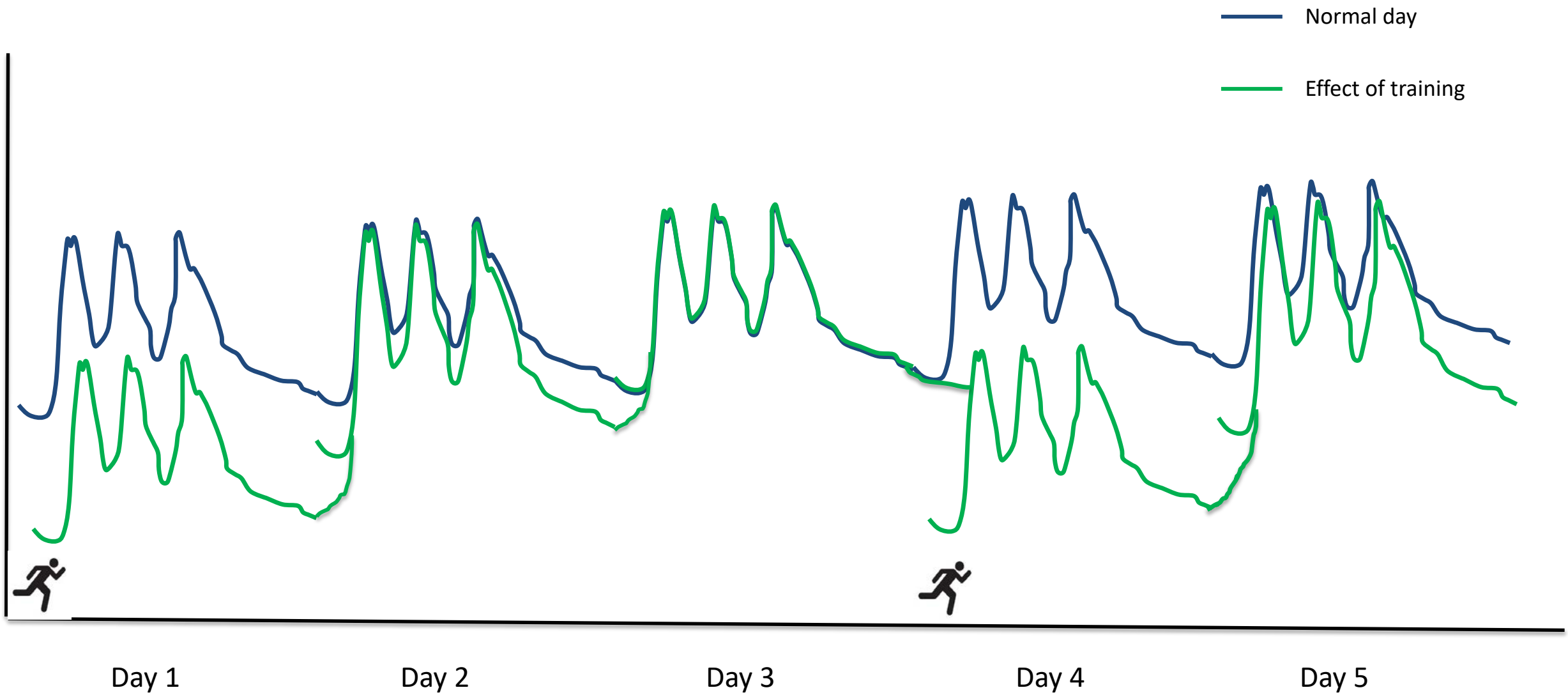
- The problem here is the carb loading. This means sugars go up and she loses some of her stores.
- No need to carb load if eating right
- Should taper down training but good to have easy run day before

