Lessons from the professionals: diabetes and pro cycling

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Abstract
Professional cycling is one of the most physically demanding endurance sports. While literature exists on the needs of people with diabetes during exercise and sport of low to medium levels of intensity, there is less information around specific needs during endurance sports, and little published information on professional endurance sports. The approach to diabetes management taken by a professional cycling team comprised solely of people with type 1 diabetes provides useful insight for health care professionals with patients wanting to take up competitive sport or exercise at more intense levels. A systematic approach to achieving tight glycaemic control is taken that includes monitoring and analysis of blood glucose levels before, during and after training and competition, and a structured and balanced nutrition and race management plan. With support from experienced health care professionals, intense physical activity and endurance sports can be an option for individuals with diabetes, as long as they are educated about their condition and disciplined and committed to achieving glycaemic control.
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Key words
cycling; professional cycling; endurance sports; intense physical activity; competitive sport; diabetes

Introduction
Professional cycling is widely regarded as one of the most physically demanding endurance sports, and one in which public interest has mounted in recent years. Professional riders undertake punishing training and racing schedules and must work at high intensities, in the most efficient way, often for many hours at a time. They must be in peak physical condition at all times and carefully manage all aspects of their physiology.

Team Novo Nordisk is the first professional cycling team to consist solely of people with type 1 diabetes, and the team's riders manage their diabetes while training and competing at a professional level.

This article explores the clinical approach taken by this unique team, along with some of the broader considerations for the athletes involved, providing specific insight into the management of diabetes and endurance sport.

Diabetes and professional cycling: double the challenge
The health benefits of physical activity in diabetes are well established and current guidelines for the management of both type 1 and type 2 diabetes recommend regular physical activity.[1,2] For people with diabetes, physical activity improves glucose control and insulin sensitivity, and reduces body fat, which potentially reduces the long-term risk of micro- and macrovascular complications.[3,4]

Exercise can, however, pose unique challenges for a person with diabetes. It is important for an individual to monitor their blood glucose (BG) before, during and after exercise in order to reveal how their body responds to exercise, and help manage these changes in order to prevent potentially dangerous BG fluctuations and avoid hyper- and hypoglycaemia. While literature exists on the needs of diabetic people during exercise and sport of low to medium levels of intensity,[5] there is less information around specific needs during endurance sports.

Team Novo Nordisk
Phil Southerland, co-founder and CEO of Team Novo Nordisk, founded what was once known as Team Type 1 in 2005.[6] Team Type 1 included athletes both with and without diabetes. In 2012, Phil and Novo Nordisk partnered, based on a shared goal to educate and inspire people around the world affected by diabetes, and Team Novo Nordisk was formed as an all-diabetes team.

Team Novo Nordisk races as part of the Novo Nordisk Changing Diabetes® programme, a global initiative to improve conditions for people living with diabetes, and those at risk of developing the condition. The aim is to show what can be achieved by people with diabetes, and the riders act as positive role models within the diabetes community.

The team competes in major professional races around the world on the International Cycling Union (UCI) Professional Continental tour, which is one level below Pro Tour teams that take part in Grand Tour races such as the Tour de France. The team's first official race was the Trofeo Laigueglia, Italy, in February 2013. To date, they have achieved more than 10 top 20 finishes including third place for Italian rider, Andrea Peron, in the first stage of the Tour de Beauce in Canada – the team's first podium finish. The team has been well received in both the professional cycling and diabetes communities, with numerous messages of support posted on the official team Facebook page from people affected by diabetes, as well as people simply inspired by their mission.

The professional cycling team competes in major races around the world

Team Novo Nordisk approach to diabetes and race management

As there is little literature on the management of type 1 diabetes in endurance sports, the Team Novo Nordisk medical team has devised a system of training and nutrition, based on current guidelines for the management of type 1 diabetes, and for type 1 diabetes in low to medium intensity levels of exercise. They have adapted the literature for management of type 1 diabetes in endurance sport using a number of sources,[5,7–18] including Exercise and Sport in Diabetes (Nagi, 2005)[5] and Legal Nutritional Boosting for Cycling (Jeukendrup, 2009).[7]

Key considerations that are taken into account in order to maintain glycaemic control during intensive exercise include: monitoring BG levels, staying hydrated, structuring suitable carbohydrate consumption and making insulin adjustments, along with appropriate strategies to prevent and treat hypoglycaemia and hyperglycaemia.

