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Noise levels in a Neonatal Intensive Care Unit before and after an educational intervention

Níveis de ruído em Unidade Terapia Intensiva Neonatal antes e após intervenção educativa

Niveles de ruido en una Unidad de Cuidados Intensivos Neonatales antes y después de una intervención educativa

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ABSTRACT
Objective: to compare noise levels in a Neonatal Intensive Care Unit before and after an educational intervention. **Methods**: Quasi-experimental, before-after type study of a single group was conducted from December 2020 to February 2021 in a Neonatal Intensive Care Unit in Minas Gerais with a sample of 94 personnel of the multidisciplinary team. Data were collected in three stages – pre-intervention noise measurement, educational intervention, and post-intervention noise measurement – and were examined by descriptive analysis. The study was approved by the research ethics committee. **Results:** at the first measurement, mean noise level at all times, by area, was 58.5dB (Area A), 61.5dB (Area B), and 61.9dB (Area C). After the intervention, the means decreased to 56.1dB (Area A), 57.4dB (Area B), and 57.3dB (Area C). **Conclusion**: noise levels after the intervention were lower, although still above recommended levels.
Descriptors: Neonatal Nursing; Intensive Care Units, Neonatal; Noise; Health Education.

RESUMO
Objetivo: comparar os níveis de ruído dentro de uma Unidade de Terapia Intensiva Neonatal antes e após uma intervenção educativa. **Métodos**: estudo quase-experimental, tipo antes-depois, com único grupo, realizado no período de dezembro de 2020 a fevereiro de 2021 em uma Unidade de Terapia Intensiva Neonatal de Minas Gerais. Amostra composta por 94 profissionais da equipe multiprofissional. A coleta de dados ocorreu em três etapas: medição do ruído pré-intervenção, realização de intervenção educativa e medição do ruído pós-intervenção. Realizou-se análise descritiva e o estudo foi aprovado pelo Comitê de Ética em Pesquisa. **Resultados:** na primeira aferição a média do nível de ruído de todos os horários por área foi de 58, 5dB (Área A), 61,5dB (Área B) e 61,9dB (Área C), após a intervenção a média reduziu para 56,1dB (Área A), 57,4dB (Área B) e 57,3dB (Área C). **Conclusão:** o nível de ruído após a intervenção foi menor, embora ainda acima do recomendado.
Descritores: Enfermagem Neonatal; Unidades de Terapia Intensiva Neonatal; Ruído; Educação em Saúde.

RESUMEN
Objetivo: Comparar los niveles de ruido dentro de una Unidad de Cuidados Intensivos Neonatales antes y después de una intervención educativa. **Métodos:** Estudio casi experimental, de tipo antes-después, con un solo grupo, realizado de diciembre de 2020 a febrero de 2021 en una Unidad de Cuidados Intensivos Neonatales de Minas Gerais. La muestra abarcó 94 profesionales del equipo multidisciplinario. La recolección de datos se llevó a cabo en tres etapas: medición de ruido antes de la intervención, realización de la intervención educativa y medición de ruido después de la intervención. Se realizó un análisis descriptivo y el Comité de Ética en Investigación aprobó el estudio. **Resultados:** En la primera medición, el nivel de ruido promedio en todos los horarios, por área, fue de 58.5dB (Área A), 61.5dB (Área B) y 61.9dB (Área C); tras la intervención, el promedio se redujo a 56.1dB (Área A), 57,4 dB (Área B) y 57,3 dB (Área C). **Conclusión:** el nivel de ruido tras la intervención fue inferior, aunque todavía por encima de lo recomendado.
Descriptores: Enfermería Neonatal; Unidades de Cuidado Intensivo Neonatal; Ruido; Educación em Salud.

INTRODUCTION

The advent of technologies in Neonatal Intensive Care Unit (NICU) settings represented a significant contribution for the care and survival of newborns (NBs)[1]. However, factors such as intense light, constant handling and noises produced both by devices and professionals cause harms[2].

Prolonged exposure to high noise levels can result in an increase in oxygen consumption, altered heart rate, cochlear injury and hearing loss, in addition to predisposing to intraventricular hemorrhage, exerting negative impacts on neurological interaction, growth and development, weight gain and hospitalization time[3,4].

