Noise Levels in the Neonatal Intensive Care Unit: Literature Review

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The purpose of this paper is to perform a quantitative literature review. Quantitative research is rooted in philosophical assumptions of positivism and determinism (Houser, 2020). Positivism assumes that features of the environment have an objective reality, and determinism is the belief that events are not random but have preexisting causes (Houser, 2020). A literature review provides an in-depth analysis of what is known and missing related to a specific topic (Houser, 2020). This quantitative literature review will focus on elevated noise levels in neonatal intensive care units (NICUs), what causes the high noise level, and what detriments increased sound levels can have on premature infants. Medical improvements have enabled infants to survive as early as twenty-two weeks of gestational age (Mayhew et al., 2022). When infants are born this early, they have an immature central nervous system, and excessive noise levels can result in problems with infants' sleep patterns, growth, and neurodevelopment (Mayhew et al., 2022).

Elevated Sound Levels in the Neonatal Intensive Care Unit: What is Causing the Problem?

The article by Mayhew et al. (2022) states that noise in the NICU can negatively impact the multiple body systems of the preterm infant. Some body systems that noise impacts include the cardiovascular, respiratory, and auditory systems (Mayhew et al., 2022). When preterm infants experience sudden and loud noises, they can exhibit changes in heart rate, apnea, hypertension, as well as disruption in their sleep patterns (Mayhew et al., 2022). According to the American Academy of Pediatrics (AAP), the recommended sound level in the NICU is 45 decibels (dB). The sounds in the NICU reach as high as 160 dB consistently (Mayhew et al., 2022). This article aims to identify the average noise levels in a level III NICU and the environmental factors

contributing to the elevated noise levels (Mayhew et al., 2022). The study found that throughout the morning, evening, and night shifts, the noise levels were consistently above the recommended 45 dB (Mayhew et al., 2022). The environmental factors noted to increase noise levels in the NICU included health care professionals (HCPs) talking too loudly at the bedside, the number of people in the room, the number of neonates in the room, the number of alarms, infant acuity, and shift type (Mayhew et al., 2022).

Key Points

This study was a descriptive, quantitative research design that utilized observational and sound-level measurements. The study received research ethics approval from the Ottawa Hospital Research Institute, Institutional Approval for the Ottawa Health Science Network Research Ethics Board, and the University of Ottawa Office of Research Ethics and Integrity. The study occurred at a level III NICU in a perinatal center in Ottawa, Canada. The researcher conducted sound measurements over a total of twenty-one shifts, including seven-day shifts (0600-1400), seven evening shifts (1400-2300), and seven-night shifts (2300-0600). However, the first two day-shift data were unusable due to malfunctions with the technology. The device used to measure the sound levels were the Casella model CEL 242-K, and the calibrator used was the Casella CEL-120. These devices were placed in the exact location each time and measured sound continuously. The sampling method used in this study was convenience sampling, where the sound was collected based on proximity to the most acutely ill neonates. Observational data was recorded hourly and documented on a data collected sheet designed by the researcher of this study Kelli Mayhew. The average sound level over all three shifts was 58.3 dB for the day shift, 53.6 dB for the evening shift, and 54.4 dB for the night shift. The

observational data showed that multiple people, including infants, HCPs, and visitors, were in the room during each shift which increased the noise level. The untimeliness of silencing alarms, the humming of the blanket and milk warmers, and the noise made by portable x-ray machines all contributed to increased sound levels in the NICU. A simultaneous multiple linear regression analysis helped to determine the significance of elevated sound levels with the environmental factors recorded. The high noise level was statistically significant and positively correlated with the number of people in the room; the p-value was less than 0.001. There was a significant pattern of the average day shift noise compared with the night shift; the p-value was 0.001. There was also a statistical significance between the shift types with a p-value less than 0.05.

Assumptions

In the article by Mayhew et al. (2022), she suggested that a way to reduce noise levels in the NICU would be to get away from open bay NICUs and instead redesign NICUs to include single patient rooms (Mayhew et al., 2022). While this may reduce the noise levels in the NICU, not all hospitals have the funding to redesign the unit altogether. Another assumption from this research is that all levels of NICUs will have the same noise level. A level III NICU center will likely have much more noise than a level I NICU. More research is required to compare the noise levels in each type of NICU ranging from level I to level IV. Another assumption the researcher has is that HCPs want to learn and implement strategies to decrease noise levels to help precipitate positive outcomes for neonates. Although hopefully, all HCPs do care for their patients and their outcomes.

