Hypoglycemia in the New Diabetes Era

BRITTANY SIEMIAWSKI DNP, APNP, PNP-PC

PEDIATRIC ENDOCRINOLOGY & DIABETES

Disclosures

- No financial disclosures

Objectives

- Define hypoglycemia, symptoms, and treatment

- Define physiological responses to hypoglycemia

- Analyze insulin pump systems and their proactive features to prevent hypoglycemia

- Summarize hypoglycemia treatment options for children on insulin pump therapy

Background

- Hypoglycemia is a large factor in diabetes management
  - Frightening for patients/families
  - Difficult to recognize/communicate needs (hypoglycemia unawareness)
  - Can lead to serious life-threatening consequences

- Young children with type 1 diabetes mellitus (T1D) are more vulnerable for clinically significant hypoglycemia because of their reduced ability to recognize symptoms and effectively communicate needs
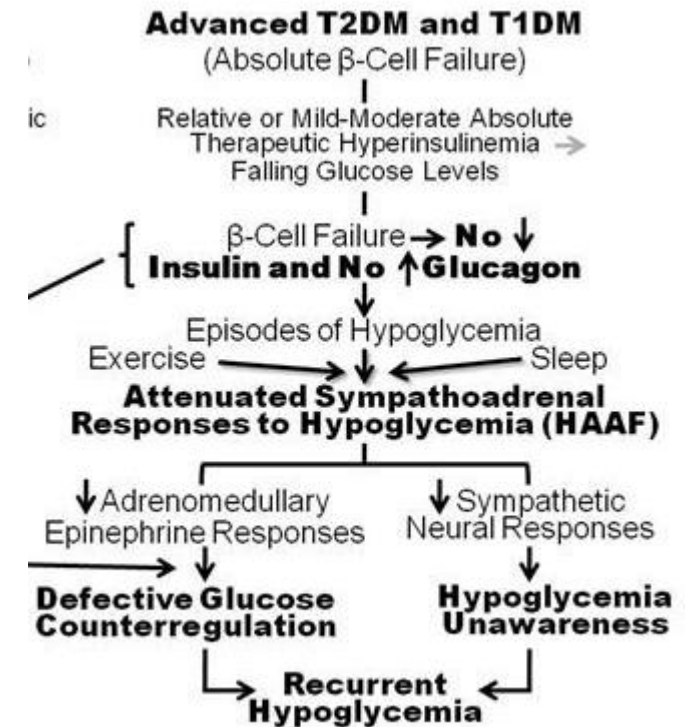
(American Diabetes Association [ADA], 2018)

Hypoglycemia in Diabetes

Broadly defined as a blood glucose level <70 mg/dL

Level	Glycemic criteria	
Hypoglycemia alert value (level 1)	≤70 mg/dl (3.9 mmol/L)	Sufficiently low for treatment with fast acting carbohydrate and dose adjustment of glucose lowering therapy
Clinically significant hypoglycemia (level 2)	<54 mg/dl (3.0 mmol/L)	Sufficiently low to indicate serious, clinically important hypoglycemia
Severe hypoglycemia (level 3)	No specific glucose threshold	Hypoglycemia associated with severe cognitive impairment requiring external assistance for recovery

Physiological Defenses

- Physiological/counterregulatory responses to hypoglycemia:

  1. Insulin levels decrease

  2. Glucagon levels increase

  3. Epinephrine increases

- In T1D, beta cell deterioration/failure occurs ultimately leading to blunted physiological responses to hypoglycemia

Hypoglycemia-Associated Autonomic Failure

Advanced T2DM and T1DM
(Absolute β-Cell Failure)

Relative or Mild-Moderate Absolute
Therapeutic Hyperinsulinemia
Falling Glucose Levels

β-Cell Failure → **No** ↓
Insulin and No ↑**Glucagon**

Episodes of Hypoglycemia

Exercise   Sleep

**Attenuated Sympathoadrenal
Responses to Hypoglycemia (HAAF)**

↓Adrenomedullary   ↓Sympathetic
Epinephrine Responses   Neural Responses

**Defective Glucose   Hypoglycemia
Counterregulation   Unawareness**

**Recurrent
Hypoglycemia**

Symptoms of Hypoglycemia

- Sweating

- Irritability, nervousness

- Feeling shaky

- Confusion

- Hunger

- Nausea

- Lightheaded, dizziness

- Fatigue

- Feeling weak

- Seizure

(ADA, 2023)

Hypoglycemia Causes in T1D

- Insulin
  - Doses (high)
  - Wrong insulin (long-acting vs. rapid-acting)
  - Administration (accidentally injected in muscle vs. subcutaneous)

