HYPERGLYCEMIA MANAGEMENT

- SYMPTOMS OF HYPERGLYCEMIA
- BLOOD GLUCOSE (BG)/A1C GOALS
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- CAUSES OF HYPERGLYCEMIA
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- HOW TO AVOID/IMPROVE HYPERGLYCEMIA
- USING TECHNOLOGY TO IMPROVE HYPERGLYCEMIA
- SPECIAL CIRCUMSTANCES IN HYPERGLYCEMIA MANAGEMENT
HYPERGLYCEMIA MANAGEMENT:

SYMPTOMS OF HYPERGLYCEMIA

- Excessive thirst
- Excessive urination
- Fatigue
- Blurred vision
- Unintentional weight loss

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HYPERGLYCEMIA MANAGEMENT:

BLOOD GLUCOSE/A1C GOALS (ADA STANDARDS OF CARE 2018)

- Remember these goals are different for each individual, review your goals with your provider
- A1c goal <7.0% for majority of individuals to help prevent development and/or progression of diabetic complications
- Tighter goal (<6.5%) may be set for new-onset diabetics, type 2 diabetics treated with insulin or metformin only
- A1c goal <8% may be appropriate for older individuals, advanced diabetic vascular complications, hypoglycemic unawareness
- Pre-prandial (pre-meal) glucose goal: 80-130
- Post-prandial (post-meal, 2 hours after) glucose goal: <180

HYPERGLYCEMIA MANAGEMENT:

CONSEQUENCES OF LONG-STANDING HYPERGLYCEMIA

- Microvascular (small vessel) complications:
  - Retinopathy
  - Neuropathy
  - Nephropathy

- Macrovascular (large vessel) disease:
  - Stroke
  - Heart attack
  - Peripheral vascular disease

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HYPERGLYCEMIA MANAGEMENT:

RELATIVE RISK OF DEVELOPING DIABETIC COMPLICATIONS BASED ON HEMOGLOBIN A1C

- Lower A1c, with goal of <7%, decreases risk of developing microvascular complications and decreases risk of progression of microvascular complications!!!
HYPERGLYCEMIA MANAGEMENT:
A FEW POTENTIAL CAUSES OF HYPERGLYCEMIA

• Fasting Hyperglycemia
  • Not enough insulin at dinner the night before (can check ~3am to help determine if this is the cause)
  • Dawn phenomenon
    • A rise in blood glucose levels 4am-8am due to increased hepatic (liver) production of glucose overnight. Can last until after breakfast
• Post-meal Hyperglycemia
  • Problems with insulin absorption (lipohypertrophy)
  • Stress
    • Physical (ie illness, recovery from surgery, infection)
    • Emotional
  • Medications
  • Insulin pump concerns

HYPERGLYCEMIA MANAGEMENT:
POST-MEAL (POSTPRANDIAL) HYPERGLYCEMIA

• Missing mealtime insulin dose (or sulfonylurea if taking)
• High carbohydrate or high-glycemic index food at meal
• Incorrectly estimated mealtime insulin dose/eating more than planned at a meal
• Timing of mealtime insulin dose in relationship to when the meal starts
• Issues with insulin absorption
HYPERGLYCEMIA MANAGEMENT: TIMING OF MEALTIME INSULIN

Rapid-acting insulin takes 10-15 minutes to absorb and start working. Taking insulin 5-10 minutes before the start of the meal will better match the absorption of food = Less post-meal hyperglycemia.

HYPERGLYCEMIA MANAGEMENT: INJECTION SITES AND RATE OF ABSORPTION

Adapted from Hovelmann et al 2017

HYPERGLYCEMIA MANAGEMENT: LIPOHYPERTROPHY

- Tumor-like swelling of fatty tissue around subcutaneous insulin injection sites
- May feel like a hard lump at your injection site
- Injection into these areas results in variable insulin absorption
- Can result in hyperglycemia after meals

Causes:

- Lack of rotation of insulin injection sites
- Not changing insulin pen needles regularly

HYPERGLYCEMIA MANAGEMENT: PROBLEMS WITH INSULIN PUMP DELIVERY/SITES

- Having pump in "suspend" feature for too long, or disconnected for >1 hour at a time
- Using a decreased "temporary basal rate" for too long
- Insulin pump failure
- Using same infusion set/tubing for too long (>3 days' duration)
HYPERGLYCEMIA MANAGEMENT: INSULIN PUMP CONCERNS

Why is this patient hyperglycemic?

- Infection is the most common cause
- If blood sugar persistently >240
  - Check urine ketones; if positive, seek medical care
- Can be associated with symptoms of abdominal pain, nausea
  - If hyperglycemic and vomiting, go to the ER
- Persistently high blood sugars can lead to:
  - DKA: Diabetic Ketoacidosis
    - Occurs more often in type 1 diabetics, but can occur in type 2 diabetes
  - HHS: Hyperosmolar Hyperglycemic State
    - More likely to occur in patients >65 years old
  - Blood sugars can be >800

HYPERGLYCEMIA MANAGEMENT: HOW TO HELP LOWER BLOOD SUGARS

- Stay well hydrated
- Avoid high glycemic index foods, meet with CDE for a refresher on carbohydrate counting
  - Increase fiber content at meals to slow absorption of carbohydrates
- Exercise
  - Avoid if blood sugar is >240mg/dl
  - Increases insulin sensitivity
  - Goal for type 2 diabetes is 150 minutes of moderate intensity exercise per week.
HYPERGLYCEMIA MANAGEMENT:
HOW TO REDUCE FREQUENCY/DURATION OF HYPERGLYCEMIA

