Preventing Continuous Positive Airway Pressure Failure

Evidence-Based and Physiologically Sound Practices from Delivery Room to the Neonatal Intensive Care Unit

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KEYWORDS

• Continuous positive airway pressure • Bronchopulmonary dysplasia
• Ventilatory-induced lung injury • Sustained lung inflation • INSURE
• Randomized controlled trial • Mechanical ventilation • Infant flow driver

KEY POINTS

- The incidence of bronchopulmonary dysplasia, and the competing outcomes death or bronchopulmonary dysplasia, is decreased with early initiation of nCPAP.
- The best available evidence supports the premise that efforts to minimize CPAP failure start in the delivery room.
- Various modes and interfaces to deliver CPAP exist; although there may be considerable differences in the ability of these various CPAP devices to prevent failure, little data from RCT exist to support this.

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- Compared with infant flow driver, bubble CPAP may decrease the risk of postextubation failure in infants less than 30 weeks' gestation who are ventilated ≤14 days.
- Available data demonstrate that the INSURE approach is not superior to use of CPAP without prophylactic surfactant in preventing CPAP failure.
- Sustained lung inflation may increase the rate of CPAP success, but may not decrease the incidence of BPD if positive pressure ventilation is needed.

WHY PREVENT CONTINUOUS POSITIVE AIRWAY PRESSURE FAILURE?

The need to identify safe and effective interventions to prevent bronchopulmonary dysplasia (BPD) has reached a critical point. In the simplest terms, BPD is the most common morbidity affecting a cohort of patients whose survival is increasing at the greatest rate. Data collected by the Neonatal Research Network recently on more than 34,000 infants born at 22 to 28 weeks gestation between 1993 and 2012 demonstrated significant increases in survival among infants born at 23, 24, and 25 weeks' gestational age (GA).[1] Importantly, these tiny babies are at the highest risk of developing BPD, with an incidence of 60% to 80%. In this same cohort of patients, it seems that practice changes over this period did little to improve the incidence of BPD.

An alternative to identifying additional interventions to prevent BPD is improving the interventions clinicians already make to support the highest risk neonates. More than 85% of the 34,000 infants in the Neonatal Research Network cohort were exposed to mechanical ventilation during their neonatal intensive care unit (NICU) stay.[1] Recent clinical data continue to support a direct relationship between exposure to mechanical ventilation and an increased risk of developing BPD.[2–6] As the survival of the tiniest babies increases, it is important to determine if a better modality of invasive mechanical ventilation exists to minimize these exposures and prevent BPD. High-frequency ventilation does not reduce the incidence of BPD in the smallest, high-risk babies.[7] Volume-targeted ventilation still remains promising, but randomized trials remain small and unconvincing.[8] Newer approaches, including neurally adjusted ventilator assist, have not yet been adequately studied.[9] These data may point to the reality that the developing human lung at 22 to 26 weeks' gestation is uniquely susceptible to injury caused by invasive mechanical ventilation. If this is true, reducing the burden of BPD will come only with limiting the exposure to invasive mechanical ventilation.

Data from randomized controlled trials (RCTs) demonstrate that routine use of continuous positive airway pressure (CPAP) significantly reduces the combined outcome of BPD (assessed at 36 weeks' gestation) or death in at-risk preterm infants, with an number needed to treat of 17.7.[10] Two other similar meta-analyses have been performed, each including slightly different combinations of trials whose comparison groups go beyond strictly CPAP versus prophylactic surfactant.[11,12] In all of these meta-analyses, the signal for benefit always points toward CPAP. Unfortunately, the routine use of CPAP does not provide a larger treatment effect; the numbers needed to treat determined across these three analyses were 17.7,[10] 25,[11] and 35.[12] It is reasonable to ask why the treatment effect is not larger, and can more be done to enhance the benefit of CPAP.

If CPAP prevents BPD by limiting the exposure to mechanical ventilation, efforts to prevent CPAP failure would likely lead to increased protective effects. In the preterm infant at highest risk for developing BPD, CPAP failure is common. Data from three large RCTs evaluating routine CPAP versus routine intubation show that 45% to 50% of high-risk babies fail CPAP within the first week of life (**Table 1**). Data from