

A 15-year-old with chest pain: An unexpected etiology

SAGE Open Medical Case Reports
Volume 10: 1–4
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DOI: 10.1177/2050313X211069026
journals.sagepub.com/home/sco



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Abstract

A 15-year-old female with no significant past medical history presented to the emergency department with 1 day of substernal and pleuritic chest pain, chills, cough, and hematuria. She also had swelling of the face and ankles that resolved by presentation. She was found to have elevated troponin and brain natriuretic peptide during initial workup. Electrocardiogram was normal, but there were significant pleural effusions on chest x-ray. She was strep positive and had blood pressure up to 150/90, prompting admission for cardiac monitoring and cardiology consultation. Blood pressure decreased down to 125/72 without intervention. She was afebrile with unlabored breathing and normal saturations. She was clear to auscultation bilaterally, with no abdominal distension or hepatosplenomegaly, and edema was not evident on exam. There was mild erythema to the bilateral tonsillar pillars. Initial considerations included viral myocarditis, pericarditis, and atypical nephritic syndrome. Workup revealed elevated antistreptolysin antibodies, low C3 complement, negative antineutrophil cytoplasmic antibodies, and negative flu testing. Renal sonography was unremarkable. Cardiology recommended echocardiography, which confirmed pleural effusions but revealed no cardiac abnormalities. Urinalysis revealed hematuria and mild proteinuria. Diagnosis was found to be post-streptococcal glomerulonephritis complicated by fluid overload and left ventricular strain secondary to hypertensive emergency. Post-streptococcal glomerulonephritis is the most common cause of acute glomerulonephritis in children. The mechanism of disease is a proliferation and inflammation of the renal glomeruli secondary to immunologic injury, with deposition of immune complexes, neutrophils, macrophages, and C3 after complement activation. This leads to hematuria, proteinuria, and fluid overload. Edema is present in 65%–90% of patients, progressing to pulmonary involvement in severe cases. Cardiac dysfunction secondary to fluid overload is a potentially fatal outcome in the acute setting. Physicians should consider post-streptococcal glomerulonephritis for patients presenting with hypertension, cardiac/pulmonary pathology, or symptoms of acute heart failure in the context of strep infection.

Keywords

Cardiovascular, nephrology, infectious diseases, general pediatrics, pulmonology

Date received: 22 July 2021; accepted: 7 December 2021

Introduction

Chest pain is a common symptom in children and adolescents but is one that is frequently anxiety provoking in families and patients. The fear of a cardiac cause is often prominent, although the true differential is far more broad. In fact, the incidence of cardiac chest pain in pediatric patients is exceedingly low, ranging from 0.2% to 1% of cases.¹

Chest pain can be seen in up to 6 in 1000 children.² The average age of presentation is ages 12–14, and most commonly, the cause of pediatric chest pain is idiopathic² or of unknown origin. Other causes include musculoskeletal, psychological, gastrointestinal, and respiratory.

Musculoskeletal causes are the most common, and include costochondritis, slipping rib syndrome, precordial

catch syndrome, muscle strain, and trauma.¹ Other common pediatric diagnoses can also cause chest pain, including asthma and respiratory infections. Gastroesophageal reflux disease, a common pediatric complaint, is another frequent etiology. Cardiac causes account for the least of the etiologies, and include pericarditis, mitral valve prolapse, and

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arrhythmias. Finally, cardiac ischemia can cause chest pain in children, but accounts for a very small proportion of cases.¹

Given the danger of undetected cardiac disease in children, and particularly in athletes, the history and physical examination are of particular importance in determining level of suspicion for cardiac involvement. Family history of cardiac disease, sudden death, or history of syncope should increase level of suspicion.¹ If there is increased suspicion for cardiac involvement, next steps include an electrocardiogram (ECG), and potentially an echocardiogram. Any abnormalities should also lead to consideration of cardiology consultation.

In this case report, we present one of those rarer presentations of chest pain that was due to cardiac etiology as a complication of the primary diagnosis.

