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Noise level in the neonatal unit

Nível de ruídos na unidade neonatal

Nivel de ruido en la unidad neonatal

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ABSTRACT

Objective: to verify the sound pressure levels (SPL) and the influence of the shift and the occurrences in these levels in a neonatal unit in Rio de Janeiro. **Method:** longitudinal, exploratory, descriptive study. Collected from November 2021 to January 2022. Categorical variables were described using absolute and relative frequencies. To verify adherence to the normal distribution, the Shapiro-Wilk test was used. For the association between exposure and outcome variables, the Mann-Whitney, Kruskal Wallis and Qui-square tests were used. Results of p < 0.05 were considered statistically significant. **Results:** 10,122 decibel records and 56 events related to activities were collected, these occurred predominantly during the day. There was a variation from 38.6 to 93.1 decibels (dB). In 96.3% of the observed period, the NPS were above the recommended. Comparing the periods, nighttime had lower SPL (p=0.000). **Conclusion:** the registered NPS are above the recommended for a safe environment.

Descriptors: Patient Safety; Infant, Newborn; Intensive Care Units, Neonatal; Noise; Noise Measurement.

RESUMO

Objetivo: verificar os níveis de pressão sonora, a influência do turno e das ocorrências nesses níveis em uma unidade neonatal do Rio de Janeiro. **Método:** estudo longitudinal, exploratório, descritivo, com dados coletados entre novembro de 2021 e janeiro de 2022. As variáveis categóricas foram descritas por meio de frequências absoluta e relativa. A aderência à distribuição normal foi verificada pelo teste Shapiro-Wilk. Para a análise da associação entre variáveis de exposição e desfecho, utilizou-se teste Mann-Whitney, Kruskal Wallis e Qui-quadrado. Considerou-se estatisticamente significativos resultados de p<0,05. **Resultados:** foram coletados 10.122 registros de decibéis e 56 eventos relacionados as atividades, que ocorreram predominantemente no período diurno. Houve variação de 38,6 a 93,1 decibéis (dB). Em 96,3% do período observado, os níveis de pressão sonora estiveram acima do recomendado. Na comparação entre os períodos, o noturno apresentou menores níveis (p=0,000). **Conclusão:** os níveis de pressão sonora registrados estão acima do recomendado para um ambiente seguro.

Descritores: Segurança do Paciente; Recém-Nascido; Unidades de Terapia Intensiva Neonatal; Ruído; Medição de Ruído.

RESUMEN

Objetivo: Verificar los niveles de presión sonora y la influencia del turno y de las incidencias en esos niveles en una unidad neonatal en Rio de Janeiro. **Método:** Estudio longitudinal, exploratorio, descriptivo, cuyos datos se recopilaron de noviembre de 2021 a enero de 2022. Las variables categóricas se describieron mediante frecuencias absoluta y relativa. Para verificar la adherencia a la distribución normal se utilizó la prueba de Shapiro-Wilk. Para el análisis de la asociación entre variables de exposición y de resultado se utilizaron las pruebas de Mann-Whitney, Kruskal Wallis y Qui-quadrado. Los resultados de p < 0,05 se consideraron estadísticamente significativos. **Resultados:** se recolectaron 10.122 registros de decibelios y 56 eventos relacionados con actividades, que ocurrieron predominantemente durante el día. Hubo una variación de 38,6 a 93,1 decibelios (dB). En el 96,3% del período observado, los niveles de presión sonora estuvieron por encima de lo recomendado. Comparando los períodos, el nocturno presentó niveles más bajos (p=0,000). **Conclusión:** Los niveles de presión sonora registrados están por encima de lo recomendado para un ambiente seguro.

Descriptores: Seguridad del Paciente; Recién Nacido; Unidades de Cuidado Intensivo Neonatal; Ruido; Medición del Ruido.

