A 19-year-old adolescent with Asperger syndrome experiences a syncopal episode during which he falls and strikes his head while standing outdoors with friends. The episode occurs in June in Colorado, where the patient and his family live. Emergency medical personnel find the patient conscious but experiencing bradycardia upon their arrival. The patient does not remember the episode, does not report any presyncopal symptoms, and states that he had been feeling well earlier that day. He has no prior history of syncopal episodes or cardiac conditions.

Two weeks earlier the patient was seen by his primary care physician for an annual physical examination and noted to have bradycardia, with a heart rate of approximately 40 beats per minute. He was otherwise well and reported no recent constitutional symptoms, respiratory illness, rash, or cardiac-related symptoms such as palpitations. Sinus bradycardia was confirmed by electrocardiography (ECG) with no other abnormalities, and the patient was referred for outpatient cardiology evaluation. A pre-visit 24-hour ambulatory ECG demonstrated predominantly sinus rhythm with second-degree (Wenckebach also known as Mobitz type 1 block) atrioventricular (AV) block (Fig 1A) and periods of complete AV block (Fig 1B). However, this result and findings from the cardiology evaluation were pending at the time of the syncopal episode.

Upon evaluation in the emergency department, the patient is afebrile, with a heart rate of 42 beats per minute and blood pressure of 122/66 mm Hg; respiratory rate and oxygen saturation are within normal ranges. The only finding of note on physical examination is bradycardia. ECG reveals sinus rhythm with first-degree heart block (PR interval 0.31 seconds); continued cardiac monitoring documents an episode of a premature ventricular contraction followed by second-degree heart block for several seconds. During attempted orthostatic blood pressure measurement, the patient converts to third-degree heart block, with a ventricular conduction rate of 25 beats per minute, and becomes presyncopal.

Laboratory evaluation shows an elevated white blood cell count of 20,600/µL (20.6 × 10⁹/L) with 82% neutrophils, 10% bands, and 6% lymphocytes; hematocrit of 41.9%; and platelet count of 344 × 10⁹/µL (344 × 10⁹/L). Metabolic panel, including potassium, calcium, magnesium, and glucose, yields unremarkable results. C-reactive protein is 2.9 mg/dL (27.6 nmol/L) (normal 0–1.0 mg/dL [0–9.5 nmol/L]).
and erythrocyte sedimentation rate is 18 mm/hr (normal 0–15 mm/hr). The patient is diagnosed with bradycardia of unknown etiology and is admitted for further evaluation and monitoring.

**DIAGNOSIS**

Additional detailed questioning after admission revealed that 3 weeks prior, the patient had returned from boarding school in Connecticut, where he lived in a dormitory off campus and walked each day through a wooded area to class. He did not, however, recall a tick bite or prior rash.

Two-tiered serologic testing for Lyme disease (LD) yielded positive enzyme immunoassay (index >7.3, cutoff value ≥0.9), immunoglobulin (Ig)M Western blot of 3/3 scored antibody bands, and IgG Western blot of 7/10 scored antibody bands. Echocardiography showed normal cardiac anatomy and function and an echobright interventricular septum with a speckling pattern suggestive of myocarditis. Cardiac magnetic resonance imaging demonstrated mild biventricular dilation.

Additional infectious causes of bradycardia were ruled out with appropriate blood, rectal, and respiratory samples negative for enterovirus, adenovirus, influenza, other respiratory viruses, cytomegalovirus, and Epstein-Barr virus by polymerase chain reaction testing; negative rapid plasma reagin results; and negative results for group A Streptococcus antibodies. Additional noninfectious causes of bradycardia such as medications, acute myocardial infarction, and inflammation were also eliminated.

**DISCUSSION**

*Borrelia burgdorferi* is the causative agent of LD, a zoonotic infection transmitted to humans in the United States via the bites of blacklegged (*Ixodes* species) ticks. LD is the most common vector-borne disease in the United States but is endemic only in the Northeast, Upper Midwest, and parts of the Pacific coast states. LD also occurs in Europe, Russia, and parts of eastern Asia, including China.

Early localized infection occurs 3 to 30 days after tick bite and typically manifests as erythema migrans (EM) rash
along with constitutional symptoms such as fever, fatigue, and arthralgias. If untreated, the bacteria may spread hematogenously, exhibiting tropism for nerve, cardiac, and joint tissues. Signs of early disseminated disease include multiple EM rashes, facial palsy, carditis, and meningitis and usually develop 3 to 6 weeks after the tick bite. Late disseminated LD most commonly causes arthritis. Patients with an EM rash who live in or have traveled to an area endemic for LD can be diagnosed clinically. In all other cases, diagnosis should be confirmed by serologic testing using a 2-tiered testing algorithm recommended by the Centers for Disease Control and Prevention.

