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Nurses' performance in the pulse oximetry test

Atuação de enfermeiros no teste do coraçãozinho

Actuación de enfermeros en la prueba del corazoncito

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ABSTRACT

Objective: to analyze nurses' performance in conducting pulse oximetry tests in a maternal and child referral hospital in the São Francisco mesoregion of Pernambuco, Brazil. **Method:** this is a descriptive, exploratory study with a qualitative approach, conducted between September and November 2022 with 13 nurses through application of a semi-structured questionnaire and interview, and consultation of 229 medical records using a semi-structured instrument. Data were stored in Microsoft® Office Excel®, analyzed quantitatively in the R software and qualitatively by the *R Interface pour les Analyses Multidimensionnelles de Textes et de Questionnaires* software. The research protocol was approved by the institution's Research Ethics Committee. **Results:** The nurses had theoretical knowledge regarding the pulse oximetry test, but adopted different conduct procedures from the screening protocol in practice. **Conclusion:** there were weaknesses in the nurses' performance related to adequate follow-up of the screening protocol, the test registration and the eligibility criteria for pulse oximetry.
Descriptors: Nursing; Neonatal Screening; Heart Defects, Congenital; Oximetry.

RESUMO

Objetivo: analisar a atuação de enfermeiros na realização do teste do coraçãozinho em um hospital de referência materno-infantil na mesorregião do São Francisco Pernambucano, Brasil. **Método:** estudo descritivo, exploratório, com abordagem qualitativa, realizado entre setembro e novembro de 2022, com 13 enfermeiros, por meio da aplicação de questionário e de entrevista semiestruturados, e consulta a 229 prontuários, por meio de instrumento semiestruturado. Dados armazenados no Microsoft® Office Excel®, analisados quantitativamente no *software* R e qualitativamente pelo *software Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires*. Protocolo de pesquisa aprovado pelo Comitê de Ética em Pesquisa da instituição. **Resultados:** Os enfermeiros possuíram conhecimento teórico com relação ao exame, mas adotaram condutas distintas do protocolo de triagem na prática. **Conclusão:** houve fragilidades na atuação dos enfermeiros relacionadas ao seguimento adequado do protocolo de triagem, ao registro do teste e aos critérios de elegibilidade para o teste do coraçãozinho.
Descritores: Enfermagem; Triagem Neonatal; Cardiopatias Congênitas. Oximetria.

RESUMEN

Objetivo: analizar la actuación de enfermeros en la realización de la prueba del corazoncito en un hospital de referencia materno-infantil en la mesorregión de São Francisco Pernambucano, Brasil. **Método:** estudio descriptivo, exploratorio, con enfoque cualitativo, realizado entre septiembre y noviembre de 2022, con 13 enfermeros, mediante aplicación de un cuestionario y entrevistas semiestructuradas, además de la consulta de 229 historiales clínicos, utilizando un instrumento semiestructurado. Los datos fueron almacenados en Microsoft® Office Excel® analizados cuantitativamente con el software R y cualitativamente con el software *Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires*. El Comité de Ética en Investigación aprobó el protocolo de investigación. **Resultados:** los enfermeros tenían conocimiento teórico sobre la prueba, pero, en la práctica, adoptaron conductas diferentes al protocolo para el tamizaje. **Conclusión:** se identificaron debilidades en la actuación de los enfermeros relacionadas con el cumplimiento adecuado del protocolo para el tamizaje, el registro de la prueba y los criterios de elegibilidad para la prueba del corazoncito.
Descriptores: Enfermería; Tamizaje Neonatal; Cardiopatías Congénitas; Oximetría.

INTRODUCTION

Congenital heart disease (CHD) is a group of structural abnormalities of the cardiovascular system resulting from changes in embryonic development. It is the most common congenital defect, affecting 0.8% of all live births. There is an average of eight to ten cases per 1,000 live births in Brazil, totaling approximately 29,000 births of children with CHD per year, of which approximately 80% require cardiac surgery. These anomalies represent the second leading cause of neonatal mortality, and are the most frequent congenital malformations with the highest mortality rate in the first year of life in Brazil[2].