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In the NICU, the main noise sources are the conversations of the team within the unit, especially during handoffs, alarms of monitors, respirators, incubators and infusion pumps, opening and closing doors, drawers, cabinets and trash cans, movement of furniture and equipment, mobile phones and noisy shoes[2,5-7].

According to the American Academy of Pediatrics for NICUs, the desirable and acceptable levels should not exceed 45 decibels (dB), and the Brazilian Association of Technical Standards (*Associação Brasileira de Normas Técnicas*, ABNT) establishes values of in-hospital noises from 35 to 45 dB as desirable and acceptable levels[3.5].

By identifying that noise generates harmful effects on NBs[3,4], it is important to sensitize and re-educate teams of health professionals working in the NICU, with a view to improving neonatal care quality and to making the environment more appropriate for the permanence of newborns[4].

Permanent Health Education (PHE) was included by the Ministry of Health as one of the strategies for the reorganization of the Unified Health System (*Sistema Único de Saúde*, SUS), which incorporates the act of daily learning and teaching in health organizations and the work process[8]. Thus, it presupposes the development of educational practices focused on solving concrete problems, enabling collective reflections and, thus, rethinking actions that favor workers' participation in decision-making related to care quality[9].

Professional qualification from the application of PHE promotes safety and tranquility in performing procedures, improving the conduct of work and changes in the organization of processes, effectively contributing to patient safety and to care quality[10]. Thus, Permanent Health Education (PHE) can be applied as an educational intervention that enables the transformation of professional practices and constitutes an important instrument that connects reality and scientific evidence in knowledge construction[11,12].

In this context, the objective of the study was to compare the noise levels in a Neonatal Intensive Care Unit before and after an educational intervention targeted at noise reduction.

METHOD

A quasi-experimental, longitudinal and prospective field study of the before-and-after intervention type, with a single group and an analytical and quantitative approach[13]. It was conducted from December 2020 to January 2021 in the NICU of a teaching hospital from Minas Gerais. The criteria set forth in the *Standards for Quality Improvement Reporting Excellence in Education* were adopted.

The population consisted of all the professionals from the multidisciplinary team (n=94) of the unit (nurses, physiotherapists, physicians, psychologists, speech therapists, social workers and nursing technicians), from the morning, evening and night shifts. The sample was for convenience, considering the following inclusion criteria: working as a member of the NICU multiprofessional team and participating in all three stages of the intervention. The individuals excluded from the research were those who were away from their work duties due to medical or maternity leaves or holidays and those who did not complete both stages of the educational intervention. Recruitment of these professionals was via individual invitations made in the unit itself after the due authorizations.

Data collection took place in three stages: noise measurement before the intervention; educational intervention for noise reduction; and noise measurement after the intervention. Noise measurement was performed with a decibelmeter, a device that measures the sound pressure level in decibel hearing levels [dB(A)] by capturing noise with a microphone (Criffer brand; Octava Plus model) that meets the NBR 10151:2019 and NBR 10152:2017 standards, with ±0.3 dB(A) accuracy. The scale used to measure the sound pressure level in the NICU ranged from 30 to 135 dB(A).

A NICU ground floor was used to select 25 strategic points for noise measurement, with the help of the researchers and an Occupational Health and Work Safety (OHWS) engineer from the institution. The NICU is separated by areas and, in order to optimize distribution of the points, it was divided as follows: Area A, with points 1 to 7: Area B, with points 8 to 17; and Area C with points 18 to 25. It is noted that the multiprofessional team works in all the areas and that the care activities were normally developed during data collection. The unit lacks acoustic barriers to prevent sound propagation.

This stage took place during one week in the morning, afternoon and night periods at pre-established times (06:25 AM, 08:00 AM, 10:00 AM, 12:25 PM, 02:00 PM, 04:00 PM, 06:25 PM, 07:00 PM and 08:00 PM), chosen for representing the noise variance according to the activities performed, such as handoffs, procedures and times without NB handling. However, during the measurement procedures, sounds inherent to the NICU, such as infants crying and alarms from continuous pumps, may have contributed to the increase in noise.

The measurement data were introduced into a *Microsoft Excel*® spreadsheet containing information related to the points, areas, days of the week and time.

