Literature List
Noise in the NICU

2017

How the tool works

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We have compiled studies to make it easier to find the reference you are looking for.

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Each study slide includes short information on the research conducted: Objective, result, and conclusions plus a link to read more or purchase the full study.

Dräger

Noise in the NICU
Literature List

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H Patel, M Feldman	Universal newborn hearing screening	Paediatr Child Health 2011;16(5):301-5

Objectives: The present statement reviews the evidence for universal newborn hearing screening (UNHS).

Methods: A systematic review of the literature was conducted using Medline and using search dates from 1996 to the third week of August 2009. The Cochrane Central Register of Controlled Trials and systematic reviews was searched. Three systematic reviews, one controlled non-randomized trial and multiple cohort studies were found.

Main Results: The results of the available literature are consistent and indicate clear evidence that without UNHS, delayed diagnosis leads to significant harm for children and their families; with UNHS, diagnosis and intervention occur earlier; earlier intervention translates to improved language outcomes; and in well-run programs, there is negligible harm from screening.

Conclusion: Based on the available evidence, the Canadian Pediatric Society recommends hearing screening for all newborns. This should be provided universally to all Canadian newborns via a comprehensive and linked system of screening, diagnosis and intervention. Several provinces, including Ontario and British Columbia, offer excellent examples of integrated systems. Advocacy, at the provincial and federal levels, is required to ensure that all Canadian infants can benefit from the advantages of early hearing loss detection and intervention.

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Almadhoob A, Ohlsson A; Cochrane Library	Sound reduction management in the neonatal intensive care unit for preterm or very low birth weight infants	Cochrane Database of Systematic Reviews 2015, Issue 1. Art. No.: CD010333.

Objectives: Primary objective to determine the effects of sound reduction on growth and long-term neurodevelopmental outcomes of neonates. Secondary objectives1. To evaluate the effects of sound reduction on short-term medical outcomes (bronchopulmonary dysplasia, intraventricular haemorrhage, periventricular leukomalacia, retinopathy of prematurity).2. To evaluate the effects of sound reduction on sleep patterns at three months of age.3. To evaluate the effects of sound reduction on staff performance.4. To evaluate the effects of sound reduction in the neonatal intensive care unit (NICU) on parents' satisfaction with the care.

Methods: We searched the Cochrane Central Register of Controlled Trials (The Cochrane Library), MEDLINE, EMBASE, CINAHL, abstracts from scientific meetings, clinical trials registries (clinicaltrials.gov; controlled-trials.com; and who.int/ictrp), Pediatric Academic Societies Annual meetings 2000 to 2014 (Abstracts2View(TM)), reference lists of identified trials, and reviews to November 2014.

Selection criteria: Preterm infants (< 32 weeks' postmenstrual age (PMA) or < 1500 g birth weight) cared for in the resuscitation area, during transport, or once admitted to a NICU or a stepdown unit.

Main Results: One small, high quality study assessing the effects of silicone earplugs versus no earplugs qualified for inclusion. The original inclusion criteria in our protocol stipulated an age of < 48 hours at the time of initiating sound reduction. We made a deviation from our protocol and included this study in which some infants would have been > 48 hours old. There was no significant difference in weight at 34 weeks postmenstrual age (PMA): mean difference (MD) 111 g (95% confidence interval (CI) -151 to 374 g) (n = 23). There was no significant difference in weight at 18 to 22 months corrected age between the groups: MD 0.31 kg, 95% CI -1.53 to 2.16 kg (n = 14). There was a significant difference in Mental Developmental Index (Bayley II) favouring the silicone earplugs group at 18 to 22 months corrected age: MD 14.00, 95% CI 3.13 to 24.87 (n = 12), but not for Psychomotor Development Index (Bayley II) at 18 to 22 months corrected age: MD -2.16, 95% CI -18.44 to 14.12 (n =12).

Conclusion: To date, only 34 infants have been enrolled in a randomized controlled trial (RCT) testing the effectiveness of reducing sound levels that reach the infants' ears in the NICU. Based on the small sample size of this single trial, we cannot make any recommendations for clinical practice. Larger, well designed, conducted and reported trials are needed.

Gemma Brown, RN, BA	NICU Noise and the Preterm Infant	Posted: 07/01/2009; Neonatal Network. 2009;28(3):165-173.

