

## A Pediatric Diabetic Ketoacidosis Patient with Multisystem Complications and a Prolonged Course

John Henry Carson, M.D.<sup>1</sup>, Lindall E. Smith, M.D., FAAP<sup>2</sup>,  
Poornima Pandiyan, M.D.<sup>2</sup>, Priyank J. Yagnik, M.D., MPH<sup>2</sup>  
University of Kansas School of Medicine-Wichita,  
<sup>1</sup>Internal Medicine/Pediatrics Residency Program  
<sup>2</sup>Department of Pediatrics

Received Nov. 4, 2018; Accepted for publication Feb. 5, 2019; Published online Aug. 21, 2019

### INTRODUCTION

The prevalence of diabetic ketoacidosis (DKA) in children with type 1 diabetes mellitus (T1DM) is 30% at the time of diagnosis.<sup>1</sup> Cerebral edema is a rare, but life-threatening complication of DKA, occurring in only 0.3 - 1% of cases.<sup>2</sup> Deep vein thrombosis and acute pancreatitis are other rare complications of DKA. Supraventricular tachycardia (SVT) as a complication of pediatric DKA has been reported.<sup>3</sup> A unique case of a pediatric patient who had multiple rare complications of DKA including cerebral edema, venous thrombosis, and hypertriglyceridemia associated acute pancreatitis is presented. The SVT episode encountered during the admission was due to complications arising from a procedure and not due to DKA itself.

### CASE REPORT

A 17-year-old Caucasian male presented to the emergency department (ED) due to altered mental status, Kussmaul respiration, hyperglycemia (serum glucose 991 mg/dl), and ketoacidosis (serum bicarbonate 8 mmol/L, anion gap 26, and urine ketones 4+). The patient was an obese (120 kg) young man with Attention Deficit Hyperactivity Disorder (ADHD). He had polyuria and polydipsia for about two weeks prior to presentation. He was seen by his primary care physician (PCP) and was discharged home with possibility of food poisoning. He did not have symptoms suggestive of dehydration or altered mental status during this visit. He developed cough, rhinorrhea, and tachypnea. His symptoms worsened over ensuing three days, and he presented to the ED.

The patient's past medical history was significant for Asperger syndrome. Over the past six years, his weight and body mass index percentile had worsened from the 95th and 93rd percentile to the 99th and 98th percentile, respectively. With obesity concerns, metabolic work-up was ordered by his PCP about five years prior to presentation. He had normal thyroid function tests, normal liver function tests, and normal glycosylated hemoglobin of 5.1% (normal < 5.7%). The only abnormal finding was a serum low-density lipoprotein (LDL) of 112 mg/dL (normal < 100 mg/dL). He was scheduled for repeat measurements of a comprehensive metabolic panel, liver function tests, thyroid function tests, and glycosylated hemoglobin by his PCP, but he missed several appointments.

In the ED, the patient was diagnosed with new onset type 1 diabetes mellitus presenting with DKA. He received a total of two liters of normal saline bolus by the transport team and another one liter in the ED. He was started on an insulin drip and 1.5 times maintenance fluids, per institutional DKA protocol, then transferred to the pediatric intensive care unit (PICU). With no improvement in mental status for 14 hours following admission to PICU, two doses of mannitol were given. Subsequently, a computerized axial tomography (CT) scan of the head revealed generalized cerebral edema.

His mental status failed to improve on hospital day two despite improvement of his hyperglycemia and hydration status. He was persistently febrile (maximum temperature 38.9° Celsius) since admission with serum procalcitonin being 20.39 ng/ml. His serum white blood count was 18,600/mm<sup>3</sup>. His cerebral edema precluded performing a lumbar puncture. He was started on empiric ceftriaxone and vancomycin for meningitis concern.

A peripherally inserted central catheter (PICC) line was inserted in his left arm for antibiotic delivery and frequent blood draws. During insertion, he had an episode of SVT which resolved with one dose of adenosine and repositioning of the PICC line. His echocardiogram showed normal function. His electrocardiogram revealed a corrected QT interval of 532 msec. Serial serum troponin I levels were performed. His peak serum troponin I was 0.49 ng/ml, which normalized over one week of hospitalization without any cardiac-specific intervention. Serial laboratory values are shown in Table 1.

