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Estudo comparativo dos níveis de pressão sonora em unidades de terapia intensiva pediátrica

Comparative study of sound pressure levels in pediatric intensive care units

Estudio comparativo de los niveles de presión sonora en unidades de cuidados intensivos pediátricos

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RESUMO

Objetivos: compreender a relação entre os níveis de NPS e o conforto acústico em Unidades de Terapia Intensiva Pediátrica. **Método:** estudo exploratório, quantitativo e comparativo, realizado em duas UTIPs. A coleta de dados envolveu observação direta não participante durante 40 horas em um estudo e 60 horas em outro, utilizando decibelímetros calibrados. **Resultados:** observou-se variações nos NPS ao longo dos turnos, destacando que, embora a rotina matinal envolva procedimentos intensivos, o turno da tarde pode apresentar níveis de ruído ainda mais elevados. A análise indicou que os NPS, independentemente do turno, frequentemente excedem os limites recomendados. O estudo também evidenciou a importância da conscientização sobre os efeitos adversos dos altos NPS na recuperação pediátrica. **Conclusão:** os achados destacam a necessidade de estratégias para minimizar a exposição ao ruído nas UTIPs, implementação de protocolos para o uso de alarmes, escolha de equipamentos mais silenciosos e promoção de ambientes mais calmos.

Descritores: Ruído ambiental; Conforto; Unidade de terapia intensiva pediátrica; Níveis de pressão sonora.

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ABSTRACT

Objectives: to understand the relationship between Noise Pressure Levels (NPL) and acoustic comfort in Pediatric Intensive Care Units (PICU). **Method:** an exploratory, quantitative, and comparative study conducted in two PICUs. Data collection involved non-participatory direct observation for 40 hours in one study and 60 hours in another, using calibrated decibel meters. **Results:** variations in NPL were observed throughout shifts, highlighting that, while the morning routine involves intensive procedures, the afternoon shift may exhibit even higher noise levels. The analysis indicated that NPL, regardless of the shift, often exceeds recommended limits. The study also emphasized the importance of awareness regarding the adverse effects of high NPL on pediatric recovery. **Conclusion:** findings underscore the need for strategies to minimize noise exposure in PICUs, including the implementation of protocols for alarm usage, the selection of quieter equipment, and the promotion of quieter environments.

Descriptors: Environmental noise; Comfort; Pediatric intensive care unit; Noise pressure levels.

RESUMEN

Objetivos: comprender la relación entre los niveles de NPS y el confort acústico en Unidades de Terapia Intensiva Pediátrica (UTIP). **Método:** estudio exploratorio, cuantitativo y comparativo, llevado a cabo en dos UTIPs. La recopilación de datos implicó observación directa no participante durante 40 horas en un estudio y 60 horas en otro, utilizando decibelímetros calibrados. **Resultados:** se observaron variaciones en los NPS a lo largo de los turnos, destacando que, aunque la rutina matutina involucra procedimientos intensivos, el turno de la tarde puede presentar niveles de ruido aún más elevados. El análisis indicó que los NPS, independientemente del turno, a menudo exceden los límites recomendados. El estudio también subrayó la importancia de la concienciación sobre los efectos adversos de los altos NPS en la recuperación pediátrica. **Conclusión:** los hallazgos resaltan la necesidad de estrategias para minimizar la exposición al ruido en las UTIPs, implementar protocolos para el uso de alarmas, elegir equipos más silenciosos y promover ambientes más tranquilos.

Descriptores: Ruido ambiental; Confort; Unidad de cuidados intensivos pediátricos; Niveles de presión sonora.

INTRODUCTION

The Paediatric Intensive Care Unit (PICU) plays a crucial role in the care of critically ill children, providing a highly specialized and intensive environment for the treatment of complex medical conditions. Amid the constant evolution of medical and technological practices, the PICU represents a vital component in the healthcare system, being a space where healthcare professionals dedicate themselves tirelessly to ensuring the stability and recovery of pediatric patients.

The PICU is defined as the sector designed to care for patients aged between 29 days and 14 or 18 incomplete years, this limit being defined according to the institution's routines.[1] These units are intended to treat children's health needs and provide highly complex care, with a team trained in this area.

