

# Lyme carditis and accelerated junctional rhythm with intermittent left bundle branch block and paroxysmal atrioventricular block



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## Introduction

Lyme disease is the most commonly reported vector-borne disease in North America, where it is transmitted by the *Ixodes* tick and caused by the gram-negative spirochete bacteria *Borrelia burgdorferi*.<sup>1</sup> The most common manifestation of Lyme carditis, first described in 1980, is atrioventricular (AV) block. It is reversible with antibiotics. Rarely, permanent pacemakers are required and death due to progressive AV block has been reported. Thus, the clinical course of Lyme carditis based on electrocardiogram (ECG) features is of interest. Herein, I present a case of Lyme carditis and accelerated junctional rhythm with intermittent left bundle branch block (LBBB) and paroxysmal AV block.

## Case report

In July 2023, a 22-year-old man with Bannayan-Riley-Ruvalcaba syndrome, syndromic scoliosis with posterior spinal fusion, and autism spectrum disorder was kneeling at church on a Sunday afternoon when he lost consciousness and lurched forward with his whole body shaking. His mother caught him, so he did not sustain any trauma. He regained consciousness after 6 seconds and was taken to the emergency department. He denied fever, malaise, arthralgia, and dyspnea.

Around the age of 15 years, he was diagnosed with suspected Bannayan-Riley-Ruvalcaba syndrome, a *PTEN* hamartoma tumor syndrome, on the basis of macrocephaly, developmental delay with autistic features, hyperpigmented lesions on his phallus, and a polypoid lesion on his tongue. Four years later, he underwent *PTEN* genetic analysis and a

## KEY TEACHING POINTS

- Lyme carditis can present as accelerated junctional rhythm with intermittent left bundle branch block and paroxysmal atrioventricular (AV) block. Isorhythmic AV dissociation may be present.
- Guideline-directed antibiotic therapy recommendations for hospitalized patients with Lyme carditis, which involves intravenous ceftriaxone with transition to oral antibiotics on clinical improvement and 14–21 days of total antibiotic treatment, does not seem to be practiced in the real world for accelerated junctional rhythm or junctional tachycardia.
- The need for temporary pacing, even in the setting of multiple episodes of paroxysmal AV block, should be evaluated on a case-by-case basis.

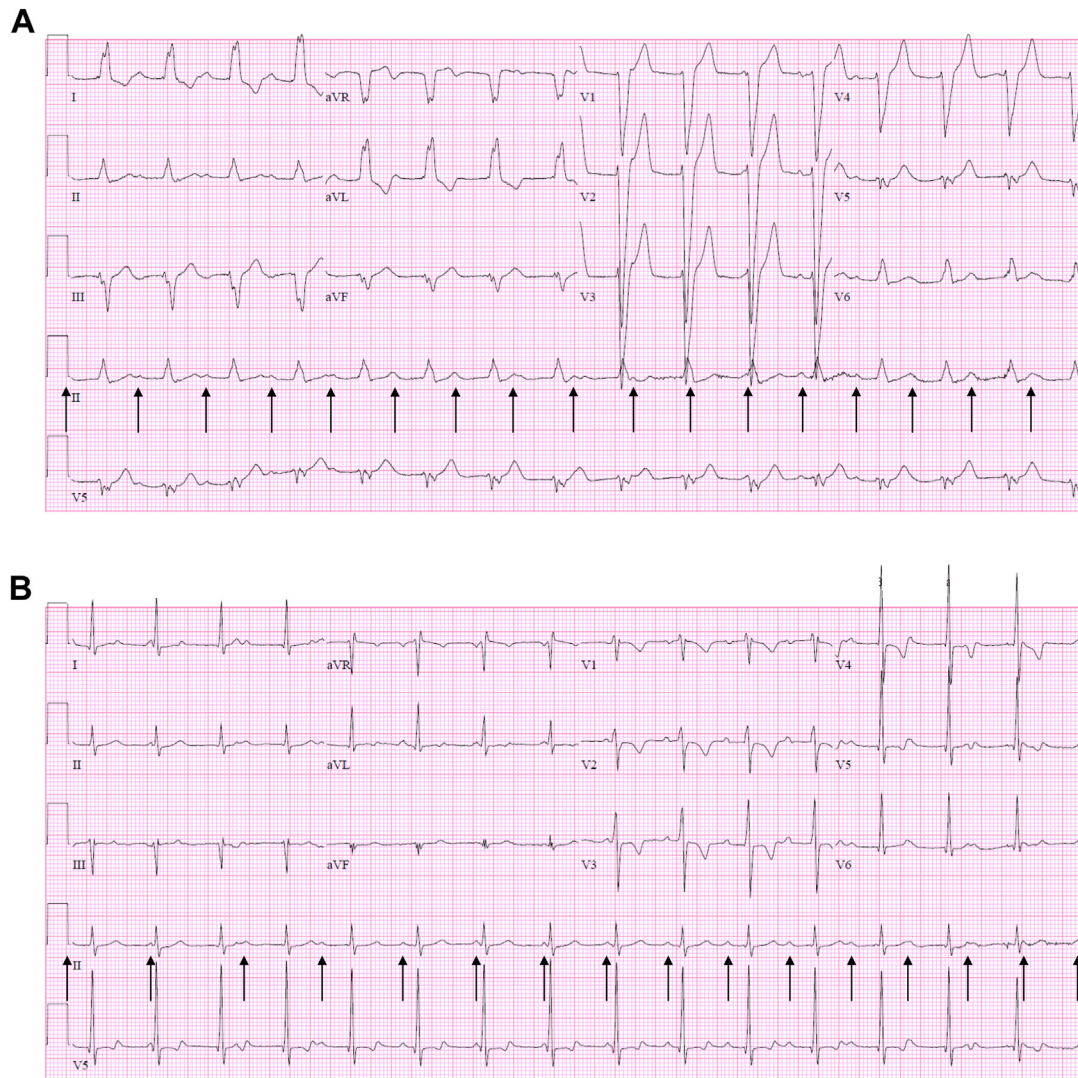
pathogenic variant, c.955\_958delACTT (p.Thr319Ter), was identified.

