Diabetic Ketoacidosis

Amber Schilling, PharmD

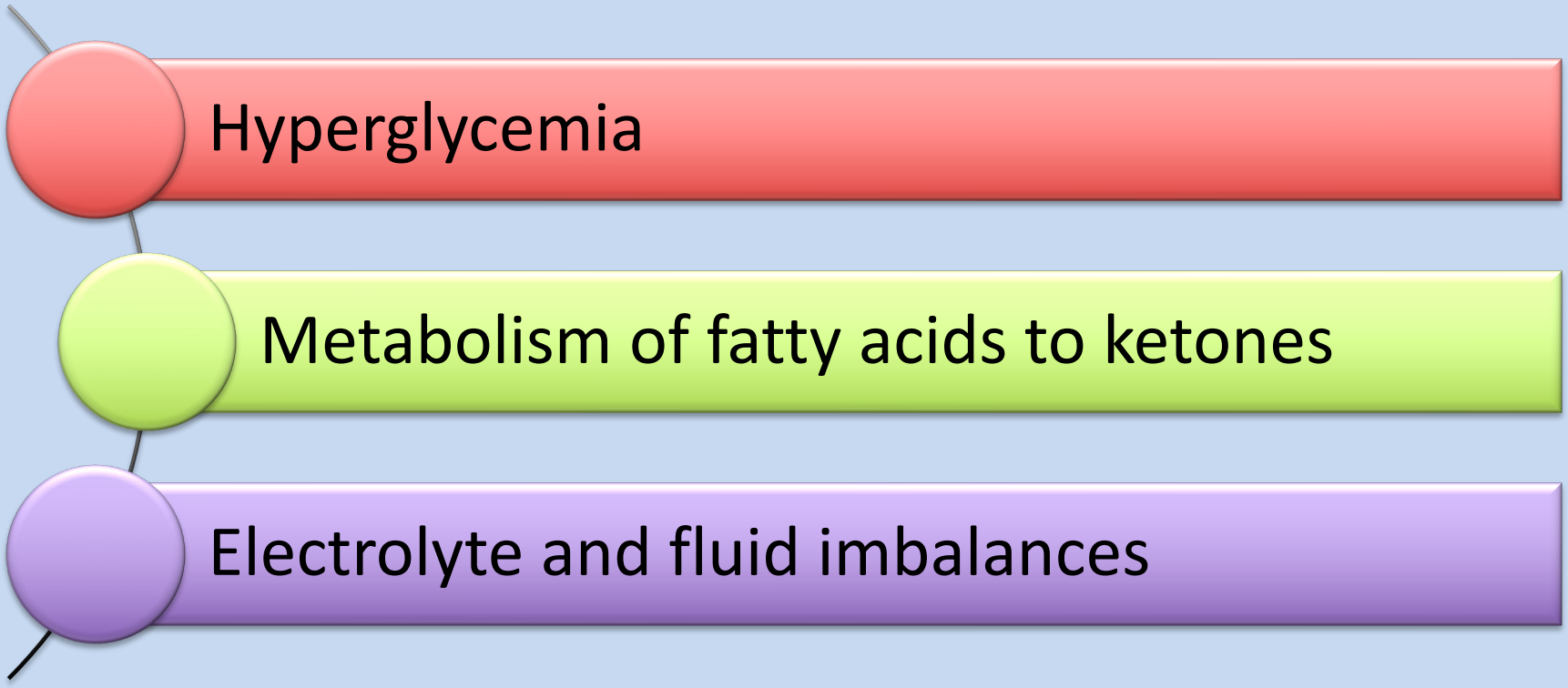
July 29, 20XX

Objectives

- Describe the clinical presentation and pathophysiology of diabetic ketoacidosis (DKA).
- List the treatment recommendations for a pediatric patient in DKA.

