

The Hospitalized Child with Diabetes/Hyperglycemia: Don't Sugar Coat It

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Disclosures

"I have no relevant financial relationships to disclose."

Objectives

- Why is this important
- Who is affected
- The role of the hospitalist
- Cases of hyperglycemia/diabetes

More Patients, More Need, More Knowledge

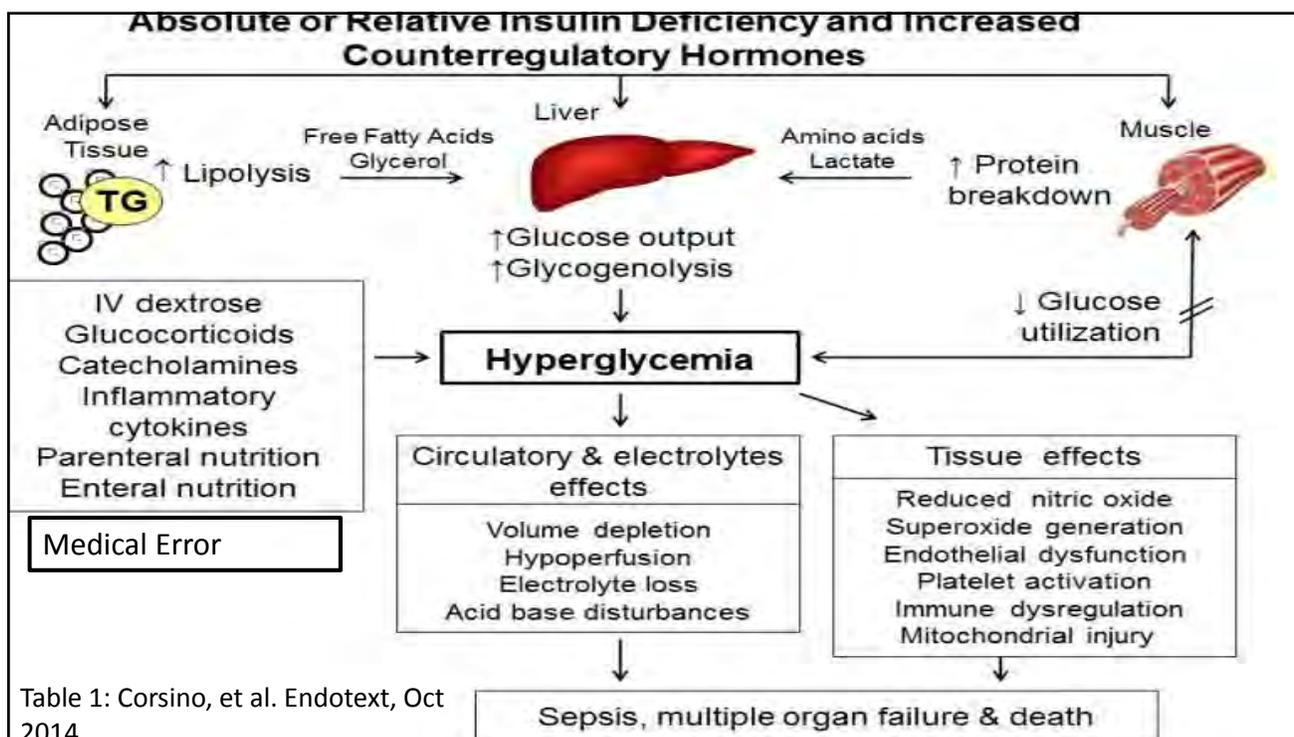
- Type 1 diabetes incidence increased by 1.8% (2002-2012) in children
- Type 2 diabetes incidence increased by 4.8% annually (2002-2012) in children
- Patients with diabetes have a 3-fold greater chance of hospitalization compared to those without

