



Abnormal Glucose

National Pediatric Nighttime Curriculum

Written by Angela F. Veesenmeyer, MD, MPH

University of Wisconsin School of Medicine &
Public Health





Abnormal Glucose: Learning Objectives

- Recognize hyperglycemia and hypoglycemia and identify common causes
- List which critical labs to send and appropriate monitoring frequency
- Learn appropriate initial therapy of abnormal glucose
- Identify complications of abnormal glucose and its treatment and how to monitor for these

Case 1 Intern

- You receive a page at 0200 that reads like this “Rm 5135 has BS 450”
- You scan your patient list and see that the page refers to a 12 yo girl transferred out of the PICU just before signout with a diagnosis of “DKA-resolved”
- What other information should you have gotten about this patient in signout?

Case 1 con' t

- Upon a quick review of the chart, you see that the girl is a new onset DM and spent 24 hours in the PICU.
- Her pH at 0500 this morning was 7.35 and her HCO₃ was 25. You can' t find a UA. She got a dose of long acting insulin before bedtime.
- What could be going on?

Case 1 con' t

- On exam she is drowsy, pale and complaining of thirst.
- What initial steps do you take?
- In the interim, the nurse pages you again to tell you that the patient is complaining of nausea and has begun vomiting. A repeat fingerstick is “unreadable”.
- What now?

Case 1 con' t

- The serum glucose is 435 mg/dl. Her pH is 7.2
- The Na is 135 and K is 3.5. HCO is 14.
- How will you manage this patient?
- What potential problems may arise during therapy?

Hyperglycemia: Definition

- Mild = fasting blood glucose 120 mg/dl – 200 mg/dl
- Moderate = fasting blood glucose 200 mg/dl – 410 mg/dl
- Severe = fasting blood glucose \geq 410 mg/dl



Hyperglycemia: Causes

- Poorly controlled IDDM or new onset IDDM
- Stress (shock, surgery, trauma)
- Medications (thiazide diuretics, steroids, salicylates)
- TPN administration

Acute Manifestations

- With mild to moderate hypoglycemia
 - Polyuria, polydipsia
 - Thirst
 - Volume depletion
 - Tachycardia
 - Poor perfusion
 - Hypotension
- With more severe hypoglycemia
 - Ketotic breath (fruity)
 - Kussmaul breathing
 - Nausea, vomiting, abd pain
 - Delirium, confusion





Diabetic Ketoacidosis: Definition

- Hyperglycemia
- Ketonemia
- Ketonuria
- Metabolic acidosis
 - pH < 7.30
 - Bicarb < 15 mEq/L

Management

- Always send stat serum glucose
- Check for easily identifiable causes e.g. TPN, IVFs, medications, infection, trauma
- Give 10-20 ml/kg NS bolus
- Start continuous infusion of insulin 0.1 units/kg/hr
- Send stat metabolic panel, VBG to check for hypokalemia, renal function, acidosis
- Urine for ketones

Management

- Notify PICU, senior resident, attending, endocrinology
- Monitor electrolytes, glucose, pH at least HOURLY
 - Glucose should not fall more than 40 mg/dl/hr (may go up to 80-100 mg/dL/hr depending on institution)
 - Add KCl +/- Kphos to IVFs when urinating
 - Add dextrose to IVFs when glucose < 250 (rather than dropping insulin rate)
- Close monitoring of neuro status
- Check again for precipitating causes

Management

- For patients who are NOT known IDDM i.e. hyperglycemia due to TPN, steroids
 - Indications for treatment include osmotic diuresis (increased urine output) and glucosuria
 - Insulin is often indicated and is preferable to decreasing the glucose load in TPN dependent patients
 - Insulin is occasionally necessary in steroid dependent patients if unable to decrease steroid dose

Case 2 Senior

- During night rounds at 2300, your intern tells you that he was called for a 10 mo patient admitted w/AGE for a HR of 140 and emesis.
- He asked the nurse to give a 20ml/kg NS bolus, assuming the tachycardia was due to dehydration from the AGE.
- After getting called to the ED for 2 more admissions, you get around to checking in on the patient to make sure the tachycardia has resolved.

Case 2 con' t

- On exam, you find a small appearing boy lying quietly in a crib.
- His HR is 155 and he is jittery and pale.
- Briefly glancing through the chart, you note that the intern was called again about the HR and ordered another NS bolus.
- He has been increasingly tachycardic throughout the night, despite fluid, and has not had any stool output for the past 5 hours.

Case 2 con' t

- What initial steps do you take in this patient' s management?
- You scan your sign out sheet and note that the baby was admitted for AGE and the plan was to rehydrate with IVFs overnight and discharge in the am. However, upon checking with the nurses, you find that his IVFs were turned off just before sign out to encourage him to drink.
- What other information would have been helpful in sign out?

