Exercise Prescription in Type 1 Diabetes

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Infiltration of β cell by T cells

Healthy islets

β cells destroyed

Type 1 Diabetes Mellitus

Incidence rate of T1D peaks in adolescence.

Type 1 Prevalence

Currently ~ 300,000 children and adults are living type 1 diabetes in Canada.

~10% of all cases of diabetes mellitus

Diagnosis can occur at any age

Insulin is a treatment, not a cure

Average life expectancy is about 7-10 years less than normal

Source: JDRF Canada
Type 1 Diabetes Management and Care

Modified from David G. Marrero Diabetes Spectr 2016;29:54-57
Image credit: Diabetes Hands Foundation
Type 1 Diabetes
New & Emerging Technologies
Glycemic Control

• Mean HbA1c levels have deteriorated from since 2010/11, particularly in teens and emerging adults.

LIVE YOUR LIFE
WITHOUT WORRYING ABOUT YOUR DEVICE
Mean HbA1c is related to technology use.

**FIG. 3.** Mean HbA1c by technology use in 2016–2018. Solid black represents injection only. Horizontal stripes represent pump only. Solid white represents injection+CGM. Diagonal stripes represent pump+CGM.

The Physical Activity Prescription

Figure Modified from: ‘How to Get 150 Minutes of Exercise Each Week’ By Sara Angle, Diabetes Forecast September 2018
Established Benefits for T1D

↑ Fitness
↑ Insulin sensitivity
↑ Well-being
↓ Unhealthy blood lipids
↓ Endothelial dysfunction
↓ Heart disease/stroke risk factors
↑ Increases longevity (~10 yrs)

Other Possible Benefits for T1D

Weight control
Microvascular disease (eyes, kidneys)
Beta cell preservation
Blood Pressure
HbA₁c (by about 0.3%)

Type 1 Diabetes – Time for Physical Activity

150 minutes per week of physical activity (~1.5% of the time)

Time for other self-care behaviours, work, sleep, friends, family, and other leisure activities
Step counts in teens with diabetes - SEARCH Study

Average step count fails to achieve age-specific targets for most youth ages 10-20 years...

O’Neill et al., Ped Ex Science 2012 Note: daily step count recommendations; school-age boys: 13,000–15,000; school-age girls: 11,000–12,000; and adolescent boys and girls: 10,000–11,700; Tudor-Locke et al., Int J Behav Nutr Phys Act 2011;8(1):78
Blood Glucose Balance in T1D

4-10 mmol/L
The amount of food, exercise and insulin is in balance

HYPO (<4.0 mg/dL)
Too little food, or too much exercise or insulin

HYPER (>10 mmol/L)
Intense, stressful exercise
Too little insulin
Acute Glucose Trends & Physical Activity/Exercise Types in T1D

Even mild physical activity can increase glycemia if insulin is withheld...

Adapted from Marble and Smith, Exercise in Diabetes Mellitus. Arch Intern Med 58: 577-588, 1936.
Insulin needs and the exercise spectrum

M.C. Riddell- *Getting Pumped: An Insulin Pump Guide for Active Individuals with Type 1 Diabetes* (www.gettingpumped.org)
Being regularly active typically lowers total daily insulin needs...

When to try bolus insulin reductions for aerobic exercise

Figure based on consensus in Riddell et al., Lancet Diabetes Endocrinol 2017 May;5(5):377-390.
When to try basal rate reductions on a pump for aerobic exercise

Note: For those on MDI, lower basal insulin by 20% on the days that individuals are MUCH more physically active

Figure based on consensus in Riddell et al., Lancet Diabetes Endocrinol 2017 May;5(5):377-390.
“You have to test your blood glucose levels often, the more the better.... Nerves will send levels sky high... When I broke the American record, I tested ten minutes before my race. I was at 140mg/dL (7.7mmol/L). Ten minutes after the race I tested again. I was at 388mg/dL (21.6mmol/L). The race lasted 21 seconds.”

Glucose Counter-regulatory Hormones: Effect on Liver

- Epinephrine
- Glucagon

Liver
- Amino acid
- Glycogen chain
- Other substrates
- Glycerol
- Glucose

Increased glucose production

Blood vessel
- Increased glucose in bloodstream
The dangers of insulin ‘stacking’ post exercise—Delayed onset hypoglycemia

Correction Boluses
Exercise
Meal Bolus

Tanenberg RJ et al., Confirmation of hypoglycemia in the “dead-in-bed” syndrome, as captured by a retrospective continuous glucose monitoring system. ENDOCRINE PRACTICE Vol 16 No. 2 March/April 2010
Managing Post Exercise Hyperglycemia

Modifying the patient’s own individualized correction factor
Moving toward advanced but accessible decision-making
Physical activity is essential for health in type 1 diabetes

Individuals with type 1 diabetes can achieve all levels of competition

Glycemic control during and after exercise remains a challenge

Aerobic exercise = hypoglycemia threat
Anaerobic exercise = hyperglycemia threat

Physiologic replacement of insulin is challenging but necessary for sport and exercise

Future work with the exercise smart artificial pancreas may help improve control