

Erin Osterholm, MD

Case Presentation:

"10-year-old male with abdominal pain"

Viewing Time

The program will take up to one hour to complete.

Target Audience

This program is designed for primary care physicians.

Other health care professionals working with patients and their families may also find this program of interest.

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Case Presentation: "10-year-old male abdominal pain"

Erin Osterholm, MD
Pediatric Chief Resident
Children's Hospitals and Clinics of Minnesota

Case Presentation: "10-year-old male abdominal pain"

A lecture presenting a case that was recently seen in a local community emergency hospital, discussing the workup and diagnosis of the case and reviewing the literature pertinent to the discussion.

Program Objectives

Upon completion of this program, participants should be able to:

- Inform participants of unusual presentations of common pediatric problems.
- Identify specific difficulties in the diagnosis of specific problems.
- Discuss potential difficulties in the management of pediatric problems.

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Receiving CME Credit

To receive CME credit you must view the entire program and complete the evaluation form at the end.

Grand Rounds

10 year old male with abdominal pain

Erin Osterholm
Pediatric Chief Resident
January 10, 2007

Our case begins in a community emergency department...

- CC: 10 year old male with abdominal pain and emesis.
- HPI: Previously healthy male with 2 day history of emesis. Vomited about 7-8 times today. Emesis is non-bloody, non-bilious. He developed abdominal pain tonight, worst in right upper quadrant, but also has generalized pain over entire abdomen. Not eaten anything today. Parents report he has seemed fatigued and weak all day.

Additional history in ED...

- PMHx- previously healthy, no hx of hospitalization or surgery
- Meds-tylenol x 1 day
- SHx- He lives with mother, father, and older brother. He is in the 4th grade and does very well in school. He is a wrestler.
- FHx-no ill contacts.

Initial physical exam

- VS- wt 28 kg, P 120, BP 114/77, R 32, sat 99% RA
- GENERAL-moderate distress secondary to abdominal pain, nontoxic appearance
- HEENT-PERRL, eyes sunken, TMs clear, OP clear with moist mucous membranes
- NECK-supple
- CHEST-tachypnea, no retractions, lungs CTA bilaterally
- CV-RRR, no murmur, normal pulses
- ABD-BS diminished, soft, diffusely tender, non-distended, no rebound
- EXTREMITIES-no edema, CR 2-3 sec
- SKIN-no cyanosis, no petechia
- NEURO-alert and oriented

Orders in the ED

- 23:40
 - Place PIV
 - Labs with IV start: comprehensive metabolic panel, CBC with diff, amylase, lipase, UA/UC
 - NS flush 800ml (28ml/kg)
 - Toradol 15mg IV x 1 for pain.

Labs start to return...

137	94	35	600	Ca 9.7	Bili 0.7, Albumin 5.9, TP 8.9, Alk phos 312 ALT 35, AST 15 Lipase 156
5.0	6	1.91		Mg 1.8	
			Phos 4.5		
	18.8	384		UA SG >1.030	>1000 glucose, >80 ketones Negative LE, N
15.3					
				Diff-N 82, L 14	

Phone call to pediatric specialty facility...

- ED physician places call to facilitate transfer of patient to pediatric facility. Explains pt is presenting with new diagnosis of diabetes and DKA with blood sugar >600 and bicarb of 6. ED physician reports pt is alert, but uncomfortable with abdominal pain and emesis.
- Transfer is arranged via ambulance and pt leaves facility at 0240.
- At this point, he has received 800mL of NS and IV is heplocked for transport.

- Anything else prior to transport?



Admit to pediatric emergency department

- 0405-pt arrives in ED
- HPI- Reviews abdominal pain, emesis, and outside labs revealing blood glucose in excess of 600. In retrospect, parents note polyuria, polydipsia, and probably 5-10 lb weight loss. In fact, his teacher commented that he seems to use the restroom excessively at school for the past month or so. Parents also note increased fatigue recently.
- No recent illnesses.