- Food
  - Eating less carbohydrates than dosed for
  - Absorption (fat, protein, fiber)
  - Timing of injection in relation to meal

- Physical activity
  - Physical education, recess

Treatment of Hypoglycemia

- "15-15 rule"
  - Treat with 15 fast-acting grams of carbohydrates and recheck blood glucose level in 15 minutes—if blood glucose level is still <70 mg/dL, treat again.
    - Examples: glucose tablets, 4 ounces of juice, skittles, fruit snacks
    - Glucagon for severe hypoglycemia

- *Physical Activity Considerations (gym class, recess)*
  - Eat an uncovered 15 grams carbs snack prior to activity
  - If eating/dosing within 2-3 hours of activity, can decrease insulin dose proactively

Insulin Pump Therapy

What is an insulin pump?

- Device that delivers insulin in two ways:
  - 1. Steady, background continuous dose ("basal")
  - 2. Surges at mealtimes or instances of high blood glucose levels ("bolus")
  - *No long-acting insulin, all rapid-acting insulin*

- Device details:
  - Insulin is delivered continuously through a flexible catheter underneath the skin
  - The pump is replaced every ~3 days
  - Various types on the market (i.e. Omnipod, Tandem, Medtronic)
  - Settings can be programmed on an hourly basis (carb ratios, correction factors, basal rates)

(ADA, 2023)

Insulin Pump Therapy Continued

Majority of insulin pumps are integrated with a continuous glucose monitor (CGM)
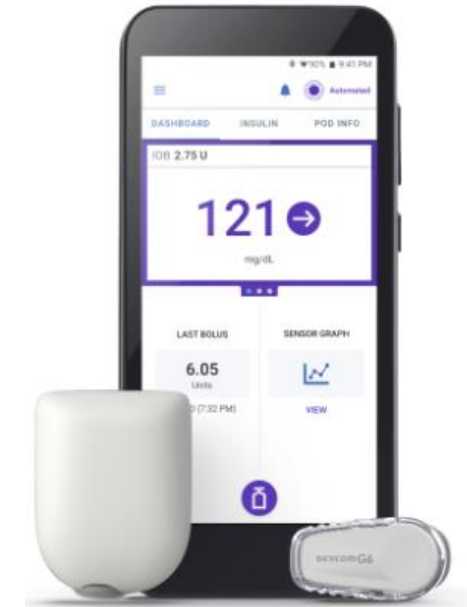
- CGM data is transmitted to the insulin pump → the pump automatically adjusts the insulin being delivered based off its algorithm/CGM reading
  - Hybrid closed-loop systems

(Tandem Diabetes Care, 2024)

(Medtronic, 2024)

(Insulet Omnipod 5, 2024)

(ADA, 2023)

Closed-Loop Insulin Pump Features

- Each pump has an individual algorithm with specific features

Generally:

- If an insulin pump senses the blood glucose/CGM reading is *dropping*, it will *decrease or suspend* the basal insulin rate

- If the insulin pump senses the blood glucose/CGM reading is *increasing*, it will *increase* the basal insulin rate or give an automatic correction dose

- Activity/exercise mode

- Sleep mode

Hypoglycemia Treatment on Insulin Pump Therapy

- If an insulin pump senses the blood glucose/CGM reading is dropping, it will decrease or suspend the basal insulin rate
  - *This means treatment for hypoglycemia may require less fast-acting carbs (<15 grams) to return to euglycemia*
  - *This avoids overtreatment on AID systems, which may subsequently result in hyperglycemia*

- Activity/exercise mode
  - *Targets a higher blood glucose, algorithm less aggressive*
  - *Must be turned on at least 1 hour before activity to reduce insulin on board going into activity*

