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A 2-Year-Old Girl With Respiratory Distress And Altered Mental Status: A Case Report

Urgent Message: While children presenting to urgent care centers usually have minor illnesses, attentiveness to vital signs and behavior is crucial to avoid missing rare but serious diagnoses. Diabetic ketoacidosis is the most common initial presentation of type 1 diabetes mellitus in young children. Capillary blood glucose measurement is a universally available screening tool that should be used liberally in ill-appearing children with alterations in level of consciousness.

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Abstract

Clinical presentation: A 2-year-old girl with no significant past medical history presented to urgent care (UC) with her parent after he noted she was "breathing faster than normal."

Physical exam: The patient was ill-appearing and lethargic. Her vitals revealed tachycardia and tachypnea. Her lungs were clear, but a deep, rapid respiratory pattern was noted with intercostal retractions.

Case resolution: A capillary blood glucose (CBG) measurement revealed a glucose of >400mg/dL. Emergency medical services (EMS) was activated, and the patient was transported to the local emergency department (ED). The patient was subsequently diagnosed with diabetic ketoacidosis (DKA) and admitted to the pediatric intensive care unit. During her hospitalization, a new diagnosis of type 1 diabetes mellitus (T1DM) was con-

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firmed, and she was discharged home after stabilizing on both long- and immediate-acting insulin; parental diabetic teaching also was provided prior to discharge. **Conclusion:** Identification of an abnormal respiratory pattern in combination with lethargy appropriately led the UC clinician to consider DKA and obtain a CBG. The critically high blood sugar in this setting led to timely referral to the ED and ultimately a favorable patient outcome.

Introduction

DKA is a potentially life-threatening complication of diabetes, particularly T1DM, and tends to be more severe in children under 5 years of age.[1] Due to the limited verbal capacity and different ranges of normal vital sign values in toddlers, signs of DKA may be overlooked by caregivers and clinicians alike.[2] The case presented here highlights how non-specific signs and symptoms coupled with characteristic changes in respiratory patterns prompted the UC clinician to screen for DKA by CBG measurement and correctly identify severe hyperglycemia.

Clinical Presentation

A 2-year-old girl presented to a UC center with her father after he noticed she was breathing more rapidly than normal when he picked her up from daycare. He reported that she was able to walk and was interactive earlier in the day. However, at the time of her UC presentation, she had become increasingly lethargic and was only arousable to tactile stimuli.

The father also reported that she had had a mild cough and nasal congestion for several days prior to her presentation. The mother offered additional history by phone stating that the patient had slept more than normal for several days prior. They denied noting any fever, changes in appetite, rash, diarrhea, or vomiting. The mother did report the patient seemed to have increased thirst, and urination (including nocturia) for 2 weeks prior to the visit but denied that her daughter experienced recent changes in weight or appetite.

The patient's social history was unremarkable; she lived at home with her parents. The parents reported that the patient was up-to-date with her routine well child visits and vaccinations. The mother had an uncomplicated pregnancy and delivery, and the patient was born at term. She had no known drug allergies and took no daily medications. Parents reported no significant family history of diabetes, autoimmune disorders, or other significant diseases in childhood.

Physical Exam Findings

Vital signs included the following:

- Temperature: 36.4˚C; oxygen saturation: 98%
- Blood pressure: 98/56 mmHg (normal for age: systolic 86-106 mmHg)
- Heart rate: 140 beats per minute (bpm) (normal for age: 90-125 bpm)
- Respiratory rate: 36/minute (normal for age: 22-36 bpm)[3]

The patient was generally thin and appeared lethargic in her parent's arms; the UC clinician noted an unusual odor to the patient's breath as well. The head and neck exam revealed clear rhinorrhea and slightly dry membranes. The cardiopulmonary exam was remarkable for mild, but regular tachycardia, and clear lungs with deep, rapid (ie, Kussmaul) respirations with intercostal retractions. The patient's capillary refill was slightly delayed. On abdominal exam, there was no distention or apparent tenderness. The neurologic assessment was limited due to lethargy, but the patient was able to withdraw to noxious stimuli in all extremities. She did not open her eyes but did moan with stimulation. The patient's skin was dry, and there was no mottling, bruising, or rashes noted.