Importance of nutrition in cyclists

It is recommended that endurance athletes consume a high carbohydrate diet during training and racing for optimal performance and recovery.[7] The amount and type (high or low Glycaemic Index) of carbohydrate recommended differs for each individual according to the type, intensity and volume of the race or training session, and timing (before, during or after the race or workout). A high carbohydrate diet can, however, be a challenge for athletes with diabetes, as consumption of carbohydrates leads to increased BG levels[19] and the need for increased total daily doses of insulin, which can increase the risk of hypoglycaemia. Additionally, as insulin is a counter-regulatory, anabolic hormone, the oxidation of fats (lipolysis) may be inhibited as a result of the increased levels of insulin, reducing a rider's fat-burning capacity, and eventually impacting on performance. Engaging in regular and prolonged exercise, such as a cycling training camp or stage race, may increase insulin sensitivity and muscle glucose uptake, therefore reducing insulin requirements. For diabetic athletes competing in endurance sports, this balance must be carefully monitored to maintain BG levels within the range for optimal performance. The riders are taught how to count and identify carbohydrates according to their Glycaemic Index so they know their individual requirements, and how to adjust their insulin regimen accordingly to stay within the optimal range.

Maintaining proper hydration is essential for all athletes but is particularly important in athletes with diabetes as high BG levels lead to dehydration.[20] Riders are taught, therefore, how much fluid to drink, and to remember to drink in cold conditions when their rate of perspiration is not as high and they may not feel like taking on fluid.

Blood glucose monitoring

To help the riders stay within the optimal BG range while competing, the Team Novo Nordisk medical team has designed a blood glucose control scoring scale, based on BG measurements at three specific time checkpoints on race day:

- BG 30 minutes before the start of the race (via glucose meter).
- Average BG during the race (via continuous glucose monitor [CGM]).
- BG at the end of the race (via glucose meter).

The measurements are recorded and analysed to make individual adjustments in nutrition and insulin dose in real time to get the rider within the optimal BG range. Scores are given based on the rider's BG levels at the three checkpoints, with the total score representing their overall BG control during the

Lessons from the professionals: diabetes and pro cycling

Phil Southerland's journey towards creating a professional cycling team with type 1 diabetes

When I was diagnosed with type 1 diabetes at 7 months old – the youngest case of diabetes on record in the world at that time – doctors told my mum that I would probably go blind or die by the time I was 25. My parents were determined not to let that happen and always treated me like a normal kid and just made sure I was always prepared with food. I started swimming when I was 5 years old and played all the normal sports that kids play. I started cycling at 12, entered various junior competitions and started climbing up the ranks. I knew pretty early on that it takes a lot of diligence and hard work to control your diabetes, and if I was going to be successful on the bike, I had to manage my diabetes off the bike.

My friend, Joe Eldridge, and I met at college, and like me he was a cyclist with diabetes, but, unlike me, his diabetes wasn't under control and he wasn't winning races. He told me that what I was doing inspired and motivated him to start taking better control of his diabetes. I then realised that this could be a powerful message to share with other people with diabetes, and Joe and I established our own cycling team, Team Type 1, in 2005, with the aim of raising awareness of the condition.

While people liked the idea of the team, when we said we wanted to do the Race Across America, a 3000 mile tag-team competition for which we needed to raise $250 000, most people said we couldn't do it. I knew it needed to be done though, for people with diabetes, so we did it! We raised the money, got the sponsorship, completed the race, and the impact on kids and people with diabetes was overwhelmingly positive. I realised we could spread this empowerment around the world through professional cycling, which we did for a number of years, and we were really successful.

Our team

Cycling is one of the most difficult sports in the world to compete in and diabetes is one of the most difficult diseases to manage. When you combine the two, many think it's impossible, but it's something our team embraces. We just have to be very systematic in our approach. We want to show that our riders struggle with a lot of the same challenges that other people with diabetes struggle with, but it shouldn't stop you from being at the top of your game.

We have a fantastic management and medical team that gives the riders the science behind what happens to their blood sugars when they train and race and educates them about how best to manage these fluctuations. We collect data on each rider at the start, during and end of the race, review it, then help the riders to control their blood sugar better. It's amazing to see the improvements the athletes have made since we brought them together in December. We hope to continually refine our system to ultimately make diabetes a non-factor in our team.

Making a difference

Team Novo Nordisk isn't just here to race and perform, we also have the responsibility to change the way people see diabetes. When athletes sign the contract to join the team, they're also signing a contract to be a role model for people with diabetes in their country and around the world.

When other cycling teams realise our entire team has diabetes the managers come up to us and say 'wow, it's so impressive' and the other athletes congratulate us. The cycling community doesn't think it's weird for us to be competing anymore, but some stigma does still exist among the public. For instance, some people think that diabetics can't eat sugar, are all overweight and can't exercise, and these are the attitudes that we hope to change.

It can be tough when you're diagnosed with diabetes, and if you're 16 and all your friends think that diabetes is 'bad', they're immediately going to feel sorry for you. However, if those same friends know that there's a team of professional athletes all with diabetes, they're going to think: 'cool'. There have been great comments on our Facebook page saying things like 'you make me proud to say that I'm diabetic' and that's fantastic. I always say to people 'welcome to the team' because they're part of our team, they help us ride faster, and they're our inspiration. I'm grateful I have diabetes and I wouldn't change it for the world – it's provided me so much opportunity and I love it!