Hospital days three and four were characterized by slow resolution of metabolic acidosis and improvement of mental status. Lumbar puncture was performed on hospital day four to guide antibiotic therapy. The cerebrospinal fluid findings were not concerning for acute bacterial meningitis. His fever also resolved by day four and serum procalcitonin decreased to 1.14 ng/ml.

His mental status returned to baseline on day five of hospitalization. He developed acute abdominal pain along with nausea and vomiting. His serum lipase and serum triglyceride on admission were 585 U/L and 2605 mg/dL, respectively. When measured again on day five, they were 1289 U/L and 419 mg/dL, respectively. These results were suggestive of acute pancreatitis secondary to hypertriglyceridemia. He developed left upper extremity discomfort and blood draw from his PICC line became difficult. His upper extremity ultrasound showed an obstructive thrombosis of left axillary and basilic veins. His PICC line was removed and he was started on low molecular weight heparin.

On day six of hospitalization, his nausea and abdominal pain resolved. He was transitioned to subcutaneous insulin regimen and transferred to the pediatric floor for diabetes education. He was discharged home on day eight of hospitalization in stable condition.

**Table I. Serial laboratory values during hospitalization.**

Serum Levels (normal values)	Day 0 ER/PICU	Day 1 PICU	Day 2 PICU	Day 3 PICU	Day 4 PICU	Day 5 PICU	Day 6 Floor
Glucose (70-90 mg/dL)	991	391	208	164	172	158	
Bicarbonate (21-32 mmol/L)	8	12	16	20	23	26	
Anion gap (5-15 mmol/L)	26	17	13	10	6	8	
Procalcitonin (<0.25 ng/mL)	20.39	8.05				1.14	
White blood cells (5.0-10.0 k/cumm)	18.6	9.5	6.9				
Troponin I (<0.07 ng/mL)		0.42	0.31	0.12	0.49	0.22	0.02
Lipase (73-393 Unit/L)	585				1235	1289	
Triglycerides (<150 mg/dL)	2605			554	393	419	

**DISCUSSION**

The incidence of cerebral edema in children with DKA is low, but it has high mortality (24%) and high morbidity (35%).<sup>4</sup> If cerebral edema occurs in a DKA patient, it is generally during the first 12 hours after the treatment rather than before treatment, although up to 20% of cases of cerebral edema occur before initiation of therapy.<sup>5,6</sup> Common risk factors for development of cerebral edema in DKA patients include new onset type I diabetes mellitus, young age at diagnosis, severe acidosis, and severe dehydration.<sup>7,8</sup>

DKA usually promotes a prothrombotic state.<sup>9</sup> A meta-analysis showed that deep venous thrombosis is common in adults with PICC line compared to central venous catheters, especially in critically ill patients and the ones with diagnosis of malignancy.<sup>10</sup> Adolescents with underlying chronic illnesses are considered to be at the greatest risk to develop in-hospital deep vein thrombosis.<sup>11</sup>

Although supraventricular tachycardia in our patient was thought to be associated with PICC line placement, there has been a case report describing the occurrence of supraventricular tachycardia in absence of a central line.<sup>3</sup> Elevated troponin level also has been seen in DKA patients. Elevated troponin level without acute coronary syndrome predicts higher risk for cardiac events and mortality in the future.<sup>12</sup> The SVT episode in the patient presented was due to complication from PICC line placement and should not be considered a complication of DKA.

Hypertriglyceridemia induced acute symptomatic pancreatitis has been described in the pediatric DKA population.<sup>13</sup> Mild elevations in serum amylase and lipase are common in children with DKA. The suggested treatment options for severe hypertriglyceridemia induced pancreatitis are insulin, heparin, and/or plasmapheresis.<sup>14-16</sup>

The late presentation of our DKA patient could have attributed to his prolonged complicated hospitalization. His persistent fever with elevated white blood count and serum procalcitonin level could have contributed to the complicated course as well. Infection usually is not present in most children with DKA, and high white blood count reflects the severity of DKA.<sup>17</sup> DKA is known to induce a proinflammatory state,<sup>18</sup> which could have contributed to his prothrombotic state leading to venous thrombosis. The SVT episode encountered

during this admission was iatrogenic, and did not seem to be a complication of DKA in this patient.

**CONCLUSION**

Our case illustrated multiple rare complications of DKA in a single pediatric patient. Although the majority of DKA patients are treated without complications, clinicians caring for such patients should anticipate a prolonged complicated course in rare instances.