Mayer-Davis EJ, et al. NEJM, April 2017
Corsino, et al. Endotext, Oct 2014

Hyperglycemia in the Hospital

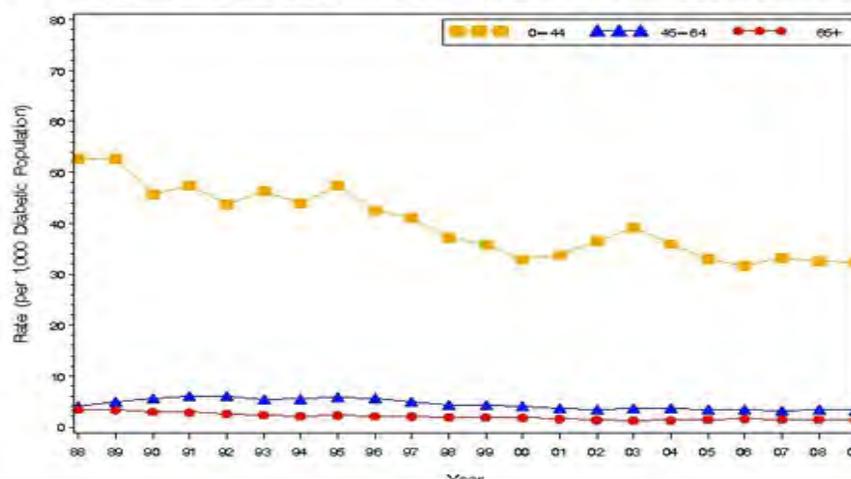
- Increased complications/mortality
- Longer hospital stay
- Higher admission to the ICU

Mabrey M, et al. Hosp Pract, 1995



Hospital Discharge Rates for Diabetic Ketoacidosis (DKA) as First-Listed Diagnosis per 1,000 Diabetic Population, by Age, United States 1988-2009

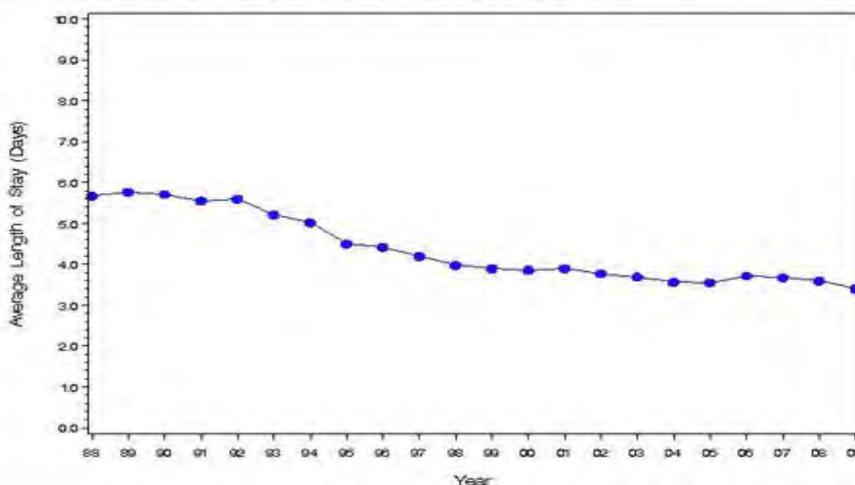
In all three age groups, the hospital discharge rates for DKA as the first-listed diagnosis per 1,000 diabetic population were lower in 2009 than in 1988. From 1988 to 2009, rates of DKA per 1,000 diabetes population were much higher among people younger than 45 years than among people aged 45 or older. In 2009, the rate per 1,000 diabetic population was 32.4 among people younger than 45 years, 3.3 among people aged 45–64 years, and 1.4 among people aged 65 years or older.



<https://www.cdc.gov/diabetes/statistics/dkafirst/fig4.htm>

Average Length of Stay (LOS) in Days of Hospital Discharges with Diabetic Ketoacidosis (DKA) as First-Listed Diagnosis, United States, 1988-2009

From 1988 to 2009, the average LOS of hospital discharges with DKA as the first-listed diagnosis decreased by 2.3 days (from 5.7 to 3.4 days). The detailed tables show that the average LOS decreased among all age and race-sex groups examined.



<https://www.cdc.gov/diabetes/statistics/dkafirst/fig2.htm>

Cost of Diabetes in America

- Total estimated annual cost of diagnosed diabetes in 2012 \$245 billion
 - 41% increase from 2007
- Contributors
 - **Hospital inpatient care (43%)
 - Prescription medications to treat complications
 - Anti-diabetic agents and diabetes supplies
 - Office visits

Diabetes Care, Mar 2013

Comparison

- Cost of asthma in US
 - \$56 billion in 2007
 - Hospital costs are the biggest contributor
- Cost of Autism Spectrum Disorders in US
 - \$11.5 billion - \$60.9 billion per year
- Cost of constipation in US
 - \$235 million per year (55% from inpatient, 23% from ED, 22% from outpatient)

Asthma and allergy foundation of America; CDC;
American Gastroenterology Association

Cost of Diabetes: New Onset

- 15% of newly diagnosed patients with Type 1 Diabetes require fluids and immediate insulin treatment
- Education inpatient vs outpatient
 - No effects on metabolic outcome
 - Increased costs with inpatient education

Jasinski C, et al. BMC Pediatrics, 2013

Cost of Pediatric DKA

- Retrospective cohort 2-18 years, 38 children's hospitals, 2004-2009 (PHIS)
- 20.3% of the DKA admissions were readmissions in 1 year
- Cost mean \$7142 (\$4125-\$11, 916)

Tieder JS, et al. Pediatrics, August 2013

Reducing Costs

- Prevent the disease
- Prevent the complications
- Prevent the readmission
- Decrease ICU admission
- Decrease LOS

Whose Job is it?