CONCLUSIONS

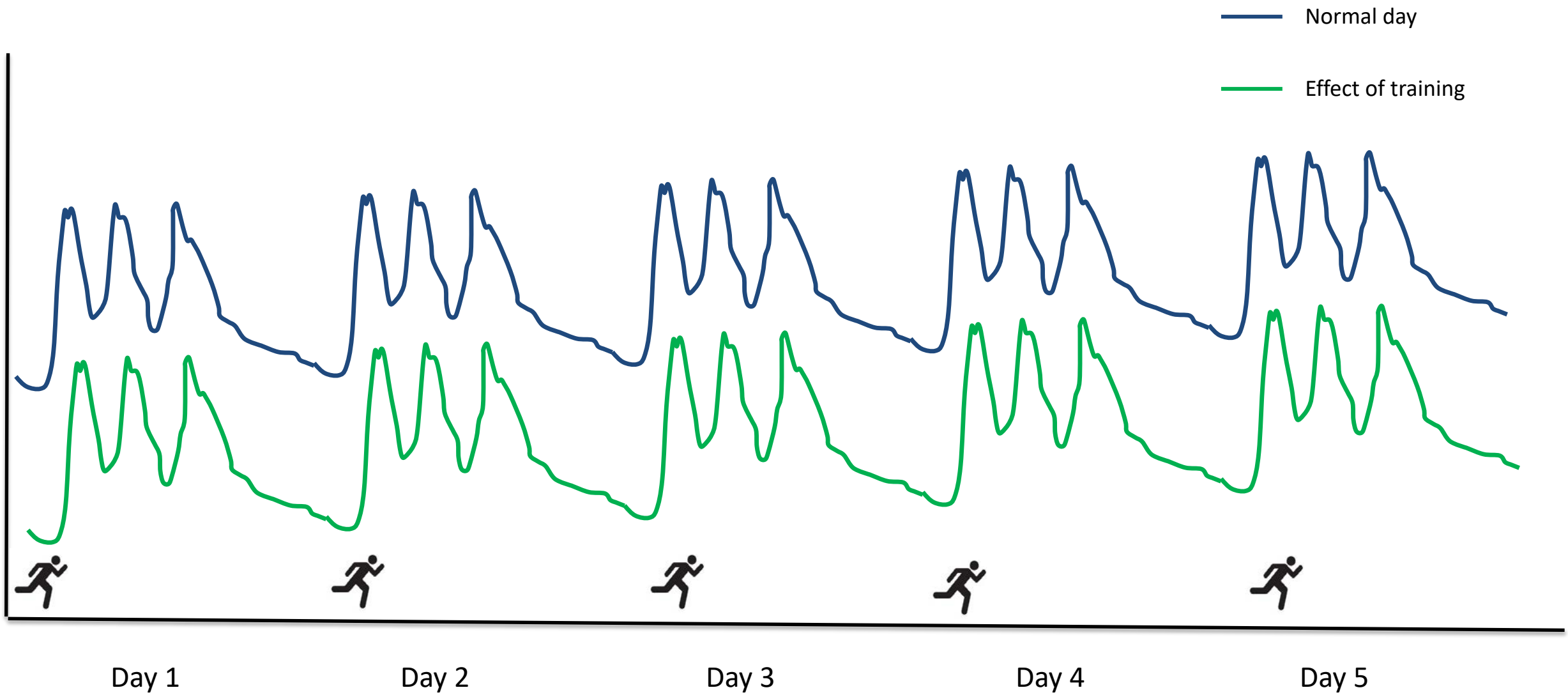
Managing exercise and T1DM -the rule of three's

- ***Best to exercise more than three times a week***
- Need to know three things about the exercise
- There are three strategies to manage glucose around exercise
- There are three things you need to remember about nutrition
- Three blood sugars say no to exercise
- There are three time points you need to plan for
- There are three time points blood glucose should be checked

Exercise 2-3 times per week



Exercise every day of week



Managing exercise and T1DM -the rule of three's

- **Best to exercise more than three times a week – as makes control easier**
- ***Need to know three things about the exercise***
- There are three strategies to manage glucose around exercise
- There are three things you need to remember about nutrition
- Three blood sugars say no to exercise
- There are three time points you need to plan for
- There are three time points blood glucose should be checked

