

Endocrine Emergencies

1. Diabetic Ketoacidosis (DKA)

Background:

- Type 1 diabetes mellitus (T1DM) is one of the most common chronic diseases of childhood and is caused by insulin deficiency following autoimmune (85% of cases) destruction of the insulin-producing pancreatic beta cells.
- The age of presentation of T1DM is bimodal, with one peak at age 4-6 years of age and the second peak in early puberty (10-14 years of age).
- Diabetic ketoacidosis is the initial presentation for children with T1DM in approximately 35% of cases.
- Biochemical diagnosis of DKA:
 - Hyperglycemia (blood glucose >200 mg/dL) AND
 - Metabolic acidosis (venous pH <7.3 and/or plasma bicarbonate <15 mEq/L)

SEVERITY OF ILLNESS:	MILD:	MODERATE:	SEVERE:
Venous pH	7.2-7.3	7.1-7.2	<7.1
Serum bicarbonate (mEq/L)	10-15	5-10	<5

- Clinically significant cerebral edema occurs in ~1% of patients with DKA and has a mortality rate of ~25%.
 - Risk factors: New onset DKA, elevated BUN and serum creatinine, low bicarbonate.

Signs and Symptoms:

- Polydipsia, polyuria, polyphagia, weight loss, lethargy, fruity-smelling breath, age-inappropriate incontinence.
- Cerebral edema: Altered mental status, sustained heart rate decelerations, age-inappropriate incontinence, recurrent vomiting, headache, lethargy, abnormal neurologic respiratory pattern.

Evaluation:

- Physical exam: General appearance, hydration status, vital signs, respiratory pattern (hyperventilation and deep Kussmaul breathing are compensatory for metabolic acidosis), mental status, neurologic findings (may range from drowsiness to coma related to severity of acidosis and/or cerebral edema).
- Labs: Serum electrolytes and beta-hydroxybutyrate, VBG, urine for ketones.

Management:

- Consult Pediatric Critical Care.
- IVF and electrolyte management:
 - 10 mL/kg 0.9% NS IV bolus once over 1 hour; consider additional 10 mL/kg 0.9% NS if perfusion is compromised.
 - 0.9% NS at 1.5x maintenance rate (max 150 mL/hr).
 - Dextrose:
 - If blood sugar >300 mg/dL- no added dextrose.
 - If blood sugar <300 mg/dL- increase glucose infusion rate (GIR) targeting blood glucose of 150-250 mg/dL.
 - Either increase infusion rate by 25% (maximum of 2x maintenance or 200 mL/hr), or increase the dextrose concentration by 2.5-5% to maximum 12.5% via PIV); only decrease insulin infusion if hypoglycemia persists despite GIR adjustments.
 - Potassium:
 - If serum level is <5 mmol/L and no evidence of renal insufficiency/failure- add 40 mEq/L of potassium.
 - If serum level is >5 mmol/L- no supplemental potassium.

- Insulin: Start regular insulin at 0.1 units/kg/hr.
 - Do NOT bolus insulin prior to initiation of infusion.
- Sodium bicarbonate is NOT routinely indicated for metabolic acidosis.
- Check vital signs, neurologic status, and glucose levels hourly.
- For symptomatic hyponatremia (altered mental status, seizures): 3% hypertonic saline [2.5 mEq/kg/dose (~5 mL/kg/dose)] IV once over 20 minutes.
- CT evidence of cerebral edema is a late finding and should not delay treatment.
- Treatment of cerebral edema:
 - Decrease IVF infusion rate to 1x maintenance.
 - Mannitol (0.5-1 g/kg/dose) IV once given over 20 minutes [in-line filter set (≤ 5 micron) should always be used for mannitol concentrations $\geq 20\%$], **OR** 3% hypertonic saline [2.5 mEq/kg/dose (~5 mL/kg/dose)] IV once over 20 minutes.

