

MEASUREMENT OF ACOUSTIC NOISE LEVELS IN A NEONATAL INTENSIVE CARE UNIT QUANTIFICAÇÃO DOS RUÍDOS SONOROS EM UMA UNIDADE DE TERAPIA INTENSIVA NEONATAL CUANTIFICACIÓN DE NIVELES SONOROS EN UNA UNIDAD DE CUIDADOS INTENSIVOS NEONATALES

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ABSTRACT

The Neonatal Intensive Care Unit (NICU) is an environment filled with people and equipment with acoustic alarms. Measurement of acoustic noise levels in the NICU is important to raise awareness of the harmful effects of noise on neonates and NICU workers. The aim of this study was to measure acoustic noise levels in NICUs. This is a descriptive, cross-sectional, quantitative study. Noise levels were measured in NICUs with a precision sound-level meter. The mean minimum decibel level (Lmin) was 48.5 dBA, and the mean maximum decibel level (Lmax) was 90.9 dBA. These values are higher than recommended by the ABNT and the WHO. This indicates a need for urgent and systematic measures to control and reduce sound levels in the NICU. Some of these measures include implementing awareness-raising educational initiatives, developing new training approaches for the multidisciplinary team, and having policies to purchase less-noisy equipment.

Keywords: Infant, Newborn; Noise; Intensive care Units, Neonatal; Maternal and Child Health; Noise Control.

RESUMO

A Unidade de Terapia Intensiva Neonatal (UTIN) é um ambiente cercado de pessoas e equipamentos com alarmes acústicos, sendo necessária a verificação do nível de ruídos e que os profissionais envolvidos tenham consciência dos efeitos nocivos que estes possam trazer para a equipe e os recém-nascidos. O objetivo deste estudo foi quantificar os ruídos sonoros existentes em uma UTIN. Trata-se de estudo descritivo, transversal, com abordagem quantitativa. Para a coleta de dados foi aferido o nível de pressão sonora no ambiente por meio de um sonômetro. Observou-se que o valor médio dos decibéis encontrados foram Lmin = 48,5 dBA e Lmax = 90,9 dBA. Esses valores foram superiores ao recomendado pela ABNT e pela OMS, demonstrando necessidade de medidas urgentes e sistemáticas para o controle e redução do nível de pressão sonora na UTIN. O desenvolvimento de programas educativos de sensibilização, novas estratégias de capacitação da equipe multiprofissional e adoção de equipamentos que produzam menos ruídos são algumas medidas que possibilitarão a diminuição do nível de pressão sonora dentro dessa unidade.

Palavras-chave: Recém-Nascido; Ruído; Unidades de Terapia Intensiva Neonatal; Saúde Materno-Infantil; Controle de Ruídos.

RESUMEN

La Unidad de Cuidados Intensivos Neonatales (UCIN) es un ambiente donde, aparte de personas, hay equipamiento con alarmas acústicas y por ello debe medirse el nivel de ruido existente. Es importante que los profesionales sean conscientes de los efectos nocivos al personal y a los recién nacidos. El objetivo de este estudio fue cuantificar los ruidos sonoros en una UCIN. Se trata de un estudio descriptivo transversal cuantitativo. Para la recogida de datos se midió el nivel de presión sonora en el ambiente a través de un sonómetro. Se observó que el valor promedio de decibeles encontrados fue Lmin = 48,5 dBA y Lmax = y 90,9 dBA. Estos valores fueron superiores a lo recomendado por la ABNT y la OMS, lo cual demuestra la necesidad de tomar medidas urgentes y sistemáticas para controlar y reducir el nivel de presión sonora en la UCIN. El desarrollo de programas educativos para crear conciencia, nuevas estrategias de capacitación de equipos multidisciplinarios y la adopción de equipamiento que genere menos ruido son algunas de las medidas necesarias para la reducción de los niveles sonoros en esa unidad.

Palabras clave: Recién nacido; Ruido; Unidades de Cuidado Intensivo Neonatal; Salud Materno-Infantil; Control del Ruido.