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The educational intervention was carried out in two stages respecting the Ministry of Health safety recommendations on prevention and control of COVID-19 transmission (groups of two to four people, distancing of two meters, mask use, disinfection of chairs with 70% alcohol, use of 70% alcohol gel for hand hygiene before and after the intervention, and pens for personal use)[14] and on days and times defined by the researchers and unit coordinators.

The first stage was divided into two moments, conversation wheel and Ask and answer game, during an optional PHE session of those stipulated by the Unit. The conversation wheel aimed at sensitizing the team, exchanging knowledge and experiences through an explanatory booklet developed by the researchers, with the topics of definition, harms, allowed levels, generating sources and control strategies (Figure 1).

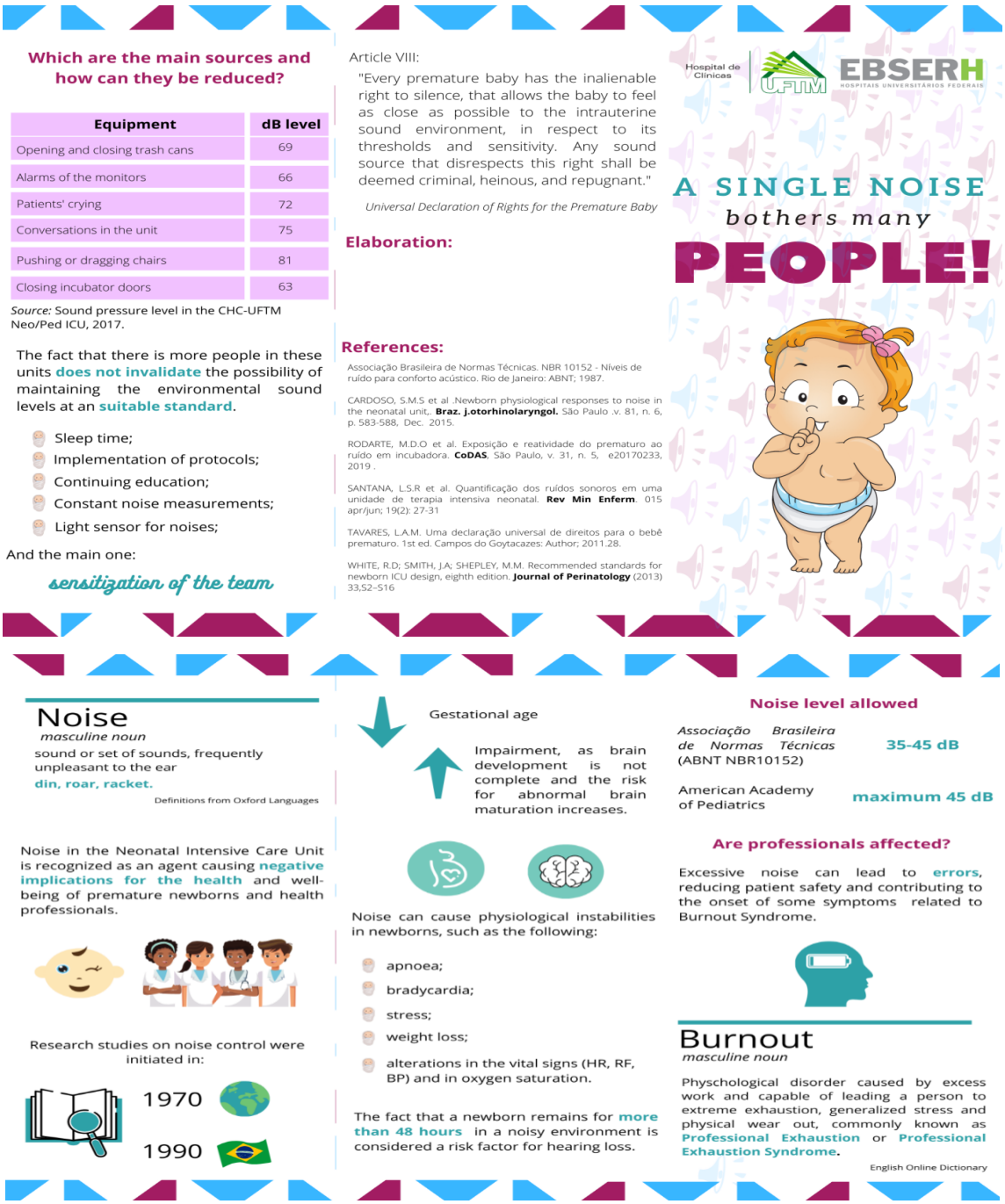

FIGURE 1: Booklet entitled "*Um barulho incomoda muita gente*" ("A single noise bothers many people"), prepared for the educational interview. Uberaba, MG, Brazil, 2021.