People often ask me what advice I would give to someone wanting to get into cycling, and my response is always the same: you can absolutely do it! I tell them to talk it through with their doctor and that it's really important to monitor your blood sugar levels, be prepared with food, always cool down and see how your body reacts during and after cycling. The same applies for cyclists wanting to increase the duration or intensity of their rides – every person with diabetes is different but if you are mindful of how your body reacts and are ready to manage this, I would encourage everyone to get on their bike.

Phil Southerland
Co-founder and CEO, Team Novo Nordisk

race. This can be analysed later and correlated with their race performance. The scores for each range are as follows:

- 3 points = 6.6–10mmol/L.
- 2 points = low: 5.5–6.6mmol/L or high: 10–12.2mmol/L.
- 1 point = low: 4.4–5.5mmol/L or high: 12.2–16.6mmol/L.
- 0 points = <4.4mmol/L or >16.6mmol/L.

The total score from the three checkpoints ranges from 0–9 and represents BG control as follows:

- 0–3 = out of target.
- 4–6 = within target.
- 7–9 = optimal target.

Physical examination

Baseline parameters are taken for all riders upon joining the team and general physiological tests are carried out including aerobic capacity, carbohydrate and fat metabolism, body fat %, BMI, blood analysis and BG levels at different exercise intensities. These data are used to evaluate each rider's physical and metabolic capacity and BG response, and to determine their individual training zones. Riders are guided on how to manage their nutrition and insulin in order to keep their BG within target. All riders use CGMs and the data collected are used along with the checkpoint scores to correlate with the rider's performance to identify trends and look for consistent patterns among the riders.

Race management

Pre-race

The riders have a high carbohydrate breakfast comprised of complex grains and a small portion of protein (intake of protein is limited as it takes longer to digest). The riders

take a pre-meal bolus dose of insulin and may add a post-meal correction dose if necessary.

The riders' BG levels may vary depending on the race start location and logistics. If they travel from the hotel to the start of the race in the team bus, BG may rise, whereas if they ride their bikes to the start, BG may drop. Riders are advised on how to make appropriate nutrition or insulin adjustments to stay in range, whatever the pre-race logistics. One hour before the race some riders will take approximately 15g of carbohydrates to keep their BG in range for the start of the race. However, they must be careful not to consume so much that they start the race with high BG as this will impede their ability to take on essential carbohydrates during the race, without risk of hyperglycaemia and dehydration.

Other factors also have to be considered for diabetic riders such as the impact of pre-race nervousness, where increased catecholamines suppress any endogenous insulin secretion and lead to the release of endogenous glucagon and increased BG levels at the start of the race.

During the race

The riders aim to start the race with BG within the optimal range (6.6–10mmol/L). If it is a little low at the start of the race it is suggested they take half a fast-acting glucose bar or sugary gel to reach optimal BG levels in preparation for the first part of the race when the tempo is usually high. The tempo often remains high for around 1 hour as the main group (peloton) tries to prevent a breakaway (a group of riders out front that leaves the peloton behind) from forming. Increased tempo leads to increased production of lactate and catecholamines, which increases the rate of glucogenolysis and causes a significant increase in BG. Some riders may spike to as much as 13.8mmol/L, but this is different for every rider. Once a breakaway is formed, the tempo in the peloton decreases to a steadier pace and additional food is required at a slower rate.

Individual riders have different roles in the race and the patterns on their CGMs therefore differ accordingly. Those that ride upfront in the breakaway group ride at a higher tempo with increased rate of glucose oxidation and glycogen utilisation, and therefore need to eat at a higher rate to prevent their BG levels from falling.

Food intake is carefully managed to keep their BG at appropriate levels at all times. Taking a 5-hour race as an example, the ideal nutrition sequence would be:

- First 2 hours – solids (80% carbohydrate/20% protein) + mixed carbohydrate/electrolyte drinks.
- 2–4 hours – energy bars/fruit bars + mixed carbohydrate/electrolyte drinks.
- Last hour – energy chews/jelly beans/glucose tablets + mixed carbohydrate/electrolyte drinks.
- Full speed/sprint (mainly at end) – fast acting sugary gels/liquids + mixed carbohydrate/electrolyte drinks.

Some carry insulin during the race and will take a correction dose if their BG levels are out of their optimal range to enable them to take on additional carbohydrates during the race. This must be carefully managed in order to avoid hypoglycaemic episodes.

During stage races, where riders can be cycling for a number of consecutive days at a time, they often need to adjust their basal insulin dose as the days of racing progress to avoid nocturnal hypoglycaemia due to increased insulin sensitivity.

