Managing exercise with an Insulin Pump

Rob Andrews – University of Exeter

Rob Andrews - conflict of interest

Investigator on

- Bariatric study -By-Band-sleeve study
- Lifestyle studies -Early ACTID, EXTOD, EXTOD education

Presentations

- Talk on education days sponsored by Novo-Nordisk, Lilly, MSD, Astra-Zeneca

Positions

- Chair of Clinical study group 3 – prevention + treatment T2DM
- Member of Royal College Obesity Forum

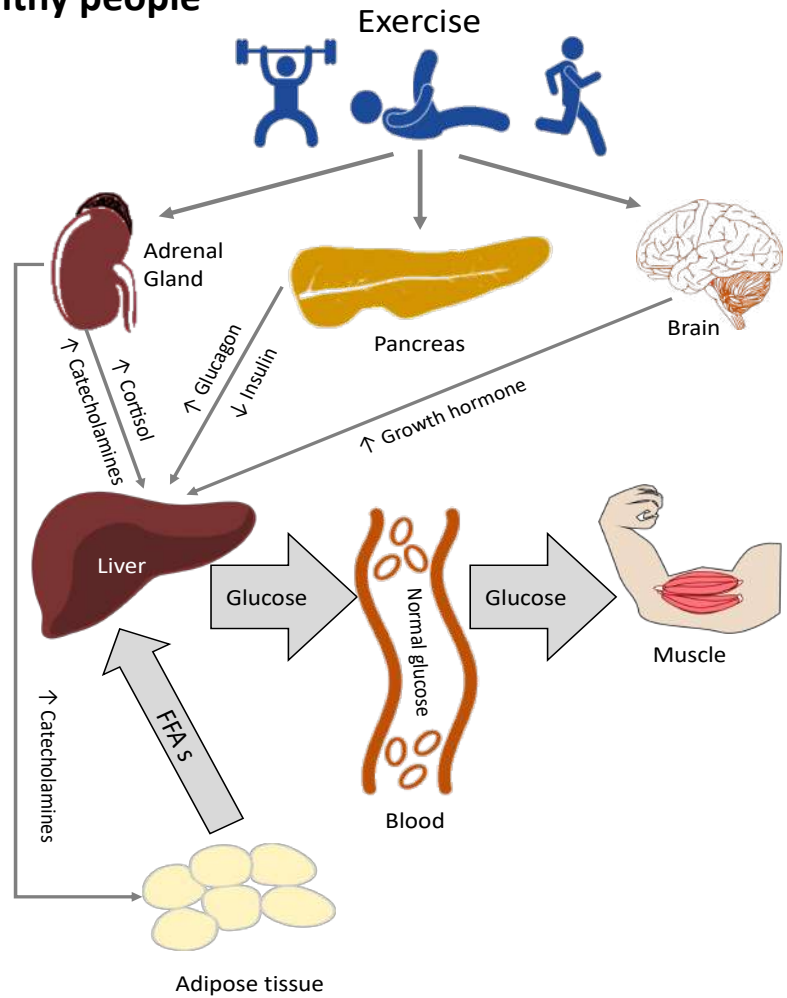
What we will cover

- A bit of physiology
- Common problems
- Preparing for exercise
- Controlling glucose during exercise
- Controlling glucose post exercise
- Tips for dealing with common problems

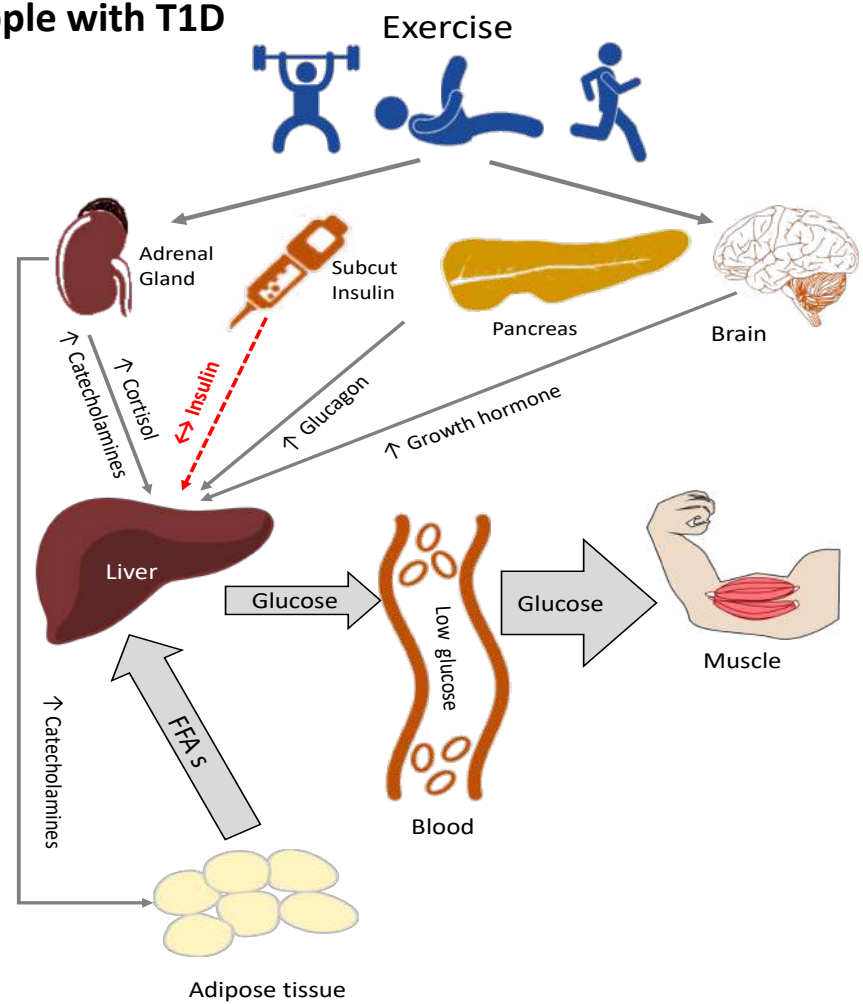
A bit of physiology

The Normal Response is, “I do”
Not, “ I suppose so”

Healthy people



People with T1D



Endocrine imbalance seen in T1DM during exercise

A. Euglycaemia
   - ↓ Insulin
   - ↑ counterregulation (glucagon, growth hormone, cortisol, catecholamines)

B. Hypoglycaemia
   - Relative hyperinsulinaemia
   - Impaired counterregulation

C. Hyperglycaemia
   - Relative hypoinsulinaemia
   - ↑Catecholamines
   - Anaerobic metabolism (lactate production)

Courtesy M Riddell

Summary 1

Patients with Type 1 diabetes have two problems

1. Inability to regulate insulin levels automatically
2. Reduced hormone response when glucose falls

But

1. Better fat burners
2. With Insulin have ability to bulk up and recover quicker

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Problems with exercise

"You were right, we should've used a smaller medicine ball."

Potential benefits of CSII v MDI

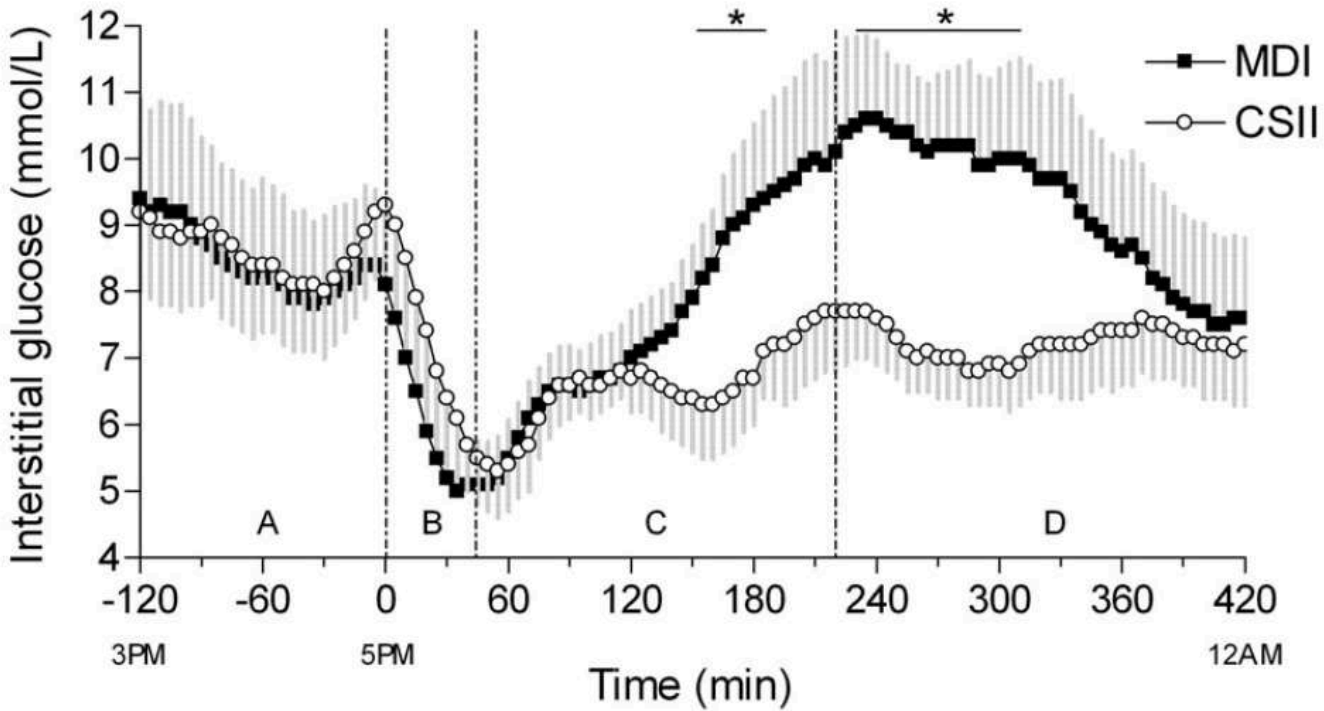
CSII

- Allows bolus dose adjustment in 0.05 unit increments
- Basal doses can be adjusted at short notice
- Allows adjustment of basal dose in increments of 0.025 units per hour

MDI

- Allows bolus doses adjustment in 0.5 unit increments
- Considerable planning required for basal dose adjustments
- Basal dose fixed for duration of insulin in last injection

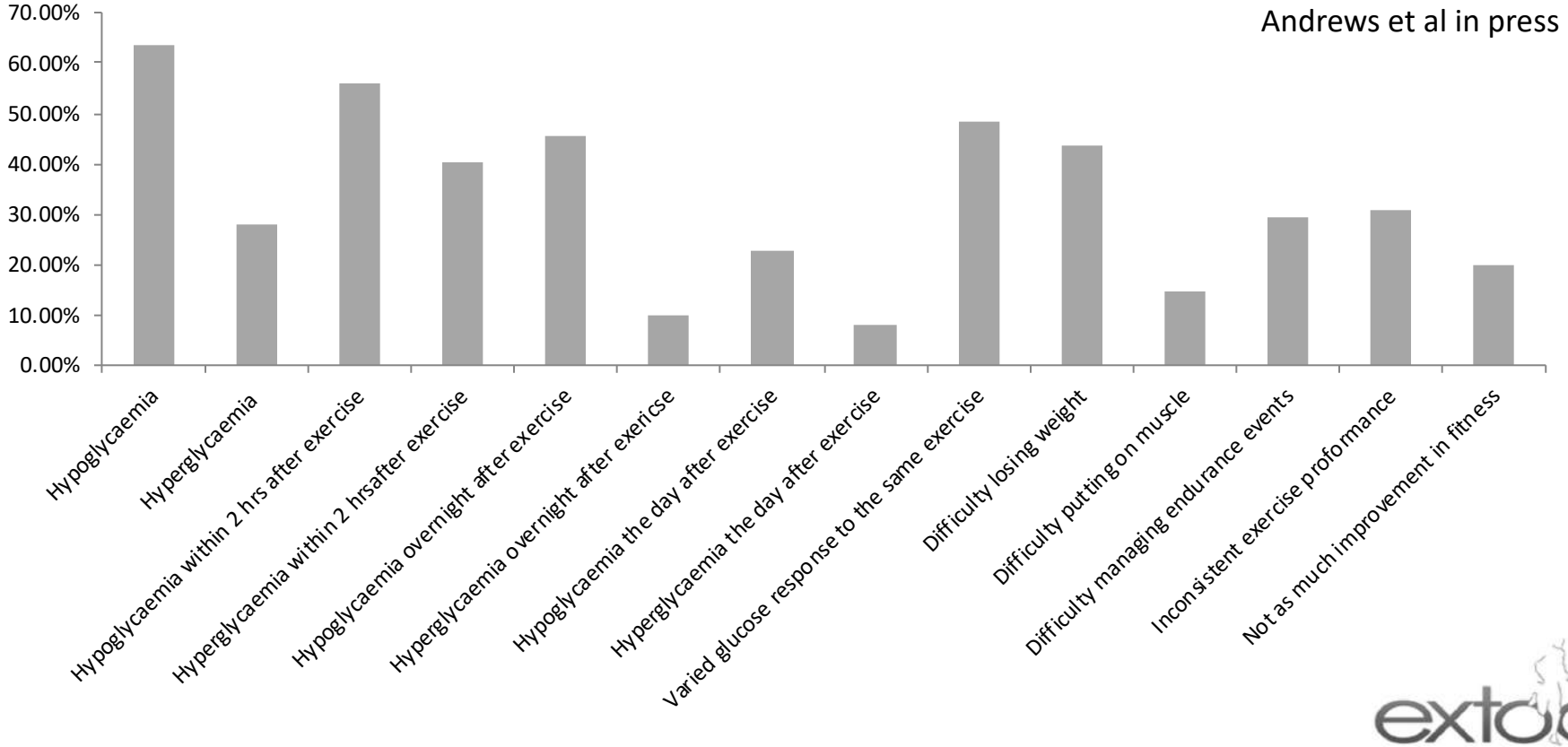
Pump vs MDI



A - before exercise
B – during execise
C - 0-3 hrs after
D - 3-6 hrs after

Yardley et al 2013

Survey of 280 patients on Pumps



Survey of 280 patients on Pumps

- 73 % of patient had an episode of hypoglycaemia that stopped them exercising over the last 6 months.
- 25 % of patient had an episode of hyperglycaemia that stopped them exercising over the last 6 months.
- 9% of patient had a severe hypoglycaemic episode that required help from someone else over the last year.

Andrews et al in press

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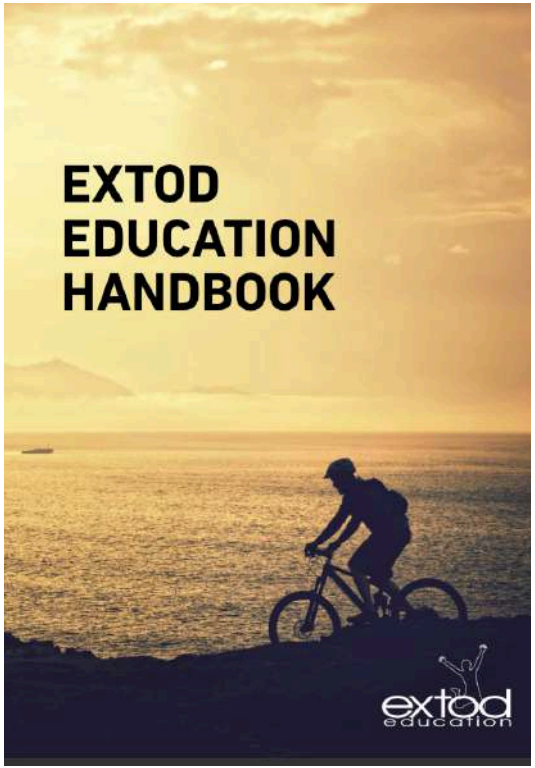
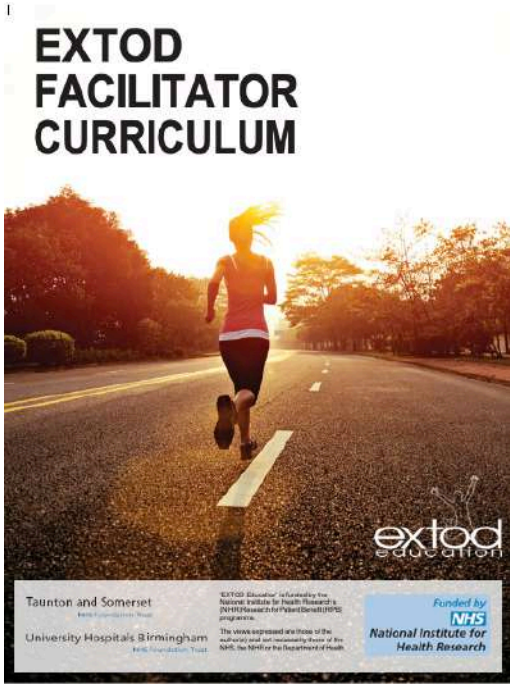
Summary 2

Patients with Type 1 diabetes on pumps when exercising

- Struggle with the varied glucose response to exercise.
- Have frequent low and high blood glucoses before and after exercise.
- Struggle to lose weight with exercise
- Find it difficult to improve fitness or personal bests

EXTOD education





Litchfield 2019
Narendran 2019

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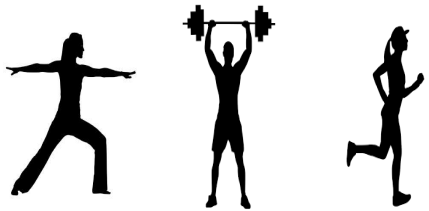
Preparing for exercise

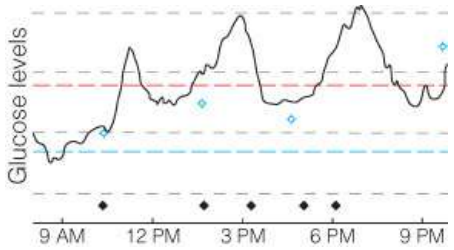
"My doctor told me to start my exercise program very gradually. Today I drove past a store that sells sweat pants."