Most newborns (NBs) with CHD are asymptomatic at birth, and prenatal echocardiography and postnatal clinical examination are the main means of identifying these malformations before symptoms begin. However, both methods

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have a variable and low detection rate, which can lead to up to 30% of children with CHD being discharged from hospital before the diagnosis is established[3-5].

Critical congenital heart disease is channel-dependent, leading to an association between systemic and pulmonary circulations, with reduced peripheral oxygen saturation levels. In this sense, pulse oximetry is an important strategy for the early diagnosis of these pathologies, with specificity above 99%, a low false-negative rate and a sensitivity of 75%, although it may not indicate changes in anomalies which do not affect saturation[6].

Therefore, Pulse Oximetry Testing (POT) was incorporated as part of Neonatal Screening within the scope of the Unified Health System (*Sistema Único de Saúde - SUS*), to be performed on all newborns with a gestational age greater than 34 weeks, between 24 and 48 hours of life, and before hospital discharge[6]. The test application within the Healthcare Networks (*Redes de Atenção à Saúde - RAS*) is the responsibility of the maternity hospitals, and the health professional (e.g., nurse, nursing technician or doctor) who will perform it must be trained in the pulse oximetry measurement technique[7,8].

Nurses are the professionals among those on the health team who can perform the POT who is responsible for its implementation in most services, as they are present in all of the care stages provided to the newborn and their family up until the moment of discharge. If instructed and knowing the correct technique, they can optimize and assist in the quality and efficiency in the process of identifying these pathologies[9].

Expanding research on the practice of nurses in this activity can contribute to strengthening a praxis based on scientific evidence and improving the quality of nursing care in neonatal screening of critical CHDs. From this perspective, this study sought to answer the following question: "How do nurses act in neonatal screening of critical CHDs in newborns?".

Thus, the objective of this study was to analyze the performance of nurses in performing the pulse oximetry test in a maternal and child referral hospital in the São Francisco mesoregion, Pernambuco, Brazil.

METHOD

This is a descriptive, exploratory study with a quantitative and qualitative approach, supported by the Consolidated Criteria for Reporting Qualitative Research (COREQ)[10]. More specifically, the present study followed the inductive method, which underpins interpreting the data without any prior theoretical basis, and was conducted in an institution located in the São Francisco mesoregion of Pernambuco, a reference for medium and high complexity maternal and child health for 53 cities in the hinterlands of Pernambuco and Bahia. The unit has inpatient clinics (delivery room, conventional intermediate care unit, shared accommodation, among others), emergency care, and has the only public pediatric Intensive Care Unit (ICU) in the São Francisco Valley[11].

The research participants were nurses working in the Shared Accommodation (SA) and Conventional Intermediate Care (IMC) Unit sectors, who had worked at the institution for a period equal to or greater than six months. An exclusion criterion was considered to be absent from work for some reason (leave of any nature or vacation) during the collection period. The inclusion of the subjects in the study was intentional[12], with the final sample consisting of 12 nurses and one male nurse, five working in the SA and eight in the IMC.

Data collection took place between September and November 2022. Participants were initially approached by the researcher in their work environment, and were informed about the objective and how the study would work. After signing the Informed Consent Form (ICF), two instruments developed by the authors were given to the participants. The first was a semi-structured, self-instructional questionnaire based on a previous study[13], which included six questions with either multiple choice or "true" or "false" options related to the theoretical and practical knowledge for performing the POT. The second was a semi-structured interview script divided into three parts: the first contained questions regarding the participants' characteristics (name, age, race), and the second related to their professional profile (education, length of service at the institution, participation in training regarding the test and knowledge about the existence of and access to the specific standard operating protocol (SOP)). The first two parts were self-completed by the participants.

The last three questions of the second instrument related to the third part were answered in an interview format, as they aimed to have the professionals discuss their practice in neonatal CHD screening from the moment of identifying children eligible for the test until recording the result. Thus, after completing the answers to both instruments, the participant chose a private place within the sector in which they worked, so that only the participant and the researcher would be present at the time of the interview. The interviews lasted an average of ten minutes. The answers to these questions were recorded with the help of an audio recorder contained in the cell phone, so that the statements could be faithfully reproduced.

