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ORIGINAL ARTICLE

Evaluation of the Neonatal screening test of congenital heart diseases performed on newborns in rooming-in of a Tertiary Hospital from January 2015 to July 2018

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Heart defects, Congenital, Neonatal screening, Rooming-in care.

Abstract

Introduction: Cardiovascular malformations are the most prevalent in newborns (NB). The prevalence of congenital heart disease (CHD) in Brazil has increased in recent years. The pulse oximetry test is currently used for the early diagnosis of CHD. **Objective:** Analyze data on the pulse oximetry test carried out in the Rooming Room of a Tertiary Hospital as a screening for the diagnosis of critical congenital heart disease (CCHD), from January 2015 to July 2018. **Methodology:** Observational, quantitative and cross-sectional research through the analysis of data from the results of pulse oximetry test carried out at the service and research in electronic medical records of patients who had an altered test. **Results:** 10,053 tests were carried out in the period with 42 changes. Of these, 15 (35.7%) had normal exams after repeating the heart test and/or performing the echocardiogram; 11 (26.2%) found heart disease on echocardiography; 13 (31%) did not repeat the heart test or did not perform an echocardiogram; 3 (7.1%) were not found. Echocardiograms were performed on 20 patients, with findings of heart disease found in 11 (false positive rate of 0.2% for pulse oximetry test). CCHD was observed in only 1 (Ebsteins Anomaly). The other findings were of acyanotic or pulmonary heart disease. **Conclusion:** It was evident that pulse oximetry test contributed to the diagnosis of CCC, to the realization of other diagnoses of CCC, as well as the need to correctly follow the protocol recommended by the SBP as a way to reduce hospitalization costs and echocardiograms.

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INTRODUCTION

Malformations of the cardiovascular system are the most prevalent anomalies in newborns (NB) [1].

The prevalence of congenital heart disease in Brazil has increased over the years, with a rate of 5.5:1,000 live births between 1989 and 1998, 9.58:1,000 live births between 1990 and 2003, and 9:1,000 live births in 2010 (2). A total of 25,757 new cases were recorded in Brazil in 2010 [3].

Critical congenital heart disease is life-threatening if not treated with surgery or catheterization in the first year of life and accounts for 25% of the heart conditions diagnosed at birth in the United States [4]. The disease is estimated to affect approximately 2.5 to 3 in every 1,000 live births, according to a study conducted in the United States in 2015 [5].

In recent years, many studies have been conducted to improve the early diagnosis of critical congenital heart disease since approximately 30% of newborns with the condition are discharged without a diagnosis [6].

The pulse oximetry test, commonly called the heart test in Brazil, is currently used to screen healthy newborns. The test is easy to perform, non-invasive, and affordable [7]. It can detect low levels of hemoglobin saturation in blood, typically present in critical congenital heart diseases such as left ventricular hypoplasia syndrome, pulmonary atresia, tetralogy of Fallot, total anomalous pulmonary venous connection, transposition of the great arteries, tricuspid atresia, truncus arteriosus, coarctation of the aorta, double outlet right ventricle, Ebstein anomaly, interrupted aortic arch, and single ventricle [8].

According to Thangaratinam S et al. [7], the sensitivity of the pulse oximetry test alone ranges from 25% to 98.5% and specificity between 98% and 100%, resulting in false positives between 0% and 2%. Therefore, it may not detect some critical heart diseases, especially coarctation of the aorta and interrupted aortic arch, which may show unaltered test results in patients with a patent ductus arteriosus.

The pulse oximetry test has been implemented in Brazil as a public health measure to expedite diagnosis and increase the survival of patients with critical congenital heart disease [9].

A thorough physical examination of newborns during rooming-in is essential since not all congenital heart diseases, including critical ones, are associated with hypoxemia or detected with a pulse oximetry test. Cardiac auscultation is used to identify murmurs or other alterations, and pulse palpation helps diagnose acyanotic congenital heart diseases. An echocardiogram is required when these signs are present and in newborns with syndromic traits [9]. The Brazilian Society of Pediatrics (SBP) has routinely recommended the pulse oximetry test in all healthy newborns with a gestational age greater than 34 weeks since 2011. The pulse oximetry test is also recommended by the American Academy of Pediatrics (AAP), American Heart Association (AHA), and the American College of Cardiology (ACC), along with an echocardiographic examination performed by a trained professional in the event of changes before hospital discharge [9].

