Texas Children's Hospital | The Woodlands

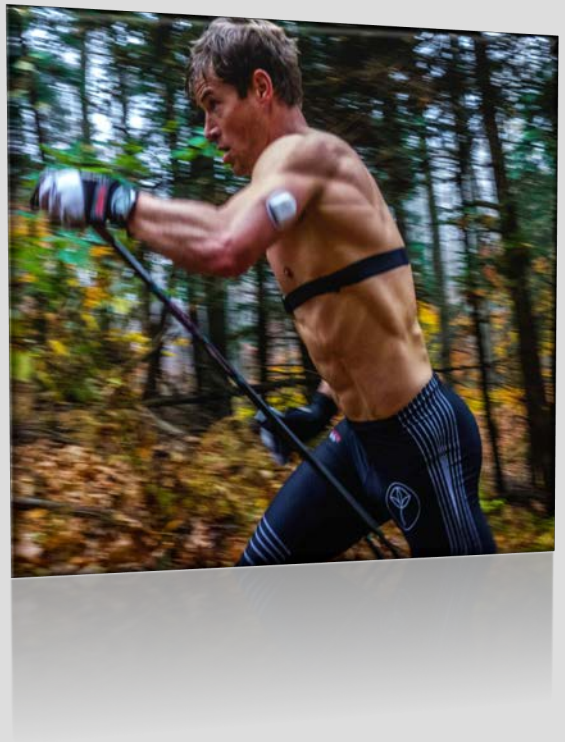
DIABETES AND ENDOCRINE

MANAGING BLOOD GLUCOSE WITH EXERCISE

By Daniel DeSalvo, MD

Presented by Debbie Featherston, MS, RD, LD, CDE

Goals and Objectives



- Provide an overview of the importance of physical activity in people with diabetes
- Address common questions on diabetes and exercise
- Describe the clinical approach to caring for diabetes during exercise

Physical Activity in diabetes

- Regular physical activity improves:
  - Psychosocial well-being
  - Cardiovascular health
  - Ideal body composition

Quirk et al. Diabet Med J Br Diabet Assoc, 2014

- Challenges with Diabetes:
  - Can be difficult to regulate glucose during and after activity
  - Fear of hypoglycemia
  - Many people have an irregular pattern of physical activity

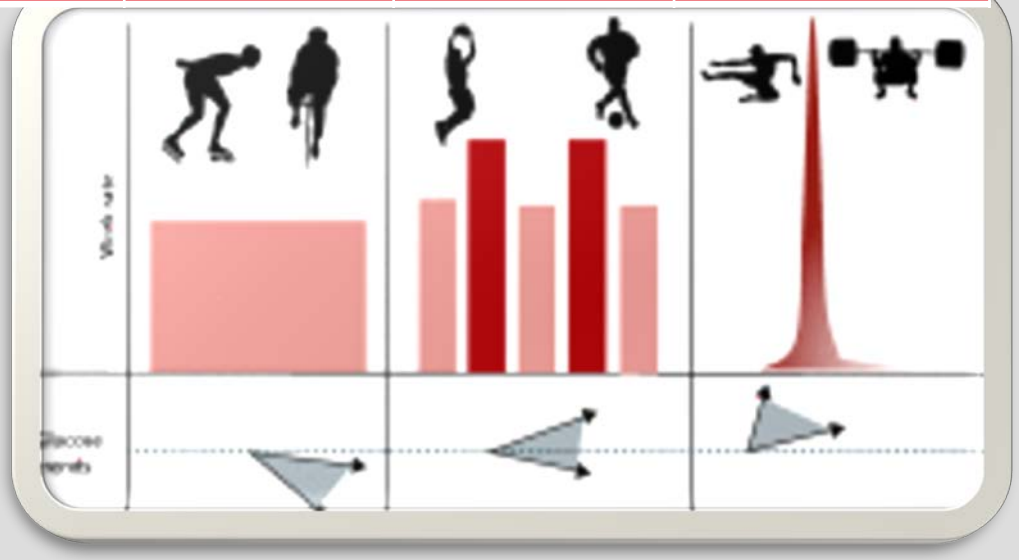
GLYCEMIC RESPONSE TO EXERCISE

- Multifactorial influences:
  - Location of insulin injection
  - Amount of insulin in circulation
    - May impair hepatic glucose output
  - BG concentration prior to exercise
  - Composition of the last meal or snack
  - Intensity and duration of the activity