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Considering that it is the responsibility and duty of nursing professionals to record information related to patient care, and that this information is an important quality indicator[14], it was necessary to access the POT records performed by nurses in the newborns' medical records. This was also justified by understanding that these data were relevant for investigating the phenomenon under study and for analyzing the performance of these professionals in their entirety, since the records represent a reflection of their professional practice.

Therefore, the records were investigated in the following manner: the medical records of newborns who were hospitalized in the sectors during the data collection period, with a gestational age greater than 34 weeks, and/or who had undergone the oximetry test were checked. This selection was done by convenience and totaled 229 medical records, available in physical or electronic form. To this end, a semi-structured instrument produced by the authors was used to extract information regarding identification of the newborn (admission sector, name, service number, date and time of birth) and the POT (record if screening had been performed, and if not, the reason; date and time of performance; location of the oximeter sensor; results; record if there was any change in the test; and conduct in the event of altered results).

The quantitative data obtained from the instruments answered by the participants and through the collection of medical records were entered and stored in the Microsoft Office Excel® program, and then analyzed with the R version 4.2.2 software using descriptive statistics.

The processing and analysis of the qualitative data related to the interviews with the participants were performed using the *R Interface pour les Analyses Multidimensionnelles de Textes et de Questionnaires* (*IRAMUTEQ®*) version 0.7 alpha 2 software, since it allows different statistical analyses of texts from interviews, documents, among others[15]. The information was organized and submitted to an analysis of the textual *corpus* by the software using simple classification on text segments through Descending Hierarchical Classification (DHC), including all morphological classes. In turn, a "colored *corpus*" was used to cut out the speech excerpts, which is a resource available in the aforementioned software. Thus, the DHC generated the dendrogram with its respective classes, which were named in light of the pertinent scientific literature to infer meaning.

The principles and standards previously established by Resolution 466/2012 of the National Health Council were followed in developing and conducting this study, and the research protocol was approved by the Research Ethics Committee of the institution involved. The anonymity of the participants was maintained by adopting codenames (N1 to N13), followed by the sector to which they belonged.

RESULTS

There was a predominance of female participants (n=12; 92.3%), brown skin color/race (n=10; 76.9%), and ages ranging from 25 to 42 years. Regarding academic background, 61.5% had between five and ten years of training (n=8), and 92.3% had postgraduate/residency degrees, with 23.1% of these being specialists in Child Health (n=3). Approximately 46.2% of the participants had worked at the study institution for between six and 10 years (n=6), and 53.8% had been in the target sectors for a period of less than or equal to one year (n=7). Regarding POT training, 61.5% responded that they had participated in training at the institution. However, 53.9% were unaware of the existence of a SOP regarding the test, while only 38.5% stated that they had access to it in the sector where they worked (n=5).

Of the 229 newborn medical records selected during the collection, 157 came from the SA, and 72 from the IMC. Of these newborns, 94.32% had a gestational age equal to or greater than 34 weeks (n=216), and 5.68% had less than 34 weeks (n=13). Pulse oximetry was performed on 91.27% of the newborns (n=209).

The textual *corpus* generated through the interviews was analyzed using DHC, and the text segments presented in each class were obtained from the statically significant words, which enabled qualitatively analyzing the data. A total of 53 text segments were generated, classified and related to 448 words that occurred 2,019 times, generating 7 classes. The utilization rate was 84.91%, with the software considering good retention of text segments from 75%13. After this stage, the DHC created a dendrogram of the classes based on the textual *corpus* analysis and the retention level of each class, including the words that were considered to refer to the nurses' discourse on POT (Figure 1).