He resided with his parents in western Pennsylvania and was an only child. He was employed as a greeter in an office plaza. He did not have heavy exposure to wooded areas, but walked regularly with his parents in areas with trees and other vegetation. There were no known tick exposures or bites. He had a regular exercise routine with his father at a gym that consisted of walking 35 minutes on a treadmill and lifting light weights 3 days per week.

On arrival to the emergency department, his blood pressure was 137/97 mm Hg and his heart rate was 99 beats/min. Aside from features associated with Bannayan-Riley-Ruvalcaba syndrome, his physical examination was unremarkable. There were no rashes. Initial blood tests were remarkable only for a thyroid stimulating hormone of <0.008  $\mu$ IU/mL (normal: 0.550–4.780  $\mu$ IU/mL). Later

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**Figure 1** Electrocardiograms demonstrated isorhythmic atrioventricular (AV) dissociation between sinus P waves (arrows) and accelerated junctional rhythms. **A:** Left bundle branch block morphology rhythm at 94 beats/min on hospital day 1 at 11:03 PM. The initial 4 P waves may have conducted with prolonged PR intervals to the QRS complexes. However, the constant R-R intervals throughout this and other tracings supported constant AV dissociation. A definitive diagnosis would require invasive electrophysiology study. **B:** Narrow QRS complex rhythm at 92 beats/min on hospital day 2 at 4:20 PM.