ED ROS

- Negative for fever, vision change, sore throat, cough, wheeze, diarrhea, dysuria, skin rash, myalgia, and headache.
- Positive for postural dizziness, rapid deep breathing, vomiting, abdominal pain, and polyuria/polydipsia.

ED Physical Exam

- Wt 28.4 kg, T 36.6, P 125, RR 34, BP 143/95
- General-no acute distress, nontoxic, calm, conversant. Hydration-moist mucous membranes, normal skin elasticity, eyes moderately sunken.
- HEENT-EOM intact, PERRL, TM-clear, OP clear
- NECK-supple, without thyromegaly
- CHEST-Kussmaul respirations, no retractions, CTA bilaterally.
- CV- RRR, no murmur, 2+ radial pulses, 2-3 sec CR
- ABD-soft, NT, nondistended
- EXTREMITIES-cool, no edema
- SKIN-without pallor, cyanosis, diaphoresis, exanthem, or petechia
- NEURO-alert and oriented

Labs/work-up

- Outside laboratory studies were reviewed highlighting BG 604, BUN 35, Cr 1.9 and anion gap of 37.
- AXR-normal per ED MD
- CXR-normal per ED MD
- 0415 VBG-6.98/22/50/5 (-24)
- 0415 blood glucose 439

Assessment/Plans

- 10 year old male with new onset IDDM and diabetic ketoacidosis with incomplete fluid resuscitation.
- Plans:
 - Repeat NS bolus 20ml/kg (600ml), then run at 75ml/hr
 - Call placed to pediatric endocrine service attending to discuss management.
 - Plan to admit pt to pediatric floor for initiation of insulin drip and diabetic education as well as close monitoring of electrolytes and acidosis.

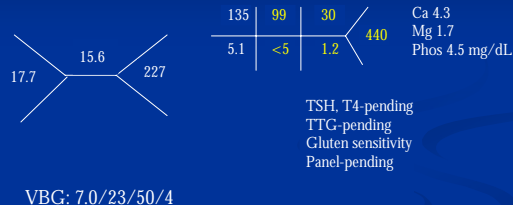
0600-Transfer to Peds Floor

- HO evaluates pt upon arrival to floor.
- HPI reviewed from both ED's-notes similar symptoms including polyuria/polydipsia, but now also notes pt has developed a frontal headache rated at 5/10 and notes that pt is sleepy after being up nearly all night.
- FHX- Paternal grandmother and paternal uncle with Type II DM, no other autoimmune conditions.

HO Physical Exam

- VS-T 36.8, P 119, R 28, BP 126/69.
- Full exam documented as normal with exception of:
- MM tachy, 1/6 systolic ejection murmur, mildly tender abdomen diffusely, and neuro-answering questions, oriented but seems tired, lethargic.

Admit Labs



HO Assessment and Plans

- 10 year old male with new diagnosis of likely Type I DM with DKA.
- Plans after phone consultation with endocrinologist:
 - Start D5 ½ NS + 20meq/L KCl + 20meq/L KPhos at 105 ml/hr
 - NPO
 - Start regular insulin drip at 3 units/hr (0.1units/kg)
 - q 2 hr electrolytes, VBG, ketones with q 4 hr Ca, Mg, Phos
 - q 1 hr glucose checks
 - VS q with neuro checks q 2 hrs x 3, then q 4 hrs

0730-Eval by endocrinologist

- HPI/ROS/FHx/SHx reviewed in complete detail.
- Exam: Pt sleeping, arouses with exam, answers questions appropriately, + ketone odor, dry mouth, nose, and deep, rapid respirations. Normal heart, lung, abdomen exam. Feet are warm with good perfusions, hands cool with 3 second CR.

Endo A/P

- DKA with severe acidosis/dehydration with Type I Diabetes Mellitus.
- Will manage with IV insulin/fluids as noted by HO except fluid will be changed to D5 NS +20KCL+20 Kphos @105ml/hr. Monitor closely. Discussed diagnosis and progress with parents including the risk of cerebral edema. Will start diabetes education tomorrow.