The test must be performed between 24 and 48 hours after birth. Pulse oximetry is measured in the right arm and one of the legs. The newborn's extremities must be warm, and the monitor must show a homogeneous waveform. The test is considered positive if the oxygen saturation (SpO2) is less than 95% in either limb in both measurements and if there is a difference greater than 3% between the right arm and leg readings. A new measurement must be performed in one hour. If the result is confirmed, an echocardiogram must be performed within 24 hours [9].

METHODS

This cross-sectional quantitative observational included data from the database of the nursing team responsible for performing pulse oximetry tests on newborns in rooming-in at a maternity hospital from January 2015 to July 2018. All newborns in the hospital during the study underwent a pulse oximetry test before discharge. The unit's nursing team performed the tests using a Mindray VS-800 oximeter, and the results were recorded in a database. A pediatrician was called in when tests had altered results, and a trained physician would perform an echocardiogram as required.

The institution's Research Ethics Committee approved the study. The medical records of patients with pulse oximetry alterations (pre- or post-ductal SpO2 less than 95% or a difference greater than 3% between measurements) were analyzed in the State Health Department's electronic medical record system (TrakCare), and the findings were correlated with echocardiogram results.

Newborns over 35 weeks of gestational age weighing more than 2000g with good sucking and swallowing reflexes were included. Newborns not meeting the inclusion criteria were excluded. The following variables were considered: newborn age at the time of the first pulse oximetry test; repetition of the test when altered; newborn age when the echocardiogram was performed after an altered pulse oximetry test; altered echocardiograms and types of heart disease found. During the study period, 10,053 tests were performed. Of these, 42 presented altered results and were selected for analysis. The data were analyzed according to percent distribution.

RESULTS

According to the unit's nursing database, 10,053 oximetry tests were performed between January 2015 and July 2018 in the rooming-in unit of a maternity hospital. Our study included 42 (0.41%) newborns with pulse oximetry alterations. The medical records of three patients were not found.

In the 39 electronic medical records analyzed, the gestational age of the newborns was 39 weeks on average. The mean weight was 3,266 g, and the mean age at the time of the oximetry test was 2.32 days. The second oximetry test, when needed, was performed within one to 48 hours. The average age at the echocardiogram was 3.97 days, ranging from 12 hours to 11 days (Table 1).

Table 1. General characteristics of the 42 newborns with altered pulse oximetry tests

Variables*	
1. Gestational age	39 ± 2.2
2. Birth weight	3.266 ± 0.5
3. Age at oximetry test (days)	2.32 (1-4)
4. Age at echocardiogram (days)	3.97 (0.5-11)

* Variables presented as mean ± standard deviation and median (range).

A descriptive analysis of the data extracted from the medical records of 39 newborns with altered pulse oximetry tests was performed for four variables: a second pulse oximetry test and its result, and the performance of an echocardiogram and its result. Fifteen (38.4%) newborns had normal test results in the second pulse oximetry test and/or in the echocardiogram; 11 (28.2%) had signs of heart disease in the echocardiogram; 13 (33.4%) were not diagnosed with heart disease for not undergoing a second pulse oximetry test or an echocardiogram.

Of the 11 newborns with a second pulse oximetry test performed, six had normal results, and five had altered test results (Table 2).

An echocardiogram was performed in three newborns with altered test results in the second pulse oximetry. Two had signs of heart disease (Table 3).

