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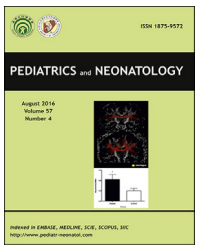

Original Article

Respiratory severity score and extubation readiness in very low birth weight infants

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Key Words
very low birth weight;
extubation;
mechanical ventilation;
respiratory severity score

Background: The respiratory severity score (RSS) is a byproduct of mean airway pressure (MAP) and fraction of inspired oxygen (FiO_2). We sought to determine whether RSS could be used as a screening tool to predict extubation readiness in very low birth weight (VLBW) infants.
Methods: In a retrospective cohort study, medical records of all VLBW infants admitted to our unit (6/1/09–2/28/12) were reviewed for infants' demographics, prenatal characteristics, and medication use. Also, records were reviewed for unplanned vs. planned extubation, blood gas, ventilator parameters and signs of severe respiratory failure [RF, defined as partial pressure of carbon dioxide (pCO_2) $>$ 65, pH $<$ 7.20, FiO_2 $>$ 50%, and MAP $>$ 10 cm] on the day of extubation.
Results: During the study period 31% (45/147) failed extubation. Overall, infants who failed extubation had a lower birth weight (BW) and gestational age (GA), and on the day of extubation had a higher RSS and percentage of having one or more signs of severe RF. In a logistic regression model, adjusting for BW, GA, RSS and RF, RSS remained the only risk factor associated with extubation failure [adjusted OR 1.63 (95% CI: 1.10–2.40); $p = 0.01$]. RSS had a sensitivity of 0.86 (95% CI: 0.72–0.94) at a cutoff of 1.26 and a specificity of 0.88 (95% CI: 0.80–0.94) at a cutoff of 2.5. There was no difference in extubation failure between unplanned vs. planned extubation [41% (9/22) vs. 29% (36/125); $p = 0.25$].
Conclusion: An elevated RSS is associated with extubation failure. Successful unplanned extubation is common in VLBW infants.

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1. Introduction

With advancement in neonatal care, there has been an improvement in survival of very low birth weight (VLBW) infants.[1–3] Over the last decade, there has been a significant decrease in mortality and major morbidities in premature infants; however, major neonatal morbidities continue to be associated with short-term and long-term adverse consequences.[4] For instance, oxygen supplementation and mechanical ventilation are essential for the survival of premature infants at the expense of long-term morbidities such as development of bronchopulmonary dysplasia (BPD) and need for frequent hospitalizations especially during the first years of life.[5,6]

Several mechanisms such as volutrauma, atelectrauma, and biotrauma have been implicated in the development of BPD in mechanically ventilated premature infants.[7] Therefore, effort to avoid intubation and mechanical ventilation and encouragement of early extubation have been undertaken to minimize ventilator induced lung injuries and to reduce the incidence of BPD.

Risk factors for extubation failure have been identified in neonates, and several extubation readiness parameters using minute ventilation and spontaneous breathing trials have been studied in premature infants.[8–14] However, the respiratory severity score (RSS), a non-invasive oxygenation index,[15,16] has not been studied as an extubation-readiness parameter in premature infants.

In this study, we sought to determine whether RSS, a non-invasive oxygenation index, could be used as an extubation-readiness parameter in ventilated VLBW infants.

2. Materials and methods

In a retrospective, cohort study, all VLBW infants who were admitted to our NICU and who were intubated on mechanical ventilation during their NICU stay between June 1st, 2009 and February 28th 2012 were identified from our electronic medical database.

We included all VLBW infants who were intubated and who were on mechanical ventilation for at least 12 h. We excluded all infants who were never intubated, who had major congenital abnormalities, and who were extubated as part of withdrawal of care and institution of comfort care.

Our primary outcome measure was extubation failure, which was defined as a need for re-intubation within 48 h following extubation.

All medical records were reviewed for infants' demographics [including birth weight (BW), gestational age (GA), gender, race, and Apgar scores at 1 and 5 min], and prenatal characteristics [including prenatal steroids, maternal diabetes, chorio-amnionitis, and use of magnesium sulfate].

Medical records were also reviewed for medications used during mechanical ventilation prior to the first extubation [including caffeine, postnatal steroids, fentanyl, midazolam, and dopamine]. Infants' characteristics at the time of extubation were reviewed [including duration of mechanical ventilation prior to the first extubation; unplanned extubation; weight and post menstrual age (PMA) at the time of extubation; and extubation to nasal intermittent mandatory ventilation (NIMV) or continuous positive airway pressure (CPAP) or a low flow nasal cannula (NC $<$ 2 L of flow)]. Factors that influence extubation-success were reviewed including severity of intraventricular hemorrhage (IVH, grade III and IV), blood culture-proven sepsis, and presence of a patent ductus arteriosus (PDA). Also respiratory factors that influenced extubation success were reviewed including the severity of respiratory distress syndrome (RDS), use of high frequency oscillatory ventilation (HFOV), and presence of an air leak. The severity of RDS was defined according to the need for more than one dose of surfactant (2—4 doses). Unplanned extubation was defined as an accidental extubation, or an unintentional extubation secondary to a dislodgement of an endotracheal tube (ET) secondary to a loose tape, or increased secretions. Unplanned extubation was also defined as dislodgment of an ET tube during the process of re-taping the tube, during endotracheal suctioning, or during the care of an infant. Patients who were electively extubated to replace an occluded ET tube or a small ET tube (that had a significant leak around it) were not considered to have received an unplanned extubation.

Patients' characteristics and respiratory parameters at the time of extubation were extracted from the medical records, including mode of mechanical ventilation, fraction of inspired oxygen (FiO_2), peak inspiratory pressure (PiP), positive end expiratory pressure (PEEP), mean airway pressure (MAP), respiratory severity score (RSS, byproduct of FiO_2 and MAP), negative logarithm of hydrogen (pH), and partial pressure of carbon dioxide (PCO_2). During the study period all patients were ventilated with a time-cycled-pressure-limited mode of ventilation.

Prior to or at the time of extubation, the presence of any criteria indicative of severe respiratory failure (RF) and need for intubation were obtained from the medical records. These criteria included $PCO_2 > 65$, pH < 7.20, $FiO_2 > 0.5$, and MAP > 10 cm.[17]

During the study period, the NICU had a policy to maintain a peripheral oxygen saturation (SpO_2) at 88%—93% in extremely premature infants. In general, infants requiring a PiP $\leq$ 20 cm of H_2O, PEEP $\leq$ 5 cm of H_2O, a ventilator rate $<$20/min and a $FiO_2 < 30\%$ to maintain a targeted SpO_2 were usually considered to be on a minimal ventilatory support in our NICU (common practice). However, the decision to extubate was at the discretion of the treating physician (usually when infants required minimal ventilatory support). The decision to extubate to a non-invasive mode of ventilation (NIMV and CPAP) or to a low flow NC was also at the discretion of the treating physician.

The study was approved by our Institutional Review Board at Metro Health Medical Center.

3. Statistical analysis

Data were expressed as percentages, means $\pm$ standard deviations, and medians and interquartile ranges. A bivariate analysis was performed to identify differences between the extubation success and extubation failure groups using Student's t test and Mann Whitney U test for parametric and non-parametric continuous variables,

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