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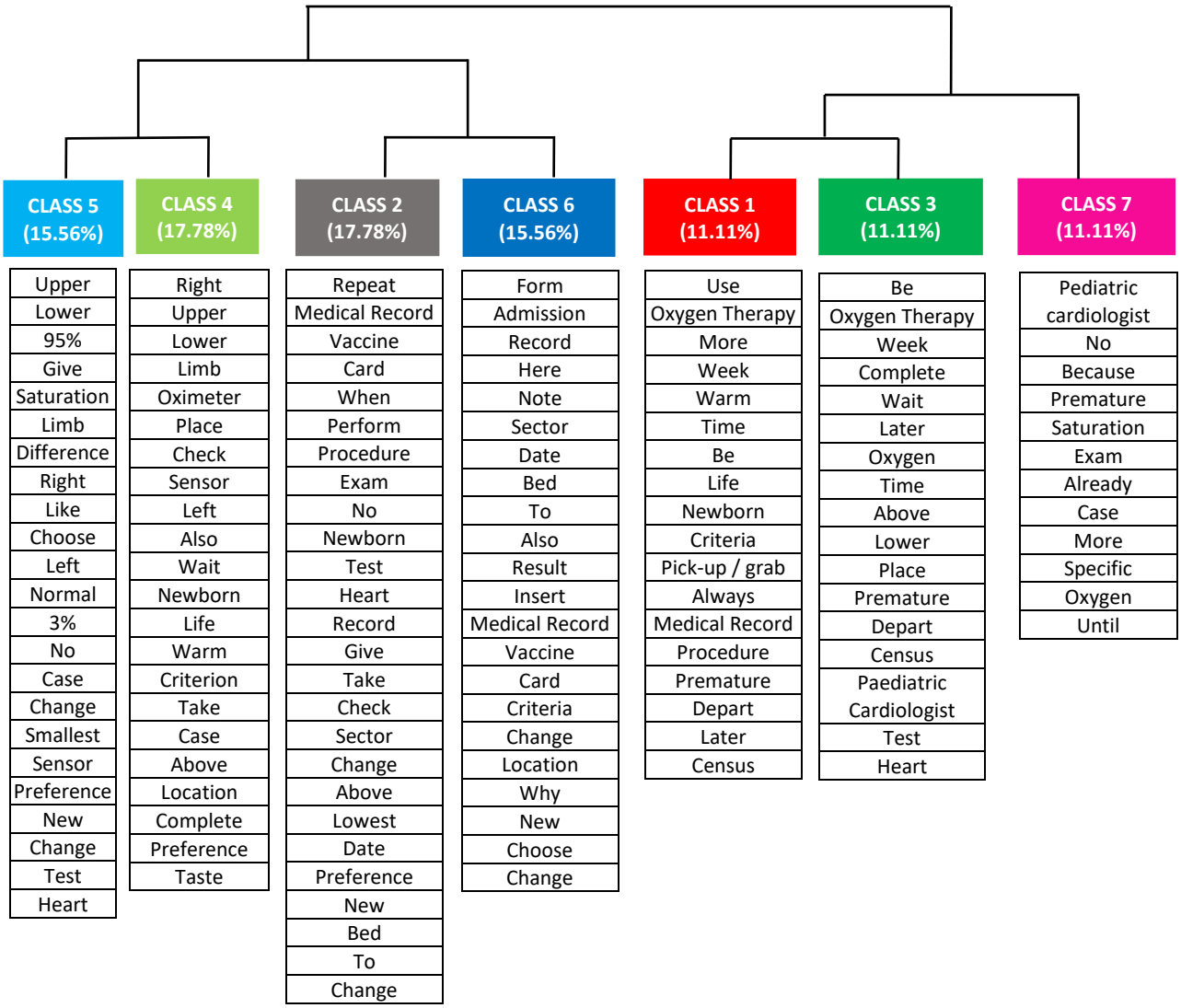

Figure 1: Dendrogram of classes according to nurses' discourse on the pulse oximetry test. Petrolina, PE, Brazil, 2023.

According to the scheme, analysis and discussion of the classes were performed from left to right, and they were grouped considering the proximity of the core ideas they presented. Afterwards, the quantitative data obtained through the instruments used and collection of medical records were verified so that they could be categorized according to the groupings formed through the DHC analysis.

Thus, three categories were organized: the group of classes 5 and 4 formed the category "Performance of the pulse oximetry test"; the group of classes 2 and 6 formed the category "Interpretation of measurement values and recording results"; and the group of classes 1, 3 and 7 formed the category "Eligibility criteria", each of which is presented below.