Monitoring Guidelines per LWPES Consensus Statement

- If signs of severe DKA or those at increased risk for cerebral edema (age <5 or new onset) → consider treatment in PICU or children's ward specializing in diabetes care.
- Monitoring:
 - Q 1 hr HR, RR, BP
 - Hourly I & O's
 - EKG monitoring may be helpful-assess T waves for evidence of hyper/hypokalemia
 - Q 1 hr blood glucose
 - Electrolytes, urea, hematocrit, blood glucose, and blood gases Q 2-4 hrs (lytes hourly as clinically indicated)
 - Q 1 hr (or more frequent) neuro observations for warning signs and symptoms of cerebral edema.

Fluid and salt replacement guidelines per LWPE consensus statement

- Fluids and Na: Objectives
 - Restore circulating volume
 - Replacement of Na and the ECF and ICF deficit of water
 - Restore GFR-enhance clearance of glucose and ketones
 - Avoid cerebral edema
- Volume expansion with isotonic fluid (10-20 mL/kg over 1-2 hours, repeated if necessary)
- Calculate IVF to rehydrate evenly over at least 48 hrs
- Use fluid with tonicity $\geq 0.45\%$ saline

DKA insulin guidelines

- Start IV insulin gtt @ 0.1 unit/kg/hr to suppress lipolysis and ketogenesis.
 - Keep at this rate until resolution of ketoacidosis
 - The resolution of acidemia invariably takes longer than normalization of blood glucose.
- Potassium replacement (KCl or combo KCl + KPhos)
 - K < 3.5 , add 60 mEq/L to IVF
 - K 3.5-5.5, add 40 mEq/L to IVF
 - K > 5.5 , no K in IV
- Bicarbonate administration controversial-may accentuate Na load and contribute to hypertonicity although may be considered in those with decreased cardiac contractility and impaired tissue perfusion associated generally with pH < 6.9 .

■ Back to our case...

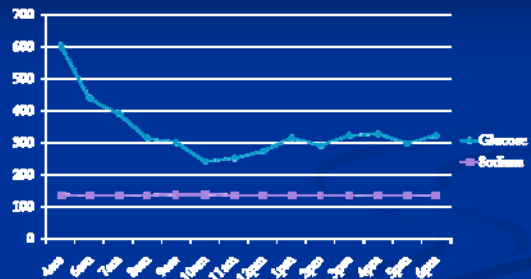
0925 Call to attending MD by RN

- RN reports that pt is complaining of worsening headache.
- Attending MD to bedside to evaluate patient. Pt reports increased frontal headache and eye pain. Sleepy but responding to voice. Exam completed with pupils equal and responsive, fundoscopic exam completed with no papilledema noted. Pt is given tylenol with plans to watch closely.

HD 1

- Pt continues to remain NPO with IVF at 105ml/hr
- Insulin drip continues at 3 units/hr with improving acidosis and glucose.
- RNs are doing neuro checks q 2 hours noting pt is sleepy, but arousable and appropriate with exam.

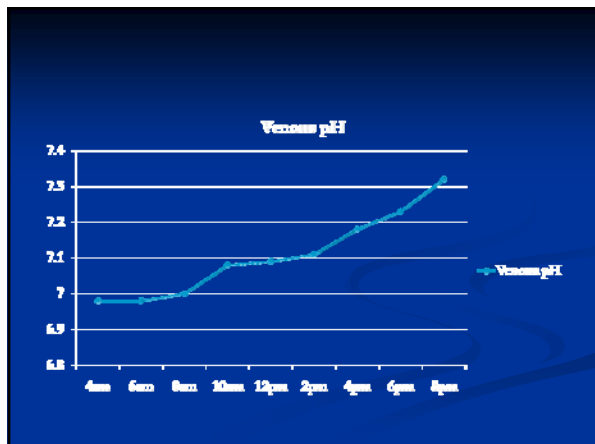
Electrolytes throughout HD 1



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1615 RN call to HO

- RN notes that pt seems more sleepy to her despite improving labs.
- HO requests vitals: T 37.1, P 79, R 20, BP 114/63 with sat 99.
- Pt is examined-arouses with exam, sits up in bed and states he was just "tired." HO calls attending physician and PICU attending to alert of pt status.

