Reduction of Noise Levels in the Pediatric Intensive Care Unit (PICU) of Beaumont Hospital

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ABSTRACT

Noise levels have increased dramatically in health care facilities as a consequence of many factors, including an increase in medical device false alarms, building-related sounds such as clattering carts and humming air conditioning units, and increased numbers of staff. The snowballing noise levels have negative physiological effects on patients and worsen nursing care. This study describes our quantitative research towards reducing noise levels in a hospital critical care unit by means of a behavior modification program. **Key words** — hospital noise, patient safety, medical device alarm, and human factors.

INTRODUCTION

An Intensive Care Unit (ICU) is a special unit designed to care for the most acutely ill patients within the hospital. Such patients need quiet and attentive personalized care. Unfortunately, it has become very difficult to achieve a quiet environment within ICU units due in part to the monitoring equipment required for these very sick patients. A June 2012 study in the *Annals of Internal Medicine* examined cortical arousal response to typical hospital noises during sleep. This study recommends that ICUs improve the acoustic environment in order to provide high quality patient care [1]. In a 2010 review on the effects of hospital noise, Choiniere noted that noise has physiological and psychological effects on the body and that excessive noise level has the potential to increase complications in patients. Choiniere also pointed out that, since nurses spend far more time in ICUs than patients, the nursing staff experiences stress from the high levels of noise [2].

The objectives of this study were: 1) To estimate the noise levels experienced by the patients as well as the nursing staff of Pediatric Intensive Care Unit (PICU) in a large Midwestern hospital; 2) To carry out an amplitude and frequency analysis of the noise; 3) To implement appropriate low- or no-cost sound reduction measures and ; 4) To quantify the reduced noise levels within the PICU by comparing the noise levels before and after implementation of the sound reduction measures.

MATERIALS AND METHODS

We analyzed the noise levels in four locations within the Beaumont PICU: (a) two patient rooms (the noise recording device was stationary); (b) the nursing station (stationary); and (c) throughout the PICU as recorded by ambulatory noise dosimeter badges worn by the nurses. The data gathered from these monitoring devices allowed us to determine whether the noise levels are exceeding WHO and U.S. Environmental Protection Agency (EPA) recommended limits for hospitals. Important in this regard are the World Health Organization (WHO) (1999) guidelines, which state that "Since patients have less ability to cope with stress, the equivalent sound pressure level should not exceed 35 dB(A) [equivalent continuous noise level] LA_{eq} in most rooms in which patients are being treated or observed… The LA_{max} of sound events during the night should not exceed 40 dB(A) indoors"[3].

Instruments: Optimus Red Class-2 Integrating Sound Level Meters (ISLM's) (CR:162C) with data logging and octave-band filters from Cirrus Research plc, (UK) were used for data collection from the stationary locations in the PICU. Dosebadge Noise Dosimeters (CR:110A) were used to collect the noise levels experienced by the two RN's on duty in each of the day shift (7 am to 7 pm) and night shift (7 pm to 7 am). (Since participation in the study was voluntary, only volunteer RN's wore the dose badge.) We used these devices to measure LA_{eq} and LC_{Peak}. LA_{eq} is the equivalent continuous noise level, which is the average exposure level over the run time. LC_{Peak} is the peak sound level.

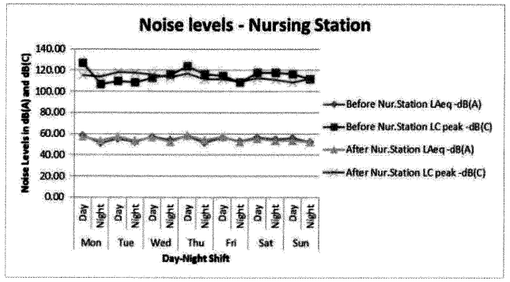
Behavioral Modification Program: In the literature review "Noise in hospital intensive care units—a critical review of a critical topic" (Oct, 2011) in the *Journal of Critical Care,* Konkani and Oakley found that educational programs to change the behavior of the ICU staff are the most commonly applied and inexpensive techniques to reduce the noise levels[4]. Our behavioral modification program for this study included an educational power point presentation to the ICU staff, as well as discussion with them of recommended practices for reducing noise levels. We advised staff to avoid bedside conversations, to keep phones in silent mode, and to reduce telephone, pager, and overhead speaker volumes. A poster of the behavior modification session was placed in the meeting room to help keep these concepts in view as a reminder.

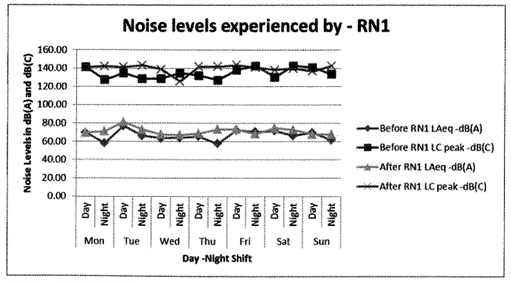
Data Collection: The data was collected in three separate one week time-frames between August, 2011 to February 2012. The first recording established a baseline, the second measured the effect of the intervention in reducing noise levels, and the third measured the long term effect of the intervention. During each timeframe the data was collected for 7 consecutive days, that is, for 168 hours of data for each week (24hr*7days=168 hours), for a final total of 504 hours (24hr*7days*3 times = 504 hours).

