

# Cycling with Type 1 Diabetes: Physiology and Management

Rafael Castol MD, MSc.

## Overview

- **Diabetes Mellitus:** definition, types & statistics
- Physiology: **the athlete with T1D**
- Baseline exams
- Management strategies
- Race day considerations



## Diabetes Mellitus (DM)

- Metabolic disorder -> **hyperglycemia**
  - defects in insulin secretion
  - insulin action, or both
- **type 1 DM**
  - absolute deficiency of insulin secretion
  - pancreatic beta-cell destruction
  - Exercise -> benefits outweigh risks???
  - Auto-manageable condition
- type 2 DM
  - Insulin resistance
  - Inadequate compensatory insulin response
  - Exercise -> cornerstone in therapy

## DM Statistics

	2013	2014	2035
Cases of diabetes (millions)	382	387	592
Prevalence (%)	8.3	8.3	10.1
Undiagnosed cases (millions)	175	179	276
Health expenditures due to diabetes (billions USD)	549	612	627
Total deaths due to diabetes (millions)	5.10	4.90	-

IDF 6th edition Diabetes Atlas, 2014 Update

## T1D Statistics U.S.

- **1.25M** Americans with T1D
  - **200k** youth (<20yo)
  - Incidence: 40k
- 2001-2009 -> **21% increase** in youth prevalence
- **\$14B** annual healthcare costs
- **<1/3** achieve target blood glucose levels
- Estimated loss of life-expectancy up to **13 years**
- **5M by 2050**
  - **>600k** youth

CDC National Diabetes Statistics Report, 2014



## Physiology

- Muscle sources of energy:
  - glucose in the blood
  - stored glycogen
- **Normoglycemia**
  - Metabolic adjustments -> **hormonally mediated**
- **Hormonal changes** -> enhanced hepatic glucose production via:
  - Glycogenolysis
  - Gluconeogenesis

## Physiology

- As blood glucose drops -> **insulin secretion drops**-> glucagon increases
- Prolonged exercise -> **counterregulatory hormones**
  - catecholamines, growth hormone, and cortisol
- **Regular training**-> increases **GLUT-4**
  - Augment muscle glucose transport
  - Enhances glucose tolerance in response to insulin and muscle contraction



## Athletes with T1D

- **Lack hormonal adaptations** for normoglycemia
- Glucose response will depend of:
  - **Exogenous insulin** concentration during exercise
  - Pre-exercise **glycemic control**
- **Exogenous insulin cannot be turned OFF!!!**
  - muscle glucose uptake **ON**
  - inhibition of hepatic glucose production **ON**
  - **Increased insulin sensitivity**
  - =>**HYPOGLYCEMIA** -> coma -> death
- **Not enough insulin**
  - impaired glucose uptake at the muscle
  - effect of **counterregulatory hormones**
  - =>**HYPERGLYCEMIA** -> ketoacidosis -> coma

## Athletes with T1D

- **Regular exercise** -> improved muscle glucose uptake
- **Determining factors:**
  - Type of exercise
  - Duration
  - Frequency
  - Intensity (aerobic vs. anaerobic)
- **Main challenges:**
  - Cycling efficiency: insulin -> inhibition of fat oxidation capacity
  - Increased insulin sensitivity
  - Reduced insulin requirements
  - Hypo/Hyperglycemia & dehydration

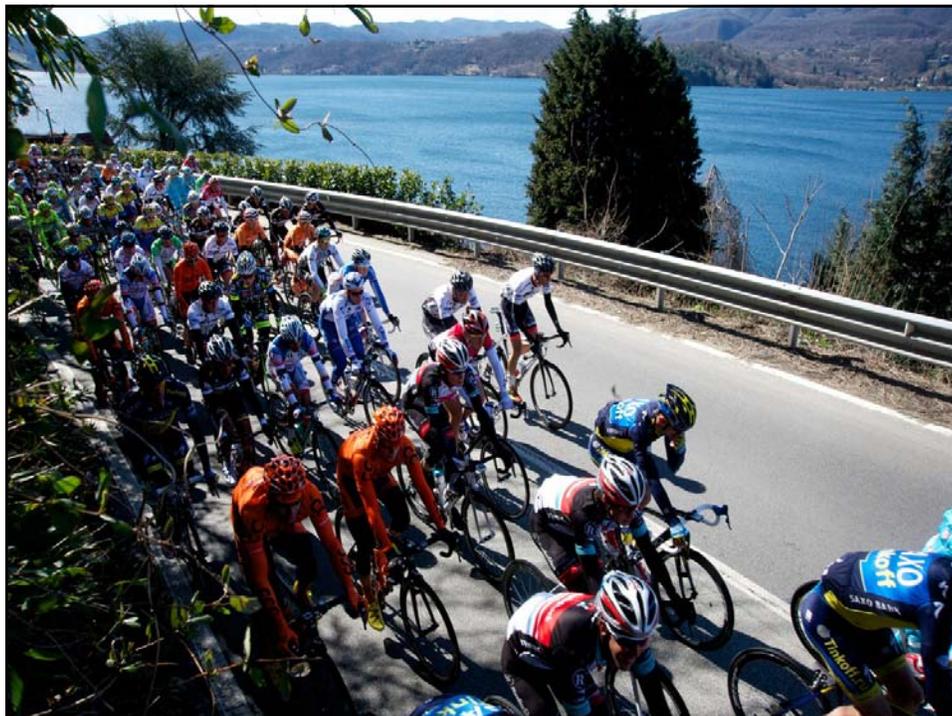
## Baseline examinations

- H&P
- Blood analysis
- Physiological testing (**lactate & BG response**)
- Determination of **individual thresholds**
- **CGM data analysis**



## Auto-management

- **Prevention:** hypo and hyperglycemia
- Detection of **BG patterns**
  - exercise variables
  - environmental factors
- Keep a **daily record**
- Trial-error phase via **auto feedback**
- Reliable understanding of **individual glucose response and needs**
- **Anticipation and decision-making**



## Key strategies

- **Frequent BG check:** before, during, and after & CGM
- Frequent training, rather than sporadic
- Morning sessions
- Multidose fast/short acting insulin regimens-> flexibility
- 15 g carbohydrate will raise blood glucose approximately 50 mg/dl
- **Timing** of insulin peak and carb intake
- Injection site
- Periodic carb intake when training >1h
- Recognize early signs of hypoglycemia

## Hypoglycemia management

- **Glucose (40-70 mg/dL)**
  - headache, weakness, hunger, dizziness, profuse sweating, tachycardia
  - **Tx: fast acting oral glucose**
- **Glucose (<40 mg/dL)**
  - Combativeness, depressed level of consciousness, seizures
  - **glucagon (1 mg i.m.)**
  - i.v. glucose
  - once mental status improved -> oral glucose
- **Glucagon emergency kit is required for race coverage**



## Race day considerations

- **Pre-race**
  - Target **optimal BG range** before start
  - Pre-race nervousness & catecholamine effect
- **During**
  - Race tempo factor
  - Weather conditions
  - Role in peloton
  - Individual nutritional sequence
  - Carry on insulin

## Race day considerations

- **Post race**
  - Abrupt Stop -> **post race hyperglycemia**
  - **Active cool down** -> lactate clearance
  - **Glycogenic window** -> optimize recovery
- Low carb dinner -> **stable overnight BG**
- **Stage races**
  - increased **insulin sensitivity**
  - basal insulin adjustments



## Conclusion

- Valuable insight for hcp's, coaches and teams to:

### **SUPPORT ATHLETES WITH T1D**

- Engage in cycling or any other sport at any level.
- Encourage them to continue training and racing.