**REFERENCES**

- Dabelea D, Rewers A, Stafford JM, et al. Trends in the prevalence of ketoacidosis at diabetes diagnosis: The SEARCH for diabetes in youth study. *Pediatrics* 2014; 133(4):e938-945. PMID: 24685959.
- Bialo SR, Agrawal S, Boney CM, Quintos JB. Rare complications of pediatric diabetic ketoacidosis. *World J Diabetes* 2015; 6(1):167-174. PMID: 25685287.
- Finn BP, Fraser B, O'Connell SM. Supraventricular tachycardia as a complication of severe diabetic ketoacidosis in an adolescent with new-onset type 1 diabetes. *BMJ Case Rep* 2018; 2018. PMID: 29545427.
- Edge JA, Hawkins MM, Winter DL, Dunger DB. The risk and outcome of cerebral oedema developing during diabetic ketoacidosis. *Arch Dis Child* 2001; 85(1):16-22. PMID: 11420189.
- Glaser N, Barnett P, McCaslin I, et al. Risk factors for cerebral edema in children with diabetic ketoacidosis. The Pediatric Emergency Medicine Collaborative Research Committee of the American Academy of Pediatrics. *N Engl J Med* 2001; 344(4):264-269. PMID: 11172153.
- Lawrence SE, Cummings EA, Gaboury I, Daneman D. Population-based study of incidence and risk factors for cerebral edema in pediatric diabetic ketoacidosis. *J Pediatr* 2005; 146(5):688-692. PMID: 15872675.
- Wolfsdorf J, Glaser N, Sperling MA, American Diabetes Association. Diabetic ketoacidosis in infants, children, and adolescents: A consensus statement from the American Diabetes Association. *Diabetes Care* 2006; 29(5):1150-1159. PMID: 16644658.
- Dunger DB, Sperling MA, Acerini CL, et al. ESPE/LWPES consensus statement on diabetic ketoacidosis in children and adolescents. *Arch Dis Child* 2004; 89(2):188-194. PMID: 14736641.
- Carl GF, Hoffman WH, Passmore GG, et al. Diabetic ketoacidosis promotes a prothrombotic state. *Endocr Res* 2003; 29(1):73-82. PMID: 12665320.
- Chopra V, Anand S, Hickner A, et al. Risk of venous thromboembolism associated with peripherally inserted central catheters: A systematic review and meta-analysis. *Lancet* 2013; 382(9889):311-325. PMID: 23697825.
- Setty BA, O'Brien SH, Kerlin BA. Pediatric venous thromboembolism in the United States: A tertiary care complication of chronic diseases. *Pediatr Blood Cancer* 2012; 59(2):258-264. PMID: 22038730.
- Al-Mallah M, Zuberi O, Arida M, Kim HE. Positive troponin in diabetic ketoacidosis without evident acute coronary syndrome predicts adverse cardiac events. *Clin Cardiol* 2008; 31(2):67-71. PMID: 18257021.
- Nair S, Yadav D, Pitchumoni C. Association of diabetic ketoacidosis and acute pancreatitis: Observations in 100 consecutive episodes of DKA. *Am J Gastroenterol* 2000; 95(10):2795-2800. PMID: 11051350.
- Tsuang W, Navaneethan U, Ruiz L, Palascak JB, Gelrud A. Hypertriglyceridemic pancreatitis: Presentation and management. *Am J Gastroenterol* 2009; 104(4):984-991. PMID: 19293788.
- Betteridge DJ, Bakowski M, Taylor KG, Reckless JP, de Silva SR, Galton DJ. Treatment of severe diabetic hypertriglyceridaemia by plasma exchange. *Lancet* 1978; 311(8078):1368. PMID: 78139.
- Lutfi R, Huang J, Wong HR. Plasmapheresis to treat hypertriglyceridemia in a child with diabetic ketoacidosis and pancreatitis. *Pediatrics* 2012; 129(1):e195-e198. PMID: 22201145.
- Flood RG, Chiang VW. Rate and prediction of infection in children with diabetic ketoacidosis. *Am J Emerg Med* 2001; 19(4):270-273. PMID: 11447509.
- Close TE, Cepinskas G, Omatsu T, et al. Diabetic ketoacidosis elicits systemic inflammation associated with cerebrovascular endothelial cell dysfunction. *Microcirculation* 2013; 20(6):534-543. PMID: 23441883.

*Keywords: diabetic ketoacidosis, brain edema, hyperlipidemia, supraventricular tachycardia, case report*