

Accuracy of the Initial Evaluation of Heart Murmurs in Neonates: Do We Need an Echocardiogram?

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Abstract. The objective of this study was to determine the differences between neonatologists and pediatric cardiologists with regards to the initial assessment of neonatal heart murmur and to evaluate the role of echocardiography in this group of patients. During a period of 1 year, all neonates with heart murmur seen in pediatric cardiology consultation from neonatal intensive care units at the Children Hospital of Eastern Ontario and Ottawa General Hospital were included in this study. Neonates with heart murmur were initially evaluated clinically by a neonatologist and the most likely clinical diagnosis was recorded. This was followed by similar evaluation and assessment by the pediatric cardiologist, who did not know the result of the previous assessment. Echocardiography diagnosis was considered the gold standard for the accurate diagnosis in the two groups, and it was done for all patients. For the neonatologists, the sensitivity to detect a pathological murmur was 78% and the specificity was 33%; the positive predictive value was 77% and the negative predictive value was 37%. For the pediatric cardiologists, the accuracy of the clinical examination showed a sensitivity of 83% in detecting a pathological murmur and a specificity of 25%; the positive predictive value was 80% and the negative predictive value was 29%. There was no significant difference between the two groups. Certified neonatologists are able to assess the significance of neonatal murmurs well as pediatric cardiologists, although echocardiogram is needed to reach the accurate diagnosis of congenital heart disease in neonates even if a pediatric cardiologist is consulted.

Keywords: Neonatal murmur — Initial evaluation — Congenital heart disease — Echocardiogram

Neonatal heart murmur is the most common reason for pediatric cardiologist consultation in neonatal intensive care units and nurseries [7]. Two-thirds of normal newborns have innocent murmurs for several days after birth [14]. However, a normal neonatal examination does not exclude congenital heart disease (CHD), and routine examination may fail to detect more than half of the cases of CHD [10, 14]. Unrecognized neonatal heart disease carries a serious risk of avoidable mortality, morbidity, and handicap [12]. The dynamic nature of neonatal circulation makes it more difficult to assess heart murmurs in the neonate compared to other pediatric age groups. Assessment of neonates with heart murmurs based on clinical examination alone may not be complete without the use of echocardiograph, which is the most accurate tool for diagnosing heart lesions [2, 11].

The purpose of this study was to determine the differences between neonatologists and pediatric cardiologists with regard to the initial assessment of neonatal heart murmur and to evaluate the role of echocardiography in this group of patients.

Materials and Methods

This prospective study was carried out during a 1-year period from July 1997 to June 1998 at the Children Hospital of Eastern Ontario and Ottawa General Hospital. All neonates with heart murmur seen in pediatric cardiology consultation from neonatal intensive care units at the age of 1–28 days were included in the study. Infants who had abnormal antenatal echocardiograms and dysmorphic infants, such as those with Down's syndromes, were excluded from the study. The study was approved by the ethics committee at the Children Hospital of Eastern Ontario and the Ottawa General Hospital. There were no changes in the routine standard protocol management of neonates enrolled in the study.

Neonates with heart murmur were initially evaluated clinically (including 12-lead electrocardiogram and chest x-ray when required) by a neonatologist in service (one of four certified neo-

natologists). The type of the murmur and the most likely clinical diagnosis were recorded. This was followed by similar evaluation and assessment by the pediatric cardiologist in service (one of four certified cardiologists), who did not know the results of the previous assessment. After the clinical evaluation, echocardiography study (two-dimensional, Doppler echo, and M-mode) was performed by the cardiologist, cardiology fellow, or an expert sonographer. The machine used was the HP 5500. Heart murmurs were classified as innocent murmur and pathological murmur [2, 11]. When the examiner failed to classify the murmur, it was labeled as possible pathological murmur. Echocardiography diagnosis was considered the gold standard in comparing the accuracy of the diagnosis in the two groups and it was done for all patients. Data were analyzed for sensitivity and specificity by means of 2×2 tables. Kappa coefficient was used to calculate the interrater agreement between the two groups.

Results

A total of 75 neonates were enrolled during the study period. The initial clinical diagnoses of the heart murmur by the neonatologists were innocent in 10 neonates, pathological in 56, and possible pathological in 9 patients (Table 1). After echocardiography (Table 2), the diagnosis of innocent murmur was changed to pathological in 7 patients. Of the 56 neonates with the initial clinical diagnosis of pathological murmur, the diagnosis of 13 of them was changed to innocent murmur after echocardiography. Of the remaining 9 infants with the clinical diagnosis of possible pathological murmur, the diagnosis of 4 of them was changed to innocent and that of 5 of them was changed to pathological after echocardiography. The initial clinical diagnoses of the heart murmur by the cardiologists were innocent murmur in 9, pathological in 61, and possible pathological in 5 neonates. After performing echocardiography (Table 3), the diagnosis of innocent murmur was changed to pathological in 6 neonates, that of pathological murmur was changed to innocent in 12, for the diagnosis of possible pathological murmur, 1 was changed to innocent and 4 were changed to pathological murmur. The results were analyzed by means of 2×2 tables, considering echocardiography as the gold standard to assess the accuracy of the clinical examination. For the neonatologists, the sensitivity to detect a pathological murmur was 78% and the specificity was 33%; the positive predictive value was 77% and the negative predictive value was 37%.