INTRODUCTION

When inside the uterus, fetuses are exposed to 28 decibels (dB) of baseline noise, referring to their mothers' vascular sounds and digestive noises. In these conditions, they are well-protected against external noises, as the uterine wall and the amniotic fluid reduce intense sounds and maternal voice by up to 35 dB[1].

However, critically-ill newborns (NBs) require hospitalization in Neonatal Intensive Care Units (NICUs), where the higher numbers of devices and health care team members providing assistance can generate excessive environmental pressure[2-4].

Exposure to a neonatal unit environment is even more harmful to preterm NBs due to the greater difficulty lowering their heart rate in the presence of external noises when compared to full-term infants, because of anatomical and physiological immaturity[5]. When exposed to excessive noise, preterm NBs can develop physiological and behavioral

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changes in the short-, medium- and long-term, such as hearing loss, major sleep disorders, increased intracranial pressure, arterial hypertension, metabolic instability, stress, irritability and weight loss[3,4,6].

Auditory impairment in newborns that were hospitalized in NICUs affects approximately 16 out of 1,000 neonates[7]. In this sense, the recommendation is that environmental sound pressure should vary from 45 dB to 50 dB[8].

To achieve these standards, the great challenge lies in human activity: in controlling the environment and their own behavior, which is considered one of the main sources of noise within the NICUs. Therefore, knowledge, planning, teamwork, motivation, permanent education and feedback are required; and the first step towards change and sensitization of the professionals is assessing environmental noise levels[8].

The literature highlights that other research studies in this still little explored care segment are necessary to devise and strengthen practices aimed at reducing NB exposure to the environmental factors found in NICUs[9].

Based on verifying the requirements that a NICU should comply with, this study is justified by the need to better understand the neonatal environment and, based on its results, contribute to safer environments for neonates.

The objective of this study was to verify the sound pressure levels and the influence of shifts and occurrence of these levels in a neonatal unit from Rio de Janeiro.

METHOD

This is a longitudinal, analytical and exploratory study conducted in the neonatal unit of a hospital that is a reference in the care of at-risk newborns from the municipality of Niterói, Rio de Janeiro, Brazil. The neonatal unit comprises three integrated spaces, namely: an intensive care component with eight incubators and/or radiant heat sources; an intermediate care space with eight regular cribs and/or incubators; and four regular cribs in the Kangaroo space, totaling 20 beds.

Data collection was conducted by one of the researchers between November 2021 and January 2022, by measuring the Sound Pressure Level (SPL) in the units with a factory-calibrated MINIPA-MSL-1355B decibel meter.

The device was positioned at the center of 8-bed intensive care space (ICU) and, subsequently, in the intermediate unit (IU), following the norms/recommendations set forth by the Brazilian Technical Standards Association (*Associação Brasileira de Normas Técnicas*, ABNT). The SPLs were measured in dB with the device operating in the A compensation and "slow" response scale.

The SPLs were measured from 7:00 am to 11:00 am (morning period), from 02:00 pm to 06:00 pm (afternoon period) and from 07:00 pm to 1:00 pm (night period). Data collection took place for seven days, contemplating all days that comprise a full week. For each collection day there was a spare day to transfer data to a computer, tabulate them and exchange the device batteries. After collection in the ICU, this same procedure was performed to measure the noise levels in the IU. The decibel meter measured the SPLs every 60 seconds in all three time intervals of a full week, and in both environments that comprise the neonatal care unit.

Data collection was performed applying an instrument prepared by the researchers themselves and containing the following information: locus, shift; number of family members that entered the neonatal unit to be with the NB; and events related to the routine activities that took place when the SPLs were measured.

The events were grouped into 4 categories: (1) Transport instances (internal and external transfers for surgeries, tests and to other hospital units); (2) Invasive procedures (collection of samples for tests, venous and arterial punctures, lumbar punctures, elective intubations); (3) Non-invasive procedures (body hygiene, radiographies and ultrasounds, implementation of phototherapy, examinations and evaluations by a specialized team, hospital admission and discharge); and (4) Professionals (shift and round handoffs, clinical discussions). Terminal cleaning in the unit and replacement of technological devices due to equipment failure were categorized as "Others".