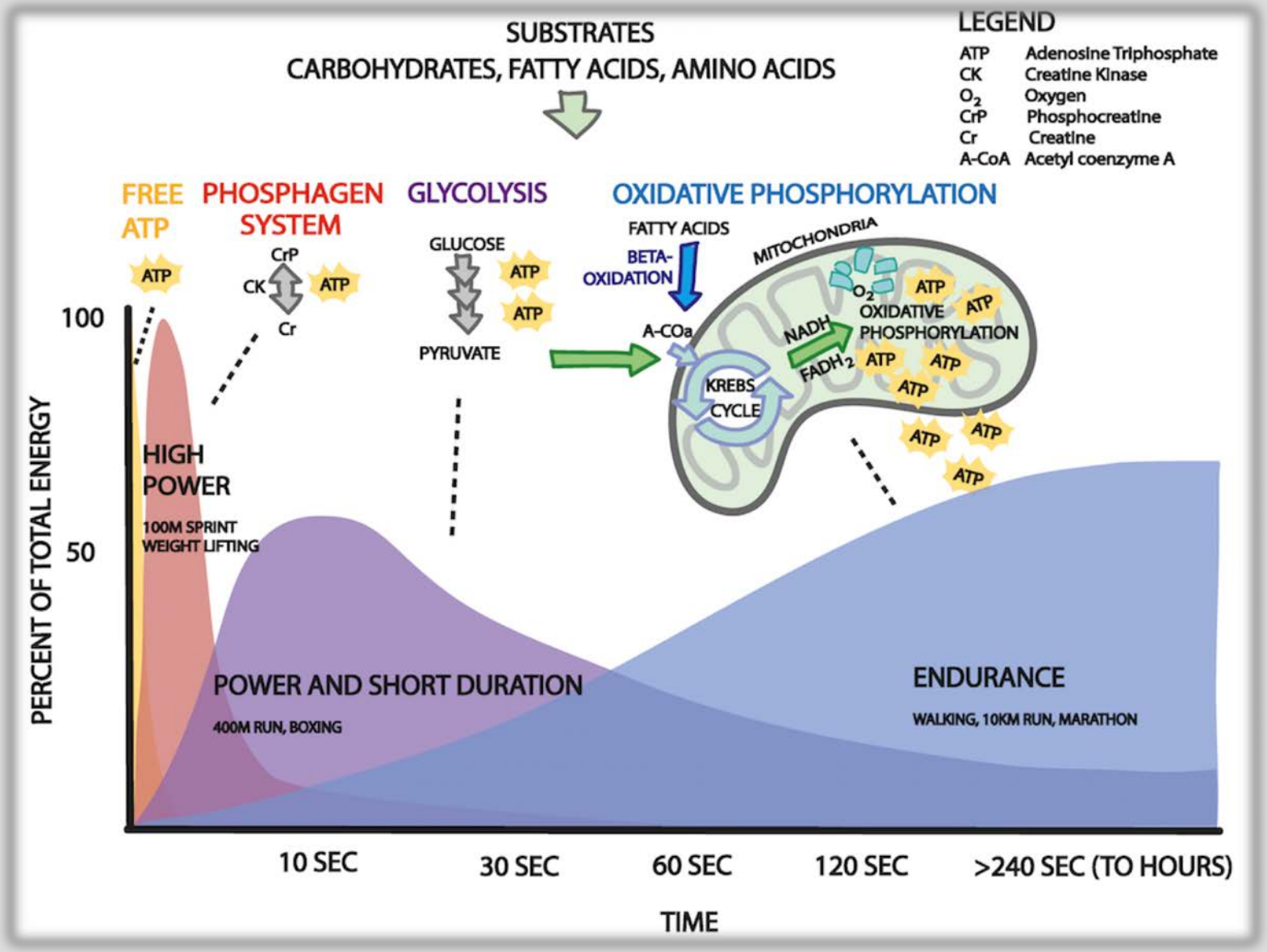
Bally L et al. Curr Opin Clin Nutr Metab Care, 2015