Deficit/Conclusion

Although the researcher makes a few assumptions, this student agrees that hospitals should prioritize strategies to decrease the noise level in the NICU. This research article helped prove that the noise level in this environment is above the recommendations set by the AAP 90% of the time (Mayhew et al., 2022). On average, they were fourteen times louder than that recommendation (Mayhew et al., 2022). There is a clear need for change in this setting. Some changes that this student agrees with include ongoing education for the staff and visitors about the importance of creating a quiet environment, silencing alarms as quickly as possible, and changing staffing ratios (Mayhew et al., 2022). The researcher has concluded that hospitals should have new and updated technology that allows the staff to visualize the dB value. Seeing a change in the noise level will enable HCPs to see an immediate change based on their behaviors. Having immediate feedback may help with positive reinforcement and drive the staff to continue to educate their colleagues and visitors on the importance of creating and maintaining a quiet environment for the neonates admitted to the unit (Mayhew et al., 2022). The most crucial goal in the NICU is to give the patients everything they need to have a positive outcome. If maintaining a quiet environment will help these neonates grow and develop, implementing strategies to meet this outcome should be a priority**.**

Level and Noise Sources in the Neonatal Intensive Care Unit of a Reference Hospital

According to an article by Hernández-Salazar et al. (2020), 15 million preterm neonates are born yearly. In most cases, premature neonates require prolonged periods in the NICU (Hernández-Salazar et al., 2020). Hospitalization in the NICU is due to problems with feeding, temperature regulation, or respiratory and infectious problems (Hernández-Salazar et al., 2020).

This prolonged stay in the NICU exposes these premature neonates to harmful stimuli for their hearing development, primarily due to noise levels greater than 45 decibels (Hernández-Salazar et al., 2020). Hearing deficits in neonates is between 0.1% and 0.6%. In infants discharged from the NICU, hearing deficits increase to 2-4% and can have a prevalence of up to 10% (Hernández-Salazar et al., 2020). Exposure to high noise levels can produce physiologic disorders such as bradycardia, apneic episodes, and diminished calories available to help aid growth (Hernández-Salazar et al., 2020). Premature NICU patients also experience stress from the high-intensity noise from alarms and staff (Hernández-Salazar et al., 2020). This study aims to identify the factors that generate noise in the NICU and find ways to create a favorable environment for these neonates to develop. Some elements identified to increase noise levels in the NICU included conversations among staff, change of shift reports, alarms, objects falling to the floor, and the ward's telephone. This study suggested implementing quiet time in the NICU to help reduce noise levels and facilitate better growth and development for neonates in the NICU.

Key Points

This study was a cross-sectional analytical, quantitative study conducted in the NICU of a hospital in San Luis Potosí, Mexico. The sampling method used in this study was non-probability purposeful sampling for premature patients. This study placed sound measuring equipment in five different zones of the NICU. The first zone is at the entrance of the NICU. The second zone is near the first nurse's station. The third zone is away from the door, the fourth zone is near the second nurse's station, and the final zone is in a side area near the entrance. The researchers collected data on a Monday, Friday, and Sunday in three different shifts. Data collection took place during the morning shift (0700-1100), the evening shift (1400-1800), and the night shift (2100-0100).

Two nursing professionals at the reference hospital collected the data in the NICU. The data collection gathered 16,200 environmental noise registries in the NICU's five critical locations. The instruments used for data collection included a data registry spreadsheet, a checklist from noise-generating sources, and a decibel meter (STEREN 400). This protocol was submitted and approved by the Ethics and Research Committee of the reference hospital. The mean sound levels for zones I, II, III, IV, and V are 62.7 dB, 64.1 dB, 64.7 dB, 63.6 dB, and 61.9 dB, respectively. Each value had statistical significance; the p-values for all the data were less than 0.05. These sound measurements from each location within the NICU for nine shifts are all greater than the AAP's recommended sound levels. The highest noise level recorded during data collection was in the mornings, with values from all three-morning shifts as follows: 64.6 dB, 63.4 dB, and 63.8 dB. All data measurements are statistically significant, with a p-value less than 0.001. In general, of all shifts and days observed, the noise level varied from 60 dB to nearly 100 dB of environmental noise in the NICU. According to this study, factors that increased noise levels in the NICU included alarms from mechanical ventilation, alarms from the cradle, alarms from the infusion pump, the ward telephone, infants crying, objects falling to the floor, and conversation by staff. The p-value from all these factors was less than 0.05.