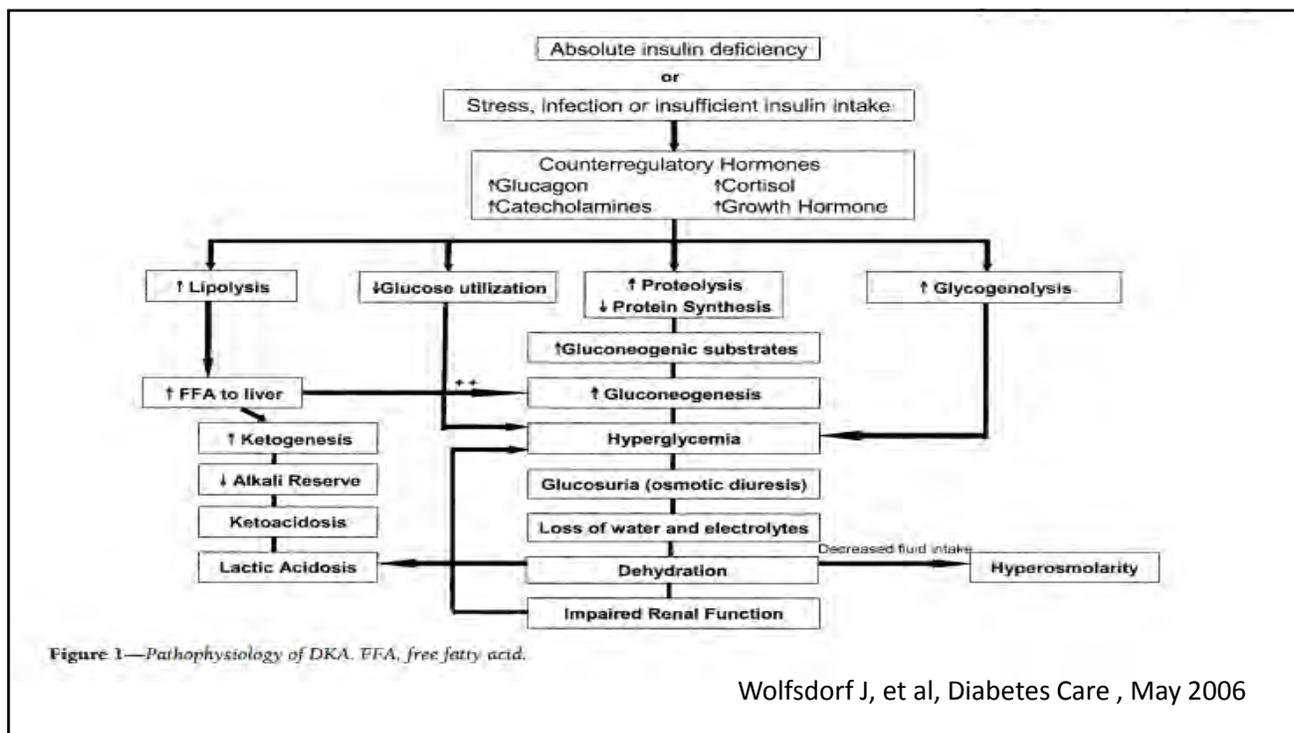
- Keeping kids out of the hospital-parents, kid, school nurse, teacher, endocrinologist, pediatrician
- Keeping kids from returning to hospital-parents, kid, school nurse, teacher, endocrinologist, *nursing staff, *pediatrician-hospitalist

Case 1

- EB is a 13 yo female who presents to the ER with weight loss, polyuria, polydipsia.
- Her exam shows:
 - Vitals: tachycardia, tachypnea
 - Neuro: sleepiness but answers appropriately
 - Mouth: dry mucus membranes
 - Resp: rapid/deep respirations, but clear
- Initial Labs:
 - pH 7.23 pCO₂ 22 PO₂ 65 HCO₃Ca 9.2
 - Na 133 K 3.4 CO₂ 13 Cr 1.10 Glucose 565

Case 1

- What does she have?
 - New Onset Type 1 Diabetes
 - What other labs are important?
 - What should be done next?
 - What should you monitor for closely?