Abstract: Premature infants in the NICU are often exposed to continuous loud noise despite research documenting the presence and damaging effects of noise on the preterm infant's development. Excessive auditory stimulation creates negative physiologic responses such as apnea and fluctuations in heart rate, blood pressure, and oxygen saturation. Preterm infants exposed to prolonged excessive noise are also at increased risk for hearing loss, abnormal brain and sensory development, and speech and language problems. Reducing noise levels in the NICU can improve the physiologic stability of sick neonates and therefore enlarge the potential for infant brain development. Recommendations include covering incubators with blankets, removing noisy equipment from the incubator environment, implementing a quiet hour, educating staff to raise awareness, and encouraging staff to limit conversation near infants.

Conclusions: The literature regarding the effects of sound on the premature infant is difficult to summarize and evaluate for two main reasons. First, hearing and its development are not entirely understood. Second, there is no coherent theoretical structure connecting the body of literature because most of the studies are isolated and phenomenologic in nature. The research does reveal negative short-term and long-term consequences of elevated noise levels in the NICU.

JOHN PANAGIOTIDIS & AMIR LAHAV	Simulation of prenatal maternal sounds in NICU incubators: a pilot safety and feasibility study	The Journal of Maternal-Fetal and Neonatal Medicine, 2010; Early Online, 1–4

Objectives: This pilot study evaluated the safety and feasibility of an innovative audio system for transmitting maternal sounds to NICU incubators.

Methods: A sample of biological sounds, consisting of voice and heartbeat, were recorded from a mother of a premature infant admitted to our unit. The maternal sounds were then played back inside an unoccupied incubator via a specialized audio system originated and compiled in our lab. We performed a series of evaluations to determine the safety and feasibility of using this system in NICU incubators.

Main Results: The proposed audio system was found to be safe and feasible, meeting criteria for humidity and temperature resistance, as well as for safe noise levels. Simulation of maternal sounds using this system seems achievable and applicable and received local support from medical staff.

Conclusions: Further research and technology developments are needed to optimize the design of the NICU incubators to preserve the acoustic environment of the womb.

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Ranganath Ranganna, Porus Bustani	**Reducing noise on the neonatal unit**	Review Article
Summary: The culture of high technology and aggressive pharmacological interventions that exist in neonatology can distract practitioners from the basic tenets of care. It would be unlikely that any adult would function effectively after a weekend spent in an intensive care room trying to get restful sleep, so why should we not try to provide the same rest for our patients that we ensure for ourselves? Noise is excessive on neonatal units and effective measures already exist to minimize it and its effects. All neonatal units should audit their sound levels and aim to improve on these for the benefits of staff and babies.		

Committee on Environmental Health	**Noise: A Hazard for the Fetus and Newborn**	Pediatrics October 1997, VOLUME 100 / ISSUE 4
Abstract: Noise is ubiquitous in our environment. High intensities of noise have been associated with numerous health effects in adults, including noise-induced hearing loss and high blood pressure. The intent of this statement is to provide pediatricians and others with information on the potential health effects of noise on the fetus and newborn. The information presented here supports a number of recommendations for both pediatric practice and government policy.		
Conclusion: Results of these studies suggest that: (1) exposure to excessive noise during pregnancy may result in high-frequency hearing loss in newborns, and may be associated with prematurity and intrauterine growth retardation, (2) exposure to noise in the NICU may result in cochlear damage, and (3) exposure to noise and other environmental factors in the NICU may disrupt the normal growth and development of premature infants. On the basis of these study results, noise-induced health effects on fetuses and newborns merit further study as clinical and public health concerns.		

Stanley N. Graven, MD and Joy V. Browne,	**Auditory Development in the Fetus and Infant**	1527-3369/08/0804-0278$34.00/0 doi:10.1053/j.nainr.2008.10.010