Performance of the pulse oximetry test

The nurses described the steps for performing the procedure during the interview, including organizing the material to be used, identifying the appropriate time to perform the test, choosing the appropriate limb, and recording the procedure.

> *I place one of the sensors on the right hand and the other on one of the feet, and wait until the reading is stable and consistent. (N2/SA)*

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> *When I go to do POT, first I (...) identify the patient and the bed; when I arrive, I introduce myself, explain the procedure and its purpose to the mother, take the oximeter, (...) place it on the newborn's right upper limb and on the foot. I usually like to do it on the right lower limb, (...), but I know very well that I can also do it on the left lower limb. (N5/SA)*
>
> *I leave the baby calm, without crying, without stress, preferably after feeding; warmed up, and then I place the oximeter on the right upper limb and wait for it to register, and then on the right lower limb, and also register, waiting for the heart rate and saturation to be correct. (N7/IMC)*
>
> *We take the oximeter that the hospital has for the POT, we observe if the limbs are warm, if they are cold, if they are cyanotic; if they are not, we take the reading, first on the right hand, (...) and on the feet we choose either the right or the left. (N11/IMC)*

Analysis of the responses obtained by the first instrument indicates that the study participants demonstrated adequate knowledge about what the POT was and the technique required to perform it; this was determined given the 92.3% correct answer rate for the questions that addressed the test concept, and 100% for those that addressed the measurement site and the factors which altered the test reading.

Regarding the data from the medical records, it was evident that the nurses' notes in all of the analyzed tests indicate that the measurements were performed in the recommended locations (n=209; 100%), namely: on the right upper limb and on one of the lower limbs, in accordance with the Ministry of Health protocol. Since only the nurses' records were analyzed, it was not possible to verify whether there were inadequacies in relation to the technique at the time of performing the test.

Interpretation of measurement values and recording results

This category refers to the nurses' actions in response to the oximetry reading results and the way in which they were recorded. The responses to the first instrument applied indicated that the nurses knew how to recognize the parameters of the values obtained in the test, with a 100% accuracy rate in the examples that presented negative and positive results, and 92.3% in the example of a doubtful result. However, the statements during the interview were different from the results mentioned above, suggesting that the professionals adopted different behaviors when interpreting the values, depending on the routine of each sector.

> *If the result is below 95%, the ideal action is to instruct the mother to warm the child and repeat the test in one hour. (N3/SA)*
>
> *Wait for a homogeneous line on the sensor until it reaches the expected value, 95% saturation in both limbs, and that there is no difference greater than 3% from one limb to the other (…). In cases where the test shows saturation less than 95% or a difference equal to or greater than 3% from one limb to the other, we repeat it after one hour. (N10/IMC)*
>
> *In our sector, we do it if the baby does not reach the necessary saturation, then we wait 24 hours and do it again the next day (…) and if it does not pass, we make a note of both records and inform the pediatrician. (N13/IMC)*

This difficulty in following up after interpreting the test results was also evident in the responses to the questionnaire and in the medical records. The question on the instrument that addressed the criteria for communicating the result to the medical team generated the greatest disagreement among the participants: 53.8% responded that the doctor should be notified if the test was altered, and 46.2% responded that the result should be communicated regardless of whether there was an alteration, which was the correct answer.

Among the analyzed records, the oximetry measurements were within the appropriate parameters in 98.08% of the cases (n=205). However, there were divergences in the adopted procedures in the four newborns who had altered results: the test was repeated in one case, obtaining normal results; the second reading was not performed in another case, but the newborn underwent echocardiographic evaluation, which confirmed the presence of a non-critical congenital heart disease. In addition to these, two medical records had no records of a second measurement, despite the previous result.

Regarding the records made, the nurses reported making notes in the medical records in the places recommended by each sector, in addition to knowing and using the child's health booklet (or vaccination card) as a place of information for the newborn and their family.