Considering exercise – three things to think about



The exercise

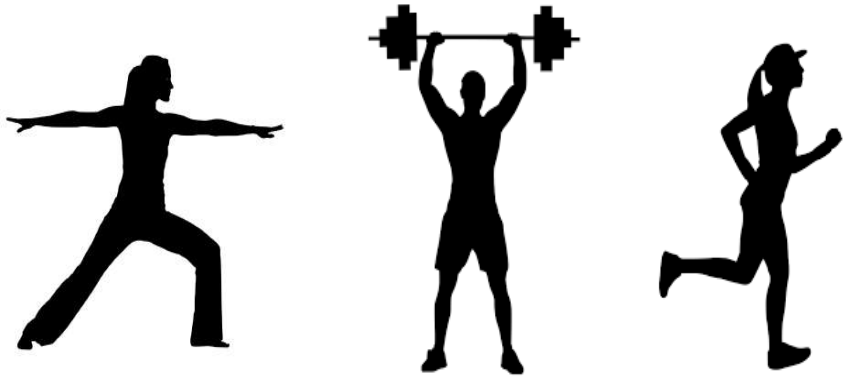
Time of day



Glucose level

The exercise – three things need to know

- Type of exercise
- Intensity of exercise
- Length of exercise



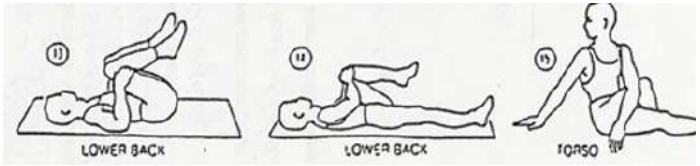
Three types of exercise

Flexibility

Anaerobic

Aerobic

NORMal glucose control during flexibility exercises



ADRENALS

PANCREAS

↓ insulin
↑ glucagon

LIVER

Small amount glucose released from liver

Normal Glucose

BLOOD

Small amount glucose used by muscle

MUSCLE

NORMal glucose control during aerobic exercise

ADRENALS

↑ Stress hormones

PANCREAS

↓ insulin
↑ glucagon

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

LIVER

Moderate amount of glucose released from liver

Small fall in Glucose

BLOOD

Moderate amount of glucose used by muscles

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

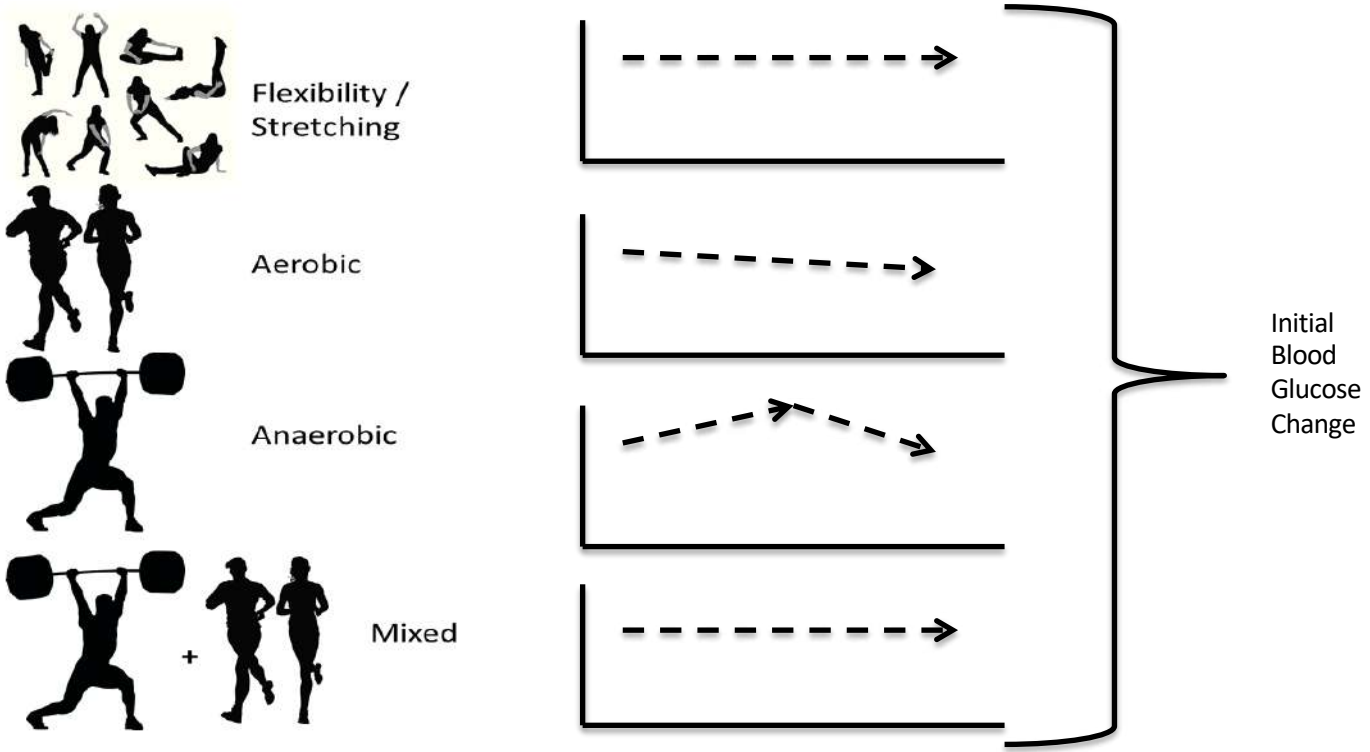
Moderate amount of glucose used by muscles

LIVER

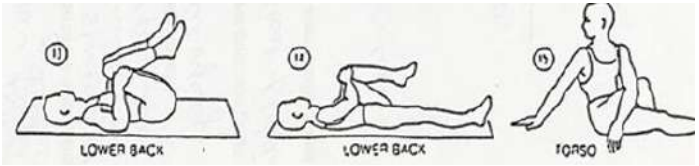
BLOOD

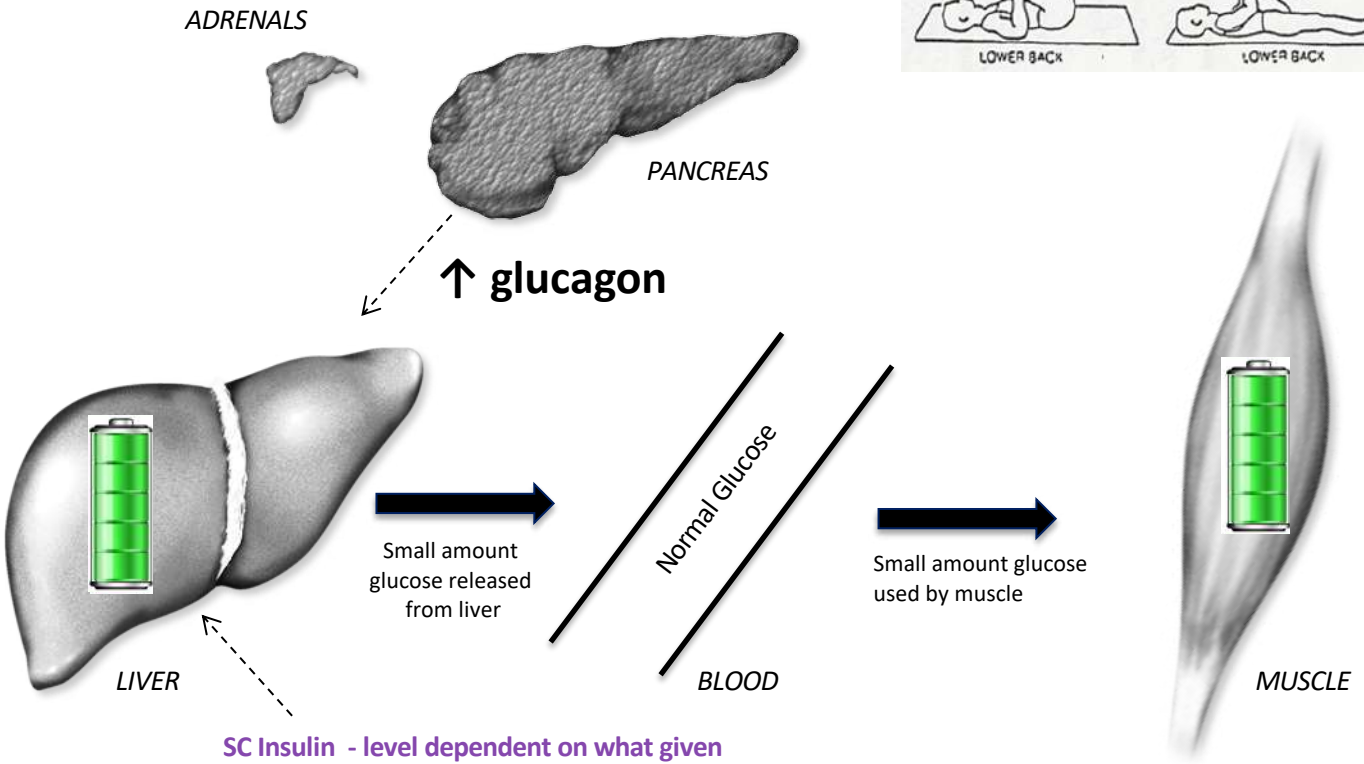
MUSCLE

Normal glucose responses to different exercises



Glucose control during flexibility exercises in type 1 diabetes (TOD)





SC Insulin - level dependent on what given

extod education

Glucose control during aerobic exercise in type 1 diabetes (TOD)

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 (TOD)

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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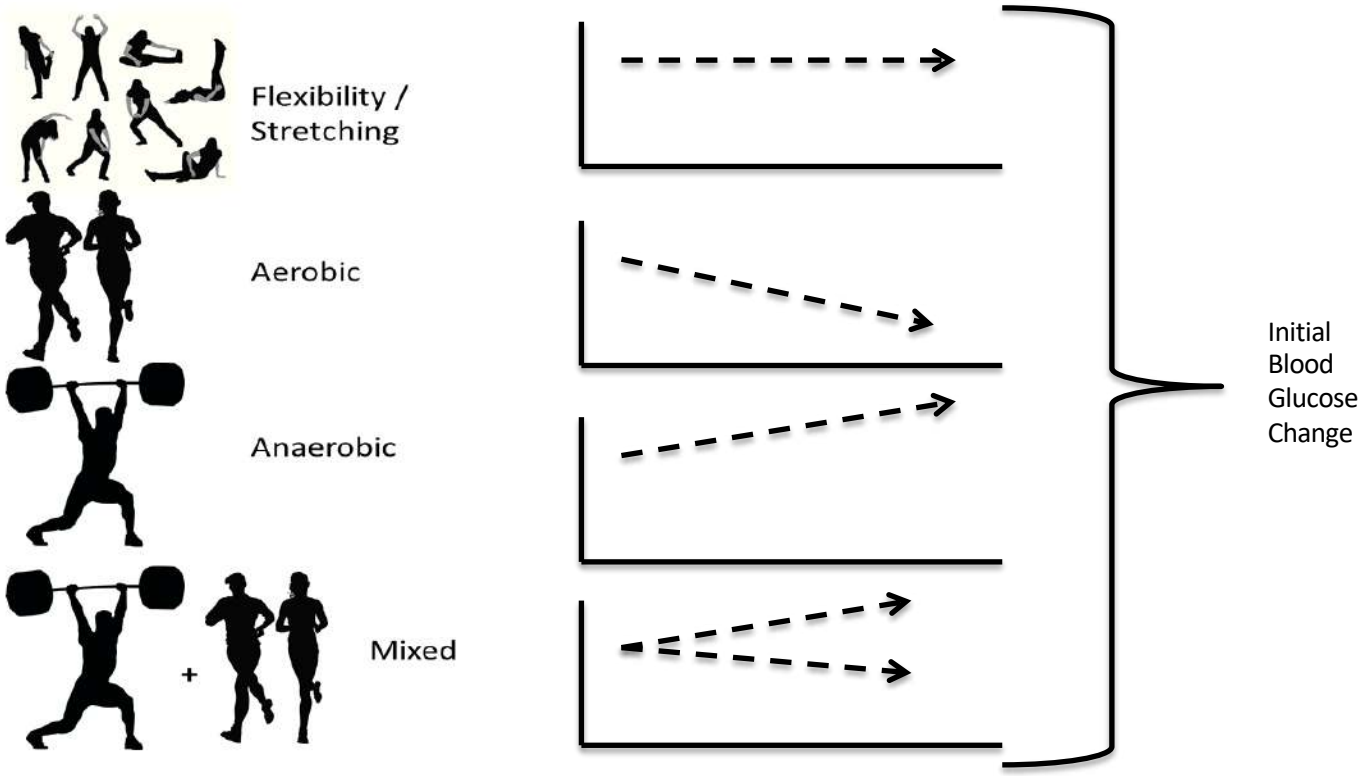
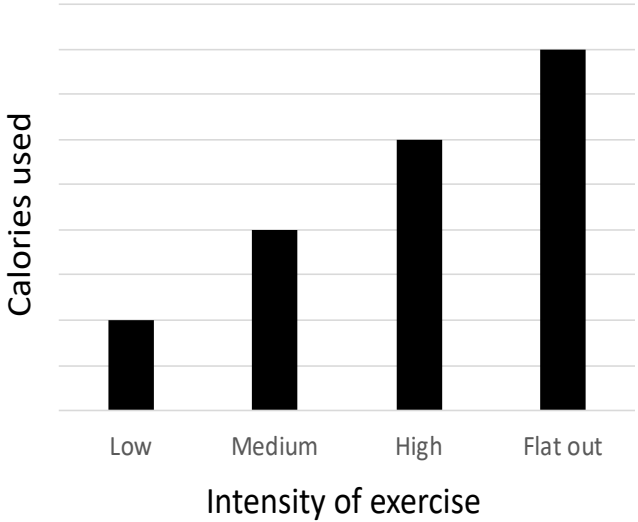
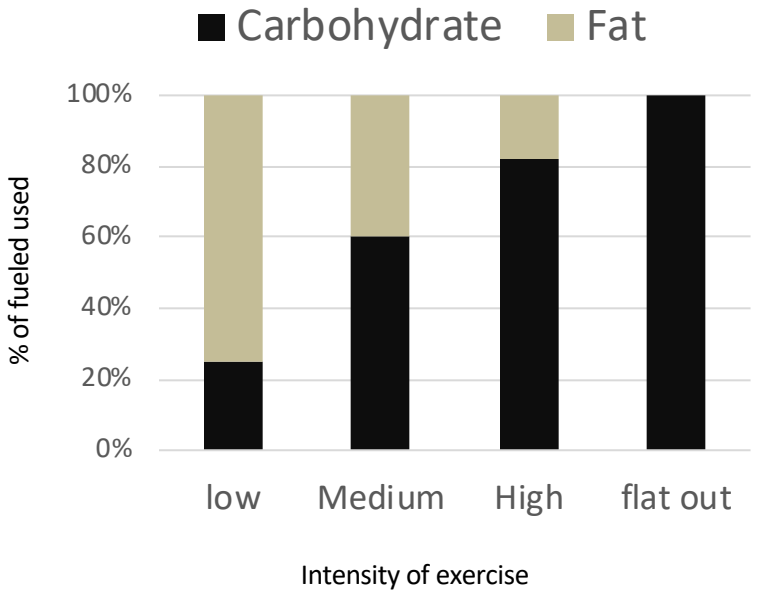
Glucose responses to different exercises in T1D

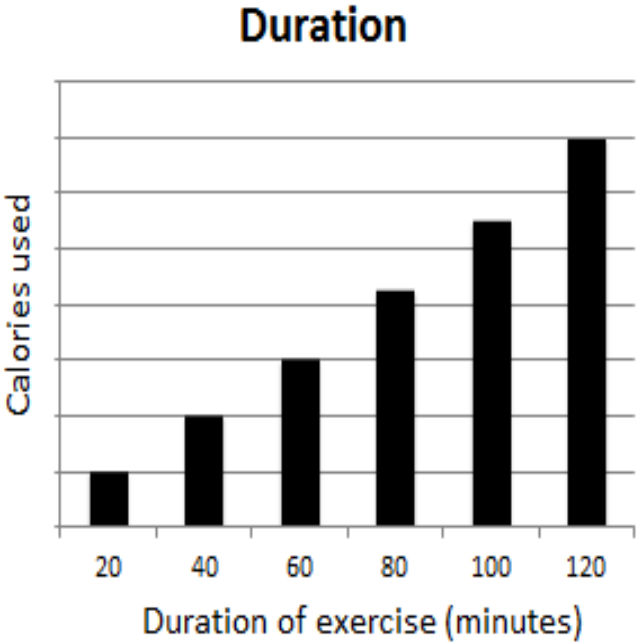


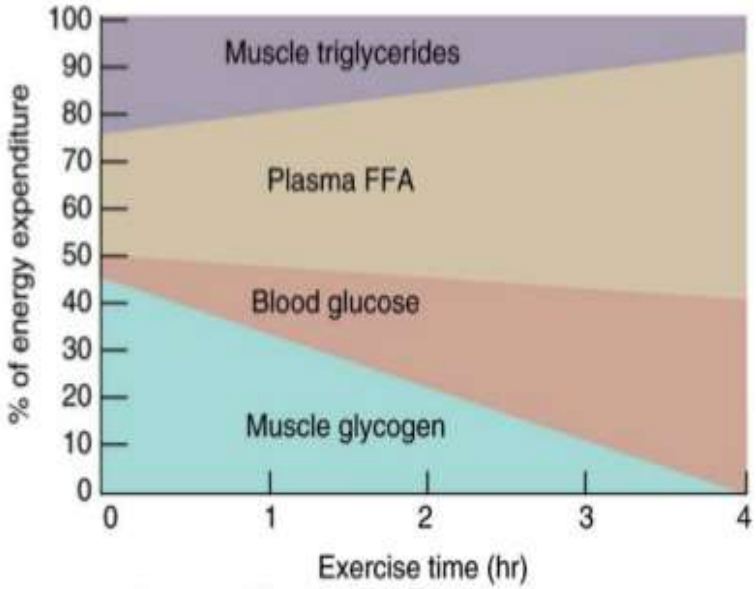
Intensity of exercise





Length of exercise





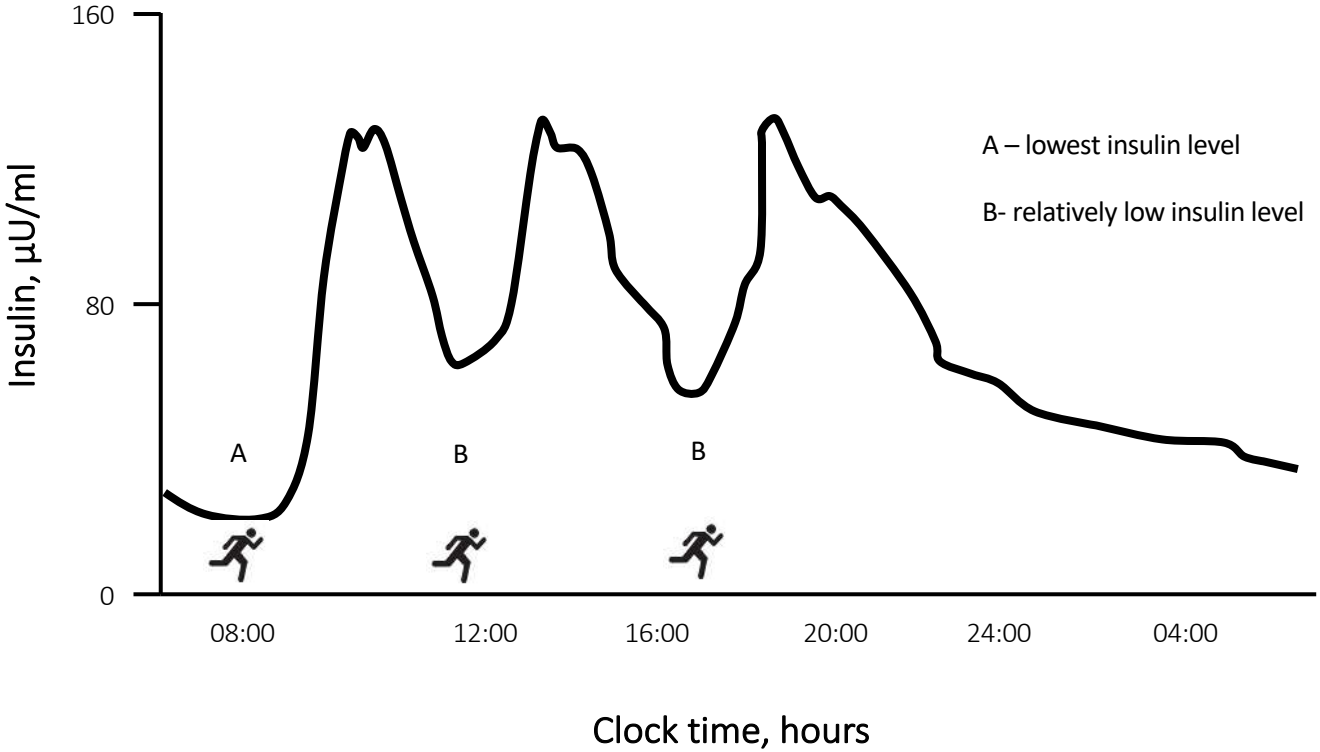
Summary 3

- Type of exercise will effect direction glucose goes in
- Intensity of exercise will determine amount of glucose used
- Length of exercise will determine amount of glucose used

