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NHS Foundation Trust

Managing glucose around exercise for people with Type 1 diabetes

Building healthier lives

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Keeping physically active is important for everyone, not just for those with diabetes, because it helps to improve or maintain people's general health. Exercise can take many forms and does not just apply to sport.

If you are not usually active or have any other health conditions, please discuss this with your Consultant/GP before starting.

Aim to be active for at least 30 minutes every day–by being more active, less energy needs to be stored in the body as fat which may;

- Improve response to insulin
- Help manage weight
- Improve how you look/feel
- Reduce stress levels
- Improve heart health

If you are currently not able to manage 30 minutes in one go, start slowly and gradually increase your activity. If you are planning to start exercising regularly or are working towards a sporting event please speak to the diabetes team about how to manage your glucose levels before, during & after exercise.

Please note:

***The following information within this leaflet is intended only for those people with type 1 diabetes on a basal bolus, multiple daily injection (MDI) or pump insulin regimes that are able to carbohydrate count and self-adjust insulin doses.**

**** Diagrams and figures contained within this leaflet have been developed by ExTOD and are protected by copyright.**

Generally, during exercise the body uses blood glucose as an energy source which may lower blood glucose levels. During times of increased activity, the body can use blood glucose more quickly. Therefore you should always consider;

- Carrying rapid acting carbohydrate
- Monitoring glucose levels before, during & after activity
- When you last injected insulin, particularly quick acting (QA) or bolus insulin

If you regularly engage in more rigorous exercise or are working towards a sporting event a healthy balanced diet is important. Ensuring adequate carbohydrate intake will guarantee muscles have a source of fuel during exercise whilst an adequate supply of protein will promote muscle recovery and growth after exercise. Therefore both carbohydrate and protein should be included within your diet according to the guidelines below:

Training load	Suggested carbohydrate intake
Very light/low intensity exercise	3–5g carbohydrate per kg body weight per day
Moderate intensity (duration approx. 1 hr)	5–7g carbohydrate per kg body weight per day
Moderate/high intensity (duration approx. 1–3 hrs)	7–10g carbohydrate per kg body weight per day
Moderate/high intensity (duration more than 4 hrs)	10–12g carbohydrate per kg body weight per day

Adapted from Burke & Deakin 2010 Clinical Sports Nutrition 4th edition

Training load	Suggested protein intake
Very light/low intensity exercise	0.8–1.0g protein per kg body weight per day
Endurance exercise	0.8–1.2g protein per kg body weight per day
Resistance/strength exercise	1.0–1.7g protein per kg body weight per day

Adapted from Burke & Deakin 2010 Clinical Sports Nutrition 4th edition

When NOT to proceed with exercise

There are times when you should not be physically active or exercise. Having a hypo in the 24 hours before exercise increases your risk of another hypo during exercise whereas the presence of ketones may indicate insufficient insulin levels.

Low Glucose	Suggested Advice
Severe hypoglycaemia • Hypo requiring 3rd party assistance	**Do not exercise for 24 hours**
Mild hypoglycaemia • Self-treated hypo	Be careful if active in next 24 hours • **Before exercise;** treat & aim for stable glucose for at least 45 mins before starting exercise • **During exercise;** stop, treat & aim for stable glucose for at least 45 mins before restarting exercise

High Glucose	Suggested Advice
Glucose above 15mmol/l & able to check for blood ketones • Ketones above 1.5mmol/l	**Do not exercise** • Correct high glucose with QA insulin injection/bolus • Drink sugar-free fluids • Wait until ketones clear before exercising
Glucose above 15mmol/l & able to check for blood ketones • Ketones below 1.5mmol/l	Low/moderate intensity exercise only • **Eaten and/or given QA insulin injection/bolus within previous two hours;** monitor • **Not eaten and/or not given QA insulin injection/bolus within previous two hours;** consider correcting high glucose with QA insulin injection/bolus