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After the PHE session, and in order to encourage participation of the team and content fixation, the Ask and answer game about harms produced by noise in NBs and in the health team was used. A total of 15 cards/questions with five answer options were prepared about the topic, as well as three Help cards: 1. Skip question card (which means that the participant should pass the turn to the other player); 2. Viewer help card (which means that the participant could request help from the rest of their group); and 3. Help in the question card (which means removing two incorrect alternatives from four questions).

The participants were drawn to answer and, subsequently, the researcher read the card chosen and offered the answer options; when a participant did not know the answer, they could ask for help and use up to three cards. If the answer was incorrect, another participant would be allowed to answer the question. The winner was the group that obtained the highest score. A total of 41 rounds/individual games were conducted, distributing nine random cards in each round.

The second stage took place 15 days later to reinforce sensitization; an action called "D Day for Noise Control in the NICU" was performed in order to warn about the harms of intense and continuous noise to neonates. In the morning, afternoon and night periods, the professionals coming in and going out the NICU were approached to hand them in the booklet entitled "*Por que você pode receber um psiu quando entrar na UTIN?*" ("Why may someone tell you 'Hush!" when entering the NICU?"). (Figure 2).

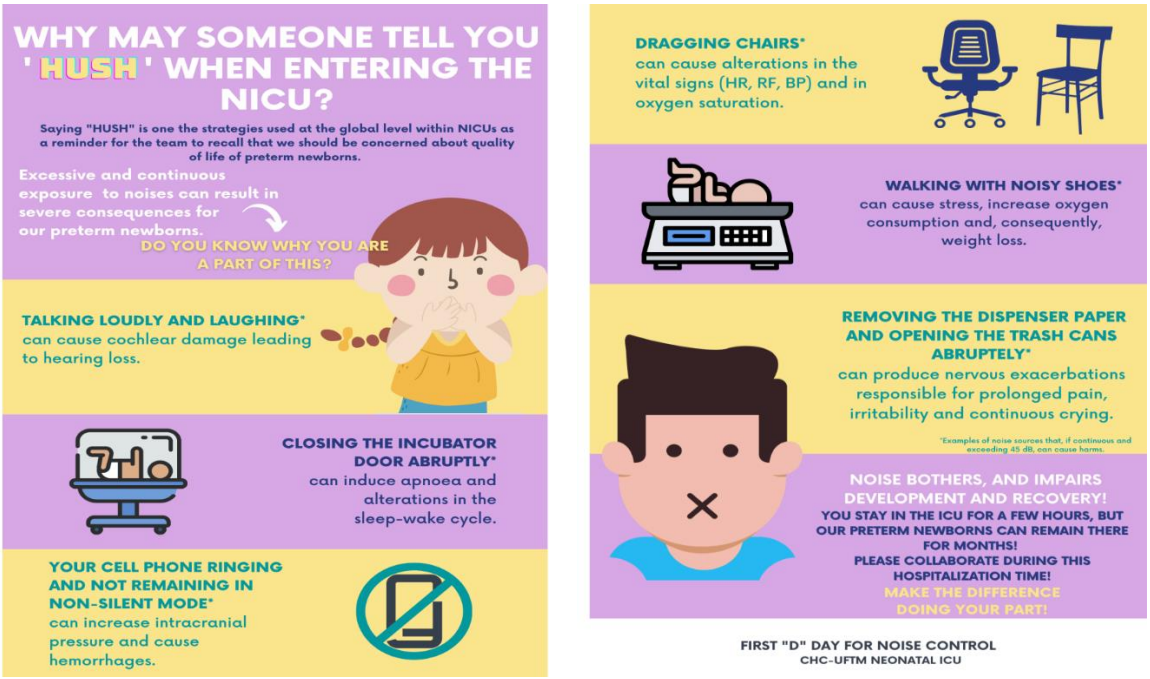

FIGURE 2: Explanatory booklet about noise handed in at "The 1st D Day for Noise Control in the NICU". Uberaba, MG, Brazil, 2021.

