Sweet Science
Diabetic Emergencies

Dr. Chris Houk

Pediatric Endocrinologist

Children's Hospital of Georgia

Diabetic Emergencies

- Hypoglycemia/Insulin Reaction
- Diabetic Ketoacidosis
- Diabetic Coma

Hypoglycemia (Insulin Reaction)

- Abnormally low blood glucose level,
  usually defined as less than 70,
  although level for infants and toddlers differs for safety.

- Determination of mild/moderate/severe based on level of function of patient, need for assistance and degree of intervention required to correct hypoglycemia

Possible Causes of Hypoglycemia in Type 1 Diabetics

- Too much insulin
- Too little food
- More exercise/physical activity than usual
- Remember that episodic borderline (55-70) hypoglycemia part of well controlled diabetes
- Excessive alcohol consumption

Signs/Symptoms of Hypoglycemia

- Pale
- Weak
- Shaky
- Palpitations
- Anxious
- Sweaty/Clammy
- Irritable
- Hungry

https://www.cornerstones4care.com/content/dam/nni/cornerstones4care/pdf/content/Tracking/LowBloodSugar.pdf

Treatment of Hypoglycemia

Cold & Clammy:
Need Some Candy

Conscious & Can Swallow

“Rule of 15”:

1. **Give 15g of fast acting carbs.**
2. **Wait 15 min.**
3. **Recheck blood glucose.**
4. **If BG not coming up, repeat.**

Rule of thumb-15g carbs will cause increase of 25-50mg/dL in BG.

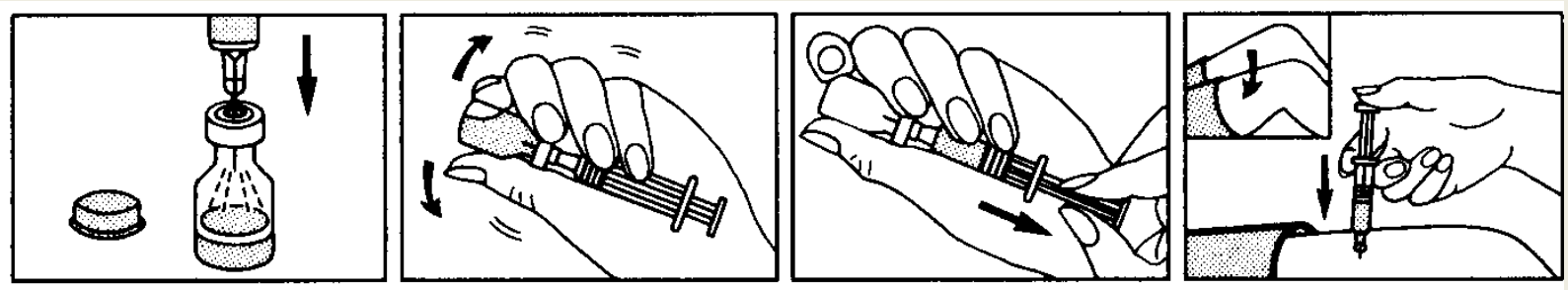
Goal: to achieve BG >100mg/dL.

Unconscious or Unable to Swallow

If lethargic, disoriented, unconscious, unable to swallow:

1. **Give ½ mg Glucagon IM (1/2 of full syringe) Baqsimi nasally, or Gvoke syringe.**
1. **Position on left side.**
2. **Call 911.**
3. **Notify parent.**
5. **Monitor glucose**
6. **Encourage eating when aroused**
7. **Can repeat Glucagon after 10-15min.**

Glucagon Emergency Kit



Lilly iPhone App will allow you to practice and show others how to use glucagon.

BAQSIMI

GVOKE


Gvoke™ PFS
(glucagon injection)
PRE-FILLED SYRINGE
Gvoke™ PFS
(glucagon injection)

Hyperglycemia

- High blood sugar. Defined differently for different individuals
- Typically >300 is uniformly considered excessive.

- Fasting blood glucose 126 or higher, although children with Type 1 Diabetes have a target that is often higher, especially infants and toddlers.