Summary: Auditory development in the fetus and infant entails the structural parts of the ears that develop in the first 20 weeks of gestation, and the neurosensory part of the auditory system develops primarily after 20 weeks' gestational age. The auditory system becomes functional at around 25 weeks' gestation. The cochlea of the middle ear and the auditory cortex in the temporal lobe are most important in the development of the auditory system. They are both easily affected by the environment and care practices in the newborn intensive care unit (NICU). The period from 25 weeks' gestation to 5 to 6 months of age is most critical to the development of the neurosensory part of the auditory system. This is the time when the hair cells of the cochlea, the axons of the auditory nerve, and the neurons of the temporal lobe auditory cortex are tuned to receive signals of specific frequencies and intensities. Unlike the visual system, the auditory system requires outside auditory stimulation. This needs to include speech, music, and meaningful sounds from the environment. The preterm as well as the term infant cannot recognize or discriminate meaningful sounds with background noise levels greater than 60 dB. The more intense the background noise, especially low frequency, the fewer specific frequencies (pitch) can be heard and used to tune the hair cells of the cochlea. Continuous exposure to loud background noise in the NICU or home will interfere with auditory development and especially frequency discrimination. The initial stimulation of the auditory system (speech and music) needs to occur in utero or in the NICU to develop tonotopic columns in the auditory cortex and to have the critical tuning of the hair cells of the cochlea occur. The control of outside noise, the exposure to meaningful speech sounds and music, and the protection of sleep and sleep cycles, especially rapid eye movement sleep, are essential for healthy auditory development. The environment and care practices for the fetus in utero or the infant in the NICU are critical factors in the development of the auditory system.

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Husam Salama, Assma Azzam, Sawan Al Omar, and Khalid Abdulhadi	**The Impact of Incubators on Noise Transmission Produced by High-Frequency Oscillatory Ventilation Inside the Neonatal Intensive Care Unit**	American Journal of Medicine and Medical Sciences 2011; 1(1): 23-27 doi: 10.5923/j.ajmms.20110101.04

Background: Use of the high-frequency oscillatory ventilator (HFOV) is a common practice inside the neonatal intensive care unit (NICU). There is a concern regarding the level of noise produced by HFOV inside the NICU.

Objectives: To evaluate and define the noise intensity produced by the HFOV and the impact of the incubator on the transmission of noise in different places inside the NICU.

Methods: Using a noise analyzer, the noise produced by the HFOV was measured in two setups: inside a quiet room, and inside the NICU during working hours. Measurements were repeated three times: first, inside and outside the tested incubator, and secondly, inside and outside the neighboring incubator. Each measurement was recorded against different HFOV amplitude and frequency settings. Each measurement lasted five minutes, where the highest and lowest readings were recorded every minute, and the mean values of noise intensity were calculated.

Main Results: Noise level was increased by more than 40% after using HFOV (50 dB vs. 84 dB and 45 vs. 78) both inside and outside the incubator during the test. The mean noise levels recorded inside the NICU and the quiet room were 86(±5) dB and 78 (±2) dB respectively. The noise records progressively reduced as HFOV ▲P decreased to 20 cmH2O no matter the frequency used.

Conclusions: The HFOV produces significant noise, which is of concern. The noise was augmented within the tested incubator while reduced inside the neighboring incubator. Given the data presented, it is recommended that noise protective tools should be used for infants receiving respiratory support using this machine as well as neighboring infants who are near a HFOV.

S Surenthiran, K Wilbraham, J May, T Chant, A Emmerson, V E Newton	Noise levels within the ear and post-nasal space in neonates in intensive care	Arch Dis Child Fetal Neonatal Ed 2003;88:F315–F318

Background: Noise exposure in neonatal units has long been suspected of being a cause of hearing loss associated with such units. The noise intensity to which the neonate is exposed varies with the type of ventilatory support used. Also, the post-nasal space is an enclosed cavity that is close to the inner ear and an area of turbulent and hence potentially noisy airflow.

Objectives: To determine noise intensities within the ear and post-nasal space in neonates on different modes of ventilatory support using probe microphones, measures previously not undertaken.

Methods: A portable instrument with a probe microphone was used for the measurements. Three groups of infants were included: (a) those receiving no respiratory support (NS); (b) those receiving conventional ventilation (CV); (c) those receiving continuous positive airways pressure (CPAP) support.

Main Results: The mean in-the-ear noise intensities (at 1 kHz) were 41.7 dB SPL (NS), 39.5 dB SPL (CV), and 55.1 dB SPL (CPAP). The noise intensities in the post-nasal space in those receiving CPAP support were higher than in the other groups, reached mean levels of up to 102 dB SPL at some frequencies, and increased with increasing flow rates.

Conclusions: The most important finding is the high noise intensities in the post-nasal space of those receiving CPAP support. Given the proximity of the post-nasal space to the inner ear, enough noise could be transmitted, especially in infants receiving the higher flow rates, to cause cochlear damage and hence hearing loss. It would therefore be wise, wherever possible, to avoid using the higher flow rates.