Post-race

Usually, the pace in the last 20km of a race is at or above the anaerobic threshold, which is different for each rider. At this intensity, blood lactate may increase, at different rates for each rider, and is subsequently recycled into more glucose, increasing BG levels. When riders stop pedalling abruptly at the end of a race, muscle contraction stops and the excess of glucose due to accumulation of lactate cannot be absorbed back into the cells without insulin causing post-exercise hyperglycaemia in diabetic people. The riders are therefore encouraged to undertake an active, 20–30 minute cool down on the turbo trainer (static bike) or by cycling back to the hotel, so glucose uptake by the muscle cells is activated through muscle contraction and the excess glucose is transported into the cell and muscle glycogen stores for optimal recovery.

During the first hour post-race, the body's capacity to absorb carbohydrates to replenish muscle and liver glycogen stores is significantly increased. It is therefore crucial to take advantage of this 'glycogenic window' to optimise recovery. Immediately after the race, the riders head back to the team bus and drink a high carbohydrate drink (70g carbohydrate/1.5 litres water). When a rider finishes their cool down they will also eat a carbohydrate/protein mix (e.g. rice bowl with eggs) and a protein shake to help repair muscle damage. The riders will then have a massage followed by dinner, at which stage their glycogen stores will be replenished, so dinner will usually be lower in carbohydrates to avoid a rise in BG. They are also encouraged not to sleep straight away so their food is properly digested and BG levels have stabilised.

If this sequence is followed (and adjusted for individual riders as appropriate), the rider should wake with their BG levels within the ideal range, ready for the day ahead.

Conclusion

Insight into the Team Novo Nordisk approach to diabetes management can be of interest to health care professionals supporting patients who want to go beyond the baseline recommended levels of activity for diabetes and take up competitive sport or exercise at more intense levels, or newly-diagnosed patients already exercising at such levels.

The Team Novo Nordisk experience demonstrates that, as long as individuals are educated about their condition and disciplined and committed to achieving control of their diabetes, with support from experienced health professionals, the presence of diabetes should not preclude them from intense physical activity and endurance sports.

It is important to note, however, that when anyone wants to progress from undertaking regular physical exercise to participating in endurance sports, they should follow an individually designed training programme based on the physiological

capacities and health-risk assessment for each individual. This is especially important for people with diabetes.

Key points to cover with patients wanting to take this step include:

- Education on counting carbohydrates.
- Advice on a practical training and competition nutrition plan that balances appropriate timing and quantity of carbohydrate consumption, with appropriate insulin dose adjustments.
- Advice on the importance of an active cool down and maintaining hydration.
- Advice on implementing a simple system for tracking BG levels before, during and after a training session/competition.
- Explaining how to use that information to tailor and refine their approach.

Disclaimer

The detail provided in this article is a description of the methods used and processes followed by Team Novo Nordisk specifically. The information is not presented as a clinical guideline on how to manage diabetes when engaging in endurance sports and should not be followed as such.

Declaration of interests

Professor Miles Fisher has received consultancy fees for lectures and advisory boards from Novo Nordisk UK in the past.

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Diary

Foundation of European Nurses in Diabetes Annual Conference
20–21 September 2013
Barcelona, Spain
Website: www.fend.org

European Association for the Study of Diabetes Annual Meeting
23–27 September 2013
Barcelona, Spain
Email: secretariat@easd.org
Website: www.easd.org

International Society for Paediatric and Adolescent Diabetes Annual Meeting
16–19 October 2013
Gothenburg, Sweden
Email: secretariat@ispad.org
Website: www.ispad.org

New Clinical Solutions in Diabetes Care
6 November 2013
Fera Lakeside Conference Centre, York, UK
Email: isla.ballard@diabetes.org.uk
Website: www.diabetes.org.uk

Autumn Meeting of Association of British Clinical Diabetologists
7–8 November 2013
Royal College of Physicians, London, UK
Email: eliseharvey@redhotirons.com
Website: www.diabetologists-abcd.org.uk

41st British Society of Paediatric Endocrinology and Diabetes (BSPED) Meeting
13–15 November 2013
The Brighton Dome, Brighton, UK
Email: bsped@endocrinology.org
Website: www.bsped.org.uk

The 5th International Conference on Fixed Combination in the Treatment of Hypertension, Dyslipidemia and Diabetes
21–24 November 2013
Bangkok, Thailand
Email: fixed2013@fixedcombination.com
Website: www.fixedcombination.com/2013/

World Diabetes Congress
2–6 December 2013
Melbourne, Australia
Email: wdc@idf.org
Website: www.idf.org/worlddiabetescongress/

2nd Joint Meeting of the ABCD and the Renal Association
13 February 2014
National Exhibition Centre, Birmingham, UK
Email: secretary@renal.org
Website: www.renal.org