Urgent Care Management

Labs included the following:

- Point of care antigen COVID-19: negative
- Glucometer: >400mg/dL x 2 readings (machine numerical high limit is 400mg/dL)

Differential Diagnosis

Altered mental status in toddlers has a broad differential. As such, it is helpful to characterize altered mental status more descriptively (eg, fussy, irritable, lethargic). This patient presented with decreased responsiveness (ie, lethargy). Etiologies considered included: head trauma, central nervous system infection, intracranial mass or hemorrhage, septic shock, intoxication/ingestion, hypoglycemia, seizure/non-convulsive status epilepticus, and DKA.

Evaluation, Medical Decision Making, and Disposition

The UC clinician astutely identified the combination of lethargy/decreased responsiveness with a Kussmaul respiratory pattern. Kussmaul respirations are defined as a rapid, deep respirations which occur as physiologic compensation mechanism in the setting of metabolic acidosis to expel the excess carbon dioxide (CO2) and raise pH.[4] With the increase in respiratory rate and tidal

volume associated with Kussmaul respirations, minute ventilation and the rate of CO2 elimination also increase proportionally. However, this resultant respiratory alkalosis response is limited by the capacity of the respiratory system and, in cases of severe acidosis, may become inadequate as the ventilatory musculature fatigues leading to respiratory failure.[4]

The patient's presentation in combination with the parents' reports of polyuria and polydipsia is also consistent with a new diagnosis of T1DM. The undetectably high blood glucose on CBG confirmed the clinician's suspicions of probable DKA. [5] Given the patient's decreased level of consciousness, EMS were activated immediately, and the patient was taken to the local pediatric ED.

Case Resolution

In the ED, the patient had intravenous (IV) access established and isotonic crystalloid bolus of 10mL/kg was initiated while awaiting laboratory results. The basic metabolic panel results were significant for sodium of 131 mmol/L, bicarbonate of 3 mmol/L, glucose of 432 mg/dL, and an anion gap of 26.3 mEq/L. A complete blood count was normal except for mild leukocytosis with a white blood cell count of 18,400/mL. The serum beta-hydroxybutyrate (BHB) was 9.9 mmol/L (levels >3mmol/L is a sensitive indicator of DKA[6]). A venous blood gas showed a pH below the limit of detection of 6.97 with a partial pressure carbon dioxide measurement of 14. After verifying the patient was not hypokalemic, the ED clinician evaluating the patient initiated a weight-based insulin infusion.

The patient was subsequently admitted to the pediatric intensive care unit where insulin infusion was continued with close monitoring of blood glucose, anion gap, and electrolytes. During the hospitalization, the patient was seen by an endocrinologist who confirmed the presumptive diagnosis of T1DM. She was transitioned to subcutaneous insulin, and the family was given dietary counseling and diabetes education. The patient was discharged home in good condition and full return to normal behavior after a 3-day inpatient stay.

At a 2-year follow-up visit, the patient had subsequently been diagnosed with Graves' disease. Her mother reported that despite these diseases, the patient was doing well on the appropriate treatments for both autoimmune endocrine disorders.

Discussion

The diagnostic criteria for DKA are: blood glucose >200mg/dl; venous pH <7.30 or serum bicarbonate <18mmol/L; and ketonuria or ketonemia.[6] The diagnosis of DKA can be challenging in younger children, such as the patient presented. The barriers to clinical assessment of younger children commonly lead to delays in diagnosis and greater severity of DKA at the time of diagnosis.[1] A 2010 study published in *The Journal of Pediatrics* found that patients with new-onset T1DM had greater than twice the likelihood of older children for presenting in DKA at the time of diagnosis.[7]

