

## Echocardiography: The Examination Request by the Pediatrician Achieving the Pediatric Cardiologist

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### Summary

**Background:** Echocardiography is a diagnostic tool used to evaluate cardiac anomalies and clarify doubts about the benign nature of certain findings of cardiovascular clinical examination.

**Objectives:** To identify the main reasons for the request of echocardiography by pediatrician and evaluate the degree of anxiety of the family generated by this conduct.

**Methods:** We included patients younger than 18 years without previous diagnosis of heart disease and referred for the first echocardiogram. Family members responsible for the patients answered a questionnaire to assess the degree of their anxiety from order to the performance of the echocardiogram, with scores between 0 and 19. Data were analyzed using percentages, standard deviation and Student's t test.

**Results:** Studied 30 patients with a mean age of 4.45 years. The most prevalent reason for referral was heart murmur (23 cases), of which 70% patients had no congenital heart disease hypothesis confirmed, after echocardiography. The average score on the anxiety questionnaire was  $11 \pm 6$  significantly associated with the presence of heart disease, with a mean of  $13.0 \pm 5.3$  vs.  $9.3 \pm 5.2$  in the group without the possibility of it ( $p = 0.007$ ).

**Conclusion:** The murmurs findings was the main reason for echocardiography request by the pediatrician. Confirmation of heart disease was higher in children under 1 year and with murmurs findings. Despite the anxiety level was higher in the group of patients who were diagnosed with congenital heart disease, this was not negligible in the family in the group of patients without heart disease. (Arq Bras Cardiol: Imagem cardiovasc. 2017;30(2):39-45)

**Keywords:** Echocardiography; Cardiovascular Abnormalities; Child; Adolescent; Pediatrics; Anxiety.

### Introduction

Monitoring a child's growth and development is the pediatrician's main job. This has always been considered essential in any society, in view of the importance of ensuring primary health care. This monitoring, called childcare, is directly related not only to health promotion, but also to better quality of life, whether for children and adolescents, or for the family members involved.<sup>1,2</sup>

When pediatricians detect any physical abnormalities, such as a heart murmur, they must be careful when they inform this finding, since a heart murmur does not always determine the existence of a pathology. As a rule, parents do not want to hear the news that their child may have a disease, especially affecting such a noble organ like the heart.

Heart murmurs are the most common abnormalities found in cardiac auscultation in childhood and are sounds generated

by turbulent sound waves that originate in the heart and/or vasculature. But innocent heart murmurs occur when some abnormality in auscultation is detected in the absence of any anatomical and/or functional abnormality of the cardiovascular system. It is estimated that 50% to 70% of children will have, at some point in childhood or adolescence, an auscultation abnormality that will be classified as heart murmur. The incidence of congenital heart diseases (CHD) occurs in 8 to 12 cases per 1,000 live births, excluding premature births (less than 1%).<sup>3</sup>

Heart murmurs are a frequent cause of referral to the pediatrician and/or pediatric cardiologist and, for that reason, it is essential to know the warning signs suggestive of heart disease in the evaluation of a child with heart murmur. Most heart murmurs in children are a benign condition and the clinical characteristics are sufficient to rule out a pathological condition.<sup>4</sup>

With the advent of non-invasive complementary tests, such as echocardiography, to assess cardiac anomalies, there is a tendency to use this resource excessively to clarify any questions on the clinical examination of the cardiovascular system, which generates financial expenses and anxiety for the patient's relatives. We did not find in the literature any studies that also assess the degree of anxiety caused by the pediatrician's echocardiography request.

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The purpose of this study was to identify the main reasons for the clinical pediatrician's request of echocardiography and evaluate the family's level of anxiety, from the request of echocardiography to the test results.

## Methods

This is a cross-sectional observational study that involved 30 patients referred for the pediatric cardiology clinic of Hospital São Paulo (Universidade Federal de São Paulo), from August to December 2015, to be evaluated and submitted to echocardiography scan for the first time. The following patient information have been obtained: age, gender, test request date and reason for referral, diagnosis hypothesis, test date and echocardiography results.

**Inclusion criteria:** patients younger than 18 years with no previous diagnosis of heart disease and referred for the first echocardiography scan, which was requested by the clinical pediatrician.

**Exclusion criteria:** patients aged 18 and diagnosed with heart disease previously confirmed by clinical and laboratory tests.

**Anxiety questionnaire:** while awaiting completion of the echocardiography scan in the waiting room and after the initial explanation about the test and its purpose, and after signing the Informed Consent form (IC), mothers or family members responsible for the patients answered a questionnaire to evaluate their degree of stress and anxiety from the request to the echocardiography scan.

