Research Paper

A Case Series of Neonatal Arrhythmias at Multiple Centres in North Maharashtra, India

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Citation Bhadane P. A Case Series of Neonatal Arrhythmias at Multiple Centres in North Maharashtra, India. Journal of Pediatrics Review. 2023; 11(4):343-350. http://dx.doi.org/10.32598/jpr.11.4.1049.1

http://dx.doi.org/10.32598/jpr.11.4.1049.1

Article info:
Received: 15 Apr 2022
First Revision: 14 Jan 2023
Accepted: 30 Jan 2023
Published: 01 Oct 2023

Key Words:
Supraventricular tachycardia, Neonate, Arrhythmias

ABSTRACT

Background: Neonatal arrhythmias (NAs) refer to abnormal heart rate and rhythm in the neonatal period. Various inherent cardiovascular, systemic, or metabolic abnormalities can precipitate NAs. We sought to evaluate the incidence, types, and implications of NAs.

Methods: A retrospective observational study was performed on newborns diagnosed with NAs during hospitalization in 4 neonatal intensive care units (NICUs) in North Maharashtra, India, from May 2018 to June 2021.

Results: During the study period, 42 neonates with arrhythmias were identified. The incidence of arrhythmias was 0.67% in the 4 NICUs. Their mean gestational age was 36 weeks (Range: 29–42 weeks). Eighteen of the infants (42.85%) were diagnosed with fetal arrhythmia (FA) during the third trimester of pregnancy. The distribution of NA types was as follows: 12(28.57%) supraventricular tachycardia (SVT), 12(28.67%) premature atrial contractions (PACs), 7(16.67%) premature ventricular contractions (PVCs), 3(7.14%) multiple arrhythmias such as SVT+PAC and AV block+PVC, and 6(14.28%) with AV block. The Wolff-Parkinson-White syndrome (WPW) was present in 2 patients. An association of NAs with congenital heart defects was identified in 18 cases.

Conclusions: Non-benign cardiac arrhythmias are significant causes of infant morbidity and even mortality if undiagnosed and untreated. The pediatrician must know the etiology, development, and natural history of arrhythmias in the fetal and neonatal periods.

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Introduction

Neonatal arrhythmias (NAs) are defined as abnormal heart rates and rhythms in the neonatal period. They include both bradycardias and tachycardias [1]. Various cardiovascular, systemic, and metabolic disorders cause NAs. The incidence of NAs is reported to be 1%–5% in all neonates [2]. Variability in the presentation of NAs is based on the rate and duration of arrhythmias. Sustained NAs can cause hemodynamic compromise in the form of cardiogenic shock, congestive heart failure, and hydrops fetalis [2-4]. NAs are generally classified as benign or non-benign. Benign arrhythmias can be classified as nodal or junctional rhythm, premature atrial contractions (PACs), and premature ventricular contractions (PVCs). Benign arrhythmias are clinically and vitally stable in nature. It is crucial to differentiate between benign and pathological variety for the guiding line of treatment. Non-benign NAs are further divided into supraventricular tachycardia (SVT), disorders of the atrioventricular conduction system, ventricular tachycardias, ventricular fibrillation, long QT syndrome, arrhythmias due to electrolyte disturbances, and so on. Non-benign or pathological arrhythmias should be diagnosed immediately to prevent sudden clinical deterioration and appropriate management [5, 6].

Despite advancements in medical sciences, NAs are still underdiagnosed in many parts of the world. In the present study, we have investigated and discussed the clinical characteristics, incidence, type of arrhythmias, risk factors, treatment, and outcome of NAs in 4 tertiary neonatal intensive care units (NICUs) in North Maharashtra, India.

Methods

A retrospective, observational study in patients with NAs was performed from May 2018 to June 2021 in the 4 leading NICUs of North Maharashtra, India. Various demographic characteristics of patients, including gender, gestational age, birth weight, maternal or gestational diseases, medications, mode of delivery, and Apgar scores, were recorded. Clinical records of each case were documented. Laboratory investigations like serum glucose, serum electrolytes, thyroid hormones, electrocardiography, echocardiography, and Holter monitoring were done to determine the type of arrhythmia. Response to each treatment and prognosis were also recorded. Patients with tachycardia due to neonatal sepsis (proved by positive culture) and sinus bradycardia that resolved within 72 hours were excluded.

