HOW THE NICU ENVIRONMENT SOUNDS TO A PRETERM INFANT

UPDATE

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ABSTRACT

Purpose: To replicate a previously published descriptive study of sound levels in the NICU.

Study Design and Methods: A descriptive study of nursery ambient sound levels and sound levels associated with nursery equipment and care activities was conducted in a Level III NICU. Measurements were obtained using a sound level meter and evaluated in light of previous findings.

Results: Contrasted with 16 years ago, room sound levels were reduced; however sound levels associated with caregiving, equipment, and activities continue to be high.

Clinical Implications: Sound levels continue to be a clinical challenge for NICU nurses. This study suggests some modification of care practices and equipment selection that could reduce sound levels and concludes that sound reduction is a continuing need in neonatal care.

Key Words: Neonatal intensive care; Sound; Health facility environment; Infant.

An article previously published almost 2 decades ago in MCN (Thomas, 1989) described sound levels in the NICU. The purpose of the research presented in this article was to replicate that study and contrast current ambient sound levels in a Level III NICU with previous findings. NICU caregivers are challenged by the need to reduce sound levels while providing critical care to fragile, high-risk infants. Sounds levels in the NICU are associated with two general concerns: sound level volume and the developmental appropriateness of the NICU auditory environment. The level of sound in the NICU has received attention for more than 25 years (Newman, 1981). Several recent studies have documented NICU sound level (Kent, Tan, Clarke, & Bardell, 2002; Krueger, Wall, Parker, & Nealis, 2005; Levy, Woolston, & Browne, 2003). Sound levels increase with acuity and technological care (Levy et al., 2003) and exhibit daily patterns related to unit routine (Byers, Waugh, & Lowman, 2006). Stimulation resulting from sound produces infant arousal that results in adverse responses, such as increased energy demand and oxygen desaturation (Trapanotto et al., 2004). Loud sounds also disrupt infant sleep, which is essential for central nervous system development. Incubators do not consistently provide protection from NICU sound exposure. The incubator may differentially accentuate or dampen certain types of sounds (Robertson, Cooper-Peel, & Vos, 1999; Robertson, Stuart, & Walker, 2001). The NICU sound environment is developmentally unsuited to the high-risk infant (Graven, 2000). Auditory stimulation in the nursery differs significantly from that of the intrauterine environment and the home. The incubator also separates sound from its source, which leads to sound distortion and difficulty localizing sound (Graven, 2000; Robertson et al., 2001).

Throughout the last few decades, concerns about NICU auditory environment have led to practice changes to reduce sound level, and recommendations for NICU acoustic environment have been published (Graven, 2000; Philbin, 2004), with both physical factors and staff behavior as the focus of sound abatement interventions (Philbin & Gray, 2002). Assessment of sound level and resultant changes in practice and unit design have resulted in NICU sound level reduction (Bremmer, Byers, & Kiehl, 2003; Byers et al., 2006; Floyd, 2005; Johnson, 2003). Few studies, however, have evaluated NICU sound level from an historical perspective.

Substantial changes in nursing practice have occurred since the 1989 Thomas publication of NICU sound levels (Krollmann, Brock, Eichel, Nader, & Neiheisel, 2002; Samson, 2006; Simpson, 2000). These changes include increasing use of technology, higher nursery acuity level, improving survival of extremely preterm infants, pressures for cost containment, and expanded understanding of the effects of nursery environment on infant outcomes. It was important, therefore, to replicate the original study of sound in the NICU to determine if sound levels had changed over time.

Study Design and Methods

Because the project did not include participation of human subjects, it was exempt from human subjects review. This study was conducted in the same institution as the 1989 research—in the 32-bed Level III NICU. The unit is comprised of 8,400 square feet and consists of five open-design rooms, each with six to eight beds, and tile flooring. Median daily census was 29. As in the original study, sound measures were performed on a typical workday. Although a formal, specific sound reduction protocol was not in practice, sound control was discussed during routine staff orientation and incorporated into ongoing developmental care. Physical layout of the nursery, including bed location, has remained the same. No major structural changes in the nursery have occurred since the original study; however, equipment and care practices reflect current nursery standards. Over time, the key differences in the physical environment have involved updates in incubators and equipment, computerized laboratory results, and increased usage of ventilatory support and fluid pumps, which reflect rising acuity. Staff transitions also have occurred over time.

> NURSERY SOUND STIMULATION PRODUCES AROUSAL, AND POTENTIALLY INFLUENCES INFANT OUTCOMES.

Sound intensity (dB) was measured using a sound level meter (Larson Davis 824). The meter was calibrated using a calibration device (Larson Davis model 250). The sound level meter met validity and reliability standards set by the American Institute of National Standards and the International Electrotechnical Commission (specified in IEC 651-1979 and ANSI SI 4-1983). As in the 1989 study, measures used the dB(A) scale, which approximates reception characteristics of the human ear (Gray & Philbin, 2000). Equivalent sound level (Leq) was recorded. Instrument resolution was 0.1 dB. Given the logarithmic scale, an increase in 10 dB is perceived as twice as loud (Gray, 2000).