INTRODUCTION

Highly specialized treatments, upon which newborns (NB) depend to survive, pose multiple challenges for infants, their parents and healthcare professionals,^{1,2} because during their hospitalization in a Neonatal Intensive Care Unit (NICU) NBs are placed in an inhospitable environment, where they are intensely exposed to noxious stimuli such as stress and pain.³

Ambient acoustic noise in NICUs is seen as a major problem because of the damage that it may cause to newborns - who are physiological frail and have to live with it during hospitalization.^{2,4} The psychological effects related to high noise levels may lead to behavioral disorders and physiological responses to stress.⁵

The concern about noise levels in incubators dates back to the 70s. In Brazil, the first studies on noise in neonatal settings, and especially in incubators, date back to the 90's. At that time in Brazil, there was no specific legislation on the level of noise in incubators. Nowadays there is only the standard of the American Academy of Pediatrics, which considers 58 dBA (A-weighted decibels) as the permitted level of noise exposure for newborns and states that a noise level of 45 dBA should not be exceeded in NICUs.^{6,7}

The Brazilian Association of Technical Standards (ABNT) does not specify levels of noise exposure in NICUs. The Brazilian standard NBR-10152 provides recommendations on the maximum acceptable decibel levels for acoustic comfort in hospitals (rooms, wards and nurseries). Up to 35 dBA is considered to be excellent and up to 45 dBA is considered to be the acceptable limit.^{8,9}

Given that the Neonatal Intensive Care Unit (NICU) is an environment filled with people, and equipments with acoustic alarms, the measurement of acoustic noise levels in NICUs should be a constant concern of the health care team, in order to improve the quality of neonatal care and the work environment. Health care professionals should be alert to changes in the patient's clinical status.¹⁰

The topic of this study was chosen because of the personal interest of the researchers in learning more about it, and due to the importance of raising awareness of this issue among health care providers. Thus, the following question arose: are the noises produced in the neonatal intensive care unit within the acceptable noise levels? In order to answer this question, this study measured the acoustic noise levels in a Neonatal Intensive Care Unit.

METHODS

This is an observational, descriptive, quantitative study. NICU noise levels were measured on October 29th and 30th, 2012. This study was conducted in a Neonatal Intensive Care Unit of a hospital in the north of Minas Gerais (MG), Brazil.

The Neonatal Intensive Care Unit of the hospital is located on the third floor, in front of the operating ward and one floor above the obstetric and maternity wards. The unit has two rooms and 12 beds: 10 neonatal beds, and 2 pediatric and/or isolation beds. The main hall and the support rooms have an area of 580.30 m², while the NICU rooms have a total area of 130.65 m².

The equivalent continuous sound levels (Leq) were measured using a precision sound-level meter (01dB SOLO Black Edition®) and the dBTRAIT32 software, version 5.1, 2003. The sound-level meter was properly calibrated and the measurements were made according to the IEC 60651 and the current Brazilian calibration standards.

The device was placed on a tripod, at approximately one meter from the ground, near the nurses' station, which is located in the middle of the intensive care unit, so that all measurements were made from a minimum distance of one meter from any surface of the room (such as walls, furniture, the ceiling or the floor).

Simultaneously with the measurement of Leq, an observer (the researcher or research assistant) manually recorded all occurrences every minute on a Microsoft Excel worksheet. The measurement and the Excel spreadsheet data were recorded every 150 minutes in the database of the dbTrait Software.

All sound pressure readings were made with the dBTrait32 software. Although the readings of the sound-level meter were constant, the application of weights to the measurement (resulting Leq) only occurred later, during data processing in the dBTrait32 application.

All measurement data arranged in graphs and tables, and compared with the events that had occurred on that day and time (according to the Excel spreadsheet).

Data collection was carried out after the study project had been examined and approved by the institution and by the Research Ethics Committee of the University of Montes Claros (UNIMONTES), opinion 85744.

RESULTS

The sound-level meter was able to measure both ambient and external noises. Ambient noises included: voices, dragging of chairs and tables, incubator alarm buzzers, water dripping from a faucet, babies crying, etc. No significant external noise was identified.

We found that the sink drain was loud when draining and this noise had to be minimized. We believe that the presence of the researcher and/or research assistant, as well as the sound-level meter interfered with the behavior of the professionals who worked in the neonatal unit. They kept their voices lower than usual and acted very fast in turning off the alarms of the incubators, monitors or infusion pumps.

As shown in Table 1, on October 29th, during the day, the overall sound pressure levels in the NICU ranged between 48.5 dBA (Lmin) and 77.9 dBA (Lmax). During the night, the levels ranged between 51.3 dBA (Lmin) and 73.2 dBA (Lmax). On 30 October, the Lmin was 48.5 dBA and the Lmax 90.9 dBA during the day, and 48.5 dBA (Lmin) and 79.7 dBA (Lmax) at night.

Table 1 - Expressive Leq values measured in the NICU. Montes Claros, MG, Brazil, 2012

	Day	Night
2012/10/29	Leq = 56.47 dBA	Leq = 59.34 dBA
	Lmin = 48.5 dBA	Lmin = 51.3 dBA
	Lmax = 77.9 dBA	Lmax = 73.2 dBA
2012/10/30	Leq = 59.98 dBA	Leq = 53.19 dBA
	Lmin = 48.5 dBA	Lmin = 48.5 dBA
	Lmax = 90.9 dBA	Lmax = 79.7 dBA

Source: Data collected by the first author.