Guide to adjusting for exercise

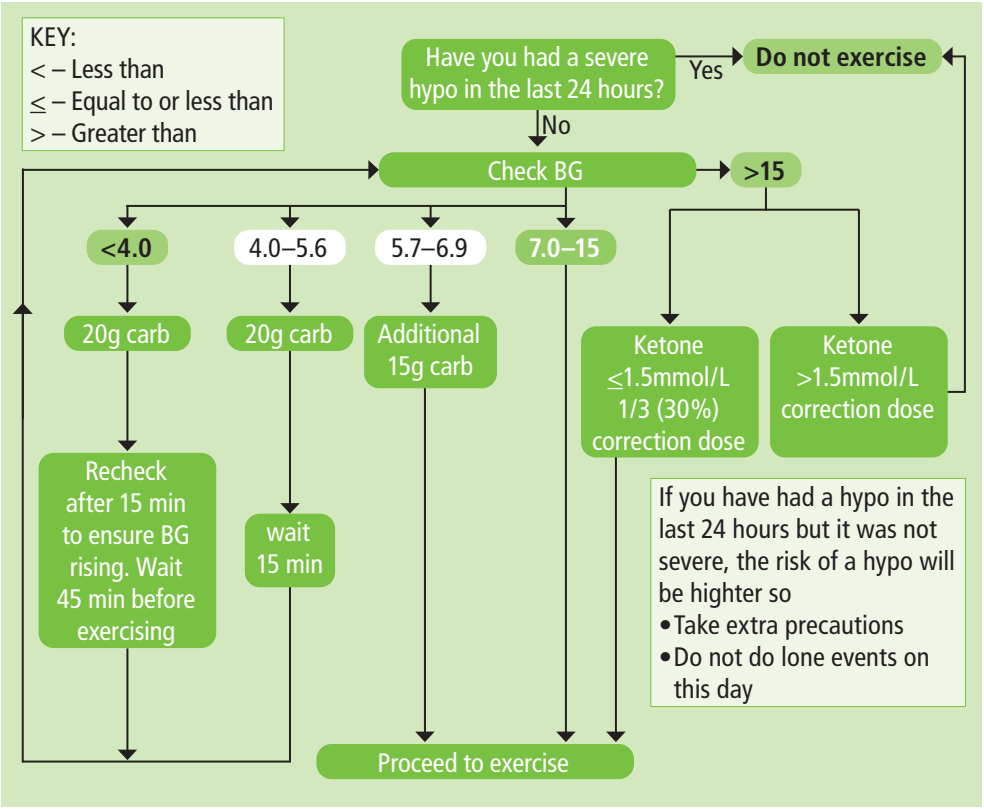
Checking your glucose levels and recording them along with any actions you take is central to being able to look back to review the changes made, progress made and to identify what needs to be refined to achieve optimal glucose around exercise. Most people tend to have a routine to their exercise doing similar things at similar times, this makes it easier to review your actions and make adjustments for future sessions. You should check glucose levels;

Before	two readings taken 10 mins apart; the second reading gives the direction in which your glucose levels are moving
During	check glucose levels every 30 mins during exercise if possible
After	check on finishing, one hour later and six hours later (or before bed)

Starting glucose values for safe exercise

The table and flowchart below give suggestions on what to do for different glucose levels before starting exercise. This is a starting point and should be adapted according to your experience.

Glucose before/on starting	Suggested Action
Less than 4mmol/L	Hypo – take 20g fast acting carbohydrate & retest in 10–15 mins
4.0–5.6mmol/L	Take 20g carbohydrate & retest in 10–15 mins
5.7–6.9mmol/L	Take 15g carbohydrate & proceed with exercise
7–15mmol/L	Proceed with exercise
Glucose greater than 15mmol/L AND Ketones below 1.5mmol/L	Correct with QA insulin injection/bolus before starting exercise – consider reduction of 30% to usual correction dose
Ketones above 1.5mmol/L	Correct with QA insulin injection/bolus– DO NOT proceed with exercise


KEY:
< – Less than
≤ – Equal to or less than
> – Greater than
Have you had a severe hypo in the last 24 hours?
Yes
Do not exercise
No
Check BG
>15
<4.0
4.0–5.6
5.7–6.9
7.0–15
20g carb
20g carb
Additional 15g carb
Ketone ≤1.5mmol/L 1/3 (30%) correction dose
Ketone >1.5mmol/L correction dose
Recheck after 15 min to ensure BG rising. Wait 45 min before exercising
wait 15 min
If you have had a hypo in the last 24 hours but it was not severe, the risk of a hypo will be highter so
• Take extra precautions
• Do not do lone events on this day
Proceed to exercise

ICE: Strategies for managing glucose DURING exercise

There are three strategies which can be used alone or in combination to help control glucose levels during exercise. Planning will allow you to choose how to manage your diabetes whereas unplanned exercise will limit your options. The ICE (Insulin Carbohydrate Exercise) strategies are:

Insulin

Insulin action of QA insulin peaks at about two hours after being given as an injection or bolus. Therefore any exercise completed within this time increases the risk of low glucose levels as high insulin levels prevent your liver from releasing any glucose to fuel exercise.

