Cardiac Murmurs in The Newborn – When to Worry?

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Abstract

Congenital Heart Disease (CHD) contributes to a large proportion of mortality among infants and young children. Newborns (birth to 1 month of age) are at higher risk of having a serious lesion requiring early intervention, than older infants and children. Detecting a murmur in a newborn on physical exam can provide a clue to the presence of CHD, but its utility is limited by provider expertise and neonatal factors, such as rapid heart rate and respiratory symptoms. Furthermore, not all murmurs are pathological. Health care providers including primary care physicians, pediatricians or nurse practitioners often face difficulties when determining whether a murmur warrants further investigation. We aim to describe key differences between innocent and pathological heart murmurs in the newborn. Further, we describe current screening protocols for Critical Congenital Heart Defects (CCHD) that may assist primary care physicians in deciding when to refer for further evaluation.

Keywords: Congenital Heart Disease, Murmur, Pulse Oximetry Screening

Abbreviations: AAP: American Academy of Pediatrics; AS: Aortic Stenosis; AVSD: Atroventricular Septal Defects; CCHD: Critical Congenital Heart Defects; CHD: Congenital Heart Disease; CPS: Canadian Paediatric Society; PDA: Patent Ductus Arteriosus; PFO: Patent Foramen Ovale; POS: Pulse Oximetry Screening; TGA: Transposition of The Great Arteries; VSD: Ventricular Septal Defect

Evaluating A Newborn with A Heart Murmur

The incidence of Congenital Heart Disease (CHD) in the general population is less than 1% [1-6]. Heart murmurs are a common finding in infants and in older children. Less than 1 percent of newborn infants have an audible murmur in the first few days of life [4,5]. In fact, a murmur may be the only clue to a severe and potentially life-threatening CHD, known as a Critical Congenital Heart Defect (CCHD) [7]. More than half of newborns with a heart murmur have a structural heart lesion when confirmed on echocardiogram [7-9]. However, not every murmur is pathological; the remainder are referred to as innocent, or physiological murmurs that originate from normal flow patterns in the absence of anatomic abnormalities of the heart. Cardiac murmurs in the newborn may also be the result of a transitional circulation, which is usually related to the Patency of the Ductus Arteriosus (PDA), or its closure. The Patent Foramen Ovale (PFO) is another part of the transitional circulation that is not usually clinically detectable [10].

Determining the etiology of a murmur in the newborn presents a challenge for health care providers. Because of this, they remain the most common reason for pediatric cardiologist consultation in neonatal intensive care units and nurseries [11,12]. A thorough evaluation including a complete history and physical examination is a crucial first step to identifying those newborns.
with pathological murmurs at increased risk for CHD. Ul Haq, et al., showed that 14% of patients with a positive family history of CHD had an anatomical heart defect themselves [13]. Infants of diabetic mothers are at increased risk for Ventricular Septal Defects (VSD), Transposition of The Great Arteries (TGA) and Aortic Stenosis (AS) [13,14]. Intrauterine infections such as maternal rubella predispose the infant to a Patent Ductus Arteriosus (PDA) and peripheral pulmonary stenosis [4]. There is also an association with maternal alcohol consumption and VSD, as well as maternal exposure to Lithium with Ebstein’s anomaly [15]. Newborns with genetic syndromes such as Trisomy 21, 22q11.2 deletion or Turner’s syndrome are also at increased risk for Atrioventricular Septal Defects (AVSD), conotruncal abnormalities and coarctation of the aorta, respectively [13]. Certain red flags on history including failure to thrive, feeding accompanied by excessive sweating, pallor, tachypnea or increased work of breathing should raise suspicion of heart failure in the context of CHD [15].

Physical examination findings of dysmorphic features or characteristics of genetic syndromes may lead the clinician to investigate the presence of a cardiac anomaly [4,15]. Other findings including cyanosis indicate a right-to-left intracardiac shunt or a single ventricle physiology, whereas findings of respiratory distress, tachycardia, tachypnea and hepatomegaly raise suspicion for heart failure. Palpation for femoral pulses along with a 4-limb blood pressure measurement are important to evaluate for an aortic coarctation [5,15]. On cardiac auscultation, the characteristics of the murmur may further help to differentiate between a pathological and innocent murmur. Loud (greater than grade III/VI) murmurs, diastolic and pansystolic murmurs, those that are harsh with unusual radiation or have abnormal second heart sounds, are more concerning for an underlying structural heart lesion [4,5,15].

When red flags are present in the history or physical examination, in conjunction with a neonatal heart murmur, referral to a pediatric cardiologist should be considered. A summary of the history and physical examination findings that should prompt consideration of cardiology referral are presented in Tables 1 & 2.