Amber L. Williams,Wim van Drongelen, Robert E. Lasky	**Noise in contemporary neonatal intensive carea**	DOI: 10.1121/1.2717500

Abstract: Weekly sound surveys (n = 63) were collected, using 5 s sampling intervals, for two modern neonatal intensive care units (NICUs). Median weekly equivalent sound pressure levels (LEQ) for NICU A ranged from 61 to 63 dB (A weighted), depending on the level of care. NICU B L(EQ) measurements ranged from 55 to 60 dB (A weighted). NICU B was recently built with a focus on sound abatement, explaining much of the difference between the two NICUs. Sound levels exceeded 45 dB (A weighted), recommended by the American Academy of Pediatrics, more than 70% of the time for all levels of care. Hourly L(EQ)s below 50 dB (A weighted) and hourly L10s below 55 dB (A weighted), recommended by the Sound Study Group (SSG) of the National Resource Center, were also exceeded in more than 70% of recorded samples. A third SSG recommendation, that the 1 s L(MAX), should not exceed 70 dB (A weighted), was exceeded relatively infrequently (< 11% of the time). Peak impulse measurements exceeded 90 dB for 6.3% of 5 s samples recorded from NICU A and 2.8% of NICU B samples. Twenty-four h periodicities in sound levels as a function of regular staff activities were apparent, but short-term variability was considerable.

Conclusions: Noises that affect health and development in NICU newborns remain to be determined. Future sound surveys should include video recordings or observers to document specific noise events in NICUs. Ear canal acoustics and the maturation of the auditory and arousal systems must also be considered in evaluating the adequacy of the NICU sound environment. Beyond room and device acoustics, individual sound exposures must be measured in order to fully evaluate the health implications of the NICU sound environment. In order to develop evidenced-based recommendations for NICU noise levels, information is needed regarding the NICU sound environment, the responses of sick newborns to sound, and the trade-offs between the aversive consequences of noise, and the benefits of those sounds to the patient and staff. Communication is necessary for effective medical care, noise-generating instrumentation is present for monitoring and intervention, and language and other sounds are important for the infants' social interactions and bonding. This study provides needed information characterizing the sound levels in modern NICUs.

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Juan Carlos Fortes-Garrido et. al.	The characterization of noise levels in a neonatal intensive care unit and the implications for noise management	Journal of Environmental Health Science & Engineering 2014, 12:104

Backround: The effects of noise are particularly harmful for the newborns, and therefore this study assesses and characterizes noise levels in a neonatal intensive care unit (NICU) in a medium-size hospital in the city of Huelva with the aim of optimizing the management and quality of care for newborns.

Methods: The equivalent continuous sound level was recorded as A-weighting curves using Type I sound level meters with levels measured during 100 milliseconds along to 15-day period in the both critical (in and out of incubators), and intermediate care units from a medium-size hospital. These devices were attached to a central beam 80 cm below the ceiling and into one of the incubators.

Results: The maximum noise levels measured for critical (C-in), C(out) and intermediate (I) were: 88.8 dBA, 97.2 dBA and 92.4 dBA, respectively, while for the equivalent noise levels for the total measuring period (15 d) were 57.0 dBA, 63.7 dBA, and 59.7 dBA, respectively. The Fourier frequency analysis has demonstrated several typical periods related to both work activities and family visit, which were: 7 days, 24 h, 12 h, and 3 h.

Conclusions: The statistical analysis revealed a clear correlation between the noise level, the kind of care room, and the time of the day. The results show that the values recommended by international bodies and agencies (AAP, WHO) are surpassed by a large margin, thus making it crucial that certain norms are followed in order to reduce the noise level in the NICU, by means of physical alterations to the layout, and raising awareness of health care personnel and visitors in order to encourage noise prevention in the daily care work and conversation. And finally, has been demonstrated that by applying the t-Student test the mean noise values in both wards are significantly different, which leads us to state that the noise level for the critical wards are higher than in the intermediate care ward.

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Kimberly A. Allen, PhD, RN	Music Therapy in the NICU: Is there Evidence to support Integration for Procedural Support?	Adv Neonatal Care. 2013 October ; 13(5):doi:10.1097/ANC.0b013e3182a0278b.

Objective: Therefore, the purpose of this review was to determine what evidence exists to support the use of music therapy in the NICU during stressful events (e.g., endotracheal suctioning). This use of music therapy is different from music used on a short-term or continuous basis in the NICU, this review only examined the use of music therapy as adjunctive to procedures with preterm infants.