This highly technological unit has emerged as a crucial space in the journey of children facing complex medical conditions. In this delicate scenario, the consideration of comfort transcends the physical sphere, encompassing emotional and psychological aspects that play a determining role in the recovery process.

From the perspective of physical and environmental comfort, the PICU plays a vital role in children's comfort. Recent studies highlight the importance of adapting the space, taking into account aspects such as lighting, temperature and the layout of equipment. The humanization of the environment, with the introduction of playful and personalized elements, has been associated with a noticeable improvement in children's comfort. [1-2]

With regard to emotional and family comfort, it is accepted that children's emotional dependence on their parents in the PICU is a crucial element. Effective communication strategies, such as implementing flexible visits and including parents in decision-making processes, are highlighted by authors as essential components for promoting emotional comfort.[4]

The nursing team plays a central role in the search for comfort in the PICU. Specialized training and the development of emotional care protocols are crucial. Simple actions, such as affectionate touch and providing clear information, have been shown to have a significant impact on children's well-being. [5]

Despite progress, challenges remain. A multidisciplinary approach, involving not only the nursing team, but also pediatricians, psychologists and physiotherapists, is essential. The

harmonious integration of these professionals aims to create a truly child-centered environment and therefore promote comfort in a comprehensive manner. [6]

The PICU, due to its intensive nature, requires special attention to the comfort of hospitalized children. In this context, the relationship between sound pressure levels, both from electromedical equipment and from the activities of healthcare professionals, plays a significant role in the experience of children in this critical environment.

Studies have shown the direct influence of sound pressure levels emitted by electromedical equipment on the comfort of children in the PICU.[7] Incessant alarms, buzzing and constant noise can cause discomfort and anxiety, negatively impacting emotional well-being and, consequently, the recovery process.

In addition to equipment, the activities of healthcare professionals in the PICU can be an additional source of sound pressure. Conversations between staff, movement of equipment and medical procedures can create a challenging acoustic environment for children. Constant exposure to hospital noise can interfere with sleep patterns, increase stress and impair quality of life during hospitalization.[7]

Given this interconnection between sound pressure and comfort in the PICU, the implementation of noise reduction strategies becomes imperative. Developing protocols for the appropriate use of alarms, choosing quieter equipment and promoting quieter environments are recommended measures.[8] In addition, raising awareness and training healthcare staff on the importance of noise control are crucial to creating a culture of respect for children's acoustic comfort.

Understanding the relationship between sound pressure and comfort in the PICU is a developing area. Future research could focus on identifying acceptable sound pressure limits, as well as developing quieter technologies and clinical practices that minimize noise exposure.

Sound Pressure Levels (SPLs) indirectly influence patient recovery, since acoustic comfort is an important factor during hospitalization, as it contributes to the well-being of patients who remain in intensive care units and are therefore exposed to SPLs, sometimes for prolonged periods of time.

The *United States Environmental Protection Agency* recommends hospital levels of 45dBA for the daytime and 35dBA for the nighttime.[9] The Brazilian Association of Technical Standards

(ABNT) (NBR 10152) agrees by suggesting 35 to 45dBA as acceptable levels for different hospital environments, the former being the desirable level and the latter the acceptable limit. [10]

After carrying out a study in 2020 on the influence of noise on the acoustic comfort of children admitted to pediatric intensive care in a federal public hospital and in 2023 carrying out a similar study in the same sector but in a state hospital, verifying similar results, in which the SPL exceeded the recommended, it was possible to measure the importance of delving deeper into the subject.

By comparing the results, this article aims to contribute to the field of teaching and research in nursing, as well as in the areas of pediatrics and intensive care, and as a way of stimulating the quality of care in pediatric intensive care and patient safety in the face of the articulation between research and care.

To this end, we selected the following as the objectives of this study: to compare the noise level profiles found in PICUs and to compare the SPLs found with the acceptable levels according to national and international noise organizations.