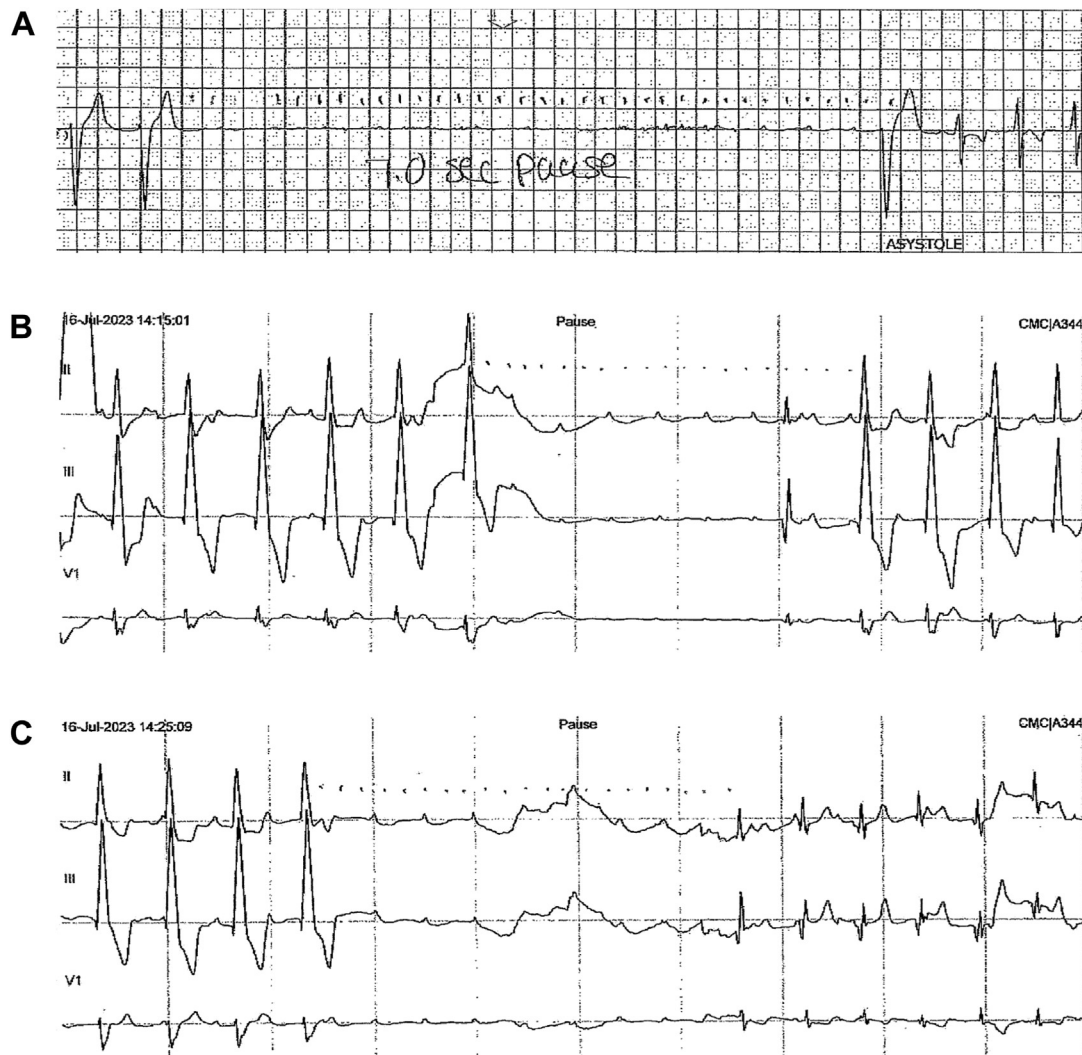
during the hospitalization, he was diagnosed with hyperthyroidism owing to a free T4 of 2.79 ng/dL (normal: 0.93–1.70 ng/dL) and a T3 of 122 ng/dL (normal: 60–180 ng/dL).

His SILC (Suspicious Index in Lyme Carditis) score was 3, or intermediate, for age <50 years, male sex, and outdoor activity or endemic area.<sup>1</sup> Accordingly, Lyme tests were ordered and intravenous (IV) ceftriaxone 3 mg daily was started. He was admitted to the intensive care unit.

The presenting ECG demonstrated isorhythmic AV dissociation between sinus P waves and an escape rhythm with LBBB morphology at 94 beats/min (Figure 1A). The LBBB morphology was typical, with a rapid intrinsicoid deflection. The primary differential diagnosis included accelerated junctional rhythm with LBBB aberrancy and accelerated idioventricular rhythm.<sup>2</sup> Less common infra-atrial reentrant arrhythmias and relatively slow AV nodal

reentrant tachycardia (or arrhythmia) with complete block in the perinodal transitional tissue, which separates AV nodal and atrial tissues, were possibilities. An ECG on hospital day 2 demonstrated a narrow QRS rhythm at 92 beats/min (Figure 1B). In between these ECGs, during the afternoon of hospital day 2, he had 3 episodes of paroxysmal AV block (Figure 2) that were associated with mild lightheadedness. Given these findings, it was believed that the initial ECG was accelerated junctional rhythm with LBBB aberrancy. Echocardiography and cardiac magnetic resonance imaging were normal.

Standard 2-tier testing for Lyme disease was performed.<sup>1,3</sup> The enzyme-linked immunosorbent assay screen for *B. burgdorferi* antibodies was positive. On hospital day 5, his Western blot returned 3 of 3 bands for immunoglobulin M antibodies (positive) and 3 of 10 bands for immunoglobulin



**Figure 2** Telemetry strips on hospital day 2 demonstrated paroxysmal atrioventricular block. **A:** Time 2:10 PM. **B:** Time 2:15 PM. **C:** Time 2:25 PM.