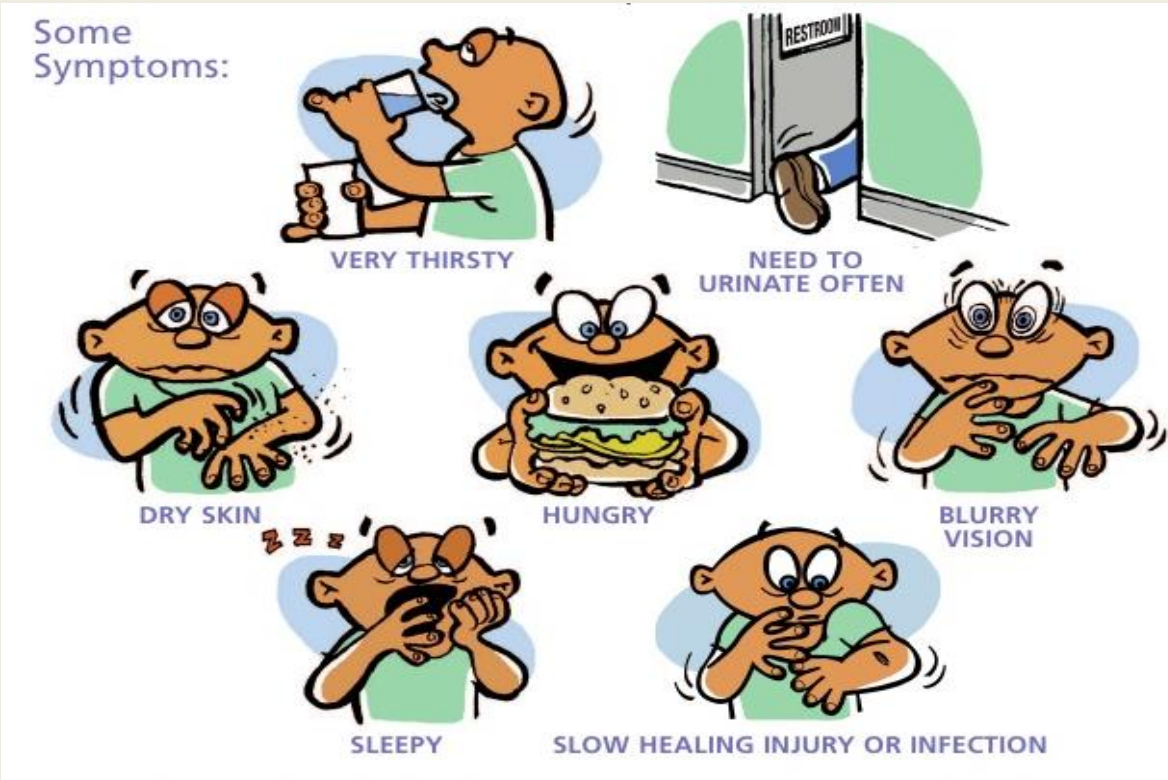
www.mayoclinic.org/diseases-conditions/**diabetes/basics/.../con-20033091**

Hyperglycemia Causes:

- Excess carbohydrates relative to insulin dose
  - Carb count incorrect
  - Inadequate insulin dose
- Improper injection technique
- Medications such as Steroids
- Physiological stress
  - Surgery
  - Illness
  - Emotional)
- Lack of physical activity;

Signs/Symptoms of Hyperglycemia

- Polydipsia
- Polyuria
- Blurry vision
- Fatigue
- Headache
- Hungry



https://www.novomedlink.com/content/dam/novonordisk/novomedlink/resources/generaldocuments/HighBloodSugar_EG.pdf

Treatment of Hyperglycemia

- Correction insulin at meals, bedtime, and other times depending on needs
- Needs determined by:
  - Timing of last insulin dose
  - Activity
  - Illness.

Hot & Dry:
Blood sugar high

Untreated sick days can lead to DKA.

Sick days often require MORE insulin for correction.
Do NOT skip long-acting insulin.

Sick Day Plan

Use with any signs/symptoms of illness…fever, nausea, vomiting.

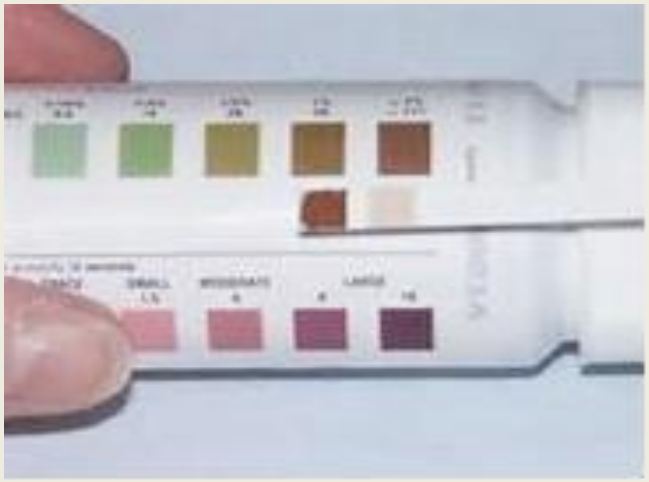
Ketones are the problem not the high sugar.

Do NOT skip long-acting insulin.

