Esc Anna Nery 2025;29:e20250006

RESEARCH

www.scielo.br/EAN

Development of a care bundle for performing the newborn pulse oximetry screening by nursing staff

Construção de bundle para a realização do teste do coraçãozinho por profissionais de enfermagem

Elaboración de un bundle para la realización del tamizaje de oximetría de pulso en recién nacidos por el personal de enfermería

Giulianna Cardoso Gevú Maganha[1]
Aline Cerqueira Santos Santana da Silva[1]
Emanuel Nunes[2]
Fernanda Garcia Bezerra Góes[1]
Fernanda Maria Vieira Pereira Ávila[1]
Marcela de Abreu Moniz[1]

1. Universidade Federal Fluminense. Rio das Ostras, RJ, Brasil.

2. Universidade de São Paulo. Ribeirão Preto, SP, Brasil.

ABSTRACT

Objective: to describe the development of a bundle for the performance of pulse oximetry screening by nursing staff. **Method**: this methodological study was conducted between October and December 2024 in a maternity hospital located in the interior of the state of Rio de Janeiro, Brazil. The development process occurred in three stages: identification of the informational needs of 27 nursing professionals regarding the pulse oximetry screening; literature review; and bundle development. Data analysis was performed using the IRaMuTeQ software with the Descending Hierarchical Classification method. **Results**: the main informational needs reported by nursing staff were related to the use of the monitor, correct positioning, pulse oximetry parameters, appropriate timing for the test, result interpretation, and the need for retesting. The lack of training was widely mentioned. The bundle developed consists of four stages: before the test, test performance, result interpretation, and management of positive results. It includes nine items detailing the procedures, responsibilities, required checks, and spaces for verification. **Conclusions and implications for practice:** the bundle, developed based on scientific evidence, facilitates adherence by providing clear and objective information. Its use contributes to minimizing errors and interpretation bias, while also systematizing the execution of the pulse oximetry screening. Furthermore, it strengthens care management and promotes continuing education in clinical practice.

Keywords: Heart Defects, Congenital; Neonatal Screening; Nursing, Team; Patient Care Bundle; Oximetry.

RESUMO

Objetivo: descrever o processo de construção de um *bundle* para a realização do teste do coraçãozinho por profissionais de enfermagem. **Método:** estudo metodológico, realizado entre outubro e dezembro de 2024, em uma maternidade no interior do estado do Rio de Janeiro, Brasil. O desenvolvimento ocorreu em três etapas: levantamento das necessidades informacionais de 27 profissionais de enfermagem sobre o teste do coraçãozinho; revisão da literatura; e elaboração do *bundle*. A análise dos dados foi realizada com o software IRaMuTeQ, utilizando-se o método de Classificação Hierárquica Descendente. **Resultados:** as principais necessidades informacionais dos profissionais de enfermagem estavam relacionadas ao uso do monitor, ao posicionamento e aos parâmetros da oximetria de pulso, ao momento adequado para realização do teste, à interpretação dos resultados e à necessidade de reteste. A ausência de treinamento foi amplamente mencionada. O *bundle* desenvolvido é composto por quatro etapas: antes do teste, realização, interpretação dos resultados e conduta frente ao teste positivo. Contém nove itens que detalham os procedimentos, os responsáveis pela execução, as verificações necessárias e espaços destinados à checagem. **Conclusões e implicações para a prática:** o *bundle*, construído com base em evidências científicas, favorece a adesão dos profissionais ao propor informações claras e objetivas. Sua aplicação contribui para minimizar falhas e vieses de interpretação, além de sistematizar a realização do teste do coraçãozinho. Ademais, fortalece a gestão do cuidado e promove a educação permanente na prática clínica.

Palavras-chave: Cardiopatias Congênitas; Equipe de Enfermagem; Oximetria de Pulso; Pacotes de Intervenções; Triagem Neonatal.

RESUMEN

Objetivo: describir el desarrollo de un bundle para la realización de la prueba de oximetría de pulso por parte del personal de enfermería. **Método**: estudio metodológico realizado entre octubre y diciembre de 2024 en una maternidad ubicada en el interior del estado de Río de Janeiro, Brasil. El desarrollo se llevó a cabo en tres etapas: identificación de las necesidades informativas de 27 profesionales de enfermería sobre la prueba de oximetría de pulso; revisión de la literatura; y elaboración del bundle. El análisis de datos se realizó mediante el software IRaMuTeQ utilizando el método de Clasificación Jerárquica Descendente. **Resultados**: las principales necesidades informativas reportadas por el personal de enfermería estuvieron relacionadas con el uso del monitor, el posicionamiento adecuado, los parámetros de la oximetría de pulso, el momento oportuno para la realización de la prueba, la interpretación de los resultados y la necesidad de repetir la prueba. La falta de capacitación fue ampliamente mencionada. El bundle desarrollado consta de cuatro etapas: antes de la prueba, ejecución de la prueba, interpretación de los resultados y manejo de resultados positivos. Incluye nueve ítems que detallan los procedimientos, los responsables, las verificaciones necesarias y los espacios para el registro. **Conclusiones e implicaciones para la práctica**: el bundle, desarrollado con base en evidencia científica, facilita la adherencia del personal al proporcionar información clara y objetiva. Su implementación contribuye a minimizar errores y sesgos de interpretación, además de sistematizar la realización de la prueba de oximetría de pulso. Asimismo, fortalece la gestión del cuidado y promueve la educación permanente en la práctica clínica.

Palabras-clave: Cardiopatías Congénitas; Grupo de Enfermería; Oximetría; Paquetes de Atención al Paciente; Tamizaje Neonatal.

Corresponding author:
Giulianna Cardoso Gevú Maganha.
E-mail: giulianna_cardoso@id.uff.br

Submitted on 01/29/2025.
Accepted on 05/14/2025.