Three things you need to know about exercise

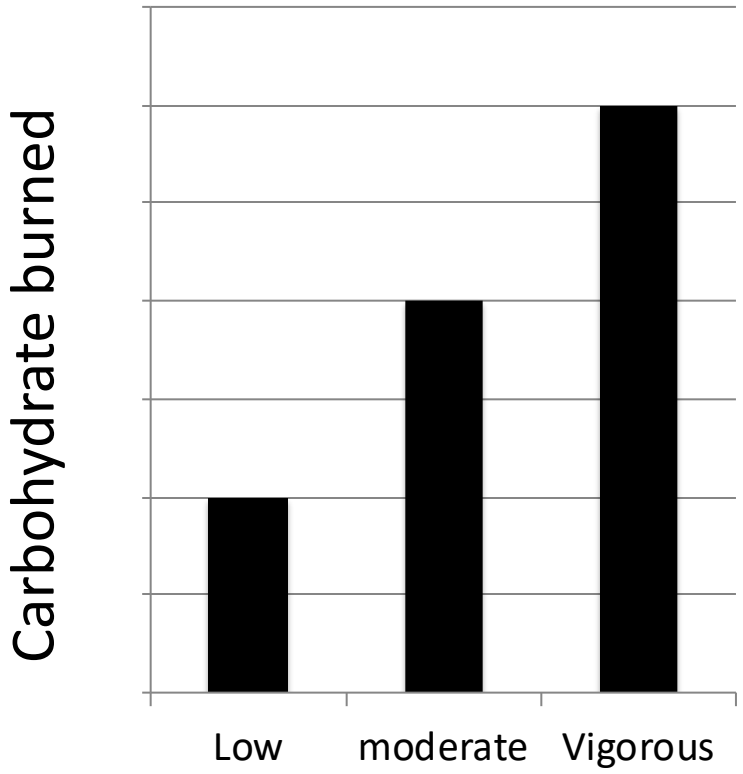
Type

Flexibility

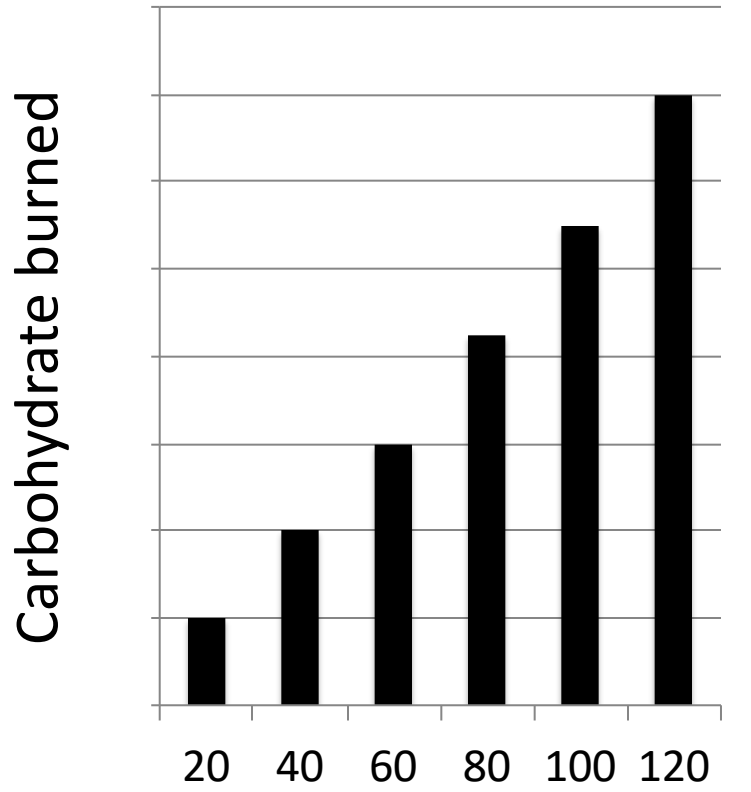
Aerobic

Anerobic

Intensity



Duration

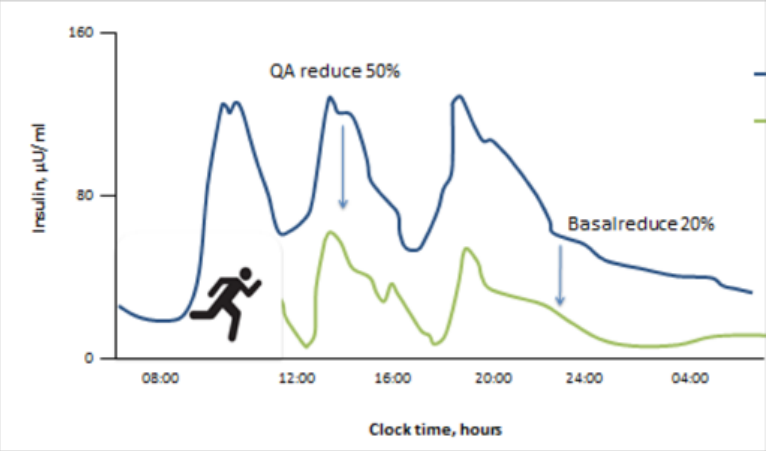


Managing exercise and T1DM -the rule of three's

- Best to exercise more than three times a week – as makes control easier
- **Need to know three things about the exercise – type, intensity and duration**
- ***There are three strategies to manage glucose around exercise***
- There are three things you need to remember about nutrition