For the purposes of this study, the SPLs considered inadequate followed the recommendation in force, which points to 45-50 dB[1] as adequate SPLs.

Considering the hypothesis that presence of the device could make people control their tone of voice and attempting to obtain results closer to reality, the decibel meter was installed one week before data collection as a way to desensitize the people that move through the neonatal unit.

The data were typed and analyzed in the *Statistical Package for the Social Sciences* (IBM SPSS®) program, version 22.0. The categorical variables were described as absolute and relative frequencies, and the numerical ones by means of central tendency (median) and dispersion (quartiles) measures, according to verification of adherence to normal distribution using the Shapiro-Wilk test. The Mann-Whitney, Kruskal-Wallis and Qui-square tests were employed to

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analyze the association between the exposure and outcome variables, according to the data characteristics. Results with p<0.05 were considered statistically significant.

Before initiating the research, its protocol was submitted to the Research Ethics Committee of the institution involved, complying with all the principles and standards pre-established in CNS Resolution No. 466/2012, which regulates research involving human beings[10].

RESULTS

A total of 10,122 records regarding decibels and 56 events related to the routine activities that took place within the unit were collected, in the morning, afternoon and night periods and in the ICU and IU environments. Of these decibel records, 28.6% (n=2.892) corresponded to the weekends and 71.4% (n=7,230) were from Monday to Friday. Table 1 presents the data related to the measurements taken.

Table 1: Decibel distribution by observation unit (n=10,122). Niterói, RJ, Brazil, 2022.

Locus	Distribution			Percentiles		p-value*
	Median	Minimum	Maximum	25	75	
ICU	64.1	39.5	93.1	59.2	68.5	0.000
IU	61.2	38.6	86.7	56.5	66.8	

Note: *Mann-Whitney Test.

During the data collection period, the number of hospitalized NBs varied from five to eight in the ICU and from two to five in the IU. Because of the protocol of restrictive measures due to the COVID-19 pandemic during the data collection period, no other family members entered the neonatal units except for parents, and the number of visitors varied from zero to five. Among the decibel records from the period, there were no visitors in 3,232 (31.9%); from one to two visitors in 5,352 (52.9%) and from three to five visitors in 1,538 (15.2%).

The SPLs varied from 38.6 dB to 93.1 dB, with a median of 62.9 (57.5-67.7). In 96.3% (n=9,751) of the measurements, corresponding to 162 hours and 51 minutes, the environment presented SPLs above 50 dB. In 3.7% (n=371) of the measurements, which equals six hours and 18 minutes, the SPLs remained below 50 dB. It was verified that the median for the SPLs in the ICU was higher when compared to those in the IU (p=0.000).

Table 2 presents the data related to the measurements and the periods involved in the study.

Table 2: Decibel distribution by observation period (n=10,122). Niterói, RJ, Brazil, 2022.

	Decibels		
Periods	Up to 50 dB n(%)	Above 50 dB n(%)	p-value*
Morning	0(0%)	3,374(100%)	
Afternoon	0(0%)	3,374(100%)	0.000
Night	371(11%)	3,003(89%)	

Note: *Chi-square test

A statistical difference was observed in the decibel distribution across the observation periods. Regarding the observation periods, the SPLs remained high in the day shifts, when compared to the night one.

The measurements and events that took place in the environments during the study period are presented below (Table 3).

Table 3: Frequency of the events that took place in the unit during the period when the Sound Pressure Levels were measured (n=56). Niterói, RJ, Brazil, 2022.

Events	n	f(%)	Mean ranks	p-value*
Transport instances	6	10.7	27.25	
Invasive procedures	11	19.6	33.77	
Non-invasive procedures	12	21.4	29.33	0.631
Professionals	27	48.2	26.26	
Total	56	100.0		

Note: *Kruskal-Wallis test.