> *I record this in the newborn kit, which has a specific field for it; I also record it in the child's vaccination record. (N5/SA)*
>
> *The test is recorded in the child's medical record, on their admission form, (...) and also on the vaccination card. Usually, these new ones have a place just for this childcare, there is also the hospital section, and there we have the place to put the POT. (N8/IMC)*

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> *I record the test in the vaccination record and in the medical record, indicating the date and time, with the limb and the saturation. (N12/IMC)*

However, when analyzing the POT records in the newborns' medical records, it was observed that there was no record regarding the date and time of the test (n=164) in 78.47% of the records in cases where oximetry was performed, and it was not possible to identify whether the test had been performed between 24 and 48 hours of life.

Although the records analyzed were not attributed in their entirety to the professionals interviewed, this data is relevant because it points to incompleteness in the nurses' notes on the test performance, although this information was mentioned in the statements, as evidenced in the following category.

Eligibility criteria

Participants also discussed the criteria used to select the NBs who would have the POT performed, according to the service profile in each sector:

> *Newborns older than 35 weeks, between 24 and 48 hours of age, who have not been on oxygen for the last 24 hours, and babies who (...) are already known to have heart disease, we do not perform this test. (N1/IMC)*

> *(...) they are always the ones who complete 24 hours of life during my shift (...); sometimes there are pediatricians who ask to bring the test forward, to see some discharge criteria (...). And the exclusion criteria, for example, a newborn who has used oxygen, always waits 24 hours after use to be able to do so. (N4/SA)*

> *Newborns between 24 and 48 hours of age, before hospital discharge. (N6/SA)*

> *When it is a full-term newborn, from 24 hours of age; when it is a preterm newborn, we wait until 34 weeks, and when the baby is using oxygen, we wait until it is off oxygen and do the test 24 hours later (...) (N7/IMC)*

Based on the analysis of these reports, it is possible to infer that most participants were aware of the correct time to perform the test, which is consistent with the questionnaire responses regarding this topic and whose accuracy rate was 92.3%.

However, it is important to note that performing the test outside the indicated period was mentioned by participants, as well as its occurrence verified in the medical records: in the cases in which the POT performance time was recorded, 6.22% were performed between 24 and 48 hours of life (n=13), and 15.31% outside the indicated period (n=32), with 3.35% before 24 hours of life and 11.96% after 48 hours of life.

Another point mentioned in the nurses' speeches was performing pulse oximetry in preterm newborns with gestational ages outside those stipulated by the Ministry of Health, using a gestational age greater than 35 weeks as the cut-off point, or waiting for newborns born with a gestational age below 34 weeks to complete 34 weeks of corrected gestational age before the test could be performed. This selection criterion, used by the participants, was observed during analysis of the medical records, in which 5.68% of the tests verified in the study were performed in newborns who had a gestational age less than 34 weeks (n=13).

The POT was not performed (n=20) in 8.73% of the selected medical records, with the reasons being compatible with the criteria indicated by the professionals: waiting to reach the corrected gestational age of 35 weeks (n=1), use of oxygen therapy at the collection time (n=6), performance of specific diagnostic tests to identify congenital heart disease such as echocardiogram (n=2) and fetal ultrasound (n=1), admission to the neonatal ICU between the first 24 and 48 hours of life (n=3), and admission to the service after the time of the test (n=2). There were no records of the POT or the factors which justified its non-performance in five medical records, although the newborns met the eligibility criteria for the test.

DISCUSSION

The data related to characterization of the research subjects demonstrate similarity with a study on pulse oximetry and the knowledge and performance of nurses conducted in João Pessoa, Paraíba, Brazil, where there was a predominance of nurses with between six and 10 years of academic training, with some type of specialization and service time in the institution for a period of up to 5 years[9].

The participants presented satisfactory knowledge about the POT, as demonstrated in the category "Performance of the pulse oximetry test" and evidenced by the data extracted from the medical records, in which no inadequacies were observed regarding the oximetry measurement location in any sector, constituting an important finding of this study. The lack of knowledge regarding the test can result in low adherence of the health teams to the protocol, as well as in late screening of children with congenital heart disease, causing significant impacts and unfavorable outcomes[16,17].