The chi-square and Fischer exact tests were employed for the analyses of categorical variables, while the t-test was used for continuous variables. Statistical significance was defined as a $P \leq 0.05$. To account for various factors, multivariate logistic regression analysis was performed. The multivariate analysis included any variable in the bivariate analysis with a $P \leq 0.2$. For statistical analysis, SPSS software, version 19 was utilized. $P<0.05$ were regarded as significant for all analyses.

An SVT was described as episodes of tachycardia (230 beats/min and more) with narrow QRS complexes. Arrhythmias with slow prolongation of the PR interval till it disappeared with a regular ventricular beat (Mobitz type 1) or abrupt failure of AV conduction of an atrial impulse without PR prolongation (Mobitz type 2) were concluded as second-degree AV block. Atrial beats that arrived earlier than the normal sinus beat were described as premature atrial complexes (PACs). Eight neonates (11%) had patterns that could not be characterized from a 2:1 sinoatrial block, and 23 (32%) had patterns that could not be distinguished from the Sinoatrial-Wenckebach block on a 12-lead electrocardiogram. Five neonates (7%) exhibited electrocardiographic patterns and rhythm issues that were difficult to differentiate from complete sinoatrial exit block or sinus arrest [3].

Results

During the study period, 42 neonates with NAs were identified out of 6253 admissions to 4 NICUs. The incidence of NAs was 0.67% in 4 designated neonatal intensive care units. The benign NAs' incidence was 0.30%, and the non-benign NAs' were 0.34%. In total, 18 patients (42.86%) were males and 24 (57.14%) were females. The NAs incidence of male and female newborns admitted to the NICUs was 0.29% and 0.38%, respectively.

Median gestational age and birth weight were 36 (range: 29–40) weeks and 3008 (range: 1400– 4020 g) g, respectively (Table 1). Fourteen neonates (33.33%) were premature (<37 weeks of gestation). During the study period, 62% of patients were born premature. The incidence of NAs in premature and term infants was 0.33% and 0.66%, respectively. Ten out of 42 patients (23.8%) had fetal arrhythmias diagnosed in the last week of gestation, and 4 of these patients had gestational diabetes as a risk factor. One newborn had minimal ascites, hepa-

Table 1. Demographic and clinical features of cases with neonatal arrhythmias (n=42)

Demographic Data	Value
Birth weight (g)*	3008 (1240–4020)
Gestational age (wk)*	36 (29–40)
Prematurity	14(33.33)
Female gender	28(66.67)
Cesarean section rate	12(47.61)
Apgar (5 minute)*	8(5–10)
Prenatal diagnosis	8(19.04)
Maternal disease (gestational diabetes, SLE)	6(14.28)
Congenital heart disease	8(38)
Mortality	1(4.7)

*Median (Min-Max).

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tomegaly, and pallor and was diagnosed with hydrops fetalis and fetal arrhythmias, along with an echo diagnosis of corrected transposition of the great arteries (C-TGA) and ventricular septal defect (VSD). Ten patients were admitted to the NICU because of arrhythmia on the first day of life, whereas NAs in 13 patients were diagnosed during their stay in the NICU for other neonatal diseases such as prematurity or respiratory distress. Two patients were hospitalized for SVT episodes leading to congestive heart failure in the third week of life. The rest of the patients had normal thyroid function tests, blood sugar levels, and serum electrolytes, especially calcium levels.

In the univariate analysis, comparing the benign arrhythmia group and non-benign arrhythmia group suggested that non-benign arrhythmias composed of more babies with appropriate gestational age (GA) ($P<0.05$), higher incidence of normal delivery ($P<0.05$), less need for mechanical ventilation ($P<0.05$), decreased mortality ($P<0.05$), and lower incidence of congestive cardiac failure, cardiogenic shock, or hemodynamic instability ($P<0.05$).

The non-benign arrhythmias included Wolff-Parkinson-White (WPW) syndrome (n=2), SVT (n=12), congenital complete heart block (CHB) (n=4), and multiple arrhythmias, including SVT+PAC (n=1), and AV block+PVC (n=1) (Figure 1). Recurrent episodes of SVT developed in 4 patients, and 2 had congenital heart diseases such as C-TGA+PFO+VSD.

Congenital heart disease (CHD) was diagnosed in 14 patients (33.33%) as Ebstein anomaly, C-TGA+VSD, D transposition of great arteries with VSD, isolated ASD, isolated VSD, and isolated PDA (Table 2). Large patent ductus arteriosus was diagnosed in 3 preterm infants. Nineteen patients (45.23%) had isolated benign arrhythmias: 12 had PAC and 7 had PVC (Figure 2).

