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Frequent PVCs Manifesting as Critical Bradycardia on Pulse Oximetry: A Real-Life Experience

Cyndee Jocson, MD; Priscila Lisboa, MD; Shelly B. Waldman, MD;
Manoj Gupta, MD

Abstract

This report presents a guide to the evaluation and management of frequent premature ventricular contractions (PVCs) in a pediatric patient. A 17-year-old female was incidentally found to have marked bradycardia, with a heart rate of 36 to 40 beats per minute on pulse oximetry and manual palpation, during an emergency department visit for a hand laceration. She was asymptomatic. Initial evaluation revealed normal electrolyte levels and an electrocardiogram demonstrating sinus rhythm with frequent PVCs in a bigeminy pattern. Cardiology assessment showed persistent PVCs, mild valvular regurgitation, and mildly reduced left ventricular function, with an ejection fraction of 49%. Holter monitoring recorded frequent (38%) monomorphic

PVCs and episodes of non-sustained ventricular tachycardia, which were not perceived by the patient. Exercise stress test demonstrated suppression of ectopy during exertion, with recurrence during the recovery phase. She was subsequently referred to electrophysiology for further evaluation.

Introduction

Premature ventricular contractions (PVCs) are common in children and adolescents and often present as an incidental finding on the electrocardiogram (ECG) or ambulatory monitoring.¹ A PVC is an early beat originating from the ventricles. It consists of a wide QRS complex with a distinct morphology and not preceded by a P wave, often

FIGURE 1 PVCs in a bigeminy pattern (blue arrows)