The booklets of the first and second stages were printed in color, illustrated by means of different images and with clear language; the content was evaluated by six nursing and medical professors from the Federal University of Triângulo Mineiro (*Universidade Federal do Triângulo Mineiro*, UFTM), who work in the Neonatology area. The assessment was made by means of a Likert scale in Google Forms and 80% consensus between the experts was considered.

The measurement after the intervention was performed 15 days after the "D Day for Noise Control in the NICU". The measurements were taken in the same conditions, places and times, and with the same device than before the intervention.

The total data collection period was 65 days with 15-day intervals between stages, being seven days for the pre-intervention noise measurement, 20 days for the conversation wheel and the Ask and answer game, one day for the D Day and seven days for the post-intervention measurement.

The data were introduced in a *Microsoft Excel*® database, with double typing for their processing. They were subsequently imported to be analyzed in the *Statistical Package for Social Science* program, version 23.0. They were

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submitted to an analysis of absolute frequencies and percentages, including central tendency (mean and median) and variability (standard deviation) measures. Pearson's correlation was employed to verify if there was any association between the times and areas from the first and second measurements, with a 95% confidence interval.

All the ethical precepts established by Resolution No. 466/2012 of the National Health Council were complied with, and this study was evaluated and approved by the Research Ethics Committee of the institution involved.

RESULTS

Of the 122 team members, 94 professionals from the multidisciplinary team participated in the study (21 nurses, ten physiotherapists, 14 physicians, a psychologist and 48 nursing technicians); sample loss was 28 professionals, 12 for being on holidays and 16 excluded because they did not participate in both stages of the educational intervention due to the need to perform care activities in addition to the reduced staff on that day.

The activities were performed at times previously agreed upon with the team, not coinciding with handoffs, performance of procedures on the NBs or drug administration.

In the Ask and answer game, the cards that represented more errors among the participants were the following: "In 2017, the noise levels in the NICU of the UFTM Clinical Hospital Complex (CHC) were measured, and the values were above the recommended. Which is the value of these measurements?", with four errors; "Which is the largest noise source in the CHC/UFTM NICU?", with three errors; and "How long does an NB has to remain in a noisy place to be considered a risk factor for hearing loss?", with two errors. The other rounds obtained the maximum score, with correct answers in all the questions.

The noise levels in both measurements are above the recommended values, as shown in Table 1.

TABLE 1: Noise levels from the first and second measurements according to the predefined times. Uberaba, MG, Brazil, 2021

	Mean		Standard Deviation		Minimum		Maximum		p-value[a]
Times	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	
06:25 AM	61.2	57	4.3	3.9	50.3	46.9	69.9	69.8	0.001
08:00 AM	60.7	56.8	3.2	3.9	52	47.6	68.8	74.3	0.859
10:00 AM	60.4	56.6	3.9	3.4	51.7	47.2	74.4	66.7	0.019
12:25 PM	61.2	57.5	3.8	3.6	47.7	45.8	72.5	67	0.030
02:00 PM	61.3	57.3	3.5	3.8	52	50	75	69.4	0.043
04:00 PM	59.7	57	3.7	3.6	49.5	44.9	69.9	67	0.383
06:25 PM	61.7	57.9	3.3	3.3	49.2	47.9	72.4	66.5	0.309
07:00 PM	60	55.6	3.5	3.2	48.5	46.1	68.3	62.1	0.60
08:00 PM	60.5	56.7	3.6	3.6	48.3	47.5	70.8	62.7	0.001

[a]Pearson's correlation

In the first measurement at all nine times, eight had mean noise values above 60 dB, with 06:25 PM standing out, which reached 61.7 dB. The second measurement showed a reduction in noise level at all times with a mean difference of 3.8 dB; the highest reduction was at 07:00 PM with 4 dB less and the lowest was at 04:00 PM with 2.7 dB less. In Pearson's correlation, two times presented p-value=0.001.