Twenty echocardiograms were performed, and findings consistent with heart disease were found in 11 patients, resulting in a false positive rate of 0.2% for the pulse oximetry test. Critical congenital heart disease was seen in one patient diagnosed with Ebstein anomaly, with marked tricuspid reflux and a patent foramen ovale. Another patient had an atrial septal defect (ASD) in the fossa ovalis region with pulmonary arterial hypertension and right ventricular hypertrophy. One patient had an intermediate atrioventricular septal defect (AVSD) with minimal atrioventricular valve insufficiency. One newborn had an ASD with persistent pulmonary arterial hypertension. Two patients had an ASD in the fossa ovalis region. One patient had a large perimembranous ventricular septal defect (VSD) with an ASD in the fossa ovalis region with high flow, a patent ductus arteriosus (PDA), and pulmonary arterial hypertension. One patient had a muscular VSD without hemodynamic repercussions and a patent foramen ovale. One patient had an intermediate AVSD with a VSD and an ASD in the fossa ovalis region and a fetal pulmonary pressure pattern with PDA. One patient had a Rastelli type A AVSD with partial pulmonary branch stenosis, a high flow pattern, and pulmonary arterial hypertension. One patient had persistent pulmonary arterial hypertension and a patent foramen ovale (Table 4).

DISCUSSION

This study included 39 newborns with altered pulse oximetry test results (0.38%) from 10,053 tests. In a similar study by Ismail AQT et al. enrolling patients in England in 2016, 0.8% of the oximetry tests performed on 25,869 newborns were positive for congenital heart disease [10]. This low percentage is explained, among other factors, by the improvement in prenatal diagnosis of critical congenital heart disease and the prompt referral of affected newborns to intensive care, the excellent quality of care provided in the delivery room, and perinatal care accompanied by good quality physical examination. Some critical congenital heart diseases may not include early hypoxemia, such as coarctation of the aorta, interruption of the aortic arch, and pulmonary stenosis. Failure to comply with the protocol recommended by the SBP may also have led to false results.

The second pulse oximetry test was performed outside the timeframe stipulated in the SBP recommendations [11] or not performed at all. Seven patients with a normal echocardiogram did not undergo the pulse oximetry test a second time, reinforcing the importance of following the protocol and avoiding unnecessary costs. Many patients referred directly for an echocardiogram could have been spared an extended hospital stay if they had undergone a second oximetry test. According to our results, just over half of the patients who underwent a second pulse oximetry test had normal test results and would not require an echocardiogram.

More than half of the patients with an abnormal first pulse oximetry result did not undergo a second test. Of these, almost 50% were discharged without an echocardiogram, at the risk of having critical congenital heart disease and developing complications inherent to late diagnosis. Two patients with abnormal second pulse oximetry test results were discharged without an echocardiogram, probably due to scheduling and performing difficulties, a prevalent yet unacceptable issue in our setting.

The echocardiograms performed in the study population assisted in diagnosing Ebstein anomaly, the most common congenital disease of the tricuspid valve, with a broad spectrum of anatomical and clinical presentation. The echocardiograms also indicated that the pulse oximetry test might be sensitive to other alterations in the neonatal period, as described in a study by Ismail AQT et al. [12]. Non-critical congenital heart diseases, such as total and intermediate atrioventricular septal defect, atrial septal defect, interventricular communication, and PDA were identified in our population. Although these are acyanotic heart diseases, pulmonary arterial hypertension may explain transient drops in oxygen saturation. In non-critical congenital heart disease cases, the pulse oximetry test may expedite referral to a specialist physician and identify alterations such as persistent pulmonary arterial hypertension.

Table 2. Proportion of newborns with a second pulse oximetry test performed.

Test result	Frequency	Percentage	Overall percentage (42)
Normal	6	54.5%	14.3%
Altered	5	45.5%	11.9%
Total	**11**	**100.0%**	**26.2%**

Table 3. Distribution of newborns according to echocardiogram results.

Echocardiogram result	Frequency	Percentage	Overall percentage (42)
Normal	1	20%	2.4%
Altered	2	40%	4.8%
Not performed	2	40%	4.8%
Total	**5**	**100%**	**12%**

Table 4. Congenital heart diseases and echocardiogram alterations.

Ebstein anomaly with tricuspid insufficiency + patent foramen ovale	1
ASD FO + PAH	2
ASD FO without PAH	2
Intermediate AVSD + PDA + PPAH	1
AVSD + PAH	1
ASD perimembranous VSD + ASD FO+ PDA+ PAH	1
Muscular VSD + PFO without repercussions	1
PDA + PPAH	1
PPAH + PFO	1

CONCLUSION

The pulse oximetry test is a routine examination and a fundamental tool for diagnosing critical and non-critical congenital heart diseases. Its importance cannot be overstated, as it can lead to early referrals and potentially life-saving interventions. This study is a stark reminder of pulse oximetry's critical role in the early diagnosis and management of congenital heart diseases.