DOI: https://doi.org/10.1590/2177-9465-EAN-2025-0006en

INTRODUCTION

Congenital heart defects (CHD) are defined as a group of malformations that affect the structure or function of the heart. This condition is one of the leading causes of infant mortality and ranks as the second leading cause of death during the neonatal period.[1] Approximately 130 million children are born with some form of CHD worldwide each year.[2]

CHD can be life-threatening if not detected early, often requiring surgical or interventional treatment — such as cardiac catheterization — within the first year of life. In Brazil, the incidence is 10 cases per 1,000 live births, accounting for approximately 10% of infant deaths and between 20% and 40% of deaths caused by congenital malformations.[3] In this context, improving the quality of diagnosis may help reduce the neonatal mortality rate associated with this condition.[4]

CHDs include a wide range of cardiac malformations with different physiological manifestations and are classified as acyanotic or cyanotic. The latter, also known as critical CHD (CCHD), require early diagnosis within the first days of life due to their rapid clinical progression, which can lead to early death. Several technologies have been employed for early detection, such as fetal or postnatal echocardiography, which stands out for providing relevant hemodynamic information and is considered the primary diagnostic method, especially for CCHD. However, its high cost and the need for specialized professionals limit its use as a screening tool.[5]

In this context, in 2014, the Brazilian Ministry of Health officially incorporated pulse oximetry — also known as the newborn pulse oximetry screening (*teste do coraçãozinho*, TC) — into the National Neonatal Screening Program within the Unified Health System (*Sistema Único de Saúde*, SUS), through Ordinance no. 20, issued on June 10, 2014. This measure aims to enable the early detection of CCHD.[6]

Screening using pulse oximetry is considered an important procedure in neonatology and obstetrics, as it represents a technological advancement that enables the early identification of CCHD. This is a noninvasive, painless monitoring of peripheral oxygen saturation (SpO_2), performed between 24 and 48 hours of life in clinically stable, asymptomatic newborns with a gestational age of 35 weeks or more, in rooming-in care, and before hospital discharge.[7] To perform TC, the pulse oximeter should be placed on the right upper limb (pre-ductal) and on one of the lower limbs (post-ductal). SpO_2 values are considered normal when they are equal to or greater than 95%, with a difference between the two measurements less than or equal to 3%.[6]

However, the clinical presentation of some CCHD may not be easily noticeable during the first days of life, as newborns may initially appear healthy due to the persistence of the ductus arteriosus. Another factor that compromises early diagnosis is hospital discharge, which typically occurs between 36 and 48 hours of life, a period when the ductus arteriosus may still be open. These factors, combined with failures in clinical assessment and improper execution of TC, may contribute to the delayed identification of CCHD.[6]

Among the health professionals involved in performing TC, the nursing staff plays a key role due to their direct and continuous contact with the newborn, providing comprehensive and humanized care to the mother-baby dyad. However, both nurses and other professionals must receive proper training to perform and interpret the test. They are responsible for identifying abnormal results and referring the newborn for specialized medical evaluation when necessary.[7]

Despite the standardized care for newborns with suspected or diagnosed CHD recommended by the Brazilian Society of Pediatrics (SBP), studies report challenges faced by nursing staff in performing TC. A case study described the situation of an asymptomatic newborn who had a negative TC result but, after hospital discharge, experienced clinical and hemodynamic deterioration and was later diagnosed with transposition of great arteries (TGA), a CCHD with a guarded prognosis.[8] Another study found that even when TC results were negative, some newborns were referred for echocardiography, and a significant proportion were diagnosed with CCHD.[7]

Challenges of this nature require the development of tools that minimize the risk of false-negative results when performing TC during newborn care. Among the various available tools, the bundle stands out. It is defined as a set of specific care measures that, when implemented together, lead to significant improvements in the quality of health care. It is therefore considered a care management tool. Like protocols, clinical guidelines, and checklists, bundles are developed by experts based on the best scientific evidence, aiming to promote safer health care practices and contribute to the reduction of adverse events.[9]

Studies have demonstrated the effectiveness of bundles in promoting safe care and have shown satisfactory outcomes in different contexts and care practices.[9,10] With the same purpose, applied to the neonatal population with suspected or diagnosed CCHD, the development of a bundle aims to standardize the care related to performing TC by nursing staff, in a simplified manner and using technical language specific to the health care field. This strategy seeks to enhance clinical practice by promoting safety and grounding care in the best available scientific evidence.

Moreover, a descriptive study indicates that the application of bundles in neonatal care is still limited.[11] In addition, there is a noticeable lack of scientific literature focused on the development of bundles specifically designed to standardize TC in newborns with suspected or diagnosed CHD, particularly those developed by nursing staff. This gap justifies the need for this study.

Therefore, the aim of this study was to describe the development process of a bundle for performing TC by nursing staff.

METHOD

This is a methodological study conducted in three stages: (1) assessment of the informational needs of nursing staff based on their knowledge and practice related to performing TC; (2) literature review; and (3) development of bundle.[12]

The first stage was conducted in a public hospital located in the interior of the state of Rio de Janeiro, Brazil, specifically in the rooming-

in unit. This facility is part of the SUS and was selected because it has a maternity ward, a rooming-in unit, a neonatal intensive care unit (NICU), and a nursery, serving as a referral center for newborn care. In addition to handling a wide range of diagnoses, this hospital has incorporated TC into its routine neonatal screening practices.

This stage included nurses, nursing technicians, and nursing aides with at least three months of professional experience performing TC, considering that this period provides sufficient practice and understanding of the process. Nursing staff who were on any type of leave, on vacation, or working exclusively in administrative roles on the day of data collection were excluded.

A convenience sampling method was adopted to recruit participants during the data collection period, which took place in October 2024. The invitation was extended in person by a nursing student, who introduced herself to the professionals, explained the study objectives in detail, and informed them that the interview would be conducted in person, would last approximately 15 minutes, and would be recorded digitally.

The structured interviews were conducted according to the participants' availability, without interfering with their work routines. They were held in a private room within the unit, in a quiet environment that ensured participants' privacy and the confidentiality of the information provided. The interviews followed a semi-structured script developed by two PhD nursing researchers, which was previously tested with two professionals. As no adjustments were needed, these tests were included in the final sample.