1. **If exercising within two hours of a QA insulin injection/bolus reduce the total QA insulin dose by 50%. After two hours of a QA insulin injection/bolus, the risk of the insulin causing a hypo is significantly lowered - so these changes do not need to be made.**
2. **For people on insulin pumps, also consider a 50% reduction in the basal rate starting one hour before exercise and keeping this reduced at 50% until the end of your exercise.**

Carbohydrate

Carbohydrate and fat are the main sources of fuel during exercise; the longer and harder/more intense the exercise the more carbohydrate is used. As high levels of insulin prevent your liver from releasing glucose, taking on board additional carbohydrate will maintain glucose levels

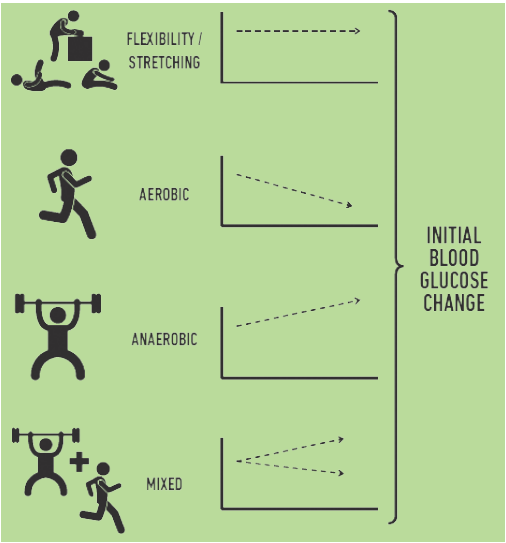
1. **Take 30g carbohydrate per hour of exercise**
2. **Choose fast release (high GI) carbohydrate during exercise**

Carbohydrate	15g	30g	50g
High GI/Quick-release			
Jelly Babies (large)	3	6	10
Jelly Beans	9	18	30
Cola	150ml (mini can)	300ml	500ml
Lucozade Body Fuel Energy Gel	½ x 45g tube	1 x 45g tube	2 x 45g tube
Apple Juice	140ml	280ml	450ml
Lucozade Sport Body Fuel	250ml	500ml	840ml
Powerade	360ml	730ml	1030ml
Gatorade	250ml	500ml	840ml

We appreciate that for many taking this much carbohydrate may seem excessive; another way of estimating carbohydrate requirements is to base it on the intensity of your exercise as shown in the table below.

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

Exercise

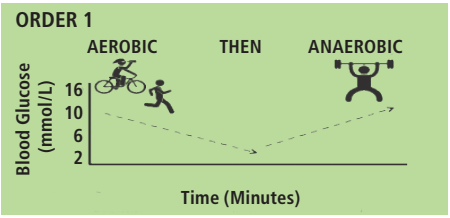


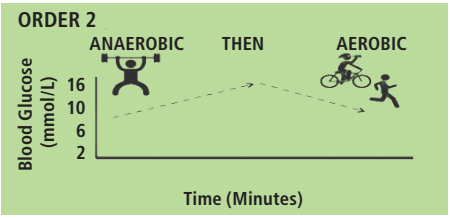
Different types of exercise will have different effects on glucose levels;

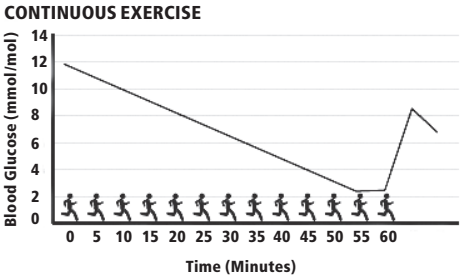
- Aerobic activities such as hiking, running, cycling etc. tend to drop glucose levels
- Anaerobic activities such as weights, sprints, HIIT etc. tend to raise glucose levels
- Mixed activities such as team sports including football, rugby, hockey etc. are a mixture aerobic and anaerobic exercise

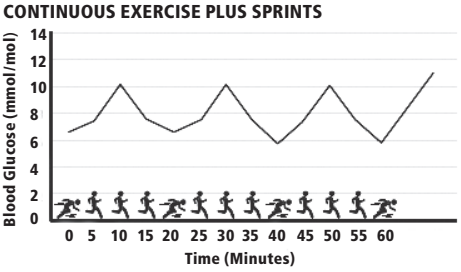
The figures below, illustrate

1. **How thinking about the order you do different types of exercise may help with control**
2. **How including 10 second sprints will help maintain glucose levels **NOT to be used to treat hypos**









ICE: Strategies for managing glucose AFTER exercise

As with managing glucose levels during exercise, you can choose to manage this by adopting one or more of the ICE (Insulin, Carbohydrate Exercise) strategies.