Time of day – three things to think about

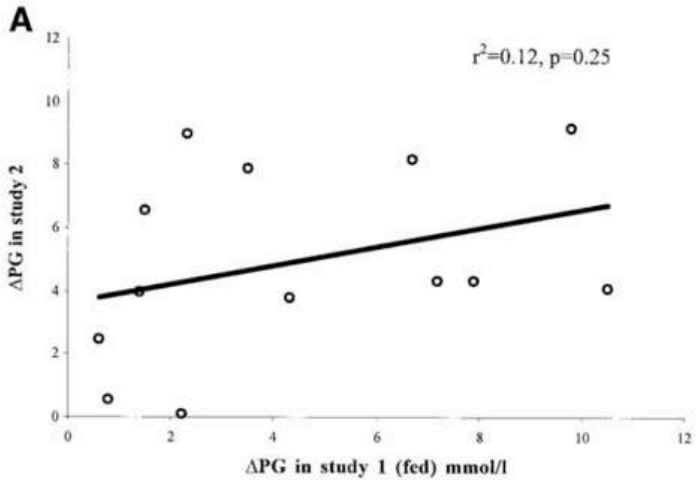
- Prevailing Insulin concentration
- When last ate
- Am or PM

Prevailing insulin levels



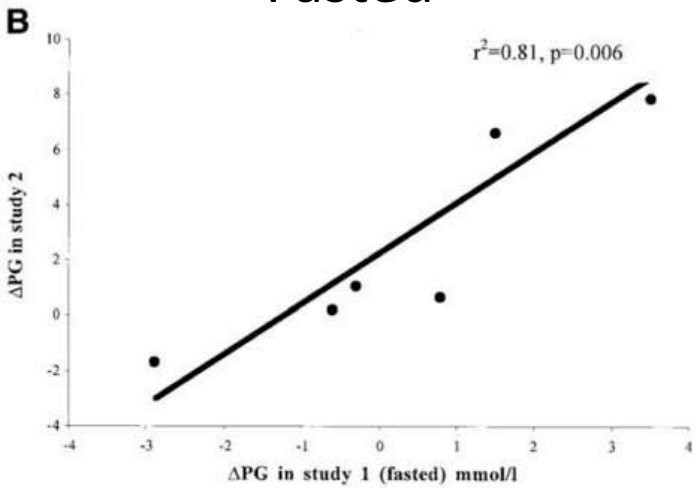
Glucose response to exercise Fed vs fasted

Fed



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

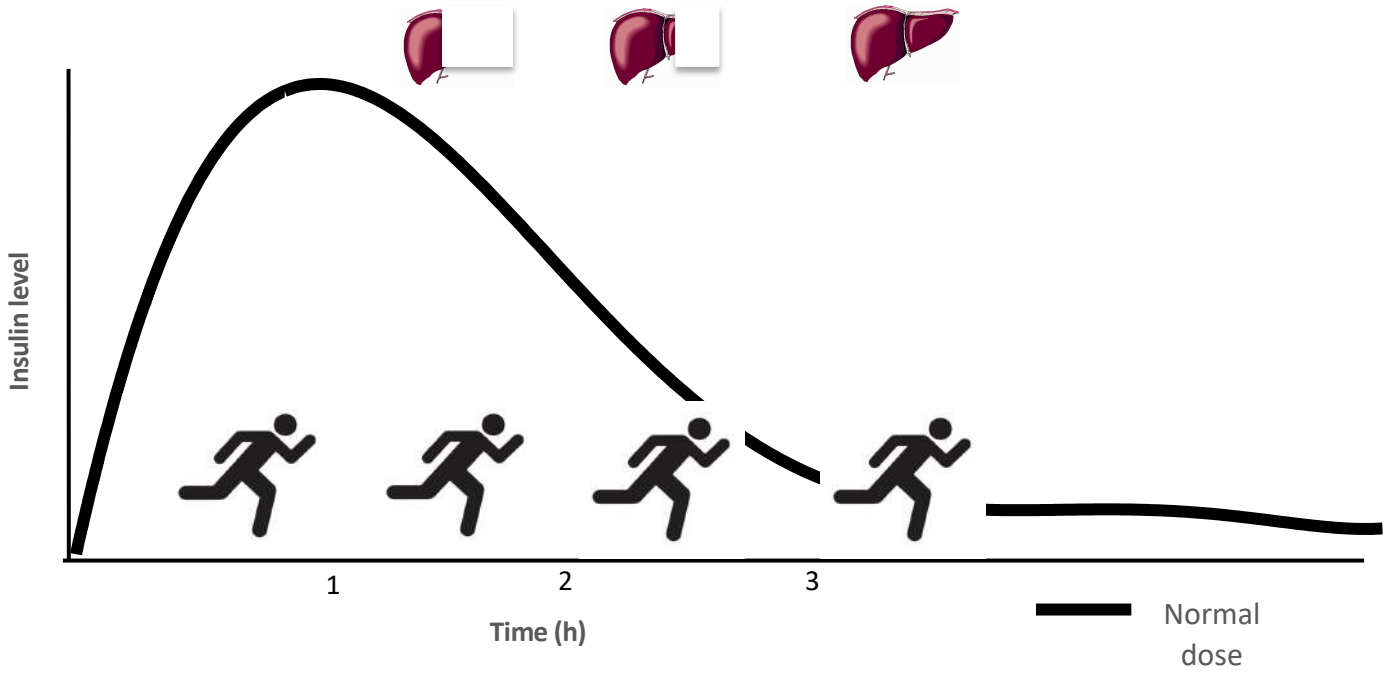
Fasted



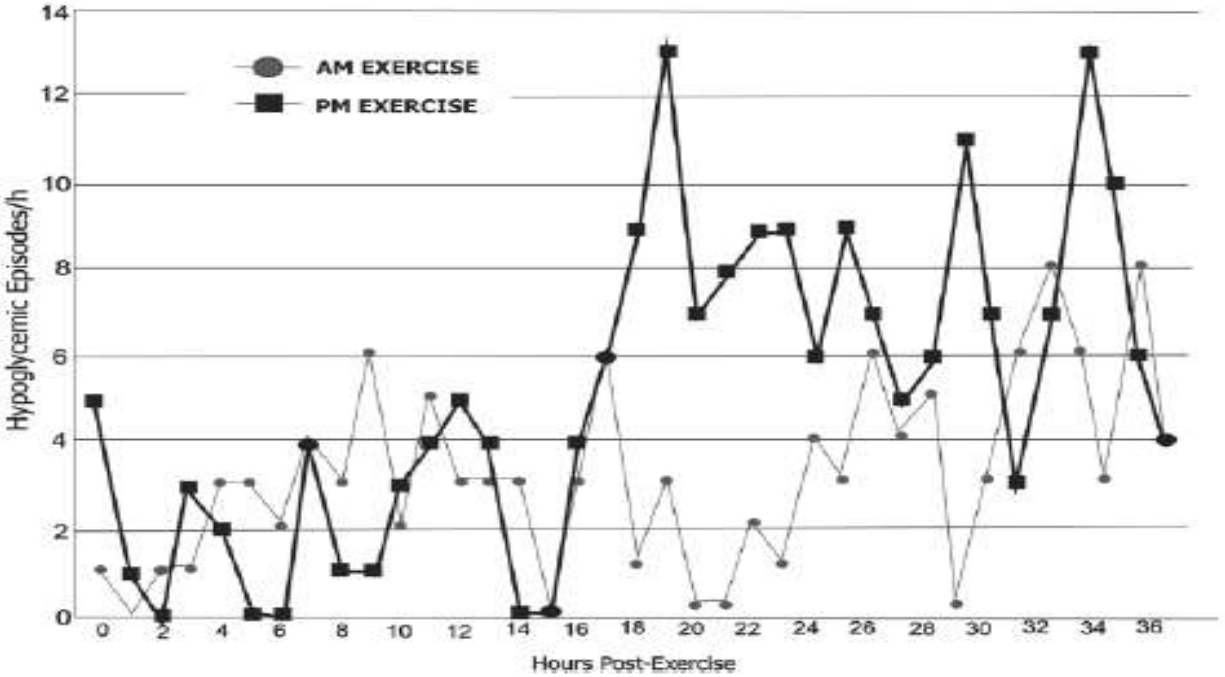
Good reproducibility in the blood glucose response to aerobic exercise in individuals with T1D in the fasted state

Biankin et al., Diabetes Care 2003

Liver glucose release and timing of fast acting insulin



Likelyhood of further hypoglycaemia following morning or afternoon exercise



Journal of Diabetes Science and Technology
2015, Vol. 9(3) 619–624

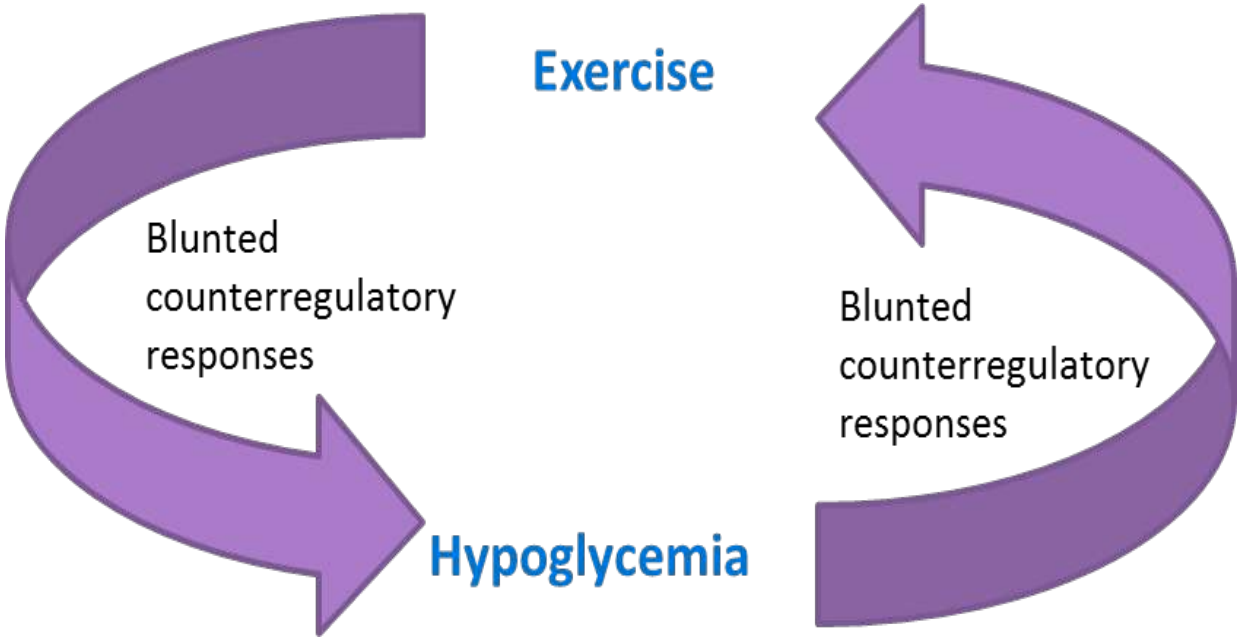
Summary 4

- Less risk of hypo if exercise when fasted
- Glucose response to exercise is more reliant if exercise fasted
- Higher risk of post exercise hypoglycaemia if exercise later in day

Glucose level– three things to think about

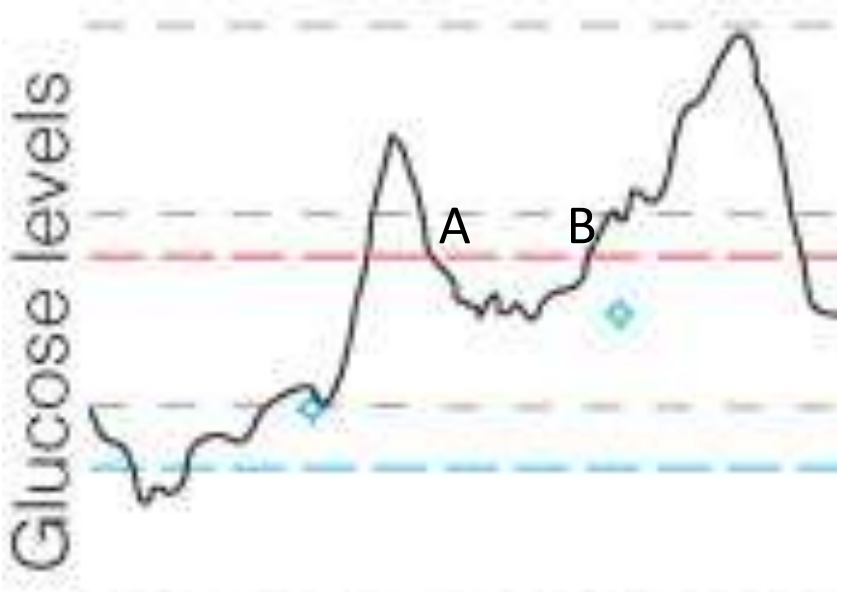
- Whether had any hypoglycaemic episodes
- Direction of travel of glucose
- Current blood glucose

Vicious Cycle of Hypoglycemia and Exercise



Ertl & Davis, Diabetes Met Res Rev, 2004

Direction of glucose



Although A and B have similar glucoses. Exercising at these point is likely to see different glucose response to exercise

A few glucoses before exercise will enable you to see direction of travel

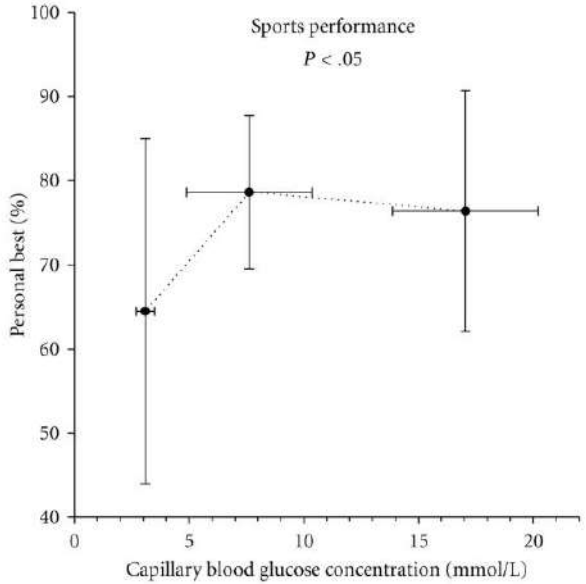
Blood glucose that say's NO

Low blood glucose Less than 3.5	High blood glucose More than 15
Severe hypoglycaemia (needed help) • Don't exercise for 24 hours	Ketones greater than 1.5 mmol/L • Take insulin and wait until have dropped to below 1.5 mmol/L before exercising
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	Ketones less than or equal to 1.5 mmol/L • Eaten less than 2 hours ago: just monitor • Eaten more than 2 hours ago: take extra insulin • Can do low-to-moderate intense exercise

Starting blood glucose

Blood glucose	Recommendations (rule of thumb)
Less than 5.6 mmol/L	Ingest 20g of glucose before exercise Delay exercise until blood glucose >5.6mmol/L
5.7 – 6.9 mmol/L	Ingest 15g of glucose Exercise can be started
7 – 15 mmol/L	Exercise can be started
More than 15 mmol/L	Check blood ketones • **If ketones greater than 1.5 mmol/L** take 1/3 (30%) of normal corrective dose of insulin and do not exercise until have dropped below 1.5 mmol/L • **If ketones less than or equal to 1.5 mmol/L** take 1/3 (30%) normal corrective dose of insulin if not eaten in last 2 hours and start to exercise, keeping an eye on your blood glucose

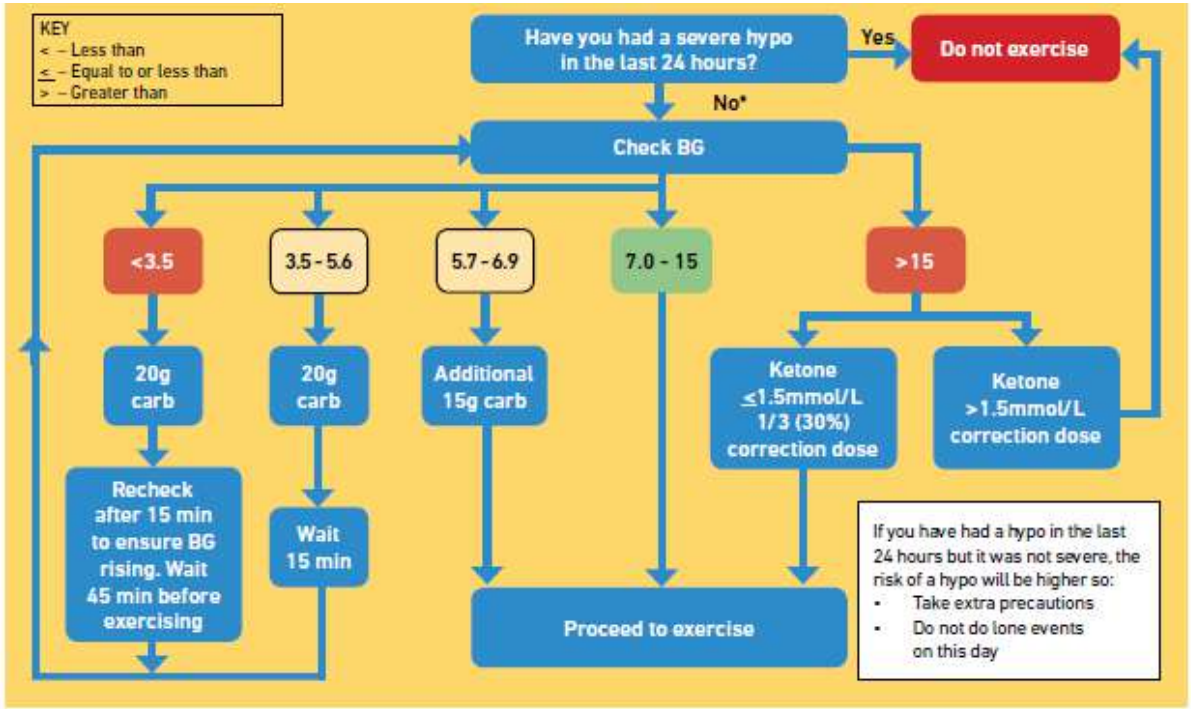
Glucose range for best performance



Kelly D et al Int J Pediatr 2010

- Clinically people seem to have ideal range for getting best performance – varies for different sports.
- Hypo before events effects performance.
- People who have recurrent hypo seem to not see as much improvement as expect – this could be due to nutritional issues rather than hypo.

