Journal of Critical Care 36 (2016) 111–115

Contents lists available at ScienceDirect

Journal of Critical Care

journal homepage: www.jccjournal.org

Noise pollution levels in the pediatric intensive care unit☆,☆☆

Bree Kramer, DO [a,*], Prashant Joshi, MD [b], Christopher Heard, MBChB [a]

[a] Women and Children's Hospital of Buffalo, State University of New York at Buffalo School of Medicine and Biomedical Sciences, Buffalo, NY
[b] University of Nebraska Medical Center, Omaha, NE

ARTICLE INFO

Available online xxxx

Keywords:
Pediatric intensive care unit
Noise levels

ABSTRACT

Patients and staff may experience adverse effects from exposure to noise.
Object: This study assessed noise levels in the pediatric intensive care unit and evaluated family and staff opinion of noise.
Design: Noise levels were recorded using a NoisePro DLX. The microphone was 1 m from the patient's head. The noise level was averaged each minute and levels above 70 and 80 dBA were recorded. The maximum, minimum, and average decibel levels were calculated and peak noise level great than 100 dBA was also recorded. A parent questionnaire concerning their evaluation of noisiness of the bedside was completed. The bedside nurse also completed a questionnaire.
Results: The average maximum dB for all patients was 82.2. The average minimum dB was 50.9. The average daily bedside noise level was 62.9 dBA. The average % time where the noise level was higher than 70 dBA was 2.2%. The average percent of time that the noise level was higher than 80 dBA was 0.1%. Patients experienced an average of 115 min/d where peak noise was greater than 100 dBA. The parents and staff identified the monitors as the major contribution to noise.
Conclusion: Patients experienced levels of noise greater than 80 dBA. Patients experience peak noise levels in excess of 100 dB during their pediatric intensive care unit stay.

1. Introduction

The detrimental effects of noise on the preterm neonate have been well documented in the literature [1]. Physiologic responses such as fluctuations in respiratory rate, oxygen saturation, heart rate, and blood pressure have been clearly demonstrated [2]. Research has also demonstrated that there are long-term effects to exposure to loud noises in the neonatal intensive care units. These effects include hearing loss, sleep deprivation and its sequela, longer recovery periods, and an overall stress response that results in disturbances of the autonomic nervous system [3]. Although there are limited data available [4], it is proposed that pediatric patients of all ages also have physiologic responses to noise that are similar to the preterm neonate [5].

Excess environmental sounds/noise can be detrimental to the pediatric intensive care unit (PICU) staff as well [6]. The National Institute on Deafness and Other Communication Diseases estimates that 10% of people aged 20 to 69 years have had permanent hearing damage, much of it secondary to exposure to excessive environmental noise. In addition to hearing loss, adults have many of the same physiologic changes as premature infants and children: increased heart rate and blood pressure and an increase in cortisol levels. Constant exposure to noise increases fatigue levels, leads to distraction, requires increased energy to perform tasks, and makes it difficult to communicate with others [3,7,8]. All of these factors may increase the risk of a medical error occurring at the bedside.

Most of the noise present in our environment and audible by the human ear ranges from 1 to 140 dBA. The safe range of noise has been recognized by a number of international associations, to be between 0 and 80 dBA [3]. These associations include the American Academy of Pediatrics (AAP), American Environmental Protection Agency, the International Noise Council, and the World Health Organization. According to the AAP, a noise level of 80 dBA is the maximum level of noise that does not produce any measurable damage, no matter how long the exposure. As a comparison, a level of 70 dBA is the level of normal street noise and 80 dBA is equivalent to heavy city traffic or a noisy office. Based on studies of occupational workplace exposure to high noise levels, the recommendations call for no more than 8 hours of exposure to 90 dBA, with no continuous noise above 115 dBA or peak above 140 dBA [7]. The literature clearly delineates that most PICUs exceed these standard recommendation for noise levels in hospitals [9,10,11].

There are many sources of noise in the PICU including equipment (eg, ventilators, pumps alarms, monitor alarms, telephones, over-head paging systems), hospital staff (eg, physicians, nurses, ancillary personnel), television or electronic entertainment sources, and visitors.

There was a concern among the critical care faculty at Women and Children's Hospital of Buffalo that the noise levels in the PICU exceed the recognizable safe range and as such may potentially causes problems for the patients, families, and health care workers.

☆ There was no financial support for this study. The equipment was borrowed from Paul Creighton, DDS, and the Department of Pediatric Dentistry.
☆☆ All authors report no conflicts of interest.
* Corresponding author at: Division of Pediatric Critical Care, Women and Children's Hospital of Buffalo, State University of New York at Buffalo School of Medicine and Biomedical Sciences, 219 Bryant St., Buffalo, NY, 14222. Tel.: +1 716 878 7442.
E-mail address: bkramer@upa.chob.edu (B. Kramer).

http://dx.doi.org/10.1016/j.jcrc.2016.06.029
0883-9441/

The aim of this study was to measure the noise levels at a given PICU bed over a 24-hour period to determine if these levels exceed the recommended safe level. There were 4 objectives to this study. The first objective was to assess how loud the noise exposure in the PICU was. The second was to determine if there was a difference in noise levels between the 2 different sides of the intensive care unit. The final 2 objectives were to determine families' and nurses' perception of the noise levels and etiology of the main noise source in the PICU.