- Additional proactive considerations:
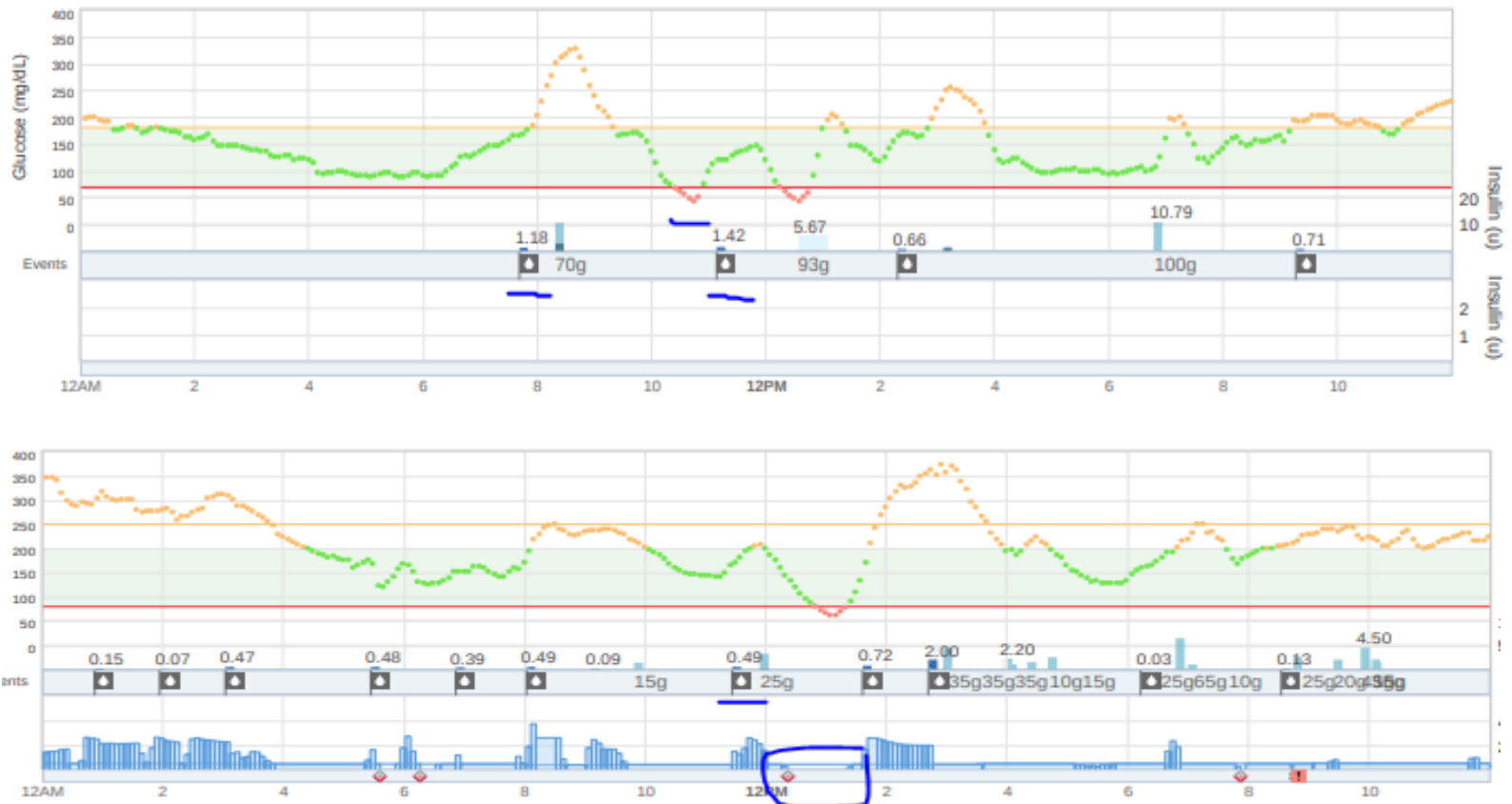 - *Reduce mealtime bolus before activity*
  - *Pre-meal dosing*

(Sherr et al., 2022)