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Regarding the events, those categorized as related to the professionals (n=27; 48.2%) and to non-invasive procedures (n=12; 21.4%) stood out. Lower frequencies were recorded in terms of the events related to transport instances (n=6; 10.7%) and to invasive procedures (n=11; 19.6%).

It was verified that there was no statistically significant association (p=0.631) between occurrence of events or not and the SPLs recorded. However, when individually comparing the mean ranks corresponding to the events, greater differences were observed in the "Invasive procedures" and "Non-invasive procedures" categories. It is then understood that during these events there was an increase in noise generated in the environment, when compared to the average of other events that occurred in the unit in the same collection period.

Of all 56 events recorded, 55.3% (n=31) took place during the morning period, 17.8% (n=10) in the afternoon and 26.7% (n=15) at night. Regarding the physical space in which they occurred and their respective periods, 58.9% (n=33) were in the ICU, with 54.4% (n=18) during the morning period, 27.2% (n=9) in the afternoon and 18.1% (n=6) at night. In turn, 41.1% (n=23) of all the events recorded took place in the IU. Of them, 56.5% (n=13) were during the morning period, 4.3% (n=1) in the afternoon and 39.13% (n=9) at night.

DISCUSSION

The sound pressure levels obtained in this study showed that NBs are constantly exposed to noise levels above the recommended[8], which evidences the extent to which NICU environments can be harmful to their neuropsychomotor development, especially for the most vulnerable preterm infants, thus turning this space into a challenging environment for premature newborns, employees and parents alike[11].

In this study, the lower sound pressure levels found during the night period represented a significant finding (p=0.000). Similar results were found in a national study conducted at a neonatal unit of a teaching hospital, where lower SPLs were also detected at during the night period, although all measurements were above the recommended[11]. Another study, conducted in Colombia, presented significant differences in the statistical analysis between work schedule and shift, with higher SPLs in the first hours of the day[12].

In the current study, the SPLs during the daytime were above the recommended in 96.3% of the periods, evidencing NBs' exposure to harmful effects that can compromise their health[13]. This finding can be associated with greater circulation of people and with the fact that varied procedures are usually performed during the day shifts.

However, it is worth reflecting on health professionals' difficulty changing their behaviors towards this scenario marked by extreme acoustic discomfort. A previous systematic review highlights that high voice levels are required to outdo the noisy environment in NICUs, due to the equipment available in the unit to maintain the NB's life, such as monitors, respirators, telephones, furniture handling, among others, exerting negative impacts on the team, the newborns and their families[13]. The same authors also highlight that high noise levels are associated with greater incidence of errors and accidents.

Evidencing the challenge of offering safe care to at-risk newborns, similar difficulties were also verified in a study conducted at a reference hospital located in the city of San Luis Potosí, Mexico, where it was noticed that the NICU environmental level was more than two-fold higher than the values recommended by the international authorities, highlighting the importance of applying strategies and actions based on permanent in-service training[14].

The scientific literature has pointed out that high SPLs during the daytime can be related to the procedures performed, to visits by multiprofessional teams and family members and to didactic activities inherent to a teaching hospital, among other practices[4,11,13]. Although the noise produced by the events related to routine activities such as invasive and non-invasive procedures presented greater differences in this study, there was no statistically significant association.

Referring to the use of incubators as a strategy to reduce noises in the neonatal unit, a Brazilian study highlights that being inside an incubator does not avoid high SPLs, as environmental sounds partially cross the incubator walls, exerting an impact on the noise level in this microenvironment, interfering with NBs' sleep and wake cycles and causing discomfort and stress[15], which further deepens and evidences the need for interventions in this knowledge area.