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However, when faced with the readings, the participants' responses indicated that there were weaknesses related to following the triage protocol, evidenced by the difficulty in identifying cases in which the results should be communicated to the medical team, as presented in the questionnaire in the category "Interpretation of measurement values and recording results". In addition, the statements and records in the medical records demonstrated that the nurses followed the recommendations in the case of a normal result, but there was no standardization in institutional practices in the case of altered results, such as performing a second measurement 24 hours after the first, or not performing a new reading. Deviations from protocols were also reported in a study in South Africa, where nurses had difficulty interpreting the measurements, resulting in inadequate screening[18].

The POT protocol of the Ministry of Health considers peripheral saturation as normal when it is greater than or equal to 95% in measurements on the right upper limb and one of the lower limbs, and with a difference <3% between the limb measurements; if either is <95% or there is a difference equal to or greater than 3% between the measurements, a new measurement must be performed in 1 hour[8]. There was recently new guidance issued from the national agency, stating that only a saturation measurement of one of the lower limbs can be performed, and a retest must be performed after 1 hour if the result is <95%, but this time with measurements of the upper right limb and a lower limb. If the change persists, the neonate must be referred for an opinion from a cardiologist or to perform an echocardiogram within the following 24 hours[5].

The Brazilian Society of Pediatrics (*Sociedade Brasileira de Pediatria - SBP*) also issued recommendations regarding the POT protocol, defining a "negative test" as a result previously considered normal; a "positive test" when peripheral saturation is less than or equal to 89% in any of the limbs; and a "doubtful test" if saturation is between 90% and 94% or a difference between the measurements is less than or equal to 4%. A new reading should be taken in this situation after one hour, up to two times; if the measurements remain altered, the test should be considered positive, and the newborn should undergo cardiological/echocardiographic evaluation. The retest addition in these cases was intended to considerably reduce the number of false positives[19].

The participating nurses stated in the interviews that they recorded pulse oximetry, a fact which was proven by checking the medical records. However, incompleteness in the nursing records for the test was evidenced in the medical records of both sectors, especially regarding the date and/or time the test was performed. This finding is in line with that found in two other studies, where professionals showed concern when recording due to factors such as the time spent on this task, work overload and staff shortages, contributing to this data being neglected in the medical record notes[13,18]. However, it is worth noting that recording all the information related to the POT provides the nurse with the assurance that screening was performed adequately, in addition to providing elements to develop research that contributes to strengthening the profession.

A relevant aspect found in this study was recognition of the Child's Handbook by the participants as an instrument for recording information related to the newborn. This document is essential for monitoring the child, and must be filled out correctly in all health services from the first moments of life, so that no data is lost and monitoring is comprehensively conducted[20].

Analysis of the "Eligibility criteria" category indicated that participants considered factors such as the possibility of hospital discharge before 24 hours of life, the use of oxygen therapy, prematurity and the presence of heart disease as parameters to determine whether or not to perform oximetry, as well as the time chosen to perform the screening. This contributed to some tests being performed outside the pre-established time and in newborns who did not fit the target audience defined by the protocol.

A systematic review performed a meta-analysis including 20 studies comparing POT performance before 24 hours of life, and between 24 and 48 hours[21]. A decrease in sensitivity was observed in those who used a saturation measurement protocol before 24 hours, since the false positive rate is higher in these cases due to the transition from fetal to neonatal circulation and stabilization of oxygen saturation levels[5,21].

The nurses' conduct in this study related to oximetry in premature newborns or those using oxygen therapy were also mentioned in an article that investigated the feasibility of implementing this method in neonatal intensive care units, with performance of the oximetry test in premature newborns and those using oxygen; however, the false-positive rate in this study was higher compared to asymptomatic newborns and in the full-term population[21]. The clinical conditions of babies requiring intensive care impact interpretation of saturation data, showing that performing POT in this specific population is not effective[22].

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Considering that newborns admitted to neonatal units undergo a more detailed and longer evaluation due to their clinical conditions, with continuous oximetry monitoring and daily physical examinations, the evidence and recommendations for screening mainly apply to low-risk newborns, as they were not normally subjected to pulse oximetry before the screening protocol, and had shorter hospitalizations after birth, with occasional physical examinations[21,23]. Thus, the current recommendation of the *SBP* is that the test be performed routinely in all newborns with a gestational age equal to or greater than 35 weeks and who are clinically well, asymptomatic, in a rooming-in environment[18]. However, it is noteworthy that there have been no updates and/or changes (to date) in the Ministry of Health protocol regarding the eligibility criteria mentioned above.