G antibodies (negative). This suggested a recent infection, as the immunoglobulin M response occurs in 1–2 weeks and the immunoglobulin g response occurs in 2–4 weeks.<sup>3</sup>

On hospital day 6, his ECG demonstrated sinus rhythm at 75 beats/min with a PR interval of 246 ms (Figure 3A). IV ceftriaxone was discontinued and he was discharged on doxycycline 100 mg twice daily for 17 days. Thus, the total antibiotic therapy duration was 23 days.

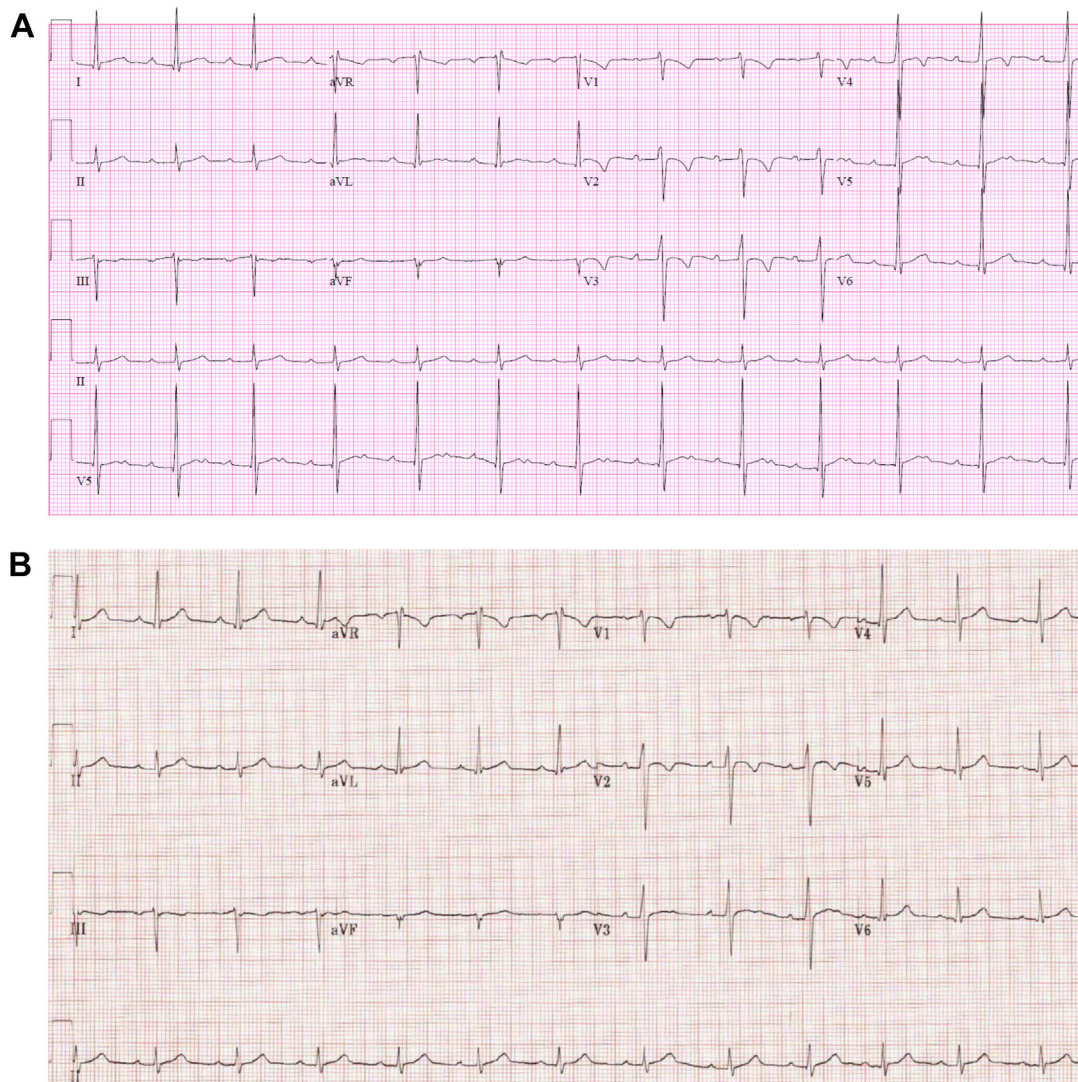
At his follow-up appointment, 17 days after initial presentation, his ECG demonstrated sinus rhythm at 77 beats/min with a PR interval of 176 ms (Figure 3B). A 30-day event monitor placed on discharge yielded a monitored time of 9 days, 20 hours, and 44 minutes. It produced 3 transmissions that recorded sinus rhythm with normal PR intervals and heart rates from 75 to 93 beats/min.