The questionnaire to assess the family members' degree of anxiety was based on the Beck Anxiety Scale<sup>5</sup> (Figure 1).

To better analyze the questionnaire's responses, the zero-to-nineteen scores described below were applied. Questions 1, 4.1 to 4.4): No = 0, a little = 1, slightly = 2 and very = 3; question 2: yes = 0 and no = 1; question 3: No = 3, a little = 2, slightly = 1 and a lot = 0.

Data were analyzed using percentages, mean ( $\pm$  standard deviation) and, for independent samples, Student's t test was performed. This study was approved by the research ethics committee via Plataforma Brasil (opinion no. 1.117.800).

## Results

From August to December 2015, we selected patients who met the inclusion criteria and whose mothers or family members agreed to answer the anxiety questionnaire after signing the Informed Consent. This is a population of 30 patients with a mean age of 4.45 (minimum = 12 days and maximum = 15 years of age), of whom 11 are females and 19 are males (37% and 63%, respectively) (Table 1).

Due to a wide patient age range, we chose to classify them into age groups (younger than 6 months, 6 months - 1 year, >1a - 5 years, > 5 - 10 years and older than 10 years). Most are represented in the age range < 6 months (33%) and from 5 to 10 (27%). The other age groups (groups) correspond 10 to 11% each (Figure 2).

Heart murmur was the most prevalent reason for referral (77%), followed by other cardiovascular complaints, including syncope, palpitations, fatigue and chest pain (23%). Of the patients referred due to heart murmur, it was found that 70% had a congenital heart defect and the others presented some mild heart diseases - minor atrial

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1. Were you worried when you learned your son would have to be tested specifically for the heart (echocardiography)?  
( ) Absolutely not    ( ) A little    ( ) Slightly    ( ) A lot
  2. Did the pediatrician clearly explain why your son would have to be tested?  
( ) Yes                    ( ) No
  3. If you answered yes to the question above, did that help you remain calm?  
( ) Absolutely not    ( ) A little    ( ) Slightly    ( ) A lot
  4. While you waited since the pediatrician requested the test until the test was completed, did you feel any of the symptoms described below?
    - 4.1 Inability to relax  
( ) Absolutely not    ( ) A little    ( ) Slightly    ( ) A lot
    - 4.2 Fear of the worst case scenario:  
( ) Absolutely not    ( ) A little    ( ) Slightly    ( ) A lot
    - 4.3 Nervousness:  
( ) Absolutely not    ( ) A little    ( ) Slightly    ( ) A lot
    - 4.4 Fear of losing control:  
( ) Absolutely not    ( ) A little    ( ) Slightly    ( ) A lot
- 

**Figure 1 – Anxiety questionnaire.**  
Adapted from Beck et al.5 Manual. San Antonio: Psychological Corporation; 1993.

**Table 1 - Overview of the sample analyzed**

Age	Sex	Waiting time <sup>a</sup>	Reason <sup>b</sup>	Professional <sup>c</sup>	Result <sup>d</sup>
3 years	M	2 months	Heart murmur	Pediatrician	no evidence of heart disease
2 years	M	1 week	Heart murmur	Pediatrician	no evidence of heart disease
8 years	F	2 weeks	Syncope waking up	Neuropediatrician	no evidence of heart disease
4 months	F	2 weeks	Fatigue when breastfed	Pediatrician	no evidence of heart disease
4 months	M	1 week	Heart murmur and fatigue when breastfed	Pediatrician	Atrial septal defect
14 days	M	1 week	Heart murmur	Pediatrician	no evidence of heart disease
6 years	M	4 months	Heart murmur	Pediatrician	no evidence of heart disease
15 years	F	2 weeks	Syncope to be investigated	General practitioner	no evidence of heart disease
8 years	M	1 month	Heart murmur	Pediatrician	no evidence of heart disease
3 months	F	1 week	Heart murmur	Pediatrician	ventricular septal defect
13 years	M	1 week	Palpitations to be investigated	General practitioner	no evidence of heart disease
12 days	F	1 day	Heart murmur	Pediatrician	ventricular septal defect
7 years	M	1 week	Heart murmur	Pediatrician	no evidence of heart disease
9 months	M	1 week	Heart murmur	Pediatrician	no evidence of heart disease
1 month	F	1 month	Heart murmur	Pediatrician	ventricular septal defect
13 years	M	1 month	Fatigue and chest pain	Pediatrician	no evidence of heart disease
2 months	M	1 month	Heart murmur	Pediatrician	no evidence of heart disease
5 months	M	1 month	Heart murmur	Pediatrician	no evidence of heart disease
5 years	M	1 week	Heart murmur	Pediatrician	no evidence of heart disease
3 years	M	3 weeks	Heart murmur	Pediatrician	no evidence of heart disease
7 years	F	1 month	Heart murmur	Pediatrician	no evidence of heart disease
2 months	F	2 months	Heart murmur	Pediatrician	Pulmonary stenosis
10 months	F	7 months	Heart murmur	Pediatrician	Pulmonary stenosis
13 years	M	1 month	Heart murmur	Pediatrician	no evidence of heart disease
2 years	M	2 months	Heart murmur	Pediatrician	no evidence of heart disease
1 year	M	1 month	Heart murmur	General practitioner	Atrial septal defect
8 years	M	2 weeks	Heart murmur	Pediatrician	no evidence of heart disease
7 years	F	3 weeks	Precordial pain	Pediatrician	no evidence of heart disease
10 years	F	2 weeks	Bradycardia to be investigated	Pediatrician	no evidence of heart disease
1 month	M	1 week	Heart murmur	General practitioner	no evidence of heart disease