Ketones

- A fuel compound that includes acetone and aceto-acetic acid. They are formed in states of starvation or in conditions, such as diabetes, in which insulin doses are low or absent.
- Ketones have a characteristic odor and high levels cause nausea and vomiting.
- Very high ketones cause the blood to become acidic leading to DKA

Checking for Ketones



Check ketones with belly pain, nausea, vomiting, fever every void (about every 2 hours) or until they resolve

Ketones: Small or Less

If ketones are Trace or Small/(15 or less) on urine ketone stick, or 0.6mmol/L or less (serum):

- Check ketones every void while sick.
- Continue usual diabetes care with above addition.
- Pink, Drink, and Play.

Ketones: Moderate/Large

- If ketones are MODERATE to LARGE/40 + or blood ketones are > 0.6mmol/L use ketone protocol.

- **Insulin eliminates ketones**
- **To eliminate ketones, extra insulin must be given. (Remember, ketones are the problem, not the high blood sugar.)**

Ketone Protocol

1. **Give shot of Apidra/Humalog/Novolog. Call office for first dose (and second dose if large ketones continue). Use correction factor to determine dose if ketones are declining.**

2. **Give sugared fluids (regular soda, & juice) based on age. Drinking SUGARED fluids creates hyperglycemia so extra insulin can be given.**

2 - 4 years old:	**10-12 oz. per hour**
5 + years old:	**14-16 oz. per hour**
Teenager:	**24-36 oz. per hour**

3. **Recheck blood sugar (and ketones) 2 hours after giving insulin.**

   -If ketones are trace/small (15), return to usual diabetes care.

   -If ketones are moderate (40) or greater repeat sugared fluids and insulin doses every 2 hours until ketones resolve.

4. **If child has: difficulty staying awake, heavy breathing, cannot tolerate fluids, hypoglycemia, severe chest/stomach pain then should be sent to the emergency room or call 911 immediately.**

DIABETIC KETOACIDOSIS

- **Diabetic Keto-Acidosis (DKA) is a potentially life-threatening acute complication of diabetes characterized by:**
  - **High ketones**
  - **High blood sugar (usually)**
  - **Acidosis**
- **DKA is caused from the build-up of ketones (fatty acids) in the blood stream and does not result from prolonged high blood sugars.**
- **DKA always develops because of insufficient insulin**

Diagnosis of DKA

- Approximately 25% of new diagnoses present in DKA, especially in younger patients (nearly 100% in those < 2 years of age).
- Recurrent DKA is always due to inadequate insulin, which typically means insulin omission.

DKA mortality ~ 0.5%

Cerebral Edema (CE) occurs in 1% of DKA and is the major cause of mortality

In those with CE:~ 1/3rd expire, ~ 1/3rd have permanent neurological injury, ~ 1/3rd recover without deficit.

Wolfsdorf, Joseph, et al. *Diabetic Ketoacidosis in Infants, Children, and Adolescents A consensus statement from the American Diabetes Association. Diabetes Care, May 2006, emed.unm.edu/pem/education/pdf/diabetic-ketoacidosis.pdf. Accessed 2 Sept. 2017.*

Increased risk of DKA at Diagnosis in:

- Young age (<5 years)
- Lower income
- Lower parental education
- Lack of health insurance

Increased DKA Risk in Known diabetics with:

- Poor metabolic control (elevated A1c)
- Previous episodes of DKA
- Peripubertal & adolescent girls
- History of depression, other psych disorders
- Unstable family
- Limited access to medical services
- Insulin pump use

Causes of DKA

- Absolute Insulin deficiency

  Diabetes not suspected &

  diagnosis delayed

- Relative Insulin deficiency

  Physiological stress causing hyperglycemia without use of additional insulin

DKA is caused by a decrease in circulating insulin associated with increase in counter regulatory hormones such as glucagon, catecholamines, growth hormone, and cortisol.

Progressive dehydration, acidosis, electrolyte imbalance cause worsening clinical state --- Like a hamster on the wheel --- until the cycle is broken with insulin and careful replacement of fluids and electrolytes (potassium, sodium, and phosphate), a self-perpetuating cycle of metabolic decompensation worsens.

Wolfsdorf, Joseph, et al. *Diabetic Ketoacidosis in Infants, Children, and Adolescents A consensus statement from the American Diabetes Association. Diabetes Care, May 2006, emed.unm.edu/pem/education/pdf/diabetic-ketoacidosis.pdf. Accessed 2 Sept. 2017.*

Treatment of DKA

- Insulin
- Careful fluid & electrolyte replacement

Signs/Symptoms of DKA

- Abdominal pain
- Dry mouth
- Weakness
- “Fruity” breath
- Chest pain
- Kussmaul Breathing (deep breathing not necessarily rapid)

Diabetic Keto-acidosis (DKA)

Author: Yan Yu
Reviewers: Peter Vetere, Gill Goobie, Sean Spence, Hanan Bassyouni*
** MD at time of publication*

Most commonly occurs in Type I Diabetes Mellitus (DM): Infection or another metabolic demand ↑ need for insulin, but no insulin is produced and no insulin was administered.