Case 2 con' t

- A fingerstick glucose is 35 mg/dl.
- The nurse asks you if you want to restart maintenance fluids (D5)?
- What is the appropriate next step in this patient's management?
- What are possible reasons for the hypoglycemia?
- A repeat fingerstick (after intervention) is 80 mg/dl

Case 2 con' t

- Three hours later, you get a text page from the intern reading “TD tachycardic again. Should I get another glucose?”
- You request another fingerstick and this time it is “unable to read”. The baby has another emesis.
- What do you do in the meantime? Would you send any other labs?
- While drawing the labs, the IV went bad and the baby has no IV access.
- How would you treat the presumed hypoglycemia? Why?

Case 2 con' t

- The serum glucose (before intervention) is 28 mg/dl.
- How would you change the IV fluids given this recurrent persistent hypoglycemia?
- A repeat fingerstick (after glucagon) is 35 mg/dl. You have IV access again.
- What does the lack of response to your adjunct therapy tell you?
- What do you do now?



Hypoglycemia: Definition

- Clinical definition is plasma glucose \leq 40-45 mg/dl
- Signs/symptoms can occur at glucose levels $<$ 70 mg/dl
- Plasma glucose normally maintained in range of 70-100 mg/dl

Hypoglycemia: Causes

- Decreased availability of glucose

- Decreased intake
- Decreased absorption
- Inadequate glycogen reserves
- Ineffective glycogenolysis
- Inability to mobilize glycogen
- Ineffective gluconeogenesis

- Increased utilization of glucose

- Hyperinsulinism
- Large tumors

- Diminished availability of alternative fuels

- Inability to oxidize fats
- Decreased fat stores

- Other mechanisms

- Sepsis, salicylates, ethanol, adrenal insufficiency, hypopit, hypothyroid

Acute Manifestations

- Activation of autonomic nervous system

- Anxiety
- Perspiration
- Palpitation
- Pallor
- Tremulousness
- Hunger
- Weakness
- Nausea/emesis

- Cerebral Glucopenia

- Headache
- Confusion
- Visual disturbances
- Personality changes
- Inability to concentrate
- Seizures
- Lethargy
- Coma



Management



- Always send stat serum glucose
- Determine age of patient (newborn?) and check medications
- If no obvious reason for hypoglycemia (normal newborn, exogenous insulin or oral hypoglycemics), draw critical samples **BEFORE** treatment*

*If unable to obtain blood after 5 mins, treat the hypoglycemia!

Critical Labs

- Glucose
 - FFA
 - β hydroxybutyrate
 - Lactate
 - Carnitine,
acylcarnitines
- Plasma insulin
 - C peptide
 - Cortisol
 - Growth hormone



Critical Labs

- When in doubt....
 - Draw 5-10 ml in a red top tube for later analysis and send on ice to lab
 - If you need to prioritize because of insufficient blood
 - Plasma insulin and C peptide are the priority
- Why???

Management



- If patient conscious and able to drink, give PO rapidly absorbed carbohydrate
 - Glucose tablets/gel, table sugar, fruit juice, honey*
- IV therapy
 - Initial bolus 2-4 ml/kg D10 administered slowly
 - Infusion of dextrose at 6-9 ml/kg/min
 - Rate of infusion (mg/kg/min) = % dextrose x 10 x rate of infusion (ml/hr) ÷ (60 x wt in kg)
 - Use D10 if peripheral IV (max concentration in PIV)

*No honey in babies < 1 year of age!

Management

- Goal is to keep serum glucose between 80-100 mg/dl initially until determine cause of hypoglycemia
- If no IV access, can give glucagon IM or SQ
 - 0.03 mg/kg up to 1 mg
 - Vomiting may follow administration so must monitor closely
- Check glucose Q 30-60 mins initially until stable



Take Home Points

- Severe hyperglycemia and hypoglycemia are medical emergencies requiring immediate evaluation and intervention.
- Appropriate labs should be checked frequently until they normalize.
- Pay close attention to neuro status (HA, drowsiness, change in VS, jitteryness) as this could signal a change in glucose and might increase risk of mortality and morbidity.

Key References

- Wolfsdorf J, Craig ME, Daneman D, et al. ISPAD Clinical Practice Consensus Guidelines 2009 Compendium. Diabetic ketoacidosis in children and adolescents with diabetes. *Pediatric Diabetes*, 2009;10: 118-133.
- Saudubray JM, de Lonlay P, Touti G, et al: Genetic hypoglycaemia in infancy and childhood: Pathophysiology and diagnosis. *J Inherit Metab Dis* 2000;23:197-214.