Diabetic Emergencies

Goals

- DKA treatment guidelines (Peds vs Adult)
- Interesting pathophysiology
- Cerebral Edema
- Controversies

Diabetic Ketoacidosis (DKA)

- Hyperglycemia (glc>250)
- Ketonemia
- Metabolic Acidosis (pH<7.3 HCO3<15)

Feast <----> Famine

Normal Glucose
Goals of Treatment

- ABCs
- Underlying Cause
- Volume deficit and dehydration
- Correct electrolytes, especially K+
- Reverse acidosis and treat glucose
- Treat Cerebral edema
- Do no harm

16 y F h/o IDDM

- BP = 153/84  P = 146  R = 30  T = 97
- Sat = 97%  Wt = 175 lbs
- Glucometer = “high”
- Complains of “pain all over”
- Looks sick, ?AMS, smells of ketones

IV, 02, Monitor

- ABC’s and D
- Move to appropriate room in your ED
- Order tests
Why?

Urine
Xrays
Cultures/Lactate
Tox?
Pregnant?
PE, MI, Pancreatitis, Thyroid, Zebras?

More on labs...

- Ca, Mg, Phos
- EKG
- Beta hydroxybutyrate?
- ABG or VBG

VBG vs ABG

- pH - 0.05 lower than arterial pH
- pO2 - 40-50 instead of 100
- pCO2 - about 5 higher than arterial pCO2 (45 rather than 40)

What do you want to do?

1. Insulin SQ, 1-2 liter NS bolus
2. Insulin IV bolus, 1-2 liter NS bolus
3. Insulin IV bolus followed by insulin drip, 1-2 liter NS bolus
4. 1-2 liter NS bolus, wait for study results for further care
There is universal agreement that the most important initial therapeutic intervention in DKA is appropriate fluid replacement followed by insulin administration.

Joint British Diabetes Societies
Inpatient Care Group
The Management of Diabetic Ketoacidosis in Adults
March 2010

Get Sick / No Insulin

Insulin << Stress Hormones

Cortisol
Catechol
GLUCAGON

Muscle  Tissues  LIVER  Fat

Hyperglycemia!

KetoACIDS KETONES

Osmotic Diuresis

Dehydration  Acidemia  Electrolytes  Renal Impairment

Fluids in DKA Part 1

- Typical adult is 6 liters down
- Volume = Normal Saline
- For adults, start with 1-1.5 liter bolus over 1 hour. More if in shock, less if heart dz
- For kids, start with 10-20ml/kg bolus over 1 hr.

ADA Guidelines for Adult Hyperglycemic Crises

Complete initial evaluation. Check capillary glucose and serum cpeptide to confirm hyperglycemia and ketonemia/ketoacidosis. Obtain blood for metabolic profile. Start IV fluids. TIP: Goal HbA1c of < 8% Na+ and HCO3-

Kitabchi et al, Hyperglycemic Crises in Adult Patients with Diabetes. Diabetes Care, 2009
Know your serum K+ level before giving insulin

- Stat K+
- EKG

Total Body K+ is Low…

- Vomiting
- Osmotic diuresis
- Hypovolemia-->hyperaldosteronism
- Typical deficit = 3-5mmol/kg

But serum K+ is usually normal or high

- Due to low pH?
- Due to insulin deficiency mostly

- Adroque et al, Medicine, 1986
Hypokalemia

- Must replete before insulin if K+ < 3.3
- Add 20mEq to 1 liter NS if hemodynamically unstable
- If stable, add 40-60mEq to 1 liter 1/2 NS and run over 2 hrs.
- Oral load?

Hyperkalemia

- Best treatment is fluids and insulin
- Consider bicarb and calcium for life-threatening hyperkalemia (ekg changes)
- You will probably still have to give potassium later on!

ADA Guidelines for Adult Hyperglycemic Crises

If K+ is normal, add 20mEq to your IVF
Recheck lytes q 2 hrs

Goals of Treatment

- ABCs
- Underlying Cause
- Volume deficit and dehydration
- Correct electrolytes, especially K+
- Reverse acidosis and treat glucose
*Insulin when K+ is OK*

- 0.1 unit/kg bolus for adults followed by 0.1 unit/kg/hr drip
- OR 0.14 units/kg drip without bolus
- If glc not down 10% in 1st hour of tx, give 0.14 units/kg bolus and resume previous tx (also consider ↑ivf)
- Children do not get bolus...just the drip at 0.1
- When glc < 200, cont insulin gtt at 0.05-0.1 units/hr; add 5% dextrose to the 1/2NS.

*The cure for acidosis is insulin...Not a normal sugar!*

- **Muscle Tissues** → **Liver** → **Fat**
- **Hyperglycemia!**
  - **KetoACIDS**
  - **KETONES**

*Your Studies Come Back*

- WBC = 31, Hgb = 13.3, Plt = 422
- Na = 123, K = 5.9, Cl = 87, bicarb = 5, BUN = 20, Cr 1.3, glc = 812.
- Large acetone
- Gap = 31
- UA, preg, utox, LFTs, cxr = neg
- EKG = sinus tach, o/w neg
How’s our Patient?

- Therapy so far = 2 liters NS
- BP = 120’ s/70’ s  HR =130’ s  RR = 30
- Altered?

ABG

- pH = 6.855
- pCO2 = 9.7
- PO2 = 126
- Bicarbonate = 1.7

What do you want to do?