METHOD

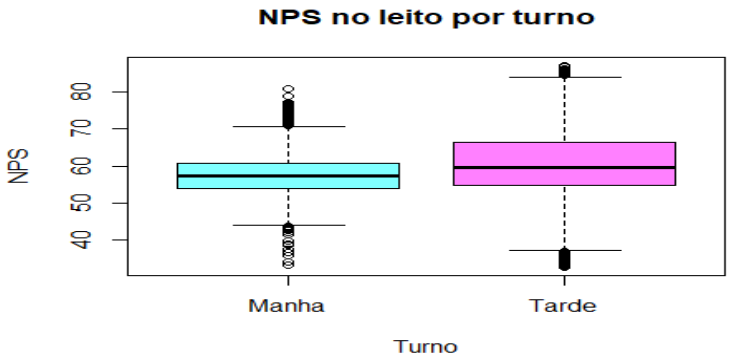
This is an exploratory, quantitative, comparative study carried out in two Pediatric Intensive Care Units (PICUs), one federal and the other state-run in the city of Rio de Janeiro, during the daytime. Both units consisted of 6 beds, separated by "curtains" that allow the privacy of the clients.

The data collection technique was non-participant direct observation for 40 hours in the first study and 60 hours in the second study, using the field diary as a guide for any incidents. Data collection was carried out by the researcher in charge, using two DEC-460 decibel meters, calibrated by XP Service Company and certified as X0691. In both studies, one of the decibel meters was positioned at the nursing station and the other at the bedside, with each bed rotating.

The variables selected for the study were: sound pressure levels, nursing station and patient bed in the PICU. The data was analyzed in three stages: organizing the data collected into a database in the form of a *Microsoft Office Excel 2010* spreadsheet; analyzing the data using the R statistical program and organizing the results into tables.

RESULTS AND DISCUSSION

Graph 1 - Boxplot 2 (NPS X Shift)



Source: survey data. Rio de Janeiro, 2024.

Graph 1 used the variable: Sound Pressure Levels (SPL) and as a Factor, Work Shift (Morning and Afternoon). It can be seen that the afternoon shift had a higher noise level than the morning shift, even though much of the care routine is carried out in the morning.

The median NPS levels are higher in the morning than in the afternoon. This indicates that, in general, NPS levels are higher in the morning. The variability of NPS levels is higher in the morning than in the afternoon. This means that NPS levels can vary more from one day to the next on the morning shift than on the afternoon shift.

There is a discrepant value in the morning shift, which is significantly higher than the other values. This value may be an outlier, which could distort the analysis. The distribution of NPS levels is asymmetrical in both shifts, with the right tail longer than the left tail. This means that there are higher NPS values than low values. The SPL levels in the PICU exceed the limits recommended by the World Health Organization (WHO) for hospital environments, which are 35 dBA during the day and 30 dBA at night.

The peak SPL (82.5 dBA) occurs during the morning shift, which can be explained by the greater number of routine procedures and activities, such as medical visits, examinations and diaper changes, and the presence of a full team, including doctors, nurses, and physiotherapists. NPS levels are lower at night when staffing is reduced and there are fewer activities.

Excessive noise in the PICU can have a number of negative impacts on patients, professionals and the work environment, such as: damage to patients' sleep and rest, hindering

their recovery; increased stress and anxiety in patients and professionals, compromising well-being and quality of care; difficulties in communication between staff and patients, increasing the risk of errors and complications; and the risk of hearing damage in professionals exposed to high levels of noise for long periods.[7-10]

These results demonstrate the need for urgent interventions to reduce noise levels in the PICU and protect patients, professionals, and the work environment. The implementation of noise control measures is essential to ensure a safe, quiet environment that is conducive to patient recovery. It is therefore essential to implement measures to reduce noise in the PICU, such as: isolating the noisiest equipment in specific rooms, using visual alarms instead of audible ones, promoting staff education about the effects of noise and control measures and, if possible, carrying out periodic measurements of SPL levels to monitor the effectiveness of control measures.