EXERCISE MANAGEMENT IN DIABETES: CONSENSUS STATEMENT

Exercise Type	Aerobic	Mixed	Anaerobic

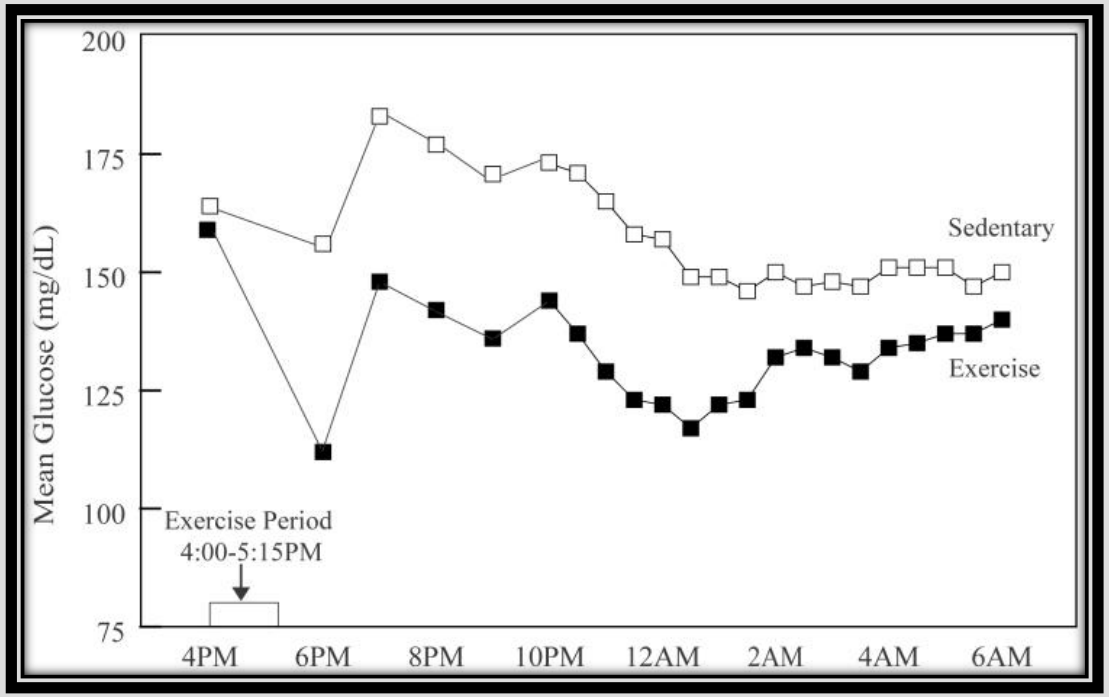


Riddell et al. Lancet Diabetes Endocrino, 2017


SUBSTRATES
CARBOHYDRATES, FATTY ACIDS, AMINO ACIDS
LEGEND
ATP Adenosine Triphosphate
CK Creatine Kinase
O2 Oxygen
CrP Phosphocreatine
Cr Creatine
A-CoA Acetyl coenzyme A
FREE ATP
PHOSPHAGEN SYSTEM
GLYCOLYSIS
OXIDATIVE PHOSPHORYLATION
ATP
CrP
CK
Cr
GLUCOSE
PYRUVATE
FATTY ACIDS
BETA-OXIDATION
A-COa
MITOCHONDRIA
O2
OXIDATIVE PHOSPHORYLATION
NADH
FADH2
KREBS CYCLE
100
50
PERCENT OF TOTAL ENERGY
HIGH POWER
100M SPRINT
WEIGHT LIFTING
POWER AND SHORT DURATION
400M RUN, BOXING
ENDURANCE
WALKING, 10KM RUN, MARATHON
10 SEC
30 SEC
60 SEC
120 SEC
>240 SEC (TO HOURS)
TIME