Assumptions

One assumption the authors made in this article is that data collected from a total of nine shifts is enough data to support the conclusion that the noise levels in the reference hospital are consistently higher than the recommendation from the AAP. Data should be collected over several weeks to say that the hospital in this study has noise levels almost triple the recommended 45 dB put in place by the AAP. Another assumption the authors made was that

moving the preterm neonates to areas of less transit would be favorable because these areas would have decreased noise levels. Moving preterm infants to a place of less transit is an interesting idea. However, a study that compares the noise levels in areas of more and less transit is needed, and preterm infants must be present in both areas to see if there is a positive correlation. In this study, the area with the lowest noise was the area with less transit. However, preterm neonates most often require more medical intervention than full-term neonates; moving them to a different location may not decrease noise because they will still need more medical professionals and equipment.

Deficit/Conclusion

Although the researchers have made a couple of assumptions, this student agrees with the conclusion that increased noise levels in the NICU are harmful to preterm neonates, and interventions must be put in place to help reduce the amount and intensity of noise in this setting. Some of the events that this study highlighted that increased noise levels in the NICU include alarms of various types, moving furniture, objects falling, and noise from dragging things on the floor. All these events are avoidable by educating the staff and families that the NICU has developing infants and that noise reduction significantly impacts the neonates' health. One of the proposed interventions in this study was to implement quiet hours. Hospitals that have already implemented quiet hours have seen significant drops in noise levels. Reduced noise levels help to increase sleep duration in premature infants, and sleep is fundament to neonatal neurodevelopment. However, the reduction in noise level is temporary and only occurs during that hour of quiet time. A quiet hour would be a cheap and easy intervention to add to NICUs worldwide. Even incorporating them three to four times a day could positively impact premature

infants in the NICU. There is a need for policy change in the NICU. Implementing policy, education, and training to the staff on the importance of noise reduction is imperative to help the neonates in the NICU grow and develop without the complications associated with increased noise levels.

Noise Level and its Sources in Neonatal Intensive Care Units of Selected Public Hospitals in Kigali City

The recommendations set by the World Health Organization (WHO) and the AAP for the acoustic environment in the NICU is 45 dB. Previous studies have shown that the average noise levels range from 48-55 dB and reach as high as 84 dB daily. Sources of noise in the NICU include noise from incubators, mechanical ventilators, alarms, and infusion pumps. In Western Europe, the loss of 45,000 Disability Adjusted Life Years (DALYs) is due to noise-induced cognitive impairments of children. There are 15 million preterm neonates born each year, and high noise levels in the NICU subject them to auditory, visual, and learning difficulties. Frequent exposure to increased noise levels places preterm neonates at risk of developing sensory neural deficits and developmental delays. Medical improvements and new technologies also threaten these neonates because they further increase the noise levels in the NICU. This study aims to bring further awareness of the issue and identify and measure the noise levels in the NICU. The goal is to protect neonates from a harmful environment and initiate further research to find ways to decrease sound levels to be implemented in hospitals worldwide.

Key Points

This study was a quantitative cross-sectional descriptive research design conducted in the NICUs of four selected hospitals in Kigali City, Rwanda. The sound level monitoring occurred in this study to determine the noise levels in six different locations of the NICUs at five separate times. The researchers used an observational checklist to identify possible sources of noise. The study occurred from March 18th to April 7th, 2019. The researchers used simple random sampling to select hospitals for this study. Data were collected during five shifts in one-hour intervals each day of the week. The shift times for data collection are as follows: morning (0700-0800), ward rounds (this varied from hospital to hospital), lunchtime (1200-1300), shift change (1700-1800 and 1900-2000) and midnight (0000-0100). The total amount of samples taken from all the hospitals totaled 840 records. The sound meter device used in this study was the Velleman DEM 200, which measures sounds between 30 and 130 dB. The sound levels from each location were computed and then averaged to determine the noise level in the NICU during each time of day. The researchers used a data capture sheet to document the sound levels and an observational checklist to identify the noise sources. The researchers of this study received approval from the Institutional Review Board of the University of Rwanda College of Medicine and Health Sciences. The data collected in the study were analyzed using descriptive statistics and analysis of variance. The average sound level at all four hospitals for the morning shift was 64.8 dB. The average noise level during ward rounds was 65.2 dB. The average noise level during lunchtime was 63.5 dB. The average noise level during a shift change was 64.5 dB. Finally, the average noise level during the midnight shift was 64.7 dB. The study's results showed statistically significant differences between noise levels during the different shifts of the day ($p < 0.001$). There was also a considerable increase in noise levels during shift change ($p = 0.003$). The noise

levels during the night shift and ward rounds were also significantly significant, with a p-value of 0.001 for both shift times. This study found that the highest contributors to increased noise levels were conversations between HCPs, alarm monitors, and equipment dropping.