Simple flowchart for glucose and exercise



If know direction of glucose from >two blood glucose readings, flash monitor, or continuous glucose monitor.

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

↓ = ↓ or ↘

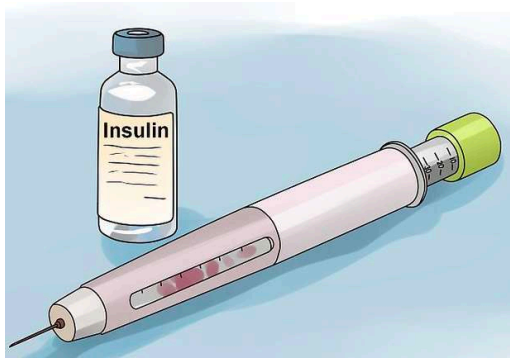
↑ = ↑ or ↗

Summary 5

- Glucoses in the last 24 hours are important in determining if someone can exercise and how they should exercise

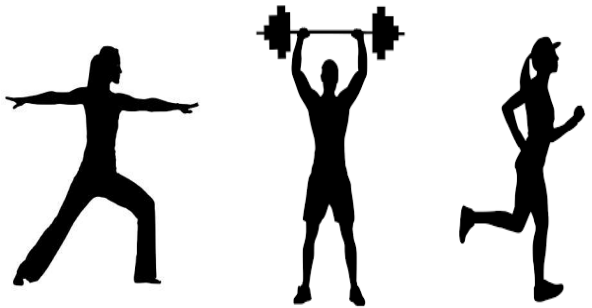
- Blood glucose just before starting to exercise can determine whether safe to exercise and whether action needs to be taken before exercise

Three ways to manage glucose during exercise - ICE



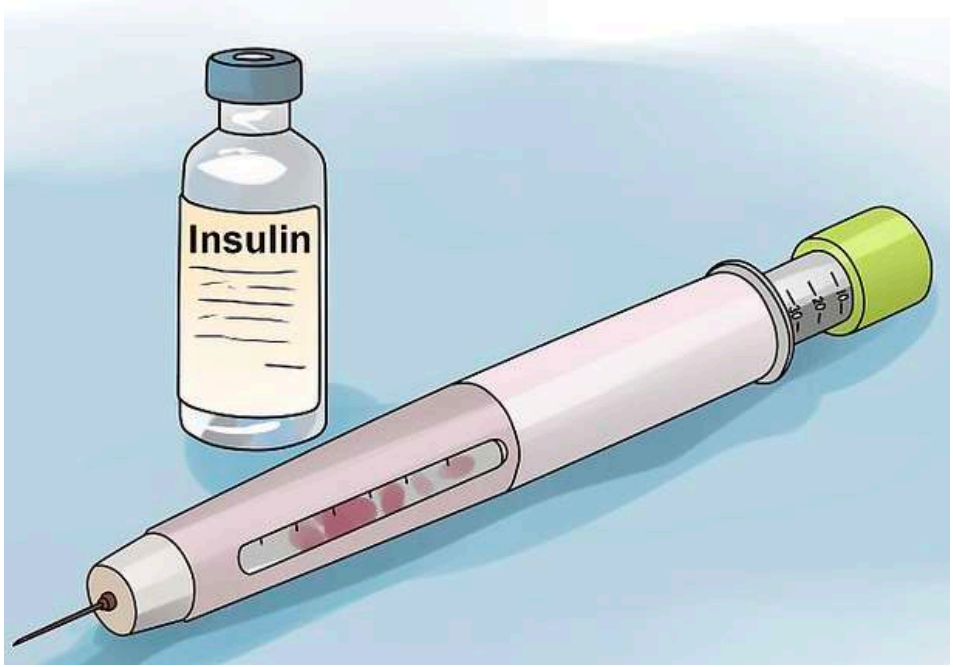
Insulin

Carbohydrate

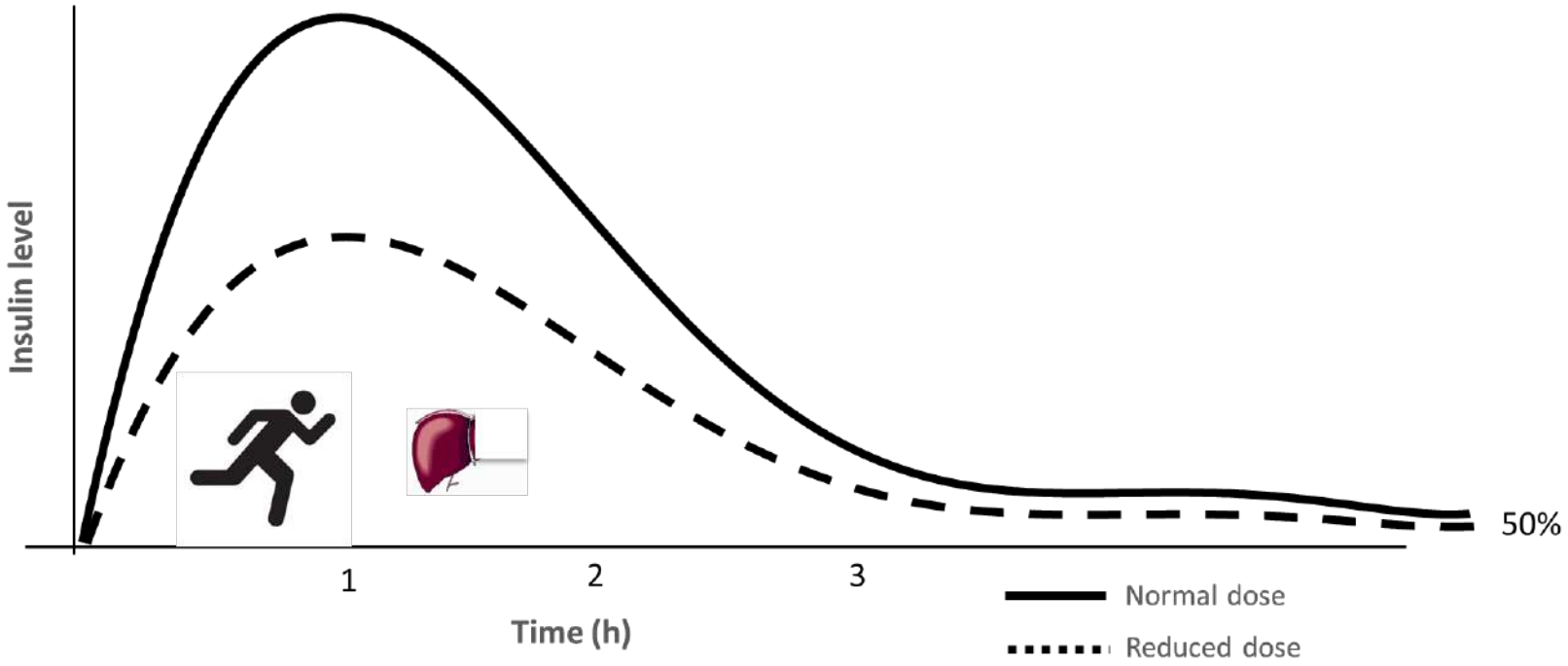


Exercise

Using insulin to manage glucose during exercise



Affect of lowering fasting acting insulin by 50%



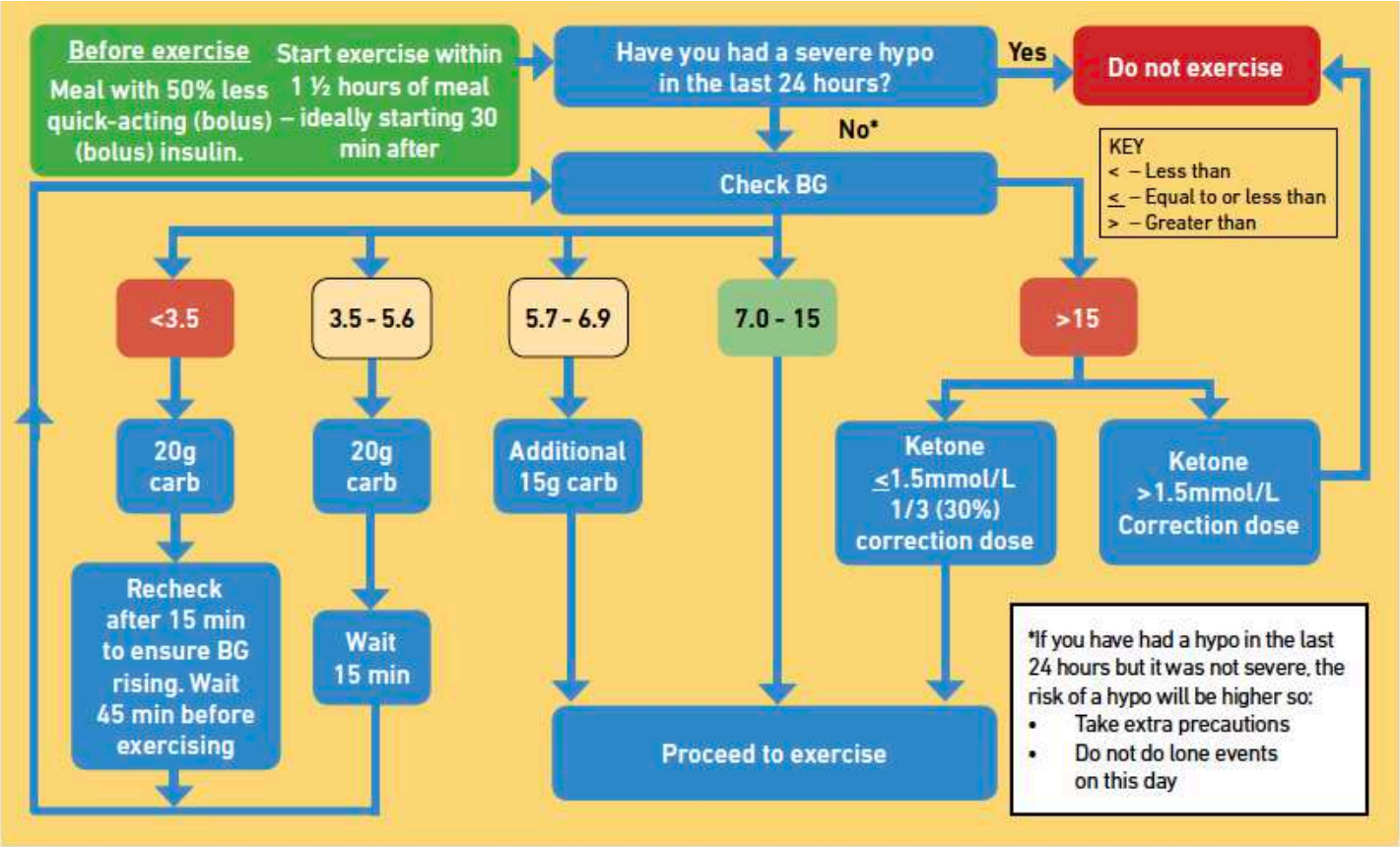
Simple strategy for insulin

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

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

Do not change background

Flowchart for simple Insulin Strategy pre exercise



Semi-quantitative method for fast acting insulin

Insulin reduction is made dependent on the intensity and type 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. Do not change background.

	% Dose reduction	
Exercise	**30 min of exercise**	**60 min of exercise**
Low intensity continuous	25	50
Medium intensity continuous	50	75
High intensity continuous	75	Not applicable
Resistance; weight lifting	0	25-50%
High intensity interval training	0	
Mixed : intermittent aerobic and anaerbic	25%	50%

Riddell MC 2017

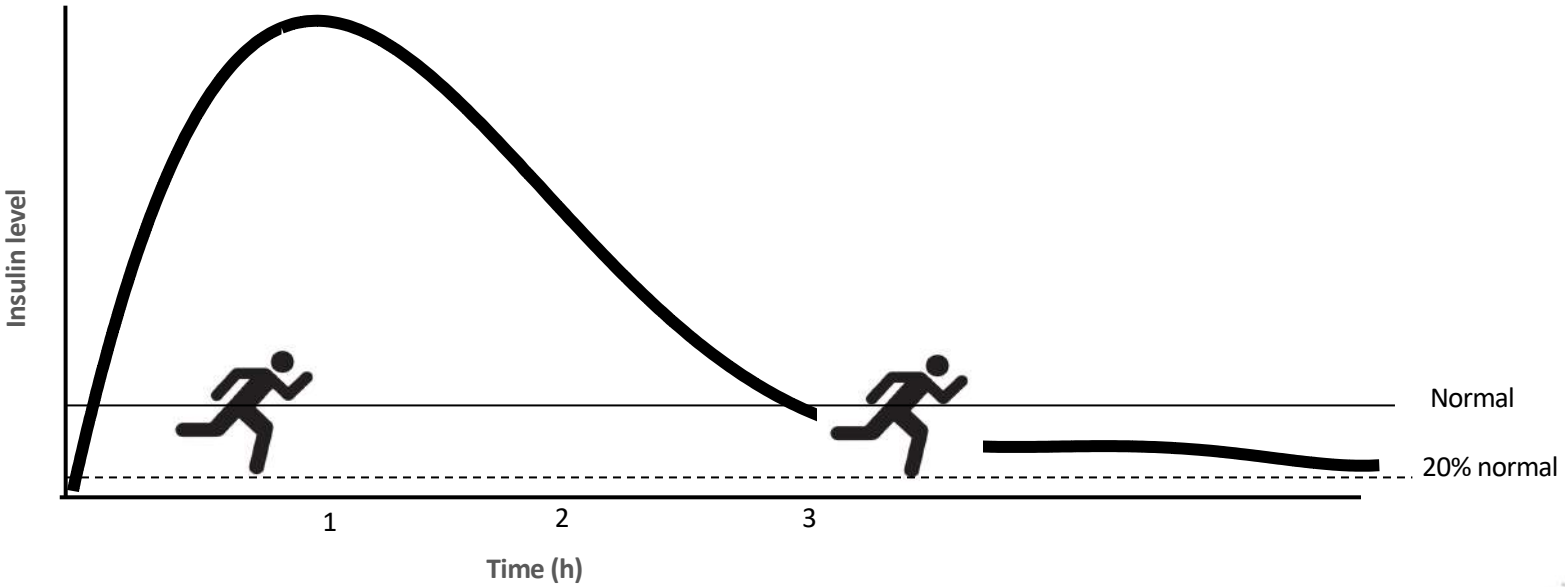
Quantitative method for fast acting insulin

- 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.

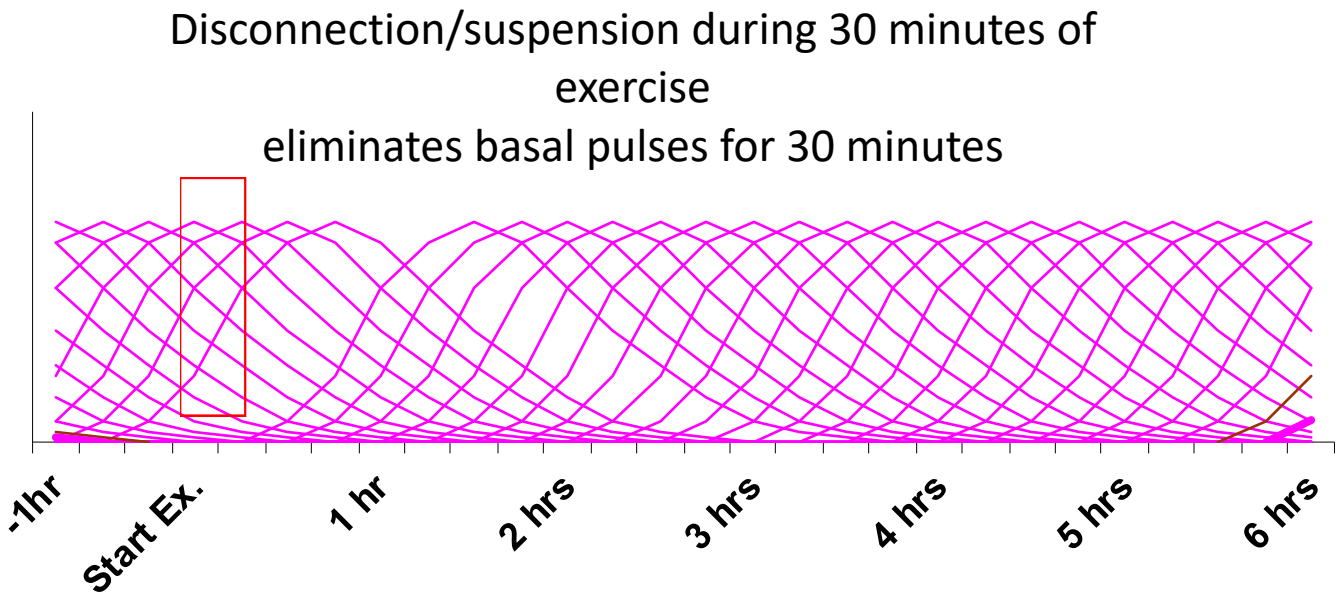
Example 1

- Diane wants to cycle for one hour after breakfast at 14 miles/hr. she normally takes insulin in ratio 1 unit for 10 grams. For breakfast he has 95 grams of carbohydrate. On her ride he will burn 75 grams of carbohydrate (see table) above. So the Difference is 95-75 = 20 grams. So she needs to take insulin to cover 20 grams – 2 units, as opposed to his normal 9.5 units.