### Table 1: Historical Findings Suggestive of Structural CHD Prompting Pediatric Cardiology Referral

| Historical Finding                        | Significance                                                                 |
|------------------------------------------|-----------------------------------------------------------------------------|
| **Family History**                       |                                                                             |
| CHD                                      | CHD more common in children with a first-degree relative who has CHD, high penetration with ventricular septal defect and mitral valve prolapse [4] |
| Sudden cardiac death                     | Increased risk of hypertrophic cardiomyopathy, inherited in an autosomal dominant pattern |
| Sudden infant death syndrome             | May be secondary to undiagnosed CHD                                        |
| **Prenatal and Perinatal History**       |                                                                             |
| In utero exposure to non-pharmacological toxins | Maternal alcohol consumption is associated with an increased risk of atrial and ventricular septal defects, and Tetralogy of Fallot |
| In utero exposure to teratogenic pharmacological agents | Some studies have demonstrated that SSRI exposure has been associated with a small, but statistically significant increased risk of ventricular septal defects and bicuspid aortic valve [4] |
|                                          | Lithium exposure is associated with Ebstein’s anomaly                       |
|                                          | Valproate is associated with coarctation of the aorta and hypoplastic left heart syndrome |
| Intrauterine infection                   | Maternal rubella infection is associated with patent ductus arteriosus and peripheral pulmonary stenosis |
| Maternal diabetes mellitus              | Increased risk of ventricular septal defect, transposition of the great arteries, and aortic stenosis |
| Preterm delivery                        | 50% of newborns weighing less than 1500 g at birth have CHD, most commonly patent ductus arteriosus [4] |
### Alarm Symptoms

| Failure to thrive | May indicate CHF in the context of CHD; poor weight gain commonly reflects decreased cardiac output or left-to-right shunting of blood with resultant pulmonary hypertension |
| Feeding intolerance as exhibited by excessive sweating, pallor, tachypnea, or increased work of breathing |

### Table 1: Historical Findings Suggestive of Structural CHD Prompting Pediatric Cardiology Referral.

| Finding | Significance |
|---------|--------------|
| Abnormal vital signs | Arrhythmia, tachycardia, hypoxia and tachypnea may indicate underlying structural heart disease |
| Blood pressure discrepancy between upper and lower limbs is suggestive of coarctation of the aorta (pressure gradient of >20 mmHg between upper and lower extremities) |
| Adventitious breath sounds | Wheezing may be associated with cardiac asthma |
| Crackles may be associated with pulmonary congestion due to congestive heart failure |
| Dysmorphic features | Newborns with genetic syndromes such as Trisomy 21, 22q11.2 deletion, or Turner’s syndrome are at increased risk for Atrioventricular Septal Defects (AVSD), conotruncal abnormalities and coarctation of the aorta, respectively [13] |
| Abnormal cardiac S₂ | Wide split fixed S₂ in atrial septal defect |
| Capillary refill | Normal capillary refill is less than 2 to 3 seconds; a delayed capillary refill may indicate poor perfusion secondary to reduced cardiac output |
| Systolic ejection click | Semilunar valve stenosis |
| Weak or absent femoral pulses | Coarctation of the aorta |
| Ascites and hepatomegaly | Congestive heart failure |

### Table 2: Physical Examination Findings in Newborns with Heart Murmurs Prompting Pediatric Cardiology Referral.

| Finding | Significance |
|---------|--------------|
| Abnormal cardiac S₂ | Wide split fixed S₂ in atrial septal defect |
| Capillary refill | Normal capillary refill is less than 2 to 3 seconds; a delayed capillary refill may indicate poor perfusion secondary to reduced cardiac output |
| Systolic ejection click | Semilunar valve stenosis |
| Weak or absent femoral pulses | Coarctation of the aorta |
| Ascites and hepatomegaly | Congestive heart failure |

### Pulse Oximetry Screening

Although some pediatricians and neonatologists may exclude heart disease based on clinical exam alone, the clinical exam is less reliable in younger children, and up to half of babies with CHD may be missed and can only be ruled out more definitively through echocardiogram [15,16]. The ability to accurately identify pathologic murmurs in the newborn by clinical examination alone varies even among subspecialists, due to differences in clinical expertise, with sensitivities ranging from 80.5 to 94.9 percent and specificities ranging from 25 to 92 percent [17,18]. Moreover, CHD may occur even in the absence of a heart murmur or other clinical findings [2,4]. One study found that by examination alone, detection rates for pathological heart murmurs in the newborn were approximately 50 percent when confirmed by echocardiogram [5]. Because of these challenges, other tools have therefore arisen to help physicians screen for CHD in the newborn.