The advances in Technoscience, associated to assistance and to technological enhancement, are important to improve neonates' survival. On the other hand, they lead to increased vulnerability in terms of the illness (mainly for the neonatal population) because of the possibility of compromising neonates' future development through the unfavorable stimuli present in the environment and in the care practices adopted in the units. As for hearing impairments, although this

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relationship has not been established in the scientific literature, it is described that noise can cause negative physiological and behavioral changes in newborns, especially in more premature ones and with possible sequelae[16]. Therefore, it is worth emphasizing the importance of incorporating care targeted at the neurodevelopment of at-risk NBs into the assistance provided, by means of safer practices such as environmental control for noise reduction.

In this sense, it is important to note that the Kangaroo Method, a perinatal care model, highlights the relevance of safe assistance for at-risk newborns and their families, with the following as part of the assistance we provide: "To identify environmental factors that interfere in NB development and to minimize the harmful sensory stimuli, reducing both their own stress and their caregivers'"[16].

In order to revert this reality, it becomes urgent to induce behavioral changes and to apply intervention actions with health professionals, with permanent education as an important strategy to develop a more qualified care practice[11].

Combined with permanent education, other alternatives can contribute to a safe environment and are already being implemented in neonatal units both in the national and international scopes. A study conducted in a neonatal intermediate care unit of a university hospital from São Paulo verified that earplug use was capable of significantly favoring active sleep time, the sleep stage that is especially fundamental for preterm newborns[17]. Such action contributed to more adequate sleep and to neurosensory development, understanding that this sleep stage is fundamental for PTNBs.

Another proposal developed in a teaching hospital from the United States to increase the health team's engagement and commitment towards noise control is the strategy called "Silence Guardian", where workers from different categories are randomly selected at the beginning of the shift to wear a red armband during their shift. These workers have the duty of safeguarding silence in the unit[11].

A more common strategy in our country is the "Nap Time", characterized by a period, generally during part of the afternoon, when lighting is reduced in the unit and the care actions and elective procedures are grouped, with the possibility of being postponed so as to not interfere with newborns' sleep. A study conducted in Rio de Janeiro verified that, although not yet within the recommended limits, the decibel reduction obtained with this strategy could decreasing the sound pressure levels by nearly 28.5%[3].

It is noted that the movement to improve and control SPLs in neonatal units requires a process involving multiple actions, which, when integrated, may effectively contribute to appropriate neurosensory development in newborns.

Study limitations

The following are considered as study limitations: the analysis of measurements obtained from a standardized time interval, pointing in a general way to events that can increase the noise levels, which precludes observing and identifying activities and devices that exerted greater impacts on environmental noise pollution; as well as the fact that the research was conducted in a single neonatal unit, precluding generalization of the results.

In turn, the results found emerge as preliminary data and are of utmost importance for the local reality and to encourage behavioral changes capable of modifying and improving the assistance provided to at-risk newborns and their families.

CONCLUSION

High SPLs were verified in the NICU and during the day shifts, with statistical significance related to the night shift, which presented lower SPLs. It is worth noting that although these nighttime values were lower than the other periods analyzed in this study, they were still higher than recommended. Transport instances, invasive and non-invasive procedures and the professionals' routine did not exert any influence on the SPLs in the neonatal unit researched.

The SPLs recorded are above the recommended values for safe care to NBs and their family members in neonatal environments, with the possibility of exerting a negative impact on infants' neurodevelopment and on their caregivers' health. It is recommended to apply interventions and permanent education for health professionals, in addition to continuously monitoring the noise levels in neonatal units.

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Authors contributions:

Conceptualization, RNP and MEDM; methodology, RNP and MEDM; software, LMS; validation, RNP, MEDM and LMS; formal analysis, RNP and MEDM; investigation, RNP; resources, RNP; data curation, RNP and MEDM; manuscript writing, RNP and MEDM; manuscript review and editing, LRS, EDP and ALDS; visualization, RNP and MEDM; supervision, MEDM; project administration, RNP and MEDM; financial support, not applied. All authors have read and agreed to the published version of the manuscript.