Results

Tachyarrhythmia in neonates was more common compared to bradyarrhythmia. Twelve patients with SVT required intravenous adenosine phosphate to revert the rhythm to normal sinus rhythm, after which propranolol was started as a maintenance therapy. Vagal stimulation was performed in each neonate but yielded no result. Two patients with C-TGA with VSD required intravenous amiodarone and maintenance therapy. One of the patients with SVT died due to congestive cardiac failure and metabolic disorders in the third month of life. One neonate who had developed tachyarrhythmia secondary to SVT resolved after 6 months. The infant was continuously on regular follow-up. One patient had Mobitz type 2 heart block, which disappeared by 8 weeks of age in two patients and did not require a pacemaker. Out of 6 complete congenital heart blocks, two patients needed a pacemaker because of symptomatic bradycardia. Benign NAs disappeared within the first month of life.

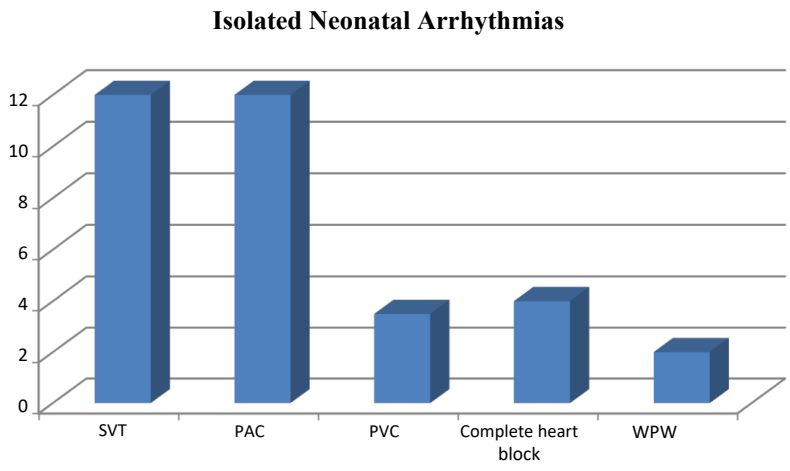

Figure 1. Types of isolated arrhythmias *Journal of Pediatrics Review*

Abbreviations: SVT: Supraventricular tachycardia; PAC: Premature atrial contraction; PVC: Premature ventricular contraction; WPW: Wolff-Parkinson-White.

Discussion

The incidence of NAs is reported as 0.1%–4.8% of healthy full-term newborns [6]. In another study, the incidence of arrhythmia was reported as 24.4 per 100000 live births [7]. Similarly, the incidence of NAs by Badrawi et al. was reported as 0.7% and 10% in NICUs, in which benign and non-benign arrhythmias were reported to be 8.5% and 1.5%, respectively [8]. In the present study, the incidence of benign NAs was 0.30%, non-benign ones were 0.34% in 4 NICUs, and 0.67% for the entire study population. The incidence of benign and non-benign arrhythmia was lower than that reported in previous studies (0.28%) [9]. We performed pulse oximeter testing in every neonate in the nursery after 24 hours of life but did not perform a 12-lead electrocardiogram; this may be the limitation in the general population, especially in cases of asymptomatic NAs.

NAs are predominantly associated with male gender, early gestational age, and maternal diseases such as diabetes and systemic lupus erythematosus (SLE), as these can be considered risk factors in identification [10]. However, a recently concluded study showed that the rate of NAs in females is slightly higher [11]. Similar to this study, our study showed female predominance (66.67%). Ectopic beats in the form of premature complexes frequently occur among full-term infants. In another study, the prematurity rate was 23.6%–38.5% among NAs cases [12]. In our study, the premature infants were 33.33%. NAs incidence was lower in preterm infants (0.03% versus 0.56%), which may be associated