- Three blood sugars say no to exercise
- There are three time points you need to plan for
- There are three time points blood glucose should be checked

Three options for managing glucose around exercise - ICE

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

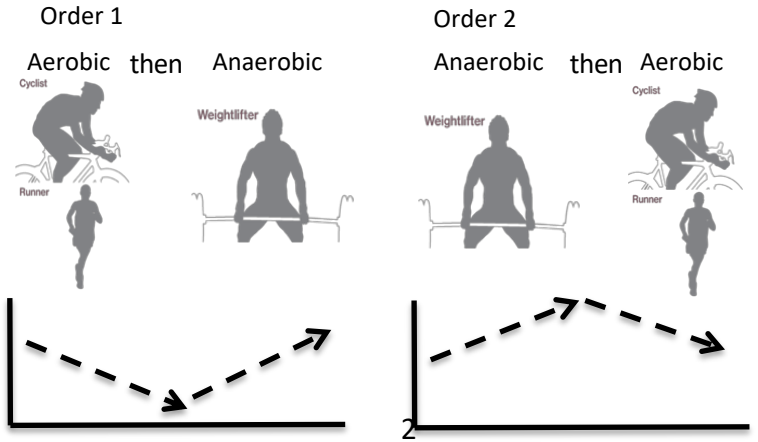
50% of normal quick acting insulin for first 2 meals/snacks after

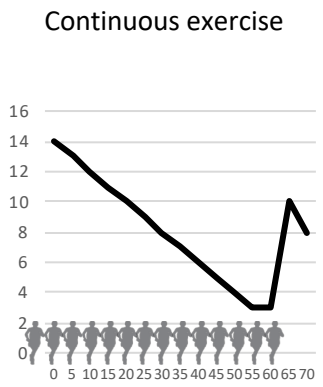
20% reduction night time background insulin
If exercise after 4 pm or longer than 2 hours