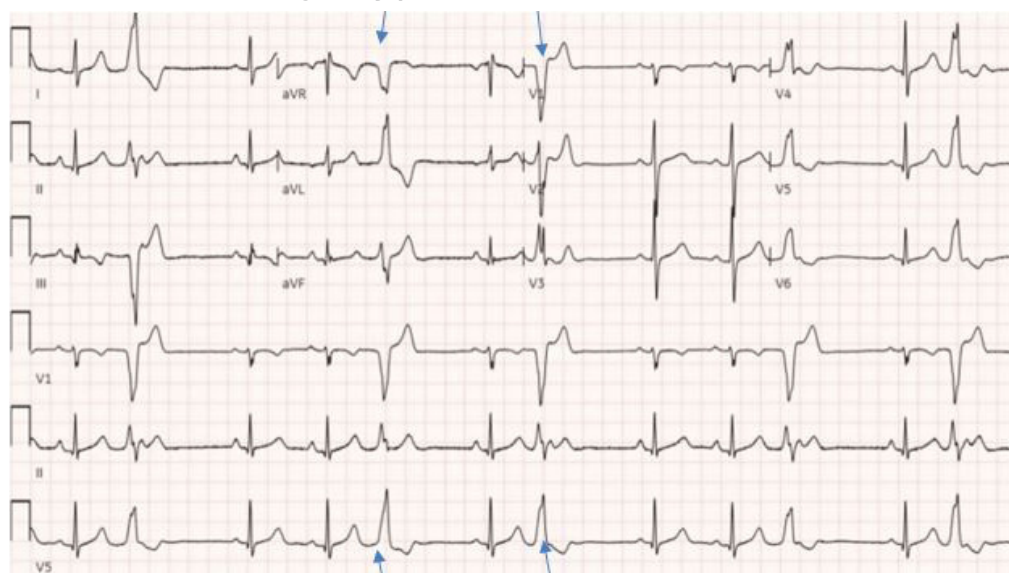




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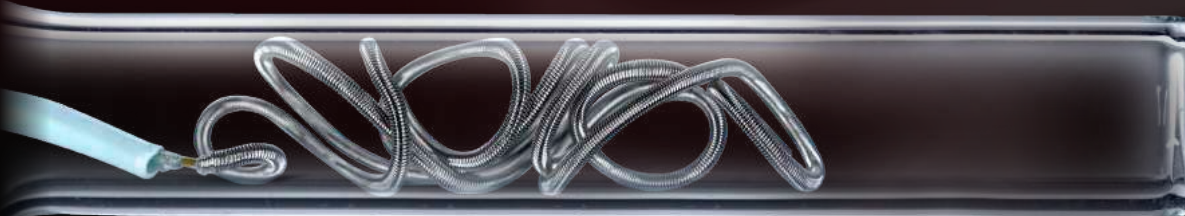
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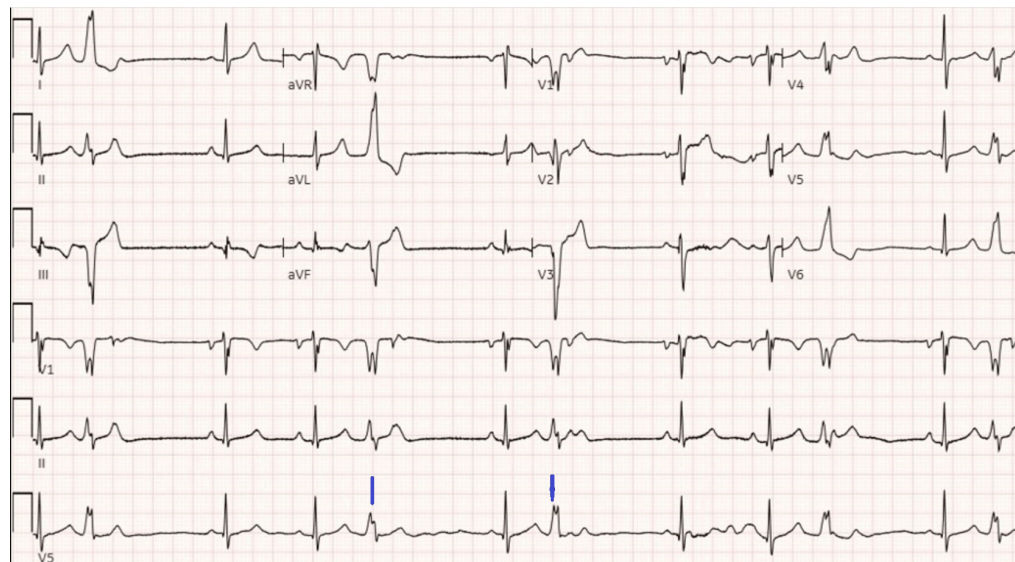


FIGURE 2 ECG showing monomorphic PVCs in a bigeminy pattern (blue arrows)



FIGURE 3 ECG during the exercise stress test showing sinus tachycardia and no PVCs

followed by a compensatory pause. A Holter monitor is useful in quantifying ectopy and arrhythmia burden. Exercise stress test (EST) is needed to assess adrenergic response to PVCs. Most PVCs are benign and suppress during exercise. An echocardiogram may be performed to rule out structural anomalies and assess ventricular function. Frequent ectopy and non-sustained ventricular tachycardia (NSVT) are associated with left ventricular (LV) dysfunction in children. If LV dysfunction develops, medication or ablation is indicated to reduce the amount of ectopy. Patients with frequent PVCs should have a detailed history, physical

examination, and echocardiogram, and may require Holter monitoring and EST for complete evaluation and management.

We report a case of an adolescent girl with PVCs manifesting as severe bradycardia on pulse oximetry. Further testing was initiated. The Holter monitor and EST showed frequent PVCs and the echocardiogram showed mildly decreased systolic function. The patient was subsequently referred to pediatric electrophysiology (EP). This article presents a guide in managing patients with frequent PVCs.

Case Presentation

A 17-year-old female presented to the emergency room for an accidental left-hand laceration while using a knife in the kitchen. Triage vital signs showed a blood pressure (BP) of 128/68, heart rate (HR) of 55 beats per minute (bpm), and oxygen saturation of 100%. The laceration was sutured, and the patient remained hemodynamically stable throughout the repair. Repeat vitals prior to discharge showed a HR of 36 bpm on pulse oximetry. The nurse performed a manual count on the right radial pulse which showed a HR of 38 bpm. Thereafter, the physician recounted the pulse and counted the HR on auscultation; and the patient's HR measured between 36 to 40 bpm on multiple examinations. The patient was completely asymptomatic at this time. She had no signs or symptoms of decreased cardiac output, and she had no dizziness or lightheadedness. She was not athletic and not very active in sports. She denied perception of premature or strong heart beats. Her past medical history was significant only for eczema and a remote history of mild intermittent asthma. She had no prior hospitalization or surgical procedure including cardiac surgery and no history of congenital cardiac defects. She had no recent history of travel or Lyme disease. There was no family history of any cardiac disease.