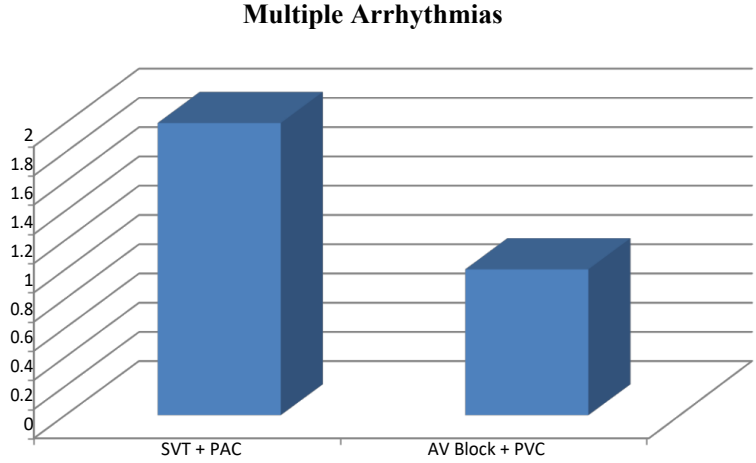

Figure 2. Types of multiple arrhythmias *Journal of Pediatrics Review*

Abbreviations: SVT: Supraventricular tachycardia; PAC: Premature atrial contraction; PVC: Premature ventricular contraction; AV Block: Atrioventricular block.

Table 2. Type of arrhythmias, echocardiographic and clinical findings, outcomes of patients

Arrrhythmias Type (n=42)		Echocardiography Findings	Clinical Findings	Outcome
Single arrhythmias	WPW syndrome (2)	Ebstein anomaly	Tachycardia, congestive cardiac	Treated with adenosine and propranolol, recurrent episodes of SVT and died due to chronic lung disease
	SVT (2)	C-TGA+PFO+VSD	Failure tachycardia	Treated with adenosine, amiodorone and had recurrent episodes of SVT
	SVT (1)	Dilated cardiomyopathy	Tachycardia, cardiac failure, hydrops	treated with adenosine and reverted back
	SVT (1)	D-TGA+PFO+VSD	Respiratory distress syndrome	Treated with adenosine and propranolol and had recurrent episodes of SVT in one of patients
	SVT (8)	Structurally normal heart	Tachycardia	Treated with adenosine and it disappeared in 1st week
	PVC (1)	Moderate sized ASD	Irregular heart rhythm	Disappeared in four weeks
	PVC (6)	Structurally normal heart	Irregular heart rhythm	Disappeared in the 1st week
	PAC (3)	VSD+small PFO	Irregular heart rhythm	Disappeared in the 1st week
	PAC (3)	Large PDA	Respiratory distress	Disappeared in three weeks
	PAC (6)	Normal	Irregular heart rhythm	Disappeared in two weeks
	Complete heart block (4)	Small PDA (physiological)	Regular heart rhythm	Not medicated and on follow-up
Multiple arrhythmias	SVT+PAC (2)	Small pathogenic PDA	Irregular heart rhythm	Treated with adenosine and propranolol on maintenance therapy
	AV block type 2+PVC (1)	Small ASD	Irregular heart rhythm	Disappeared in 1st week of life

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Abbreviations: WPW: Wolff-Parkinson-White syndrome; D-TGA: Dextro-transposition of great arteries; C-TGA: Corrected transposition of great arteries; PFO: Patent foramen of ovale: ASD: Atrial septal defect; VSD: Ventricular septal defect; PDA: Patent ductus arteriosus; SVT: Supraventricular tachycardia; PVC: Premature ventricular contraction; PAC: Premature atrial contraction; AV Block type 2: Atrioventricular block type 2.

with the admission rate of 60% in our NICUs. Six of our patients had gestational diabetes and SLE, which we identified as maternal risk factors.

SVT is the most common type of tachyarrhythmia in fetuses in the intrauterine period and neonates. WPW syndrome is diagnosed in 16%–26% of infants along with SVT [13]. The incidence of SVT was reported to be 30% and as high as 70% –80% of patients with NAs in past studies [10, 14]. In our study, 28.5% of patients had isolated SVT, but two patients had WPW syndrome. Only one infant with SVT had signs or symptoms of cardiac failure.

In another study, 10 neonates had variable signs of hydrops fetalis, and 9 had fetal SVT [15]. Cardiac failure was diagnosed in only one of our patients with SVT in the study. Two patients had fetal SVT, and one patient had mild signs of hydrops fetalis. Treatment of SVT mainly includes pharmacological and rarely ablation therapies

Acute management with intravenous adenosine phosphate and maintenance therapy with a beta-blocker is usually effective. In our patients, SVT improved with medical therapy, including adenosine and propranolol, and cardiac function improved with no recurrence except in one patient with C-TGA+ASD+VSD, who required intravenous and oral amiodarone because of treatment failure of propranolol [16].