The script was divided into two sections. The first addressed participant demographics, including age, gender, education level, and work unit. The second section contained specific questions aligned with the study's objective: 1) *How is pulse oximetry performed in newborns?* 2) *How should the newborn be positioned or presented at the time of pulse oximetry?* 3) *What conditions in the newborn contraindicate performing pulse oximetry?* 4) *How do you proceed if the pulse oximetry result indicates a saturation below the recommended level?* 5) *What should be observed on the monitor during pulse oximetry?* 6) *What factors can interfere with performing pulse oximetry in newborns?* 7) *Do you have any questions or doubts regarding the pulse oximetry procedure in newborns? If so, what are they?* 8) *Have you received training on how to perform pulse oximetry in newborns?*

After the full transcription of the interviews, they constituted the primary data source and were submitted to lexicographical analysis using IRaMuTeQ software, applying the Descending Hierarchical Classification (DHC) method. The content of the responses (text segments) was analyzed based on the principles of thematic analysis, which involves identifying the core meanings that make up a communication, whose presence or frequency holds relevant significance for the analytical focus. For data interpretation, the active forms from each text segment class were retrieved, and based on this process, the aim was to reach the core understanding of the informational needs expressed by the nursing staff, grounded in their knowledge and practice related to performing TC. Inferences and interpretations were made in light of the conceptual frameworks that underpin this study.[13]

In the second stage, an integrative literature review was conducted to gather updated information on the methodological process and the key components, aiming to identify, analyze, and synthesize reliable and recent data on the topic. Searches were guided by the following review question: *What does the scientific health care literature address regarding the performance of TC in newborns?*

The search and selection phase of the publications was conducted in December 2024 in the following databases: LILACS, BDENF, SciELO, Scopus, PubMed, and Web of Science.

Controlled terms standardized in the Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH) were used in Portuguese, English, and Spanish. The descriptors were combined in pairs and trios using the Boolean operator "AND" and quotation marks ("") to narrow and organize compound terms. The search strategy was structured as follows: *(tw: (Nurse)) AND (tw: (Knowledge)) AND (tw: (Congenital heart defects)) AND (tw: (Rooming-in)) AND (tw: ("Neonatal screening")) AND (tw: (Oximetry))*.

Original articles available in full text that answered the review question were included. Duplicates, editorials, manuals, theses, and dissertations were excluded. The time frame considered the last 5 years to ensure updated information that would support the knowledge base used in the development of the bundle. A tool developed by the research authors was used to characterize each selected publication. Studies were organized in a Microsoft Excel® (version 2007) spreadsheet containing the following information: author, year, title, journal, objective, study type, and recommended care. These data were organized and summarized in the spreadsheet for subsequent analysis and to support the development of the bundle.

In addition to the literature review, the recommendations of Brazilian Ministry of Health and SBP were consulted to guide the theoretical content in the development of the bundle, in alignment with the official agencies and entities responsible for standardizing newborn care in the context of TC.

The third stage involved a series of meetings with the research team to develop the bundle. During these meetings, key elements were defined, including the structure of the bundle, its layout, and the organization and distribution of theoretical content, with the aim of compiling and synthesizing information on the topic in the form of a checklist. The adoption of the checklist format is justified by the fact that the bundle consists of a list of tasks that must be verified when performing TC in a practical, interactive manner. This approach guides the actions of professionals and supports both the expansion of knowledge and its incorporation into nursing practice.

The study complied with the ethical principles established in Resolution no. 466/2012 of the Brazilian National Health Council. All participants were assured of confidentiality and anonymity of their information by signing an Informed Consent Form (ICF). The project was approved by the Human Research Ethics Committee at Universidade Federal Fluminense under opinion no. 7.015.028 and CAAE no. 79810724.6.0000.8160.

RESULTS

This section presents the results according to the stages used in the development of the care management tool titled: *"Bundle for Performing the Newborn Pulse Oximetry Screening by Nursing Staff."*

First stage – assessment of the informational needs of nursing staff based on their knowledge and practice in performing TC

A total of 27 nursing professionals participated in the study, including 18 (66.7%) nursing technicians, 7 (25.9%) nurses, and 2 (7.4%) nursing aides. Participant age ranged from 39 to 78 years, with a mean age of 49.9 years. All participants were female. Regarding educational level, 12 (46.15%) had completed high school, 9 (34.62%) had completed higher education, and 5 (19.23%) had incomplete higher education.

Using DHC, a total of 27 texts were processed, resulting in 317 text segments, of which 289 were classified, yielding a utilization rate of 91.1%. These segments were organized based on the frequency of lemmas (root forms), grouped by vocabulary similarity within each class and by difference relative to the other classes, resulting in six distinct clusters. The dendrogram displays the words with associative strength, confirmed by the chi-square test results ($\chi^2 \geq 3.84$), as well as the relationship between the classes, as shown in Figure 1.

Initially, the software divided the corpus into four subcorpora. The first was composed of Class 6 (pink) (13.8%), which, lexically, is opposed to the other classes (1, 2, 3, 4, and 5). The second consisted of Class 5 (blue) (16.6%), which was further subdivided, generating the third subcorpus, formed by Classes 1 (red) (14.9%) and 2 (gray) (18.7%), which are associated with each other. Finally, the fourth subcorpus consisted of Classes 4 (light blue) (17.6%) and 3 (green) (18.3%). This indicates that although there is similarity between some classes (1, 2, and 5), there is divergence in relation to Classes 3 and 4.

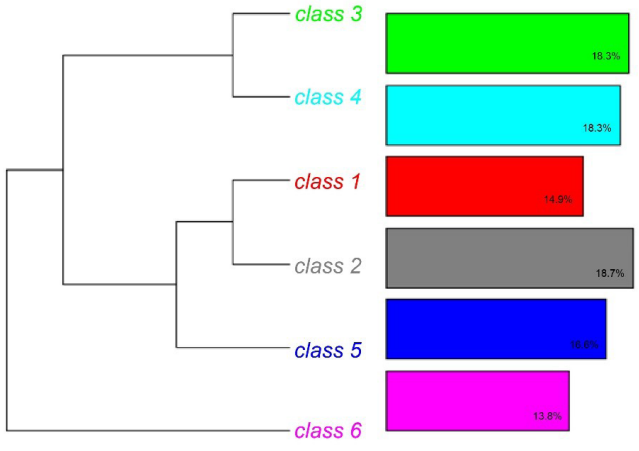

Figure 1. Dendrogram of the Descending Hierarchical Classification with significant words. Rio de Janeiro, RJ, Brazil, 2025.

Chart 1 presents the classes generated from the analysis of the text corpus, as well as the theoretical content identified based on the informational needs of the nursing staff, grounded in their knowledge and practice related to performing TC. The following elements were highlighted for inclusion in the bundle: use of monitor, proper placement of pulse oximeter, pulse oximetry parameters, appropriate timing for performing TC, interpretation of results, and the need for retesting. In addition, the professionals reported a lack of training for performing TC.

Second stage – literature review

Based on the assessment of the informational needs identified from the knowledge and practice of the nursing staff regarding the performance of TC, an integrative literature review was conducted to support the development of the bundle.