- Increase frequency of monitoring blood glucose levels when on an intensive insulin regimen
  - Associated with 0.2% reduction in A1c for every additional blood glucose test per day

- Use of continuous glucose monitoring system (CGM)
  - Associated with 0.5-2% reduction in A1c
  - The more you wear it, the more likely you will be able to achieve a reduction in your A1c

HYPERGLYCEMIA MANAGEMENT: CGM OPTIONS

- Medtronic
- Dexcom G5
- Freestyle Libre

HYPERGLYCEMIA MANAGEMENT:
SPECIAL CIRCUMSTANCES: MENSTRUATION & LUTEAL PHASE HYPERGLYCEMIA

- Women with T1D experience changes in insulin sensitivity throughout the menstrual cycle
- In pre-menopausal women with T1D, there is hyperglycemia and increased insulin resistance around the time of ovulation and during the luteal phase (2nd half) of the menstrual cycle
- Might be explained by ↑ estrogen levels just prior to ovulation, and ↑ progesterone in the 2nd half of the cycle which can lead to ↑ calories taken in and ↑ carbohydrate intake
SPECIAL CIRCUMSTANCES: MENSTRUATION & LUTEAL PHASE HYPERGLYCEMIA
-In a small study of women with T1D, combination birth control pills did not eliminate the changes in glucose control seen during the luteal phase
-If on insulin pump, using temporary basals or a different basal pattern around the time of ovulation until the start of menses can help overcome this resistance
-If on MDI, temporarily increasing basal insulin (Lantus, Levemir) can help with this phenomenon as well
-Closed loop systems may be very beneficial here given the ability to dynamically change insulin delivery from day to day

SPECIAL CIRCUMSTANCES: MENOPAUSE
-Limited data in the literature; most T2D data
-Small studies have shown glycemic control deteriorates in postmenopausal state
-Large clinical trial in postmenopausal women with T2D showed significant difference in A1C in those on hormone replacement therapy (HRT) vs. those not on HRT (7.9 vs 8.5)
-In postmenopausal women without diabetes, estrogen therapy has been associated with improved insulin sensitivity and ↓ fasting BGs
-Could HRT improve glycemic control and decrease risk of complications in women with diabetes?

SPECIAL CIRCUMSTANCES: EXERCISE
-Exercise effect on BGs depends on exercise type and duration, starting BG, IOB, last meal
-Aerobic exercise (walking, jogging, cycling) → hypoglycemia
-Resistance/strength training (free weights, weight machines, resistance bands) → modest rise in BGs
-High intensity interval training (brief vigorous exercises alternating with low/moderate intensity exercises) → BGs usually increase
-Exercise-induced hyperglycemia thought to be due in part to ↑ counterregulatory hormones (epinephrine, cortisol, growth hormone)
-If on CSII, may need to use temp basal rather than suspending insulin delivery
-Conservative post-exercise correction may be helpful
-Prolonged cool down period (aerobic exercise) can help with post-exercise hyperglycemia

SPECIAL CIRCUMSTANCES: CAFFEINE
-Over 80% of adults in the US consume caffeine daily, mostly from beverages
-Caffeine affects BG levels despite lack of carbohydrates
-Caffeine intake, especially along with carbohydrates, may ↑ BGs and cause insulin resistance
-High BGs may take longer to recover
-In T1D, even black coffee can cause elevated BGs
-In a few small studies, caffeinated coffee caused BGs to increase up to 20% in the postprandial state
-For caffeinated beverages, adding an extra 5-10 grams of carbs to meal doses may be beneficial; in pump users increasing AM basal rate to account for caffeine effect
HYPERGLYCEMIA MANAGEMENT

SPECIAL CIRCUMSTANCES: STEROIDS

- Steroids (AKA corticosteroids, glucocorticoids) are known to raise BG levels
- Steroids are given to reduce inflammation; frequently used for asthma and arthritis
- Can be helpful for other autoimmune disorders as well
- Steroids cause insulin resistance, causing insulin (your own or injected insulin) to work less effectively
- Steroids also trigger extra glucose to be released by the liver
- Make sure to tell the provider prescribing steroids that you have diabetes so you can develop a diabetes treatment plan with your diabetes team.

To counteract the steroid effect:

- Check BG levels more often (CGM helpful here)
- If you take insulin, you’ll likely need to increase your dose (i.e. temporary basals, ↑ basal insulin, ↑ mealtime insulin, strengthen corrections)
- If you take pills (i.e. glyburide, glipizide, glimepiride), you may need to increase the dose, add additional medication, or possibly even add insulin temporarily
- As steroid dose is tapered down, diabetes drug doses will need to be tapered as well
- Steroid injections can affect BG levels for up to a few weeks
- Steroid inhalers and creams don’t typically affect BG levels.

HYPERGLYCEMIA MANAGEMENT: REFERENCES

- Diabetes Care Volume 41, Supplement 1, 2018: Glycemic Targets
- Diabetes Care Volume 36, December 2013: Thirty Years of Research on the Dawn Phenomenon: Lessons to Optimize Blood Glucose Control in Diabetes
- Ismael-Belgi F et al. Individualizing Glycemic Targets in Type 2 Diabetes: Implications of Recent Clinical Trials. Annals of Internal Medicine April 19 2011
- AADE: Insulin Injection Know How: ProTips (and Tricks) for Easier and Better Insulin Injections
HYPERGLYCEMIA MANAGEMENT:

REFERENCES


www.EPICconferences.org