The introduction of Pulse Oximetry Screening (POS) has been shown to be an accurate, cost-effective and noninvasive screening method for the detection of CCHD with high specificity (99.9%) and moderate sensitivity (76.5%) [1,2,19-21], with sensitivity increasing (82-92%) when combined with physical examination. CCHD lesions include duct-dependent cardiac abnormalities (hypoplastic left heart syndrome, pulmonary atresia, transposition of the great arteries and tricuspid atresia) and cyanotic heart lesions including tetralogy of Fallot, total anomalous pulmonary venous return and truncus arteriosus (Table 3) [3,6,20].
Early detection of CCHD is critical to ensure rapid intervention and surgical management. The Canadian Paediatric Society (CPS) and American Academy of Pediatrics (AAP) recommend the implementation of routine POS for all newborns [3,20]. A positive screen is indicated by saturations below 90% on either the right hand (preductal saturation) or any foot (postductal saturation), below 95% in both extremities after three measurements, or a difference of more than 3% between preductal and postductal saturations after three measurements (Figure 1) [3,20,21]. Infants with a positive screen should have further evaluation, including assessment by a pediatric cardiologist and echocardiogram. Though uncommon, false positive screens may result from other conditions causing hypoxemia, such as hemoglobinopathies or persistent pulmonary hypertension of the newborn. Routine POS should be performed between 24-36 hours of age, as screening before 24 hours increases this rate of false positives [2].

**Table 3:** Structural heart lesions detectable using pulse oximetry screening [6].

| Cyanotic | May Be Cyanotic |
|----------|----------------|
| Cyanotic left heart syndrome | Coarctation of the aorta |
| Pulmonary atresia with intact ventricular septum | Double outlet right ventricle |
| Total anomalous pulmonary venous return | Ebstein’s anomaly |
| Tetralogy of Fallot | Interrupted aortic arch |
| Transposition of the great arteries | Defects with single ventricle physiology |
| Tricuspid atresia | |
| Truncus arteriosus | |

![Figure 1: Pulse oximetry screening guidelines for the detection of critical congenital heart disease; adapted from the Canadian Pediatrics Society [3].](image)
Determining When to Refer in The Setting of CHD

In the setting of CHD, a thorough history, physical examination including auscultation for neonatal murmur, and pulse oximetry screening must be carefully combined in order to determine when to refer to pediatric cardiology. The utility of POS is in differentiating newborns at risk for CCHD who require urgent pediatric cardiology referral. We recommend that POS should be implemented universally prior to a newborn being discharged from hospital. Newborns with a cardiac murmur who pass the POS but have red flags on history or physical examination as indicated in (Tables 1 and 2) should also be referred for further assessment. Finally, a newborn with a murmur and negative POS with no red flags should be followed closely by their primary physician to monitor for any symptoms of cyanosis, heart failure, failure to thrive or feeding intolerance. If red flags arise on reassessment, or the murmur characteristics become concerning, the newborn warrants further evaluation. It should be noted that our final recommendation may vary by clinical experience, geographic location and availability of follow-up.

When referring to pediatric cardiology, we recommend that no further diagnostic testing be conducted by the primary physician. Chest x-rays and electrocardiograms rarely assist in the diagnosis of a heart murmur and are therefore not cost-effective. In a study performed by Mackie, et al., the addition of electrocardiography did not improve the sensitivity in the detection of CHD [17].

In geographically remote areas, where pediatric cardiologists may be unavailable for urgent referral, phonocardiography may be considered. Phonocardiography involves digital heart sound recordings which can be reviewed by a pediatric cardiologist remotely, to distinguish between innocent murmurs and murmurs that are likely to be pathologic. Newborns with murmurs that are determined likely to be pathologic should be transported to a clinical centre which can accommodate echocardiogram and examination by a pediatric cardiologist [4].

Conclusion

Neonatal heart murmurs continue to pose a challenge to healthcare providers. Based on their audible characteristics alone, there may be insufficient information to confidently rule out a structural heart lesion. However, complete history and physical examination remain crucial to identify the critical features that may alert the clinician to the presence of critical congenital heart disease (CCHD). Although Pulse Oximetry Screening (POS) has been shown to improve the detection of CCHD, any newborn with a cardiac murmur should be seen by a health care provider after discharge, as vigilant follow-up of all newborns is recommended, as it is possible a newborn with CCHD may escape early screening. For newborns who have clinical findings suggestive of a cardiac condition (i.e., Failure to thrive/poor feeding, cyanosis, decreased pulses, respiratory distress) or have a pathologic cardiac examination, an urgent referral to a pediatric cardiologist for immediate assessment is warranted.