AEROBIC EXERCISE TYPICALLY LOWERS BGS

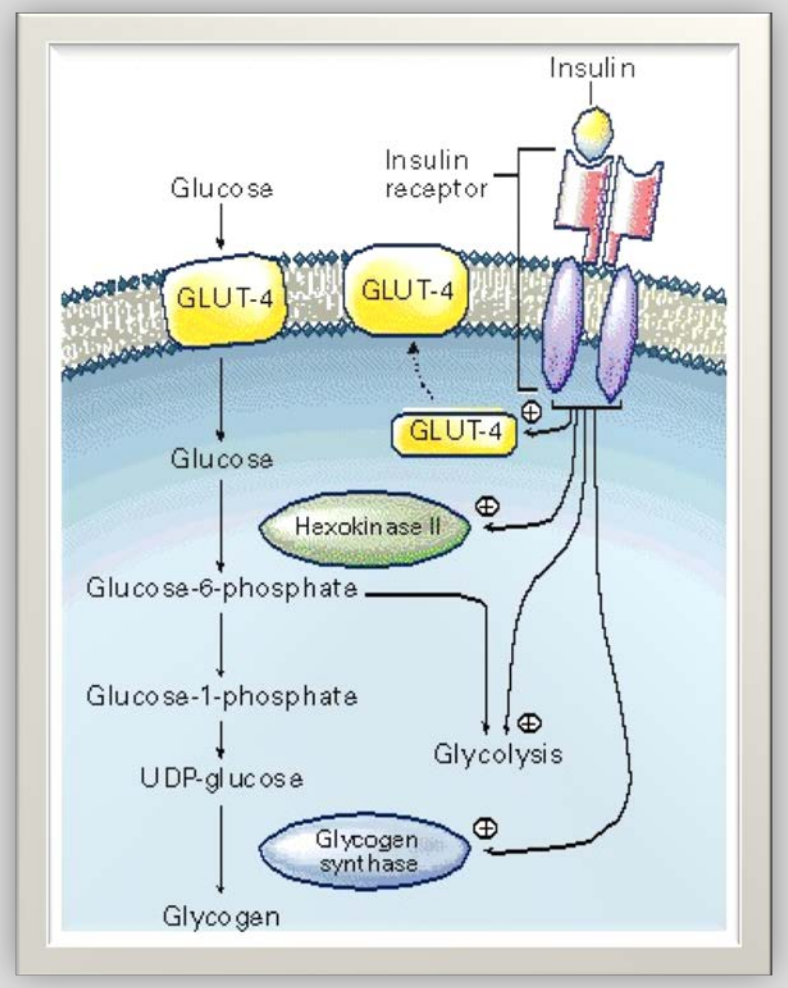
- Immediately and over time



DirecNet Study, J Pediatr, 2005

EXERCISE INDUCTION ON CELLULAR LEVEL

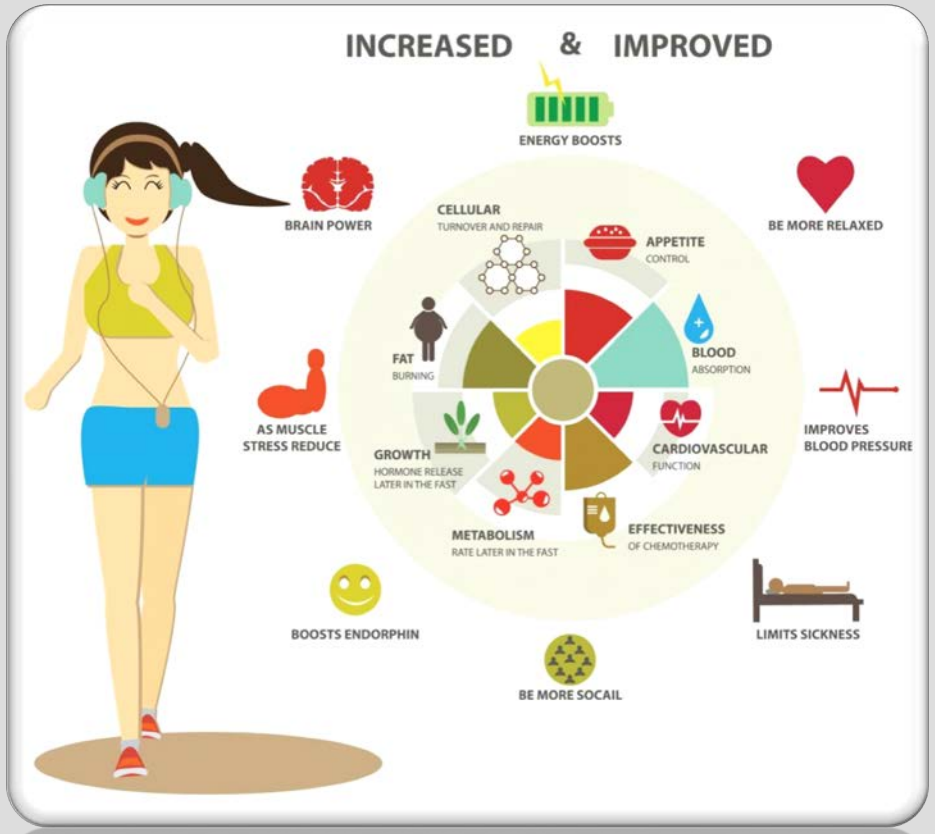
- Muscle contraction stimulates the muscle cell to uptake glucose and enhances glycogen storage in muscles
- Regular exercise enhances insulin sensitivity