The search resulted in the following distribution of publications: LILACS (n = 52), BDENF (n = 52), SciELO (n = 3), Scopus (n = 178), PubMed (n = 12), and Web of Science (n = 197), totaling 494 publications. Of these, 22 were duplicates. After applying the exclusion criteria, 450 publications were discarded. During the full-text reading phase, an additional 17 studies were excluded for not answering the research question. Thus, the final sample consisted of five publications.

Based on the evidence selected in the integrative literature review[14-18] and through the convergence of themes, the studies indicate that the methodological process for developing a bundle should consider aspects such as cost, ease of implementation, and adherence to the proposed actions. Furthermore, the success of the bundle is directly related to the execution of all items, without omitting any steps.

As it is a specific topic, such as CHD, the selected studies did not directly address the components of a bundle aimed at performing TC. Therefore, the definition of the theoretical content was guided by the informational needs identified among the nursing staff, combined with the standardization of care for newborns with suspected or diagnosed CHD, as recommended by SBP.[19]

Third stage – development of the bundle

Based on the stages described above, the first version of the bundle was developed. It is structured into four stages and consists of nine items related to performing TC, as described below:

1st stage – before the test (newborn); check:

- Gestational age ≥35 weeks
- Age between 24 and 48 hours of life
- Normothermic
- Calm

Pulse oximeter; check:

- Neonatal sensor is available
- Sensor is correctly positioned
- Device is functioning properly

Chart 1. Theoretical content regarding the performance of the pulse oximetry screening to compose the bundle.

Class 1 – Care practices adopted when performing TC Active forms ($\chi^2 \geq 3.84$ and $p<0.0001$): "wave," "heart rate," "oxygen saturation," and "monitor"	
Topics for inclusion in the bundle:	
- Nursing staff should monitor SpO_2 and HR to ensure accurate test performance.	- The type and functioning of the monitor used in the health care facility may influence the results when performing TC.
Text excerpts:	
"[...]if the line is completely flat, smooth, or very irregular, fluctuating a lot, then you cannot rely on it (Part. 06)"	*"[...]sometimes the monitor takes a while to start, and we wonder, is this how it's supposed to be, or is it not?... (Part. 23)".*
"Oxygen saturation and heart rate; if the curves are symmetrical and there are no alterations, then that's it (Part. 22)"	*"If the result is altered, you have to wait one hour and repeat the test; if it's still altered, an echocardiogram should be requested; the monitors here are not very good, which raises doubts (Part. 26)"*
Class 2 – Nursing staff's knowledge about TC **Active forms ($\chi^2 \geq 3.84$ and $p<0.0001$):** *"communicate," "repeat," "physician," "give," "alter," "pediatrician," "echo," "request," "echocardiogram," "normally," "exam," "already," "refer," "conduct,"* and *"result"*	
Topics for inclusion in the bundle:	
- TC is performed differently among professionals, with no standardization regarding the appropriate timing for repeating the exam in the case of an altered result.	- There are divergences among professionals regarding contraindications for performing TC in newborns.
Text excerpts:	
"If the pulse oximetry screening result is altered, an echocardiogram is performed. Here, we don't repeat the exam if it's altered; we go straight to the echocardiogram (Part. 17)"	*"I think it can be performed on all babies. There's nothing that contraindicates it, or if there is, I don't remember right now (Part. 11)"*
"[...] mormally, the test is repeated; it's done again the next day (Part. 03)"	*"[...]in the case of prematurity, it can't be done. That's the only situation I think is contraindicated (Part.07)"*
Class 3 – Factors influencing the performance of TC Active forms ($\chi^2 \geq 3.84$ and $p<0.0001$): "noise," "interfere," "environment," "disrupt," "cold," "lower," "more," "hunger," "think," "factor," "difficult," "irritated," "nothing," "doubt," and "also"	
Topics for inclusion in the bundle:	
- External factors such as noise, lighting, heat, and cold can affect the newborn's clinical condition and, therefore, may alter the TC result.	- Reports indicate that crying, bowel movements, hunger, and irritability can interfere with TC. Additionally, there is a lack of knowledge regarding the influence of these factors.
Text excerpts:	
"*External factors, I think lighting and noise. I try to make the environment as calm as possible so it doesn't startle or alter the baby [...] (Part. 22)"*	*"There's nothing that disrupts the performance of the test. Noise doesn't interfere, at least that's what I think (Part. 06)"*
"[...]I think the only thing that can interfere with the test is the room temperature. I can't recall anything else (Part. 11)"	*"If the baby is restless and hungry, it can interfere. Or the baby may be well adapted but has stool or urine — all of that interferes (Part. 23)"*

* **Legend:** oxygen saturation (SpO_2); heart rate (HR); CCHD: critical congenital heart defect.

Chart 1. Continued...

Class 4 – Strategies adopted to calm the newborn during TC Active forms ($\chi^2 \geq 3.84$ and $p<0.0001$): "calm," "possible," "cry," "try," "bed," "turn off," "pacifier," "reading," "move," "a lot," "glucose," "stress," and "restless"	
Topics for inclusion in the bundle:	
- Strategies that focus on the baby's positioning and clinical condition at the time of TC.	- The use of non-nutritive sucking techniques, including glucose pacifiers and breastfeeding, is also adopted.
Text excerpts:	
"The baby should be lying in the crib on their back [...] should be calm and not crying, otherwise it disrupts the test (Part.09)"	"[...]*We try to keep the baby as calm as possible, without crying. Sometimes we use a glucose pacifier to keep them quiet (Part. 12)"*
"The baby should be placed in the supine position, kept comfortable and protected from the cold (Part.23)"	*"If the mother is present, I let the baby breastfeed a little, because the baby needs to be as calm as possible."*
Class 5 – Performing TC Active forms ($\chi^2 \geq 3.84$ and $p<0.0001$): "discharge," "receive," "coloration," "here," "condition," "training," "healthy," "pre-discharge," "present," "there," "perform," "moment," "life," "48 hours of life," and "cyanosis"	
Topics for inclusion in the bundle:	
- The professionals reported different practices, highlighting the lack of standardized procedures regarding the appropriate timing for performing TC.	- There is a need for information about how to perform TC and a lack of training among the nursing staff in the health care facility.
Text excerpts:	
"[...]usually within the first 12 hours of life, between 12 and 24 hours of life (Part. 03)"	*"The only doubt is that we don't know how to perform it. We just do what the doctor asks, but we don't know what to observe or what it means [...] (Part. 08)"*
"I don't know at what moment in life the pulse oximetry screening should be performed (Part. 12)"	*"[...]I have never received training to perform it. Let's say experience is what trains us — our training is done through daily practice (Part. 09)"*
Class 6 – Placement and interpretation of TC results Active forms ($\chi^2 \geq 3.84$ and $p<0.0001$): "place," "left," "pulse oximeter," "lower limb," "lower," "right upper limb," "side," "upper limb," "limb," "right," "right lower limb," "position," "injury," "hand," "take," "above," and "upper"	
Topics for inclusion in the bundle:	
- Uncertainty regarding which limbs the pulse oximeter should be placed on to perform TC.	- Divergence among professionals regarding what constitutes a normal (i.e., negative) result for CCHD.
Text excerpts:	
"Now I'm unsure about the upper part. I think we place it on the side of the heart, so on the left side, right? (Part. 14)"	*"[...]It has to show a value of 98 percent, 100 percent, 99 percent, something like that [...] (Part. 16)"*
"[...]I usually place the pulse oximeter on the right upper and lower limbs. Sometimes I place it on the left, wherever it gives a better reading. So it doesn't really matter which upper or lower limb (Part. 13)"	*"[...]It has to be between 96 percent and 100 percent. And for it to be normal, it usually has to show 100 percent, right? [...] (Part. 13)"*