What’s New

1. Congenital heart disease must be considered in the workup for a newborn with a heart murmur
2. Pulse oximetry screening should be done routinely for every newborn 24-36 hours after birth
3. Pulse oximetry screening can help identify critical congenital heart lesions that warrant urgent cardiology follow-up and further workup
4. Close follow-up of all newborns with a murmur is warranted

References

1. Thangaratinam S, Brown K, Zamora J, Khan KS, Ewer AK (2012) Pulse oximetry screening for critical congenital heart defects in asymptomatic newborn babies: a systematic review and meta-analysis. The Lancet 379: 2459–2464.
2. Wong KK, Fournier A, Fournier A, Fruitman DS, Graves L, Human DG, et al. (2017) Canadian Cardiovascular Society / Canadian Pediatric Cardiology Association position statement on pulse oximetry screening in newborns to enhance detection of critical congenital heart disease. Can J Cardiol 33: 199-208.
3. Narvey M, Wong KK, Fournier A (2017) Pulse oximetry screening in newborns to enhance detection of critical congenital heart disease. Paediatr Child Health 22: 494-498.
4. Frank JE, Jacobe KM (2011) Evaluation and management of heart murmurs in children. Am Fam Physician 84: 793-800.
5. Khalilian MR, Malekian A, Aramesh MR, Dehdashtian M, Maryam T (2016). Innocent versus pathologic murmurs: A challenge of neonatal examination. J Clin Neonatal 5: 174-178.
6. Mahle W, Newburger J, Matherne G, Smith FC, Hoke TR, et al. (2009) Role of pulse oximetry in examining newborns for congenital heart disease: A scientific statement from the AHA and AAP. Pediatrics 124: 823-836.
7. Rein AJ, Omokhodion SI, Nir A (2000) Significance of a cardiac murmur as the sole clinical sign in the newborn. Clin Pediatr (Phila) 39: 511-520.
8. Bansal M, Jain H (2005) Cardiac murmur in neonates. Indian Pediatr 42: 397-398.
9. Ainsworth S, Wylie JP, Wren C (1999) Prevalence and clinical significance of cardiac murmurs in neonates. Arch Dis Child Fetal Neonatal Ed (Edn) 80: 43-45.
10. Arlettaz R, Archer N, Wilkinson AR (1998) Natural history of innocent heart murmurs in newborn babies: controlled echocardiographic study. Arch Dis Child Fetal Neonatal Ed 78: 166-170.
11. Geggel RL (2004) Conditions leading to pediatric cardiology consultation in a tertiary academic hospital. Pediatrics 114: e409-e417.
12. Al-Ammouri I, Ayoub F, Dababneh R (2016) Original Article Is pre-discharge echocardiography indicated for asymptomatic neonates with a heart murmur? A retrospective analysis. Cardiol Young 26: 1056-1059.

13. Ul Haq F, Jallal F, Hashmi S, Jumani M, Imdad A, et al. (2011) Risk factors predisposing to congenital heart defects. Ann Pediatr Cardiol 4: 117-121.

14. Narchi H, Kulayat N (2000) Heart disease in infants of diabetic mothers. Images Paediatr Cardiol 2: 17-23.

15. Etoom Y, Ratnapalan S (2014) Evaluation of children with heart murmurs. Clin Pediatr (Philia) 53: 111-117.

16. Kardasevic M, Kardasevic A (2014) The importance of heart murmur in the neonatal period and justification of echocardiographic review. Med Arch 68: 282-284.

17. Mackie AS, Jutra LC, Dancea AB, Rohlicek CV, Platt R, et al. (2009) Can cardiologists distinguish innocent from pathological murmurs in neonates? J Pediatr 154: 50-54.

18. Azhar AS, Habib HS (2006) Accuracy of the initial evaluation of heart murmurs in neonates: Do we need an echocardiogram? Pediatr Cardiol 27: 234-237.

19. Zhao QM, Ma XJ, Ge XL, Liu F, Yan WL, et al. (2014) Pulse oximetry with clinical assessment to screen for congenital heart disease in neonates in China: A prospective study. Lancet 384: 747-754.

20. Mahle WT, Martin GR, Beekman RH 3rd, Morrow WR (2012) Endorsement of Health and Human Services recommendation for pulse oximetry screening for critical congenital heart disease. Pediatrics 129: 190-192.

21. Narayen IC, Blom NA, van Geloven N, Blankman EIM, van den Broek AJM, et al. (2018) Accuracy of pulse oximetry screening for critical congenital heart defects after home birth and early postnatal discharge. J Pediatr 197: 29-35.