Intracardiac defects, electrolyte abnormalities, and maternal or gestational diseases such as diabetes, gestational hypertension, or SLE can cause cardiac arrhythmias. A European review study showed a good correlation between congenital heart disease and neonatal and fetal arrhythmias [17]. In our research, CHDs were

diagnosed in 33.33% of patients. Though the majority of children with SVT have structurally normal hearts, children with CHD accounted for 21% and 28% of patients with SVT in two series [18, 19]. On the contrary, SVT was reported to account for 47%–68% of fetal tachycardia, and only 2% of cases were associated with structural abnormalities [20]. In the present study, CHDs were diagnosed in 19% of patients with SVT.

Atrial and ventricular ectopic beats are benign and self-limited. The most common cause of an irregular cardiac rhythm in the fetus is supraventricular extrasystole. Ectopic beats occur in 1% of healthy newborns upon routine screening and disappear within the first month of life [8, 21]. Ventricular and supraventricular ectopy was diagnosed in 47% of our patients and vanished by the fourth week of life. Complete congenital heart block (CHB) in structurally normal hearts may occur in infants born to mothers with collagen vascular disorders such as SLE. Symptomatic CHB develops due to low cardiac output and heart rates [22]. In this study, two mothers had SLE.

In conclusion, cardiac arrhythmias in neonates are an important cause of infant morbidity and an occasional cause of infant mortality if undiagnosed and untreated. Early diagnosis, differentiation, and treatment of non-benign neonatal arrhythmia are necessary and are mostly successful, as seen in our patients. The pediatrician must know the etiology, pathogenesis, and natural history of arrhythmias in the fetal and neonatal periods. The author believes the present data will help enhance awareness of NAs in NICU patients.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles are considered in this article. The participants were informed of the purpose of the research and its implementation stages. They were also assured about the confidentiality of their information and were free to leave the study whenever they wished, and if desired, the research results would be available to them. A written consent has been obtained from the subjects. principles of the Helsinki Convention was also observed.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Conflicts of interest

The author declared no conflict of interest.

Acknowledgements

The author thanks all patients or guardians for providing the case datails.

References

1. Tanel RE, Rhodes LA. Fetal and neonatal arrhythmias. Clin Perinatol. 2001; 28(1):187-207. [DOI:10.1016/S0095-5108(05)70074-9] [PMID]

2. Ban JE. Neonatal arrhythmias: Diagnosis, treatment, and clinical outcome. Korean J Pediatr. 2017; 60(11):344-52. [DOI:10.3345/kjp.2017.60.11.344] [PMID] [PMCID]

3. Jaeggi E, Öhman A. Fetal and neonatal arrhythmias. Clin Perinatol. 2016; 43(1):99-112. [DOI:10.1016/j.clp.2015.11.007] [PMID]

4. Picchio FM, Prandstraller D, Bronzetti G, Cervi E. Follow-up of neonates with foetal and neonatal arrhythmias. J Matern Fetal Neonatal Med. 2012; 25 Suppl 4:53. [DOI:10.3109/14767058.2012.714980] [PMID]

5. Kundak AA, Dilli D, Karagöl B, Karadağ N, Zenciroğlu A, Okumuş N, et al. Non benign neonatal arrhythmias observed in a tertiary neonatal intensive care unit. Indian J Pediatr. 2013; 80(7):555-9. [DOI:10.1007/s12098-012-0852-3 PMid:23054850]

6. Refaat M, Abohelwa MM, Ahmed M, Elgehiny A, Ibrahim M, Zakka P, El Rassi I, Bulbul Z, Bitar F, Arabi M. Arrhythmias in neonates and infants at a tertiary care center. Cureus. 2021Jan 22;13(1). [DOI:10.7759/cureus.12861]

7. Turner CJ, Wren C. The epidemiology of arrhythmia in infants: A population- based study. J Paediatr Child Health. 2013; 49(4):278-81. [DOI:10.1111/jpc.12155]

8. Badrawi N, Hegazy RA, Tokovic E, Lotfy W, Mahmoud F, Aly H. Arrhythmia in the neonatal intensive care unit. Pediatr cardiol. 2009; 30(3):325-30. [DOI:10.1007/s00246-008-9355-4]

