



Effects of ventilation on hearing loss in preterm neonates: Nasal continuous positive pressure does not increase the risk of hearing loss in ventilated neonates

Shantanu Rastogi^{a,*}, Michel Mikhael^a, Panayot Filipov^a, Deepa Rastogi^b

^a Division of Neonatology, Maimonides Infants and Children Hospital, Maimonides Medical Center, Brooklyn, NY 11219, United States

^b Division of Respiratory and Sleep Medicine, Children's Hospital at Montefiore, Albert Einstein College of Medicine, 3415 Bainbridge Avenue, Bronx, NY 10467, United States

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ABSTRACT

Introduction: There is increased risk of hearing loss in preterm neonates. This risk is further increased by environmental noise exposure especially from life support equipment such as ventilation. Nasal continuous positive airway pressure (NCPAP) used for respiratory support of preterm neonates is known to be associated with prolonged exposure to high levels of noise. However, there is paucity of information on the effect of NCPAP as compared to mechanical ventilation on hearing loss among preterm neonates.

Methods: A retrospective chart review was performed on neonates with birth weight (BW) <1500 g. Association of clinical factors including the use of NCPAP and mechanical ventilation with failure of hearing screen were studied. Those who failed hearing screen were followed for 2 years to observe long term effects of NCPAP on the hearing loss.

Results: Of 344 neonates included in the study, 61 failed hearing screen. Gestational age ($p = 0.008$), BW ($p = 0.03$), ventilation ($p = 0.02$), intrauterine growth retardation ($p = 0.02$), necrotizing enterocolitis (NEC) ($p = 0.02$), apnea ($p < 0.001$), use of vancomycin ($p = 0.01$) and furosemide ($p = 0.01$) were associated with failure of hearing screen. On multivariate analysis, ventilation (OR 4.56, $p = 0.02$), apnea (OR 2.2, $p < 0.001$) and NEC (OR 2.4, $p = 0.02$) were predictors of failed hearing screen. As compared to those not ventilated, the odds of failing hearing screen was 4.53 ($p < 0.01$) and 4.59 ($p < 0.01$) for those treated with NCPAP and mechanical ventilation respectively, with there being no difference between these two ventilatory modalities. Of the 61 neonates, 42 were followed for 2 years, of which 19 had confirmed hearing loss. Among these 19 neonates, there was no difference ($p = 0.12$) between those who were treated with NCPAP or with mechanical ventilation.

Conclusion: There is no increase in the hearing loss in preterm neonates treated with NCPAP as compared to mechanical ventilation despite being exposed to higher environmental noise generated by the NCPAP.

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1. Introduction

Hearing loss occurs in up to 4% of all neonates admitted to the neonatal intensive care unit (NICU) [1] and is significantly higher in preterm neonatal survivors [2]. This increased risk of hearing loss in preterm neonates may be related to prematurity, its associated clinical morbidities and prolonged environmental noise trauma

leading to cochlear hair cell damage. As these hair cells lack the ability to regenerate, severe and prolonged noise exposure may lead to permanent and complete hearing loss in preterm neonates [3]. Preterm neonates are exposed to multiple sources of acoustic trauma during their stay in the NICU. Of particular importance is noise created by life-support equipment like the isolette, alarms from vital sign monitors and ventilators [4]. The incidence of hearing loss has been directly correlated with the method [5,6] and the length of ventilation used [3] for managing respiratory distress in preterm neonates.

Noninvasive ventilation like nasal continuous positive pressure (NCPAP) is increasingly used as alternative ventilatory modality since its use is associated with lower pulmonary morbidity when compared to mechanical positive pressure ventilation. NCPAP is associated with a decrease in broncho-pulmonary dysplasia

Abbreviations: NICU, neonatal intensive care unit; NCPAP, nasal continuous positive airway pressure; GA, gestational age; BW, birth weight; LOS, length of stay; IVH, intraventricular hemorrhage; NEC, necrotizing enterocolitis; ROP, retinopathy of prematurity; CMV, cytomegalovirus.

* Corresponding author at: Maimonides Infants and Children Hospital, 1048 Tenth Avenue, F-119, Brooklyn NY 11219, United States. Tel.: +1 718 283 8853.

E-mail address: srastogi@maimonidesmed.org (S. Rastogi).

without increase in other morbidities in preterm neonates [7–12]. Despite these advantages, concerns remain regarding significantly higher noise exposure to preterm newborns managed by NCPAP as compared to those who are either receive no respiratory support or managed by mechanical ventilation [13]. Two-thirds of the neonates on bubble NCPAP are exposed to ≥ 90 dB of noise [14] which is significantly higher than the maximum acceptable noise level of 45 dB [4]. Furthermore, NCPAP is used for periods of weeks to months which exposes the preterm neonates to higher noise level for a prolonged period of time. Despite the evidence of prolonged and severe noise exposure due to bubble NCPAP which may increase the risk of hearing loss, there is paucity of clinical information on the incidence of hearing loss associated with NCPAP use in the NICU.