Lowering background insulin

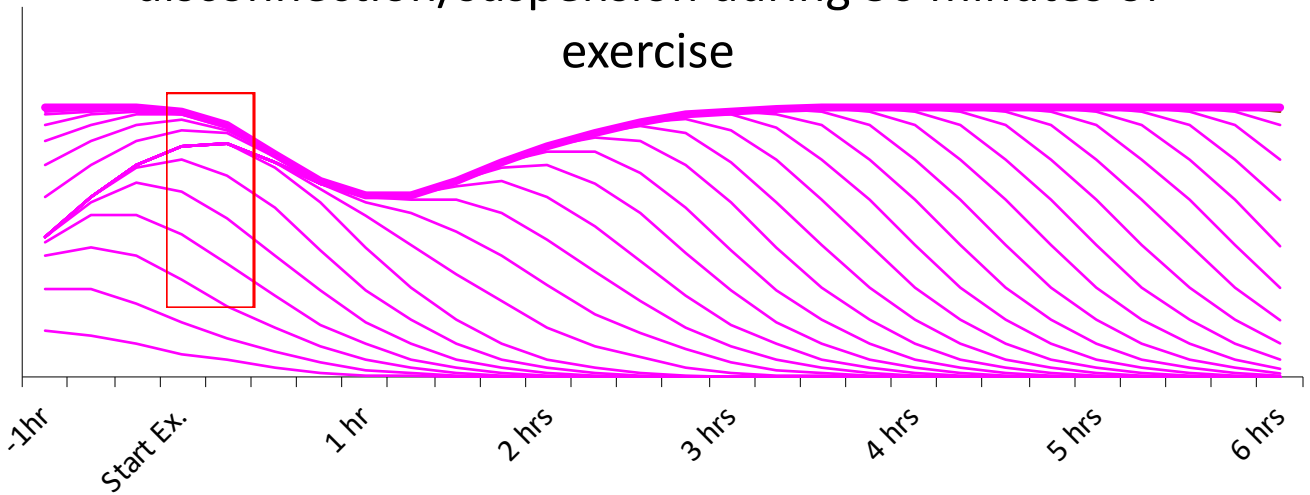


Effect of pump disconnection on basal insulin levels



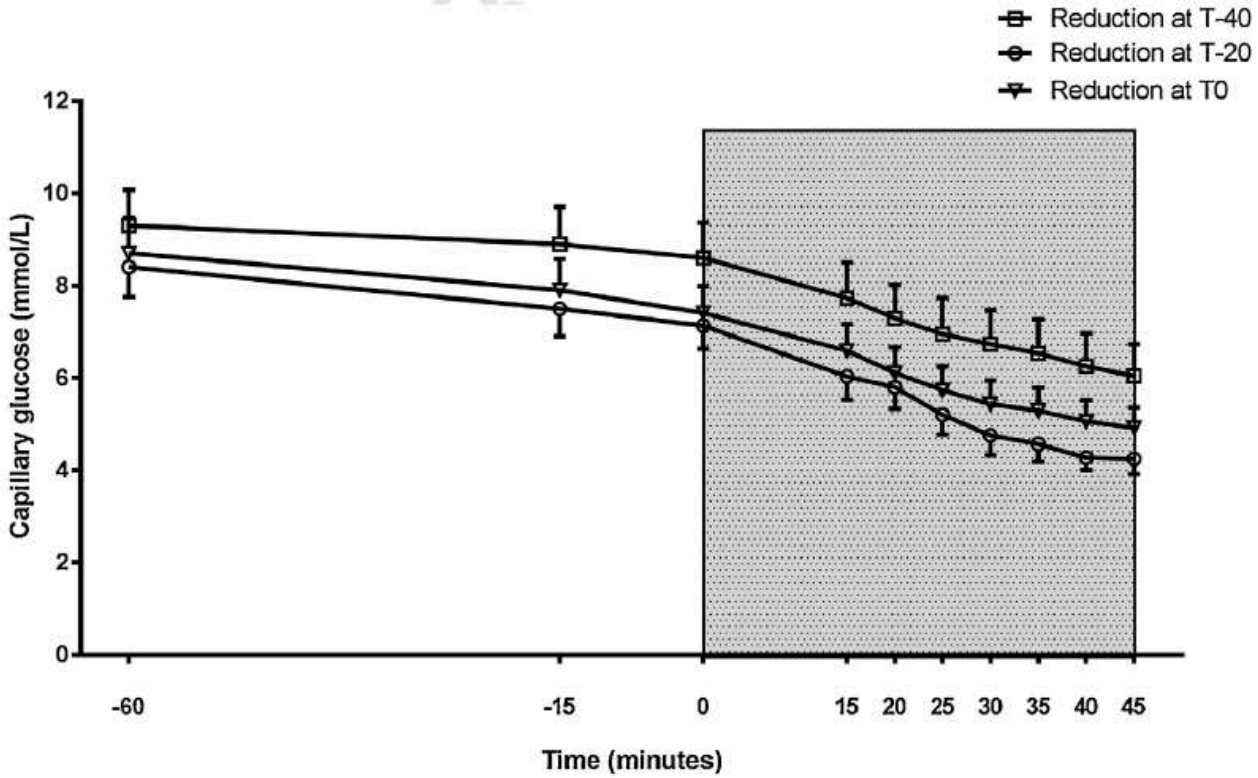
Effect of pump disconnection on basal insulin levels

Level of active basal insulin resulting from disconnection/suspension during 30 minutes of exercise



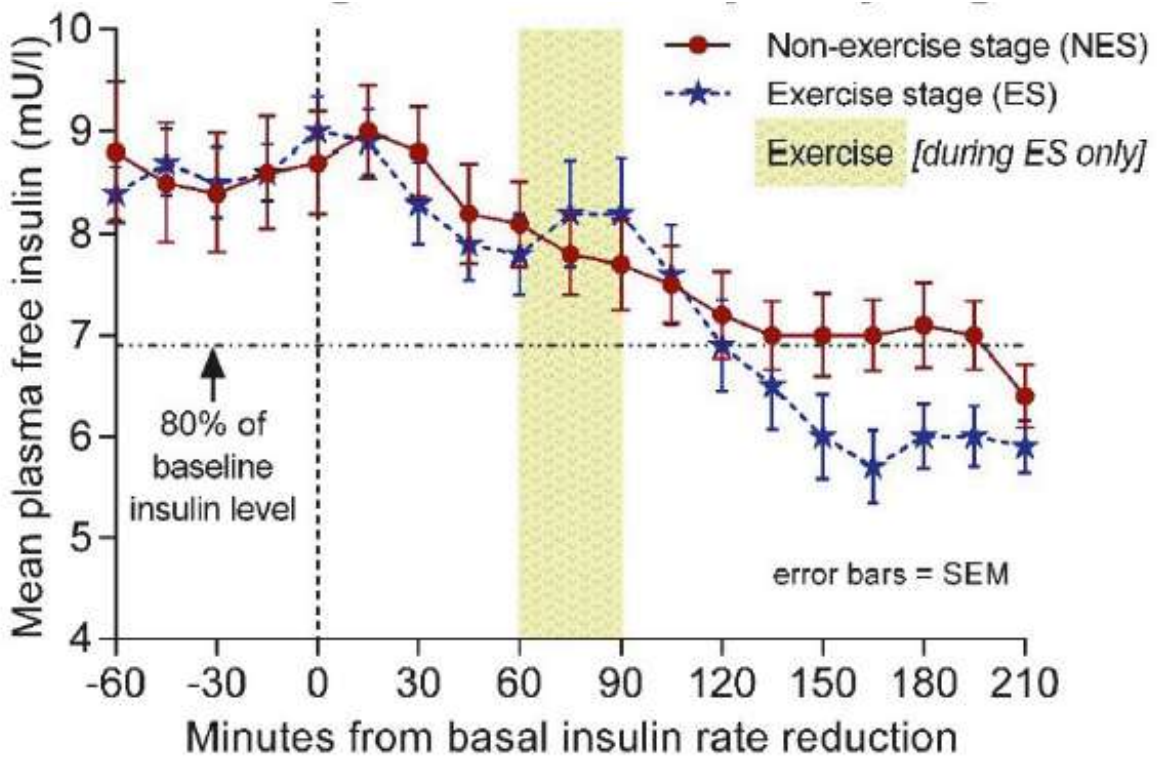
Disconnection during a short exercise session has minimal effect on insulin levels

Discontinuing for short period of time



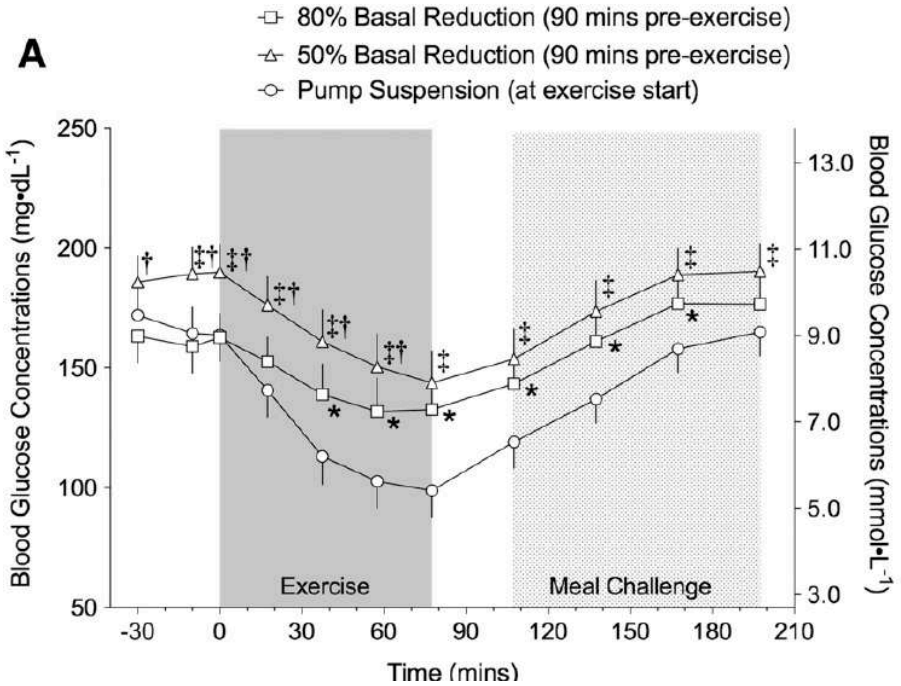
Roy flemming et al 2019

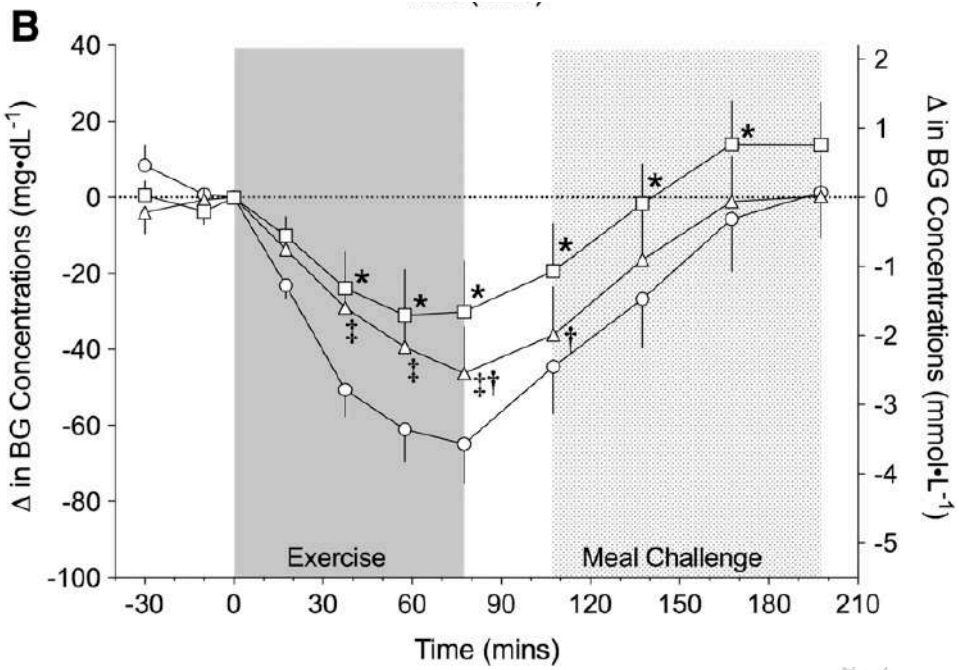
Insulin levels when reduce pump by 50%



McAuley et al (2016) *Diabetologia* **59**: 1636-1644

How much to reduce by





Zaharieva DP et al 2019

Semi-quantitative method basal insulin pump

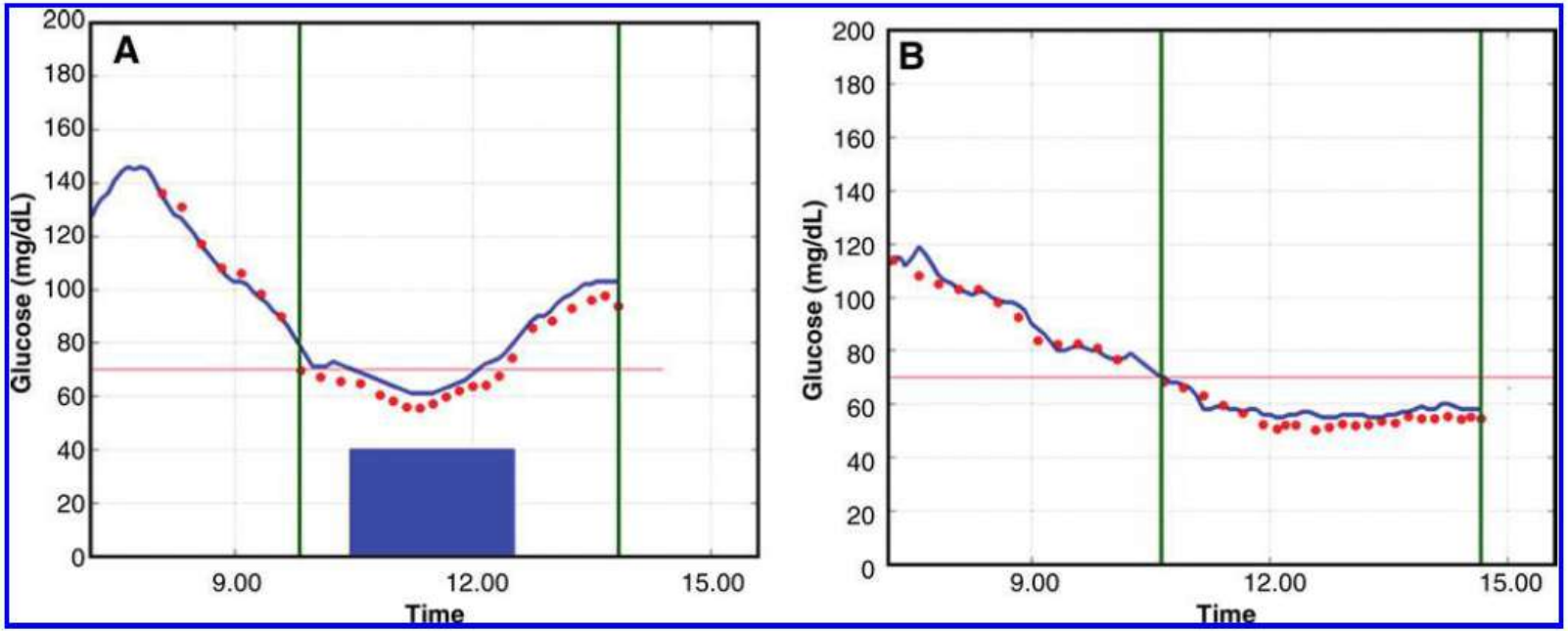
Insulin reduction is made dependent on the intensity and type of the exercise that has been preformed. Reduction with exercise only if exercising 3 hours after meal.

	Exercise ~ 30 minutes	Exercise ~ 60 minutes
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
Resistance (anaerobic)	No reduction	50% basal reduction, performed 90 min before exercise
High intensity interval training	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

Riddell MC 2017

extod

LGS on v LGS off



Garg et al (2012) *Diabetes Technology & Therapeutics* **14(3)**:205-209

What should the setting be

Variables	All (n = 31)	Group A PLGM-T 90 mg/dL (n = 18)	Group B PLGM-T 70 mg/dL (n = 13)	P
During the 3-day period				
Time (%) in <54 mg/dL	0 (0; 0.5)	0.1 (0; 0.4)	0 (0; 0.6)	0.726
Time (%) in <70 mg/dL	2.3 (0.3; 4.3)	1.8 (0.3; 4.5)	2.3 (0.5; 3.9)	0.920
Time (%) in 70-180 mg/dL	65.1 (53.7; 72.6)	64 (51; 71.9)	65.1 (59.6; 73.4)	0.423
Time (%) in >180 mg/dL	35 (22.6; 43.2)	35.4 (24.7; 47.6)	35 (19.4; 38.5)	0.401
Time (%) in >250 mg/dL	5.4 (3.4; 11.6)	5.5 (3.1; 10.9)	5.4 (4.6; 12.2)	0.841
SD (mg/dL)	56.3 (49.3; 62.5)	56.9 (48.4; 66.1)	56.3 (49.4; 62.3)	0.968
%cv	36 (33.9; 37.5)	36 (34.1; 37.5)	35.7 (33.9; 37)	0.873
SGT suspension (n)	12.0 (9-14)	12.0 (8-14)	12.0 (9-14)	0.732
SGT suspension (min)	673.1 (520-982)	614.6 (482-938)	796.2 (600-1032)	0.222
During the three nights				
Time (%) in <54 mg/dL	0 (0; 0)	0 (0; 0)	0 (0; 0)	0.772
Time (%) in <70 mg/dL	0.4 (0; 3.8)	0.2 (0; 4.2)	1.5 (0; 1.9)	0.817
Time (%) in 70-180 mg/dL	69 (53.6; 80)	66.3 (50.9; 80)	72.1 (57.4; 79.6)	0.603
Time (%) in >180 mg/dL	23.1 (15.6; 42.7)	32 (16.1; 47.7)	21.5 (15.6; 37.4)	0.631
Time (%) in >250 mg/dL	3.1 (0; 10.4)	3.1 (0.1; 10.4)	3.4 (0; 9.8)	0.760
SD (mg/dL)	46.5 (38.4; 56.9)	47.9 (38.2; 56.4)	46.1 (38.9; 56.3)	0.936
%cv	31.2 (25.5; 35.5)	31.3 (25.2; 35.7)	31.2 (26; 35.1)	0.749
SGT suspension (n)	4.0 (2–5)	4.0 (1–4)	4.0 (3-5)	0.337
SGT suspension (min)	259.8 (195-353)	236.6 (123-357)	308.9 (241-351)	0.357

54 = 3
70= 3.9
90 = 5
180=10
250=14

Cherubini v et al 2018

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Integrating other sources

Original Article

The Impact of Accelerometer and Heart Rate Data on Hypoglycemia Mitigation in Type 1 Diabetes

Journal of Diabetes Science and Technology
2014, Vol. 8(1) 64–69

DOI: 10.1177/1932296813516208
dst.sagepub.com
SAGE

Matthew Stenerson, MD[1], Fraser Cameron, PhD[2], Darrell M. Wilson, MD[1], Breanne Harris, BS[1], Shelby Payne[1], B. Wayne Bequette, PhD[2], and Bruce A. Buckingham, MD[1]

Table 2. Number of Hypoglycemic Readings in the Simulator for Each Intervention Group.