Case report

A 15-year-old female with no significant past medical history presented to the emergency department (ED) with a 1-day history of substernal and pleuritic chest pain. She reported that she woke up that morning with chest discomfort and shortness of breath, and later had fever, chills, diaphoresis, and swelling of her face and ankles. She was not menstruating and, other than a mild intermittent cough, she denied other symptoms, including sore throat, rash, vomiting, and diarrhea. Although swelling resolved, her chest pain persisted throughout the day, prompting her presentation in the ED. On initial evaluation, she was afebrile with an initial blood pressure of 180/70. Her other vital signs were within normal limits. On physical examination, she was in no acute distress, and lungs were clear to auscultation bilaterally without labored breathing or hypoxemia. Cardiac exam was without murmur and her peripheral pulses were 2+ bilaterally in all extremities. No abdominal distension or hepatosplenomegaly were identified. There was mild erythema to the bilateral tonsillar pillars without frank tonsillar exudate, and no clinical edema was noted in the face or extremities. The remainder of her physical exam, including the skin exam, was unremarkable. Initial laboratory evaluation in the ED revealed an elevated high-sensitivity troponin-T of 16 ng/L (normal < 11 ng/L) and brain natriuretic peptide (BNP) of 5901 pg/mL (normal < 125 pg/mL). Urinalysis revealed significant hematuria (>50 RBC/hpf) and proteinuria of 30 mg/dL, but was otherwise unremarkable. She was admitted for further evaluation and management.

Upon admission, her blood pressure had decreased to 125/72. An ECG was obtained and showed normal sinus rhythm. A chest x-ray (CXR) was notable for trace pleural effusions and bilateral reticular interstitial opacities, concerning for pulmonary edema (see Figure 1). A rapid swab for *Streptococcus pyogenes* was obtained due to erythematous tonsillar pillars and was positive. Initial differential considerations included viral myocarditis, pericarditis, and atypical nephritic syndrome. Nephrology was consulted and



Figure 1. Admission chest radiograph showing diffuse reticular interstitial opacities and trace pleural effusions, concerning for pulmonary edema.

recommended a renal ultrasound, which revealed no abnormalities. Cardiology was also consulted and recommended an echocardiogram which revealed significant bilateral pleural effusions in the setting of a structurally normal heart. Further laboratory evaluation included a complete blood count (CBC), comprehensive metabolic panel (CMP), lipid panel, antistreptolysin antibodies (ASO), C3 and C4 complements, antinuclear antibodies (ANA), antineutrophil cytoplasmic antibodies (ANCA), myeloperoxidase, and urine protein/creatinine ratio. Lab workup was significant for an elevated ASO of 834 IU/mL (normal < 150 IU/mL) and low C3 complement of 21 mg/dL (reference range 90–180 mg/dL). Protein continued to be detected in urine dipstick tests. Creatinine, albumin, total protein, and urine protein: creatinine ratio were normal at 0.66 mg/dL (reference range 0.6–1.1 mg/dL), 3.9 g/dL (reference range 3.8–5.1 g/dL), 6.9 g/dL (reference range 6.3–8.0 g/dL), and 74 mg/g (normal < 200 mg/g), respectively. Viral respiratory testing was also negative. Although there was lack of acute illness symptoms, presumptive diagnosis of strep infection was made given the erythematous tonsillar pillars, positive strep test, and elevated ASO antibodies. This, along with low C3, hypertension, hematuria, and proteinuria on dipstick test, led to diagnosis of post-streptococcal glomerulonephritis (PSGN). Treatment was initiated with amoxicillin and fluid restriction, with slow improvement in her tachycardia and hypertension to normal values. Physical exam remained unremarkable. In addition, her troponin and BNP trended downward with conservative therapy (see Table 1), and she was able to be discharged home with oral antibiotics and close subspecialty follow-up.

Table 1. Patient's cardiac lab markers during admission.

	Admit	12h	18h	24h	36h	48h	Discharge
Troponin (ng/L)	16	16	18	14	15	8	<6
BNP (pg/mL)	5901	7764	5349	3489	2538	2243	1257

BNP: brain natriuretic peptide.

Final diagnosis

PSGN complicated by fluid overload and left ventricular strain secondary to hypertensive emergency.

Discussion

Chest pain or pressure, along with elevated troponin and viral symptoms, can lead to multiple diagnostic considerations. In the pediatric population, leading differential diagnoses often include viral myocarditis or pericarditis. However, in this patient, hematuria resulted in a broadened differential. Hematuria indicates kidney injury and can result from lesions involving the glomerulus, renal interstitium, renal vascular supply, or urinary tract.³ The patient denied hematuria on history, but had red blood cells present on urinalysis, indicating microscopic hematuria. Microscopic hematuria along with proteinuria, as in our patient, especially when accompanied by hypertension or edema, strongly suggests glomerulonephritis.³