When considering the possibility of DKA, the limited-scope diagnostic equipment in UC centers, in addition to an appropriate history and physical exam, can effectively screen patients of any age for DKA. A CBG is a rapid, accurate, and ubiquitous screening tool that can quickly determine if significant hyperglycemia, a requisite criterion for DKA, is present.[6] Urine dipstick tests detect the presence acetone and acetoacetate (rather than BHB) through a chemical reaction. The absence of urinary ketones on dipstick testing (ie, ketonuria) is 97% sensitive for excluding DKA.[8]

The non-specific symptoms associated with diabetes and DKA coupled with limited verbal abilities and the relatively rapid respiratory rate—which is normal in toddlers compared to older children and adults—are likely contributors to diagnostic delays. Consequently, many young children have multiple healthcare visits during the month of initial T1DM diagnosis before the condition is finally identified.[9] Additionally, DKA is often precipitated by another illness such as a viral upper respiratory infection (URI) or gastroenteritis. Given that vomiting and abdominal pain are the most common symptoms of DKA in children, it is understandable that early symptoms of DKA can be confused with residual symptoms of the triggering illness.[10,11] While Kussmaul respirations, lethargy, and tachycardia were present in this child, they can be late findings and may not be evident in mild-moderate DKA.[10]

The peak incidence of T1DM occurs between 8-12 years of age.[12] However, the incidence is increasing most rapidly among children under 5 years.[13] This group is also at the highest risk of delayed diagnosis, severe dehydration, and presentation with severe DKA.[14] The risk for T1DM is multifactorial with influences from environment, geography, genetics, diet, and predisposing viral illness.[15] The association with preceding viral infections is believed to partially explain seasonal increases in the incidence of T1DM in children.[16] COVID-19 infection has also been shown to increase the likelihood of developing T1DM even beyond the first month post-infection.[17,18] Therefore, it is of particular importance for UC clinicians to keep new-onset T1DM and

DKA in the differential for ill-appearing children, especially during peaks in the incidence of viral URI. This is crucial because the risk of developing T1DM is higher after viral infection, and UC centers tend to see higher volumes during these seasons.

Treatment for pediatric DKA is nuanced and begins with volume expansion to correct hypoperfusion/shock with isotonic crystalloid (eg, 0.9% normal saline or balanced solutions) beginning with a 10-20mL/kg bolus and reassessing. Close monitoring of electrolytes, particularly potassium, and blood glucose levels is critical, especially after beginning IV insulin treatment. Insulin is a less urgent therapy and should not be started for at least 1 hour and only after electrolyte levels are known.[19]

Given the risks of iatrogenesis (eg, cerebral edema, hypoglycemia, hypokalemia), it is generally most appropriate to activate EMS rapidly from UC and defer DKA management to personnel in the ED. Obtaining IV access in children, calculating infusion rates, and setting up IV pumps are uncommon UC procedures that can predispose to dosing errors and delays in definitive care.

Ethics Statement

Informed written consent was obtained from the parent of the patient.

Takeaway Points

- While the peak incidence of T1DM onset is 8-12 years, the incidence of T1DM in children under 5 years is increasing.
- Consider DKA in children who present with lethargy and/or rapid, deep respirations, even if there is no known history of diabetes, and consider a very low threshold to check a CBG level.
- Young children and toddlers are more likely to present with severe DKA and have delays in diagnosis due to limited verbal abilities and non-specific symptomatology (eg, vomiting and abdominal pain).
- Absence of classic symptoms of T1DM (eg, polyuria, polydipsia, and polyphagia) is common in younger patients with new-onset diabetes.
- The diagnostic criteria for DKA are hyperglycemia (>200mg/dL), acidemia, and ketonemia. A urine dipstick is a sensitive screening test for ketosis and Kussmaul respirations can serve as a useful clinical surrogate indicating acidemia.
- In children, both T1DM and DKA are most commonly precipitated by viral infections. It is therefore especially important during viral URI season to remain attentive to children's behavior and vital signs to reduce the likelihood of missing cases of DKA. ■

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