Noise Exposure in the Neonatal Intensive Care Unit: A Prospective Study

Selena Liao, MD; Lauren Moneta, MD; Johnathan Galati; Troy Lubianski, RN; Noe Coopersmith, BS; Anna-Marie Wood, BA; Lindsey McEvoy, BA; Nicholas Vigo, BS; Christopher Hart, BA; William Martin, PhD; Jess Mace, MPH; Heather Durham, MS, AuD; Carol MacArthur, MD; Peter Stegger, PhD
1Oregon Health & Science University; 2Oregon Clinical and Translational Research Institute

Abstract

Background: Hearing loss rates in neonatal intensive care units (NICU) run at 2-15%, compared to 0.3% in full-term births. The etiology of this increase remains unknown. In this study, we focus on a preventable cause: sound exposure levels. Design: Pilot prospective outcomes study. Methods: 54 out of 150 NICU infants, < 37 weeks gestational age, were enrolled in an IRB-approved study. A noise dosimeter measures each infant’s cumulative sound pressure level exposure. Daily logs record the bed type, location, number of patients per room, and events. Results: The average sound pressure level per individual admission ranged from 55-69 dBA. There were no significant differences between bed types, infant location, or number of children per room. Conclusions: All infants received sound exposures that substantially exceeded American Academy of Pediatrics (AAP) guidelines of <45 dBA for the NICU setting. We were unable to detect differences based on patient characteristics with our current study population. Reducing NICU decibel levels should concentrate on bed/room design, individual alarm noise, and staff education regarding the sources and consequences of sound exposure. Newborn hearing screening protocols should consider additional testing to determine the risk of noise-induced hearing loss.

Introduction

Hearing loss rates in neonatal intensive care units (NICU) run at 2-15% of admissions, compared to the 0.2-0.3% rate of congenital hearing loss in full-term births. Although the medical management of these children is more challenging than full-term births, the etiology of this 10-50x greater rate of hearing loss remains unknown. In this study, we focus on sound exposure levels as they are a largely preventable cause of acquired hearing loss.

The National Institute for Occupational Safety and Health (NIOSH) has issued criteria that set 85 dBA over 8 hours per day as the upper limit of acceptable cumulative sound exposure for adults. However, recent evidence on astronauts, who were repeatedly exposed to noise in the International Space Station at a range of 52.4 to 70.2 dBA, demonstrated small, but significant, permanent threshold shifts after a mean flight duration of only nine days. Thus, in the NICU setting, where a length of stay can range from weeks to months, continuous exposure to ambient sound levels >50 dBA, could potentially result in life-long consequences from noise-induced hearing loss. In 1997, the American Academy of Pediatrics (AAP) published guidelines entitled Noise: a Hazard for the Fetus and Newborn, which advised that noise levels >45 dBA are of concern with regards to general health and hearing. To date, there is no official recommended decibel limit for prevention of hearing loss in neonates.

<table>
<thead>
<tr>
<th>Organization (target population)</th>
<th>Protection of</th>
<th>Dose limit (dBA per hour)</th>
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<tbody>
<tr>
<td>NIOSH (adults)</td>
<td>hearing</td>
<td>85 dBA over 8 hours</td>
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<tr>
<td>World Health Organization (pediatrics)</td>
<td>hearing</td>
<td>70 dBA over 24 hours</td>
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<tr>
<td>Journal of Perinatology (neonates in the NICU)</td>
<td>sleep, vital signs, speech</td>
<td>50 dBA over 24 hours</td>
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<tr>
<td>AAP (neonates in the NICU)</td>
<td>hearing, growth</td>
<td>45 dBA over 24 hours</td>
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Table 2. Dose criteria set by various organizations for noise exposure limits

Results

The average sound pressure level per admission ranged from 55-69 dBA. All patients’ sound exposure levels exceeded the limits recommended by the AAP by at least a factor of 10.

Average dBA associated with bed types were: Incubator 62.7 (95% CI: 61.6-63.9), basinette 62.2 (95% CI: 60.8-63.7), warmer 61.4 (95% CI: 59.9-62.9), crib 58.3 (95% CI: 52.9-63.8). Average dBA associated with bed location were: Isolation 61.1 (95% CI: 47.6-74.6), Pod 1 63.1 (95% CI: 61.5-64.6), Pod 2 60.9 (95% CI: 57.6-64.1), Pod 3 61.3 (95% CI: 58.6-64.0), Pod 4 61.8 (95% CI: 59.5-64.1), Pod 5 62.5 (95% CI: 60.4-64.5), Pod 6 63.0 (95% CI: 61.6-64.4), Pod 7 62.5 (95% CI: 60.4-64.4), Pod 8 63.7 (95% CI: 59.4-68.4). Average dBA associated with # of children per room were: One 63.8 (95% CI: 59.9-67.7), Two 63.2 (95% CI: 60.2-66.3), Three 61.6 (95% CI: 60.1-63.0), Four 61.8 (95% CI: 59.9-63.6), Five 61.4 (95% CI: 60.1-62.7), Six 62.3 (95% CI: 60.7-63.8), Seven 63.6 (95% CI: 61.8-65.4). None of these values reached significance at α = 0.05.

23% of our data points were recorded as 0 dBA. Cribs were most likely to have 0s recorded (35.1%) and warmers were the least (16.3%). Isolation rooms were most likely to have 0s recorded (40.1%) compared to 15.7% recorded at 24 h.

Discussion

All of the patients had noise exposures that far exceeded the AAP recommended limit of 45 dBA. Our dosimeters have a significant limitation in their inability to detect sound pressure levels below 65 dBA, however, this also means that all of our recorded levels are underestimates of the actual sound pressure levels experienced. The averaging of 0 dBA data produced wide standard deviations, which likely contributed to our inability to detect significant differences in the sound levels associated with any specific factors in the NICU. However, we did find that the most non-enclosed bed type, as well as private rooms with only 1 child were more likely to record 0s (sound levels <65 dBA), which would seem to indicate that these factors may be quieter than the others. This makes intuitive sense, given that previous studies have shown enclosed incubator-type beds to produce more noise and that private rooms should theoretically protect a subject from ambient NICU noise.

Conclusions

All infants received sound exposures that substantially exceeded AAP guidelines of <45 dBA for the NICU. Device limitations reduced our ability to detect a difference between different factors contributing to noise exposure. Strategies for reducing NICU decibel levels should concentrate on bed/room design, alarm noise, and staff education regarding the sources and consequences of sound exposure. Newborn hearing screening protocols should consider additional testing to determine the risk of noise-induced hearing loss.

Contact

Selena Liao, MD
Oregon Health & Science University
Email: selena.liao@gmail.com

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References