Original Article

doi: https://doi.org/10.1590/1983-1447.2024.20230170.en

Factors associated with the indication of neonatal echocardiography in the investigation of congenital heart diseases

Fatores associados à indicação de ecocardiografia neonatal na investigação de cardiopatias congênitas

Factores asociados a la indicación de la ecocardiografía neonatal en la investigación de cardiopatías congénitas

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How to cite this article:
Silva MT, Silva ACSS, Santana JJ, Góes FGB, Assis GGT, Matos PSD, Cunha AL. Factors associated with the indication of neonatal echocardiography in the investigation of congenital heart diseases. Rev Gaúcha Enferm. 2024;45:e20230170. doi: https://doi.org/10.1590/1983-1447.2024.20230170.en

ABSTRACT

Objective: To analyze the factors associated with the indication of echocardiography for the investigation of congenital heart disease among newborns.

Method: Retrospective sectional study through the collection of 848 medical records of patients admitted to maternity hospitals in Rio de Janeiro-Brazil, respecting the time frame from September to December 2022.

Results: The average age of mothers was 26.5±6.3 years; 52.7% were classified as brown. The average age of the newborns was 3.5±5.6 days. Maternal variables: gestational age (OR=6.93, CI:3.76-12.80), number of gestational risk factors (1.90: 1.47-2.45) and number of medications (1. 97: 1.40-2.77); and neonatal variables: age (1.07: 1.03-1.02), prematurity (10.55: 5.29-21.03) and number of risk factors (2.62: 2.03-3 .38) were significantly associated with the indication for echocardiography (p<0.001).

Conclusion: It is concluded that the different maternal and neonatal variables, gestational age, number of gestational risk factors, number of medications, age, prematurity and number of risk factors, respectively, showed a significant association for the indication of echocardiography. Therefore, the identification of these factors will enable the investigation of congenital heart disease at an opportune time among newborns.

Descriptors: Heart defects congenital. Echocardiography. Pediatric nursing.

RESUMO

Objetivo: Analisar os fatores associados à indicação de ecocardiografia para a investigação de cardiopatia congênita entre recém-nascidos.

Método: Estudo seccional retrospectivo por meio da coleta em 848 prontuários de pacientes internados em maternidades no Rio de Janeiro-Brasil, respeitando o recorte temporal de setembro a dezembro de 2022. Realizados cálculos da razão de chance, intervalo de confiança de 95% em nível de significância de 5%.

Resultados: A média de idade das mães foi de 26,5±6,3 anos;52,7% foram classificadas como pardas. A idade média dos recém-nascidos foi de 3,5±5,6 dias.As variáveis maternas: idade gestacional (RC=6,93, IC:3,76-12,80), número de fatores de risco gestacional (1,90:1,47-2,45) e número de medicamentos (1,97:1,40-2,77); e as variáveis neonatais: idade (1,07:1,03-1,02), prematuridade (10,55:5,29-21,03) e número de fatores de risco (2,62:2,03-3,38) se associaram significativamente à indicação de ecocardiografia (p<0,001).

Conclusão: Conclui-se que as distintas variáveis materna e neonatal,idade gestacional, número de fatores de risco gestacional número de medicamentos, idade, prematuridade e números de fatores de risco, respectivamente apresentaram associação significativa para a indicação da ecocardiografia. Logo, a identificação desses fatores possibilitará a investigação de cardiopatia congênita em momento oportuno entre os recém-nascidos.

Descritores: Cardiopatias congênitas. Ecocardiografia. Enfermagem pediátrica.

RESUMEN

Objetivo: Analizar los factores asociados a la indicación de la ecocardiografía para la investigación de cardiopatías congénitas en recién nacidos.

Método: Estudio seccional retrospectivo a través de la recolección de 848 historias clínicas de pacientes ingresadas en maternidades de Río de Janeiro-Brasil, respetando el período de septiembre a diciembre de 2022. Cálculos del odds ratio, intervalo de confianza del 95% en el nivel de significancia de 5%.

Resultados: La edad promedio de las madres fue de 26,5±6,3 años; El 52,7% fueron clasificados como pardos. La edad promedio de los recién nacidos fue de 3,5±5,6 días. Variables maternas: edad gestacional (OR=6,93, IC:3,76-12,80), número de factores de riesgo gestacional (1,90:1,47-2,45) y número de medicamentos (1,97:1,40-2,77); y variables neonatales: edad (1,07:1,03-1,02), prematuridad (10,55:5,29-21,03) y número de factores de riesgo (2,62:2,03-3,38) se asociaron significativamente con la indicación de ecocardiografía (p<0,001).