Insulin

Because exercise improves insulin sensitivity, any insulin (basal/ background or QA injection/bolus) will lower glucose levels MORE than before exercise. To reduce the risk of low glucose levels;

1. **50% reduction to QA insulin injection/bolus for next two meals/ snacks after exercise**
2. **50% reduction to QA insulin injection/bolus for corrections for next 12 hours after exercise**

Exercise improves insulin sensitivity for up to 48 hours afterwards with the greatest effect seen six hours following exercise as stress hormone levels drop. This is particularly the case for exercise that has been completed after 4pm, lasted more than two hours, has been done at high intensity, or which is new to you. In these situations you can reduce the risk of overnight low glucose levels by;

1. **20% reduction to evening/night time background insulin injection if on twice daily background insulin**
2. **20% reduction to basal rates on going to bed for six hours if on an insulin pump**

Carbohydrate

Glucose is stored as glycogen within the muscles and liver. Exercise drains the stores which must be replenished if you wish to exercise regularly. If you are regularly exercising for more than one hour (or 30 minutes at high intensity) not refuelling will result in fatigue during exercise, limit improvements in fitness and may increase risk of low glucose levels after exercise. To replenish your glycogen stores and help repair muscle;

1. **Have a carbohydrate AND protein recovery snack after exercise, aiming for a ratio 4g carbohydrate:1g protein**
2. **Choose slow release (low GI) carbohydrate foods after exercise**

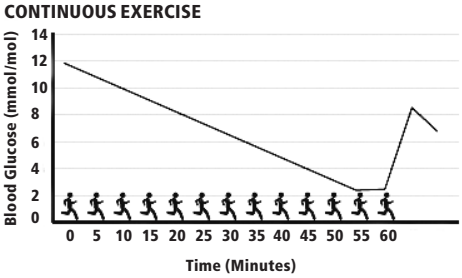
Carbohydrate	15g	30g	50g
Low-medium GI/Slow-Medium release			
Cereal bar	½–1	1–2	2½–3
Raisins	45g	90g	150g
Cornflakes	3 tablespoons	6 tablespoons	10 tablespoons
Kitkat	1 x 2 finger	1 x 4 finger	2 x 4 finger
Semi-skimmed milk	300ml (½ pint)	600ml (1 pint)	1000ml (¾ pint)
Low-fat fruit yoghurt	1 x individual (125g)	2 x individual (250g)	3–4 x individual (450g-600g)
Potato crisps	1 x 25g bag	2 x 25g bag	3–4 x 25g bag
Dried apricots	5	10	17
Weetabix	1½	3	5
Shredded Wheat	1	2	3–4

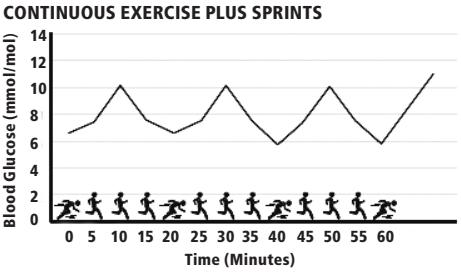
Protein	10g
Lean meat or chicken	30g
Fish	40g
Soya beans	70g
Tofu, lentils, kidney beans	125g
Baked beans	200g
Cashew nuts	60g
Almonds	50g
Seeds (e.g. pumpkin, sunflower)	50g
Eggs	2 small
Cows' milk	330ml ($^{2}/_{3}$ pint)
Soya milk	400ml (¾ pint)
Skimmed milk powder	90g
Yoghurt	200g
Hard cheese (e.g. Cheddar)	40g
Breakfast cereal	110g
Sliced bread	3 thick slice

Exercise

These figures illustrates

1. **How higher glucose levels on finishing exercise can be managed by including a 10 minute 'warm-down' period**
2. **How including 10 second sprints will help maintain glucose levels **NOT to be used to treat hypos**





The information contained within this leaflet is starting advice; by applying each strategy, recording what happens and adapting them to your individual experiences you should have worked out how best to manage your glucose levels before, during and after exercise. We also can help you adjust the above starting regimes according to how you respond to them – so keep accurate records (the following table may help) and keep in touch!

For more information:
www.extod.org
www.runsweet.com
www.excarbs.com

Exercise planned e.g. jogging, tennis				
Start time				
Finish time				
Intensity/Borg scale (see pg. 9)				
Type of activity	**Aerobic ☐**	**Anaerobic ☐**	**Mixed ☐**	**Flexibility ☐**
Predicted effect on glucose	**Fall**	**Rise**	**Stay the same**	
Planned action to optimise glucose level – focus on one option to start, then review	**Insulin**	**Carbohydrate**	**Exercise**	
Glucose levels	**Start**	**During**	**Finish**	**2 hrs after**
Comments (What went to plan? What did not go to plan? What would you change?)				

For further information/advice contact

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