Definition[1,2]

- DKA is serious metabolic complication of diabetes characterized by:



DKA, diabetic ketoacidosis

Precipitating Factors

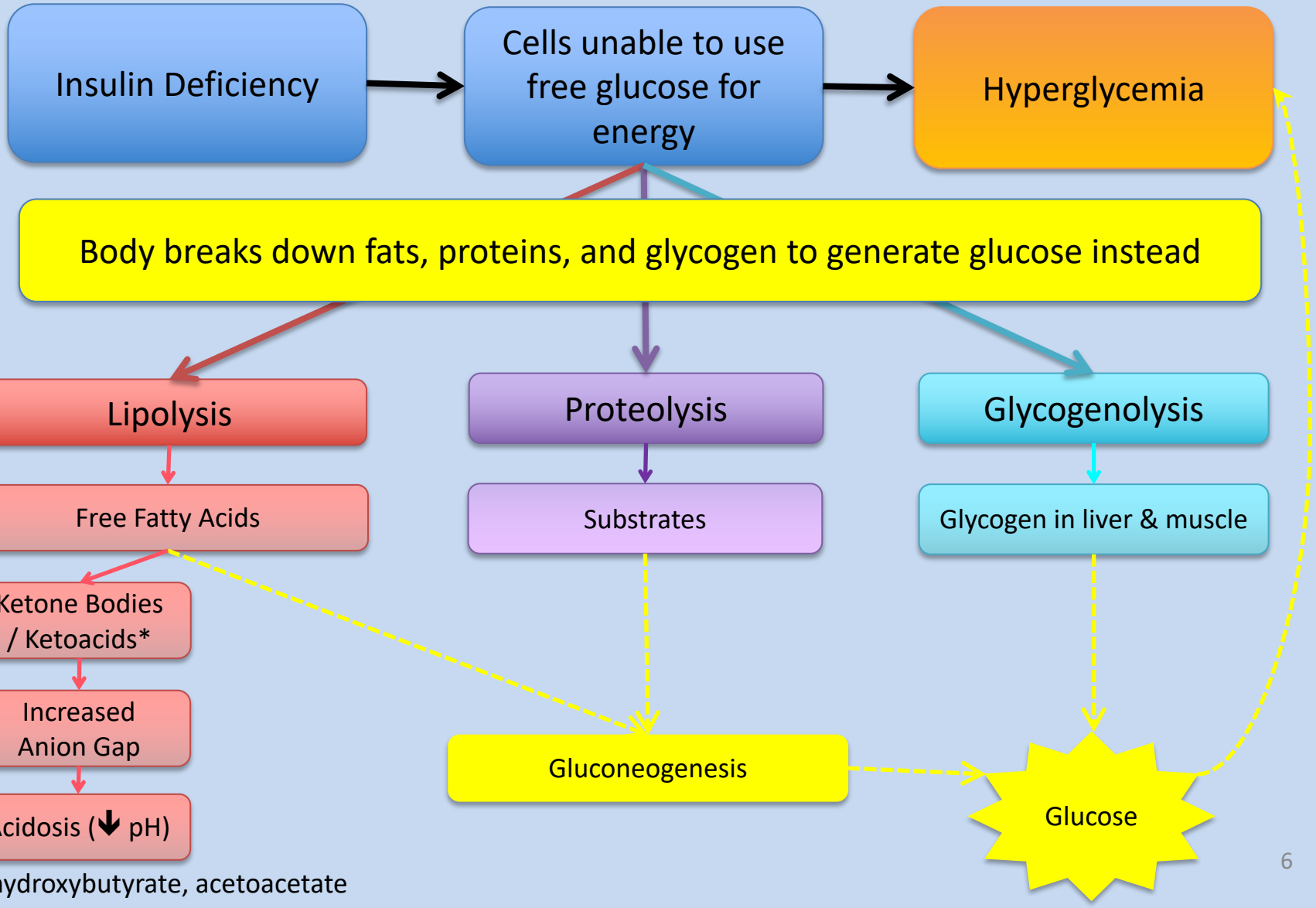
- Infection (most common)
- Inadequate insulin therapy
- New-onset Diabetes Type 1
- Pancreatitis
- Eating disorders
- Certain Medications

Epidemiology

- Prevalence
  - DKA is the most common cause of death in children and adolescents with Type I Diabetes.[1]
  - Cerebral Edema (complication of treating DKA) occurs in up to 1% of DKA episodes in children[1]
    - Mortality rate: 20-40%
    - Accounts for 57-87% of DKA deaths in children

