



When too sweet is not so good: Pediatric Diabetic Ketoacidosis

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Goals & Objectives

- Review the pathophysiology of diabetes
- Understand the mechanism and treatment of Pediatric Diabetic Ketoacidosis

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- **MISSION:** To prevent and cure diabetes and to improve the lives of all people affected by diabetes

1-800-DIABETES

- November is **NATIONAL** Diabetes month.
- November 14 is **INTERNATIONAL** Diabetes Day

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What is diabetes?



- Diabetes is a disorder of glucose metabolism
- Occurs when the normal response to elevated blood sugar in the body is no longer adequate to control glucose levels
- Occurs when there is a lack of or insensitivity to insulin in the body

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Simplification of Diabetes



- Insulin production problem
- Insulin response problem

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Statistics



- 2006
- Prevalence among pediatrics – 0.18%
- 6,379 youth
- Among young children, Type I diabetes accounted for >80% of diabetes
- About 164, 369 youth diagnosed with diabetes

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Why do we care?



- Incidence of diabetes in the pediatric population:
 - 193,000 Americans under the age of 20 have been diagnosed with Diabetes
 - 0.24% of that population
 - 2011-2012 annual incidence of diagnosed diabetes in youth
 - 17,900 – Type I Diabetes
 - 5,300 – Type II Diabetes

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Risk Factor for Diabetes in Children



- Genetics
- Environments
- Obesity
- Lack of Exercise

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Deaths



- 7th leading cause of death in the United States in 2015 based on the 79,535 death certificates in which diabetes was listed as the underlying cause of death.
- In 2015, diabetes was mentioned as a cause of death in a total of 252,806 certificates.
- Diabetes may be underreported as a cause of death. Studies have found that only about 35% to 40% of people with diabetes who died had diabetes listed anywhere on the death certificate and about 10% to 15% had it listed as the underlying cause of death

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Cost of diabetes



- \$245 billion: Total costs of diagnosed diabetes in the United States in 2012
- \$176 billion for direct medical costs
- \$69 billion in reduced productivity
- After adjusting for population age and sex differences, average medical expenditures among people with diagnosed diabetes were 2.3 times higher than what expenditures would be in the absence of diabetes.

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Costs..



- Average price of Insulin nearly tripled from 2002-2013
- Total cost of diabetes/prediabetes in the US:
\$ 322 billion
- African Americans and Hispanics are over 50% more likely than non-Hispanic whites to have diabetes
- Health care costs for those with Diabetes is 2.3x greater than those without

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- Center for Disease Control puts out a periodic report
- The National Diabetes Statistics Report
- Data collected from
 - Agency for Healthcare Research and Quality
 - US Census Bureau
 - India Health Services
 - Published studies

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- Most common call ins to EMS dispatcher
 - Hypoglycemia episode
 - Hyperglycemic episode
 - Illness related to chronic complications of diabetes
 - Chief complaints where diabetes can mask symptoms (chest pain, neurological symptoms)

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Signs and Symptoms



- Frequent urination including nocturnal enuresis
- Polyuria
- Polydipsia
- Polyphagia
- Fatigue
- Blurry Vision
- Poor wound healing
- Weight loss
- Nausea
- Rapid breathing
- Fruity odor to breath

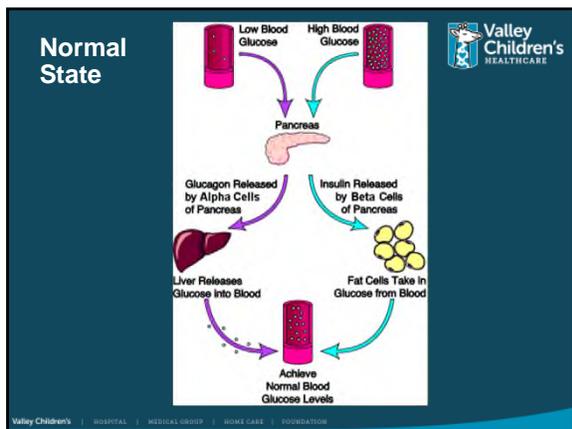
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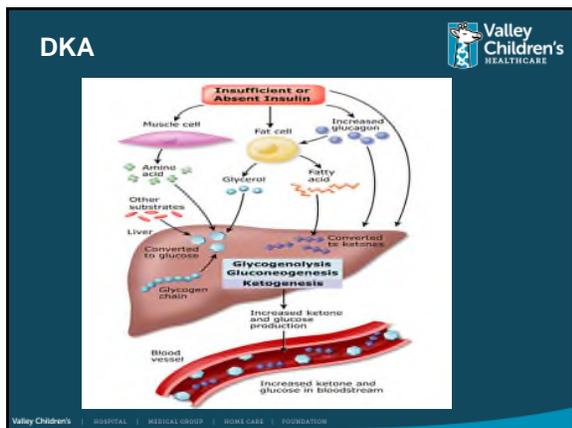
Ketoacidosis

