Utility of Bedside Dynamic Lung Compliance in Preterm Neonates with Respiratory Distress Syndrome

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ABSTRACT

Background: Respiratory distress syndrome (RDS) is common in premature neonates due to deficiency of alveolar surfactant, increased alveolar surface tension, microatelectasis and low lung volume. Pulmonary compliance is significantly reduced in RDS, resulting in increased work of breathing and need for assisted ventilation. Dynamic lung compliance (DLC) is the change in volume divided by the peak inspiratory transthoracic pressure. There are no data on usefulness of DLC in preterm neonates to determine readiness for extubation.

Objective: To determine if DLC can determine extubation readiness in preterm neonates with RDS.

Design/Methods: Retrospective chart review of all preterm ≤1500 grams admitted to Flushing Hospital Medical Center NICU from 2012-2017 with the diagnosis of RDS and intubated. Neonates with congenital anomalies and neurologic impairment were excluded. Maternal data included maternal age, multiple pregnancy and antenatal steroid status. Neonatal data included gestational age (GA), gender, treatment of patent ductus arteriosis (PDA), Maquet brand, SERVO–I ventilator transmitted tidal volume (Vt), peak end-expiratory pressure (PEEP) and peak inspiratory pressure (PIP) at intubation and at extubation to determine DLC. Data were analyzed using percentages, mean, standard deviations and chi-square, $p < 0.05$ were considered to be significant.

Results: Of 250 charts reviewed, 188 met exclusion criteria. Of the remaining 62, median GA was 28.85 weeks (17.7% between 25-27 weeks, 53.2% between 27.1-30 weeks, 29% between 30.1-35 weeks) and 64.5% male. Neonates were intubated within 12 hours of life and only one (1.6%) was intubated >24 hours of life. Mean maternal age was 30.95 ± 5.8 years and 58% were singleton. Less than half (41.9%) did not complete antenatal steroids. DLC at the time of intubation, at time of extubation and delta DLC were determined. Binary logistic regression with delta DLC (p=0.38), GA (p=0.02) and treated PDA (p=0.81) predicted reintubation model ($x^2 = 8.87$, p=0.03).

Conclusions: In our small sample, delta DLC was not predictive of readiness for extubation. GA was the single significant predictor of readiness for extubation.

INTRODUCTION

- Respiratory distress syndrome (RDS) is common in premature neonates due to deficiency of alveolar surfactant, increased alveolar surface tension, micro-atelectasis and low lung volume.

- Pulmonary compliance is significantly reduced in RDS, resulting in increased work of breathing[4] and need for assisted ventilation.

- Minimizing time on mechanical ventilators reduces risk of development of ventilator-associated lung injury, bronchopulmonary dysplasia (BPD), neurodevelopmental impairment and death.[1]

- Neonatologists determine readiness for extubation based on ventilator settings, blood gas analysis, gestational age and current weight.

- Extubation failure rates as high as 40-50% among extremely premature infants has been reported in some neonatal intensive care units (NICU).[2]

- Dynamic lung compliance (DLC) is the change in volume divided by the peak inspiratory transthoracic pressure.[6]

- Bedside calculation of dynamic lung compliance can be performed based on tidal volume (Vt), peak inspiratory pressure (PIP) and peak end expiratory pressure (PEEP).[7]

- Balsan et al (1990) determined that a higher mean value of compliance was associated with successful extubation, specifically values ≥1.3 mL/cm H_2O was associated with successful extubation in 94% of patients.

OBJECTIVE

To determine if DLC can determine extubation readiness in preterm neonates with RDS.

METHODS

- **Design**: Retrospective chart review
- **Setting**: Flushing Hospital Medical Center Neonatal Intensive Care Unit
- **IRB**: Approved by Flushing Hospital Medical Center
- **Time Frame**: 2012 – 2017
- **Inclusion criteria**: All preterm neonates <1500 grams with diagnosis of RDS and intubated
- **Exclusion criteria**: Neonates with major congenital anomalies, preterm infants with significant neurologic impairment, including the presence of intraventricular hemorrhage grade III and IV, preterm infants with birth weight <1500 grams without RDS and infants transferred out of our facility
- **Tool** : **Dynamic lung compliance** from settings on Maquet brand, SERVO – I ventilators used NICU
  Vt: tidal volume
  PEEP: peak end-expiratory pressure
  PIP: peak inspiratory pressure

  DLC=Vt/PIP - PEEP

- **Statistical analyses**: Percentages, means and standard deviations, $p < 0.05$ will be considered significant

RESULTS

- **Charts reviewed**: 62/250 met inclusion criteria

- **Median gestational age** (GA): 29 weeks

- **GA** : 25-27 weeks (17.7%)
     27.1-30 weeks (53.2%)
     30.1-35 weeks (29%) figure 1

- **Gender**: male 65%

- **Intubation** <12 hours of life: 98.4%

- **Mean maternal age**: 31 ± 6 years

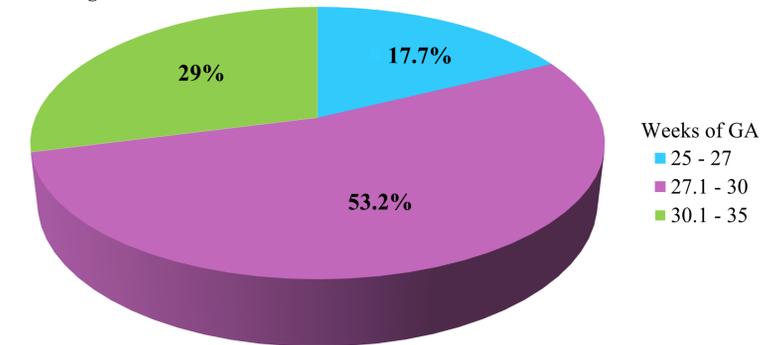- **Type of pregnancy**: singleton 58%

- **Completed antenatal steroids**: 58.1%

- **Binary logistic regression**: Delta DLC (p=0.38)
                GA (p=0.02)
                Treated PDA (p=0.81)

- **Predicted reintubation model**: $x^2 = 8.87$, p=0.03

Figure 1. Gestational Age

Weeks of GA
- 25 - 27
- 27.1 - 30
- 30.1 - 35

17.7% / 29% / 53.2%

CONCLUSIONS

- Delta DLC was not predictive of readiness for extubation.

- GA was the single significant predictor of readiness for extubation.

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