2. Materials and methods

After institutional review board approval and informed consent (and assent if the patient was >7 years of age and not sedated or intubated), the noise levels at the PICU bedside were measured over a 24-hour period. This was ascertained in several ways: looking at the average 24-hour exposure of noise, the percent of time noise level was greater than 70 and 80 dBA, and the percent of time the peak noise level exceeded 100 dBA. These numbers were determined from the acceptable standards set forth by the AAP, American Environmental Protection Agency, International Noise Council, and the World Health Organization. The PICU at Women and Children's Hospital of Buffalo is a 20-bed unit that is divided into 2 sides, a “closed” side ($n = 9$ beds), with walls and doors separating the individual rooms, and an “open” side ($n = 11$ beds) where the dividers between rooms is limited to curtains. The selection of a bedside was performed randomly. To ensure that all beds were allocated on an equal basis, a randomly predetermined bed utilization schedule was prepared for each block of 20 patients. Each bedside was used as per the randomization sequence; however, if there was no patient in that bed space, then the next preassigned bed was used. The “missed” bed was then used next and the assignment of beds was again continued per the predetermined schedule. The study rotated in this manner for a total of 5 predetermined sequences.

The noise level was continuously measured using a NoisePRO DLX dosimeter (Quest Technologies, Oconomowoc, Wis), a noise logging device (Fig. 1). The NoisePRO device is capable of recording the room noise level in decibels (dB) as frequently as every second with a high degree of accuracy and sensitivity [12]. Its use is approved by the Occupational Safety and Health Administration for the measurement of occupational noise level exposure. The NoisePRO was setup in a standard manner as used for assessing noise exposure.

After passing a daily calibration test using the supplied 140-dB calibration device (accurate to within ±0.1 dB), the microphone was placed about 1 m from the patient's head, in a location where the microphone was unlikely to be disturbed by the staff or the patient. The average noise level for each minute was recorded over a 24-hour period. The noise monitor also recorded the level of any peak noise over 100 dB each minute during this 24-hour period.

The sources of noise were assessed by the completion of a survey by both the bedside nurse (day and night staff) and the patient's family. In addition, their perceptions of the degree of the noise level in the room were also recorded. The nursing notes for the duration of the study period were also collected for each patient. The parents were present through the different periods from 43% to 61% of the time, with there being more parent presence during the daytime hours.

The data collected were analyzed using a *t* test, χ^2, and analysis of variance analysis to look and compare the noise logger levels with time of day and the nurses' assessment of noise in the room with the noise logger.

3. Results

A baseline noise level of commonly used equipment was obtained in a room on the closed side of the unit. The only equipment in the room was the one being tested and the door to the room was shut. Baseline noise levels were as follows: ventilator alarm, 70 dBA; high-frequency oscillatory ventilator (on a mean arterial pressure of 28, Hz of 10, and Amp of 35), 63 dBA; high-frequency oscillatory ventilator alarm, 73 dBA; IV pump alarm, 74 dBA; and monitor alarm, 78 dBA.

One hundred patients were recruited into the study over a 10-month period during the 2010 calendar year. All patients admitted to the ICU were eligible for enrollment in the study. Of the 101 patients and families approached, all but 1 family consented to the study. No patients were excluded from the study. The average age at enrollment was 7 years with a range of 23 days to 26 years, 54% of these patients were female.

More than half (56%) of the patients were located on the “open” side of the PICU, as was expected by the randomization method.

Seventy-two percent of the patients experienced a period of the day where the average noise level (>1 minute) was above the recommended 80 dBA. Overall, the average noise level in an individual room ranged from 56.1 to 79.5 dB. Upon further analysis, it was noted that about 3% of the day the rooms experience noise levels above 70 dBA. In addition, peak noise levels were greater than 100 dBA for slightly more than 10% of the day (Fig. 2). Overall, the average noise level in an individual room ranged from 56.1 to 79.5 dBA. The highest peak noise level recorded was 134.5 dB (range, 105.1-146.3 dB). Patient demographics as well as noise levels (Fig. 3) between the isolation rooms (closed side) and curtained rooms (open side) were compared, and no difference between average, minimum, and maximum noise levels was found. There was also no difference between the percent of time peak levels exceeded 100 dBA.

The nurses perceived the time between 7 PM and 9 PM as the noisiest time of the day (Fig. 4) and this is reflected in the data (Figs. 2 and 3). Using Freidman analysis, it was determined that the daytime noise level was noisier than the nighttime noise level over the 12-hour periods of time. Also, using 2-way analysis of variance, we could determine

Fig. 1. NoisePRO recording device.