Nasal Intermittent Positive Pressure Ventilation for Preterm Neonates: Synchronized or Not?

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KEYWORDS

• Synchronization • NIPPV • Bilevel • BPD • Noninvasive ventilation • Preterm infant

KEY POINTS

- Nasal intermittent positive pressure ventilation (NIPPV) is a strategy that provides positive pressure above the positive end-expiratory pressure level.
- Bilevel NIPPV and conventional mechanical ventilator-driven NIPPV differ substantially in pressures and cycling times; both methods can be used in a nonsynchronized or synchronized mode.
- Results of a metaanalysis suggest beneficial effects of synchronized CMV NIPPV in preterm infants with regard to extubation failure when compared with continuous positive airway pressure support.
- Little evidence exists on the efficacy of synchronization during CMV NIPPV and bilevel NIPPV and the impact on important outcomes such as bronchopulmonary dysplasia and mortality.

INTRODUCTION

In the last decade, the early use of nasal continuous positive airway pressure (CPAP) has become a cornerstone in the treatment of respiratory distress syndrome in infants born very prematurely.[1] However, CPAP failure occurs in up to 50% of extremely low birth weight infants.[1–4] Apnea of prematurity and progressive respiratory acidosis are the most common reasons for CPAP failure.[5] Nasal intermittent positive pressure ventilation (NIPPV) has become increasingly popular in neonatology, with the goal to avoid intubation and invasive ventilation. NIPPV is defined as any mode of assisted ventilation that delivers pressure throughout the respiratory cycle with additional phasic increase in airway pressure without the presence of an endotracheal tube;

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NIPPV therefore augments CPAP with superimposed inflations to a set peak pressure.[6] The devices used for this purpose can be broadly classified into 2 categories: bilevel positive airway pressure (bilevel NIPPV) and conventional mechanical ventilator-driven (CMV) NIPPV. They differ substantially in maximal peak inspiratory pressures (PIP) and cycling times.[7] In a large pragmatic randomized controlled trial (RCT), the use of NIPPV did not reduce the rate of death or BPD in extremely low birth weight infants, as compared with CPAP.[8] In this trial, both bilevel NIPPV and CMV NIPPV were used, because of the variability between different NIPPV devices used in clinical practice. Interpretation of results of all studies is complicated by the different devices used to provide NIPPV, the multiple clinical indications, different patient populations, duration and settings of respiratory support (ie, inspiration time, PIP), weaning processes and the use of synchronization during NIPPV.[9] This review focuses on the different NIPPV strategies, indications and reviews current techniques and evidence with regard to synchronization.

RATIONALE FOR THE USE OF NASAL INTERMITTENT POSITIVE PRESSURE VENTILATION

Attention to several perinatal therapies, such as antenatal corticosteroids, surfactant replacement, early CPAP, and the increased use of noninvasive ventilation strategies have improved respiratory outcomes in very preterm infants.[10–12] Nonetheless, prolonged intubation and mechanical ventilation, barotrauma and volutrauma as well as oxygen toxicity are associated with the development of bronchopulmonary dysplasia (BPD).[13] In addition, respiratory instability, including apnea of prematurity and frequent fluctuations in oxygen saturation, may contribute to a poor neurodevelopmental outcome and may increase morbidity as well.[14–17] Although CPAP stabilizes lung volume and improves apnea and upper airway obstruction, it does not effectively improve ventilation and has limited benefits in infants with poor respiratory efforts.[18] Therefore, NIPPV as a mode of noninvasive ventilation has been proposed to avoid mechanical ventilation and stabilize respiration in preterm infants. The mechanisms of action of NIPPV are not yet fully understood. In surfactant-deficient newborn piglets, NIPPV reduced the pulmonary inflammatory response compared with invasive ventilation.[19] Several investigators have shown that NIPPV, especially when used in the synchronized mode, reduces the work of breathing (WOB) and chest wall distortion, and improves gas exchange.[20–23] It is postulated that the intermittent distending pressure above positive end-expiratory pressure (PEEP) level increases the mean airway pressure, which more efficiently recruits the lung and improves functional residual capacity.[24–26]

MODALITIES OF NASAL INTERMITTENT POSITIVE PRESSURE VENTILATION SUPPORT

Differences Between Bilevel Nasal Intermittent Positive Pressure Ventilation and Conventional Mechanical Ventilator-Driven Nasal Intermittent Positive Pressure Ventilation

Devices used to provide bilevel NIPPV mostly deliver a variable flow and aim to provide 2 alternate PEEP levels (high and low). The inspiration times on the bilevel NIPPV are much longer and the respiratory rates are typically lower than those set during CMV NIPPV, to allow spontaneous breathing on both levels of PEEP. The PIP generated by bilevel systems are generally between 9 and 11 cm H_2O.[7] With variable flow systems, the flow toward the baby increases during inspiration and decreases during expiration. Variable flow therefore has been shown to reduce WOB in preterm infants.[27]

CMV NIPPV, in contrast, is delivered by a conventional ventilator and provides a constant flow. Higher PIP are delivered with inspiration times that are comparable with those used during invasive mechanical ventilation (**Fig. 1**). With constant flow