An ECG was performed, which showed a HR of 74 bpm with sinus rhythm and frequent PVCs in a bigeminy pattern (Figure 1). Serum electrolytes were normal. The patient was discharged home in a stable condition with cardiology follow-up. At the cardiology visit, the HR was noted to be 40 bpm. Repeat ECG showed similar PVCs in a bigeminy pattern (Figure 2). Echocardiogram showed mild mitral regurgitation, mild aortic valve insufficiency, and mildly decreased LV systolic function with an ejection fraction of 49%. The Holter monitor showed multiple runs of NSVT at a rate of 130 to 135 bpm and no sustained tachyarrhythmia, with a minimum HR of 63 bpm, a maximum HR of 175 bpm, and frequent (38%) single monomorphic PVCs. The patient did not perceive any of these NSVT episodes or PVCs. An EST was performed which showed sinus rhythm with frequent PVCs at baseline,



with occasional couplets and triplets. The PVCs were suppressed at a HR of 118 bpm. At peak exercise, no ectopy was noted at a HR of 190 bpm (**Figure 3**). During recovery, PVCs were noted to return approximately two minutes after peak exercise at a HR of 131 bpm (**Figure 4**). Multiple episodes of NSVT at a HR of 139 bpm were also noted during the recovery period. The patient was referred to an EP Specialist for further evaluation and treatment, and she was scheduled for an EP study.

Discussion

A premature ventricular contraction (PVC) is an early beat originating from the ventricles. It consists of a wide QRS complex with a distinct morphology, and is not preceded by a P wave, often followed by a compensatory pause.² This pause is related to increased ventricular filling and increased stroke volume, which may be perceived by the patient as a forceful beat.³ It may appear as: an isolated beat, or two consecutive PVCs called a couplet, or alternating PVC with a normal QRS complex called bigeminy, or a PVC in every third beat called trigeminy.²

PVCs are a common finding in children and adolescents and are frequently encountered as an incidental finding on ambulatory monitoring.² When discovered, patients should be asked if they have experienced skipped beats, palpitations, chest pain, dizziness, or syncope. A family history of sudden cardiac death, sudden unexplained car accidents or drowning, cardiomyopathy, long QT syndrome, or Brugada syndrome should be elicited.⁴ Although most patients have normal hearts, evaluation should focus on ruling out any structural heart disease, cardiomyopathy, or channelopathy.²

A 24-48 hour Holter monitor is useful in quantifying the amount of ectopy (ectopy burden), presence of couplets, and/or ventricular tachycardia (VT).⁵ An exercise stress test is helpful in assessing adrenergic response to PVCs and efficiency of the cardiorespiratory system. Typically in pediatric patients, PVCs are benign when suppressed during exercise. On the other hand, a worsening



FIGURE 4 ECG during recovery showing an 8-beat non-sustained ventricular tachycardia (blue arrows) at a HR of 139 bpm

PVC burden suggests increased risk of adrenergic sensitive arrhythmias.² An echocardiogram may be performed to rule out associated structural heart anomalies and to evaluate ventricular function. The exact mechanism of LV dysfunction in patients with frequent PVCs remains unclear, but is thought to be related to ventricular asynchrony, changes in calcium levels, and decreased myocardial perfusion.^{2,5} Frequent ventricular ectopy, presence of couplets, and ventricular tachycardia are found to be associated with LV dysfunction in children.⁶ In the adult population, studies have shown that a PVC burden of greater than 24% was associated with decreased LV systolic function. However, this cut-off value has not been validated in children.⁷ A retrospective study by Bertels et al. found that children with LV dysfunction had a PVC burden of 30% or more, however the impact of duration still remained unclear. In a more recent study by Sharma et al., a PVC burden of more than 20% did not correlate with LV dysfunction.⁸ Isolated PVCs in children with structurally normal hearts have a relatively benign course and may resolve spontaneously. There is a reported trend toward resolution of PVCs in patients who did not undergo any intervention.⁸ If LV dysfunction develops, medication or ablation is indicated to reduce the amount of ectopy.⁶