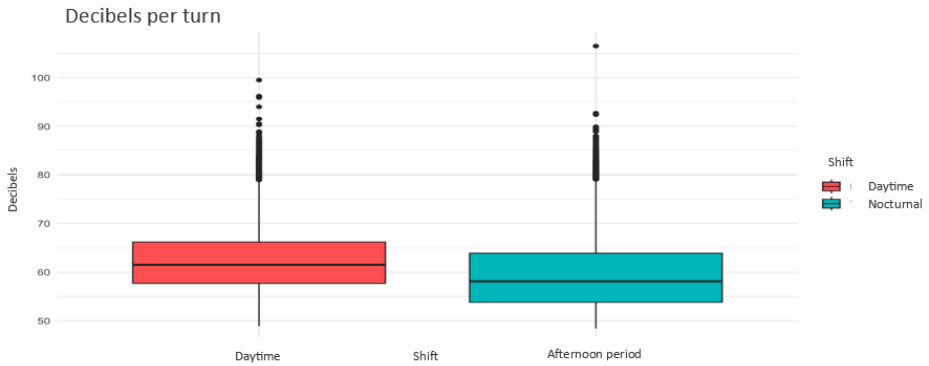
Graph 2 used the Variable: Decibel Levels (dB) and as a Factor, Work Shift (Morning and Afternoon). The average decibel level on the morning shift is approximately 70 dB. The average decibel level on the afternoon shift is approximately 65 dB. The decibel levels are, on average, 5 dB higher on the morning shift than on the afternoon shift.

The distribution of decibel levels in both shifts is asymmetrical, with most values below the average. In the morning shift, there is a higher concentration of values between 60 and 70 dB, while in the afternoon shift, the concentration of values is more dispersed. In the morning shift, there is a discrepant value above 80 dB. The variability of decibel levels is greater on the morning shift than on the afternoon shift. This means that decibel levels can vary more from one day to the next on the morning shift than on the afternoon shift.

Possible explanations for the difference in decibel levels between the shifts could be related to the number of patients in the PICU, which could be higher in the morning, which could increase decibel levels. Procedures performed may be different on the morning and afternoon shifts, which can affect decibel levels. Communication between healthcare professionals can be more intense on the morning shift, which can increase decibel levels.

With a view to mitigating decibel levels, it is recommended to: collect more data to confirm the difference in decibel levels between shifts, investigate the possible causes of the difference in decibel levels between shifts, implement measures to reduce decibel levels in the P-ICU, especially on the morning shift.[4-8]

Graph 2 - Decibels per shift



Source: survey data. Rio de Janeiro, 2024.

In the most recent study, the afternoon was quieter than the morning, contrasting the results found in the previous study.

Table 1 - Measures of dispersion stratified by shift

Shift	Average	Median	Minimum	Maximum	Variance	Standard Deviation
Morning	62,4	61,5	48,9	99,5	39,9	63,2
Afternoon	59,5	58,1	48,4	106,5	48,9	69,9

Source: survey data. Rio de Janeiro, 2024.

Table 1 corresponds to data from the most recent study (2023). In the afternoon there was greater amplitude and variance in the data. However, the morning period has a higher average noise level, which can be explained by the fact that nursing professionals, doctors and *staff are* more active in routine patient care. It shows the dispersion measures (variance and standard deviation) of sound pressure levels (SPL) stratified by work shift (morning and afternoon).

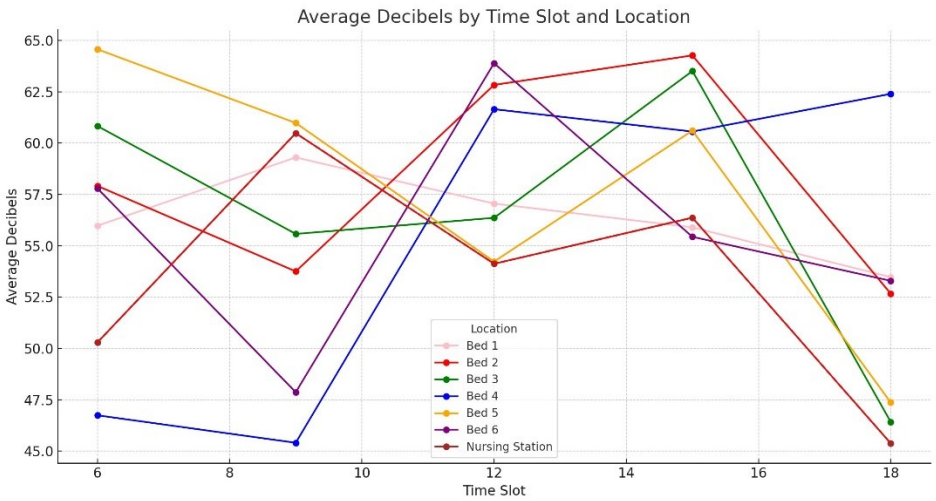
The variance of SPL levels is higher in the morning shift (39.9) than in the afternoon shift (48.9). This indicates that SPL levels are more dispersed on the morning shift, i.e.