The lowest difference between the means corresponding to the noise levels from both measurements was at 04:00 PM, and the lowest noise level from the first measurement is also identified at this time. At the other moments, the difference remained proportional in both measurements (Figure 3).

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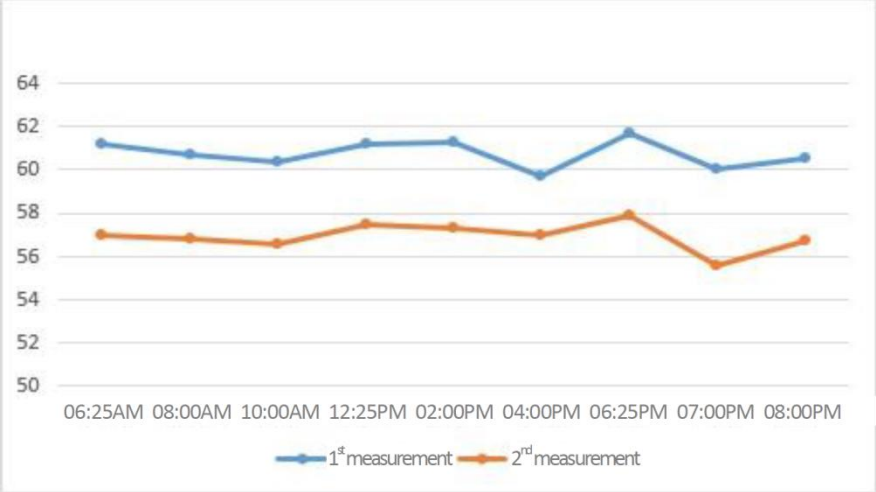

FIGURE 3: Distribution of the noise level mean values in the first and second measurements, by time. Uberaba, MG, Brazil, 2021.

The comparison of the noise levels between the areas and times is presented in Table 2.

TABLE 2: Comparison of the noise levels between the areas and times before and after the intervention. Uberaba, MG, Brazil, 2021.

	AREA A (Points 1 to 7)			AREA B (Points 8 to 17)			AREA C (Points 18 to 25)		
Times	**1st**	**2nd**	**p-value[a]**	**1st**	**2nd**	**p-value**	**1st**	**2nd**	**p-value**
06:25 AM	55.8	55.7	0.122	63.2	58.1	0.416	63.7	57.1	0.115
8:00 AM	60.5	56.6	0.580	60.7	56.6	0.365	60.9	57.5	0.830
10:00 AM	59.9	56.1	0.867	60.5	57.0	0.059	60.9	56.5	0.044
12:25 PM	57.8	56.9	0.981	62.4	57.7	0.352	63.0	58.0	0.148
2:00 PM	59.3	56.3	0.253	61.9	58.4	0.244	62.4	57.0	0.003
4:00 PM	58.2	55.8	0.855	60.1	56.7	0.591	60.7	58.6	0.086
6:25 PM	58.6	57.7	0.045	62.7	57.8	0.101	63.4	58.6	0.484
7:00 PM	57.8	54.3	0.168	60.7	56.4	0.473	61.4	56.0	0.586
8:00 PM	58.9	55.0	0.393	61.2	57.9	0.619	61.1	56.8	0.558

[a]Pearson's correlation

Areas A, B and C presented 2.4 dB, 4.1 dB and 4.6 dB reductions, respectively. In the first measurement, the noise level mean values at all the times by area were 58.5 dB, 61.5 dB and 61.9 dB, respectively, dropping to 56.1 dB, 57.4 dB and 57.3 dB after the intervention. Area A presented the lowest noise levels in both measurements, but it reached the lowest reduction in terms of dB (Table 2). In Pearson's correlation, Area C presented p=0.003 at 02:00 PM.

DISCUSSION

The mean noise level of this study is above the American Academy of Pediatrics recommendations, in line with other studies[2,5,6,15,16]. Although the consequences of excessive noise to newborns have been proven, in the care practice the challenges for noise control are complex and the national production on the theme is limited[12].

Behavioral and environmental changes should be instituted in NICUs in order to reduce these levels. The literature recommends reducing conversations among the team members, using quieter equipment, sound absorption devices and, for individual protection of NBs, ear protectors and sound-absorbing tissues to cover the incubators[2,6,7,17,18]. The devices should be adjusted to signal real critical situations, in order to avoid excessive alarms that cause stress and fatigue to the professionals, mainly the nursing team by direct contact at the bedside[19,20].