* **Legend:** oxygen saturation (SpO_2); heart rate (HR); CCHD: critical congenital heart defect.

2nd stage – performing the test (pulse oximeter sensor); check:

- Sensor is positioned on the right upper limb (RUL)
- Sensor light is in contact with the inner part of the RUL

Saturation waves; check:

- Waves are regular (homogeneous)

Pulse oximeter sensor; check:

- Sensor is positioned on one of the lower limbs (LL)
- Sensor light is in contact with the inner part of the selected LL

3rd stage – result; check and interpret:

- **Negative result:** Saturation difference between the RUL and one of the LL is less than 4%. Record it in the newborn's health booklet and proceed with routine care
- **Questionable result:** Wait 1 hour and restart the process from the 1st stage
- **Positive result:** Saturation difference between the RUL and one of the LL is greater than or equal to 4%. Immediately notify the on-call physician

4th stage – conduct in case of a positive result:

- **On-call physician:** request an echocardiography, as shown in Figure 2.

The bundle developed is an original tool created by the research team.

DISCUSSION

The bundle developed in this study was designed based on the assessment of the informational needs of the nursing staff, grounded in their knowledge and practice related to performing TC. It consists of nine items organized into four stages: before the test, performing the test, interpreting the result, and conduct in the event of a positive result. The theoretical framework was supported both by the evidence selected during the integrative literature review and by SBP recommendations, which provided, respectively, the methodological guidance and the essential elements for standardizing TC.

Stage 1, "before the test", is part of the bundle and includes guidelines that, according to SBP recommendations,[19] must be verified prior to performing TC. According to these guidelines, the test should preferably be performed between 24 and 48 hours after birth. This strategy reduces the false-positive rate without compromising the diagnosis of pathological cases. The informational needs expressed by the nursing staff regarding this step may lead to variability in how the test is performed, which poses a risk to the newborn. This is evidenced by the fact that when the test is performed after 24 hours of life, the false-positive rate is only 0.05%, whereas when performed before this period, the rate rises to 0.5%.[20] These findings reinforce the importance of implementing care protocols and/or bundles as care management tools focused on diagnostic and therapeutic accuracy as well as the early identification of clinical emergencies.[20]

Regarding the placement of the sensor to measure SpO_2 during TC, it was possible to identify different types of knowledge based on each professional's prior learning and individual clinical experience. This item was included in the bundle, not only indicating the limbs where the sensor should be placed but also emphasizing that the sensor light must be in direct contact with the inner part of the skin. This guideline is essential to ensure that the red light emitter (LED) can accurately read the newborn's blood oxygen level, thereby guaranteeing a correct SpO_2 waveform reading.[19]

TC is recommended by the American Academy of Pediatrics, the American Heart Association, and the American College of Cardiology. Although there is no global consensus on the ideal technique for performing the test, in Brazil, a standardized protocol established by SBP[19] guides health professionals and services in its execution. Based on the findings of this study, the recommendations established by SBP appear to be insufficient to ensure adherence among professionals and health care services in clinical practice on their own. The use of the bundle as a care management tool can contribute to the standardization of TC procedures, promoting the adoption of best practices. Additionally, it supports, encourages, and strengthens continuing education while addressing the informational needs identified among nursing staff throughout this process.

Another item included in the bundle refers to the factors that influence the performance of TC. Although participants mentioned some interferences, their responses were largely limited to environmental factors and situations that cause discomfort to the newborn, without considering other elements that also directly impact the accuracy of TC. Among these factors are hypoperfusion, which reduces signal intensity and leads to SpO_2 readings lower than the actual values; the use of certain medications that affect perfusion, such as dopamine, anesthetics, and sedatives; as well as factors such as skin pigmentation, the presence of carboxyhemoglobin, fetal hemoglobin — which has a higher affinity for O_2 —, methemoglobin (associated with the use of certain drugs), body temperature, and altitude. All these aspects were included in the bundle to expand professionals' knowledge about risk factors that may compromise the accuracy of TC results. Mastering this knowledge strengthens autonomous and evidence-based decision-making, fostering a shift in care practices. This shift directly contributes to performing the test safely and consistently, ensuring reliable results and, consequently, the safety of the newborn.[18]

Timing for retesting was also included in the bundle, considering the points raised by the participants. According to the protocol recommended by SBP, if the TC result is abnormal, a retest should be performed after 1 hour. If the abnormality persists, an echocardiography must be performed before hospital discharge.[21] The indication of this specific retest interval is justified by the possibility of rapid clinical deterioration associated