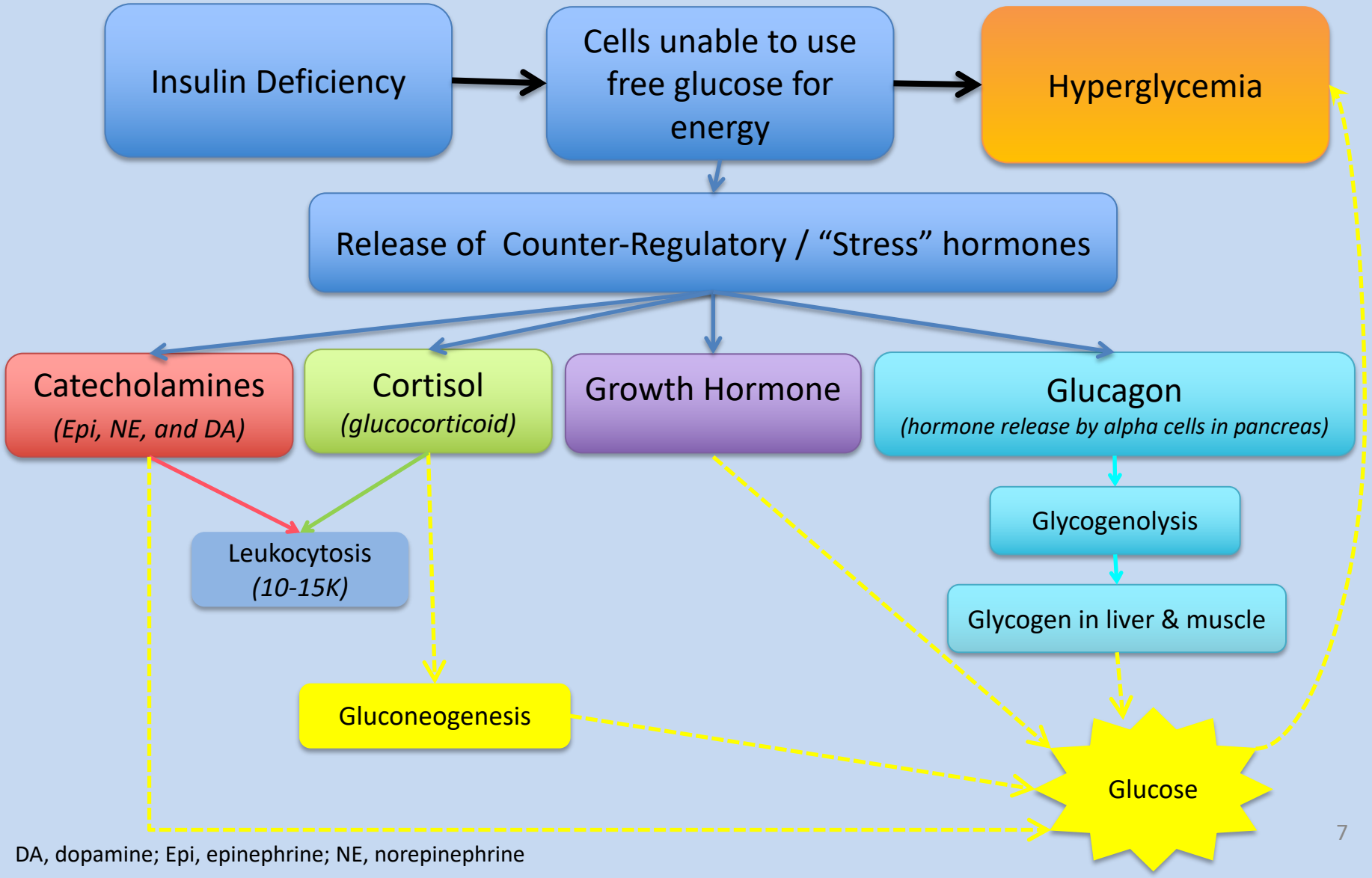
DKA, diabetic ketoacidosis

Pathophysiology[1]