Methods: A total of four (4) research studies were identified meeting the inclusion criteria. All studies (n = 4) evaluated physiologic variables (e.g., heart rate, respiratory rate, oxygenation saturation) and three studies23–25 also examined infant behavior after the stressful event. Two of the studies used a single stressful event endotracheal suctioning;23, 26 while the other two studies24, 25 included inconsolable or agitated infants and recorded the inconsolable or agitated episode as the stressful event without introducing a specific distressing intervention. The studies are organized by the type stressful event. Recommendations are offered as to the future of music therapy in the NICU clinical setting.

Results: It has been found that preterm infants in the NICU are touched, positioned, examined, and manipulated more than 8–12 times over a 4-hour period to assess and evaluate their clinical status.1, 4 Each of these stimuli can be viewed as a stressor by the immature system of a premature infant,5 which can lead to impaired oxygenation, blood flow, heart rate, and behavioral responses.3, 5–8 While not all stressors can be removed from the critical care environment, loud noises and sound has received extensive attention over the past several decades, as a modifiable factor.

Conclusions: Finally, the statistical analysis plan for many of studies involved comparison of means from the entire post intervention stage. While knowing that the intervention on average was helpful over a specified time period, it would be helpful to include statistical analyzes that can account for changes each minute, as having the infant return to baseline is critical to preventing injury from hypoxia. At this point, using music therapy to prevent or aid in reducing hypoxia in premature infants during stressful events is unclear and cannot be recommended. Additional data are necessary, especially follow-up studies examining the well-being of premature infants who were exposed to higher than recommended sound levels. Overall, music therapy may be a helpful intervention for infants, but additional research is necessary before implementing music therapy as an intervention for sick premature infants experiencing stressful events in the NICU.

Back

Debra H. Brandon, Donna J. Ryan, Angel H. Barnes, RN, BSN	**Effect of Environmental Changes on Noise in the NICU**	Neonatal Netw. 2007 Jul-Aug;26(4):213-8.

Objective: To evaluate the effect of changes in the NICU environment on sound levels.

Design: A prospective quasi-experimental design evaluated sound levels in a 43-bed NICU. Decibel levels were monitored utilizing a data-logging dosimeter for 24 hours weekly over 12 months. Sound levels were also measured inside four different incubator models.

Results: Decibel levels were analyzed to identify changes in noise levels following alterations in the NICU environment. Installation of motion-sensing motorized paper towel holders significantly increased levels at beds closest to the towel dispensers, as did thetrial of a new communication system. Decibel levels in four different incubators revealed varying noise levels. This study suggests that all environmental changes must be monitored to ensure that they reduce rather than increase noise levels.

Conclusions: This study suggests that changes in the environment do not always have the intended result. Environmental modifications that are thought to be innocuous may result in small but significant increases in noise levels. Environmental alterations that are expected to decrease noise may not do so. Even small increases in noise levels from individual environmental modifications may have cumulative or exponential effects on the total sound environment. When environmental changes are planned, NICU personnel must include selection criteria that consider the noise they produce.

Allysa Jennie Knutson	**Acceptable Noise Levels for Neonates in the Neonatal Intensive Care Unit.**	Independent Studies and Capstones. Paper 643.

Objective: The purpose of this study is to evaluate noise exposures in an urban level IIIC NICU and determine the levels and sources of noise exposure. The assessments of the levels occurring in the NICU were compared to the 45 dBA noise standard recommended by the American Academy of Pediatrics. Finally, recommendations regarding behavior modifications and appropriate sound level for NICUs are provided.

Methods: This project included conducting sound surveys of naturally occurring noise in the NICU environments. There was no direct neonate involvement. This project was submitted for IRB review and was approved, Dec 21, 2011. On February 3rd, 2012 St. Louis Children's Hospital NICU Unit Based Joint Practice Team then approved the project and data collection was started. The project included two studies, one evaluated the NICU environment and the other evaluated the neonate environment within the incubator.

Results: Study 1: Overall, when assessing the NICU environment in both the West Unit (open) and the East Unit (single family rooms and hallways) the sound level averages are higher than the current recommended standard of 45 dBA.

Conclusions: Sound levels in the NICU and incubator environment were found to be much higher than the recommended standard of 45 dBA. The recommendation does not appear to have a good justification for why 45 dB is the appropriate sound level in the NICU. Sound levels ranged in the NICU environment from 48 to 55 dBA which may be attributed to the HVAC system. Sound levels within the incubator ranged from 58 to 71 dBA. Using behavior modifications such as properly closing doors of the incubator and turning oxygen to face out will help to lower sound level exposure to the neonate. Further research needs to be completed to determine appropriate sound level that promotes neonate tranquility.