One month after discharge, his thyroid stimulating hormone was  $<0.010$   $\mu\text{IU/mL}$  and his free T4 was 122 ng/dL. He was started on methimazole with continuing endocrinology follow-up. Hyperthyroidism was not felt to contribute to accelerated junctional rhythm.<sup>2</sup>

## Literature review

A literature review of Lyme carditis and detailed cases of junctional rhythms was conducted. Differences between accelerated junctional rhythm (also known as nonparoxysmal junctional tachycardia), with heart rates typically 70–130 beats/min, and junctional tachycardia, with heart rates typically 120–220 beats/min, are detailed elsewhere.<sup>2</sup> The lower limit of accelerated junctional rhythm has been considered 60 beats/min.<sup>2</sup> A primary search of the PubMed database was performed on September 1, 2023, using “Lyme” and “junctional” for Medical Subject Headings terms. A secondary search was performed of reference lists and Google Scholar citations of the selected articles.

The searches yielded 8 publications describing 10 patients.<sup>4–11</sup> The primary search of PubMed retrieved 30 initial articles, of which 4 articles were identified for the review.<sup>4,9–11</sup> The secondary search retrieved 4 additional articles.<sup>5–8</sup> One article, an abstract, described a presenting heart rate of 50 beats/min but designated the arrhythmia as accelerated junctional rhythm.<sup>6</sup> The final patients, with the



**Figure 3** A: Electrocardiogram (ECG) on hospital day 6, or the day of discharge. B: ECG on postdischarge day 11.

patient from this article listed as case 8 under accelerated junctional rhythm, are listed in [Table 1](#). All articles were from the northeast region of the United States.<sup>1</sup>

In 8 patients who were described to have received only IV ceftriaxone, 6 were described to have completed home courses totaling 3 or 4 weeks.<sup>4,8–10</sup> Outpatient antibiotics were not described in 2 other patients, in whose cases only IV ceftriaxone was reported.<sup>5,11</sup> One patient received oral doxycycline and refused hospitalization for IV antibiotics owing to insurance issues.<sup>6</sup> Another patient was prescribed oral doxycycline owing to misinterpretation of the initial ECG and had resolution of complete AV block with a normal ECG by the time IV antibiotics were considered 2 weeks later.<sup>7</sup>

## Discussion

This is the first report of Lyme carditis and accelerated junctional rhythm with intermittent LBBB and paroxysmal AV block. Isorhythmic AV dissociation was an accompanying

phenomenon. Clinical management issues were also noteworthy. First, the patient was managed without temporary pacing. Second, successful treatment with IV ceftriaxone and transition to oral doxycycline after clinical improvement strengthens recommendations in 2020 guidelines from the Infectious Diseases Society of America, American Academic of Neurology, and American College of Rheumatology.<sup>12</sup>

In 1970, Levy and Edelstein<sup>13</sup> described isorhythmic AV dissociation during accelerated junctional rhythm with “rhythmic fluctuation of the interval between the P and QRS waves, most often with the P oscillating gradually back and forth across the QRS” in “a 44-year-old man with chronic myocarditis.” They called this “pattern I” behavior.<sup>13</sup> Using intra-arterial blood pressure recordings, they theorized it resulted from a feedback control loop between influence of PR intervals on arterial blood pressures and subsequent influence of arterial blood pressures on the sinoatrial node frequency through the baroreceptor reflex. This phenomenon has been observed in a previously reported patient.<sup>7</sup>