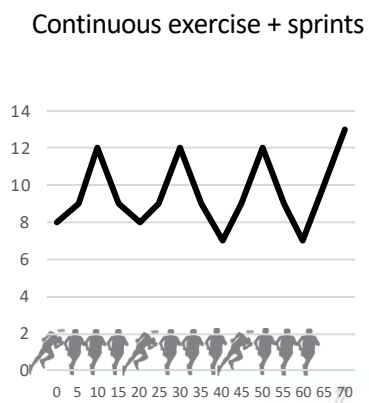
Carbohydrate for exercise

Situation	General CHO Recommendations
Habitual diet	**Light training** 3-5 g/kg/d
	Mod exercise 5-7 g/kg/d
	High (1-3h/d) 6-10 g/kg/d
	Very high (>4-5h/d) 8-12 g/kg/d
Pre event meal eaten 1- 4 hours pre exercise	A minimum of 1-4g/kg BW for exercise > 1 h duration Consider Low GI choices
During activity (> 1 hour)	30-60 g/h Up to 90 g/h
Ultra Endurance (>3 hours)	Consider High GI choices
Recovery	1 -1.2g/kg during the first hour

Exercise type and intensity







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Managing exercise and T1DM -the rule of three's

- Best to exercise more than three times a week – as makes control easier
- Need to know three things about the exercise – type, intensity and duration
- **There are three strategies to manage glucose around exercise – Insulin, carbs or exercise**
- ***There are three things you need to remember about nutrition***
- Three blood sugars say no to exercise
- There are three time points you need to plan for
- There are three time points blood glucose should be checked

Three things to remember about nutrition

Feed

- Ensure patients meet their total daily energy requirements

Fuel up

- Muscles require glucose as a main source of fuel
- With 30-60g carbohydrate per hour of exercise to replace the glucose used during exercise
- For recovery after exercise within 45mins

Fluid

- Start well hydrated
- Stay hydrated
- Water is best for any exercise up to 90mins

Managing exercise and T1DM -the rule of three's

- Best to exercise more than three times a week – as makes control easier
- Need to know three things about the exercise – type, intensity and duration
- There are three strategies to manage glucose around exercise – Insulin, carbs or exercise
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Three blood glucose levels that say “no”

Low blood glucose

- Severe hypoglycaemia
  - Don’t exercise for 24 hours

- Blood sugar less than 5.6 just before exercise
  - Take appropriate action before starting to exercise

High blood glucose

- Blood glucose >15 mmol/L with Ketones
  - Take insulin wait until have gone before exercise