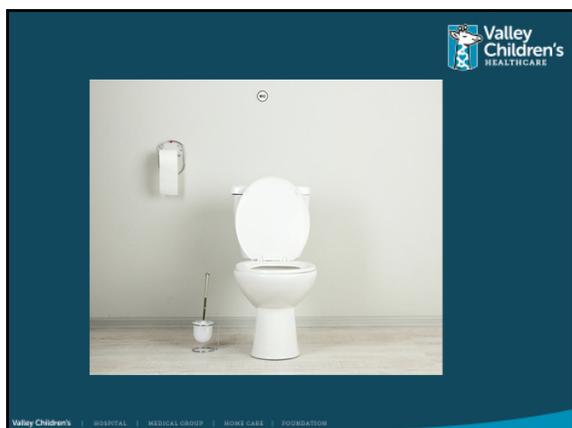


- Ketones – are made in the body when the body breaks down fat for energy
- When you have excess ketones in the body –this is known as **ketosis**
- DKA is ketosis in a diabetic – excessive ketones in the body, now affecting the blood sugar and increased acidity of the blood

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Risk Factors for DKA



- Poor diabetes control
- Inter-current illness
- Missed insulin
- Insulin pump failure
- Eating disorders
- Young Children

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HISTORY...HISTORY...HISTORY

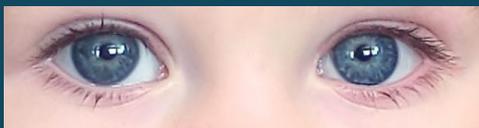


- Talking to the family is SO important
- Key questions in regards to urination/drinking/weight loss
- Family history of diabetes
- Any recent illnesses?

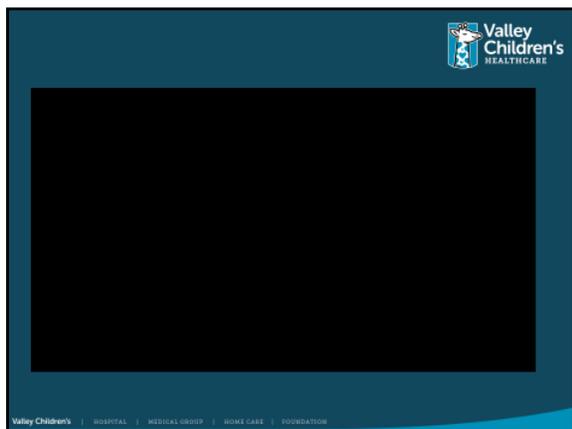
- Last dose of medication? Last time alcohol was consumed?
- Last time patient ate?
- Last blood glucose? Ketones in urine?
- Recent illnesses?

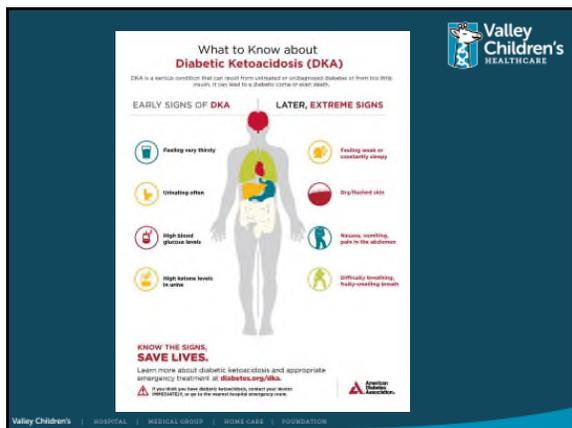
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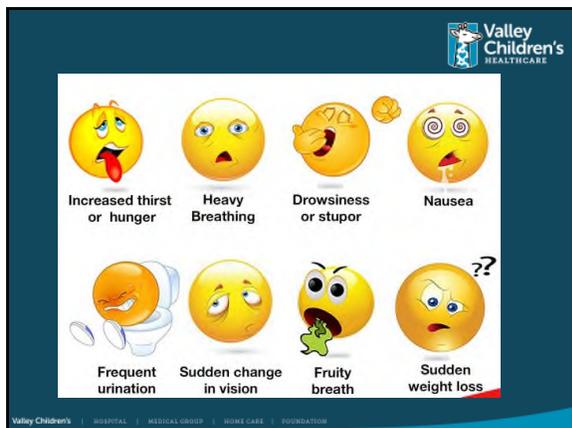
Before you even touch the patient....