Lyme carditis results from direct spirochete invasion of cardiac tissue and typically manifests as conduction delay in the AV node. Approximately 16% to 29% of children with early disseminated LD have associated ECG abnormalities, although not all affected patients are symptomatic. Additional manifestations include myocarditis, endocarditis, pericarditis, pericardial effusion, tachyarrhythmias, and prolonged QT interval. Recent studies of early disseminated LD demonstrated that children older than 10 years of age were more likely to have carditis compared to younger children.

Recent developments have broadened the understanding of Lyme carditis. A 2013 report of sudden death in 3 young, otherwise healthy adults due to Lyme carditis suggests that it may be an underrecognized cause of sudden cardiac death. None of the patients had antecedent EM rash or clinical suspicion of LD at the time of death. A retrospective analysis of third-degree heart block due to LD found that 40% of patients with third-degree heart block presented with syncope and that males ages 10 to 45 years were disproportionately affected.

**Differential Diagnosis**
The differential diagnosis of heart block in an adolescent may include acute rheumatic fever, cardiomyopathy, viral myocarditis, postoperative state, and digitalis or β-blocker toxicity. Given its nonspecific presentation of fatigue, palpitations, and possibly syncope, Lyme carditis can be challenging to diagnose, particularly when antecedent clues of tickborne disease are lacking. Because the bites of blacklegged ticks are typically painless and nymphs are very small (the size of a pinhead), many individuals with LD have no recollection of a tick bite. Moreover, an EM rash may not develop or be noticed; a recent study found that only 42% of reported Lyme carditis cases had associated EM. Therefore, clinicians should consider Lyme carditis in patients with epidemiologic risk for disease and compatible clinical presentation, even if typical antecedent clues are absent.

**Management**
Those who have mild carditis can be managed as outpatients and treated with oral antibiotics such as doxycycline or amoxicillin for 14 to 21 days. All patients with first-degree AV block with a PR interval equal to or greater than 300 milliseconds, second- or third-degree AV block, or symptoms of cardiac disease (eg, chest pain or syncope) should be hospitalized for continuous monitoring. Temporary pacemaker placement may be necessary. Hospitalized patients should be treated...
with ceftriaxone and switched to oral antibiotics when the PR interval is less than 300 milliseconds for a total treatment duration of 14 to 21 days. Conduction disturbances typically improve within 7 days and resolve by 6 weeks.

**Prognosis**

When LD is recognized and treated early in the course of disease, patients typically recover quickly and without complications. Fortunately, most patients with Lyme carditis are seropositive upon presentation, so if LD is suspected, the diagnosis can usually be confirmed by serologic testing. Untreated conduction delay, however, can fluctuate and progress rapidly to life-threatening third-degree (ie, complete) heart block, as demonstrated in this patient. Therefore, timely recognition and treatment of Lyme carditis is essential to avoiding serious complications.

**Patient Course**

The patient was treated with ceftriaxone 2 g intravenously daily. Presyncopal symptoms and heart rate improved (Fig 2). Upon discharge, the boy’s heart rate had increased to 69 beats per minute, with residual first-degree AV block. He continued ceftriaxone treatment for a total of 10 days but developed urticaria and was switched to oral doxycycline 200 mg twice daily to complete a total of 28 days of antibiotic treatment. Four weeks after discharge, the patient was asymptomatic, and 24-hour ambulatory ECG demonstrated normal sinus rhythm with an average heart rate of 74 beats per minute and borderline first-degree AV block (PR interval 170–200 milliseconds). Exercise stress test performed 6 weeks after discharge yielded normal results.

**Summary**

- Carditis is a potentially life-threatening manifestation of early disseminated Lyme disease and may not be preceded by a history of tick bite or typical clinical signs.
- Studies suggest that adolescents and males appear to be at greater risk for Lyme carditis and specifically third-degree heart block.
- Recent sudden cardiac deaths due to Lyme disease in young adults highlight the importance of prompt recognition and treatment of Lyme carditis.
- Although Lyme disease can only be contracted in certain parts of the United States, Europe, and Asia, it is essential to consider the diagnosis and obtain a detailed travel history in patients presenting with signs or symptoms of Lyme disease in any location.

**Suggested Readings**

Visual Diagnosis: 19-year-old Boy with Syncope and Bradycardia
Christina A. Nelson, Mark A. Farina, Daniel Olson, Samuel R. Dominguez and Elizabeth J. McFarland
Pediatrics in Review 2016;37;e25
DOI: 10.1542/pir.2015-0121

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