Abstract

Objective: To demonstrate that neonatal ventilators produce high noise levels through bone conduction (BC) as well as air conduction (AC).

Study Design: Noise levels were measured from three ventilators at the end of the endotracheal tube, ETT (simulating BC) and a set distance (simulating AC).

Methods: A sound level meter (Quest 1900) was used to measure the noise levels 4 feet from the ventilator and at the end of a balloon attached to the end of the ETT to simulate a lung. Three ventilators (Sensormedics 3100A, VIP Bird and Bunnell Jet) and a Positive airway pressure machine (Viasys infant flow system) were tested.

Results: Noise levels were significantly higher (8-13dB) at the end of the ETT than 4 ft from the ventilator.

Conclusion: High noise intensities are being presented not only as AC, but as BC to the infants. This study demonstrates how ear protection alone will not save these at-risk infants from hearing damage. More must be done to decrease flow rates and develop quieter machines.

Introduction

Noise exposure in NICUs has been proven to be a significant factor in neonatal associated hearing loss. Studies have shown that the prevalence of neonatal hearing loss could be as high as 3%. Risk factors associated with hearing loss (1.8%) were severe birth asphyxia and assisted ventilation >5 days (1).

The US environmental protection agency recommends sound levels in NICUs to not exceed 45dB. (2) Following this discovery NICUs have instituted noise protection via ear muff or ear plugs.

The aim of this study is too not only measure the noise levels of the most common ventilators used in the NICU, but to make an estimate of the noise being presented as bone conduction from the Endotracheal tube.

Methods and Materials

Three commonly used ventilators were investigated:

- The SensorMedics 3100A (Sensormedics, Yorba Linda, USA) is a high frequency oscillatory device of the diaphragm type (MAP max 40 mbar, amplitude 0-80mbar). Inspiratory time can be varied with the position of the diahragm.
- The VIP Bird (Bird, Palm Springs, CA) is conventional, microprocessor controlled and pneumatically powered ventilator. Jet ventilation was added to the VIP Bird via Bunnell Life Pulse (Bunnell Inc., Salt Lake City, USA) a high frequency jet ventilator.
- Additional test system: The Viasys Infant Flow (Viasys Healthcare, PalmSprings, USA) CPAP (continuous positive airway pressure) system was also tested utilizing a nasal CPAP delivery system.

Bone conduction simulation device:

- Direct noise conduction was simulated using a nitrite balloon attached to the patient end of the ETT (Endotracheal tube). This provided direct sound conduction from the ventilator tubing to the sound level meter.

Results

Noise levels were significantly higher (8-13dB) at noise emulator, (simulating direct noise presented as bone conduction to the infant) compared to the ambient machine noise 4 ft from the ventilator for all ventilators studied. Of note, Noise levels for the CPAP system were significantly higher than the ventilator systems.

Conclusions

Previous studies have shown high ambient noise levels in NICUs, but have failed to address the actual noise presented to the infant. ETT transmission of noise as a direct bone stimulus through the skull has been overlooked. This study has shown that high noise intensities are being presented not only as AC, but as BC to the infants though the ETT or nasal cannula. This study demonstrates how ear protection alone will not save these at-risk infants from hearing damage. More must be done to decrease noise exposure and develop quieter machines.

Bibliography


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Subject area: Pediatric Otolaryngology

EBM Level: 5 (expert opinion based on bench research)