Richter, Physiol Rev, 2013

CLINICAL BENEFITS OF REGULAR EXERCISE

- Increased sensitivity to insulin
- Insulin works more efficiently
- Lowers the total daily dose of insulin
- Aids in maintaining ideal body weight, CV health and metabolic health



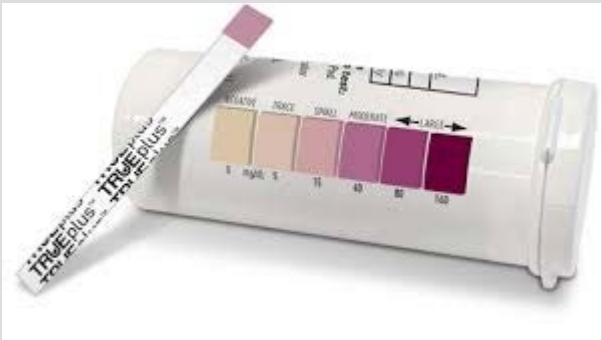
WHY DOES BG GO UP AFTER EXERCISE?

- Eating extra carbs
- Reducing insulin
- Counter regulatory hormones ie. Game Day
- Anaerobic exercise- glycogenlysis

Turner et al. Scand J Med Sci Sports, 2015

CAN YOU EXERCISE IF BG IS HIGH?

- YES, even if > 300 mg/dl as long as there are no ketones.
  - If ketones are 0.5-1.1, restrict exercise to light intensity for less than 30 minutes
  - If ketones are >1.1, Do Not Exercise.



Riddell et al. Lancet Diabetes Endocrinol, 2017

- Peak athletic performance at 108-144mg/dl

Kelly et al. Int J Pediatr, 2010

KETONE CHART

	OK	Caution	Danger	Emergency
Blood Ketone	< 0.6	0.6-1.0	1.1-3.0	>3.0
Urine Ketone	Negative or Trace	Small	Moderate to Large	Very Large
What To Do	Fluids and Monitor	Fluids and Monitor	Rapid Acting Insulin, Fluids, Monitor and notify parents and/or providers	Follow Emergency Protocol, Rapid Acting Insulin, Fluids, Monitor

KETOSIS TREATMENT

- Rapid Acting Insulin
- Sugar free Fluids- 1 oz per age per hour
- BG and ketone rechecks every 3 hours
- If symptoms, follow emergency contact protocols per provider

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DIABETES AND ENDOCRINE

10 BEST PRACTICES FOR MANAGING EXERCISE AND DIABETES

1. CHECK BG BEFORE, DURING AND AFTER EXERCISE

- Establish goal BG prior to activity (typically 125-180 mg/dl)

BG prior to activity	Management strategy (30-60 minutes of exercise)
<90	Eat 10-20 grams Carb
90-124	Ingest 10 grams Carb
125-180	Ok to exercise
181-300	Ok to exercise, consider partial correction dose
>300	Check ketones, give correction dose