Figures 1, 2 and 3 illustrate the sound pressure levels measured (in dBA) in the NICU on October 29th and 30th, 2012. The blue line represents the readings of the device, while the red line indicates the acceptable noise limit.

The minimum noise level was 48.1 dBA and was associated with the following events: conversations, sink noises and trash noises. The Lmax was 63.7 dBA (Figure 1) and corresponded to the cry of a baby and people talking softly.

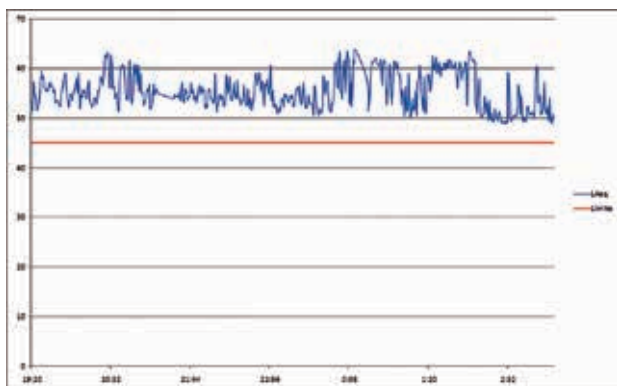


Figure 1 - Noise levels at night (2012/10/29), Montes Claros, Minas Gerais – Brazil, 2012. Source: Data collected by the author.

Figure 2 indicates that the minimum noise level during the morning was 54.1 dBA. It was associated with the following events: footsteps, conversations, handling of plastic packages. The Lmax during the morning was 66.9 dBA (left hand-side of Figure 2) and corresponded to conversations.

In the afternoon, the minimum noise level was 51.6 dBA and was associated with the following events: laughter, foot-

steps and conversations. The Lmax during the afternoon was 74.5 dBA (right-hand side of Figure 2) and corresponded to the cry of a newborn, handling of the trash container, opening of doors and faucets, cleaning of the floor, handling of the cleaning bucket, heart monitor noises, paper being crumpled, putting on and removing of gloves, and using masking tape.



Figure 2 - Noise levels during the day - morning levels are shown on the right-hand side and afternoon levels are shown on the left-hand side – (2012/10/30). Montes Claros, MG – Brazil, 2012. Source: Data collected by the author.

When comparing the values measured during the night shift of October 29th and the day shift of October 30th, we found that there was little variation between the mean levels measured (55 and 59 dBA, respectively).

The noise levels measured during the course of the day were well above the recommended level, and more than 50% above the acceptable level of acoustic comfort (35 dBA).

Figure 3 shows that the maximum Leq measured was 64.7 dBA – corresponding to the constant noise of the respirator, the opening and/or closing of trash lids, the alarm of an incubator, and the continuous infusion pump. The minimum Leq measured was 49.4 dBA and corresponded to the noise of the respirator.

DISCUSSION

In the hospital setting the number and sophistication of resources needed for quality care generate high levels of noise pollution, creating a disturbing environment and contributing to the development of pathophysiological changes both in patients and health care providers.¹¹ An environment that may seem relatively quiet to adults can represent an enormous aggression to premature newborns.

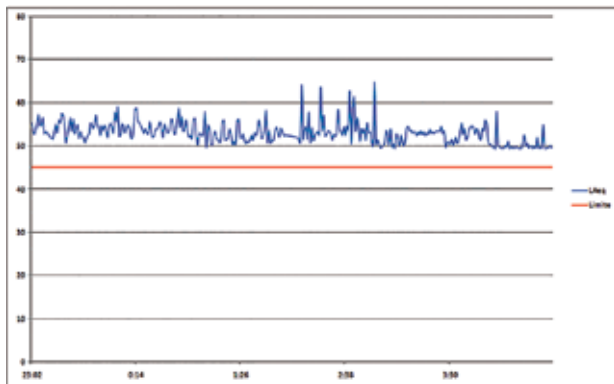


Figure 3 - Noise levels at night (2012/10/30). Montes Claros, MG, Brazil, 2012. Source: Data collected by the author.

Minimizing risks to newborns involves the use of interventions to reduce sound levels. Key steps in planning and targeting these interventions are the identification of noise sources and the assessment of their contributions to the sound levels inside the NICU. In order to assess the contribution of each noise source, it is necessary not only to identify each event they are connected with, but also to link these events with their respective sound levels.¹

Despite the current standards and the existence of conclusive evidence of the harmful effects of noise, studies have recorded sound levels that are higher than acceptable limits both in NICUs and in incubators.^{1,4} This is partly due to negligence on the part of workers and partly due to a lack of knowledge.

