

Is it Harmful to Nurses' Hearing When Infants and Young Children Scream During Emergency Department Procedures? A Pilot-Feasibility Study

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Introduction

Emergency Departments (ED)s are widely recognized as baseline noisy environments due to medical devices producing frequent alarms at high volumes as well as sounds from patients, families, and staff. While most sounds in the ED environment are at a safe level, noise-induced hearing loss (NIHL) can be caused by repeated or prolonged exposure to any sound at or over 85 dB [1]. In addition to noise-induced hearing loss, noise exposure has been associated with negative effects on cardiovascular health, sleep, mental health and cognitive function [2]. Important factors in minimizing NIHL include proximity to, duration of exposure, and loudness of the noise source.

The primary aim of this feasibility study was to determine if local ambient noise levels (dB) could be measured during common pediatric ED procedures. The secondary aim of this study was to determine if the local ambient noise level (dB) during common pediatric ED procedures exceeds recommended levels for safety.

Methods

We performed a prospective feasibility study from April 2021 to December 2024 enrolling a convenience sample of children under the age of 6 years undergoing routine pediatric emergency procedures determined through usual clinical practice. A decibel meter (Reed R8080 Sound Level Meter) was used to record maximal dB levels and duration of procedures for patients requiring either intravenous (IV) placement, urine catheterization, nasal swabs, intramuscular injections or heel blood stick.

Study staff measured the distance (in millimeters) between the patient's mouth and the nurse's closest ear after the nurse was in position to perform the clinical procedure. The decibel meter was then held at approximately the same distance from the patient. Recording began when the nurse initiated the procedure, and decibel levels were captured at one-second intervals. Following the procedure, each nurse was asked to rate two qualitative scores on a scale from 0 to 5: one for the nurse's noise pain level during the

procedure (0 = no pain, 5 = highest pain) and one for the perceived intrusiveness of the study team member during the procedure (0 = not intrusive, 5 = highly intrusive).

The age and gender of enrolled patients were abstracted from electronic health records and included for descriptive purposes. The use of a J-Tip was offered for some patients prior to IV placement as part of a routine clinical procedure to enhance patient comfort. The J-Tip is a single-use, subcutaneous needleless injection device that delivers lidocaine for local anesthesia. It is primarily used before needle procedures [3]. Child Family Life Specialists also participated in procedures when available, providing procedural support and distraction techniques to patients. This study received approval from the Institutional Research Ethics Board and informed consent was obtained prior to initiation of data collection.

Statistical Methods

This was a pilot study with a planned enrollment of 30 patients to assess the feasibility of recording noise levels in the setting of a pediatric ED. The analysis was exploratory without pre-specified formal hypotheses. Noise level statistics were first calculated per-patient (i.e. maximum and mean noise level among all decibel meter readings during a procedure), then summarized for the study cohort using descriptive statistics. Spearman's correlation coefficients (r) were calculated to evaluate the association between maximum or mean noise level and the distance from the decibel meter to the patient. Post-hoc Wilcoxon rank-sum tests (two-sided) were conducted comparing type of blood-draw procedure (with & without J- tip). We used R software (R Core Team, Vienna, Austria) for statistical analysis.

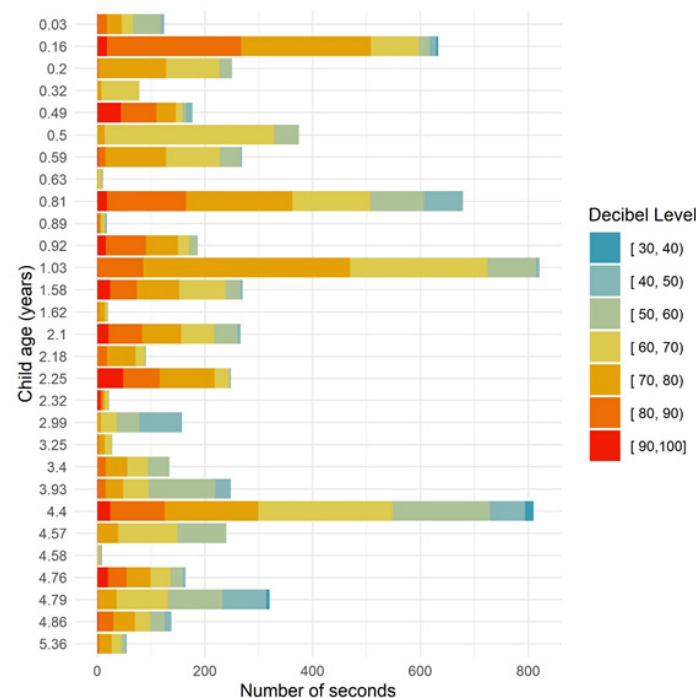


Figure 1: Duration of Noise Level Subranges by Procedure.

Each stacked bar represents one procedure, with all procedures sorted by child age. For each procedure, the total length of the bar represents the duration of the procedure in seconds. The bars are subdivided by color based on the distribution of decibel measurements recorded during each procedure.