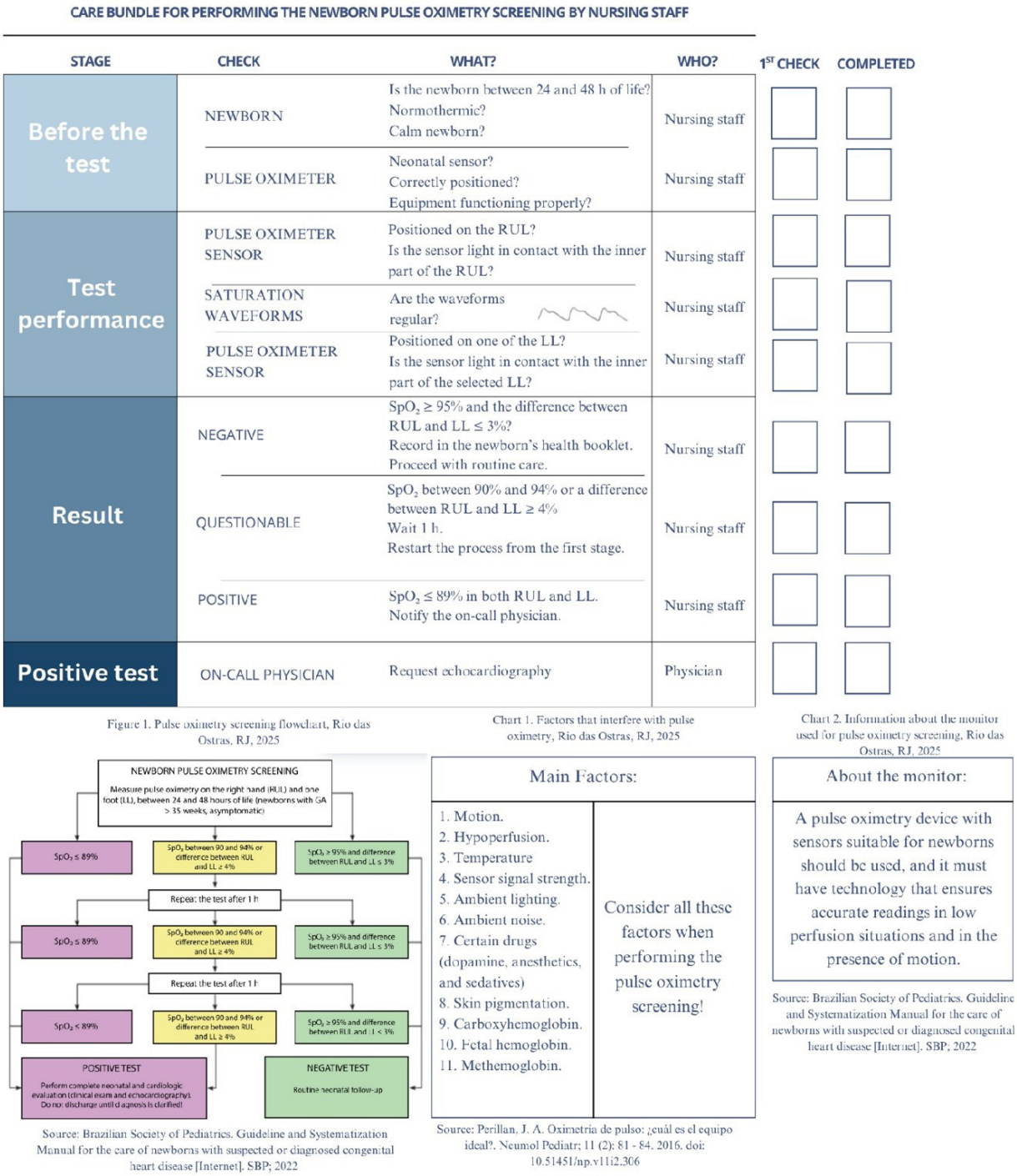

Figure 1. Pulse oximetry screening flowchart, Rio das Ostras, RJ, 2025

Source: Brazilian Society of Pediatrics. Guideline and Systematization Manual for the care of newborns with suspected or diagnosed congenital heart disease [Internet]. SBP; 2022

Chart 1. Factors that interfere with pulse oximetry, Rio das Ostras, RJ, 2025

Main Factors:	
1. Motion. 2. Hypoperfusion. 3. Temperature 4. Sensor signal strength. 5. Ambient lighting. 6. Ambient noise. 7. Certain drugs (dopamine, anesthetics, and sedatives) 8. Skin pigmentation. 9. Carboxyhemoglobin. 10. Fetal hemoglobin. 11. Methemoglobin.	Consider all these factors when performing the pulse oximetry screening!

Source: Perillan, J. A. Oximetría de pulso: ¿cuál es el equipo ideal?. Neumol Pediatr; 11 (2): 81 - 84. 2016. doi: 10.51451/np.v11i2.306

Chart 2. Information about the monitor used for pulse oximetry screening, Rio das Ostras, RJ, 2025

About the monitor:
A pulse oximetry device with sensors suitable for newborns should be used, and it must have technology that ensures accurate readings in low perfusion situations and in the presence of motion.

Source: Brazilian Society of Pediatrics. Guideline and Systematization Manual for the care of newborns with suspected or diagnosed congenital heart disease [Internet]. SBP; 2022

Figure 2. Bundle for performing pulse oximetry screening by nursing staff. Rio de Janeiro, RJ, Brazil, 2025.

with CCHD, which increases the risk of morbidity and mortality, as well as the risk of the newborn being discharged without the test being properly repeated. Therefore, including this item in the bundle emphasizes its role as a care management tool and promotes a better understanding of the importance of TC for the health and safety of newborns with CCHD among nursing staff.

Studies have demonstrated the effectiveness of bundles in promoting safe care. A review on the implementation of bundles to reduce central line-associated bloodstream infections (CLABSI) in critically ill patients showed a reduction of between 26% and 100% in the occurrence of this complication following the adoption of this tool, confirming its positive impact.[9] Another

study, conducted with the neonatal population, developed a care bundle focused on the use of peripherally inserted central venous catheters, achieving significant results in controlling CLABSI.[22] In light of such findings, the importance of using bundles applied to specific care practices and contexts is reinforced, as is the case with the bundle developed in this study, which is aimed at standardizing the performance of TC.