In recent years, technological advances have become important factors for the provision of better care to critical patients. However, the increased number of devices with acoustic alarms added to the noise generated by conversations between health care providers end up transforming the ICU into a stressful and noisy environment.¹¹⁻¹³

The acceptable values recommended by both international and national standards are often exceeded, as shown in Table 1. Although the values measured in this study were close to the acceptable limit (45 dBA), they at no time reached what is considered the comfort level (35 dBA) by the ABNT.

The harmfulness of noise is related to the frequency of noise, the time of acoustic rest, the intensity of sound pressure, the actual years of exposure, and the individual's susceptibility.¹⁴ Susceptibility to hearing damage from exposure to noise may be influenced by disease, age, hereditary factors and exposure to other agents, such as drugs.¹⁵ Age is a key variable in the magnitude of the damage caused by noise. Newborns' tolerance to auditory and non-auditory effects of noise may be lower than that of adults.¹⁶ In addition, preterm newborns are more susceptible to environmental effects than full-term newborns. The lower the gestational age at birth, the greater the impairment, because brain development is not yet complete and the risk of abnormal brain maturation is increased.¹⁷

The noise levels measured during the course of the day were well above the recommended level, and more than 50% above the acceptable level of acoustic comfort (35 dBA), which is worrying. A mean value of 35 dB causes vegetative reactions and changes in the electroencephalogram. It results in changes in sleep pattern, an important factor not only for physical, mood, and intellectual capacity recovery, but also for brain growth and organ maturation.¹⁷

The literature states that noise levels between 55 and 65 dB may lead to nervous excitement and stress, making patients more sensitive to pain. This in turn leads to an increase in the amount and time of use of medications required by the patient. The World Health Organization (WHO) recommends sound levels of up to 40 dBA in NICUs during the day and a reduction of 5-10 dBA during the night.¹⁸

In this study, as in previous studies,^{12,19} the sound levels measured during the day and the night exceeded the recommended limits.

The results of this study show that the sound levels measured at no time were within the acceptable limits recommended by national⁸ and/or international standards.¹⁸

The lack of knowledge about the recommended sound levels as well as the lack of systematic measurements of noise level in the NICU make it difficult to assess the success of their efforts and do not foster the maintenance of proactive behaviors for ensuring an acoustically comfortable and safe environment for newborns, their families and health care providers.²⁰

All health professionals should be involved in improving the quality of neonatal care. The measurement of acoustic noise levels in NICUs should be a constant concern of the health care team, in order to improve the quality of neonatal care, as well as their work environment, which is filled with people and noisy equipment.

The performance of health care providers may also be adversely affected by the prolonged exposure to high sound levels. This exposure may cause them to make mistakes and thus compromise patients' safety, since professionals who work in Neonatal Intensive Care Units are expected to make quick decisions and provide intensive care to newborns in critical conditions.²⁰

Architectural adjustments should be made in the ICU, with the use of noise-absorbing walls, ceilings and floors, divisions between beds in larger units, and installation of rubber seals on doors and windows. Moreover, it is important to assess the noise levels of equipments prior to their purchase and implement a continuing education program for NICU professionals.⁵

Noise reduction programs require the cooperation of the ancillary staff, including the housekeeping staff, laboratory technicians and X-ray technicians. It is important that hospital administrators implement continuous education programs to achieve a cultural change at the worksites.^{5,21}

While recognizing that the nursing staff occupies a key position in the context of a neonatal intensive care, it is important to note that the implementation of strategies to minimize sound levels requires the joint effort of the entire multidisciplinary team, including managers.²² A hospital might build a whole new NICU or renovate an existing one completely and still not yield measurable improvements in sound levels if the culture of noise remains unchanged.²³

CONCLUSION

The values measured in this study are higher than the levels recommended by the ABNT and the WHO. This indicates the need for urgent and systematic measures to control and reduce the levels of sound pressure in the NICU. The NICU was found to be a noisy environment. The vocal intensity measured in this setting can be explained by the natural tendency to increase one's vocal effort while speaking in the presence of noise, in order not only to be audible to the other party but also to listen to oneself and achieve speech intelligibility (Lombard effect).

Some of these measures include implementing awareness-raising educational initiatives and developing new training approaches for the multidisciplinary team. However, behavioral change alone is not enough. It should be accompanied by a frequent monitoring of noise levels, changes in the physical structure of the building, purchase of quieter equipment, and the implementation of a noise prevention program.

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