Absolute **Insulin deficit**

Lack of insulin to suppress lipolysis allows the body to start producing energy from triglycerides

Release of Free Fatty Acids from **Adipose tissue**

Hydrolysis of Free Fatty Acids in the **Liver** *(ketogenesis)*

Acetyl Co-A *Used as energy by the "starving" cell*

Ketone bodies (acidic energy molecules: βOHB, AcAc) formed & accumulated in the blood

Ketouria

Metabolic acidosis (↑ anion gap: keto-acids consume serum HCO_3^-)

↓ ECF volume concentrates ketone bodies, exacerbates acidosis

Severe Dehydration (up to 4-5L dry) (↓ JVP, orthostasis: postural hypotension/ postural tachycardia, ↑ resting HR)

Disrupts enteric nervous system → ↓ gastric emptying, ileus

Abdominal pain, nausea, vomiting (↑ dehydration)

Blowing off CO_2 to try to offset acidosis

Kussmaul respiration (deep, fast breathing)

Breathing off ketones

Ketone breath (fruity odor)

Disruption of electrical signaling in brain, spinal cord, and nerves

↓ perfusion to brain, spinal cord, and nerves

Weakness, confusion, +/- coma

Alters total body water & ion osmosis

Electrolyte imbalance

If pt alert & H_2O accessible

Polydipsia

Note: Due to neuronal metabolism, ketone bodies are the only other energy molecule besides glucose that can be used by the brain... thus, the body produces them when low on glucose.

Note: in DKA, body K+ is lost via osmotic diuresis & vomiting. But diffusion of K+ out of cells may cause serum [K+] to be falsely normal/elevated. To prevent hypokalemia, give IV KCl along with IV insulin as soon as serum K+ <5.0mmol/L. But ensure patient has good renal function/urine output first!

Glucose remains in blood, NOT utilized by muscle, fat cells

Hyperglycemia (↑ blood [glucose])

If > 12mmol/L, glucose filtration > reabsorption, ↑ urine [glucose]

Glucosuria

Glucose in filtrate promotes **osmotic diuresis**: large-volume urine output

Polyuria

Hypothalamic cells sense low intra-cellular glucose, triggering feelings of hunger

Polyphagia

Cells "starved" of glucose triggers ↑↑↑ release of catabolic hormones: Glucagon, Epinephrine, Cortisol, GH ("counter-regulatory hormones")

Body tries to ↑ blood [glucose], to hopefully ↑ cell glucose absorption

↓ Protein synthesis, ↑ proteolysis **(in muscle)**

↑ Gluconeogenesis & ↑ glycogenolysis **(in liver)**

↑ Gluconeogenic substrates for liver

Treating DKA: 1) +++ fluids. 2) Insulin + KCl. 3) Follow the anion gap until it closes. 4) Identify the precipitant. 5) treat low PO4 (typically occurs a few hours to a day after ketosis resolves due to ↑ ATP production.

Legend: Pathophysiology | Mechanism | Sign/Symptom/Lab Finding | Complications

Published **June 17, 2013** on www.thecalgaryguide.com

Dangers of DKA

- Cerebral edema
- Permanent neurologic injury
- Death

DKA severity is defined by degree of acidosis.

Diabetic Coma

- What is the cause?

- High blood sugar with untreated DKA?
- Low blood sugar without treatment?

- Treatment depends on the cause. If in doubt and no way to check blood sugar or ketones, treat as hypoglycemic.

Questions ???

- Wolfsdorf, Joseph, et al. *Diabetic Ketoacidosis in Infants, Children, and Adolescents A consensus statement from the American Diabetes Association. Diabetes Care, May 2006, emed.unm.edu/pem/education/pdf/diabetic-ketoacidosis.pdf. Accessed 2 Sept. 2017.*
- (n.d.). Retrieved September 03, 2017, from http://medical-dictionary.thefreedictionary.com/Ketones
- Http://www.merckmanuals.com/professional/endocrine-and-metabolic-disorders/diabetes-mellitus-and-disorders-of-carbohydrate-metabolism/diabetic-ketoacidosis-dka. (n.d.).
- (n.d.). Retrieved September 03, 2017, from https://www.cornerstones4care.com/content/dam/nni/cornerstones4care/pdf/content/Tracking/LowBloodSugar.pdf
- (n.d.). Retrieved September 03, 2017, from https://www.novomedlink.com/content/dam/novonordisk/novomedlink/resources/generaldocuments/HighBloodSugar_EG.pdf
- "Diabetic Ketoacidosis in Infants, Children, and Adolescents A consensus statement from the American Diabetes Association." *Www.thecalgaryguide.com, 17 June 2013. Accessed 3 Sept. 2017.*