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Initial management



- Blood glucose
- IV fluids – NS
 - Typically start with 20ml/kg UP TO a MAX of 1000ml

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Upon arrival to the hospital



- Repeat blood glucose
- Venous blood gas
- Urine for ketones/glucose
- Basic chemistries
 - Electrolytes/BUN/Cr/Mag/Phos/Ca
- Other Lab work
 - CBC
 - Osmolality
 - Serum beta-hydroxybutyrate
 - Hemoglobin A1C
 - Lipase & Amylase

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Blood Gas



- Blood gas can be either ABG or VBG
- Components:
 - pH: indicates if acidotic/alkalotic
 - PO2: amount of oxygen dissolved in the blood
 - PCO2: amount of carbon dioxide dissolved in the blood
 - HCO3: amount of bicarbonate in the blood

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Adjunct Testing



- New onset diabetics
 - Antibody levels
 - Thyroid function
 - Anti-insulin abs
- Known diabetic
 - Search for the trigger...
 - Underlying illness (chest xray, head CT, etc)

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Treatment of DKA GOALS



- Correct dehydration
- Correct acidosis
- Reverse ketosis
- Restore normal blood glucose levels
- Avoid complications

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Tools in treatment



- Venous access
 - Typically 2 large bore peripherally IVs
- Bedside glucose/chemistry machine
- IVF's
 - With and without electrolytes
- Insulin

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Treatment cautions



- Fluid OVERLOAD is bad
- Insulin BOLUS is bad
- Be cautious of false elevations in electrolyte derangements

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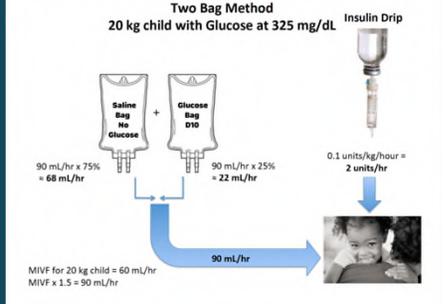
Insulin



- Insulin is NOT bolused in DKA
- Insulin is run as continuous infusion : typically 0.1U/kg/hr
- Why insulin:
 - Turns off production of ketones
 - Decreases blood glucose

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Two Bag Method 20 kg child with Glucose at 325 mg/dL



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- When to transition from insulin drip to subcutaneous insulin
- Stable and normal glucose
- Bicarbonate ≥ 15 mmol/L
- Patient can tolerate food

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Common traps

- Pseudohyponatremia
 - For every 100mg/dL of glucose above 100, there is a 1.6mEq fall in the serum sodium
 - Therefore, a normal serum sodium would indicate significant dehydration
- Bicarb IS NOT NEEDED for acidemia
 - Rarely indicated
 - Complications include Cerebral Edema/Cerebral Acidosis
- Decreasing IV insulin
 - You should be increasing the dextrose containing fluids instead

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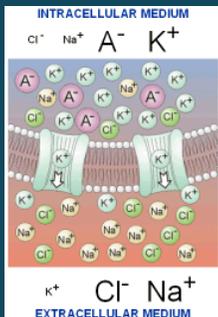
- Giving an Insulin BOLUS
 - Results in more episodes of hypoglycemia
 - Slow recovery of DKA
- Under-reacting to Hyper/Normo - kalemia
 - **Total body potassium can be severely depleted but extracellular potassium levels can be falsely reassuring as acidosis leads to shift of potassium out of cells.** Regardless, hypokalemia is a critical cause of morbidity and mortality and should be immediately addressed.