Conclusion

Isolated PVC's are common in pediatric population. It is not uncommon for otherwise healthy, asymptomatic adolescents to present with an irregular heart rhythm. Patients with PVCs should have a detailed cardiac history, family history, and thorough physical examination, and they may require a 24-48 hour Holter monitor. Anyone presenting with an abnormal physical examination and/or a high PVC burden should undergo an echocardiogram and exercise stress testing. Rarely, frequent PVCs can present as critical bradycardia on clinical examination and pulse oximetry.

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CYNDEE JOCSO, MD

Pediatric Cardiology
Louisiana State University
Manning Family Children's
New Orleans, LA, USA



SHELLY B. WALDMAN, MD

Department of Pediatrics
Harlem Hospital
New York City, NY, USA



PRISCILA LISBOA, MD

Division of Neonatology
University of Chicago in Peoria
Peoria, IL, USA



MANOJ GUPTA, MD

Division of Pediatric Cardiology
Children's Hospital at Montefiore
Bronx, NY, USA
MGupta@montefiore.org

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Major Congenital Heart Defects in Fetus Linked to Worse Obstetric Outcomes

Findings Could Impact How Doctors Care for Some Mothers

Rachael Robertson, Enterprise & Investigative Writer, MedPage Today

Pregnancies with fetal major Congenital Heart Defects (CHDs) had significantly higher rates of poor obstetric outcomes than those without defects, a decade-long Danish nationwide cohort study found.

Nearly 23% of pregnancies with fetal major CHDs exhibited adverse obstetric outcomes compared with 9% of those without them (adjusted OR 2.96, 95% CI 2.49-3.53), researchers led by Gitte Hedermann, MD, of Statens Serum Institut in Copenhagen.

"Almost one in four women carrying a child with a major congenital heart defect develop placenta-related adverse obstetric outcomes," Hedermann emphasized to MedPage Today.

Although women carrying a child with transposition of the great arteries did not have significantly increased risk, all other subtypes of fetal major CHDs carried greater risk of adverse obstetric outcomes, including:

- Preeclampsia (aOR 1.83, 95% CI 1.33-2.51)
- Preterm birth at less than 37 weeks (aOR 3.84, 95% CI 3.15-4.71)
- Fetal growth restriction (aOR 3.25, 95% CI 2.42-4.38)

The authors pointed out that the fetal heart and placenta develop concurrently and "are hypothesized to share common regulatory pathways in early fetal life," which may impact long-term outcomes for the children, though much is still unknown about this relationship.

"Other studies have shown that children born with a major congenital heart defect have increased morbidity and mortality if they are born preterm or with a low birth weight," Hedermann said. "Unfortunately, our study

also highlights that these complications are more prevalent for this group."

Jerrie Refuerzo, MD, a maternal-fetal medicine physician with UTHealth Houston who was not involved in the study, said that she's already on high alert for adverse obstetric outcomes in this population.

However, the new evidence "is going to change the frequency by which I see these patients, especially as they get closer to their due date," Refuerzo told MedPage Today. "[For] the majority of these adverse outcomes, the frequency typically increases as they get closer to 37, 38, 39 weeks' [gestation], and so seeing them more frequently in the third trimester will be my new strategy for making sure we can intervene early to improve those outcomes."

She noted that for most isolated congenital anomalies, women come into the pregnancy healthy with no medical conditions. Because of this, the focus of prenatal care is often the fetus more so than the mother.

"We have to remember that it's a package deal -- it's mom and baby," she said, noting that whatever is happening to the mom -- like hypertension or preeclampsia -- directly or indirectly impacts the baby as well.