Conclusión: Se concluye que las diferentes variables maternas y neonatales, edad gestacional, número de factores de riesgo gestacional, número de medicamentos, edad, prematuridad y número de factores de riesgo, respectivamente mostraron asociación significativa para la indicación de ecocardiografía. Por lo tanto, la identificación de estos factores permitirá investigar las cardiopatías congénitas en un momento oportuno entre los recién nacidos.

Descriptores: Cardiopatías congénitas. Ecocardiografía. Enfermería pediátrica.

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INTRODUCTION

Congenital heart disease (CHD) consists of anomalies involving the heart and great vessels. The incidence of these diseases is 1 in every 100 live births worldwide, with an estimated 130 million children affected by some type of CHD. In Brazil, the incidence of CHD is estimated at 10 cases per 1000 live births, being the third main cause of death during the neonatal period[1,2].

As 2.8 million births occur in Brazil each year, it is estimated that around 29,000 new cases of CHD are identified each year. In severe forms of this condition, congenital heart disease can be responsible for up to 30% of deaths in the neonatal period, representing the malformation with the greatest impact on infant morbidity and mortality, in addition to generating substantial increases in public health expenses[1–3].

Congenital heart diseases (CHD) can be classified as acyanotic and cyanotic, the latter also known as critical CHD or severe CHD, requiring immediate therapeutic intervention. Many newborns (NB) are discharged from hospital without having been diagnosed with the disease and progress to shock, hypoxia or early death, without even having received adequate treatment[4,5]. Therefore, fetal and postnatal diagnosis of cardiac anomalies is extremely important to reduce infant morbidity and mortality in our country[6].

In CHD, the mixing of the systemic and pulmonary venous return reduces peripheral oxygen (O_2) saturation. Therefore, it is recommended to routinely measure pulse oximetry or doing "Teste do Coraçãozinho" (TC) in all newborns before hospital discharge[5]. It is crucial that instructions on this test are communicated clearly to families, in a language understandable to each of them, so that adequate clarifications are offered[7].

Technological advances and the dissemination of techniques, such as echocardiography, have contributed significantly to improving the diagnosis of congenital heart diseases. However, despite these advances, the survival rate in the neonatal period is still limited, and therefore investments in assistive technology and professional training aimed at this population are necessary[8].

In 2014, the Brazilian Ministry of Health (MS) made public the decision to universally incorporate pulse oximetry, also known as TC, as part of the Neonatal Screening program of the Unified Health System (SUS), aiming to detect early onset of critical congenital heart disease (CCHD). This decision was established through Ordinance No.20, of June 10, 2014[9].

TC ("Teste do Coraçãozinho") is a non-invasive and painless assessment of oxygen saturation (SpO2) performed between 24 and 48 hours of life in apparently healthy newborns (NB) with gestational age ≥ 35 weeks, before hospital discharge. SpO2 is measured by placing the oximeter on the right upper limb and one of the lower limbs[5]. Also, the test has a sensitivity of 76% and specificity of 99% for definitive diagnosis[10]. However, it is important to highlight that there are critical congenital heart defects that may require early intervention and are not easily screened by the TC.

Therefore, performing TC (pulse oximetry) does not eliminate the need for a thorough and detailed physical examination, carried out by nurses or doctors, on all newborns before hospital discharge. Some CHD, whose clinical presentation is related to the closure or restriction of the ductus arteriosus (called duct-dependent congenital heart diseases), may not show visible symptoms at the time of hospital discharge, which generally occurs between 36 and 48 hours after birth. During this period, cardiac auscultation may appear normal, as the ductus arteriosus may not have closed completely yet, considering that spontaneous closure occurs within 72 hours of life[10].

Echocardiography (ECHO) is a diagnostic method that provides important hemodynamic information, such as estimating pulmonary pressure and evaluating ventricular function, reducing the need for cardiac catheterization. The sensitivity of this test in diagnosing congenital heart disease reaches a safety level of up to 83%, with a specificity of approximately 97.7%, allowing the identification of risk and facilitating appropriate treatment[11], being considered the best screening method, especially for CHD, both in the fetal and postnatal period. However, its use as a screening tool is unfeasible due to the significant associated costs and the need for specialized professionals[12].