The participants in this study demonstrated difficulties in interpreting and recording readings, and established eligibility criteria that were not in accordance with the screening protocol, which was also demonstrated through the analysis of test records. The lack of participation in training related to the POT by professionals and the lack of knowledge about the institutional SOP are factors which may have contributed to this. Thus, a need for investments in professional qualification becomes clear, with theoretical and practical training that not only educates nurses about the importance of the test and how to perform it, but also how to interpret the results and respond appropriately to a newborn who fails it[24].

Nurses are in a leadership position within CHD screening, being responsible for performing the POT, interpreting the algorithm and documenting the results, in addition to providing education to families about this test. By understanding the fundamentals of the need for screening, the updated protocols and recommendations on the method and its limitations, these professionals can have a positive impact on the lives of newborns and their families through early identification of these malformations and timely treatment.

Study limitations

A lack of observation of the tests being performed in practice made it impossible to analyze the POT execution technique. Incompleteness of the data provided in the medical records made it difficult to analyze the period in which the tests were performed, highlighting the importance of adequate records for improving the care quality and promoting research. In addition, the number of participants and the fact that it was developed in a single institution may restrict generalizing the obtained results, but which can be countered by the particularities in the study interview content.

CONCLUSION

The nurses participating in this study demonstrated adequate knowledge regarding pulse oximetry testing. However, their statements during the interviews and the information analyzed in the newborns' medical records were divergent, which was evidenced by the difficulty in following the protocol when interpreting the values resulting from the measurements, incompleteness in the data recorded in most of the medical records regarding the period in which the test was performed, and adopting eligibility criteria outside of what was established in the screening protocol, which indicated weaknesses in the POT performance by these professionals.

These facts highlight the need for educational reinforcement and continuous monitoring by the institution and professionals in order to identify flaws and correct them as necessary, thus ensuring systematic and efficient POT execution and in accordance with the established standards, as well as the benefits arising from the screening protocol. A highlight of this study was the nurses' recognition of the child's notebook as a place to record information about the newborn.

The role of nurses in pulse oximetry testing includes obtaining knowledge about the test, identifying newborns eligible for the protocol, performing the test and interpreting its results and its development, as well as adequate and complete documentation of the test, so that it can contribute to early identification and presumptive diagnosis of CHD, and consequently reducing morbidity and mortality in this population from it.

Finally, it is suggested that the POT protocol be updated and unified by the competent bodies, ensuring standardization of eligibility criteria and interpretation of results in order to improve the process quality for identifying these diseases. Furthermore, it is necessary to develop new studies at the national level which discuss nurses' practice in performing pulse oximetry with the purpose of promoting the visibility of nurses in this process to stimulate developing strategies which contribute to professional training and strengthening evidence-based practice, as well as the leading role of nursing in the field of neonatal screening for CHD.

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Conceptualization, J.T.D.O., P.H.A.F.S. and H.F.S.; methodology, J.T.D.O., P.H.A.F.S., H.F.S. and I.J.S.A.C.; software, J.T.D.O., H.F.S. and I.J.S.A.C.; validation, J.T.D.O., P.H.A.F.S. and H.F.S.; formal analysis, P.H.A.F.S., H.F.S. and I.J.S.A.C.; investigation, J.T.D.O.; resources, J.T.D.O.; data curation, J.T.D.O.; manuscript writing, J.T.D.O., C.G.S.O. and L.G.S.L.; writing - review and editing, J.T.D.O., P.H.A.F.S., H.F.S. and I.J.S.A.C.; visualization, J.T.D.O., P.H.A.F.S., H.F.S., I.J.S.A.C., C.G.S.O. and LGSL; supervision, P.H.A.F.S., H.F.S. and I.J.S.A.C.; project administration, J.T.D.O., P.H.A.F.S. and H.F.S. All authors read and agreed with the published version of the manuscript.