Intervention	Readings below 70 mg/dl
Actual (real life)	336
PLGS	127
PLGS + HRM	97
PLGS + accelerometer	86
PLGS + accelerometer + HRM	80

extod

Using carbohydrate to manage glucose during exercise

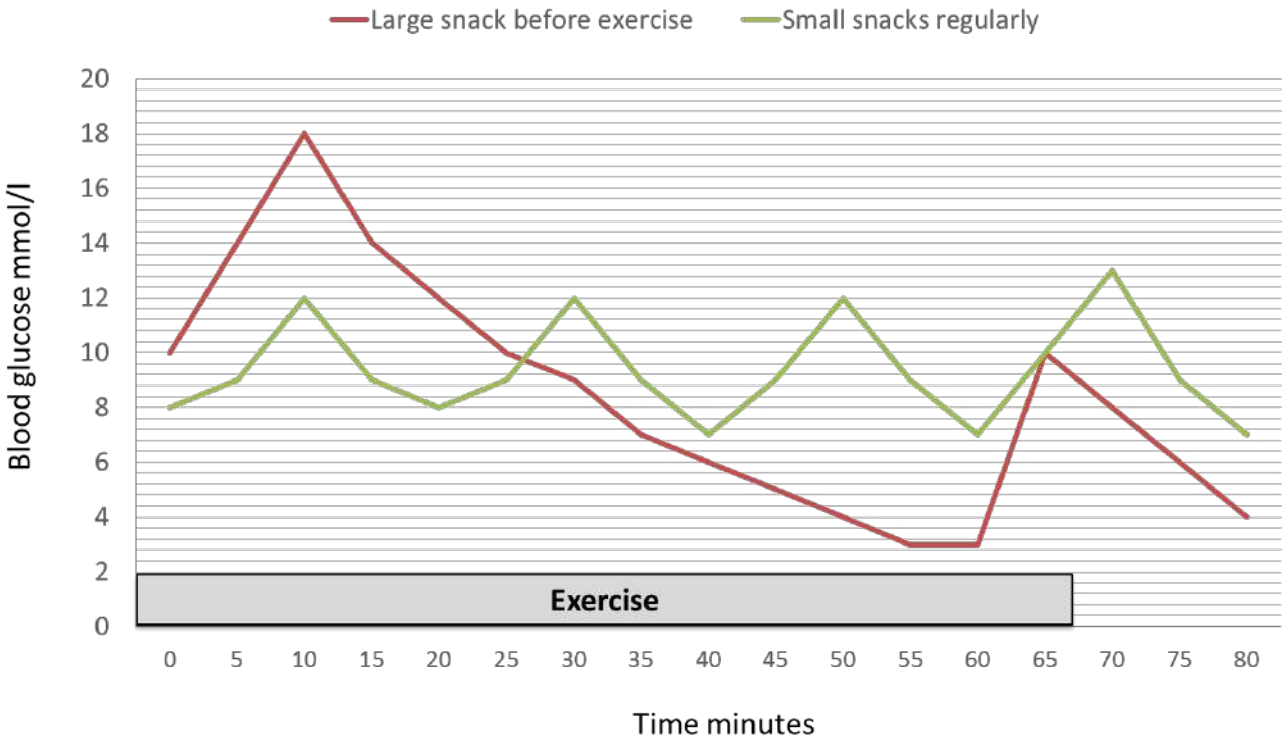
Simple carbohydrate regime

- 30 grams/ hr

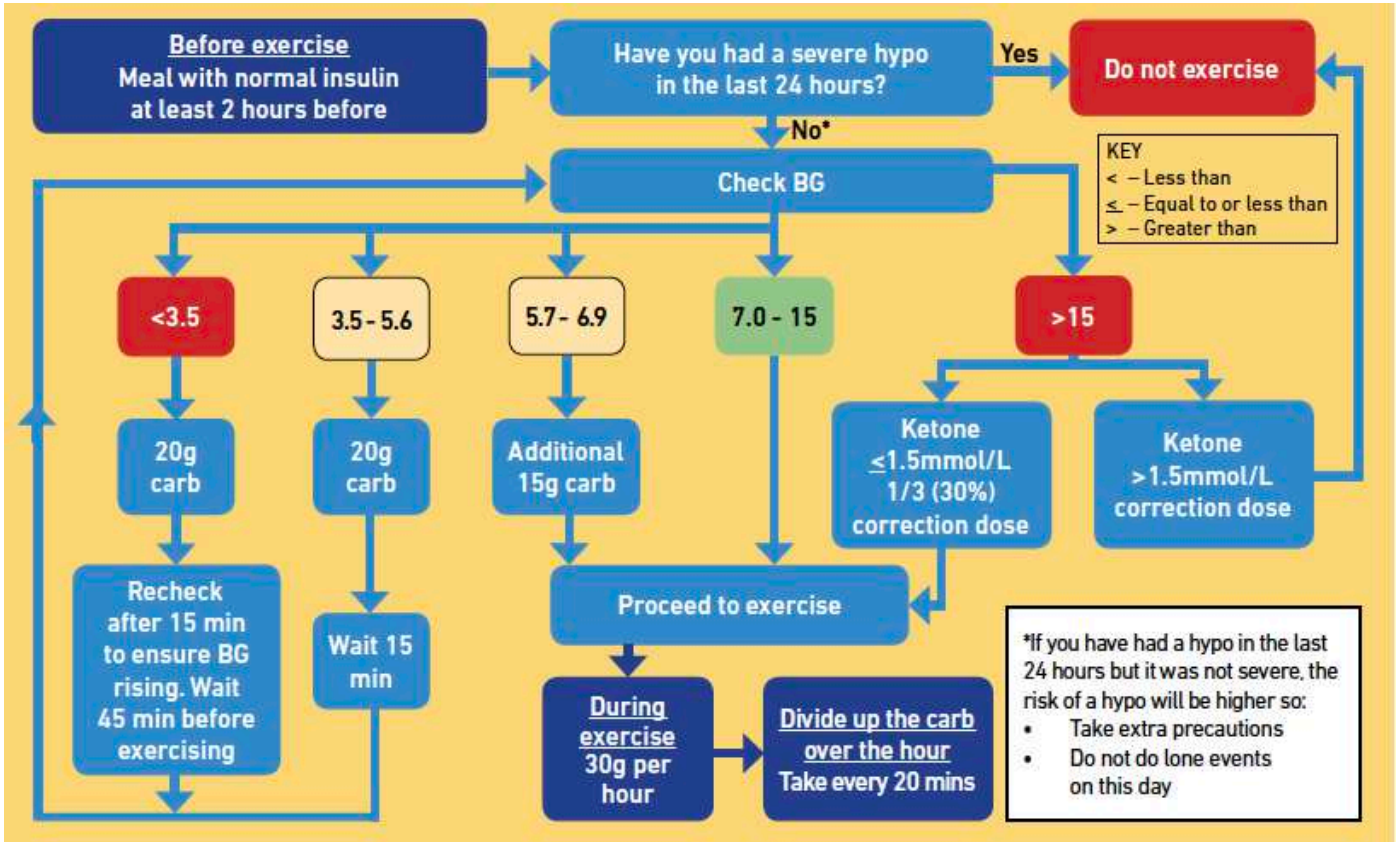
Examples of carbohydrates you could try

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



Simple Flowchart for Carbohydrate replacement during exercise



Semi-quantitative method

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

- For example: Diane wishes to exercise at intense activity for 60 minutes. She weighs 56 kg so will take 20 grams at the start, 20 grams at 20 minutes and 16 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

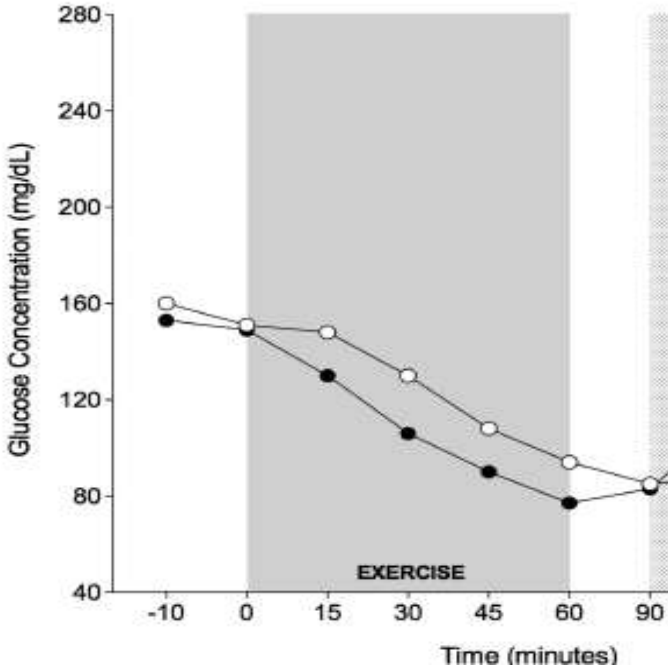
Using EX carb table

- For example: Diane wishes to cycle for 1 hour at ~ 14 miles per hour. Using table below this requires 75 g, so will take 25 grams at the start, 25 grams at 20 minutes and 25 grams at 40 minutes.

Type of Activity	Speed/ intensity	Carb (grams) per kg per hour	Carbs (grams)for 75kg person per hour	Carbs for me WT=
Walking	3 miles/hr	0.33	25	
	5 miles/hr	0.67	50	
Running	5 miles/hr	1.0	75	
	8 miles/hr	2.1	158	
	10 miles/hr	2.8	210	
Cycling	6 miles/hr	0.45	34	
	10 miles/hr	0.78	59	
	14 miles/hr	1.34	101	75
	18 miles/hr	2.0	150	
	20 miles/hr	2.7	203	

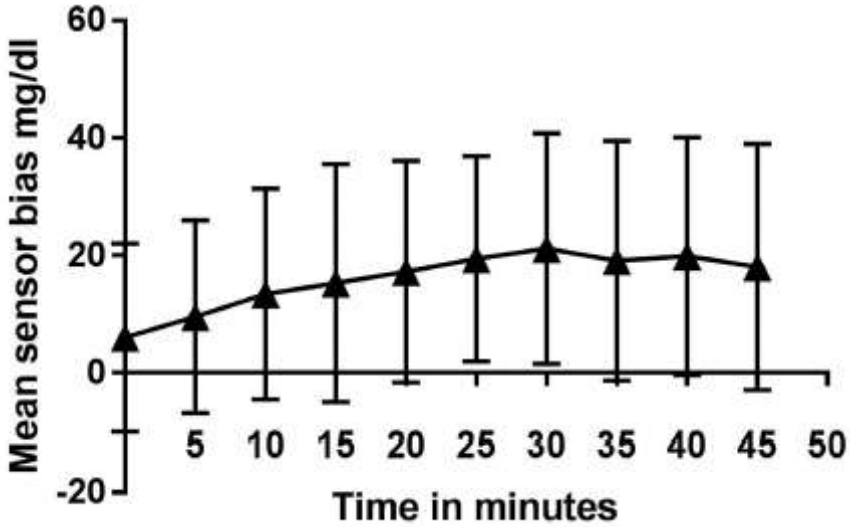
CGM while exercising

Lag of CGMS – White blood glucose, Black CGM



Zaharieva DP et al 2019

Change in bias during exercise



Larose S et al 2019

MARD during exercise

	Freestyle libre	Dexcom	Medtronic
Overall	13.2. ± 10.9 (N =462)	16.8 ± 12.3 (N=540)	21.4 ± 17.6 (N=502)
Exercise	22.2 ± 15 (N=845)	15.7 ± 14.6 (N = 24)	19.4 ± 13.5 (N = 22)

But during hypoglycaemia MARD was 36.3 ± 12

Moser O et al 2019

extod

Continous Glucose Monitoring (CGM) and carbohydrate intake algorithm for exercise

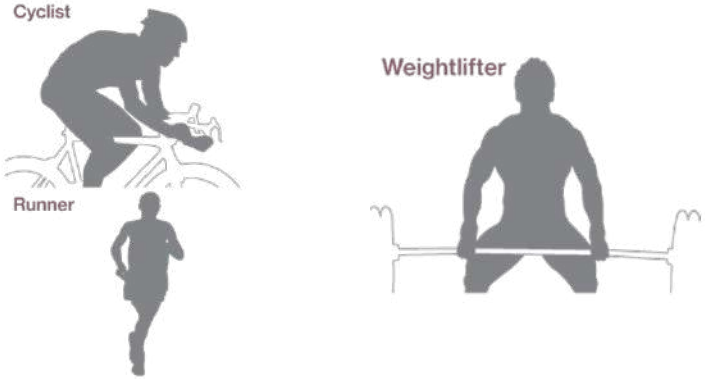
CGM Glucose level	Trend arrow(s)	Action	Comments
<5.0 mmol/L	None or downward trending	16-20g CHO	Stop exercise if blood glucose ≤ 3.9 mmol/L (70 mg/dL)
5.0-6.1 mmol/L	↓ Medtronic ↘ Dexcom/ Libre	16g CHO	
5.0-6.1 mmol/L	⇊ Medtronic ↓ or ⇊ Dexcom/ Libre	20g CHO	
6.1-6.9 mmol/L	Any downward trending arrows (all manufacturers)	8g CHO	

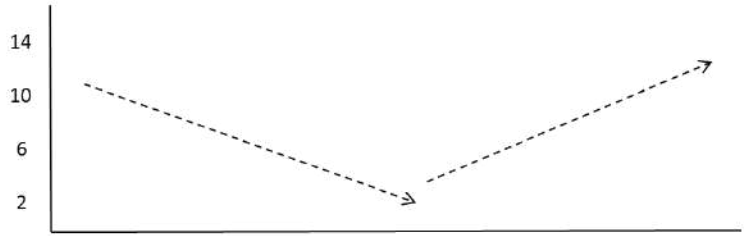
Using exercise to manage glucose during exercise

Order of gym events

Order 1

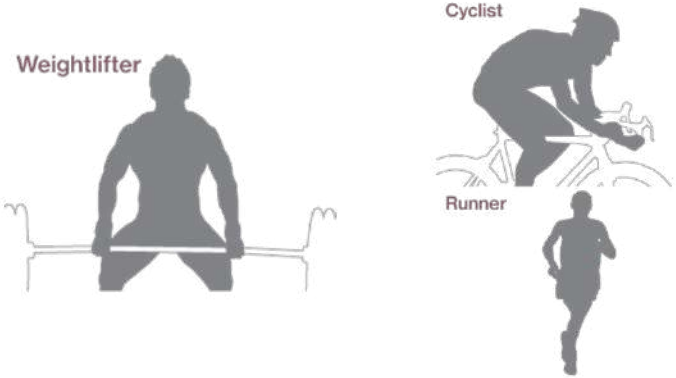
Aerobic then Anaerobic

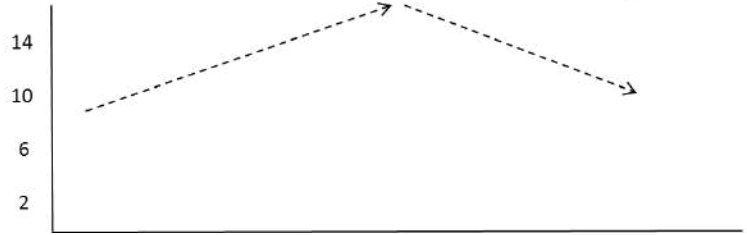




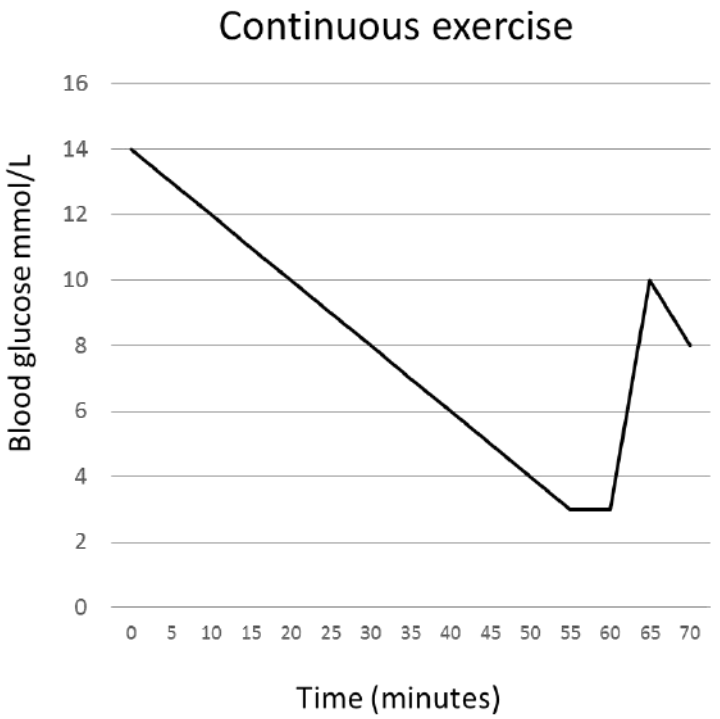
Order 2

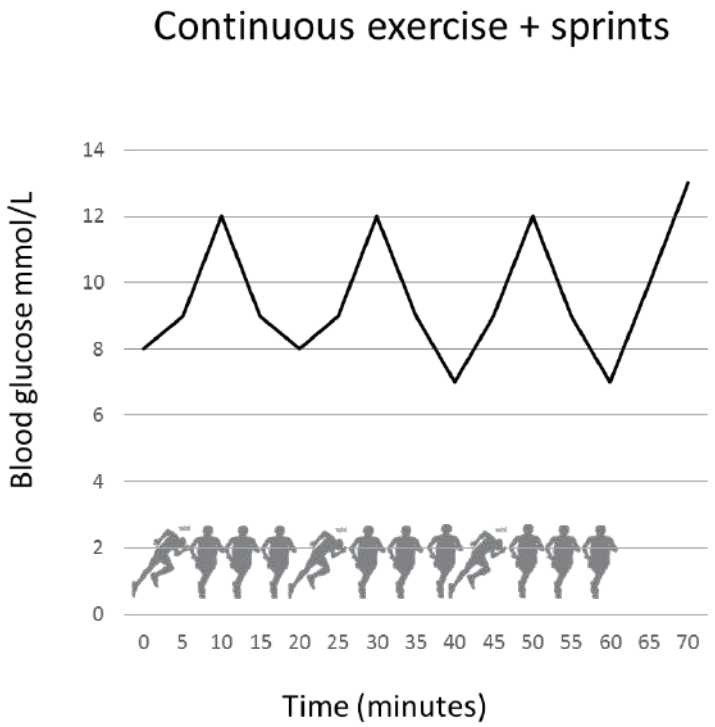
Anaerobic then Aerobic





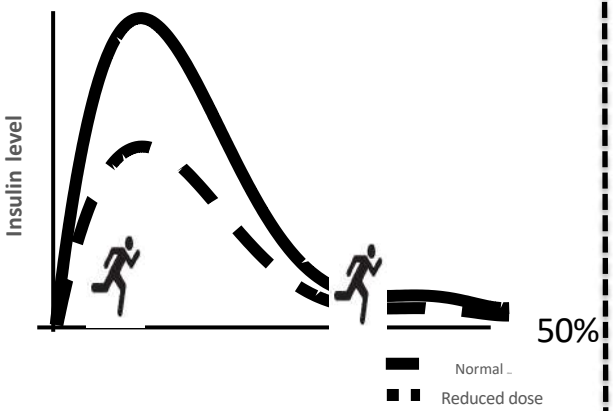
Using intensity of exercise to control glucose





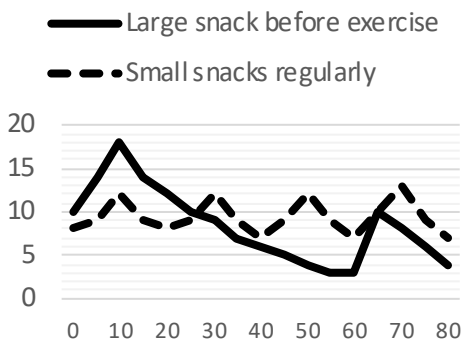
Three options for managing glucose during exercise - ICE

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



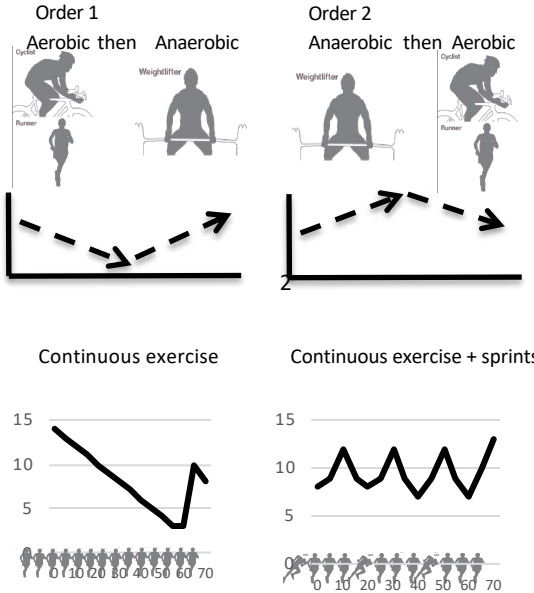
Reduce quick acting by 50% if exercising
Within 2 hrs of meal
Or
Exercise 2 hours after meal