Back

Paul E .et. al.	Neonatal Incubators: A Toxic Sound Environment for the Preterm Infant?	Pediatr Crit Care Med. 2012;13(6):685-689.

Backround: High sound pressure levels may be harmful to the maturing newborn. Current guidelines suggest that the sound pressure levels within a neonatal intensive care unit should not exceed 45 dB(A). It is likely that environmental noise as well as the noise generated by the incubator fan and respiratory equipment may contribute to the total sound pressure levels. Knowledge of the contribution of each component and source is important to develop effective strategies to reduce noise within the incubator.

Objective: The objectives of this study were to determine the sound levels, sound spectra, and major sources of sound within a modern neonatal incubator (Giraffe Omnibed; GE Healthcare, Helsinki, Finland) using a sound simulation study to replicate the conditions of a preterm infant undergoing high-frequency jet ventilation (Life Pulse, Bunnell, UT).

Methods: Using advanced sound data acquisition and signal processing equipment, we measured and analyzed the sound level at a dummy infant's ear and at the head level outside the enclosure. The sound data time histories were digitally acquired and processed using a digital Fast Fourier Transform algorithm to provide spectra of the sound and cumulative sound pressure levels (dBA). The simulation was done with the incubator cooling fan and ventilator switched on or off. In addition, tests were carried out with the enclosure sides closed and hood down and then with the enclosure sides open and the hood up to determine the importance of interior incubator reverberance on the interior sound levels

Results: With all the equipment off and the hood down, the sound pressure levels were 53 dB(A) inside the incubator. The sound pressure levels increased to 68 dB(A) with all equipment switched on (approximately 10 times louder than recommended). The sound intensity was 6.0 × 10(-8) watts/m(2); this sound level is roughly comparable with that generated by a kitchen exhaust fan on high. Turning the ventilator off reduced the overall sound pressure levels to 64 dB(A) and the sound pressure levels in the low-frequency band of 0 to 100 Hz were reduced by 10 dB(A). The incubator fan generated tones at 200, 400, and 600 Hz that raised the sound level by approximately 2 dB(A)-3 dB(A). Opening the enclosure (with all equipment turned on) reduced the sound levels above 50 Hz by reducing the revereberance within the enclosure.

Conclusions: The sound levels, especially at low frequencies, within a modern incubator may reach levels that are likely to be harmful to the developing newborn. Much of the noise is at low frequencies and thus difficult to reduce by conventional means. Therefore, advanced forms of noise control are needed to address this issue.

Wachman EM, Lahav A.	The effects of noise on preterm infants in the NICU.	Arch Dis Child Fetal Neonatal Ed. 2011 Jul;96(4)

Abstract
Preterm infants in the neonatal intensive care unit (NICU) are constantly exposed to ambient noise that often exceeds recommended levels. There is a growing concern that such noise puts preterm infants at high risk for adverse health effects. This review looks at the effects of NICU noise on the cardiovascular, respiratory, auditory and nervous systems. Loud transient noise has negative short-term effects on the cardiovascular and respiratory systems of preterm infants, although direct evidence linking noise to neonatal pathology is still unclear. Further controlled trials with larger sample sizes are needed to determine the effects of more extensive exposure to NICU noise on early brain maturation and long-term developmental outcomes.

Kent WD, Tan AK, Clarke MC, Bardell T.	Excessive noise levels in the neonatal ICU: potential effects on auditory system development.	J Otolaryngol. 2002 Dec;31(6):355-60.

Objective: Several recent studies have found exceedingly high noise levels in the neonatal intensive care unit (NICU) and in incubators. The purpose of this study was to perform a detailed noise assessment in a Canadian NICU.

Methods: A noise level meter was used to evaluate ambient noise levels in three rooms of the NICU and to compare those levels with measurements taken inside an occupied incubator.

Results: Mean hourly noise levels measured inside the incubator (61 dB) were significantly higher than those measured outside (55 dB). Ambient noise levels were also significantly higher in rooms where staff activity was greatest (59 dB). In addition, peak noise levels in excess of 120 dB were found.

Conclusion: These findings are consistent with those of previous studies and suggest that noise levels in the NICU are excessive. Furthermore, staff activity is a significant contributor. The suggestion that noise in the NICU is detrimental to both auditory and central nervous system development is discussed and intervention strategies are recommended.