The identification of a normal TC result revealed variations in the nursing staff's understanding of the criteria for interpreting the test. This criterion, defined in the updated SBP recommendation, is crucial for the decision-making process of the professional who performs and interprets the test, as subsequent medical actions depend on the result obtained. For example, in the presence of a positive test — characterized by SpO_2 less than or equal to 89% in either limb (RUL or LL) — the newborn must be immediately and thoroughly evaluated by the neonatologist and undergo cardiological evaluation and an echocardiography for diagnostic confirmation. The divergences identified among professionals regarding the interpretation of TC highlight a significant gap in knowledge and practice, which can put the newborn's life at risk. In this context, the bundle developed in this study serves as a strategy capable of contributing to the expansion of professional knowledge, the qualification of care, and the improvement of the quality and safety of care provided to newborns through organized and accessible content.[6]

The lack of training, reported by the nursing staff in this study, was also identified in another study as a significant limitation in performing TC. This deficiency directly contributes to an increase in false-positive results. The unacceptable number of false positives is mainly associated with the lack of ongoing training for the teams responsible for performing the test. Therefore, it is essential to emphasize that training must be continuous, considering both the updates issued by regulatory bodies and the need to train new professionals entering health care services.[21]

Another study conducted in a rooming-in unit found that nursing staff had only a basic understanding of TC. While they acknowledged the importance of this screening and were familiar with its core concepts, they showed limited proficiency in both performing the procedure and interpreting the results — findings that are consistent with those of the present study.[23] This highlights the need for more effective knowledge-sharing strategies and clearer, more precise guidelines for clinical practice. Thus, the bundle developed in this study — designed to address the informational needs of nursing staff — stands out as a valuable tool for improving the quality and consistency of TC performance.

However, for the successful implementation of the bundle in the rooming-in setting, the active involvement of the nurse is essential — particularly in leading training efforts and promoting ongoing education for the team, aligned with daily workflows. It is crucial to provide feedback on adherence to the bundle and to continuously emphasize the importance of screening for CCHD through TC. This helps engage the entire team in newborn care and encourages reflection on clinical practices, recognizing that even asymptomatic newborns may still present with CCHD. This strategy enables the identification of critical gaps and areas in need of improvement. Strengthening the team through educational processes fosters the reorganization of care, centered on preventing errors during test execution. This approach is directly linked to improving care quality and reinforcing a culture of patient safety within the neonatal setting.[24]

Moreover, the findings of this study led to the development of a bundle designed in a visual, practical, and engaging format, which supports greater adherence to standardized care and, consequently, to best practices for performing TC. The bundle not only provides step-by-step guidance on how to perform TC but also promotes care practices that ensure accurate and reliable results. It addresses potential informational gaps that may arise during both the test and retest processes, while also strengthening the professional's autonomy — enabling nursing staff to perform the procedure independently, safely, and with a high standard of quality.

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

The bundle developed in this study was designed based on the informational needs of nursing staff, grounded in their knowledge and clinical practice related to performing TC. This tool consists of nine items organized into four stages: before the test, performing the test, interpreting the results, and management of a positive result. The bundle consolidates evidence-based information and supports adherence by providing clear, objective, and practical guidance that helps minimize errors and interpretation biases. As such, it promotes the standardization of TC procedures in alignment with SBP recommendations. Additionally, this is a low-cost, easy-to-implement tool that can significantly improve the accuracy of TC as a screening method for the early detection of CCHD in newborns.

Implementing this tool directly contributes to improving the organization and safety of CCHD screenings. It ensures that procedures are performed in a systematic, standardized, reliable manner. The bundle clearly outlines each step to guarantee that all essential phases are performed safely, effectively, and in line with the best clinical practices. Additionally, the tool is an effective resource for care management and continuing education. It supports the ongoing professional development of nursing staff by integrating up-to-date knowledge into clinical decision-making processes.

As a limitation, this study was conducted in a single setting with a limited number of participants, which may restrict the generalizability of the findings. Furthermore, it is important to develop implementation strategies for the bundle and define the expected outcomes within the institutions where it will be applied. Finally, it is essential to validate the bundle with expert reviewers and the target population, reinforcing the need for continued research.

ACKNOWLEDGMENTS

No acknowledgments.

FINANCIAL SUPPORT

No funding.

DATA AVAILABILITY RESEARCH

The contents underlying the research text are included in the article.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