1630-Eval by PICU

- PICU MD evaluates after notification of sleepiness in pt with DKA.
- When MD enters room, pt is sitting up in bed, playing nintendo. He answers questions appropriately and has a normal physical exam including fundoscopic examination. Plan to monitor pt closely, but no management changes at this time.

1730-Evaluated by attending endocrinologist

- Endocrinologist also comes to evaluate pt after concerns from HO regarding sleepiness and possible altered LOC.
- At 1730, pt is sleeping, but wakes easily with normal pupils and fundi. He does complain of HA with exam.
- A/P: Appears sleepy rather than altered LOC secondary to edema. Monitor closely.

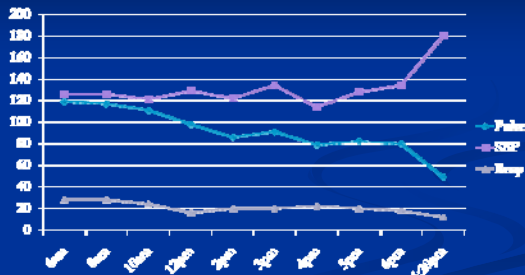
1815-Neuro assessment by RN

- RN completes bedside neuro assessment. She holds up 4 fingers and asks "how many?" Pt responds with 3 and then refuses to answer any more questions, unclear to RN if pt is understanding her.

1820-Acute status change

- Pt sits forward, has emesis x 1, then becomes non-responsive to voice. Pulse rate on oximeter is noted to decrease to 75, then 49 per RN in room. O2 sats drop to 88%. Pt having agonal respirations.
- RN calls HO and ICU STAT.

Review of HD 1 vitals



1825-Emergent transfer to ICU

- Pt assessed by PICU MD and immediately transferred to ICU.
- Upon admit, pt is non-responsive to voice, BP 182/100, P 52, R 12, O2 sat 92 on 10L via face mask. Pupils are 2mm bilaterally and reactive.
- FSG is 323, pH 7.23, Na 135
- Order for mannitol 30 grams IV given.

1830-PICU course

- While RN is drawing up mannitol, pupils are observed to change by MD to 6mm and very minimally reactive.
- Pt is given mannitol 30 grams IV x 2 doses with pupils returning to 3mm and reactive. Pulse increases into the 80's and BP into the 140's/80-90's.
- Pt does not become verbal, but does start grinding his teeth and scratching with his hands.

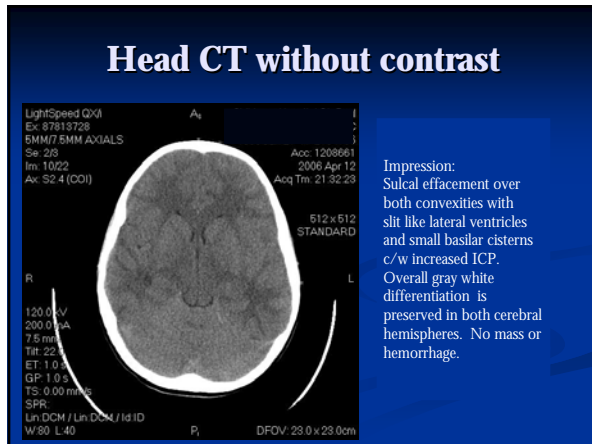
- Pt is given premeds for intubation including lidocaine, thiopental, atropine, and vecuronium.
- He is intubated with 5.5 cuffed ET tube with no major changes in hemodynamics.
- Neurosurgery is called emergently to pt's bedside.

Neurosurgery consult

- Neurosurgeon notes events including DKA with increasing lethargy, hypertensive event, and pupillary enlargement. After brief discussion with parents of current status, pt undergoes a R frontal twist drill insertion of a Camino ICP monitoring device. Opening pressure is 26.
- Neurosurg recs include 3% NaCl to keep Na low to mid 150's, keep pt adequately sedated, Head CT once stable enough for transport. If ICPs consistently >20, drain to be placed.

