Neurally Adjusted Ventilatory Assist for Noninvasive Support in Neonates

Kimberly S. Firestone, MSc, RRT[a], Jennifer Beck, PhD[b,c], Howard Stein, MD[d,e,*]

KEYWORDS

• Noninvasive ventilation • Premature infant • Neural trigger
• Neurally adjusted ventilatory assist (NAVA) • Patient-ventilator interaction
• Synchrony • Respiratory distress syndrome

KEY POINTS

- Neurally adjusted ventilatory assist (NAVA) and noninvasive ventilation (NIV)-NAVA allow both the timing and degree of ventilatory assist to be controlled by the patient.
- NIV-NAVA delivers synchronized ventilation independent of leaks.
- NIV-NAVA results in improved patient-ventilator interaction, reliable respiratory monitoring, and effective ventilation at levels determined by the patient.
- NIV-NAVA has great potential as a mode of respiratory support in neonates to prevent endotracheal intubation, allow early extubation, and as a novel way to deliver continuous positive airway pressure.

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[a] Neonatal Respiratory Outreach Clinical Liaison, Neonatal Intensive Care Unit, Neonatology Department, Akron Children's Hospital, One Perkins Square, Akron, OH 44308, USA; [b] Keenan Research Centre for Biomedical Science, St. Michael's Hospital, Department of Pediatrics, University of Toronto, 30 Bond Street, Toronto, ON M5B 1W8, Canada; [c] Institute for Biomedical Engineering and Science Technology (iBEST), Ryerson University and St. Michael's Hospital, Department of Chemistry and Biology, 350 Victoria Street, Toronto, ON M5B 2K3, Canada; [d] Neonatal Intensive Care Unit, Promedica Toledo Children's Hospital, Department of Pediatrics, 2142 North Cove Boulevard, Toledo, OH 43606, USA; [e] University of Toledo, Department of Pediatrics, University of Toledo Health Science Campus, 3000 Arlington Avenue, Toledo, OH 43614, USA
* Corresponding author. Department of Pediatrics, Promedica Toledo Children's Hospital, 2142 North Cove Boulevard, Toledo, OH 43606.
E-mail address: Howardstein@bex.net

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INTRODUCTION

The prolonged use of an endotracheal tube and mechanical ventilation may cause upper airway damage and predispose the neonate to the development of chronic lung disease (CLD) or bronchopulmonary dysplasia.[1] Respiratory support without endotracheal intubation has become a primary mode of management to avoid intubation or as postextubation treatment for spontaneously breathing respiratory deficient infants. This often can be accomplished through the use of noninvasive respiratory support delivered via nasal mask or prongs. The options of nasal continuous positive airway pressure (nCPAP) or nasal intermittent positive pressure ventilation (NIPPV) are predominant selections of choice for this support. Recently a Cochrane review compared available literature for NIPPV versus nCPAP in preterm infants after extubation and showed that NIPPV may be more effective than nCPAP in reducing extubation failure.[2]

The goal of NIPPV, similar to invasive ventilation, is to provide respiratory muscle unloading and adequate ventilation while maintaining lung volume through the application of positive end-expiratory pressure (PEEP) while also preserving normal physiologic functions, decreasing airway injury, and preventing respiratory tract infections. This method of noninvasive support has been used by many neonatologists; recent data from more than 900 neonatal intensive care units (NICUs) in the Vermont Oxford Network showed that 28% to 31% of very low birth weight neonates received support with NIPPV at some point during their hospitalization. However, failure can occur, with approximately 30% of these infants requiring reintubation.[2]

Although noninvasive ventilation (NIV) may be clinically effective without synchronization, it may be important in delivering effective NIPPV for many reasons. Nonsynchronized NIV is time-cycled, pressure-controlled ventilation with or without a preset constant flow and can be unresponsive to the patient's spontaneous breathing pattern. Alternatively, synchronized NIPPV has been delivered using pneumatic controller signals, such as pressure, flow, or abdominal displacement. However, in the presence of leaks, rapid respiratory rates, and small tidal volumes, achieving good communication between the patient and the ventilator remains a challenge.[3] The matter of appropriate cycling-off is not addressed, and most conventional NIPPV modes are pressure targeted, which provides no accountability for the variable respiratory demand observed in preterm newborns.[4] Asynchrony during ventilation has the potential for adverse effects that can lead to upper airway constrictor muscle activation,[5,6] diversion of ventilator breaths into the stomach,[7] increased mean airway pressure and fraction of inspired oxygen (Fio_2), and fluctuations in blood pressure and intracranial pressure.[8] Nonsynchronized ventilation may deliver high pressures during spontaneous exhalation, increasing the risk of barotrauma to the airways and airleak.[8] Often ignored, during NIPPV, monitoring the patient's respiration is problematic, as the parameters used to evaluate respiratory metrics are also affected by leaks.

One newer method of delivering assisted ventilation has the potential to overcome these challenges. The neural trigger uses the electrical activity of the diaphragm (Edi) to trigger and control the ventilator. This type of ventilation is known as neurally adjusted ventilatory assist (NAVA). The ventilator delivers mechanical breaths that are synchronized to initiation, size, and termination with each patient's breath and is controlled by the patient.[9,10] This Edi signal is obtained from a specialized indwelling nasogastric feeding tube with embedded sensing electrodes (NAVA catheter). When it is properly positioned, it can accurately and reliably trigger and cycle the ventilator breath, independent of airway leaks.[11] This makes it possible to use nasal interfaces that cannot achieve a tight seal. Conceptually, these characteristics may make