Recognizing DKA

- Younger children
 - Not the classic history
 - Misdiagnoses of pneumonia, RAD, bronchiolitis
 - Kusmaul respirations
- Labs
 - Bicarbonate <15 mmol/L
 - pH <7.25

Cerebral Edema

- Present in 0.5-1% of all episodes of DKA in children
- Most common cause of mortality in children (60-90% of DKA deaths)
 - Once present death occurs in 20-25%
 - Morbidity 10-25%

Treatment: Protocols may vary

- Initial fluid bolus of Normal Saline 10-20 mL/kg over 1-2 hours
 - If in an outside ER, can run this in transport
 - Do not recommend an initial insulin bolus
- IV insulin drip of 0.1 u/kg/hr
 - Protocols may vary if basal insulin already given
- Laboratory monitoring usually every 2-4 hours for serum
 - POC glucose is every hour

Insulin: Appropriate Dosing

- Case of the 3-year-old with new onset Type 1 Diabetes
- Typical starting dose of insulin:
 - 0.5 u/kg/day=TDD
 - Younger 0.3 u/kg/day
 - Pubertal 0.7-0.8 u/kg/day
 - 50% Glargine (long acting insulin: Lantus, Basaglar)
 - Carbohydrate Ratio 500/TDD (Insulin aspart/lispro)
 - Correction factor 1800/TDD

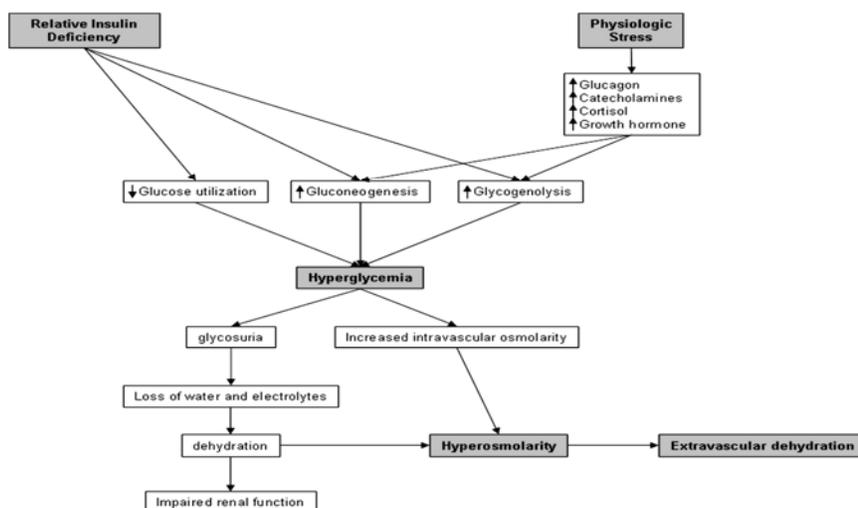
Case 2

- AS is an 8 yo male seen at PCP 9 days ago with hyperglycemia (“hi”) attributed to patient eating pancakes and syrup for breakfast. He also had polyuria, polydipsia, and weight loss. Presents to ED “lethargic, oriented to name alone”
- Labs:
pH 7.06 pCO₂ 19 pO₂ 55 HCO₃ 5.4
Na 144 K 4.1 Cl 100 CO₂ <5 BUN 54 Cr 3.49 Glucose 1498

Case 2

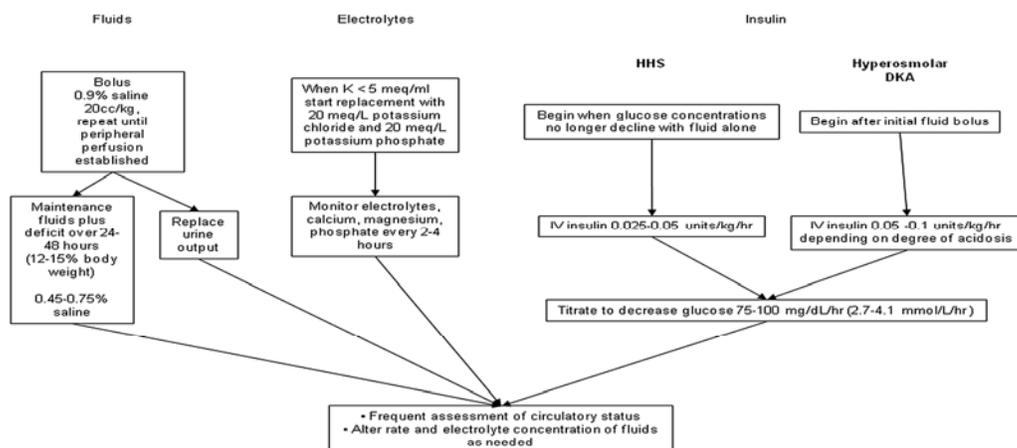
- Diagnosis
 - New Onset Type 1 Diabetes
 - Other labs
 - Corrected Na=166 mEq/L
 - Osmolality
 - CPK
- AMS/ICU
- Step away from the protocol