**Table 1** Published cases of Lyme carditis with accelerated junctional rhythm or junctional tachycardia

Case	First author	Year	Age (y)	Sex	SILC score	HR (beats/min)	PAVB	TPM	PPM	Antibiotics
Accelerated junctional rhythm										
1	Kaltman <sup>4</sup>	2005	7	M	8	73	—	—	—	C
2	Kaltman <sup>4</sup>	2005	15	M	6	79	—	—	—	C
3	Kaltman <sup>4</sup>	2005	9	F	11	65	—	—	—	C
4	Karim <sup>5</sup>	2020	54	F	7	62	—	—	—	C
5	Chaudhry <sup>6</sup>	2021	57	M	8	50	—	—	—	D
6	Burns <sup>7</sup>	2023	26	M	9	60	—	—	—	D
7	Yadav <sup>8</sup>	2023	42	F	7	≈ 102	—	—	—	C
8	Wang	2023	22	M	3	94	+	—	—	C → D
Junctional tachycardia										
1	Frank <sup>9</sup>	2011	3	F	8	163	—	—	—	C
2	Cunningham <sup>10</sup>	2017	12	M	3	≈ 228	—	—	—	C
3	Beach <sup>11</sup>	2023	17	M	12	185	+	+	—	C

C = intravenous ceftriaxone; D = oral doxycycline; F = female; HR = heart rate; M = male; PAVB = paroxysmal atrioventricular block; PPM = permanent pacemaker; SILC = Suspicious Index in Lyme Carditis; TPM = temporary pacemaker.

Dashes (—) indicate not present or not performed. Pluses (+) indicate present or performed.

*B. burgdorferi* invasion may result in diffuse involvement of the cardiac conduction system. Bundle branch block has been described in Lyme carditis.<sup>1</sup> In the case report patient, acceleration-dependent block may have been partially responsible for LBBB, as the accelerated junctional rhythm had heart rates of 94 beats/min when associated with LBBB and 92 beats/min when associated with narrow QRS complexes. Transient recovery of His-Purkinje conduction was observed with narrow QRS complexes with faster heart rates following paroxysmal AV block in telemetry strips presented in Figure 2. This may have been due to the waxing and waning behavior of Lyme carditis.<sup>1</sup> Finally, phase 3 block may also have been a contributing factor given the pathologic state.<sup>14</sup>

Paroxysmal AV block may have resulted from phase 4 AV block, which most often occurs in the presence of a diseased His-Purkinje system.<sup>14</sup> Although often preceded by a bradyarrhythmia, it may also occur suddenly if anterograde impulses fail to enter distal conduction system levels, thereby allowing spontaneous phase 4 depolarization to occur. This manifestation of automaticity does not typically occur owing to “overdrive suppression.” In the case report patient, spontaneous phase 4 depolarization could have occurred if anterograde impulses from the accelerated junctional rhythm were blocked within the His-Purkinje system.

Guideline-directed antibiotic therapy recommendations for hospitalized patients with Lyme carditis are considered a “weak recommendation” and supported by “very low-quality evidence.”<sup>12</sup> The recommendation consists of IV ceftriaxone followed by transition to oral antibiotics on clinical improvement, for 14–21 days of total antibiotic therapy. IV ceftriaxone for at least 3 weeks, which generally requires a peripherally inserted central catheter line on discharge home, seemed to be the preferred treatment. In the literature review, no patients with either accelerated junctional rhythm or junctional tachycardia received guideline-recommended antibiotic therapy. Other experts recommend IV antibiotics for at least 10–14 days followed by oral antibiotics, for a total

course of 14–21 days.<sup>1</sup> Optimal antibiotic therapy is an unsettled area that requires prospective study.

Guidelines designate temporary pacing as a “strong recommendation” with “moderate-quality evidence” for “symptomatic bradycardia due to Lyme carditis that cannot be managed medically.”<sup>12</sup> Yet, other experts recommend temporary pacing for “symptomatic bradycardia or bradycardia with high-risk electrocardiographic features.”<sup>1</sup> In real-world practice, a study using the National Inpatient Sample from 2003 to 2014 revealed that 1216 of 2282 (53.5%) patients with Lyme carditis and complete heart block were managed without temporary or permanent pacing.<sup>15</sup>

No patients in the literature review with Lyme carditis and accelerated junctional rhythm received a temporary or permanent pacemaker. An algorithm for suspected Lyme carditis incorporating the SILC score has been proposed, but is not yet validated.<sup>1</sup>

In the case report patient, management without temporary pacing was reasonable given his young age, absence of prior cardiac disease, history of spinal fusion, and presence of developmental delay. In addition, he was in an intensive care unit and receiving IV ceftriaxone. Episodes of paroxysmal AV block were short in duration and only mildly symptomatic.

## Conclusion

Lyme carditis can present with accelerated junctional rhythm with intermittent LBBB and paroxysmal AV block. It can be fully reversible with guideline-directed antibiotic therapy. Temporary pacing is of uncertain value, particularly in young adults without underlying cardiac disease.

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