Since the neonatal component of infant mortality is directly associated with the care provided, it is essential to ensure adequate assistance at the time of birth and in the care offered to NB. It is widely recognized that nurses stand out among the health professionals involved in carrying out the TC, as they are in closer contact with patients and offer holistic and comprehensive care to the mother-child binomial[7]. However, both nurses and other health professionals must be properly trained to perform and interpret the test and are responsible for identifying any abnormalities and referring newborns to a specialist doctor, if necessary[13].

In view of the above, the concrete need to conduct local and regional studies is justified due to the importance of obtaining knowledge about CHD, especially because they are a notable public health problem associated with significant mortality rates in children under one year of age. Thus, it is convenient to develop a study that aims to contribute to the development of more individualized and assertive strategies. Also, health professionals must have in-depth knowledge of all the steps necessary to care for newborns

with CHD, so that they can identify risk predictor factors for newborns with heart diseases. The study may also contribute to the development of more accurate care plans and the adoption of more effective diagnostic strategies, with a focus on increasing survival and quality of life for this population.

Thus, the following research question was defined: what factors are associated with the indication of echocardiography in the investigation of congenital heart disease among newborns? And the objective is to analyze the factors associated with the indication of echocardiography for the investigation of congenital heart disease in newborns.

METHOD

Retrospective sectional study developed in two public maternity hospitals (called hospital unit A and hospital unit B), located in the state of Rio de Janeiro, Brazil. The research description was based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines[14].

The units are centers specialized in the care for newborns and have the same legal nature, all being municipal government agencies with a certain degree of autonomy and characterized as follows: one as a high-risk maternity hospital and the other as a low-risk maternity hospital, which guarantees universal access to people with CHD, through regionalization and hierarchization.

To estimate the number of medical records selected in each researched center, sampling was carried out on the average number of births in each one (units A and B), for a period of four months, corresponding to the data collection period. Sample calculation assumed a margin of error with a significance level of 5%, a 95% confidence interval and the average number of births estimated for the data collection period was 1,552 (unit A) and 1,984 (unit B) for each maternity hospital. Thus, a sample size of 309 and 320 records, respectively, was defined, selected by convenience sampling.

Data collection was carried out in the archive service of each institution, between January and March 2023, based on exposure variables in 848 medical records of the binomial (mother-baby) hospitalized in the rooming-in sector, respecting the time frame that comprised the period between September and December 2022. It should be noted that in the referred scenarios when the mother or newborn's clinical condition worsens, and transfer to another sector is required, the mother and child's medical information is kept in different charts.

All records that met the following inclusion criteria were included: gestational age equal to or greater than 35 weeks, patients who underwent the TC and who were in the rooming-in sector. Medical records of newborns admitted to the Neonatal Intensive Care Unit (NICU), unavailable for access or with poor data completeness were excluded, in order to minimize potential information bias. Thus, variables of interest for the study that had more than 20% of losses (missing data) would be excluded from the analyses. However, it should be mentioned that no variable in this study was excluded.

Data collection was carried out using physical records and the data was entered into an electronically structured form, created on the Google Forms virtual platform, with the insertion of information regarding maternal health and the health of newborns. The form was previously tested and adjusted regarding the newborn's age variable, which was originally described in hours and then adjusted to days. The collection was carried out by two undergraduate students at each institution, under the supervision of the supervisor, a doctor in nursing and with experience in developing such research.

The independent or exposure variables were classified into two groups, (i) those related to the mother and (ii) those related to the newborn. Thus, the qualitative maternal variables were skin color (categorized as white and non-white) and education (categorized as secondary/higher education, complete primary education and no education/incomplete primary education). On the other hand, variables such as age, number of pregnancies, number of medications used by the mother, number of prenatal appointments, gestational age, number of pregnancies, births and abortions were analyzed in their continuous forms. The gestational risk factors listed were diabetes, high blood pressure, urinary tract infection, alcohol consumption, smoking, premature labor, use of illicit drugs, pre-eclampsia, hypothyroidism, syphilis, anemia, asthma, epilepsy, premature displacement of the placenta and placenta previa. For the purpose of descriptive analyses, the following categories were assumed to quantify gestational risk factors: none, one, two, three or more. For inferential analyses, the continuous form of this variable was considered, generated from the sum of all gestational risk factors listed. Furthermore, the two most prevalent gestational risk factors were considered, which were the presence of diabetes and high blood pressure (both categorized as yes; no). The serological reagents investigated were toxoplasmosis, syphilis, HIV, rubella, hepatitis and cytomegalovirus. In the analyses, the sum of all reactive serologies recorded in the medical records was performed. This procedure resulted in a continuous variable that was subsequently analyzed.

