ISSN: 2755-0281

Journal of Pediatrics Research Reviews & Reports

SCIENTIFIC Research and Community

Case Report

Open Access

Tachycardia Unresponsive to Crystalloid Bolus

Meryam Jan[1], Rima Dababneh[2], Joseph Shiber[1]* and Emily Fontane[1]

[1]University of Florida College of Medicine - Jacksonville, Florida, USA

[2]Department of Pediatric Cardiology, Rush University, Chicago IL, USA

ABSTRACT

Dehydration is a common complaint in the pediatric emergency department. The treatment is typically focused on oral or intravenous rehydration with the goal of normalization of vital signs, primarily the heart rate but potentially also the blood pressure. The failure of routine therapy may lead to the consideration of other etiologies, including potential chronic conditions. We present a unique case of a twenty-three-month-old female who initially presented to the pediatric emergency department with signs of dehydration secondary to vomiting and diarrhea as well as tachycardia that did not improve with fluid resuscitation. Although physical examination findings were subtle, laboratory testing later confirmed the diagnosis of thyrotoxicosis. She was started on treatment with atenolol and methimazole. This case describes thyroid disease in a young child without a history of maternal autoimmune illness, which is rarely diagnosed in the emergent department. Healthcare providers should be cognizant of the spectrum of clinical findings in pediatric hyperthyroidism, since the early recognition and treatment is crucial for improved outcomes with this life-threatening pediatric condition. We discuss the consequences of undiagnosed Grave's disease and review common findings that can assist with early diagnosis in the emergency department.

***Corresponding author**

Joseph Shiber, Departments of Emergency Medicine, Neurology, and Surgery, USA. Tel: 1-919-244-3981.

Received: January 13, 2024; **Accepted:** January 17, 2024; **Published:** January 22, 2024

Case Presentation

A twenty-three-month-old girl was brought to the pediatric emergency department by her grandmother for non-bloody, non-bilious vomiting and watery diarrhea that had been worsening over a four-day period. In addition, the child had subjective fever and was noted to be less active than usual. She was born full-term and had an unremarkable perinatal and medical history. Her grandmother reported that the child had been small since birth. Review of records demonstrated her birth weight to be 6 lbs at 41 weeks gestational age (3rd percentile). On exam, she appeared weak and small for her age. She was ill-appearing without signs of respiratory distress. Her skin appeared sallow. Her rectal temperature was 98.7 F, heart rate was 149 beats per minute (bpm), blood pressure was 112/73 mmHg, respiratory rate and oxygen saturation were normal. Her weight was currently at the 26th percentile after having previously achieved over the 40th percentile. She had normal skin turgor and moist mucous membranes. Cardiac exam demonstrated a hyperdynamic precordium and grade III/VI harsh systolic murmur. Her lungs were clear. Her abdomen was soft and nontender. Rapid blood glucose test was normal. Her treatment in the pediatric emergency department included two intravenous 20 mL/kg crystalloid boluses and intravenous ondansetron. Upon reassessment, her heart rate was higher at 155 bpm, and blood pressure remained elevated at 120/70 mmHg with other vital signs unchanged. Serial examination revealed subtle proptosis, mild tremor of outstretched arms, and fine hair on the scalp. Her grandmother confirmed that these findings had developed over the last several months. Her newborn screen was without abnormalities. There was no maternal history of thyroid disease, thyroidectomy, or radioiodine ablation. Review of her growth chart revealed a drop in weight from 43rd to 26th percentile over the last 2 months.

Diagnostic tests in the pediatric emergency department included a 12 lead EKG that was notable for sinus tachycardia at 164 bpm with early repolarization. A chest radiograph showed a normal heart size and no lung abnormalities. Echocardiogram showed hyperdynamic systolic function, normal valves and chamber size, and no septal defect. Her serum chemistry panel was notable for a bicarbonate of 12 mmol/L and an anion gap of 30 mg/dL.

Discussion

Differential Diagnosis

sepsis, primary tachyarrhythmia, myocarditis, undiagnosed congenital cardiac disease (such as ASD, VSD, or aortic coarctation), sympathomimetic poisoning, anticholinergic poisoning, serotonin syndrome, anemia, leukemia, hyperthyroidism.

Actual Diagnosis

Pediatric Grave's Disease

The Condition

Pediatric Graves' disease is rare, with an estimated incidence of 0.1 to 3.0 cases per 100,000 children. It is more common among girls and most often associated with a maternal history of thyroid disorder due to transplacental passage of thyroid stimulating

immunoglobulins (TSIs) which may persist after thyroidectomy or radioactive iodine ablation. However, rarer causes of hyperthyroidism such as genetic mutations may present throughout varying ages in childhood and often are missed diagnoses at initial presentation. Case reports of Graves' disease beyond the neonatal period in children less than 4 years of age are extremely rare. Undiagnosed cases can have significant consequences on the physiological development of a child and have been associated with decreased intellectual ability, heart failure, atrial fibrillation, and death [1-4].