To address this knowledge gap, the aim of this study was to compare the incidence of hearing loss in preterm neonates <1500 g who were treated with bubble NCPAP with those who were treated with mechanical ventilation. We hypothesized that the risk of hearing loss in the neonates treated with NCPAP was not greater than that in neonates who were mechanically ventilated.

2. Materials and methods

A retrospective chart review was conducted between January 2003 and December 2007 on preterm infants admitted to the NICU at the Maimonides Infant and Children Hospital. This study was approved by the institutional review board at Maimonides Medical Center and was conducted in compliance with Health Insurance Portability and Accountability Act regulations. There were 454 neonates born with birth weight (BW) <1500 g. We excluded neonates with congenital malformations, and genetic syndromes. Of 454 neonates, 33 were transferred for cardiac surgery, ECMO or back to the referral hospital and 77 either did not meet inclusion criteria or expired (Fig. 1) and remaining 344 were included in the study.

We studied the incidence of failed hearing screen in 344 neonates. We then investigated the association of failure of hearing screen with clinical variables including BW, gestational age (GA), ethnicity and gender along with antenatal factors such as chorioamnionitis and intrauterine growth retardation (IUGR) (<3rd percentile). Postnatal factors included were Apgar scores, ventilation (use of NCPAP and/or mechanical ventilation), anemia (hematocrit of <30), apnea (cessation of respiration for >20 s associated with bradycardia or cyanosis) treated with caffeine, intraventricular hemorrhage (IVH) (grades 3 and 4, diagnosed by ultrasound), periventricular leukomalacia (PVL) (diagnosed by ultrasound), culture positive sepsis/meningitis and necrotizing enterocolitis (NEC) (presence of pneumatosis intestinalis). Additionally, the association of failed hearing screen with the use of phototherapy, and medications including gentamicin, vancomycin and furosemide were also studied.

2.1. Respiratory management

A uniform method of respiratory management has been practiced in our NICU for over a decade as previously described [15]. All spontaneously breathing neonates with respiratory distress are placed on bubble NCPAP using short binasal prongs (Hudson RCI, Research Triangle, NC) with 5 cm H₂O pressure within first 10 min of life irrespective of their GA and BW. Those who are not breathing spontaneously or fail a trial of NCPAP are intubated and mechanically ventilated. Surfactant is used only as rescue treatment. The flow of air in the NCPAP is maintained at 8 l/min with 5 cm of H₂O pressure.

2.2. Hearing screen

Hearing screen in the NICU is performed between 34 and 35 weeks post conceptional age when the neonate is close to discharge from the NICU. It is performed by a trained nurse or

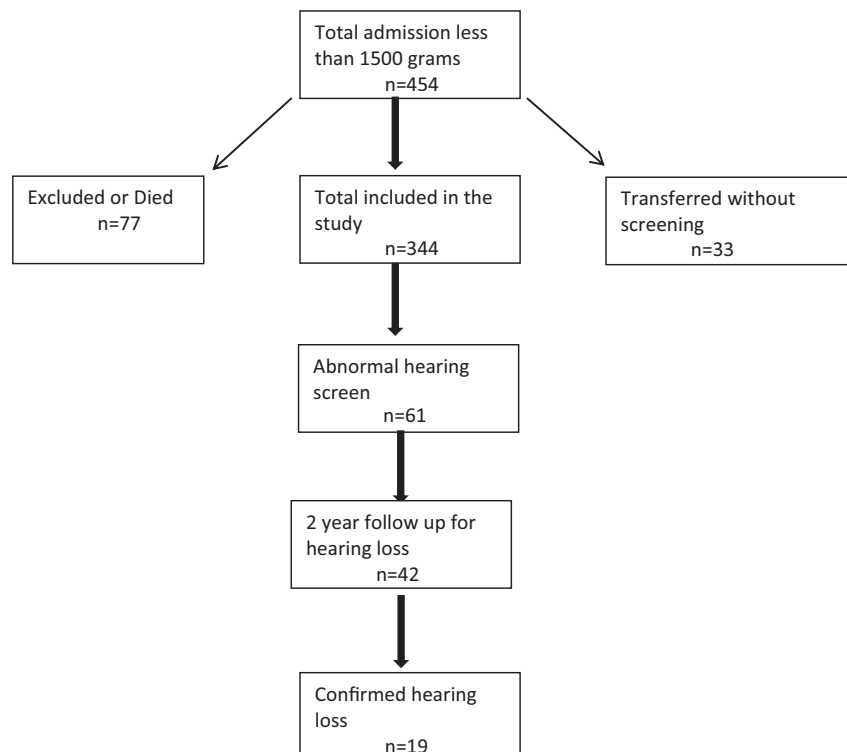


Fig. 1. Algorithm of the study design.

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