Qualitative variables related to the newborn included prematurity (yes; no) and weight classification: appropriate for gestational age (AGA); small for gestational age (SGA); large for gestational age (LGA). The variables age of the newborn, birth weight (kg), saturation in upper and lower

limbs were analyzed in their continuous forms. Furthermore, the risk factors for newborns listed were maternal infection, prematurity, malformation, respiratory disorders, premature rupture of ovular membranes (PPROM), hypoglycemia, meconium aspiration, congenital syphilis, problems related to ABO incompatibility, twinning, infection of the urinary tract infection (IUT) and asphyxiation. For the purpose of descriptive analyses, the following categories were assumed to quantify risk factors for the newborn: none, one, two, three or more. For inferential analyses, the continuous form of this variable was considered, generated from the sum of previously described risk factors for newborns. Finally, the categorical variable (yes; no) was considered to confirm congenital heart disease.

The dependent variable or outcome was the indication for echocardiography to diagnose congenital heart disease. This information was recorded in the analyzed records and, for analysis purposes, it was treated as a qualitative variable categorized into two levels (yes; no).

Descriptive analyzes were based on the presentation of the mean and standard deviation (SD) for quantitative variables. Qualitative variables were described based on absolute (n) and relative frequency (%). Inferential analyzes were conducted based on bivariate models that assessed the association between each independent variable and the dependent variable. The analyzes were based on the calculation of the odds ratio and respective 95% confidence interval and a significance level of 5% was assumed. The database was created with Microsoft Excel and analyzed using the IBM SPSS program (Statistical Package for Social Sciences, v.16.0).

The study complied with Resolution No. 466 of 2012 of the National Health Council[15], and was submitted to the Ethics and Research Committee of Universidade Federal Fluminense (CEP/UFF) under Protocol No.5,461,380 and Certificate of Presentation for Ethical Appraisal (CAAE) , No. 58069522.6.0000.8160.

RESULTS

A total 890 medical records that met the inclusion criteria were selected. Of this total, 42 records of newborns admitted to the NICU were excluded. Although established as exclusion criteria, no records were excluded due to unavailability of access or poor data completeness. The sample of 848 medical records consisted of newborns whose mothers had a mean age of 26.5±6.3 years. Most mothers were classified as brown (52.7%) and had completed high school education (59.3%). The majority had not suffered miscarriages (80.1%). The most prevalent type of birth was vaginal (72.4%), 43.7% had 10 or more prenatal consultations and the average gestational age was 39.0±1.7 weeks. Most were not taking medication (59.7%) and did not have reactive serology (73.0%). However, the fact that 53.0% had at least one gestational risk factor, 16.6% had diabetes and 16.0% had high blood pressure (Table 1) deserves attention.

As shown in Table 2, the newborns evaluated were, on average, 3.5 days old (SD (±5.6) and ranged from zero to 37 days. The average birth weight was approximately 3.2kg (SD±0.49). Most of the babies in the sample were not premature (93.2%) and had not been admitted to the ICU (95.6%). The prevalent classification in this group was babies with appropriate weight for gestational age (AGA) (83.7%) and 39% had at least one risk factor described in their medical records.

Measurement of saturation values in the upper and lower limbs showed that most newborns had an oxygen saturation (SpO2) greater than 95%. Only one infant had saturation below 95% and was referred for echocardiography and diagnosed with CHD. However, it is noteworthy that 45 (5.3%) newborns were referred for echocardiography examination, even when SpO2 values were higher than recommended and, of these, 31 (68.9%) newborns were diagnosed with some type of CHD.

The bivariate analyzes presented in Table 3 showed that gestational age, number of medications used by the mother and sum of gestational risk factors were significantly associated with the indication for echocardiographic examination. In other words, babies whose mothers had a gestational age of less than 37 weeks, as well as those greater than 43 weeks, were approximately seven times more likely to be indicated for echocardiography. On the other hand, the odds ratio of 1.90 (95%CI=1.47-2.45) observed suggests that when there is an increase in a gestational risk factor, the chance of the outcome occurring increases by 90%. A similar interpretation can be made regarding the number of medications used by the mother, which showed a 97% increase in the chance of an indication for echocardiography.

Regarding newborn variables (Table 3), it was observed that the baby's age, prematurity and number of risk factors were significantly associated with indication for echocardiography. Specifically in relation to the number of risk factors, the result found suggests that for each unit increase in the exposure variable there is an increase of approximately 160% in the chance of the outcome in question occurring. In other words, with each increase in a risk factor, the chance of the outcome occurring is 2.60 times greater (95% CI: 2.03-3.38).