For the cardiologists, the accuracy of the clinical examination showed a sensitivity of 83% in detecting a pathological murmur and a specificity of 25%; the positive predictive value was 80% and the negative predictive value was 29%. There was no significant difference between the two groups for all parameters. The kappa coefficient to assess the agreement in auscultation between the two groups was 0.62 (95%

Table 1. Initial evaluation by neonatologist and cardiologist of 75 neonates with heart murmur

Clinical diagnosis	No. of Neonatologist assessments (%)	No. of cardiologist assessments (%)
Innocent murmur	10 (13)	9 (12)
Pathological murmur	56 (75)	61 (81)
Possible pathological murmur	9 (12)	5 (7)
Total	75 (100)	75 (100)

Table 2. Changes in neonatologist clinical diagnosis after performance of echocardiography

Clinical diagnosis	No. (neonatologist) (%)	No. after echocardiography (%)	
		Innocent murmur	Pathological murmur
Innocent murmur	10 (13)	3 (4)	7 (9)
Pathological murmur	56 (76)	13 (17)	43 (57)
Possible pathological murmur	9 (12)	4 (5)	5 (7)
Total	75 (100)	20 (27)	55 (73)

Table 3. Changes in pediatric cardiologist clinical diagnosis after performance of echocardiography

Clinical diagnosis	No. (cardiologist) (%)	No. after echocardiography (%)	
		Innocent murmur	Pathological murmur
Innocent murmur	9 (12)	3 (4)	6 (8)
Pathological murmur	61 (81)	12 (16)	49 (65)
Possible pathological murmur	5 (7)	1 (7)	4 (5)
Total	75 (100)	16 (21)	59 (79)

confidence interval, 0.41–0.83). The most common etiology for pathological heart murmur was patent ductus arteriosus (49%), followed by ventricular septal defect (8%), atrial septal defect (7%), transposition of the great arteries (3%), and others (8%) (Table 4).

Discussion

Detection of a murmur depends on the examiner's skill and experience, the timing and frequency of the examination, and the conditions under which the examination takes place. Failure to identify pathological murmur may delay necessary medical or surgical intervention and cause unwanted sequences [12]. Therefore, reaching a final diagnosis is

Table 4. Heart lesion-specific diagnosis of 75 neonates with heart murmur

Diagnosis	No. of cases (%)
Normal heart	19 (25)
Patent ductus arteriosus	37 (49)
Ventricular septal defect	6 (8)
Atrial septal defect	5 (7)
Transposition of the great arteries	2 (3)
Aortic stenosis	1 (1.3)
Pulmonary stenosis	1 (1.3)
Atrioventricular septal defect	1 (1.3)
Others	3 (4)
Total	75 (100)

essential in a neonate with a heart murmur. The neonatal examination detects only 44% of cardiac malformations that present in infancy, and if a murmur is heard there is a 54% chance of an underlying cardiac malformation [1]. Our study showed that 75% of neonatal murmurs referred to pediatric cardiology from a neonatal tertiary care center were secondary to organic heart disease. Only 25% of patients had innocent heart murmur; most were secondary to pulmonary artery branch stenosis or tricuspid regurgitation. The most common murmur diagnosis in the neonatal intensive care unit was patent ductus arteriosus; this is also reported by Geggel [M] in a similar study. In older infants and children, clinical cardiovascular examination is a very sensitive and accurate method of screening for the underlying heart disease, and echocardiogram is unlikely to reveal clinically unsuspected heart disease [3, 4, 13]. This scenario did not hold true in the case of neonates with heart murmur, in whom echocardiography is necessary whenever congenital heart disease is suspected [2, 11]. Our study showed that in a neonatal tertiary care center the sensitivity of clinical examination alone in detecting pathological murmurs by expert neonatologists and cardiologists was only 78 and 83%, respectively, whereas the accuracy of both groups (neonatologists and cardiologists) in detecting innocent murmurs was unsatisfactory. This supports the fact that echocardiography has dramatically improved the accuracy of diagnosis of congenital heart disease in neonates, and it is an essential tool in the evaluation of neonates with heart murmur.

Our study showed that there were only minimal differences between the neonatologists and cardiologists in the initial clinical evaluation of neonates with heart murmur; no similar comparison between such groups was found in the literature. Previous studies have assessed the diagnostic accuracy of

pediatricians' clinical auscultation skills to assess murmurs in children and cardiac simulators. Hansen et al. [8] concluded that general pediatricians were good at diagnosing innocent murmurs, whereas McCrindle et al. [9] concluded that pediatric cardiologists have excellent diagnostic accuracy. However, Gaskin et al. [6] showed that pediatric residents had only 33% diagnostic accuracy. Farrer et al. [5] showed that the sensitivity of the senior house officers' examination to assess the clinical significance of the neonatal murmur was 71% and the specificity was 91%; the positive predictive value was 71%, and the negative predictive value was 91%. These results are similar to those reported in this study. That is, a trained neonatologist is able to assess the significance of, and determine appropriate management for, neonatal murmurs, although echocardiogram is needed to reach the accurate diagnosis of congenital heart disease in neonates even if a pediatric cardiologist is consulted.

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