2. Hypoglycemia

Background:

- Definition: Plasma glucose of ≤ 40 mg/dL.
- Hypoglycemia occurs when the rate of glucose utilization exceeds glucose production.
- Non-symptomatic (mild) hypoglycemia is acceptable in patients following a prescribed ketogenic diet.
- Etiologies:
 - Fasting or poor oral intake (especially in young children).
 - Hypermetabolic states: Sepsis, shock, burns, oncologic processes.
 - Disorders of carbohydrate, amino acid, and fatty acid metabolism.
 - Typically present during the first 2 years of life.
 - Increased utilization of glucose: Hyperinsulinemia, oral hypoglycemic.
 - Hormone deficiencies: Growth hormone and cortisol deficiency, hypothyroidism.
 - Ingestions: Oral hypoglycemic agents, ethanol, salicylates, beta blockers.

Signs and Symptoms:

- Tremor, irritability, feeding difficulty, sweating, weakness, lethargy, tachypnea, hypothermia, seizure, coma.

Evaluation:

- Physical exam: General appearance, neurologic and cardiopulmonary status.
- Labs:
 - Critical blood samples obtained before therapeutic intervention: Plasma glucose, free fatty acids, beta-hydroxybutyrate, lactate, total and free carnitine, acylcarnitines, plasma insulin, C-peptide, cortisol, growth hormone.
 - Consider complete metabolic panel, ammonia, salicylate, ethanol, sulfonyleurea, metabolic screening, urine ketones and reducing substances.
- Consider sepsis evaluation (CBC, CRP, UA, blood and urine cultures) if febrile.

Management:

- For patients with intact neurologic status:
 - Rapidly-absorbed carbohydrate (0.3 g/kg; max dose 20g).
- For patients with altered mental status or refractory hypoglycemia to above intervention:
 - Dextrose [0.25 g/kg/dose (2.5 mL/kg/dose of 10% dextrose solution)] IV bolus at rate of not to exceed 3 mL/min.
 - D5 0.9% NS at 1x maintenance (increase to D10 0.9% NS if hypoglycemia persists).
- For patients with altered mental status and inability to obtain IV access:
 - Glucagon (0.03 mg/kg/dose; max 1 mg/dose) IM/SC once.
- Serum glucose should be monitored every 30 to 60 minutes, and dextrose infusions adjusted as needed to maintain euglycemia.

- For patients with fever or appear toxic:
 - Consider antibiotics (see Sepsis & Septic Shock section in Infectious Emergencies).

3. Hyperglycemia

Background:

- Definition: Blood glucose >125 mg/dL or plasma glucose >150 mg/dL.
- Pathogenesis: Relative or absolute insulin deficiency and an increase in counterregulatory hormones (glucagon, catecholamines, cortisol, growth hormone).
- Risk factors: Serious infections, sepsis, trauma, stress, obesity, cystic fibrosis, Cushing's syndrome, pheochromocytoma, medications (glucocorticoids, cyclosporine, beta-blockers, oral contraceptives).
- Diabetic Ketoacidosis (DKA) and hyperosmolar hyperglycemic state (HHS; also called nonketotic hyperglycemia) are the two most serious acute complications of hyperglycemia.

Signs and Symptoms:

- Dehydration (osmotic diuresis caused by glucosuria), tachypnea (when ketoacidosis is present), altered mental status, lethargy, weakness, seizure, coma.

Evaluation:

- Physical exam: General appearance, volume status, neurologic and cardiopulmonary status.
- Labs: Basic metabolic panel; consider VBG, hemoglobin A1C.
- For patients with fever or toxic appearance: CBC and blood culture.
- For patients with altered mental status: Consider head CT.

Management:

- Asymptomatic or mild to moderate hyperglycemia (glucose <200 mg/dL):
 - Repeat plasma glucose.
 - For suspected bacterial infection: See Sepsis and Septic Shock section in Infectious Emergencies.
 - Obtain fasting plasma glucose to evaluate for diabetes mellitus.
- Symptomatic (ketoacidosis) or severe hyperglycemia (glucose >200 mg/dL):
 - Consult a Pediatric Endocrinologist.
 - For suspected bacterial infection: See Sepsis and Septic Shock section in Infectious Emergencies.
 - See Diabetic Ketoacidosis section in Endocrine Emergencies.