Table 1 – Distribution of sociodemographic variables and variables related to pregnancy and childbirth of mothers assisted in two maternity hospitals in the municipality of Rio de Janeiro. Rio de Janeiro, Rio de Janeiro, Brazil, 2023

Variables	N	%	Mean (±SD)	Min-Max
Age (n=845)			26.5 (±6.2)	14-44
Reported skin color (n=808)				
Asian	6	0.8		
White	177	21.9		
Brown	426	52.7		
Black	199	24.6		
Education (n=784)				
Uneducated	3	0.4		
Incomplete primary education	61	7.8		
Complete primary education	210	26.8		
High school	465	59.3		
Number of pregnancies (n=838)			2.3 (±1.6)	1-21
One	298	35.6		
Two	255	30.4		
Three	158	18.8		
Four	72	8.6		
Five or more	55	6.6		
Number of deliveries (n=676)			1.9 (±1.3)	1-10
One	321	47.5		
Two	205	30.3		
Three	91	13.5		
Four or more	59	8.7		

Table 1 – Cont.

Variables	N	%	Mean (±SD)	Min-Max
Number of miscarriages (n=844)			0.3 (±0.6)	0-5
None	675	80.1		
One	131	15.5		
Two or more	37	4.4		
Type of delivery (n=846)				
Cesarean section	233	27.6		
Vaginal birth	613	72.4		
Number of prenatal appointments (n=826)			9.0 (±3.1)	0-20
None	9	1.1		
1 to 6	141	17.1		
7 to 9	315	38.1		
10 or more	361	43.7		
Gestational age in weeks (n=844)			39.0 (±1.7)	24.4-46.4
Total number of medications taken by the mother			0.5 (±0.7)	0-3
None	506	59.7		
One	268	31.6		
Two	59	6.9		
Three	15	1.8		
Total serological reagents			0.8 (±0.9)	0-5
None	619	73.0		
One	218	25.7		
Two	11	1.3		

Table 1 – Cont.

Variables	N	%	Mean (±SD)	Min-Max
Gestational risk factors				
None	398	47.0		
One	287	33.8		
Two	119	14.0		
Three or more	44	5.2		
Gestational risk factors investigated				
Diabetes	141	16.6		
High blood pressure	136	16.0		
Urinary tract infection	70	8.2		
Alcoholism	66	7.8		
Smoking	57	6.7		
Premature labor	38	4.5		
Use of illicit drugs	24	2.8		
Pre-eclampsia	16	1.9		
Hypothyroidism	16	1.9		
Syphilis	9	1.1		
Anemia	9	1.1		
Asthma	6	0.7		
Epilepsy	5	0.6		
Premature placental displacement	3	0.4		
Placenta previa	1	0.1		

Source: Research data, 2023.

Table 2 – Distribution of variables related to newborns admitted to two maternity hospitals in the municipality of Rio de Janeiro. Rio de Janeiro, Rio de Janeiro, Brazil, 2023

Variables	N	%	Mean (±SD)	Min-Max
Age in days (n=841)			3.5 (±5.6)	0-37
Birth weight in kilograms (n=847)			3.21 (±0.49)	650.0-4760.0
Premature baby (n=842)				
No	785	93.2		
Yes	57	6.8		
Baby referred to the NICU* (n=842)				
No	805	95.6		
Yes	37	4.4		
Weight classification (n=835)				
Appropriate for gestational age	699	83.7		
Small for gestational age	65	7.8		
Large for gestational age	71	8.5		
SPO2 values – UL**				
Below 95%	1	0.1		
96 – 97%	33	3.8		
98 – 99%	218	25.7		
100%	571	67.3		
Not informed	26	3.1		
SPO2values– LL**				
Below 95%	0	0		
96 – 97%	29	3.4		
98 – 99%	186	21.8		
100%	605	71.3		
Not informed	26	3.1		

Table 2 – Cont.

Variables	N	%	Mean (±SD)	Min-Max
Total risk factors for the newborn			0.6 (±0.9)	0-6
None	519	61.0		
One	239	28.1		
Two	61	7.2		
Three or more	30	3.7		
Risk factors for the newborn				
Maternal infection	164	19.3		
Prematurity	56	6.6		
Malformation	30	3.5		
Breathing disorder	22	2.6		
Jaundice	19	2.2		
PROM***	17	2.0		
Hypoglycemia	16	1.9		
Congenital syphilis	15	1.8		
Meconium	14	1.6		
ABO*** status	14	1.6		
Twinship	8	0.9		
Urinary tract infection	6	0.7		
Asphyxiation	5	0.6		
Indication for echocardiography				
Indicated	45	5.3		
Not indicated	803	94.7		
Congenital heart disease (n=45)				
Yes	31	68.9		
No	14	31.1		

Source: Research data, 2023.
*NICU – Neonatal intensive care unit
LL- lower limb; UL- upper limb; ***PROM- Premature rupture of ovular membranes;*ABO status- blood incompatibility.