*a: waiting time from the echocardiography scan request to its completion; b: reason for referral for echocardiography; c: doctor requesting the echocardiography; d: echocardiography results.*

septal defect (2), minor ventricular septal defect (3) and mild pulmonary stenosis (2) (Table 2).

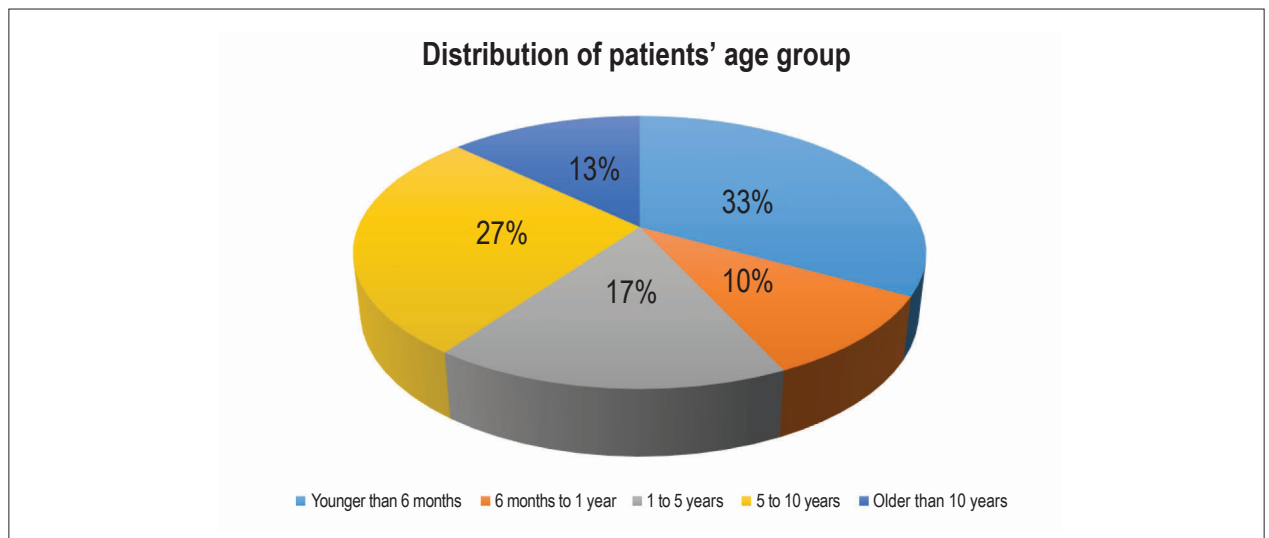
By analyzing patients whose reason for referral was heart murmur (n = 23), it was found that there was no significant difference regarding the average waiting time between the group of those who had a chance of heart disease (2.3 ± 1 weeks on average) and the group with no evidence of heart disease (3.9 ± 4 weeks on average), p = 0.29 (Figures 3 and 4).

Regarding the questionnaire of anxiety, the average score was 11 ± 6, being significantly related (p = 0.007) to the presence of a chance of heart disease, averaging 13.0 ± 5.3 vs. 9.3 ± 5.2, if there is no chance.