- Take note of BG patterns during and after exercise
  - Adjust insulin and carb intake accordingly

Riddell et al. Lancet Diabetes Endocrino, 2017

2. REDUCE INSULIN PRIOR TO EXERCISE

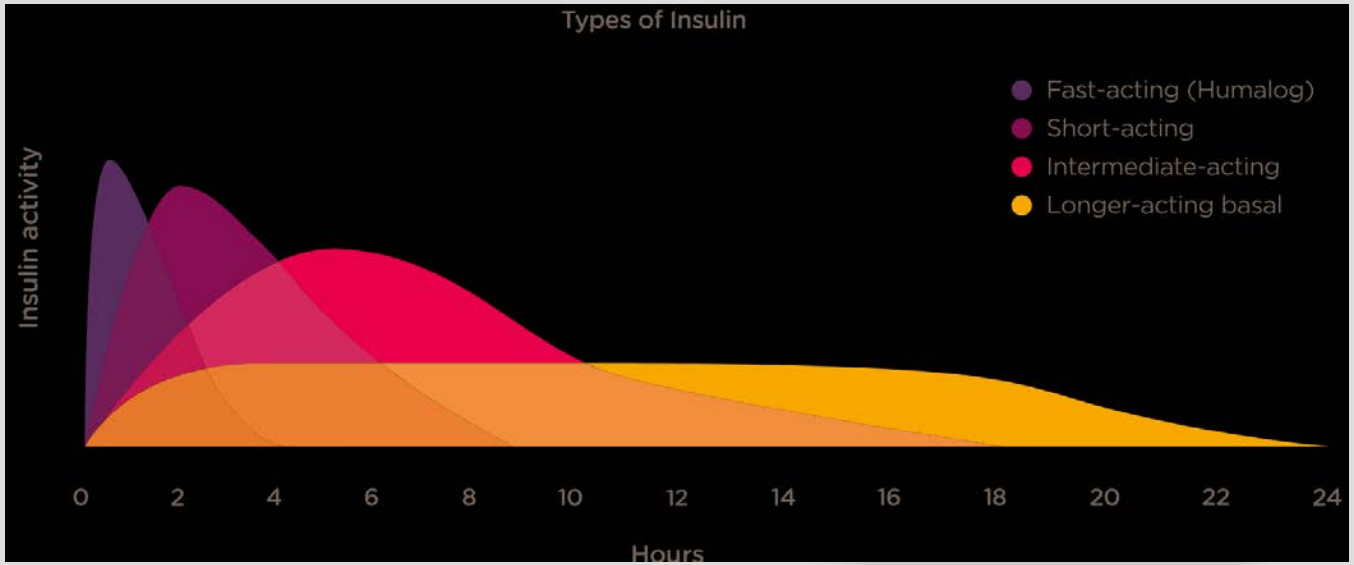
- If anticipating activity within 1-2 hours after bolus, reduce insulin by 25-75%
- Pumpers: utilize a temp basal rate for activities > 45 minutes
  - Set 30-60 minutes prior to activity
  - Start with 90% basal rates for light activity
  - 70% basal rates for moderate activity
  - 50% basal rates for strenuous activity and adjust from there

- Patients on injections: consider reducing long-acting dose prior to Very Active days

Franc et al. Diabetes Obes Meta, 2015

McAuley et al. Diabetologio, 2016

3. TAKE NOTE OF INSULIN ON BOARD



4. PUMPERS-AVOID PROLONGED BASAL SUSPENSIONS

- Avoid complete basal suspensions > 1-2 hours
  - Possible ketones and hyperglycemia
- Use Temporary Basal Rates

- If prolonged detachment from pump:
  - Take long acting insulin
  - Take rapid insulin