PICU A/P

- A: 10 y/o male with new onset Type I DM, DKA, and near herniation event secondary to cerebral edema, now S/P Camino placement.
- P:-NPO
 - Continue full mechanical ventilation-maintain normocarbica
 - Sedation/paralysis, add barbiturates if needed
 - Pressors prn-guided by ICP monitoring, goal CPP>60
 - Ancef while ICP monitor in place.
 - Continue insulin drip per endocrine with electrolyte monitoring.



PICU HD 2

- S: Overnight pt's ICP's have remained <20, remains sedated, dopamine infusion was started to maintain CPP>50. Pt on 3% NaCl gtt. Otherwise, no major events-remains on insulin gtt and full mechanical ventilation.
- O: Tm 36.6, BP 136/63, Vent rate 16, CVP 3, ICP 9-14, CPP 50-lower 60's
Sedated, mechanically ventilated, orally intubated, ICP monitor in place, ng tube in place.
No eye, nasal drainage, lips pink.
Lungs-clear bilaterally
Heart-nml S1, S2, 1/6 systolic murmur
Abd-soft with good BS

PICU HD 2

- Exam cont...
Neuro-pupils equal, brisk. Opens eyes to painful stimuli and moves extremities with flexion withdrawal to stim, does not open eyes to voice.
Labs-pH 7.3, CO2 41, pO2 124
Na 145, K 3.3, Cl 117, Gluc 206, BUN 9, Cr 0.4
Mg 1.2, urine-negative for ketones. CXR clear with ETT in place

HD 2 A/P

- A: Newly diagnosed insulin dependent Diabetes Mellitus, neurologic deterioration with probable cerebral edema requiring mechanical ventilation.
- P: -Mechanical ventilation
-Sedation and analgesia-wean as ICP/ CPP allow to follow neuro exam
-Dopamine prn to keep CPP>60
-Follow labs, blood sugar, I/O's on insulin gtt.

PICU HD 3-4

- Pt remains on insulin gtt decreased to 1.5 units/hr with resolution of acidosis and BG 150-200.
- ICP monitoring continues with ICPs decreasing to 4-12.
- Pt showing purposeful movements, active as sedation weaned.
- Day 4-extubated after short period of propofol sedation without problems.

HD 5

- ICP monitor removed.
- Pt transitioned to subcutaneous insulin with Glargine (Lantus) and Aspart insulin (Novolog).
- Transferred to pediatric floor.
- Upon transfer, RN notes pt is alert and oriented although fine motor control is not appropriate, pt is weak-unable to stand, also notes drooling with attempts to eat.

HD 6-7

- Diabetes education with family continues.
- Pt noted to have weakness when working with PT/OT. Noted to fall toward right, weakness with head movement, weakness vs discoordination of both R upper and lower extremity. Pt unable to communicate in full sentences.
- Also develops uncontrolled jerking movements of his left leg, seems to "jump off the bed."

NEUROLOGY consulted

- Neurologist reviews entire hx of events of past 6 days. Notes current concerns are decreased head and neck control, weakness that seems worse on the right, and unusual movements consisting of "flinging out" of his arms and legs when he tries to initiate a movement. Also notes unsteadiness when trying to stand.

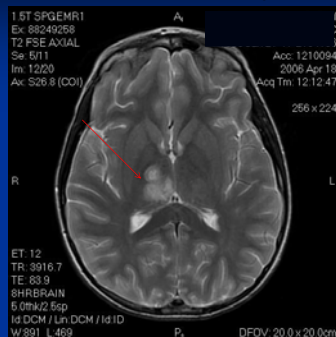
NEURO consult

- A/P: 10 year old with DKA and secondary acute cerebral edema and herniating event, treated rapidly. His picture is extremely concerning for injury to the deep tracts, particularly basal ganglion, but cannot rule out thalamic injury. History raises question of hemiballismus suggesting subthalamic injury. Cognitively, he seems aware, but has psychomotor retardation and bradykinesia.

NEURO recs

- Initiate full speech, OT, and PT evaluation including formal swallow evaluation to assess aspiration risk.
- MRI of brain with diffusion-weighted images.
- Likely will need an inpatient rehab hospitalization-would consult PMR.