9. Doi Y, Ueda K, Ogino K, Hayashi T, Takahashi A, Waki K, Arakaki Y. Incidence of non- benign arrhythmia in neonatal intensive care unit: 18 years experience from a singlecenter. Journal of Arrhythmia. 2022. [DOI:10.1002/pd.4210] [PMID] [PMCID]

10. Pike JI, Krishnan A, Kaltman J, Donofrio MT. Fetal and neonatal atrial arrhythmias: An association with maternal diabetes and neonatal macrosomia. Prenat Diagn. 2013; 33(12):1152-7. [DOI:10.1002/pd.4210] [PMID]

11. Zeitler EP, Poole JE, Albert CM, Al-Khatib SM, Ali-Ahmed F, Birgersdotter-Green U, et al. Arrhythmias in female patients: incidence, presentation and management. Circulation research. 2022; 130(4):474-95. [DOI:10.1161/CIRCRESAHA.121.319893]

12. Binnetoglu FK, Babaoglu K, Turker G, Altun G. Diagnosis, treatment and follow up of neonatal arrhythmias: Cardiovascular topic. Cardiovasc J Africa. 2014; 25(2):58-62. [DOI:10.5830/CVJA-2014-002]

13. Srinivasan C, Balaji S. Neonatal supraventricular tachycardia. Indian Pacing Electrophysiol J. 2019; 19(6):222-31. [DOI:10.1016/j.ipej.2019.09.004] [PMID] [PMCID]

14. Bruder D, Weber R, Gass M, Balmer C, Cavigelli-Brunner A. Antiarrhythmic medication in neonates and infants with supraventricular tachycardia. Pediatr Cardiol. 2022; 43(6):1311-8. [DOI:10.1007/s00246-022-02853-9] [PMID] [PMCID]

15. Gilljam T, Jaeggi E, Gow RM. Neonatal supraventricular tachycardia: Outcomes over a 27-year period at a single institution. Acta Paediatr. 2008; 97(8):1035-9. [DOI:10.1111/j.1651-2227.2008.00823.x] [PMID]

16. Epcacan S. [Management of neonatal supraventricular tachycardias; A single center experience (Turkish)]. Eurasian J Med Investig. 2019; 3(1):46-53. [DOI:10.14744/ejmi.2019.01092]

17. Hernandez-Madrid A, Paul T, Abrams D, Aziz PF, Blom NA, Chen J, et al. Arrhythmias in congenital heart disease: a position paper of the european heart rhythm association (EHRA), association for european paediatric and congenital cardiology (AEPC), and the European Society of Cardiology (ESC) Working Group on Grown-up Congenital heart disease, endorsed by HRS, PACES, APHRS, and SOLAECE. EP Europace. 2018; 20(11):1719-53. [DOI:10.1093/europace/eux380]

18. Weindling SN, Saul JP, Walsh EP. Efficacy and risks of medical therapy for supraventricular tachycardia in neonates and infants: S.N. Weindling, J.P. Saul, E.P. Walsh. Division of Pediatric Cardiology, Department of Pediatrics, Dartmouth-Hitchcock Medical Center, Lebanon, NH. Am Heart J 1996;131: 66–72. ACC Curr J Rev. 1997; 6(2):77. [DOI:10.1016/S1062-1458(97)83295-3]

19. Tanel RE, Walsh EP, Triedman JK, Epstein MR, Bergau DM, Saul JP. Five-year experience with radiofrequency catheter ablation: Implications for management of arrhythmias in pediatric and young adult patients. J Pediatr. 1997; 131(6):878-87. [DOI:10.1016/S0022-3476(97)70037-4] [PMID]

20. Kothari DS, Skinner JR. Neonatal tachycardias: An update. Arch Dis Child Fetal Neonatal Ed. 2006; 91(2):F136-44 [DOI:10.1136/adc.2004.049049] [PMID] [PMCID]

21. Fillipps DJ, Bucciarelli RL. Cardiac evaluation of the newborn. Pediatr Clin North Am. 2015; 62(2):471-89. [DOI:10.1016/j.pcl.2014.11.009] [PMID]

22. Mawad W, Hornberger L, Cuneo B, Raboisson MJ, Moon-Grady AJ, Lougheed J, et al. Outcome of antibody-mediated fetal heart disease with standardized anti-inflammatory transplacental treatment. J Am Heart Assoc. 2022; 11(3):e023000. [DOI:10.1161/JAHA.121.023000] [PMID] [PMCID]

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