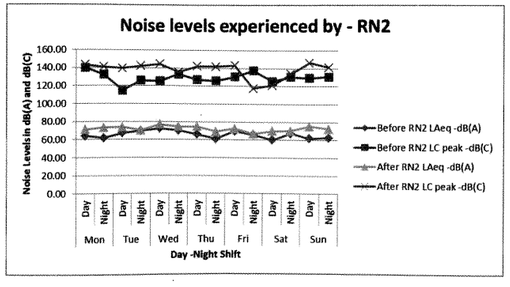
RESULTS AND DISCUSSION

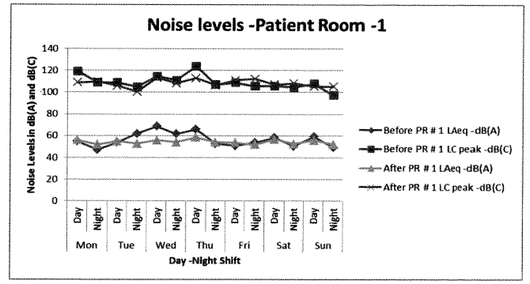
Krueger et al [5] have classified the sources of hospital ICU noises as *operational* and *structural*. Operational sources include the noise produced by staff, operating equipment (telephones, pagers, drug delivery tubing system, overhead speakers, medical devices alarms, etc.) and visitors. Structural sources include noise produced by the ventilating and air-condition system, squeaking sounds from opening and closing of doors, and so forth. Since controlling structural noise sources is expensive, in this study we focused on reducing the noise generated by operational sources. From the graphs, it is clear that the equivalent continuous noise level LA_{eq} in the patient rooms were between the ranges of 45 dB (A) to 65 dB (A), which is well above the recommendation of WHO (35 dB (A)). The equivalent continuous noise level LA_{eq}, as experienced by nurses RN1and RN2, was in the range of 60 dB (A) to nearly 80 dB (A). The LA_{eq} at the nursing station was between 50 dB (A) to 60 dB (A). Over all, the behavior modification was not effective in reducing the noise levels. A study published in the *Journal of Ergonomics* (Aug, 2012) suggests that decision by emergency medical service workers as to whether to adopt workplace ergonomics interventions was strongly influenced by the perceived ergonomics advantage as by perceived endorsement by supervisors and superiors [6]. Our own observations during this study backed up these findings.

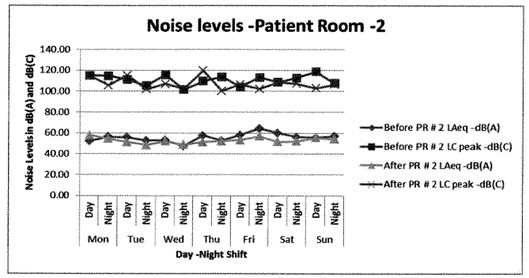
There are many variables that impact noise levels within the ICU areas of which a behavior modification session can only touch on. The results of this study pointed us towards the importance of management of false alarms; as a consequence, some of the authors of this study conducted a literature review related to false alarms [7]. We are planning to continue this research with a behavior modification program along with alarm management technique to reduce the noise levels in the ICU.











CONCLUSION

Since staff, visitors and operational instruments all contribute substantially to the increasing noise level, it is very important to apply a combined effective program to reduce noise.

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REFERENCES

1. Buxton O, Ellenbogen J, Wang W, et al. Sleep disruption due to hospital noises: A prospective evaluation. Annals of internal medicine,Online First- June 2012.
2. Choiniere D. The Effects of hospital noise. Nursing Administration Quarterly 2010;34(4): 327–33.
3. Berglund B, Lindvall T, Schwela D. Guidelines for community noise. World Health Organization; 1999 Available from: http://www.who.int/docstore/peh/noise/guidelines2.html. Accessed Date: 3/16/11.
4. Konkani A, Oakley B. Noise in hospital intensive care units-a critical review of a critical topic. J Crit Care. 2012 Oct;27(5):522.e1-522.e9. doi: 10.1016/j.jcrc.2011.09.003. Epub 2011 Oct 26.
5. Krueger C, Schue S, Parker L. Neonatal intensive care unit sound levels before and after structural reconstruction. MCN: The American Journal of Maternal/Child Nursing 2007;32(6): 358-62.
6. Weiler MR, Lavender SA, Mac Crawford J, et al. Identification of factors that affect the adoption of an ergonomic intervention among Emergency Medical Service workers. Ergonomics. 2012 Nov;55(11):1362-72. doi: 10.1080/00140139.2012.714474. Epub 2012 Aug 28.
7. Konkani A, Oakley B, Bauld T J. Reducing Hospital Noise: A Review of Medical Device Alarm Management. Biomedical Instrumentation & Technology, Nov/Dec-2012, pending publication.