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Other recommended strategies are keeping the doors of the unit closed to avoid external noise, limiting the entry of people and posting silence signs in the environment to draw the attention of the health, cleaning and caretaking professionals, parents and family members[19]; however, these strategies were not identified in the unit during the study.

It is noted that the evaluation of noise level should be judicious, as it can be influenced by the moment measured, by procedures and by the number of people in the environment; it is recommended to mask the actual measurement moment and measure at different times[19]. The measurements in this study were not masked; after the intervention, the professionals consciously or unconsciously followed the guidelines, as well as in other studies[1-3,14,21].

The mean of noise before and after the educational activity and across the measurement times was close, and remained constant during day and night, differently from other studies in which the measurement values in the daytime were higher. The highest values during daytime are related to the larger number of professionals in the sector, clinical interventions and visits, among other practices[5,7,21]. A study conducted in Mexico deduces that the noise level variability in different shifts and days is due to activities, type of patient and their complexities and number of people working in the sector[5].

This study implemented a noise care bundle, as it obtained a minimum reduction of 5.0 dB and a maximum of 7.4 dB in the ambient levels and a minimum of 8.8 dB and a maximum of 9.3 dB in the incubators. These precautions included speaking in a low voice, avoiding conversations in the room, not hitting or writing on the top of incubators, responding to the alarms as quickly as possible, handling medical equipment carefully, minimizing opening and closing of incubators, and reducing the volume of alarms and phone bells. Despite the significant decrease, the noise levels in the environment remained above the recommended, whereas the incubator levels in the night shift were below 45 dB[19].

For being a gradual and continuous process and requiring time and involvement, sensitizing the team can be challenging but it is one of the fundamental elements in the change process within the unit[7]. The implementation of specific programs and protocols, together with educational programs and continuing education, contributes to adherence to proper behaviors, employee engagement as active participants and surveillance[14,20].

Through PHE it is possible to design a continuous and effective learning methodology, using problematization and inclusion of the subjects in the process[11]. The applicability of informative materials and playful approaches such as games expand access to information and contribute to more effective content fixation, representing a support tool for learning[21]. In this scenario, PHE is an instrument that enables critical analysis and construction of knowledge about the local reality; therefore, it needs to be thought and adapted[22].

In this study, 16 professionals were not included because they were not able to participate in the intervention stages, corroborating other research studies which showed that the team's time availability is a harmful factor in PHE conduction, in addition to the high work demand, deficit of employees and difficulty reallocating patients among the employees, thus proving to be impact factors in demotivation of the team for participation[10].

The noise levels in both measurements were above the recommended values. It is important to note that there may be aspects linked to noise that do not depend only on the professionals, such as air conditioning noise, noise from trash can lids, computers, door hinges and coatings, which do not promote noise absorption or maintenance of the equipment[23].

Protective interventions aimed at reducing noises can be implemented, such as measuring noise frequently, installing automatic doors, electronic panels indicating decibels in the environments, noise flags, not wearing high heels, avoiding the use of mobile phones, reducing telephone bell volumes, performing handoffs in a separate room from the hospitalization rooms, placing anti-impact stickers on the trash cans, doors, drawers and cabinets, signaling the unit with posters stimulating silence, and maintaining periodic educational programs on noise for the health team[22].

Study limitations

Noise measurement by times was considered as a limitation, as it did not allow analyzing the noise variations in continuous periods. However, the method presented made it possible to perform a local diagnosis.

It is suggested to conduct other studies to identify the elements that generate noises in the NICU for the implementation of specific interventions and to analyze knowledge retention over time. The strategy used has limitations in terms of participation of the team and should be continuous for a change in the professionals' stance.

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CONCLUSION

The noise levels before and after the educational intervention remained above the recommended at all times: the mean levels were 58.5 dB, 61.5 dB and 61.9 dB in the first measurement, respectively; after the intervention, the mean values dropped to 56.1 dB, 57.4 dB and 57.3 dB; and two times, 06:25 AM 08:00 PM, presented p-value=0.001. New research studies, measurements and implementations should be carried out for follow-up purposes.

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