

Initial Respiratory Support of Preterm Infants

The Role of CPAP, the INSURE Method, and Noninvasive Ventilation

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KEYWORDS

• Respiratory support • Preterm infants • CPAP • Noninvasive ventilation

KEY POINTS

- Respiratory support of preterm infants is increasingly being achieved through noninvasive methods.
- Nasal continuous positive airway pressure (CPAP) is safe and is at least as effective as management via conventional mechanical ventilation.
- Nasal CPAP is associated with a decreased risk of developing chronic lung disease compared with conventional mechanical ventilation.
- An intubate, surfactant, and extubation (INSURE) strategy has been successfully applied both early and late in the course of respiratory distress syndrome.
- Techniques for administering exogenous surfactant while providing noninvasive respiratory support require further investigation.

INTRODUCTION

This article explores the potential benefits and risks for the various approaches to the initial respiratory management of preterm infants. The authors focus on the evidence for the increasingly used strategies of initial respiratory support of preterm infants with continuous positive airway pressure (CPAP) beginning in the delivery room (DR) or very early in the hospital course and blended strategies involving the early administration of surfactant replacement followed by immediate extubation and stabilization on CPAP. Where possible, the evidence referenced in this review comes from individual randomized controlled trials (RCTs) or meta-analyses of those trials.

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HISTORICAL PERSPECTIVE

Based on the combined weight of multiple RCTs and their subsequent meta-analyses performed in the 1990s, surfactant was given as part of the initial resuscitation and management of preterm infants either at risk for or with evidence of respiratory distress syndrome (RDS). Available evidence led neonatologists to develop strong convictions that among infants who were intubated for respiratory distress, early surfactant administration was associated with decreased risk of pneumothorax (typical relative risk [RR] 0.63 [95% confidence interval (CI) 0.59–0.82]; typical risk difference [RD] -0.05 [95% CI -0.08 to -0.03]); decreased chronic lung disease (CLD) (typical RR 0.70 [95% CI 0.55–0.88]; typical RD -0.03 [95% CI -0.05 to -0.01]); and decreased mortality (typical RR 0.87 [95% CI 0.77–0.99]; typical RD -0.03 [95% CI -0.06 to -0.00]).¹ Intubation and surfactant administration immediately following birth was thought to be effective and lifesaving in infants thought to be at risk for RDS. On the weight of such sentiment, the proportion of infants receiving surfactant within 2 hours of life became a therapeutic goal, a standard endorsed by the National Quality Forum for infants born less than or equal to 29 weeks' gestation.²

However, as the adage goes, things change. Investigators began to more broadly examine the possibility of less-invasive respiratory support with the possibility of alternate approaches that potentially avoid deleterious outcomes of the accepted standards of care. An understanding that the physiology and the severity of illness of RDS were tied closely with the ability to establish a functional residual capacity (FRC)³ led to treatment involving the administration of continuous distending pressure in lieu of surfactant replacement. Both CPAP and surfactant replacement were seen as leading to the same final goal of establishing and maintaining FRC. As such, the spectrum of respiratory support given to preterm neonates continues to evolve and become increasingly complex.

DRAWBACKS OF THE CONVENTIONAL APPROACH

Despite the well-documented benefits of surfactant replacement therapy, there are several negative aspects related to the way surfactant is administered and the subsequent respiratory management that follows. The act of placing an endotracheal tube (ETT) is invasive and may be traumatic. Laryngoscopy and intratracheal intubation is often unsuccessful⁴ and may cause hypoxemia, bradycardia, increased cranial pressure, systemic and pulmonary hypertension, and airway trauma.⁵ In part to avoid these complications, the American Academy of Pediatrics has suggested that sedation be offered to all nonemergent intubations; however, this too may be associated with undesirable side effects, such as respiratory depression that could potentially interfere with spontaneous respiration. Surfactant replacement itself is associated with changes in cerebral blood flow, although the impact of these changes is not fully understood.⁶ Most relevant to this article, avoidance of mechanical ventilation use altogether may be the best way to avoid or reduce the risk of CLD from volutrauma and barotrauma.^{7,8} Additionally, animal data suggest that mechanical ventilation is associated with inflammatory lung injury.⁹ As such, reduction of mechanical ventilation by means of noninvasive ventilation has become the most accepted method by which to reduce ventilator-associated lung injury and CLD.

In 1987, a game-changing report by Avery and colleagues⁷ suggested that one center's less-invasive approach, namely stabilization with nasal CPAP from birth in preterm infants with respiratory distress, was associated with a decreased risk of CLD when compared with 7 other centers that relied on conventional mechanical ventilator management. In 2001, Van Marter and colleagues¹⁰ noted similar protective

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