Philbin MK, Gray L.	Changing levels of quiet in an intensive care nursery.	J Perinatol. 2002 Sep;22(6):455-60.

Objective: To document low sound levels, the range and pattern of levels, and the relative effects of operational (staff and equipment generated) and facility (building generated) noise on the acoustic environment of a level III nursery.

Study Design: A quasi-experimental, prospective, longitudinal study of one bed space. Operational noise was reduced through staff behavior change while facility noise was reduced through renovation.

Results: Initial noise levels were typical of those in the literature and in recently measured nurseries. About 80% of sound levels were between 62 and 70 dBA. The lowest levels (L(min)) were 60 to 65 dBA. After staff behavior change, L(min) was about 56 dBA although the highest levels (L(max)) remained at 78 to 100 dBA. Levels following renovation were reduced to L(min)s of 47 to 51 dBA and L(max)s of 68 to 84 dBA, perceived as three or four times quieter than initially.

Conclusion: Staff behavior as well as the acoustical characteristics of the facility determine the levels of noise and quiet in an intensive care nursery.

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Biabanakigoortani A et. al.	**Effect of peer education on the noise management in Iranian neonatal intensive care unit.**	Iran J Nurs Midwifery Res. 2016 May-Jun;21(3):317-21. doi: 10.4103/1735-9066.180392.

Background: Advancements in neonatal intensive care unit (NICU) science and technology have increased the survival rate of preterm infants. Despite these advances, they are still facing with neurobehavioral problems. Noise level in NICU is a potential source of stress for preterm infants. It should be decreased to the standard level as much as possible. The purpose of this study was to evaluate the effect of peer education on the performance of staff in noise management in the NICU.

Materials and methods: A pre-post test quasi-experimental design was used. Fifty-eight staff members (nurses and physicians) participated in this study. Sound pressure levels were measured before and after the intervention. Peer education program formed the intervention. The staff performance in noise management was evaluated before and after the intervention by using a questionnaire. Data analysis was done by using t-test.

Results: The results of the study showed that the mean sound level in different environments significantly decreased after the intervention. It reached from 86.7 to 74.9 dB in the center of unit and from 68.2 to 48.50 dB in the infants' bedside ($P < 0.0001$). The mean score of the staff performance in noise management significantly increased after the intervention, compared to the pre-intervention score. It increased from 74.6 to 83.4 ($P < 0.0001$).

Conclusion: Peer education was found to be successful in noise management because behavioral changes were done to avoid generating unnecessary noise by the staff.

Karam O, Donatiello C, Van Lancker E, Chritin V, Pfister RE, Rimensberger PC.	**Noise levels during nCPAP are flow-dependent but not device-dependent.**	Arch Dis Child Fetal Neonatal Ed. 2008 Mar;93(2):F132-4. Epub 2007 Dec 18.

Objective: Nasal continuous positive airway pressure (nCPAP) has been shown to improve the outcome of infants with respiratory distress syndrome. However, noise generation could be of concern. Therefore, our study was designed to measure the noise levels of various CPAP drivers.

Design: For infants admitted to our neonatal intensive care unit and paediatric critical care unit, we measured the noise level in the oral cavity, using a microphonic probe with a flexible capillary tube. Various CPAP drivers and interfaces have been tested.

Results: 27 measurements were made in eight infants. Mean noise level was 88.6 (SD 18.8) dB and was correlated with flow ($p<0.01$) but not with pressure. A noise level above 90 dB was detected in 67% of the measurements.

Conclusion: nCPAP drivers are valuable devices for neonatal care that may prevent primary mechanical ventilation or re-intubation, but generate a large amount of noise, often higher than occupational limits accepted for adult workers. Therefore, new devices must be designed to minimise this possible noxious exposure of premature infants to unacceptably high noise levels.

Kirchner L, Wald M, Jeitler V, Pollak A.	**In vitro comparison of noise levels produced by different CPAP generators.**	Neonatology. 2012;101(2):95-100. doi: 10.1159/000329558. Epub 2011 Sep 17.

Introduction: Minimization of noise exposure is an important aim of modern neonatal intensive care medicine. Binasal continuous positive airway pressure (CPAP) generators are among the most important sources of continuous noise in neonatal wards. The aim of this study was to find out which CPAP generator creates the least noise.