Hedermann's study utilized the Danish Fetal Medicine Database, which includes data on nearly all pregnancies in Denmark. The country has free healthcare, and 95% of pregnant people opt to get ultrasonography scans in the first and second trimesters.

Among 534,170 pregnancies during the study period from June 1, 2008 to June 1, 2018, only 745 had isolated fetal major CHDs.

Singleton pregnancies that resulted in a live-born child at 24 weeks' gestation or later and without chromosomal abnormalities were included; stillbirths were excluded because of incomplete data. Infants with major CHDs and postnatally-diagnosed, associated major extracardiac malformations were also excluded.

Genetic testing was performed on 42% of included pregnancies. Median maternal age was 29 for those with major CHDs and 30 for those without. The majority of mothers identified as white (91.4%).

For children with more than one major CHDs, only the most severe diagnosis was registered. The primary outcome was a composite of preeclampsia, preterm birth, fetal growth restriction, or placental abruption; secondary outcomes included each adverse obstetric event individually.

An additional 10 studies (five cohort and five case-control) were included in a meta-analysis, which revealed that univentricular heart, atrioventricular septal defect, and tetralogy of Fallot were associated with a higher risk of preterm birth and fetal growth restriction. Again, though, fetal transposition of the great arteries was not associated with these outcomes.

In terms of limitations, authors noted that the associations between major CHD subtypes and other factors were hampered by small numbers. The database also did not have data on preexisting gestational diabetes, a risk factor for both major CHD and adverse obstetric outcomes, although Denmark has very low levels of this condition. Plus, the study only included live births.



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Children's Hospital of Philadelphia Researchers Spotlight Adults with Hypoplastic Left Heart Syndrome (HLHS) Thriving Without Transplants

Study Highlights Largest Single-Center Cohort of Adults with HLHS with Longest Follow-up

Researchers at Children's Hospital of Philadelphia (CHOP) reported long-term clinical outcomes for the largest single center cohort of individuals who underwent complex reconstructive surgery for hypoplastic left heart syndrome as newborns. In this cohort, more than 30% survived without a transplant to at least 35 years of age. Among these individuals, there was a significant group of adults who reported good to excellent clinical outcomes and quality-of-life (QOL), consistent with a "high-performing" Fontan phenotype. The findings were published in the *Journal of the American College of Cardiology*.

Prior to this study, limited data existed concerning longer-term outcomes for patients with HLHS. To bridge this gap, researchers examined long-term survival and the impact of patient factors on survival for newborns with HLHS, as well as functional and health outcomes, including QOL in adulthood.

"Our study highlights the impact of CHOP's pioneering surgical approaches to pediatric heart disease," said J. William Gaynor, MD, a lead study author and surgeon in the Cardiac Center at Children's Hospital of Philadelphia. "While more research is needed, our findings offer hope for a future where high-functioning adult patients with CHD are the norm."

In this retrospective study, researchers analyzed patients with HLHS and associated variants who underwent complex open-heart surgeries between January 1984 and December 2023. The authors noted that while survival has plateaued over the past two decades, they are encouraged by the adult individuals reporting good to

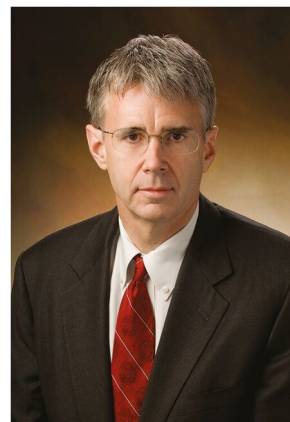
excellent health and few Fontan-related complications without a transplant.

The study findings also underscore the importance of maintaining cardiac care for adults with congenital heart disease. CHOP's Philadelphia Adult Congenital Heart Disease Center and Fontan Rehabilitation, Wellness, Activity and Resilience Development program (FORWARD) are designed to provide specialized care, evaluation and ongoing monitoring of individuals with single ventricle heart defects and Fontan circulation. In the past, research has primarily focused on identifying "risk factors" associated with worse survival and outcomes for patients with HLHS. However, in the future, CHOP's innovative programs addressing adults with CHD will be instrumental in helping researchers better understand what is driving patient success.