When we analyzed all patients with no evidence of heart disease (n = 23) who have been referred due to heart murmur (n = 16) or other cardiovascular complaints (n = 7), there was no significant difference between the groups regarding the score in the anxiety questionnaire (9.1 ± 5 vs. 9.8 ± 5.7), p = 0.74.

## Discussion

An innocent or physiological murmur is the only finding in the physical examination of a child or adolescent that does not have abnormalities in the cardiovascular system.<sup>6</sup> Seven basic characteristics can be used to identify an innocent murmur:



**Figure 2** – Distribution of the age groups of the patients analyzed.

**Table 2** – Echocardiography results of patients referred due to cardiac murmur

Echocardiography results	Total (N)	Total (%)
Atrial septal defect (ASD)	2	8.7
Ventricular septal defect (VSD)	3	13
Pulmonary stenosis	2	8.7
No evidence of heart disease	16	69.6
Total	23	100

abnormalities in auscultation according to the position or breathing, short duration, no association with clicks or heart sounds, no irradiation, low amplitude, smooth and occurrence limited to systole.<sup>7</sup>

In addition to the characteristics described above, three requirements are needed to diagnose an innocent murmur: the doctor must safely the auscultation characteristics of the physiological murmur in question, a detailed clinical history directed to the cardiovascular system should not reveal any evidence of heart disease, and complete physical examination (in addition to auscultation) cannot suggest the possibility of a heart disease existing.<sup>8</sup>

In this study, all patients with heart murmur and with final diagnostic hypothesis of a congenital heart disease after the echocardiography results (30% of the cases of heart murmur) were under 1 year of age, which definitely justifies the test request to assess the heart murmur findings.<sup>9</sup>

The heart murmur finding is without a doubt one of the most frequent reasons of referrals to the pediatric cardiology clinic, but in isolation, it is not an indication for an echocardiography scan to be performed. Not all patients with suspected heart disease has the diagnosis confirmed after conducting additional tests.<sup>10,11</sup> In our study, 70% of the

patients referred due to heart murmur had no suspicion of heart disease confirmed by echocardiography, therefore, they only had innocent heart murmurs.

Two studies with larger samples than ours also showed high rates of patients with no evidence of heart disease and/or patients with physiologic murmurs. In a study conducted in eastern Turkey, of the 243 patients with heart murmur detected on cardiac auscultation, 209 (86%) were diagnosed as having an innocent murmur, representing an even higher rate than that found in our study (86% vs. 70%), considering only patients with heart murmur.<sup>12</sup> In the study by Castilho,<sup>6</sup> of the 393 patients aged seven days to seventeen years of age referred for an echocardiography scan, 64% were normal on clinical examination, with a concordance rate (Kappa = 74%) between the diagnosis made on clinical bases (medical history and physical examination) and diagnosis with echocardiography. Note that, in this study, the main reason for referral was the presence of heart murmur among children with no heart disease.<sup>6</sup>

It is very important to pay attention to certain data in the medical history that may indicate the presence of a disease: changes in the pattern of growth and development; physical appearance (signs of chromosomopathy) and patient's general condition; vomiting and recurrent pneumonia, and arthritis and arthralgia (acquired heart diseases); family history of sudden death and cardiovascular pathologies diagnosed early. Chest pain, cyanosis, dizziness, dyspnea, syncope and palpitations are among the classic signs and symptoms that suggest the presence of a circulatory dysfunction.<sup>3,13</sup>

Regarding who should initially evaluate pediatric patients with heart murmur, a study conducted by Discigil et al found that both clinical pediatricians and cardiologists can evaluate heart murmurs by auscultation with high concordance rate for patients with no abnormalities or physiological murmur. The results found by these authors showed that of the murmurs detected in pediatric patients by pediatricians, a concordance

Ratio of waiting time of patients diagnosed with innocent heart murmur

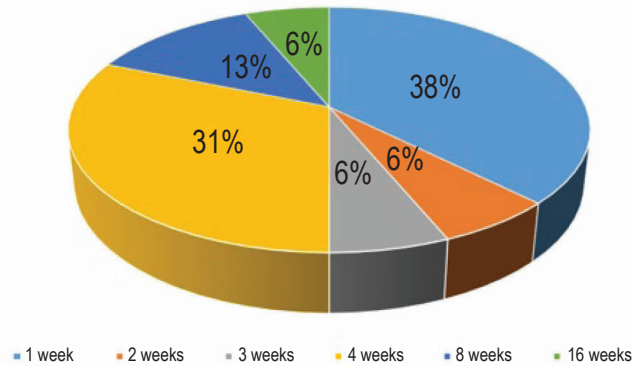


Figure 3 – Waiting time of patients with innocent heart murmur.