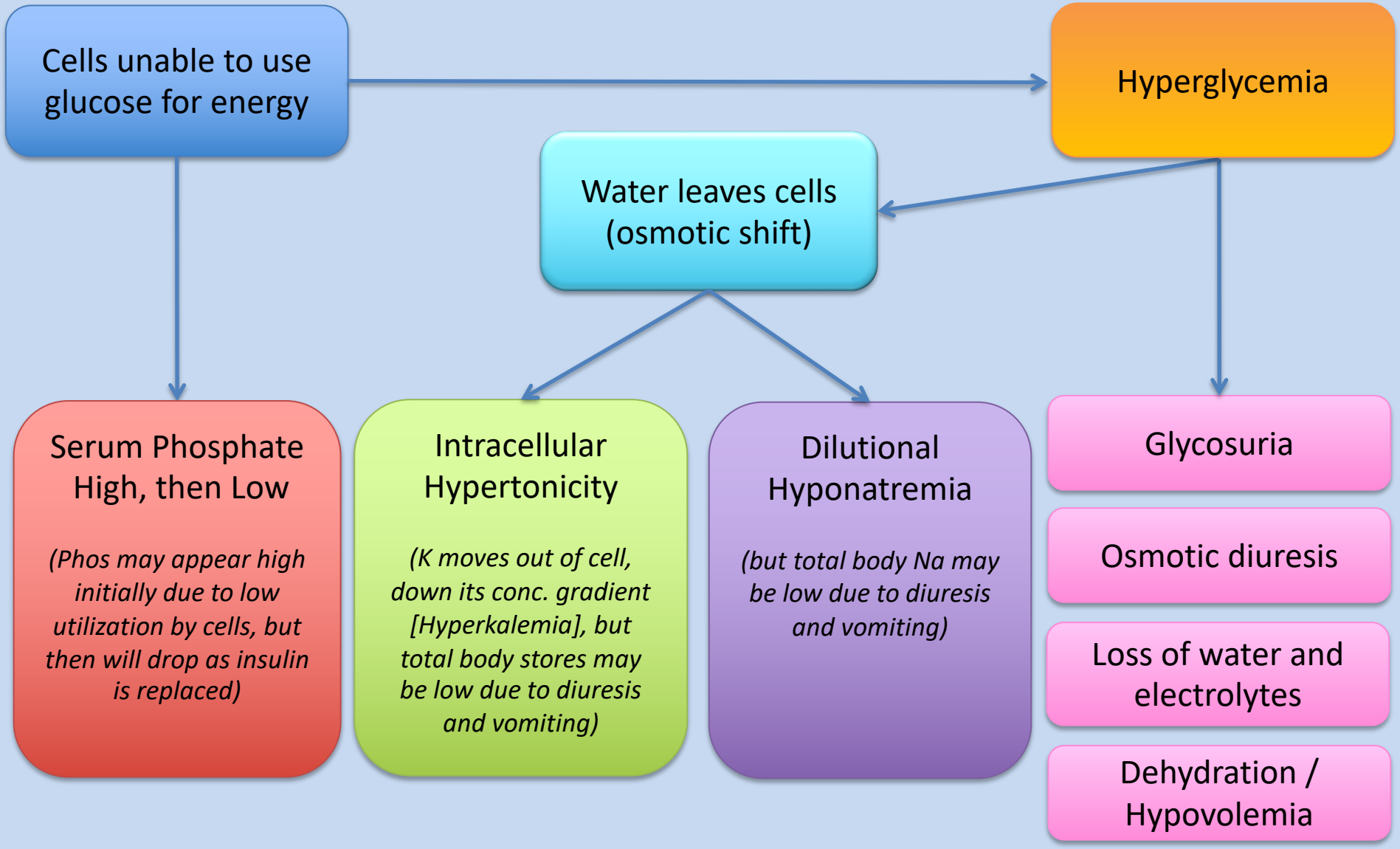
*beta-hydroxybutyrate, acetoacetate

Pathophysiology[1]



DA, dopamine; Epi, epinephrine; NE, norepinephrine

Pathophysiology[1]



Pathophysiology[1]

- The metabolic derangements in DKA can also be accompanied by:
  - Severe inflammatory state (↑CRP, ROS, etc.)
  - Hypercoagulable state
    - Thrombosis

CRP, C-reactive protein; DKA, diabetic ketoacidosis; ROS, reactive oxygen species

Clinical Presentation[1]

- Evolves in <24h
- Polyuria
- Polydipsia
- Weight loss
- Nausea
- Vomiting
- Dehydration
- Weakness
- Mental status changes
- Diffuse abdominal pain
- Poor skin turgor
- Kussmaul respirations
- Fruity breath 2/2 exhaled acetone
- Tachycardia
- Hypotension
- Leukocytosis (10-15K)

Diagnosis[1]

- Diagnostic Criteria from ADA Guidelines (2009)[1]