"Moving forward, based on these study findings, we plan to focus more research on adults with CHD, looking at why they are doing well without a transplant," said Jack Rychik, MD, Director of the FORWARD program at Children's Hospital of Philadelphia. "For us, success is seeing our patients thrive as adults. We are committed to finding new, personalized ways to help them heal, grow stronger and live their best lives."

Dr. Gaynor said they will continue to follow the cohort of adult individuals to better understand their lives in greater depth, including health and wellness, approach to exercise, emotional and cognitive abilities, as well as careers and relationships.

This study was funded by a grant from Big Hearts to Little Hearts, an organization



J. William Gaynor, MD

aimed at improving the lives of children and adults with CHD through research, programs, and advocacy. Additional funding includes the Mortimer J. Buckley Jr. M.D. Endowed Chair in Cardiac Surgery, the Thomas L. Spray, MD Endowed Chair in Pediatric Cardiothoracic Surgery and the Daniel M. Tabas Endowed Chair in Pediatric Cardiothoracic Surgery at CHOP.

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AI Tech Detects Hidden Heart Disease Doctors Often Miss

Kurt Knutsson

You might think heart disease comes with warning signs. But some of the deadliest types, like structural heart disease (SHD), creep in silently. No chest pain. No shortness of breath. Nothing until it's too late. Now, a new AI tool called EchoNext is changing the game. It can flag hidden heart problems that even trained cardiologists miss, just by analyzing a standard ECG. That's right: a routine, five-minute heart test you've probably already had could now unlock life-saving information, if AI is watching.

What is Structural Heart Disease, and Why Is It So Dangerous?

SHD refers to defects in the heart's walls, valves, or chambers. Some are present at birth. Others develop slowly over time. Either way, they often go unnoticed until something major happens, like a heart attack or stroke. That's why experts sometimes call SHD the "hidden" heart disease. Here's the problem: even the ECGs doctors routinely use to spot heart issues often can't detect SHD on their own. And that's where EchoNext comes in.

EchoNext: The AI That Knows When to Dig Deeper

EchoNext was created by researchers at Columbia University and NewYork-Presbyterian. The tool was trained on over 1.2 million ECG and echocardiogram pairs from more than 230,000 patients. Its job? Figure out when a patient's ECG suggests a deeper look is needed, specifically, an echocardiogram, the ultrasound that gives a detailed view of heart structure. "EchoNext basically uses the cheaper test to figure out who needs the more expensive one," explained Dr. Pierre Elias, who led the study. And the results? Stunning.

EchoNext Outperformed Human Cardiologists

In tests, EchoNext correctly flagged 77% of structural heart disease cases from ECGs. Cardiologists? Just 64%. Even more impressive: when tested on nearly 85,000 people, EchoNext identified over 7,500 at high risk for undiagnosed SHD. A year

later, researchers found that 73% of those who followed up with echocardiograms were indeed diagnosed with SHD, a rate far above average. These groundbreaking results were published in *Nature*, one of the world's most respected scientific journals. That's not just a better test. That's a potential lifesaver.

Why This Matters Now More Than Ever

Millions walk around every day with SHD and no idea. They skip heart screenings because nothing feels wrong. Even when they do get an ECG, subtle warning signs can slip by unnoticed. EchoNext doesn't miss them. And it doesn't get tired or distracted. This isn't about replacing doctors, it's about giving them a powerful new tool to catch what humans alone can't.

What This Means For You

You don't need to wait for symptoms to take your heart health seriously. If you've ever had an ECG, or you're getting one soon, AI could now help spot hidden risks your doctor might miss. Tools like EchoNext make it easier to catch heart problems early, even if you feel fine.

This means fewer surprises. Fewer missed diagnoses. And a better shot at treatment before it's too late. It's not about replacing doctors. It's about giving them, and you, a better shot at catching problems early. Ask your doctor if AI tools are being used to review your heart tests. You deserve every advantage. Right now, EchoNext is being used in research settings-but tools like it are quickly moving toward wider use in hospitals and clinics.





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kate.f.baldwin@gmail.com

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John W. Moore, MD, MPH
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