there is a greater difference between the measured values. The standard deviation of SPL levels is higher on the morning shift (6.32) than on the afternoon shift (6.99). This measure confirms the greater dispersion of SPL levels on the morning shift. Possible explanations for the greater dispersion of NPS levels on the morning shift: traffic may be heavier on the morning shift, which can increase NPS levels randomly, leading to greater dispersion of the data.

The activities carried out in the workplace can be different in the morning and afternoon shifts, which can affect NPS levels in a non-uniform way, resulting in greater dispersion of the data.

Weather conditions can be different in the morning and afternoon shifts, which can influence SPL levels in a random way, contributing to the greater dispersion of the data. The average SPL levels are higher on the morning shift (62.4) than on the afternoon shift (59.5). This indicates that, in general, SPL levels are higher on the morning shift. The median NPS level is higher on the morning shift (61.5) than on the afternoon shift (58.1). This confirms that, in general, NPS levels are higher on the morning shift.

Graph 3 - Average decibels by time slot and location



Source: survey data. Rio de Janeiro, 2024.

It can also be seen that the average of the time slots is all above the established target of 45 dBA. The minimum values for both beds and shifts were also above this target. Another highlight in the analysis of the data from Graph 3 is that the afternoon on all collection days showed slightly lower decibels than the morning.

Some international and national bodies recommend hospital levels of 45dBA for the daytime and 35dBA for the night. [7-10] Studies have described the harmful effects of high SPLs on children admitted to PICUs and NICUs. These include: hypoxia, increased release of adrenocorticotrophic hormone and adrenaline, increased heart rate, systemic vasoconstriction, pupil dilation, increased arterial and intracranial pressure, increased oxygen consumption and calorie expenditure, which in the long term can lead to delayed weight gain.[11-13]

The data contradicted the researchers' expectation that the morning shift would generate higher sound pressure levels than the afternoon, since most of the routine procedures such as bathing, changing diapers, changing infusions, physical examinations and medical visits take place during this period.

Recent studies have shown that in NICUs and PICUs, the main sources of noise are staff conversations inside the unit, especially during shift changes, as well as electromedical equipment such as alarms from monitors, respirators, incubators and infusion pumps; opening and closing doors, drawers, cupboards and garbage cans, moving furniture and equipment, mobile phones, noisy shoes, some of which are difficult to mitigate.[13-16]

Regarding the noise produced by hospital staff, the large number of employees within the unit contributes to the increase in noise, the sounds of personal cell phones, the social interactions of staff such as conversations, laughing, talking loudly and even asking a colleague for help, as reported in different studies, may be some of the factors that influenced the generation of high SPL, especially in the nursing station. [17-19]

The 2023 study, corroborated by the findings of other similar studies on the same subject, showed that decibels, regardless of the shift, exceed the limits recommended nationally and internationally.[15-18]

The data obtained from the study carried out in 2020 shows that the decibel values found far exceeded the maximum limit recommended by the national and international bodies mentioned above, reaching 87dBA. Unfortunately, in the 2023 study, this pattern was repeated with a peak of 106.5dBA.

CONCLUSIONS

It is believed that more studies should be carried out on the subject as a way of encouraging hospital Continuing Education to give lectures demonstrating the harmful effects of decibels exceeding the recommended level and helping to raise awareness among professionals.

There is a strong need to improve noise level management within hospital units. It is hoped that the knowledge gained in this comparative study will stimulate the management of paediatric intensive care units, in particular, to create strategies that minimize the generation of excess sound pressure levels, in order to improve the quality of care provided and as an attempt to break this pattern of maintaining ineffective acoustic comfort for hospitalized patients.

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