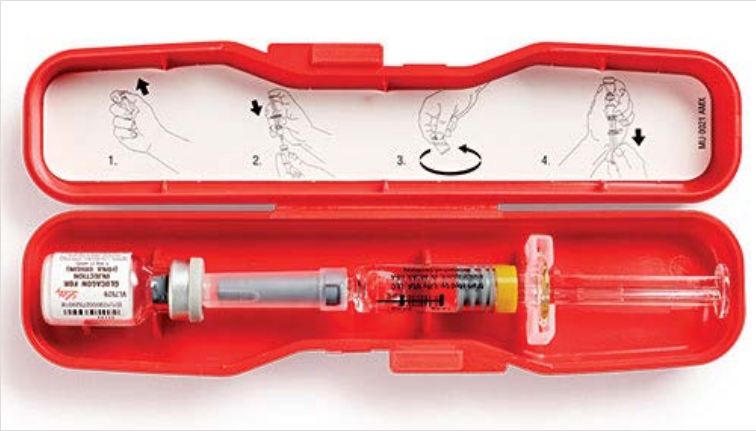
Heinmann et al. Diabetes Care, 2009

5. ALWAYS HAVE HYPOGLYCEMIA TREATMENT AVAILABLE

- Easily consumed carbs
- 15:15 Rule
- Glucagon
- Follow with Complex carbs and fat/protein

GLUCAGON

Glucagon Kit



Baqsimi nasal spray

GVoke premixed syringe

Verify BG * Treat * Roll on side * Call 911 * Recheck BG

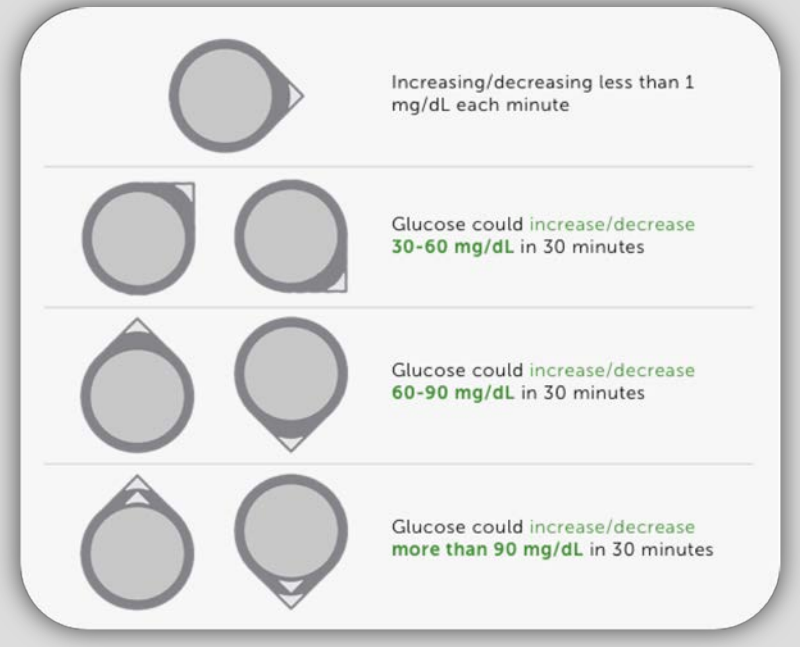
6. ALWAYS CHECK BEDTIME BG AND POSSIBLE 2AM BG

- Increased risk of nocturnal hypoglycemia after exercise
  - DirectNet Study- 26% of exercise nights
- Consider eating snack (10-20 gram carb) or decrease nighttime basal insulin
  - Ideal Bedtime BG: 120-150 mg/dl

DirecNet Study. J Pediatr, 2005

7. FOR CGM USERS: LOOK AT BG AND TREND ARROW

- Consider where glucose is and where heading
  - 30-60-90 rule
  - Eat carbs if:
    - 100 (arrow angled down)
    - 130 (arrow straight down)
    - 160 (double arrow down)



- Remote monitoring by coach, parent, trainer is helpful

8. COORDINATE WITH COACHES- TEAM APPROACH

- Teaching moments go both ways
- Exercise is important for a person with diabetes
- Signs and symptoms of hypoglycemia and hyperglycemia
- How to treat highs and lows

9. MOST IMPORTANTLY – HAVE FUN!

- Encourage students to find activities they enjoy
- Diabetes and exercise can be challenging, but don't give up
- Be an ambassador for diabetes and for exercise
- There are no limits

10. THE FUTURE OF DIABETES

- System:
  - Pump
  - CGM
  - Algorithm