MRI



Impression-
Pronounced edema within the right thalamus extending into the brain stem, less pronounced abnormality within L thalamus. Restricted diffusion in R parietal lobe.

PMR

- After evaluation by rehab medicine, pt is noted to be excellent candidate for inpatient rehabilitation.
- Insulin regiment is stabilized and pt is transferred to rehabilitation hospital on day #10 with continued uncontrolled movements, improving speech and strength.

6 weeks later...

- Pt is discharged home after completing an intensive inpatient rehabilitation program.
- Discharge note from rehab facility notes overall improved speech, still mild dysarthria, no cognitive deficits via tests of receptive and expressive language. Improved gross motor skills, but still struggling with fine motor movements of R arm and leg.

- Pt independent in dressing and eating, needs assistance with grooming and writing is difficult. He needs assistance to get from floor to standing.
- He wears AFOs and standing balance is improving.
- He does PT/OT 2-3x /week
- Psychosocially, he is adjusting to his new disabilities as anticipated and will return to school soon.

Diabetic Ketoacidosis-Definition

- Decrease in effective circulating insulin associated with elevations in counter-regulatory hormones including glucagon, catecholamines, cortisol and growth hormone, with impaired glucose utilization and resultant hyperglycemia and hyperosmolality.
- Increased lipolysis, with ketone body production causes ketonemia and metabolic acidosis
- Biochemical diagnosis:
 - Hyperglycemia (glucose > 200 mg/dL) with
 - Venous pH <7.3 and/or bicarbonate <15 mmol/L

Frequency of DKA

- Leading cause of morbidity and mortality in children with type 1 diabetes mellitus
- Present at time of diagnosis of T1DM in 15-67%
- Risk is 1-10% per pt per yr in pts with established T1DM
- Increased risk w/ poor metabolic control or prior episodes of DKA, peripubertal and adolescent girls, children w/ psychiatric disorders, difficult family circumstances

Morbidity and Mortality of DKA

- Mortality rate 0.15%-0.31%
- **Cerebral edema accounts for 57-87% of deaths**
 - Mortality 21-25%
 - Significant morbidity 10-26%
- Other morbidity: hypokalemia, hyperkalemia, other CNS complications, hematoma, thrombosis, sepsis, infections, aspiration pneumonia, pulmonary edema, ARDS, pneumomediastinum, subcutaneous emphysema, rhabdomyolysis

DKA and cerebral edema

- Typically occurs 4-12 hrs after treatment initiated, but may develop *before* treatment initiated or *anytime* during treatment
- Signs and Symptoms:
 - Onset of headache
 - Recurrence of vomiting
 - Gradual decrease or deteriorating level of consciousness-irritability, increased drowsiness
 - Inappropriate slowing of pulse rate
 - Increase in blood pressure
 - Decreased oxygen saturation

Cerebral Edema in DKA

- Risk factors
 - Attenuated rise in measured serum sodium concentrations during therapy (little evidence to show associations between volume or Na content of IVF OR rate of change in serum glucose)
 - Severity of acidosis
 - Greater hypocapnea at presentation
 - Elevated serum urea nitrogen (BUN)
- Demographic factors placing at increased risk
 - Presentation with new onset T1DM
 - Younger age
 - Longer duration of symptoms

Management of cerebral edema

- Reduce rate of IVF
- IV Mannitol 0.5-1 g/kg over 20 minutes if signs of cerebral edema
 - Repeat in 2 hrs if no initial response
 - Hypertonic saline (3%) 5-10 mL/kg over 30 minutes as an alternative
- Intubation and ventilation may be necessary
 - Aggressive hyperventilation has been associated with poor outcome in one study of DKA-related cerebral edema

Take Home Points

- Close neurologic monitoring is essential in patients with DKA.
- Remember that the severity of acidosis and the attenuated rise in serum sodium with treatment are risk factors for cerebral edema.
- Cerebral edema typically occurs 4-12 hours after initiation of treatment, but can develop ANY time during DKA.

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