Method: In an experimental setup, two jet CPAP generators (Infant Flow® generator and MediJet®) and two conventional CPAP generators (Bubble CPAP® and Baby Flow®) were compared. Noise production was measured in decibels in an A-weighted scale [dB(A)] in a closed incubator at 2 mm lateral distance from the end of the nasal prongs. Reproduction of constant airway pressure and air leak was achieved by closure of the nasal prongs with a type of adhesive tape that is semipermeable to air.

Results: The noise levels produced by the four generators were significantly different ($p < 0.001$). Values measured at a continuous constant flow rate of 8 l/min averaged 83 dB(A) for the Infant Flow® generator with or without sound absorber, 72 dB(A) for the MediJet®, 62 dB(A) for the Bubble CPAP® and 55 dB(A) for the Baby Flow®.

Conclusion: Conventional CPAP generators work more quietly than the currently available jet CPAP generators.

König K, Stock EL, Jarvis M.	**Noise levels of neonatal high-flow nasal cannula devices--an in-vitro study.**	Neonatology. 2013;103(4):264-7. doi: 10.1159/000346764. Epub 2013 Mar 5.

Background: Excessive ambient noise levels have been identified as a potential risk factor for adverse outcome in very preterm infants. Noise level measurements for continuous positive airway pressure (CPAP) devices demonstrated that these constantly exceed current recommendations. The use of high-flow nasal cannula (HFNC) as an alternative non-invasive ventilation modality has become more popular in recent years in neonatal care

Objective: To study noise levels of two HFNC devices commonly used in newborns. As a comparison, noise levels of a continuous flow CPAP device were also studied.

Methods: In-vitro study. The noise levels of two contemporary HFNC devices (Fisher & Paykel NHF™ and Vapotherm Precision Flow®) and one CPAP device (Dräger Babylog® 8000 plus) were measured in the oral cavity of a newborn manikin in an incubator in a quiet environment. HFNC flows of 4-8 l/min and CPAP pressures of 4-8 cm H2O were applied. The CPAP flow was set at 8 l/min as per unit practice.

Results: Vapotherm HFNC generated the highest noise levels, measuring 81.2-91.4 dB(A) with increasing flow. Fisher & Paykel HFNC noise levels were between 78.8 and 81.2 dB(A). The CPAP device generated the lowest noise levels between 73.9 and 77.4 dB(A).

Conclusion: Both HFNC devices generated higher noise levels than the CPAP device. All noise levels were far above current recommendations of the American Academy of Pediatrics. In light of the long duration of non-invasive respiratory support of very preterm infants, less noisy devices are required to prevent the potentially adverse effects of continuing excessive noise exposure in the neonatal intensive care unit.

Pineda R, Durant P, Mathur A, Inder T, Wallendorf M, Schlaggar BL.	**Auditory Exposure in the Neonatal Intensive Care Unit: Room Type and Other Predictors.**	J Pediatr. 2017 Apr;183:56-66.e3. doi: 10.1016/j.jpeds.2016.12.072. Epub 2017 Feb 8.

Objective: To quantify early auditory exposures in the neonatal intensive care unit (NICU) and evaluate how these are related to medical and environmental factors. We hypothesized that there would be less auditory exposure in the NICU private room, compared with the open ward.

Study Design: Preterm infants born at ≤ 28 weeks gestation (33 in the open ward, 25 in private rooms) had auditory exposure quantified at birth, 30 and 34 weeks postmenstrual age (PMA), and term equivalent age using the Language Environmental Acquisition device.

Results: Meaningful language ($P < .0001$), the number of adult words ($P < .0001$), and electronic noise ($P < .0001$) increased across PMA. Silence increased ($P = .0007$) and noise decreased ($P < .0001$) across PMA. There was more silence in the private room ($P = .02$) than the open ward, with an average of 1.9 hours more silence in a 16-hour period. There was an interaction between PMA and room type for distant words ($P = .01$) and average decibels ($P = .04$), indicating that changes in auditory exposure across PMA were different for infants in private rooms compared with infants in the open ward. Medical interventions were related to more noise in the environment, although parent presence ($P = .009$) and engagement ($P = .002$) were related to greater language exposure. Average sound levels in the NICU were 58.9 ± 3.6 decibels, with an average peak level of 86.9 ± 1.4 decibels.

Conclusion: Understanding the NICU auditory environment paves the way for interventions that reduce high levels of adverse sound and enhance positive forms of auditory exposure, such as language.