1. Soares AM. Mortalidade em doenças cardíacas congênitas no Brasil – o que sabemos? [miniieditorial]. Arq Bras Cardiol. 2020;115(6):1174-5. https://doi.org/10.36660/abc.20200589. PMid:33470318.
2. Ferreira TA, Coutinho SC, Pereira AS, Carvalho LTM, Lopes TQS, Oliveira TYU, et al. O acesso aos serviços de saúde para o acompanhamento de cardiopatia congênita neonatal no município de Manaus: relato de experiência. Rev Foco. 2024;17(11):e6962. http://doi.org/10.54751/revistafoco.v17n11-193.
3. Ministério da Saúde (BR). Cardiopatia congênita afeta cerca de 30 mil crianças por ano no Brasil [Internet]. Brasília (DF): Ministério da Saúde; 2022 [citado 2024 mar 18]. Disponível em: https://www.gov.br/saude/ptbr/assuntos/noticias/2022/novembro/cardiopatia-congenita-af eta-cerca-de-30-mil-criancaspor-ano-no-brasil
4. Galli ACA, Silva MPC, Ued FV, Rezende LV, Ruiz MT, Contim D. Bundle para regulação da temperatura corporal de recém-nascidos maiores de 34 semanas: construção e validação. Rev Eletr Enferm. 2024;26:76948. http://doi.org/10.5216/ree.v26.76948.
5. Garcia AJM, Martínez AA, Mendoza YC, Gallegos SA. Diagnóstico prenatal y del recién nacido con cardiopatía congénita crítica: los tres pilares del tamiz cardiaco. Rev CONAMED. 2023;28(1):37-45. http://doi.org/10.35366/110870.
6. Ministério da Saúde (BR). Secretaria de Ciência, Tecnologia e Insumos Estratégicos. Comissão Nacional de Incorporação de Tecnologias no SUS. Teste do coraçãozinho (oximetria de pulso) na triagem neonatal. Relatório nº 115. [Internet]. Brasília (DF): Ministério da Saúde; 2014 [citado 2023 out 27]. Disponível em: https://docs.bvsalud.org/biblioref/2017/11/875369/testecoracaozinho-final.pdf
7. Silva MT, Silva ACSS, Santana JJ, Góes FGB, Assis GGT, Matos PSD et al. Fatores associados à indicação de ecocardiografia neonatal na investigação de cardiopatias congênitas. Rev Gaúcha Enferm. 2024;45:e20230170. http://doi.org/10.1590/1983-1447.2024.20230170.pt. PMid:39082493.
8. Bearare JRB, Napolitano LFB, Nakakogue RAW, Cintra KL. Transposição de grandes artérias: a importância do teste do coraçãozinho como exame de triagem. REAS. 2020;12(11):e4557. http://doi.org/10.25248/reas.e4557.2020.
9. Silva MPC, Bragato AGC, Ferreira DO, Zago LB, Toffano SEM, Nicolussi AC et al. Bundle para manuseio do cateter central de inserção periférica em neonatos. Acta Paul Enferm. 2019;32(3):261-6. http://doi.org/10.1590/1982-0194201900036.
10. Silva MP, Rocha NH, Teixeira CL, Ued FV, Ruiz MT, Contim D. Bundle to care for newborn children of mothers with suspected or confirmed diagnosis of COVID-19. Rev Gaúcha Enferm. 2021;42(spe):e20200391. https://doi.org/10.1590/1983-1447.2021.20200391.
11. Uema RTB, Shibukawa BMC, Rissi GP, Rodrigues BC, Felipin LCS, Higarashi IH. Construção de um *bundle* para alívio da dor na punção arterial norteado pela Tradução do Conhecimento. Esc Anna Nery. 2022;26:e20220181. http://doi.org/10.1590/2177-9465-ean-2022-0181pt.
12. Teixeira E. Interfaces participativas na pesquisa metodológica para as investigações em enfermagem. Rev Enferm UFSM. 2019;9:e1. http://doi.org/10.5902/2179769236334.
13. Minayo MCS. O desafio do conhecimento: pesquisa qualitativa em saúde. 14ª ed. São Paulo: Hucitec; 2014.
14. Huang Y, Zhong S, Zhang X, Kong L, Wu W, Yue S et al. Large scale application of pulse oximeter and auscultation in screening of neonatal congenital heart disease. BMC Pediatr. 2022;22(1):483. http://doi.org/10.1186/s12887-022-03540-7. PMid:35962379.
15. Kluckow M. Barriers to the implementation of newborn pulse oximetry screening: a different perspective. Int J Neonatal Screen. 2018;4(1):4. http://doi.org/10.3390/ijns4010004. PMid:33072930.
16. McIntyre AM, Lindeman C, Bernales M. Barriers and Facilitators perceived by the health team for the implementation of pre and post ductal saturometry as a method of detection of congenital heart diseases in newborns, prior to discharge. Rev Chil Pediatr. 2018;89(4):441-7. http://doi.org/10.4067/S0370-41062018005000405. PMid:30571816.
17. Asdo A, Mawji A, Agaba C, Komugisha C, Novakowski SK, Pillay Y et al. Repeatability of pulse Oximetry Measurements in Children During Triage in 2 Ugandan Hospitals. Glob Health Sci Pract. 2023;11(4):e2200544. http://doi.org/10.9745/GHSP-D-22-00544. PMid:37640488.
18. Perillan JA. Oximetría de pulso: ¿cuál es el equipo ideal? Neumol Pediatr. 2016;11(2):81-4. http://doi.org/10.51451/np.v11i2.306.
19. Sociedade Brasileira de Pediatria. Manual de orientação. Sistematização do atendimento ao recém-nascido com suspeita ou diagnóstico de cardiopatia congênita. SBP [Internet]; 2022 [citado 2025 jul 1];4:1-14. Disponível em: https://www.sbp.com.br/fileadmin/user_upload/23544cMO_Sistemat_atend_RN_cSuspeita_CardCongenita.pdf
20. Escobar MF, Valencia P, Jaimes LM, Hincapié LC, Pulgarín EE, Nasner D et al. Resource use decrease after implementation of care bundles for treatment of postpartum hemorrhage. J Matern Fetal Neonatal Med. 2022;35(25):7874-81. http://doi.org/10.1080/14767058.2021.1937989. PMid:34112062.
21. Carvelo GMT, Kanitz F, Cruz LV, Von Zuben VGM. Teste da oximetria de pulso em unidade neonatal de referência - avaliação após 3 anos de sua implantação como teste de triagem universal. Resid Pediátr. 2021. Ahead of Print. http://doi.org/10.25060/residpediatr-2021.v11n3-197.
22. Silva MP, Rocha NH, Teixeira CL, Ued FV, Ruiz MT, Contim D. Bundle to care for newborn children of mothers with suspected or confirmed diagnosis of COVID-19. Rev Gaúcha Enferm. 2021;42(spe):e20200391. http://doi.org/10.1590/1983-1447.2021.20200391. PMid:34161547.
23. Queiroz IM, Lucena GP. A importância do teste do coraçãozinho no diagnóstico precoce de cardiopatias congênitas. Rev Recien Rev Cient Enferm. 2020;10(29):145-54. http://doi.org/10.24276/rrecien2358-3088.2020.10.29.145-154.
24. Branco A, Lourençone EMS, Monteiro AB, Fonseca JP, Blatt CR, Caregnato RCA. Education to prevent ventilator associated pneumonia in intensive care unit. Rev Bras Enferm. 2020;73(6):e20190477. http://doi.org/10.1590/0034-7167-2019-0477. PMid:32813804.

AUTHOR'S CONTRIBUTIONS

Study design. Giulianna Cardoso Gevú Maganha. Aline Cerqueira Santos Santana da Silva.

Data collection. Giulianna Cardoso Gevú Maganha. Aline Cerqueira Santos Santana da Silva. Emanuel Nunes. Fernanda Garcia Bezerra Góes.

Data analysis and interpretation. Giulianna Cardoso Gevú Maganha. Aline Cerqueira Santos Santana da Silva. Emanuel Nunes. Fernanda Garcia Bezerra Góes. Fernanda Maria Vieira Pereira Ávila. Marcela de Abreu Moniz.

Manuscript writing and critical revision. Giulianna Cardoso Gevú Maganha. Aline Cerqueira Santos Santana da Silva. Emanuel Nunes. Fernanda Garcia Bezerra Góes. Fernanda Maria Vieira Pereira Ávila. Marcela de Abreu Moniz.

Approval of final version of the manuscript. Giulianna Cardoso Gevú Maganha. Aline Cerqueira Santos Santana da Silva. Emanuel Nunes. Fernanda Garcia Bezerra Góes. Fernanda Maria Vieira Pereira Ávila. Marcela de Abreu Moniz.

Accountability for all aspects of content and integrity of the published article. Giulianna Cardoso Gevú Maganha. Aline Cerqueira Santos Santana da Silva.

ASSOCIATED EDITOR

Aline Okido

SCIENTIFIC EDITOR

Marcelle Miranda da Silva