Table 3 – Association between maternal and newborn variables and indication for echocardiography in newborns from two maternity hospitals in the municipality of Rio de Janeiro. Rio de Janeiro, Rio de Janeiro, Brazil, 2023

Variables	OR	CI 95%	P value
Maternal Characteristics			
Age*	1.04	0.99-1.08	0.148
Reported skin color*			
White	1.0		
Non-white	0.72	0.32-1.67	0.453
Education*			
Complete primary education	0.63	(0.23-1.72)	0.370
Uneducated/incomplete primary education	0.83	(0.19-3.67)	0.810
Gestational age in weeks*			
38-42 weeks	1.0		
≤37 or ≥43 weeks	6.93	3.76-12.80	<0.001
Number of pregnancies*	1.05	0.89-1.23	0.599
Number of deliveries*	1.06	0.86-1.30	0.603
Number of miscarriages*	1.35	0.89-2.03	0.156
Number of prenatal appointments*	1.04	0.94-1.14	0.483
Number of gestational risk factors	1.90	1.47-2.45	<0.001
Total serological reagents	0.72	0.36-1.43	0.343
Number of medications taken by the mother	1.97	1.40-2.77	<0.001
Presence of diabetes			
No	1.0		
Yes	5.50	2.97-10.18	<0.001
Presence of high blood pressure			
No	1.0		
Yes	1.78	0.87-3.56	0.237

Table 3 – Cont.

Variables	OR	CI 95%	P value
Characteristics of the newborn			
Age in days*	1.07	1.03-1.02	<0.001
Weight classification*			
Appropriate for gestational age	1.0		
Small for gestational age	2.12	0.85-5.28	0.106
Large for gestational age	2.88	0.97-5.37	0.901
Premature baby*			
No	1.0		
Yes	10.55	5.29-21.03	<0.001
Number of risk factors for the newborn	2.62	2.03-3.38	<0.001
Birth weight*	1.00	0.99-1.00	0.163
Saturation in upper limbs*	0.94	0.63-1.40	0.744
Saturation in lower limbs*	1.00	0.65-1,55	0.994

Source: Research data, 2023.
*Variable had missing data; OR = odds ratio; CI = confidence interval

No significant associations were observed for some of the variables investigated, both maternal and those related to the newborn. However, the relationship between the baby's SpO2 and the indication for echocardiography deserves mention. The lack of association between these two factors and the indication for echocardiography is a counterintuitive result, since it would be expected that a lower SpO2 would be associated with a greater chance of indication for carrying out this test and investigating CHD.

DISCUSSION

It was found that maternal variables such as gestational age, number of medications and the sum of gestational risk factors, as well as neonatal variables, age of the newborn, prematurity and the number of risk factors, were associated with the outcome. indication of echocardiography in the investigation of congenital heart disease.

This fact corroborates data from a recent publication by the Brazilian Society of Cardiology that updates the indications for echocardiography in neonatal cardiology, citing maternal and neonatal characteristics as recommendations[16]. Another study shows that risk factors for the development of CHD include family history (first-degree relatives) and maternal and fetal conditions[17].

In the present study, attention is drawn to the fact that 53.0% of mothers had at least one gestational risk factor, with emphasis on 16.6% who had diabetes, followed by those with high blood pressure (16%) which, despite such prevalence rate, did not show significant association for the indication of echocardiography.

A study confirms this finding explaining that among the clinical conditions that increase the risk of CHD, pre-gestational diabetes is associated with an increased risk of birth defects, maternal and perinatal morbidity and mortality. Furthermore, this condition threatens normal fetal cardiac

development on several levels, which explains the wide spectrum of associated congenital heart diseases, from minor structural diseases and/or functional defects to severe heart diseases, with possible long-term sequelae[18,19].