Carbohydrate for exercise



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

Exercise type and intensity



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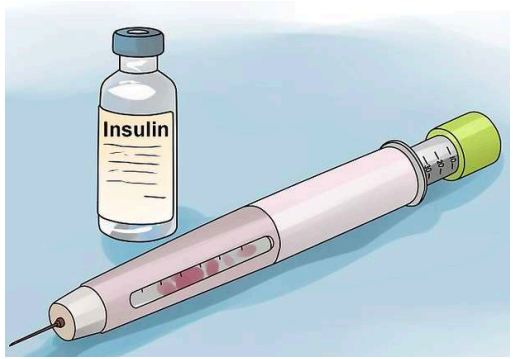
Summary of the three options

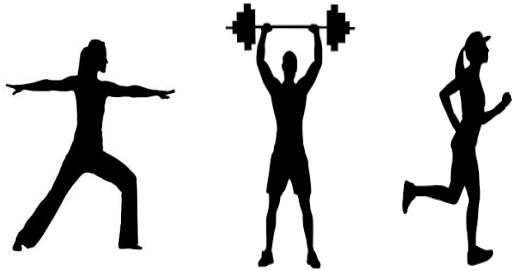
Strategy	Pros	Cons
Reducing pre-exercise fast acting insulin	Reduces hypoglycaemia during and following exercise, reduces carbohydrate requirement	Needs planning Not helpful for spontaneous exercise, or for exercise more than 2 hours after taking fast acting insulin
Exercise carbohydrate	Useful for unplanned 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

Three ways to manage glucose post exercise - ICE



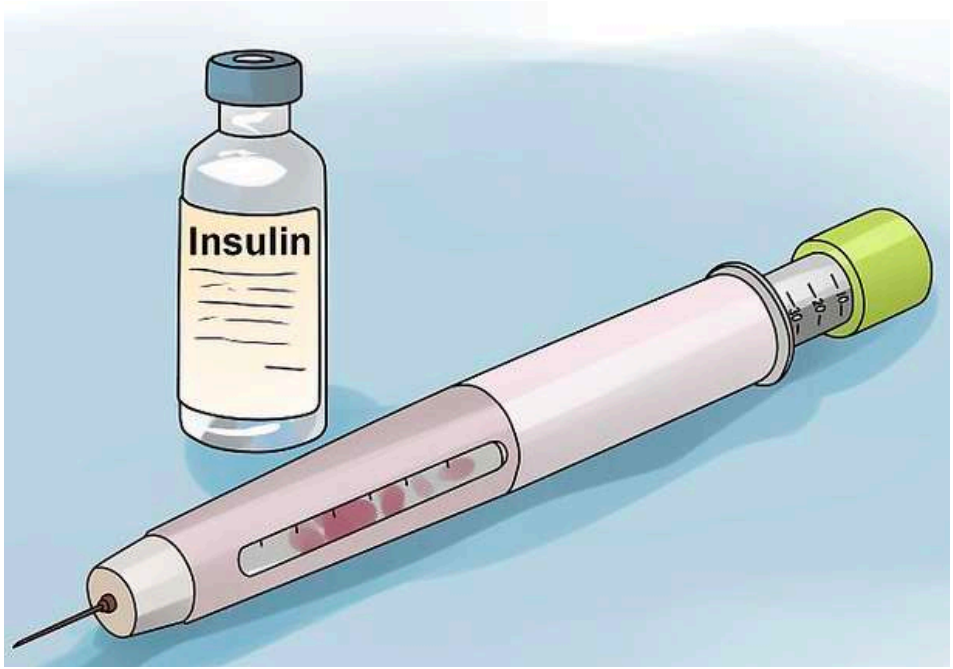
Insulin

Carbohydrate

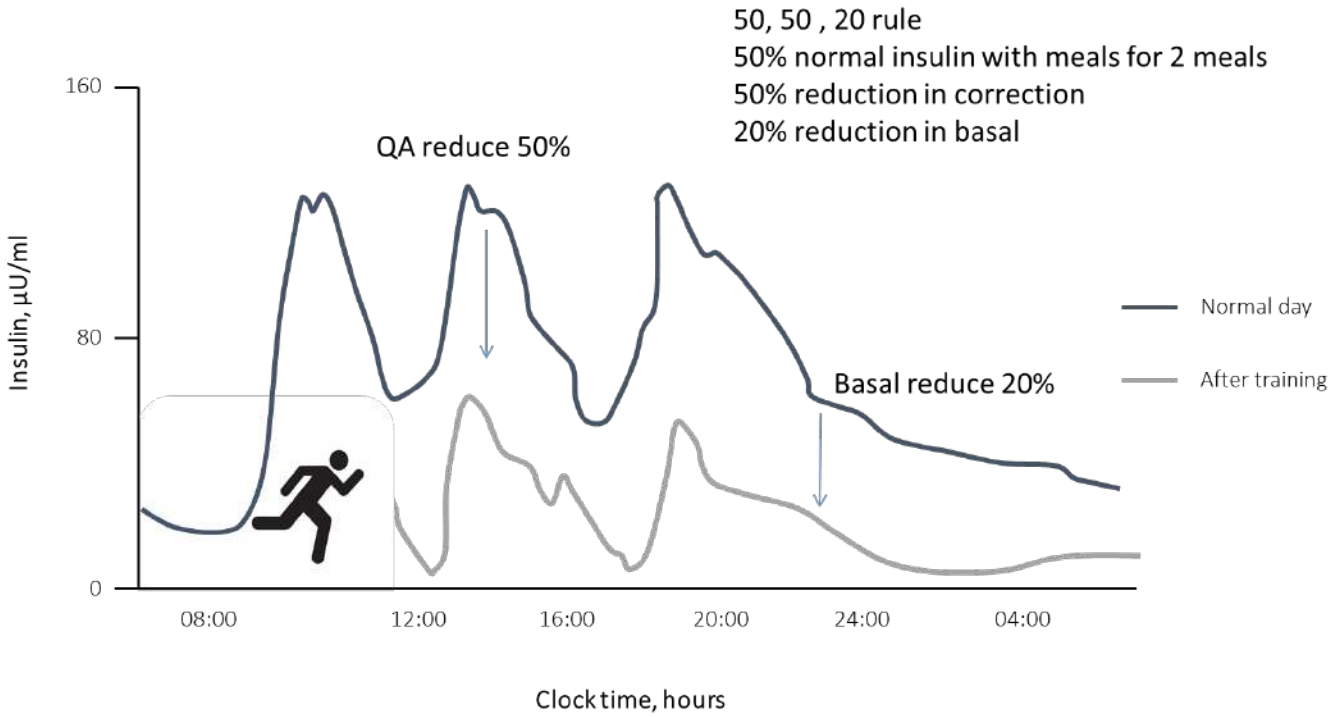


Exercise

Using insulin to manage glucose post exercise



Effect of exercise on Insulin sensitivity



Simple strategy for insulin post exercise

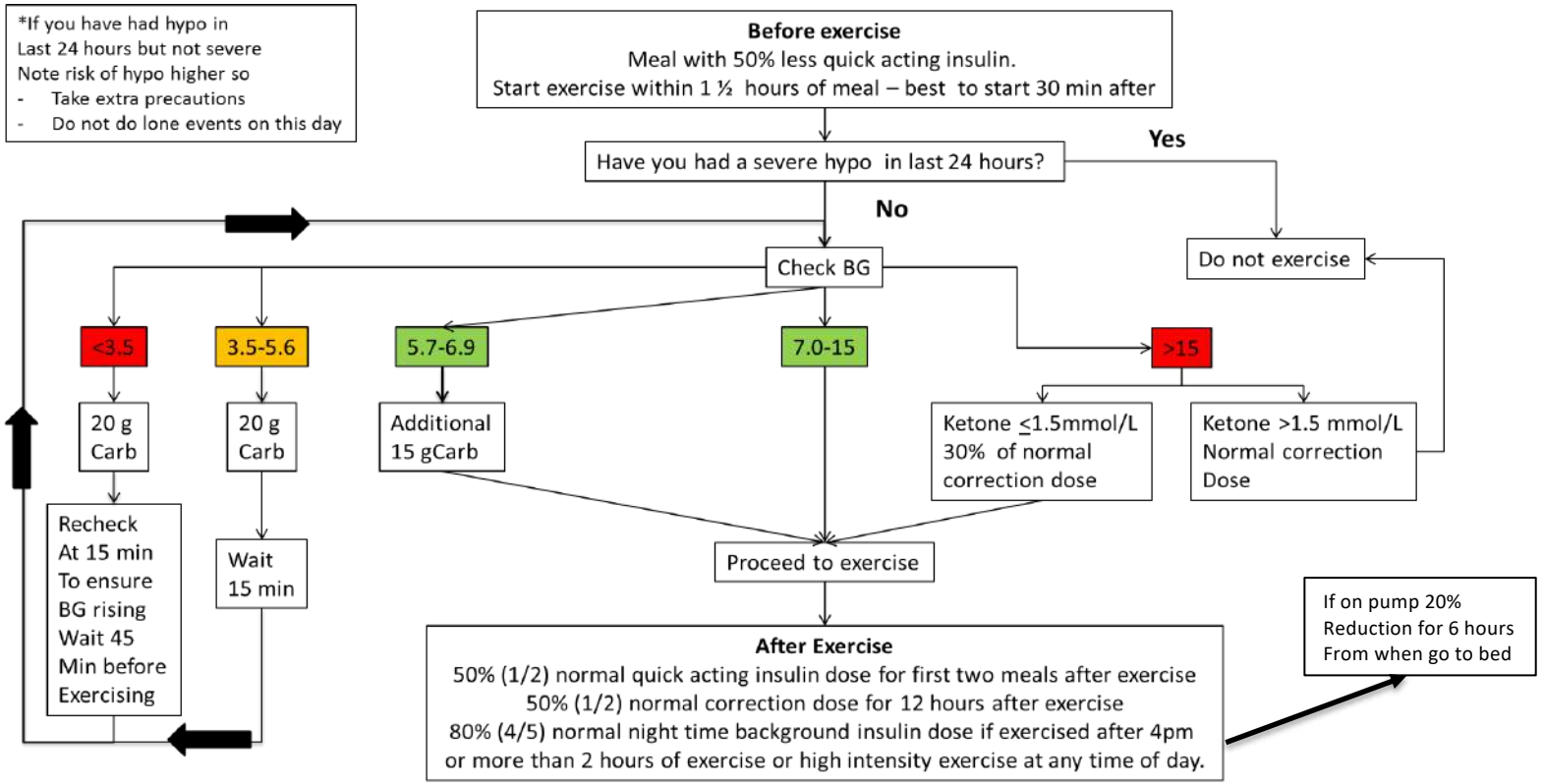
50 50 20 rule

- 50% reduction of normal bolus that would give with snack/meal – for first 2 meals/snacks post exercise

- 50% reduction of normal correction would give for 12 hrs

- 20% reduction of normal evening background or 20% reduction basal rate for 6 hrs from when go to bed if exercise >2hrs, new exercise or exercise after 4pm.

Simple flow sheet for changing insulin post exercise



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

Riddell MC 2017

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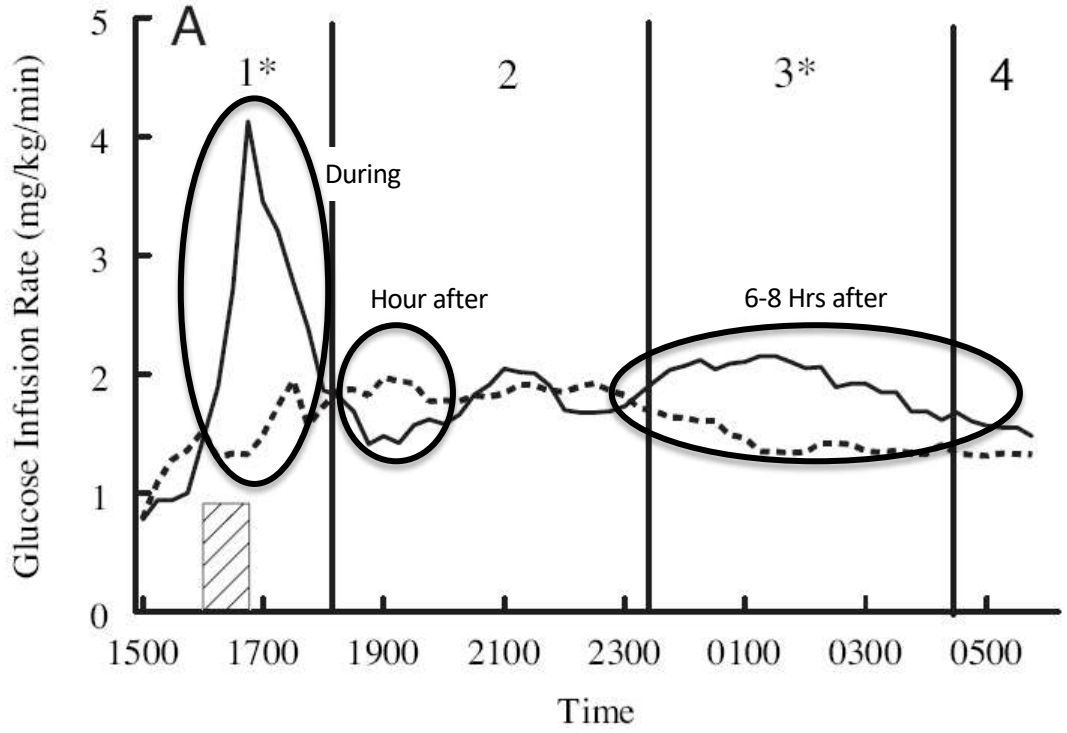
Using carbohydrate to manage glucose post exercise

Three times need to give glucose



McMahon, S. K. et al. J Clin Endocrinol Metab 2007;92:963-968

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.

M

C

nilk

extod

Recovery food

- Protein and Carbohydrate together improve glycogen storage 2 hours post exercise
- 4 carb : 1 protein
- 1g/kg/hr Carb (greater than 90 minutes 1.2 g/kg/hr)
- 0.2g/kg/hr Protein (up to 20 grams)




Preventing hypoglycaemia overnight – Bedtime snacks

If blood glucose <10 before bed then suggest have protein and carbohydrate snack (30 grams carb + 15 gram protein).

If blood glucose <7 before bed as well as a snack may need to make reduction in basal rate of 10% for 6 hours.

Closed loop overnight - hypoglcyaemia

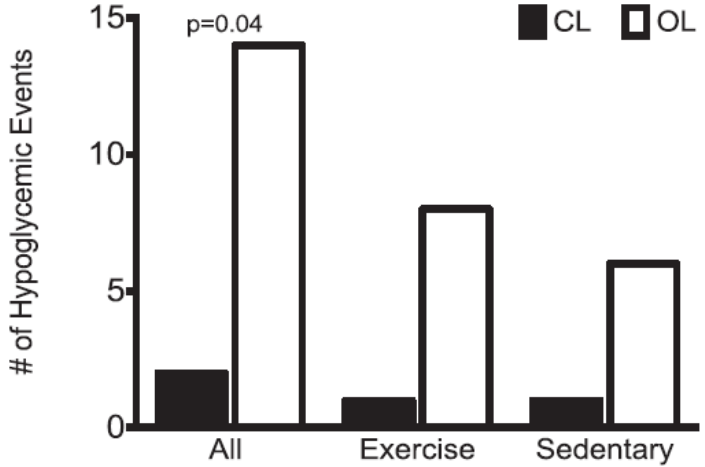


Figure 2—*Episodes of overnight treatable hypoglycemia (reference blood glucose <60 mg/dL) during OL and CL.*

Sherr et al (2013) *Diabetes Care* **36**:2909-2914

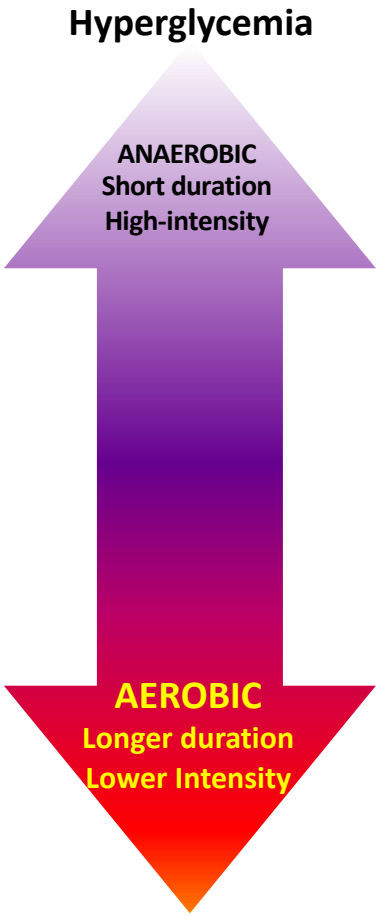
Using exercise to manage glucose post exercise

Using exercise to lower glucose post exercise

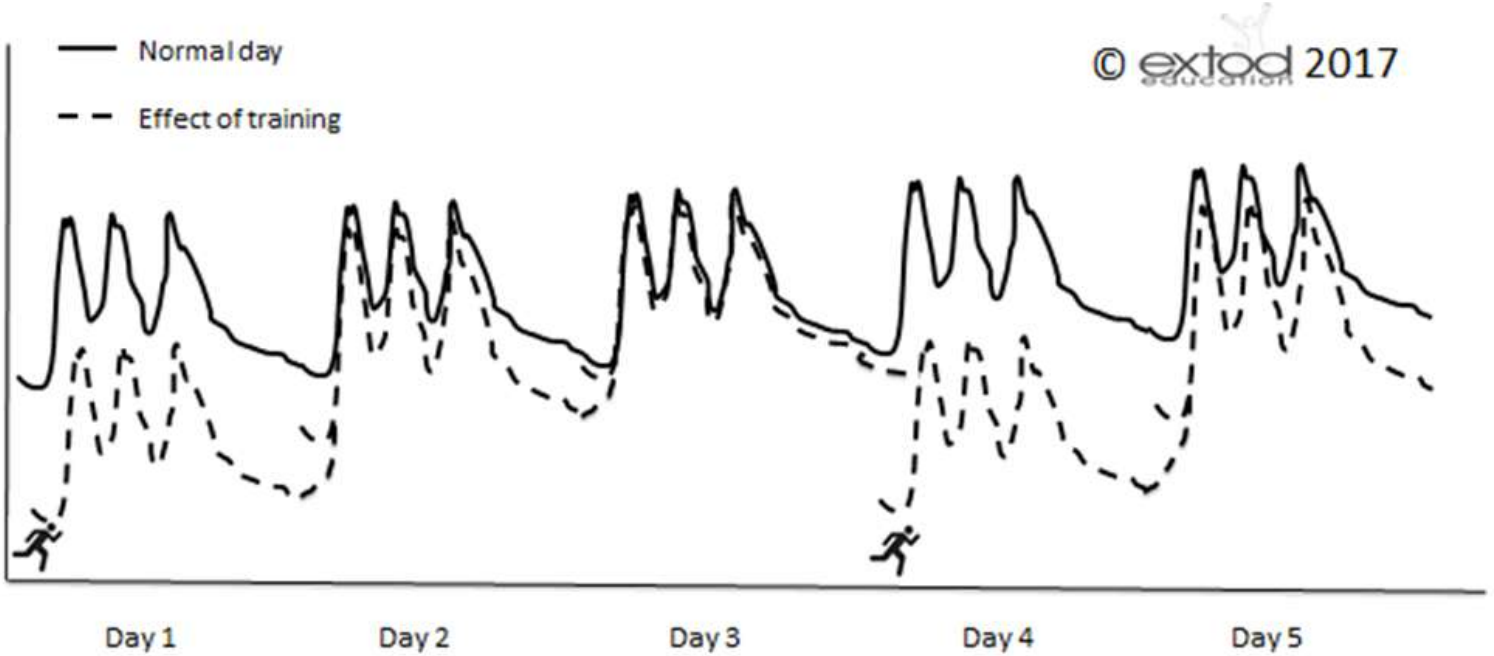
Weightlifting, Tag
Sprinting, Diving, Swimming, Gymnastics,
Wrestling, Dodge ball, Volleyball, Ice hockey, Track cycling