Pathophysiology of HHS



Zeitler, P. HHS Syndrome in Children. J of Pediatrics. 2011

Treatment Summary



Notes:

- Cardiac monitoring is required in all patients
- Monitor creatine kinase (CK) every 2-3 hours
 - Rising creatine kinase suggests rhabdomyolysis and should prompt nephrology consultation
 - Consider treatment with dantrolene for fever associated with rising CK
- Use central venous catheters with caution
- Heparin may be indicated for immobile patients or when central venous catheter is in use.

Zeitler, P. HHS Syndrome in Children. J of Pediatrics. 2011

Case 3

- 14 yo male, obese post op day 2 right orbital repair. Glucose of 168 mg/dL (random) checked with post operative labs. Consult from plastic surgery on day prior to discharge for hyperglycemia.
- What else?
 - Hx
 - Fluids
 - Fever
 - Post operative

Case 3

- What next?
 - Labs, glucose checks
 - Fasting BMP, c-peptide, A1C
 - Fasting and two hour postprandial glucoses
 - Stop IVFs with dextrose
 - Get evaluation when well as outpatient
 - Modified OGTT in hospital
 - Endocrine consult/outpatient visit

Stress-Induced Hyperglycemia

- Common in critical illness
 - 49-72% of children with BG >150 mg/dL in critical care setting
 - 20-35% of children with BG >200 mg/dL in critical care setting
 - 3.8-5% of children with BG >150 mg/dL in emergency room
 - Higher rate of mortality

Srinivasan V. J Diabetes Science and Technology, Jan 2012

Other Cases

- 17 yo male with Type 1 diabetes, uncontrolled admitted with cellulitis
 - Dextrose free fluids
 - Infection will likely lead to hyperglycemia
 - Uncontrolled
 - We've likely increased doses to compensate for the poor compliance=she may have hypoglycemia on her home doses
 - Likely have not been to clinic in awhile
 - Send a hemoglobin A1C
 - Make sure this patient is not in DKA

Other Cases Continued

- 13 yo female with type 2 diabetes admitted pre-operatively for appendicitis
 - Give Lantus
 - Hold Metformin
 - Lactic Acidosis
 - Renal effects
 - Glucoses
 - Dextrose – free IVFs vs Dextrose containing
 - Testing every 4-6 hours-correction dosing
 - Starvation ketones

Potential Surgical Protocol

- Prior to full NPO status, continue home insulin regimen
- **Upon arrival-Check POCT blood glucose (BG). Target range 80-240 mg/dl**
- - **BG 80-240 mg/dl:** Proceed with anesthesia. Dextrose-free IVFS. BG should be checked each hour.
- - **BG<80 mg/dl:** Start IV with D5 at maintenance rate. Recheck BG in 10-20 minutes and proceed with anesthesia if BG>80 mg/dl. Check BG every hour. Change to dextrose-free IV fluid if BG>200 mg/dl.
- - **BG>240 mg/dl:** Check urine ketones.
- - **Ketones negative-trace/small-moderate:** Start IV with dextrose-free fluid at maintenance. Give 50% of usual correction dose of rapid-acting insulin. Proceed with anesthesia. Check BG every 30 minutes.
- - **Ketones>large:** Call Endocrine service as soon as possible. Do not proceed with surgery.

Post Operative

- **BG monitoring:**
 - If **taking PO**, check qAC, qHS, 3 hours after any short acting insulin is given.
 - **Without PO intake** - q3-4 hours
- **Hypoglycemia management:**
 - **If pOAL** - If BG <70, give 15gm of carbs and recheck in 15 min after snack is completed, until BG >70. If BG <50 mg/dl, okay to give 30 gm of carbs and recheck BG in 15 min.
 - **While NPO on dextrose** - Increase infusion rate, may switch to D10 if needed

Postoperatively, may go back to home regimen when PO intake is allowed. Expect relatively higher BGs post-op secondary to stress.

Making Change

- Identify DKA early
 - Know DKA complications
- Treat DKA appropriately
- Identify contributors to worsening hyperglycemia in the hospital
 - Change treatment if indicated

Questions