PSGN is the most common cause of acute glomerulonephritis in childhood.^{4,5} The mechanism of disease is proliferation and inflammation of the renal glomeruli secondary to immunologic injury, with deposition of immune complexes in the glomeruli, which triggers complement activation and inflammation, allowing for subsequent deposition of neutrophils, macrophages, and C3.⁶ Immune complexes occur in response to Group A *Streptococcus* nephritogenic strains. Cytokines also participate and amplify the damage.⁷ Due to deposition of C3 into the glomeruli, there is transient reduction in serum C3 levels, as evidenced in our patient. This immunologic and inflammatory response leads to glomerular injury with resultant hematuria as well as increased permeability, allowing for leakage of protein and mild proteinuria notable on urinalysis.^{7,8} This glomerular injury also causes excessive fluid and sodium retention, which then results in edema and hypertension.⁵

Most cases of PSGN occur between the ages of 5 and 15 years of age.^{5,9} It is rarely seen in children younger than 2 or older than 18 years of age. The latency period from infection to presentation of PSGN is often 1–2 weeks after pharyngitis but can be longer after skin infections. PSGN frequently presents with edema, gross hematuria, and hypertension, although two-thirds of patients with hematuria can present with microscopic hematuria.⁹ Proteinuria is also common, although it is rarely in the nephrotic range. Nephrotic range proteinuria is generally associated with a

worse prognosis and should prompt consideration of other diagnoses.⁷

Diagnosis of PSGN requires evidence of both glomerulonephritis and infection with group A *Streptococcus*. Abnormal results on urinalysis (hematuria, proteinuria) are sufficient to diagnose glomerulonephritis. However, about 20% of children are asymptomatic carriers of streptococci in the nasopharynx, and therefore positive strep test or culture from the throat should not be considered adequate evidence for diagnosis of PSGN.⁷ As a result, diagnosis usually depends on serologic evidence. In our patient, elevated ASO was used to help make the diagnosis, but other possible serologic tests include anti-DNAse B, antistreptokinase, and antihyaluronidase. ASO and anti-DNAse B are most frequently tested, but ASO is less frequently elevated than anti-DNAse B.⁷ Serologic evidence of depressed C3 also helps with diagnosis and is present in greater than 90% of cases.⁷ Renal biopsy is not necessary to make the diagnosis of PSGN, but may be used in cases with features atypical of PSGN, such as normal C3 levels or nephrotic range proteinuria.⁵ Prognosis in children is generally excellent, but serious complications can occur.

Edema presents in 65%–90% of patients with PSGN.⁵ Hypertension is also extremely common and is present in most patients. Moreover, a recent review estimated that approximately 20% of patients may have hypertensive emergency at presentation.¹⁰ Although many patients are relatively asymptomatic, cardiac dysfunction secondary to fluid overload and severe hypertension can be a potentially serious complication in the acute setting. Other serious potential sequelae include hypertensive encephalopathy and pulmonary edema. However, cases of cardiac dysfunction and sequelae in patients with PSGN are more rare. Congestive heart failure with decreased ejection fraction is a more commonly documented complication, but prolonged QT duration and myocarditis have also been described.^{5,11}

Although congestive heart failure was considered in our patient, this was not determined to be the cause of her cardiac complications. Elevated BNP and pulmonary edema on CXR lead to initial consideration. BNP is a natriuretic peptide released from the ventricles in response to volume expansion and pressure overload, causing myocardial stretch and wall stress. Although BNP is a very sensitive screening measure to help identify patients in need of echocardiography, it can be found in many other conditions (such as cardiac inflammatory or infectious diseases, sepsis, and renal failure).^{12,13} In our patient, normal echocardiography and the lack of other signs of acute heart failure, such as hepatomegaly and pitting edema, made this diagnosis less likely. She did have pulmonary edema, but this was attributed to PSGN-related fluid overload.

Due to elevated troponin-T, type II myocardial infarction (MI) as a cause of the chest pain was also considered. Type I MI occurs when there is evidence of atherothrombotic coronary artery event but type II MI involves a mismatch in

oxygen supply and demand from a condition other than atherosclerotic heart disease.¹⁴ In our patient, a mismatch in oxygen supply and demand was possible in the setting of pulmonary edema and hypertensive emergency, respectively. The fourth universal definition of MI by the American College of Cardiology requires evidence of acute myocardial injury in the setting of clinical evidence of acute myocardial ischemia for diagnosis.¹⁴ However, the evidence of acute myocardial injury must be through detection of rise in cardiac troponin above the 99th percentile of the upper reference limit of normal, a level of at least 236 ng/L in females, which our patient did not satisfy.¹⁵ Another cause of elevated troponin-T includes kidney failure with increased creatinine, but our patient was found to have a normal creatinine, making this less likely.¹⁶ Finally, troponin can be elevated following preload-induced mechanical stretch or physiologic stretches in otherwise normal hearts.¹⁴ Given the fluid overload in our patient, myocardial strain caused by preload-induced wall stress was determined to be the etiology of the elevated troponin, especially in the setting of hypertensive emergency, which can exacerbate myocardial strain.