Basketball, Football, Tennis, Lacrosse
Skating
Skiing (slalom & downhill), Field hockey
Rowing (middle distance)
Running (middle distance)

In-line skating
Cross country skiing
Brisk Walking
Jogging
Cycling
} Warm down



Effect of exercising 2 times per week on insulin levels required for glucose control



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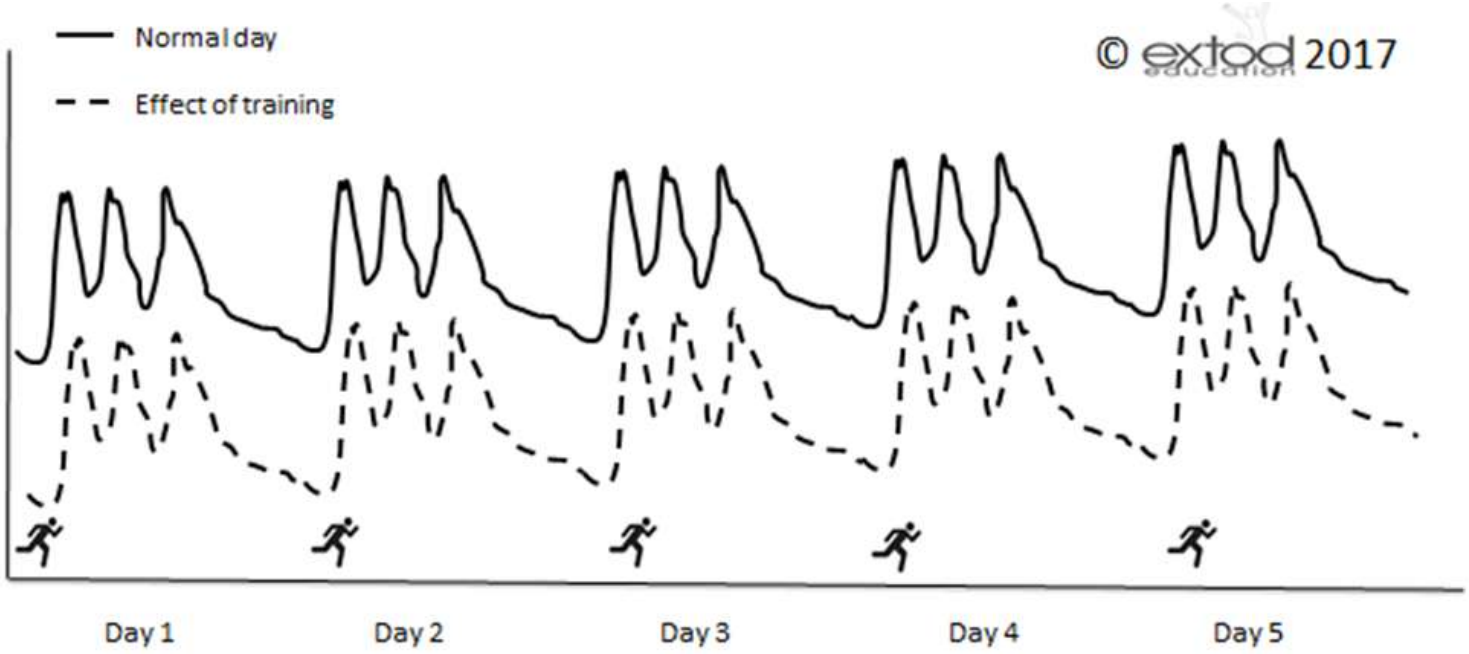
Effect of exercising everyday on insulin levels required for glucose control



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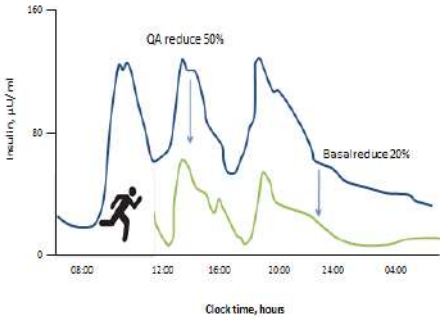
Three options for managing glucose after exercise - ICE

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

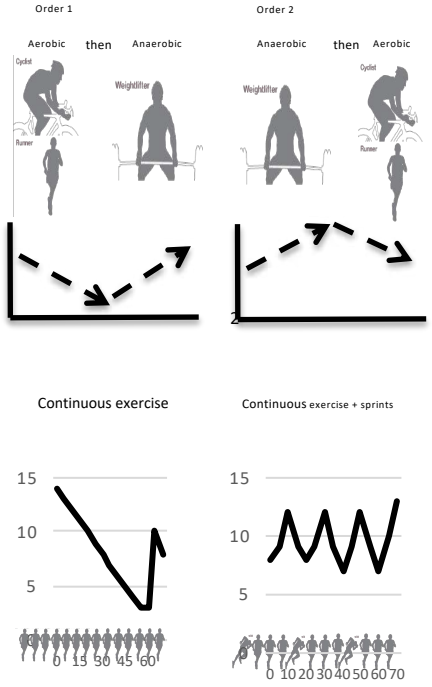
50% of normal quick acting insulin for first 2 meals/snacks after

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



Standard advice not working

Hey Dude when I said “curls might help, that is not what I meant!”

High glucose before exercise

1. Train mind to deal with stress

- Doing mind exercises to deal with the stress of a match can help to control glucose prematch. Below are links to some apps that can be tried for this
  - http://www.aheadinthegame.ca/ahead-in-the-game-app/
  - http://www.sportsmind.com.au/index.php/intro
  - https://www.headspace.com/sport

2. Prolonged warm up

- Additional stretches and warm up can help lower glucose

3. Take bolus with a bit of food 20 minutes and 40 minutes into exercise

- This means slightly more fast acting insulin will be around
- Taking food during exercise will cushion the fall.

4. **Increase background insulin level**

- 20% increase for hour before exercise

Managing rising glucose during exercise when pump off

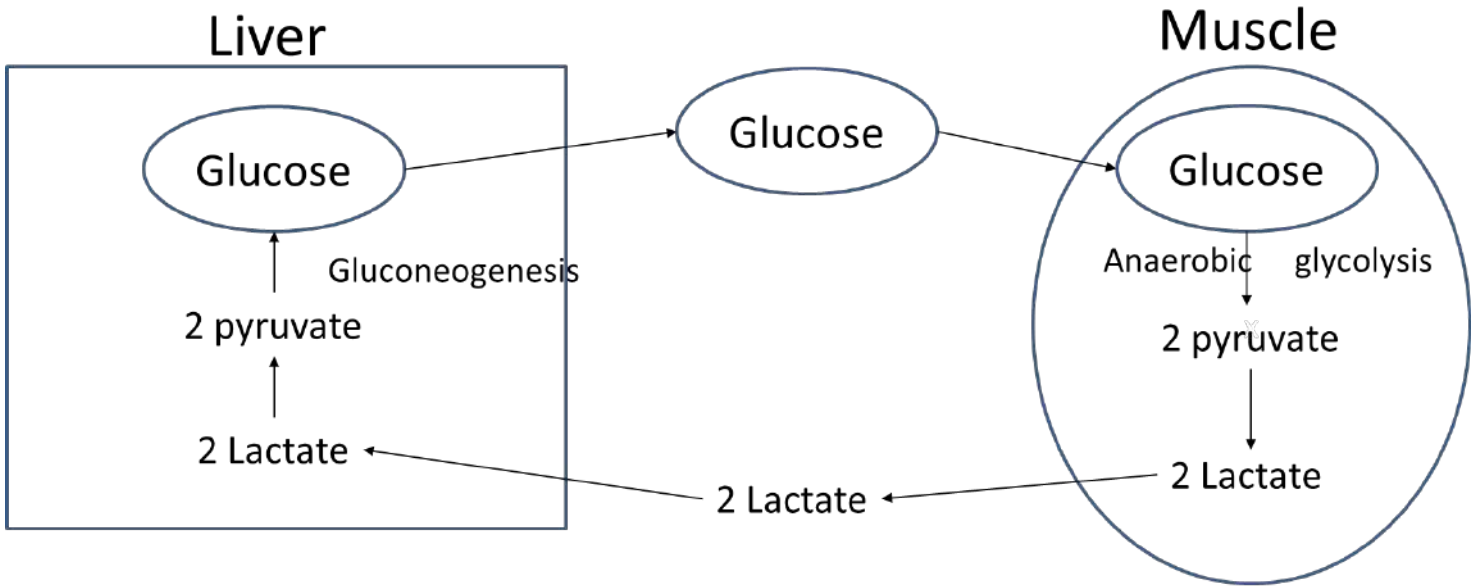
- Confirm that has not been rising in the hours before exercise.
- Look at when eating in relationship to food
- Take bolus just before taking off pump with this being the amount of background would have during the exercise. If have natural break eg two halves then give amount for first half and then recheck for second and give further bolus if needed.

Managing high glucose post exercise

Four possible reasons

- Insulin level dropped to much
- Late absorption of food taken during exercise
- Build up of lactate
- Dehydration

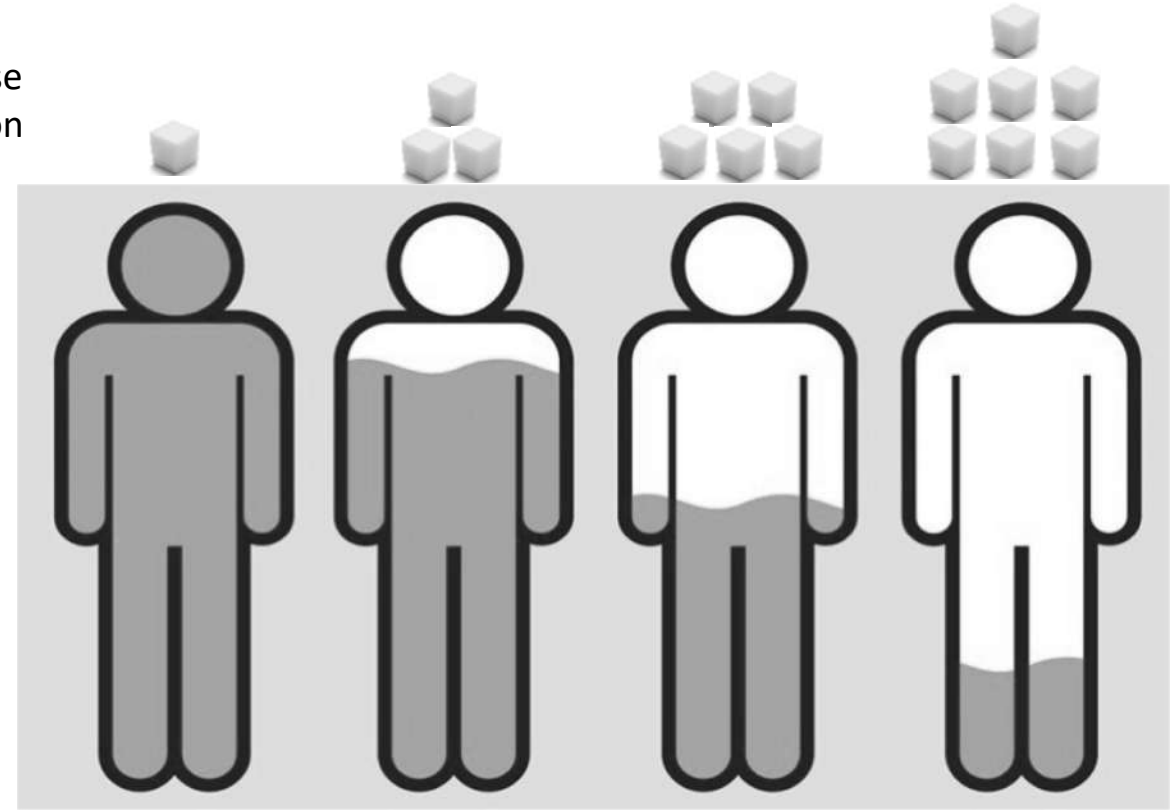
Reasons for glucose going up post exercise- Cori cycle



When stop Anaerobic Exercise blood glucose level goes up

High blood glucose post exercise

Blood glucose concentration



Dehydration may be a cause of raised glucose

Thus rehydration may lower glucose

Dehydration

Hydration

High glucose post exercise

Ensure rehydrate as this will help to lower glucose

Three options

1. Prolonged warm down

- Additional stretches and warm down can help lower glucose

2. Take bolus

- We would suggest 1/2 (50%) of correction
- Watch glucose carefully and remember to have recovery food.

3. Increase background

- Start with 150% rate for an hour – may need more

If happens often think about increasing background towards end of exercise

Why do my times not improve?

Why am I having so many hypos around exercise?

Daily carbohydrate requirements

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

Burke, L.M., (2010)

Daily protein requirements

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

Burke, L.M., (2010)

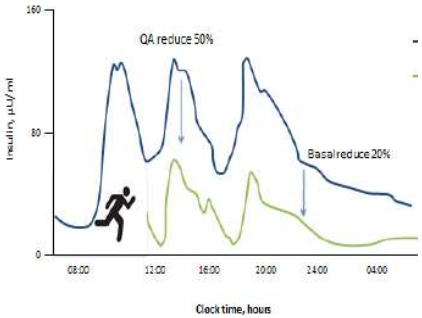
“I have not failed. I’ve just found 10,000 ways that won’t work”

Thomas Edison (1847-1931)

extold

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

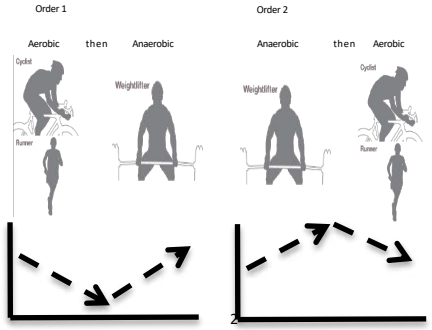
50% of normal quick acting insulin for first 2 meals/snacks after

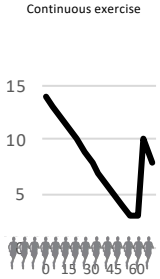
20% reduction night time background insulin
If exercise after 4 pm or longer than 2 hours

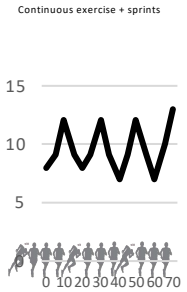
Carbohydrate for exercise

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

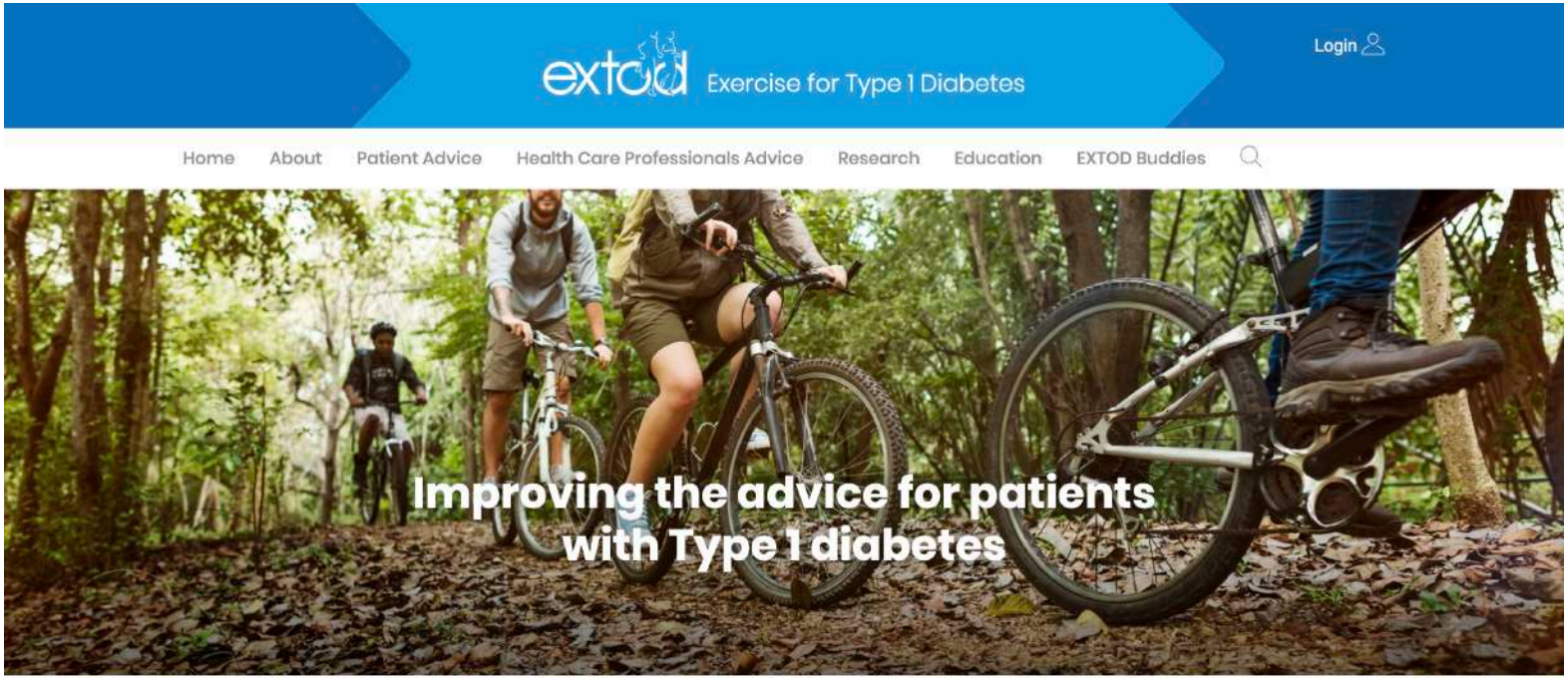
Exercise type and intensity







Further information – www.EXTOD.org



Managing glucose level through exercise

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