Another maternal characteristic that showed significant association with indication for echocardiography was the use of medications. It was found that the more medications were associated, the greater the chance of indication of neonatal echocardiography. Such data is confirmed by the Brazilian Fetal Cardiology Guideline, pointing out that exposure to Angiotensin Converting Enzyme Inhibitors (ACEI), retinoic acid and non-hormonal anti-inflammatory drugs in the third trimester increase the risk of CHD by 2% or more. In addition to the referred medications, the use of anticonvulsants, lithium, vitamin A, selective serotonin reuptake inhibitors and non-steroidal anti-inflammatory drugs in the first and second trimesters play an important role, showing an association of 1 to 2% probability of generating newborns with CHD[17].

In this study, gestational age below 37 weeks, as well as above 43 weeks, showed a significant association with the outcome indication for echocardiography. Premature birth and congenital heart disease are two of the main causes of mortality, morbidity and disability associated with perinatal events. A study carried out in Portugal showed that premature newborns are twice as likely to have cardiac anomalies; another stated that premature infants are 9.2 times more likely to develop abnormalities in the atria and atrial septum and twice as likely to develop abnormalities in the ventricles and ventricular septum, compared to full-term newborns[18,20]. Therefore, performing echocardiography may have therapeutic implications in the care of these newborns. This fact can be explained by the physiological immaturity of the organs, as CHD is characterized by malformation in the heart and large vessels, where individual cardiac defects can occur or together with pathogenic and pathophysiological aspects[20].

Regarding the findings obtained, interestingly, the variable oxygen saturation (SpO2) of newborns, according to "TC" (oximetry) was higher than the recommended saturation (greater than or equal to 95%), and, therefore, was not associated with the outcome. However, despite the lack of association with the outcome, echocardiography was recommended for these newborns, who were diagnosed with CHD. This confirmed that performing TC (oximetry) does not rule out the need for a thorough and detailed physical examination, associated with the clinical parameters presented by newborns.

It is known that TC or arterial pulse oximetry is a good screening method, simple, painless, non-invasive, fast and low-cost, capable of identifying disorders early and allowing immediate adoption of measures. It should be performed routinely, preferably between 24 and 48 hours of life, before hospital discharge, in apparently healthy newborns, who are stable, both hemodynamically and clinically, with a gestational age greater than 35 weeks[1,10].

According to the Brazilian Society of Pediatrics (SBP), this strategy managed to reduce the rate of false positives, while at the same time it did not delay the diagnosis in pathological cases. The test is considered negative when SpO2 is greater than or equal to 95% and the difference between measurements in the right upper limb and the lower limb is less than or equal to 3%[10]. However, such information contrasts with the findings of the present study, since the SpO2 of the evaluated newborns were above (SpO2 100%) the recommended values, both in the upper and lower limbs.

Given these SPO2 values found in the present study, compared to the TC protocols established in maternity wards, the newborns in the present study would not qualify as having a questionable test, which is when SpO2 is between 90% and 94%, or when there is a difference between the measurements of the right upper limb and the lower limb greater than or equal to 4%, a fact that would further reduce the chance of a suspected heart disease, as in this situation, the test must be performed again after one hour, twice. If these oximetry measurement values persist after the third evaluation, the test will be considered positive and only in this case will the newborn undergo cardiological evaluation through echocardiography[10].

Newborn screening for congenital heart defects has been implemented nationally in the United States, resulting in the preservation or improvement of the quality of life of a large number of children. According to what is postulated in the literature, through TC (oximetry), cardiac changes can be traced. Therefore, the examination must be carried out in neonatal units and maternity wards[21]. However, some aspects of the TC must be considered, as despite its high sensitivity for the definitive diagnosis, the exam alone is not capable of excluding or confirming the presence of the disease nor of guiding the initial approach to deal with a positive case[10].

The present study aims to broaden the discussion on the most assertive way, through commonly used screening methods, to identify newborns with heart disease, as TC alone would not identify 45 (100%) newborns of the total sample investigated (n=848) who were indicated for echocardiography and of these, 31 (68.9%) who were diagnosed with CHD, who would consequently lose the chance of diagnosis. Depending on their type of heart disease, newborn babies would be deprived of living or of living a quality life. In line with these data, one study reported two cases of CHD that

were no longer identified due to negative screening results. Both newborns underwent prenatal ultrasound screening and clinical examination and no anomalies were found. One of these cases resulted in death, while the other had cardiovascular collapse[22].

Regarding the best screening method, a literature review reported that the majority of evidence describes that early diagnosis of CHD was performed through obstetric ultrasound, with two studies pointing to the effectiveness of obstetric ultrasound together with echocardiography for the determination of the diagnosis. Two articles specified the performance of only the fetal echocardiography exam for diagnosis and two described the performance of other exams for diagnostic screening, such as clinical examination and peripheral oxygen saturation in the first 24 hours, but no consensus was reached on which is the best method for diagnosing CHD[23].