Ratio of waiting time of patients diagnosed with pathological heart murmur

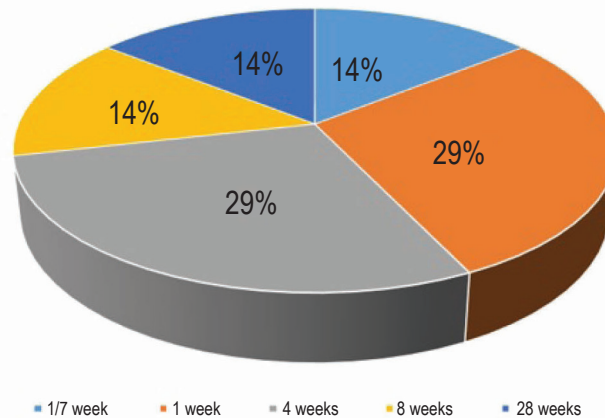


Figure 4 – Waiting time of patients with pathological heart murmur.

of 94% was obtained with pediatric cardiologists among innocent murmurs and 35% among pathological murmurs, showing that the vast majority of the murmurs considered pathological by the pediatrician have not been confirmed by the pediatric cardiologist (65%).<sup>14</sup> In our study, the vast majority of referrals due to cardiac murmur were performed by pediatricians (20 cases - 91%) and 65% had normal echocardiography scans, i.e., the murmur was diagnosed as innocent.

Taking the medical history and conducting a heart examination are essential for the clinical diagnosis of an innocent murmur, so the pediatricians must use this resource correctly before requesting any further tests. There are even electronic stethoscopes and computing resources that can increase the sensitivity and specificity of auscultation as a diagnostic tool.<sup>15, 16</sup>

The decision to request an echocardiography scan should take into account the particularities of each case, with special attention to the cost effectiveness of the procedure and the time required for the test to be carried out, as in our study, both the patients with congenital heart disease and those with no evidence of heart disease waited for a considerable time to have the echocardiography completed.<sup>17</sup>

According to the Brazilian Society of Cardiology, the main indications and recommendations of echocardiography scans in patients under 18 include anatomical, functional, and heart rhythm disorders.<sup>18</sup> Neonates presenting signs and symptoms consistent with congenital heart diseases should be carefully examined as quick as possible, as delays in the diagnosis and intervention of serious conditions can be fatal for these patients.<sup>19</sup>



<sup>20</sup> As in our sample we did not find any patients referred for heart murmurs tests due to poor prognosis heart diseases and in need of immediate intervention, it is to be expected that both groups (with and without evidence of heart disease) have waited, on average, at least two weeks to have their tests done. Otherwise they would have been examined at the hospital level.

As the average score on the anxiety questionnaire was slightly lower in the group of patients with no evidence of heart disease ( $9.3 \pm 5.2$ ) regarding the group with heart disease, we can hypothesize that this is due to the potential absence of further information given to the family about the potential diagnosis of an innocent murmur and, therefore, the no-need of an echocardiography scan.

## Conclusions

Our study showed that heart murmur is the main reason for the pediatrician to request an echocardiography scan and the rate of patients with no evidence of heart disease and/or innocent murmur accounted for the majority of cases. Although the average score in the anxiety questionnaire was higher in the group of patients diagnosed with congenital heart disease, the degree of anxiety of the family members in the group of patients with no heart disease was not negligible during the waiting time before the tests, but further studies are needed with larger samples to accurately determine the emotional and financial consequences of such procedures,

both with respect to the patients' families and the healthcare system. What we can say without a doubt is that medical history and physical examination are essential before requesting further tests.

## Authors' contributions

Research creation and design: Barbosa LG, Freitas ABR, Proença MABM, Silva CMC; Data acquisition: Barbosa LG, Freitas ABR, Proença MABM, Silva CMC; Data analysis and interpretation: Barbosa LG, Freitas ABR, Proença MABM, Silva CMC; Statistical analysis: Barbosa LG, Freitas ABR, Proença MABM, Silva CMC; Manuscript drafting: Barbosa LG, Freitas ABR, Proença MABM, Silva CMC; Critical revision of the manuscript as for important intellectual content: Barbosa LG, Freitas ABR, Proença MABM, Silva CMC.

## Potential Conflicts of Interest

There are no relevant conflicts of interest.

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## Academic Association

This study is not associated with any graduate program.

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