Hyperthyroidism in the pediatric population is not uncommon. During the neonatal and infancy periods, it is usually attributed to a maternal history of thyroid disorder due to transplacental passage of TSIs. It is estimated that 1% to 12.5% of neonates born to women with Graves' disease will have symptomatic hyperthyroidism. Compared to hyperthyroidism, Graves' disease is rare in pediatrics with an incidence as low as 0.01 per 100,000 cases and may be associated with genetic mutations. 1 These children may present with protean symptoms throughout varying ages in childhood with the diagnosis often delayed. Progressive and undiagnosed symptoms can be fatal if untreated, with a mortality rate as high as 20% if left unidentified, usually from heart failure [2,3,4].

A key difference is that neonatal thyrotoxicosis secondary to maternal TSIs is a transient disorder which typically resolves after maternal antibodies have cleared from the neonate's bloodstream, usually by 8-20 weeks postnatal age, whereas Graves' disease is progressive [5]. Our patient had hyperthyroidism despite a negative history of maternal thyroid disease and a normal newborn screen. This may potentially occur in the absence of maternal autoimmunity because of activating mutations in the TSH receptor [6]. However to our knowledge, there are no case reports demonstrating this phenomenon in a patient as young as ours. Graves' disease also predisposes one to other autoimmune disorders as seen in our patient who was later diagnosed with juvenile myasthenia gravis [7].

Symptoms and sequelae of thyroid disease are attributed to the biochemical effects of thyroid hormones on cellular processes throughout the body. Thyroid hormones have a direct effect on vascular smooth muscle cells and cause decreased systemic vascular resistance and a decreased mean arterial pressure, which leads to the activation of the renin-angiotensin-aldosterone system. Moreover, thyroid hormone directly affects the action potential and repolarization currents in cardiac myocytes which accelerate the heart's intrinsic sinoatrial rhythm. The effect of thyroid hormones on the circulatory system includes increased heart rate, intravascular volume and cardiac output [8].

Newborn screening in the United States remains the most common tool for identification of the diagnosis in early life but can be negative in children who develop hyperthyroidism in later years. Identifying subtle but significant physical signs and symptoms is crucial in initiating the work-up for hyperthyroidism. Uncommon but significant findings in the newborn include hyperviscosity syndrome and microcephaly [9,10]. Findings such as irritability, jitteriness, and restlessness have been reported but are nonspecific. Ocular findings such as proptosis as seen in our patient and exophthalmos have been reported in the literature but may be difficult to identify in a small or uncooperative child.11,12 Common symptoms such as extremity tremor, tachycardia, elevated blood pressure, and heat intolerance are most often reported [3-13]. Our patient had both tachycardia unresponsive to fluid resuscitation, and hypertension, which prompted further investigation as other exam findings were not suggestive of cardiogenic shock or pulmonary edema. Unfortunately, many children who remain undiagnosed for a prolonged period of time will develop arrhythmias and progress to overt cardiac failure [14].

Treatment / Management

Treatment involves cardio selective beta-blockers in the acute period (atenolol or propranolol) with long-term methimazole which is the only anti-thyroid medication approved for use in children. Administer antipyretics such as acetaminophen if febrile and glucocorticoids, such as dexamethasone or hydrocortisone to decrease peripheral conversion of T4 to T3 [15]. Propylthiouracil (PTU) is no longer used in the pediatric population due to the significant risk of developing fulminant liver failure [16]. It is important to establish care with a pediatric endocrinologist promptly, perhaps even with a consultation in the emergency department if such a resource is available.

Patient Course

Her T3 and free T4 were elevated at 3.30ng/dL and 5.89 ng/dL respectively and TSH was markedly suppressed at <0.005 mIU/L. Her examination and laboratory findings were conclusive for hyperthyroidism. She was admitted to a monitored bed on the pediatric service, and a pediatric endocrinologist was consulted for recommendations. Her thyroid stimulating immunoglobulin (TSI) was 299% of reference control confirming Graves' disease as the etiology of hyperthyroidism in this patient and she was started on treatment with atenolol and methimazole. Longitudinal follow-up demonstrated that the child also developed juvenile myasthenia gravis the same year she was diagnosed with Graves' disease and is currently being treated with pyridostigmine. Four months after initiation of treatment, her growth charts revealed weight at the 70th percentile for age and sex.

Conclusion

Although sinus tachycardia in the setting of dehydration and fever are common presenting signs in the pediatric population in ED and outpatient settings, failure to respond to routine interventions such as antipyretics and rehydration should prompt a clinician to consider alternate diagnoses. Maintaining a high index of suspicion for other etiologies such as cardiac rhythm or function abnormalities, shock or other less common systemic illnesses such as hyperthyroidism can lead to their early detection and successful management which provides for favorable short and long-term patient outcomes.

Lessons for the Clinicians

- Not all tachycardia in children is due to dehydration
- Elevated temperature doesn't always indicate an infectious process
- Failure of elevated heart rate and temperature to normalize after intravenous fluids and antipyretics should prompt further investigation of underlying etiology
- Hyperthyroidism can be subtle initially in young children

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