Continuous Positive Airway Pressure Strategies with Bubble Nasal Continuous Positive Airway Pressure

Not All Bubbling Is the Same: The Seattle Positive Airway Pressure System

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KEYWORDS

• CPAP • Continuous positive airway pressure • Bubbling • Seattle PAP system
• Premature infant • Bronchopulmonary dysplasia

KEY POINTS

- Evidence is accumulating that bubble nasal continuous positive airway pressure (CPAP) is preferred, and suggests that the bubbling provides support in addition to mere administration of CPAP.
- However, CPAP failure requiring intubation and mechanical ventilation is common. CPAP failure is associated increased morbidity (in developed countries) and mortality (in developing countries).
- More research to understand the effects of bubbling and CPAP on the developing respiratory system function and disease in premature infants is essential.
- The pilot work done on high-amplitude bubble nasal CPAP (Seattle PAP) has observed some encouraging results and additional trials of safety and efficacy are forthcoming.

INTRODUCTION

Neonatology is a relatively new field in pediatrics that was launched when information and practice about supportive therapies became available that improved survival in neonates that were afflicted with respiratory distress and/or prematurity. For example, understanding and addressing proper thermoregulation and humidity in premature infants in pioneering work from Silverman and coworkers[1,2] was

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associated with dramatic improvements in survival. Death from respiratory failure was also common and implementation of respiratory support strategies, including support with mechanical ventilation and supplemental oxygen, both improved survival, and created a "new" disease, termed bronchopulmonary dysplasia (BPD) in 1967.[3] Refining respiratory support strategies with positive pressure and supplemental oxygen have remained active areas of research and implementation at the same time that the population of premature infants have changed dramatically to markedly premature neonates poorly prepared developmentally for supportive therapeutics. Survival in markedly premature infants, as little as 22 to 23 weeks gestation, was possible, primarily through improvements in obstetric management in the perinatal period. The major improvements have been broad and have focused on the perinatal period, including the more widespread use of antenatal steroid administration to mothers likely to deliver a premature infant than before the consensus statement on antenatal steroids was published; the treatment of premature neonates with exogenous surfactant and less injurious forms of positive pressure support with nasal continuous positive airway pressure (CPAP) and other noninvasive modes of respiratory support.[4–6] Challenges remain in perinatal strategies, and one of the dominant challenges is how to improve success of noninvasive respiratory support in this challenging patient population until neonates mature to the extent that no respiratory support is needed.

CONTINUOUS POSITIVE AIRWAY PRESSURE IN PREMATURE INFANTS

Brief History of Nasal Continuous Positive Airway Pressure in Premature Neonates

Noninvasive respiratory support using nasal CPAP was first reported in 1973 by Kattwinkel and colleagues[7] and was demonstrated to be associated with a low incidence of BPD.[8] This report launched literally decades of work on implementation and research in improving nasal CPAP, which included evaluating nasal interfaces, and addressing different ways in which to generate CPAP.[9] Despite decades of experience in implementation of nasal CPAP and the strong data supporting its efficacy in improving outcomes in premature infants, other forms of noninvasive respiratory support including heated humidified high flow nasal cannula and nasal intermittent positive pressure have been studied and adopted widely despite a lack of evidence observing an improvement in outcomes or for that matter equivalent outcomes to routine utilization of nasal CPAP.[10–12] Reasons for investigation of alternatives to nasal CPAP include the difficulty of maintaining effective CPAP for a long period of time (literally weeks to months) that requires a highly qualified and trained bedside care team, and the reported failure rates for nasal CPAP when failure is defined as the need for intubation for more invasive support. In fact, in the 3 trials that have, in combination, shown that nasal CPAP administered immediately after delivery was associated with lower rates of death or BPD in infants between 24 and 29 weeks' gestation than in those supported with invasive ventilation (even when invasive ventilation was used only for administration of exogenous surfactant[13–15]), demonstrated failure rates of at least 50%. Thus, optimism from the improved outcomes as initial support and/or early support on nasal CPAP is tempered by the trial data, indicating that the need for intubation in these studies are high. In fact, in the SUPPORT trial (Surfactant, Positive Pressure, and Oxygenation Randomized Trial) the CPAP group had an intubation rate of 83% during the hospitalization.[15] Based on the data that early nasal CPAP improves outcomes and based on the high failure rates, efforts to lower the failure rate have been undertaken, and the mechanisms for high failure rates has not been resolved fully.