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Potassium administration



- Relative depletion of potassium in DKA!
- Predominantly intracellular cation



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Composition of body fluids



Extracellular fluid (plasma)		Intracellular fluid	
Na ⁺	142 mmol/L	Na ⁺	10 mmol/L
K ⁺	4 mmol/L	K ⁺	160 mmol/L
Ca ²⁺	2 mmol/L	Ca ²⁺	<0.01 mmol/L
Mg ²⁺	1 mmol/L	Mg ²⁺	13 mmol/L
Cl ⁻	105 mmol/L	Cl ⁻	3 mmol/L
HCO ₃ ⁻	27 mmol/L	HCO ₃ ⁻	10 mmol/L
Phosphates	1 mmol/L	Phosphates	100 mmol/L
Protein	70 g/L	Protein	200 g/L
Osmolality	290 mosmol/L	Osmolality	290 mosmol/L

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Hypo/Hyper- kalemia

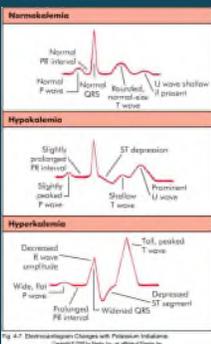


Fig. 8-7. Electrocardiogram Changes with Potassium Imbalance. (Reprinted with permission from UpToDate.com)

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Cerebral Edema



- Can occur between 4-12 hours after initiation of therapy
- Occurs in 0.3-1% of those children in DKA

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Risk factors for Cerebral Edema



- Rapid correction of hyperglycemia
 - Goal is to correct <100mg/dL of glucose per hour
 - Sodium bicarbonate administration
 - Younger age
 - Sicker patients
 - Fluid overload

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Presenting signs/symptoms



- Change in vital signs
 - Hypertension/hypotension
 - Tachycardia/bradycardia
 - Erratic respirations
 - Pupillary changes

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Treatment of Cerebral Edema



- Reduce rate of IVF administration
- Elevate head of bed at least 30 degrees
- Administer mannitol

- May need to intubate for impending respiratory failure
- CT scan

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Normal Brain



Cerebral Edema



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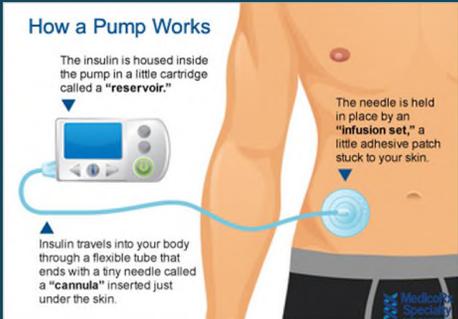


How a Pump Works

The insulin is housed inside the pump in a little cartridge called a "reservoir."

Insulin travels into your body through a flexible tube that ends with a tiny needle called a "cannula" inserted just under the skin.

The needle is held in place by an "infusion set," a little adhesive patch stuck to your skin.



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Type of Insulin	Appearance	Action times after injection (in hours)
Rapid-acting • Lispro (Humalog) • Glulisine (Apidra) • Aspart (NovoRapid)	Clear 	 <p>Onset: 10 to 15 mins Peak: 1 to 2 hours Duration: 3 to 5 hours</p>
Intermediate-acting • NPH (Humulin-N, Novolin-NPH)	Cloudy 	 <p>Onset: 1 to 3 hours Peak: 5 to 8 hours Duration: up to 18 hours</p>
Slow or long-acting • Glargine (Lantus) • Detemir (Levemir)	Clear 	 <p>Onset: 90 mins Peak: None Duration: up to 24 hours</p>

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Quick Review Quiz

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- Every patient with altered mental status should have a blood glucose checked
- A. True
- B. False

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- You are called to a home to assess a young child who is not acting right. You immediately notice that the child is breathing hard and fast. His breath smells fruity. He is arousable but seems tired.
- After your ABCs, what is the next step in management?
- A. Establish IV access
- B. Check a blood glucose
- C. Transport immediately
- D. Give him a sternal rub

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- The components of DKA may include:
- A. hyperglycemia
- B. acidosis
- C. altered mental status
- D. all of the above

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- The goal in the first hour of treatment in a patient with DKA is:
 - A. Maintain euglycemia as quickly as possible
 - B. Volume resuscitate
 - C. Start an Insulin drip
 - D. Restore normal blood potassium concentrations

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- Signs of dehydration may include the following
 - A. Altered mental status
 - B. Prolonged capillary refill
 - C. Dry mucous membranes
 - D. All of the above

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- Consideration of transitioning to subcutaneous insulin should occur when:
 - A. The child has a normal mental status
 - B. The child blood glucose is below 300
 - C. The child has cleared all ketones from the urine
 - D. The child's blood pH is 7.10 or greater

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- You are currently managing a young child that presented with DKA. You have started an insulin drip and the 2 bag system to restore electrolyte imbalance. The nurse calls you to the bedside stating the child has stopped responding "normally to her." What steps should you consider?
- A. Check a blood gas
- B. Obtain a Head CT
- C. Administer Mannitol
- D. Elevate the head of the bed

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References



- Available upon request

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