Management of PSGN involves treatment of the infection, often accomplished with penicillins or, if allergic, erythromycin, as well as symptomatic treatment. Salt and water restriction can be used for fluid overload. When severe, fluid overload and hypertension can be managed with loop diuretics and antihypertensive medication.⁷

Conclusion

Although pediatric patients generally fare excellently in cases of PSGN, serious complications secondary to fluid overload and severe hypertension can occur in the acute setting. Clinicians should be mindful of glomerulonephritis in patients presenting with hypertension or cardiac/pulmonary pathology in the context of hematuria or streptococcal infection.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received financial support towards the open access publishing fee for this article from the Research Open Access Publishing (ROAAP) Fund of the University of Illinois at Chicago. The author(s) received no financial support for the research and/or authorship of this article.

Ethical approval

Our institution does not require ethical approval for reporting individual cases or case series.

Informed consent

Written informed consent was obtained from a legally authorized representative of the minor subject for anonymized patient information to be published in this article.

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References

1. Barbut G and Needleman J. Pediatric chest pain. *Pediatr Rev* 2020; 41(9): 469–480.
2. Kocis K. Chest pain in pediatrics. *Pediatr Cardiol* 1999; 46(2): 189–190, <https://pedclerk.uchicago.edu/sites/pedclerk.uchicago.edu/files/uploads/chest.pdf>
3. Patel HP and Bissler JJ. Hematuria in children. *Pediatr Clin North Am* 2001; 48: 1519–1537.
4. Andrae M and Langlois DM. Group A streptococcal infections. *Pediatr Rev* 2011; 32(10): 423–430.
5. VanDeVoorde RG 3rd. Acute poststreptococcal glomerulonephritis: the most common acute glomerulonephritis. *Pediatr Rev* 2015; 36(1): 3–12; quiz 13.
6. Rodriguez-Iturbe B and Batsford S. Pathogenesis of post-streptococcal glomerulonephritis a century after Clemens von Pirquet. *Kidney Int* 2007; 71(11): 1094–1104.
7. Rodriguez-Iturbe B. Postinfectious glomerulonephritis. *Am J Kidney Dis* 2000; 35(1): 46–48.
8. Couser WG. Basic and translational concepts of immune mediated glomerular diseases. *J Am Soc Nephrol* 2012; 23(3): 381–399.
9. Simckes AM and Spitzer A. Poststreptococcal acute glomerulonephritis. *Pediatr Rev* 1995; 16(7): 278–279.
10. Gunasekaran K, Krishnamurthy S, Mahadevan S, et al. Clinical characteristics and outcome of post-infectious glomerulonephritis in children in southern India: a prospective study. *Indian J Pediatr* 2015; 82(10): 896–903.
11. Idhate T, Zaki SA and Shanbag P. Cardiac status in children with acute poststreptococcal glomerulonephritis. *Saudi J Kidney Dis Transpl* 2017; 28(4): 830–835, <https://pubmed.ncbi.nlm.nih.gov/28748885/>
12. Tsai SH, Lin YY, Chu SJ, et al. Interpretation and use of natriuretic peptides in non-congestive heart failure settings. *Yonsei Med J* 2010; 51(2): 151–163.
13. Madriago E and Silberbach M. Heart failure in infants and children. *Pediatr Rev* 2010; 31(1): 4–12.
14. Thygesen K, Alpert JS, Jaffe AS, et al. Fourth universal definition of myocardial infarction. *J Am Coll Cardiol* 2018; 72(18): 2231–2264.
15. Mariathas M, Allan R, Ramamoorthy S, et al. True 99th centile of high sensitivity cardiac troponin for hospital patients: prospective, observational cohort study. *BMJ* 2019; 364: 1729.
16. Banerjee D, Perrett C and Banerjee A. Troponins, acute coronary syndrome and renal disease: from acute kidney injury through end-stage kidney disease. *Eur Cardiol* 2019; 14(3): 187–190.