Lab Value	DKA
Plasma glucose (mg/dL)	≥ 250 Magnitude of value is "independent of the severity" of DKA
Arterial pH	≤ 7.3
Serum HCO3- (mEq/L)	≤ 15
Urine Ketones	+
Serum Ketones*	+ "Key diagnostic feature in DKA"[1] Beta-hydroxybutyrate level is also useful for diagnosis
Anion Gap	>10

*Nitroprusside test estimates acetoacetate and acetone levels, but not beta-hydroxybutyrate (the main metabolic product in ketoacidosis). Thus, serum ketone value can underestimate severity of ketoacidosis

Treatment Goals & Pharmacological Therapies[1]

Treatment Goal	Pharmacological Therapy Recommended
Correct dehydration from osmotic diuresis	IV Fluid Resuscitation
Correct hyperglycemia and insulin deficiency	Insulin REGULAR continuous infusion
Correct electrolyte imbalances	K Supplementation Phos Supplementation
Prevent Cerebral Edema	PRN mannitol infusion ready at bedside

Pharmacological Therapy[1]

- IV Fluid Resuscitation
  - 10-20 mL/kg 0.9% NaCl over 1-2 hr[4]
  - Repeat if necessary[3,4]

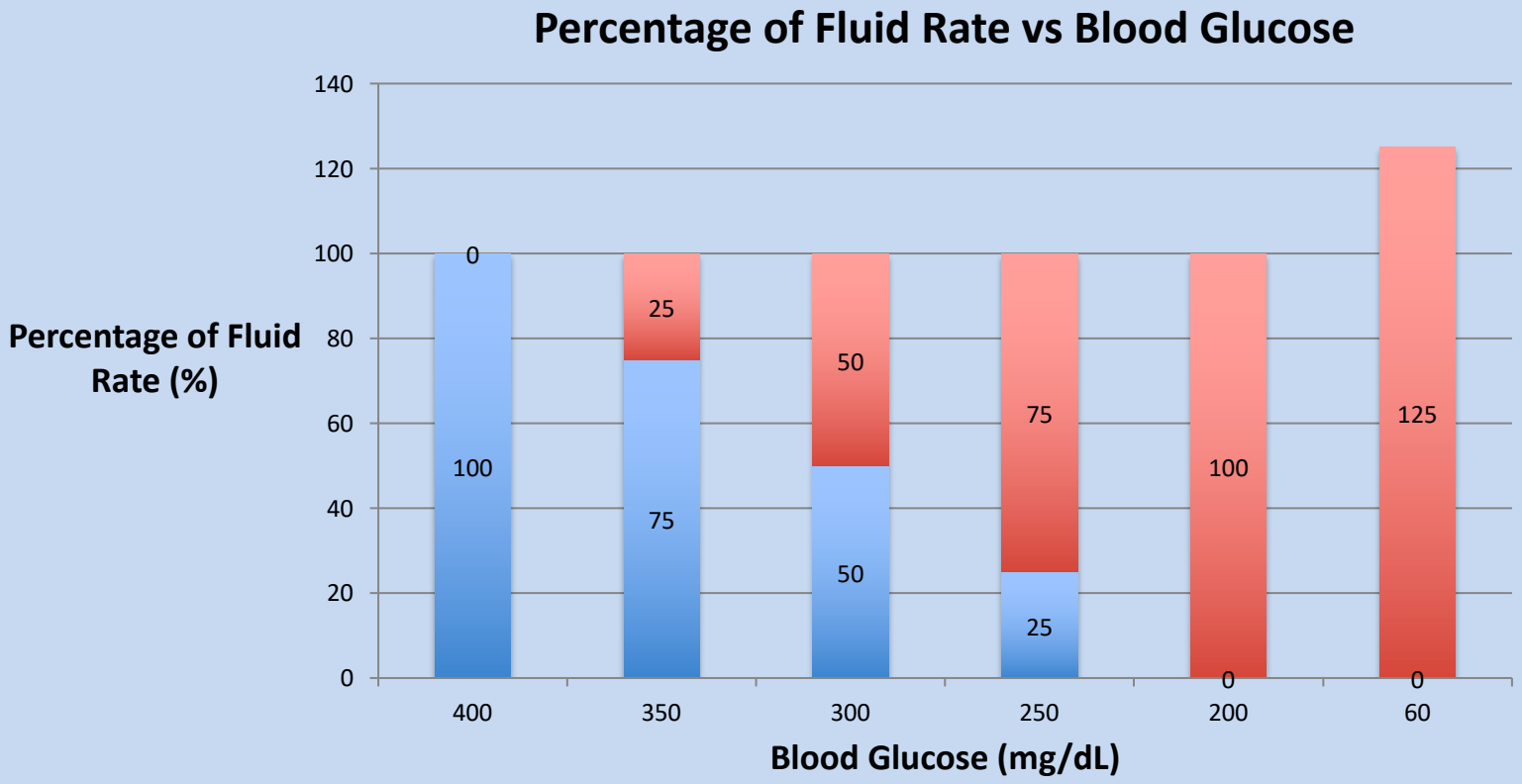
- Subsequent Fluid Management
  - Incomplete agreement in the literature[4,5,6]
  - 1.5-2x maintenance[5]
  - Continue until acidosis resolved, urine ketones clear
  - Fluid type:
    - NS or ½NS based on corrected Na (or ¾ NS[6])
    - Add dextrose to avoid hypoglycemia and cerebral edema

