Noninvasive Respiratory Support in the Preterm Infant

Vineet Bhandari, MD, DM

KEYWORDS

• SNIPPV • NIPPV • Nasal ventilation • Neonate • Respiratory distress syndrome • Surfactant • Bronchopulmonary dysplasia

KEY POINTS

- Nasal intermittent positive pressure ventilation is a mode of noninvasive respiratory support that combines nasal continuous positive airway pressure and intermittent mandatory ventilation.
- Compared with nasal continuous positive airway pressure, synchronized or non-synchronized nasal intermittent positive pressure ventilation has been shown to be superior in keeping infants extubated.
- Pilot randomized controlled trials have suggested that use of synchronized nasal intermittent positive pressure ventilation or nasal intermittent positive pressure ventilation, with or without early surfactant (<2 hours of life), may decrease bronchopulmonary dysplasia.

INTRODUCTION

Noninvasive respiratory support in neonates can be achieved by a variety of interfaces using the mouth or nares and a positive pressure source. This article focuses on recent studies that have used nasal intermittent positive pressure ventilation (NIPPV) as a method of noninvasive ventilator assistance mostly in premature newborns. NIPPV is essentially a mode for providing intermittent mandatory ventilation using nasal prongs.[1]

A BRIEF HISTORY OF NIPPV

Early use of NIPPV was directed toward controlling apnea of prematurity,[2] but the report of increased risk of gastrointestinal perforations in sick neonates[3] put the technique into disfavor. Although a small randomized study of synchronized NIPPV (SNIPPV) using nasopharyngeal prongs showed promise,[4] only after two independently conducted randomized controlled trials (RCT) with adequate sample size[5,6]

Division of Perinatal Medicine, Department of Pediatrics, Yale University School of Medicine, Yale Child Health Research Center, Room 219, PO Box 208081, 464 Congress Avenue, New Haven, CT 06520, USA
E-mail address: vineet.bhandari@yale.edu

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was there renewed interest in this technique. The major difference between the early reports and the more recent RCTs was the use of synchronization, although one[6] of them also specifically used an orogastric tube left open and placed above the infant for decompression of the stomach.[1]

MECHANISM OF ACTION

Recent animal studies have provided data regarding physiologic effects of NIPPV. In neonatal lambs, NIPPV leads to glottal narrowing in the volume control mode.[7] Furthermore, this active glottal narrowing originates secondary to bronchopulmonary receptors.[8] More significantly, pulmonary inflammation is decreased in surfactant-deficient newborn piglets managed with NIPPV versus invasive ventilation.[9,10]

In human neonates the precise mechanism of action is not known; however, most studies done with NIPPV have suggested short-term benefits, especially with the use of synchronization. These studies have been done in a small number of clinically stable babies over a few hours. Using NIPPV, Kugelman and colleagues[11] observed a decrease in respiratory rate, but increased blood pressure and discomfort. With NIPPV, the delivered peak inspiratory pressure (PIP) was variable in either direction of the set PIP.[12] There was improved stability of the chest wall, improved pulmonary mechanics and thoracoabdominal motion synchrony, decreased flow resistance,[13] and increased tidal and minute volumes[14] in infants on SNIPPV. Other investigators have not found such improved lung mechanics, but did note decreased work of breathing and reduced chest wall distortion.[15–17] SNIPPV could be adding increased intermittent distending pressure above positive end expiratory pressure, with increased flow delivery in the upper airway.[4] We suggest that, in the long-term, the overall effect is recruitment of collapsed alveoli[18] with increasing functional residual capacity and improved gas exchange, especially in the sicker neonate.[1]

CURRENT USE OF NIPPV

Interest in the use of NIPPV in neonates can be gauged by several recent reviews from countries across the globe.[1,19–24] In the United Kingdom, 48% of 91[20] and in Ireland 61% of 28[25] units surveyed reported using NIPPV, whereas it was 98.7% of 81 units in Brazil.[26] No such data are available from the United States. It is important to mention that a variety of ventilators and settings are used to provide NIPPV.[1,20,23] Therefore, the studies are very heterogeneous.

NIPPV in the primary mode refers to its use soon after birth with or without a short period ($\leq$2 hours) of intubation for surfactant delivery, followed by extubation.[1] The secondary mode refers to its use after a longer period (>2 hours to days to weeks) of intubation.[1]

TECHNIQUE

Given the earlier experience with NIPPV, which demonstrated an increased incidence of gastrointestinal perforations,[3] recent RCT have used SNIPPV.[4–6] All three of these trials selected the Infant Star ventilator (CareFusion, Yorba Linda, CA) with the Star-Sync module (CareFusion, Yorba Linda, CA) for synchronization. Subsequent nasal ventilation studies using the SNIPPV approach have used the same ventilator.[15,17,27–31] However, synchronization of nasal ventilation has also been reported using the Sechrist IV-200 SAVI ventilator (Sechrist Industries, Anaheim, CA)[16] and a nasal-flow synchronized ventilator (Giulia; Ginevri, Rome, Italy) that detects the inspiratory effort by means of a pneumotachograph.[32] Noninvasive ventilation using neurally