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- Three blood sugars say no to exercise – two low and one high
- ***There are three time points you need to plan for***
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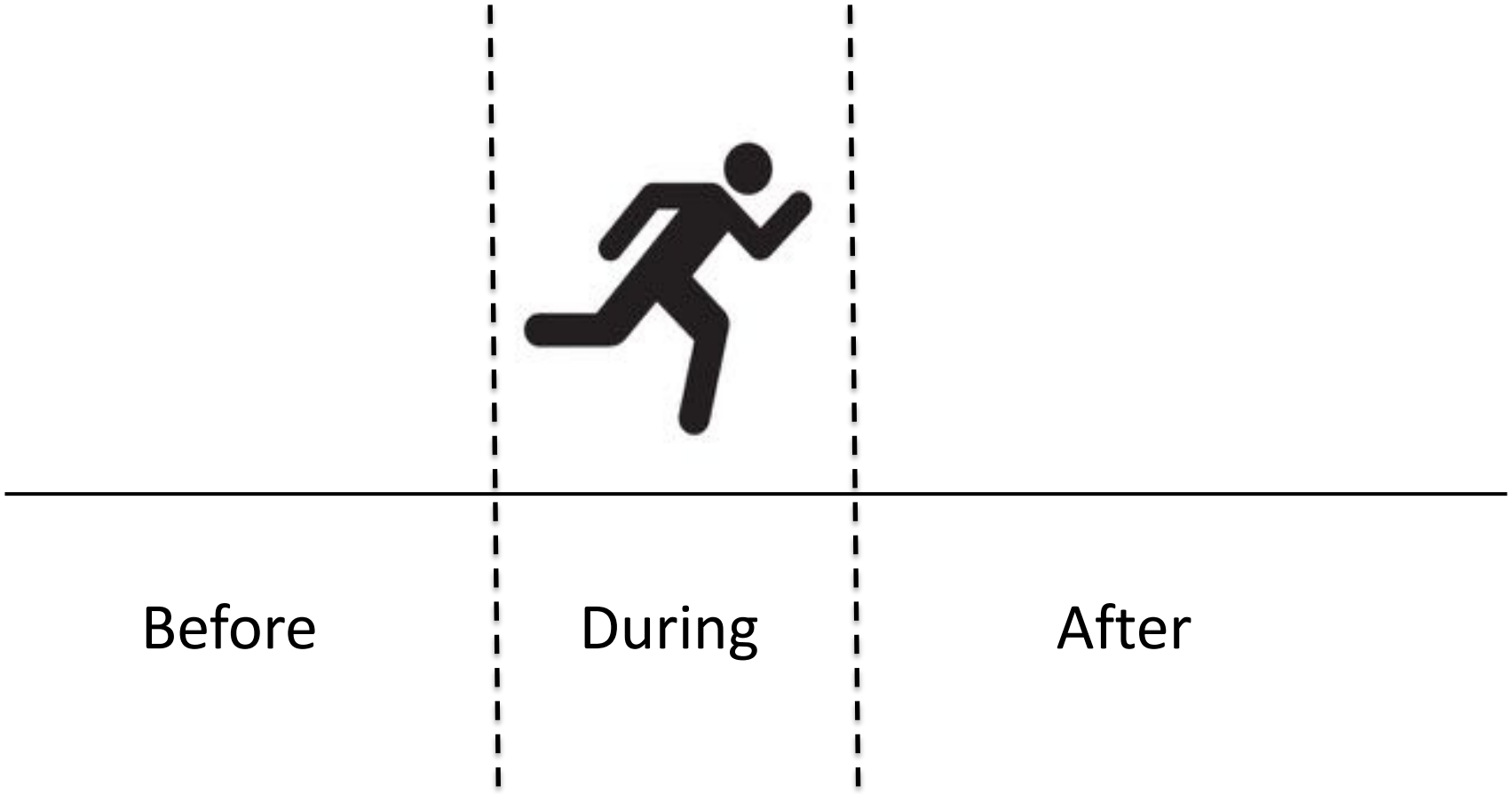
Three time points need to plan for



Three time points need to take blood glucose

At least 2 before
To see trend

Every 30 minutes

One when finish
At 6-8 hours or before bed
3 am if new exercise or
Very intense or prolonged

Before

During

After

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- Three blood sugars say no to exercise – two low and one high
- **There are three time points you need to plan for – before, during and after**
- **There are three time points blood glucose should be checked**

Additional sources of info

Books

- Diabetic Athlete's Handbook by Sheri Colberg
- Getting Pumped ! A diabetes and exercise guide for active individuals with Type 1 diabetes by Michael Riddell
- Type 1 Diabetes - Clinical Management of the Athlete by Ian Gallen

Websites Exercise advice

- http;//www.extod.com
- http://www.runsweet.com
- http://www.ext1d.com.au- * need to pay
- http://teamwildathletics.com - * need to pay for
- http://www.teamnovonordisk.com/
- http://www.excarbs.com/
- http://dtc.ucsf.edu/living-with-diabetes/activity-and-exercise/exercise-guidelines-faqs/

Websites Dietary advice

- http://www.ausport.gov.au/ais/nutrition/factsheets/special_diets/diabetes_and_sports_nutrition
  http://www.dafne.uk.com/

Dates to remember

- EXTOD JDRF HCP Exercise and Type 1 conference in Glasgow 18/10/2019
- EXTOD JDRF Patient Exercise and Type 1 conference in Glasgow 19/10/19
- See ABCD website