Healthcare professionals must be instructed on the importance of following the protocol recommended by the SBP as a way of minimizing the risk of newborns with critical congenital heart disease remaining undiagnosed and reducing the costs of prolonged hospitalizations and unnecessary echocardiograms.

REFERÊNCIAS

1. Tennant PW, Pearce MS, Bythell M, Rankin J. 20-year survival of children born with congenital anomalies: a population-based study. Lancet. 2010;375(9715):649-656. doi:10.1016/S0140-6736(09)61922-X
2. Huber J, Peres VC, Santos TJ dos, Beltrão L da F, Baumont AC de, Cañedo AD, et al.. Cardiopatias congênitas em um serviço de referência: evolução clínica e doenças associadas. Arq Bras Cardiol [Internet]. 2010Mar;94(3):333-8. Available from: https://doi.org/10.1590/S0066-782X2010000300009
3. Pinto Júnior VC, Branco KM, Cavalcante RC, Carvalho Junior W, Lima JR, Freitas SM, Fraga MN, Souza NM. Epidemiology of congenital heart disease in Brazil. Rev Bras Cir Cardiovasc. 2015 Mar-Apr;30(2):219-24. doi: 10.5935/1678-9741.20150018. PMID: 26107454; PMCID: PMC4462968.
4. Wren C, Reinhardt Z, Khawaja K. Twenty-year trends in diagnosis of life-threatening neonatal cardiovascular malformations. Arch Dis Child Fetal Neonatal Ed. 2008;93(1):F33-F35. doi:10.1136/adc.2007.119032
5. Reeder MR, Kim J, Nance A, et al. Evaluating cost and resource use associated with pulse oximetry screening for critical congenital heart disease: Empiric estimates and sources of variation. Birth Defects Res A Clin Mol Teratol. 2015;103(11):962-971. doi:10.1002/bdra.23414
6. Oster ME, Lee KA, Honein MA, Riehle-Colarusso T, Shin M, Correa A. Temporal trends in survival among infants with critical congenital heart defects. Pediatrics. 2013;131(5):e1502-e1508. doi:10.1542/peds.2012-3435
7. Thangaratinam S, Daniels J, Ewer AK, Zamora J, Khan KS. Accuracy of pulse oximetry in screening for congenital heart disease in asymptomatic newborns: a systematic review. Arch Dis Child Fetal Neonatal Ed. 2007;92(3):F176-F180. doi:10.1136/adc.2006.107656
8. Ailes EC, Gilboa SM, Honein MA, Oster ME. Estimated number of infants detected and missed by critical congenital heart defect screening. Pediatrics. 2015;135(6):1000-1008. doi:10.1542/peds.2014-3662
9. Sociedade Brasileira de Pediatria. Departamento de Cardiologia e Neonatologia. Diagnóstico precoce de cardiopatia congênita crítica: oximetria de pulso como ferramenta de triagem neonatal [Internet]. [Rio de Janeiro]: Sociedade Brasileira de Pediatria; 2011. Disponível em: Disponível em: http://www.sbp.com.br/pdfs/diagnostico-precoce-oximetria.pdf
10. Ismail AQT, Cawsey M, Ewer AK. Newborn pulse oximetry screening in practice. Arch Dis Child Educ Pract Ed. 2017;102(3):155-161. doi:10.1136/archdischild-2016-311047
11. Shahzad M, Wagar T, Waheed KAI, Gul R, ST Fatima. Pulse oximetry as a screening tool for critical congenital heart defects in newborn. J Pak Med Assoc. 2017; 67(8).
12. Plana MN, Zamora J, Suresh G, Fernandez-Pineda L, Thangaratinam S, Ewer AK. Pulse oximetry screening for critical congenital heart defects. Cochrane Database Syst Rev. 2018 Mar 1;3(3):CD011912. doi: 10.1002/14651858.CD011912.pub2. PMID: 29494750; PMCID: PMC6494396.