Considering that the TC ensures the screening of potentially fatal CHDs, the findings obtained allow reflection on some factors. In this regard, a study emphasizes that the test must be carried out by a health professional who is part of the neonatal team and suggests that this professional should preferably be a doctor, pediatrician, neonatologist or nursing professional trained in the pulse oximetry reading technique to measure SpO2 levels[24]. In this scenario, the nurse is the best qualified professional to carry out neonatal screening. In addition to being well informed and knowledgeable about the correct handling of pulse oximetry, nurses can enhance and contribute to the quality and effectiveness of this method[13].

Thus, for cardiological neonatal screening to achieve its fundamental objective of early detection, information, training and strategy implementation work is necessary. Therefore, the TC needs to be known and embraced by different health professionals, mainly obstetric nurses and neonatologists who work in the typical scenarios for carrying out the test[25].

It is understood that nurses are essential for carrying out neonatal screening as long as they are properly trained in its execution and interpretation, and it is their responsibility to identify any abnormalities on the TC scan, especially in the case of a negative test. Therefore, nursing professionals must be aware of the necessary and valuable clinical assessment carried out through a thorough physical examination, in addition to identifying possible maternal and fetal risk factors associated with the development of CHD, in addition to other factors that may intervene in the measurement of pulse oximetry. Furthermore, the main objective of these good practices is to reduce the number of false positive tests, helping newborns with CHD to be properly diagnosed in a timely manner and receive effective treatment. After this careful assessment, newborns must be examined by a specialist who will provide the most appropriate treatment[13,25].

Another important factor is that it is necessary to prioritize the adoption of good practices by health professionals, since poor test execution has a high probability of preventing the identification of newborns with congenital heart disease, which can greatly impact the morbidity and mortality of these individuals. Another study reports that it is necessary for the professional responsible for carrying out the procedure to know some factors capable of interfering with the test result, among which, movement of the newborn, hypoperfusion, hypothermia, intensity of the sensor signal, quality of the pulse oximetry device, ambient lighting (phototherapy), environmental noise, use of catecholamines and carboxyhemoglobin. All these aspects must be considered and evaluated by the professional, as non-compliance can lead to errors in diagnosis, procedures and, in some cases, the death of the newborn[25,26].

A limitation of this study is its retrospective design with data collection carried out only through medical records given the possible issues related to errors or inconsistencies in the information records. It is suggested that new prospective investigations be carried out that seek to highlight other risk factors associated with the indication of echocardiography in the investigation of CHD, permeating the identification of these factors by professionals involved in providing care at any level of health care.

The identification of maternal and neonatal variables associated with the outcome of echocardiography plays a crucial role in obtaining more accurate conclusions when investigating congenital heart disease, which can have a positive impact on reducing morbidity and mortality in this population segment. Furthermore, in line with the scientific literature, this study emphasizes the importance of evaluating maternal and neonatal characteristics as criteria for indicating neonatal echocardiography, and emphasizes that the TC must be complemented by a thorough and detailed physical assessment.

CONCLUSION

This study found that different maternal variables (gestational age, number of medications and sum of gestational risk factors) and neonatal variables (age of the newborn, prematurity and various risk factors) were associated with the indication for echocardiography examination in the investigation of CHD.

Among the maternal and fetal factors, the increase in one risk factor stands out, as well as the number of medications used by mother and infant, which were the factors most associated with the analyzed outcome. In view of the above, it is understood that the identification of these factors may contribute to early diagnosis, allowing a timely and more accurate assessment, regarding the interventions necessary for an accurate treatment.

The findings of this study confirm that performing a TC (oximetry) does not rule out the need for a thorough and detailed physical examination, combined with the clinical data of the newborn before hospital discharge, as it is necessary to consider its limitations and use a multidisciplinary approach for a delicate and complex care for all newborns in maternity wards and/or neonatal units.

Thus, the recognition of maternal and neonatal characteristics is an important implication in the clinical practice of nurses in the face of the complex phenomenon of suspecting the presence of CHD. To achieve this, the referred professionals must be able to identify non-apparent manifestations, aiming to reduce morbidity and mortality due to congenital heart disease.

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The authors declare that there is no conflict of interest.

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Associate editor:
Helena Becker Issi

Received: 08.14.2023
Approved: 01.12.2024

Editor-in-chief:
João Lucas Campos de Oliveira