During the typical (i.e., median) procedure:

Mean dB = 69 (IQR 64, 73)

Maximum dB = 92 (IQR 84, 96)

Duration of time when dB > 85 was 6 seconds (IQR 0, 47)

Results

Table 1: Patient and Procedure Characteristics.

Variable	N = 30 ¹
Child age (y)	2.10 (0.63, 3.93)
Child age (categorized)	
0-1 year	11 (38%)
1-3 years	8 (28%)
3-6 years	10 (34%)
Unknown	1
Child gender (categorized)	
Female	14
Male	16
Procedure type	
Blood	10 (33%)
Blood (J-tip)	11 (37%)
Not recorded	1 (3.3%)
Other	8 (27%)
Number of procedures	
1	18 (60%)
2	12 (40%)
Child life present in room	6 (20%)
Pain score	
0	16 (53%)
1	7 (23%)
2	1 (3.3%)
2.5	1 (3.3%)
3	3 (10%)
4	2 (6.7%)
RN perception of intrusiveness	
0	27 (90%)
1	1 (3.3%)
2	1 (3.3%)
3	1 (3.3%)
Distance from DB meter to child (mm)	520 (400, 597)
Maximum DB level	92 (84, 96)
Mean DB level	69 (64, 73)
Procedure duration (s)	182 (78, 270)
Duration (s) >= 85 DB	6 (0, 47)

¹Median (Q1, Q3); n (%)

Pediatric patients (ages 0 to <6 years) undergoing routine ED procedures, such as IV placement, were observed. Sound levels were measured near nurses' ears to capture peak child noise exposure. Patient demographics, procedure types, and exposure durations were summarized to describe participant and procedure characteristics.

We enrolled 30 children (14 female and 16 male) with a median age of 2.10 years (Table 1). Procedures included blood draws (with or without IV placement, n=10; 33%), blood draws with a J-tip (n=11; 37%), and others including urine catheterizations and intranasal swabs. Measuring noise levels was generally feasible with most nurses (n=27; 90%) reporting no intrusiveness of the recording instrument. The decibel meter was placed at a median distance of 520 mm (IQR 400, 597) from the child's mouth, and distance was not correlated with either the maximum or mean recorded decibel level (r=0.17 and 0.02, respectively).

The median procedure duration was 3 minutes (IQR 1.3-4.5 minutes). For the typical (i.e. median procedure), the mean noise level was 69 dB (IQR 64, 73), the maximum noise level was 92 dB (IQR 84, 96), and the duration that noise levels exceeded 85 dB was 6 seconds (IQR 0, 47). Mean dB levels were lower during blood draws with a J-Tip compared to those without (66 vs. 71; p=0.04). The nurses' perception of their own noise-related pain, as reported on a scale of 0 to 5, was predominantly low, with a median score of 0 (IQR 0, 1).

Discussion

Pediatric Emergency Department (PED) nurses are crucial care providers for ill and injured children in our medical system, and they often cannot avoid the occupational hazard of repeated or prolonged exposure to loud noises [4]. Despite careful management of patient pain and anxiety, children often cry or scream while PED nurses are performing minor diagnostic or therapeutic procedures.

Long or repeated exposure to sounds at or above 85 dB over an 8-hour work shift is the recommended exposure limit set by the National Institute for Occupational Safety and Health (NIOSH) (NIOSH, 1998) [3]. Reference to these national standards places our findings in the context of established industry guidelines. In addition to hearing loss, previous studies surveying nurses have found that higher self-reported noise exposure in the workplace was associated with an increased prevalence of health conditions such as mental health conditions, elevated stress levels and higher burnout scores [5]. In our study, noise levels above 85 dB occurred for 47 seconds or more in one quarter of pediatric procedures. Previous work has reported that baseline emergency department noise levels are typically lower, with one study finding that average sound levels in a selected ED were consistently at or below 70 dB, and another study reporting the average noise level in a pediatric ED of 68.7 dB over a 24-hour period [6,7]. PED nurses reported experiencing mild discomfort and pain despite exposure to loud patients during procedures. However, in subsequent discussions, many nurses attributed these low levels of self-reported distress to occupational desensitization acquired through prolonged pediatric clinical experience.

This study was limited by the use of a small convenience sample from a single site and the availability of the research team members to collect data. However, despite these limitations, this pilot study showed that some PED nurses performing painful or uncomfortable procedures on children do experience dB levels at and above levels that can cause hearing loss. These findings demonstrated the feasibility of bedside decibel measurement in assessing nurses' occupational exposure to noises that induce noise-induced hearing loss (NIHL). Future research could use this technique to evaluate and seek ways to reduce nurses' occupational exposure to conditions that may be hazardous to their hearing and other related non-auditory health effects. In addition, future research should include comparisons of measured exposure against national standards such as those from NIOSH and OSHA and incorporate baseline ambient noise measurements to fully assess the incremental risk posed by pediatric procedures. Overall, reduced exposure to harmful noise levels could also be considered a factor when implementing interventions to decrease patient pain and distress during procedures. These findings underscore the importance of monitoring and addressing occupational noise exposure in pediatric emergency settings to protect nurses' hearing while supporting safe and effective patient care.

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