Corrected Na = (Na) + 1.6[(glucose-100)/100]

2-Bag System[3]

No Dex Bag
- NS
- KCl 15-30 mEq/L
- KPhos 15-30 mEq/L

Dex Bag
- D10
- ½ NS
- KCl 15-30 mEq/L
- KPhos 15-30 mEq/L



Pharmacological Therapy[1]

- Insulin
  - Regular Insulin continuous infusion
    - 0.05 unit/kg/hr[3,6]
    - Give until the DKA is resolved
      - Note: Hyperglycemia will correct faster than ketoacidosis
      - (6 hr, 12 hr)
  - When starting patient on home SQ insulin, allow overlap of 1-2 hours

Pharmacological Therapy[1]

- K
  - Hyperkalemia should correct w/ insulin and volume expansion
  - However, total body stores are likely low
  - Add K to IV fluids to prevent hypokalemia
    - Keep serum K between 4-5 mEq/L
    - Add 20-30 mEq / L to IV fluids
    - Do not add if K>5.5 and / or pt is not urinating[3]

Pharmacological Therapy[1]

- Phos
  - Phos will be pulled back into cells when insulin allows cells to utilize glucose
  - Add Phos to IV fluids as necessary to prevent hypophosphatemia
    - Add 20-30 mEq/L IV fluids (use K Phos)

Pharmacological Therapy[1]

- Cerebral Edema
  - Prevention: Decrease serum glucose gradually
    - Duke's 2-bag system
  - Treatment: Mannitol infusion, prn, ready at bedside
    - 0.5-1 g/kg IV, over 10 mins

Monitoring[1]

Q2hr until stable:

- Hemodynamics / Hydration Status
- Electrolytes
- Venous pH
- Urinary output
- SCr
- BUN
- BG

s/s of cerebral edema

- Highest risk in the 1st 8-12 hrs
- Sudden, severe headache
- ↓ consciousness
- HTN
- Bradycardia
- Seizures
- Pupillary changes
- Papilledema
- Respiratory arrest

Monitoring[1]

- Resolution of DKA defined as:
  - BG <200
  - PLUS 2 of the following:
    - Bicarb ≥ 15
    - pH, venous > 7.3
    - AG ≤ 12

References

1. Kitabchi AE, Umpierrez GE, Miles JM, Fisher FN. Hyperglycemic crises in adult patients with diabetes. *Diabetes Care.* 2009; 32:1355-43.
2. Broderick K, ed. Duke Internal Medicine Survival Guide, 2013.
3. Duke Pediatric Medicine Survival Guide.
4. Glasser NS, Ghetti S, Caspter TC, et al. Pediatric diabetic ketoacidosis, fluid therapy, and cerebral injury. *Pediatric Diabetes.* 2013; 14:435-446.
5. Wolfsdorf J, Glaser N, Sperling MA. Diabetic ketoacidosis in infants, children, and adolescents: a consensus statement from the ADA. *Diabetes Care*. 2006; 29(5): 1150-59.
6. Wolfsdorf J. The International Society of Pediatric and Adolescent Diabetes guidelines for management of diabetic ketoacidosis: do the guidelines need to be modified? *Pediatric Diabetes*. 2014; 15:277-286.

Diabetic Ketoacidosis

Amber Schilling, PharmD

July 29, 20XX