1. One more liter NS, start insulin, give bicarb
2. Two more liters NS, start insulin
3. NS at 200ml/hr, start insulin
4. Give mannitol, send to CT scanner

Cerebral Edema

- 0.3% to 1% of pediatric DKA
- 21% to 24% mortality
- 21% to 26% permanent neuro morbidity
- 57% to 87% of all DKA deaths
Who’s at risk?

• Younger
• New onset DKA (67%)
• Higher BUN
• Low pCO2
• Low pH
• Failure of Na to rise appropriately

Glaser et al, NEJM, 2001
Edge et al, Diabetologia, 2006
Hoorn et al, J Pediatr, 2007
Lauerman et al, J Pediatr, 2005

When does it happen?

• Typically becomes clinical 4-12 hours after initiation of treatment
• Some are already symptomatic when they arrive…

Krane et al, NEJM, 1985
Hoffman et al, American Journal of Neuroradiology, 1988

Symptoms and Signs of Cerebral Edema

• Headache
• Recurrence of vomiting
• Inappropriate slowing of heart rate
• Rising blood pressure
• Decreased oxygen saturation
• Change in neurological status:
  - Restlessness, irritability, increased drowsiness, incontinence
  - Specific neurologic signs, e.g., cranial nerve palsies, abnormal pupillary responses, posturing

Muir et al, Diabetes Care, 2004
Krane et al, NEJM, 1985
Hoffman et al, American Journal of Neuroradiology, 1988

Should I get a CT?

• If you are really concerned, CT can help establish baseline or reveal other sequelae
• CE is clinical diagnosis
• CT has false positives and negatives
Treatment of Cerebral Edema

- Mannitol 0.25-1g/kg bolus
- 3% NaCl 5-10mL/kg over 30 minutes

Wolfsdorf et al, Diabetes Care, 2006
Dunger et al, Pediatrics, 2004
Jeha et al, UpToDate, 2008

Did I cause the cerebral edema?

Osmotic Edema Theory

- Treatment drops intravascular osms--->water shifts into brain--->swelling
- Aggressive IVF and insulin BAD

Edge et al, Diabetologia, 2006
Hoom et al, J Pediatr, 2007

Vasogenic Edema Theory

- Hypoperfusion-->injury-->reperfusion injury
- Supported by MRI studies
- No link between rate of fluid or insulin administration.
- Strong link with severity of illness

Glaser et al, J Pediatr, 2004
Figueroa et al, Endocrine Research, 2005
Glaser et al, NEJM, 2001
Lawrence et al, J Pediatr, 2005
Pediatric Fluids Summary

- Treat shock and sepsis with NS boluses
- If stable after 10-20ml/kg….
- Start NS (+/-K) at 1.5- 2x maintenance
- Switch to dextrose + NS or 1/2 NS (+K) when serum glc < 300. (4-6hrs of NS)
- Aim to keep glc between 150-200 mg/dl

Wolfsdorf et al, Diabetes Care, 2006  Dunger et al, Pediatrics, 2004
Jeha et al, UpToDate

Should I give her bicarb?

- Increased risk of cerebral edema
- May cause other bad things
- No evidence that it helps
- ARF or diarrhea?

Yeah, but what about that pH?

- Treat perfusion problems with fluids
- Treat infection with fluids and abx
- Treat ketoacidemia with insulin
- Watch for hyperchloremic acidosis

Should I give Bicarb to Adults?

- May cause bad things
- No evidence that it helps
- Diarrhea or ARF?
- Consider in low pH and severe cardiac dz?

Kitabchi et al, Hyperglycemic Crises in Adult Patients with Diabetes, Diabetes Care, 2009
How is our Patient?
3 hours later…

- 3.5 liters of NS, insulin gtt at 10 units/hr
- BP = 130/70
- HR = 120’s
- RR = 30’s
- Na = 129, K = 6, Cl = 98, C02 < 5
- glc = 621, gap ≥ 26
- Corrected Na = 141 (from 140)
- Mental status?

What if I have to intubate?

- Treat shock before intubating if possible
- Take your absolute Best shot
- Immediate blood gas
- Bicarb?

Ventilation Goals

- Avoid hyperventilation
- May decrease intracranial blood flow and worsen cerebral edema
- Aim for pt’s own pCO2

Phos?

- “Prospective studies have not shown clinical benefit from phosphate replacement; however, severe hypophosphatemia (<1 mg/dl), which may manifest as muscle weakness, should be treated even in the absence of symptoms.” Wolfsdorf et al, Diabetes Care, 2006
- Can use Kphos as part of the potassium replacement
- Phos replacement can drop calcium, so monitor.

Central Line?

- Children in DKA ↑ risk DVT
- DKA suggested prothrombotic state?
- Do it if you have to, avoid it if you can.

Worly et al, Pediatrics, 2004
Gutierrez, Crit Care Med, 2003

When are you done?

- Close the gap (bicarb may still be low)
- Eating and drinking
- Transition to SQ insulin

Special Peds Considerations

- Expand volume with NS 10-20ml/kg bolus over 1-2 hours. Repeat x1 prn
- Gentle rehydration at 1.5-2 x maintenance to avoid cerebral edema... (maybe)
- No insulin bolus... only use drip (usually 0.1unit/kg/hr)
- Avoid bicarb, central lines, ABG’s (use venous or capillary samples)
- Treat cerebral edema with mannitol or hypertonic saline (3%)