Examples

Omnipod 5
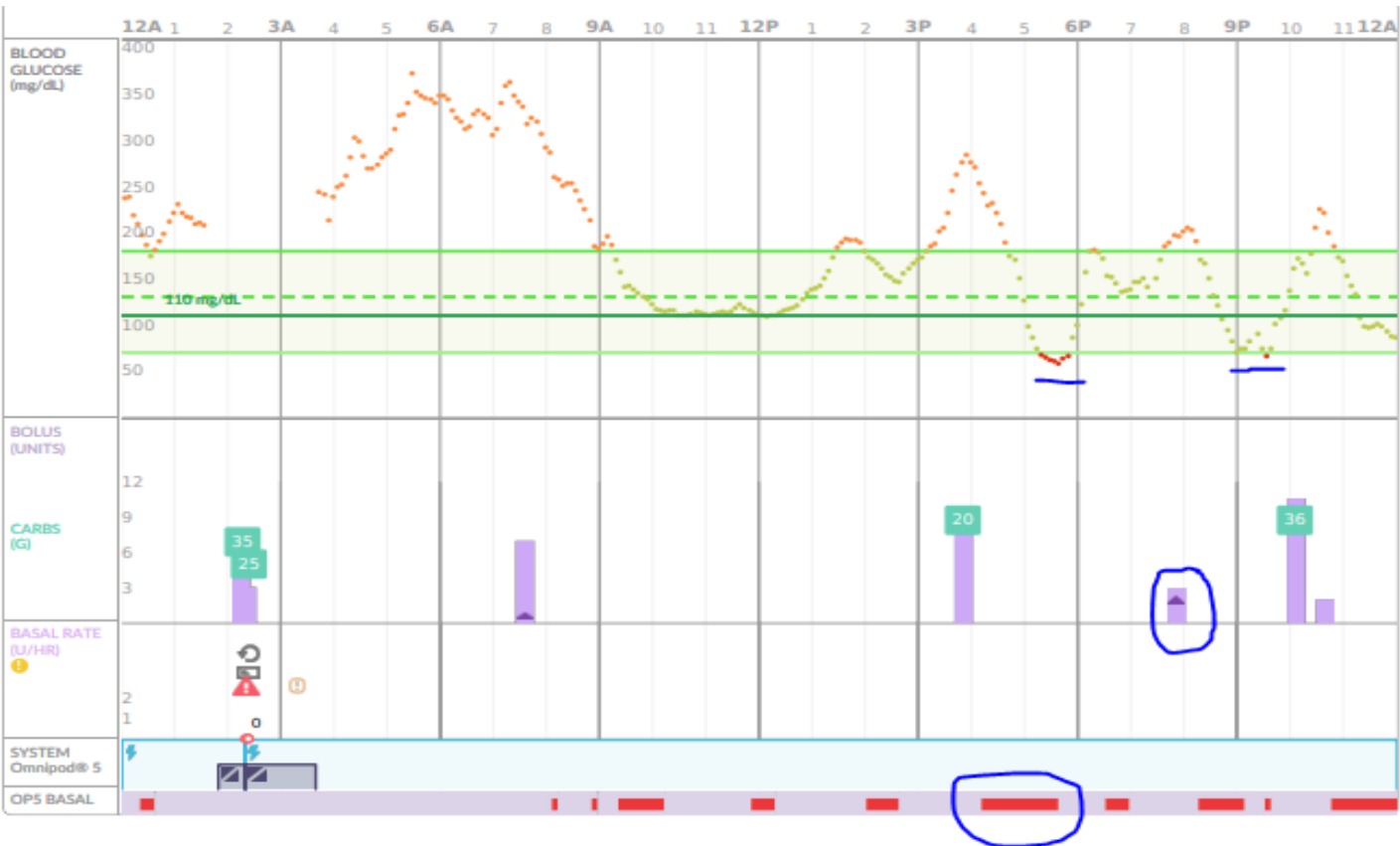
Examples

Tandem T-slim

Summary

- Hypoglycemia is a limiting factor in T1D management

- Physiological responses to hypoglycemia are blunted in T1D

- Hypoglycemia is generally defined as a blood glucose level <70 mg/dL

- Symptoms of hypoglycemia include irritability, sweating, hunger, weakness

- Technology is helpful in reducing hypoglycemia (CGMs, insulin pumps)

- Treatment for hypoglycemia on insulin pump therapy may include
  - Activity mode proactively
  - Less fast-acting carbs (<15 grams)

- Other features to consider to prevent hypoglycemia on insulin pump therapy:
  - Pre-meal dosing
  - Reduce bolus dose proactively before activity

Thank you!

References

- American Diabetes Association. (2018). Glycemic Targets: Stands of Medical Care in Diabetes-2018. *Diabetes Care, 41*(1), S55-S64. https://doi.org/10.2337/dc18-S006

- American Diabetes Association. (2023). *Treatment & care: Hypoglycemia (Low blood glucose).* https://diabetes.org/living-with-diabetes/treatment-care/hypoglycemia

- American Diabetes Association. (2023). *About diabetes: Insulin pumps: Relief and choice*. https://diabetes.org/about-diabetes/devices-technology/insulin-pumps-relief-and-choice

- Davis, H. A., Spanakis, E. K., Cryer, P. E., & Davis, S. N. (2021). Hypoglycemia during therapy of diabetes. *Endotext*. https://www.ncbi.nlm.nih.gov/books/NBK279100/#

- Sherr, J. L, Heinemann, L., Fleming, A., Bergenstal, R. M., Bruttomesso, D., Hanaire, H., Holl, R. W., Petrie, J. R., Peters, A. L., & Evans, M. (2022). Automated insulin delivery: Benefits, challenges, and recommendations. A consensus report of the joint diabetes technology working group of the European Association for the study of diabetes and the American Diabetes Association. *Diabetes Cares, 45*(12), 3058-3074. https://doi.org/10.2337/dci22-0018