Nursery equipment used in the measurement of sound level included an empty incubator (AirShields C550), cardiopulmonary alarm (Philips Intellivue MP70), intravenous pump (IMED Gemini PC-1), and ventilator (Servo 300). Equipment was set up in an unoccupied bed space within the nursery, and caregiving activities within the surrounding nursery were not altered. Sound level measurements within the incubator included overall level and levels produced by

TABLE 1. Comparison of NICU Sounds Recorded in 1989 and 2005

Location	Sound	1989 dB(A)	2005 dB(A)
Room	Quiet	58-62	47
	Talking	58-64	49
	Radio	60-62	53
	Sink faucet	66	57
Incubator interior	Writing on hood surface	59	62
	Incubator alarm	67	68
	Motor off	38-42	38
	Motor on	55	60
	IV pump alarm	56	61
	Opening plastic sleeve	67	58
	Ventilator tube bubbling	62	61
	Cardiorespiratory alarm	55	59
	Finger tapping on hood	70	65
	Closing incubator cabinet	70	73
	Closing solid plastic porthole	80	73
	Dropping head of mattress	88	87

Note. The incubator motor was on unless noted otherwise. The following sound levels are provided as a point of reference for interpretation of values provided in the table: quiet bedroom, 30 dB; typical conversation, 50 dB; crying infant, 60 dB; barking dog, 70 dB; heavy street traffic, 80dB; leaf blower 90 dB (Knott, 2001).

specific equipment and care-related activities. Measures were taken in specified and replicated locations, and incubator interior measures were taken from a consistent spot approximating infant head position. Sound level was recorded three times in rapid-succession preset time periods—0900, 1200, 1800—and values were then averaged. Measures were highly consistent, as evidenced by a mean standard deviation of 1.16 dB(A). Analysis involved descriptive statistics. Values were then contrasted with values from the prior study.

Results

Findings are provided in Table 1. For the ambient nursery sounds recorded outside the incubator, sound levels were substantially lower in 2005 than in 1989, but for sound levels inside the incubator, most levels were the same or higher in 2005. Motor operation is a major contributor to overall sound level within the incubator. Sound levels associated with opening/closing porthole and plastic porthole sleeves, although reduced in the newer model incubator, remained high. Likewise, using the incubator hood as a work surface (writing, tapping) and closing the incubator cabinet continue to be sources of loud sounds. Sounds related to caregiving equipment, such as IV and cardiopulmonary alarms and ventilator tubing bubbling, also remain at high levels. Dropping the head of incubator mattress was the loudest sound at both time points (current study 87 dB(A)).

HIGH SOUND LEVELS WERE ASSOCIATED WITH CAREGIVING EQUIPMENT AND SPECIFIC NURSING ACTIVITIES.

Limitations

Study limitations include the possibility that staff modified their behavior during recording, that measurements occurred on one day, and that the sound meter used in this study was different from that used in the first study, although they were comparable, valid, and reliable sound meters. Single measures of specific sounds at each time point also were done, and it was not possible to compare the data using inferential statistics. In retrospect, additional information describing the patient population and environment would have assisted in evaluating findings from the original and replication studies.

Clinical Implications

This study showed that the sound intensity (dB) of the NICU environment in this institution was lower for eight of the tested areas in 2005 than in 1989; most of these areas were outside the incubator. For the rest of the areas, the sound intensity was either the same or higher. It is clear that control of sound continues to be a clinical challenge for nurses in the NICU. Although the 2005 data showed a noticeable reduction in room sound level, the sound related to caregiving equipment and activities generated sound levels

Suggested Clinical Implications

- Awareness of ambient sound level and ongoing control is an important aspect of neonatal care.
- Certain sound levels in incubators are high, including opening/closing porthole and plastic porthole sleeves, using the incubator hood as a work surface (writing, tapping), and closing the incubator cabinet. Incubator hoods should not be used as work surfaces, and care should be coordinated so other activities can be minimized.
- Be aware that noise caused by IV and cardiopulmonary alarms and ventilator tubing bubbling is high. Prompt response to alarms and removal of fluid from tubing is warranted.
- Nurses should be aware that dropping the head of the incubator mattress was the loudest sound measured. Levers should be used to gently raise or lower the mattress.
- Assessment of sound levels associated with specific care activities may help the care provider modify infant exposure to loud sounds.
- Equipment selection should include evaluation of sound level criteria.

louder than general conversation and louder than some sounds perceived to be loud, such as a crying infant.

The room sound level recorded during quiet condition (47 dB(A)) lies within the range of recommended allowable continuous background sound levels for the NICU (37-47 dB(A)) (Philbin, 2004). By contrast, most sounds recorded within the incubator are higher than 50 dB(A) Leq, the recommendation for NICU hourly sound limit (Graven, 2000). Several sounds that were recorded as average values in this study also exceed the recommended 1 second Lmax of 70 dB(A) (Graven, 2000).

Neither the past nor current studies were designed to test the effect of staff practices on sound level; thus the impact of developmental care strategies and increased awareness of sound cannot be assessed. It is interesting, however, to note the reduction in room sound levels, which are largely determined by caregiving staff, and the contrasting persistence of equipment-related sound levels. Several of these sounds can be controlled through nursing actions, such as promptly responding to alarms, removing fluid accumulation from ventilator tubing, performing care when opening and closing portholes, plastic porthole sleeves, and incubator cabinets, gently using levers to elevate and recline the head of the mattress, and avoiding using the incubator as a work surface. Evaluation of sound level is an important component in equipment purchase decisions; nurses should take an active role working with industry to reduce sound level in NICU equipment. ✣

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