Assumptions

One assumption the authors made is that modifications to the sound level of conversations in the NICU can be modified; this is a fair assumption. However, everyone in the NICU setting must be on board for this to effectively decrease noise levels in the NICU. Providers, nurses, health care technicians, and family members must want to decrease the volume at which they speak and decrease the number of nonessential conversations within the NICU setting. Another assumption made is that during data collection, the NICU staff was acting as they usually do daily. Because there was a research study in progress, the NICU staff may have changed their behavior to make their facility appear better. Therefore, the data collected may only partially indicate the noise levels in the NICU. Regardless, the levels collected within the study were still higher than the recommendations the WHO and the AAP made. The authors' final assumption is advocating for a noise-free environment in the NICU. Eliminating noise in the NICU is not a realistic goal. A noise-free environment is not the best practice because any unintentional noise, such as dropping equipment, would be even more intense in sound volume, causing adverse effects on the neonate. These neonates need extensive medical care and multiple HCPs a more realistic goal would be to reduce noise levels to the recommendation set by the AAP.

Deficit/Conclusion

This student agrees with the conclusion the authors made. The authors concluded that current noise levels in the NICU are unsafe and negatively impact the care of the neonates within the NICU (Dusabe et al., 2020). The authors inferred that some sources of increased noise in the NICU could be modified to reduce sound levels in the NICU (Dusabe et al., 2020). One proposed idea was reducing noise from conversations between HCPs and family members (Dusabe et al., 2020). This student believes this intervention could work if the staff receives adequate education and training. The staff would then be responsible for adequately educating the family members about remaining quiet in the NICU. The authors proposed that medical equipment modifications could help reduce noise and increase the safety of neonates (Dusabe et al., 2020). Medical equipment modifications can help reduce the constant noise level in the NICU caused by the humming of incubators, blanket warmers, and bottle warmers. This study proved that change is required in the NICU setting to help neonates grow and develop while eliminating the increase of adverse effects caused by increased noise.

Conclusion

According to the research conducted by all three articles, current noise levels in NICUs worldwide are too loud and exceed the AAP's current recommendations (Dusabe et al., 2020; Hernández-Salazar et al., 2020; Mayhew et al., 2022). All three articles discussed the adverse effects of excessive noise levels on preterm neonates. These adverse effects include heart rate changes, apnea, elevated blood pressure, hearing deficits, increased oxygen consumption, sleep disorders, increased environmental stress, and increased intracranial pressure (Dusabe et al., 2020; Hernández-Salazar et al., 2020; Mayhew et al., 2022). Therefore, implementing strategies

to help reduce the noise volume in the NICU is imperative. A NICU free of excessive noise decreases the need for supplemental oxygen, reduces time on respiratory support, and decreases the length of hospital stays. Each article identified different ways to help reduce noise levels in the NICU. These strategies include environmental redesigns, scheduled daily quiet time, ongoing education, reminders to maintain a quiet environment, and silencing alarms quickly (Dusabe et al., 2020; Hernández-Salazar et al., 2020; Mayhew et al., 2022).

Further research is needed to evaluate the effectiveness of these interventions. The interventions this student believes would be worth implementing in the clinical setting include scheduled daily quiet times, ongoing education and training for the staff, frequent reminders to maintain a quiet environment, and silencing alarms as soon as possible. Decreasing noise levels in the NICU will not only help the nursing practice by providing a safe and healthy environment for the neonates admitted to the NICU. It will also positively impact the nurses working in this clinical setting. Nurses working in the NICU have identified noise as a significant factor contributing to burnout syndrome, tiredness, headaches, and irritability (Hernández-Salazar et al., 2020). These conditions can become chronic with more time working in the NICU (Hernández-Salazar et al., 2020). These conditions can cause more accidents and professional performance errors (Hernández-Salazar et al., 2020). Nurses use mechanisms to combat these adverse effects, including music therapy during their shift and conversing with their co-workers, increasing the noise levels within the NICU (Hernández-Salazar et al., 2020). Therefore, noise reduction programs and interventions benefit patients and the nursing staff. These neonates deserve an environment that will aid their growth and development, not hinder it. All members of healthcare that work in or visit the NICU must recognize how they impact the noise levels within the environment, especially the nurses, because they spend the most time with the

patients. Once HCPs recognize their part in contributing to the noise, they must be consciously aware and consistently work to maintain a quiet environment.

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