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Clinical paper

Decrease in delivery room intubation rates after use of nasal intermittent positive pressure ventilation in the delivery room for resuscitation of very low birth weight infants☆,☆☆

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ABSTRACT

Background: The literature supports minimizing duration of invasive ventilation to decrease lung injury in premature infants. Neonatal Resuscitation Program recommended use of non-invasive ventilation (NIV) in delivery room for infants requiring prolonged respiratory support.
Objective: To evaluate the impact of implementation of non-invasive ventilation (NIV) using nasal intermittent positive pressure ventilation (NIPPV) for resuscitation in very low birth infants.
Study design: Retrospective study was performed after NIPPV was introduced in the delivery room and compared with infants receiving face mask to provide positive pressure ventilation for resuscitation of very low birth weight infants prior to its use. Data collected from 119 infants resuscitated using NIPPV and 102 infants resuscitated with a face mask in a single institution. The primary outcome was the need for endotracheal intubation in the delivery room. Data was analyzed using IBM SPSS Statistics software version 24.
Results: A total of 31% of infants were intubated in the delivery room in the NIPPV group compared to 85% in the Face mask group ($p = <0.001$). Chest compression rates were 11% in the NIPPV group and 31% in the Face mask group ($p < 0.001$). Epinephrine administration was also lower in NIPPV group (2% vs. 8%; $P = 0.03$). Only 38% infants remained intubated at 24 hours of age in the NIPPV group compared to 66% in the Face mask group ($p < 0.001$). Median duration of invasive ventilation in the NIPPV group was shorter (2 days) compared to the Face mask group (11 days) ($p = 0.01$). The incidence of air-leaks was not significant between the two groups.
Conclusion: NIPPV was safely and effectively used in the delivery room settings to provide respiratory support for VLBW infants with less need for intubation, chest compressions, epinephrine administration and subsequent invasive ventilation.

Introduction

About 10% of newborns require some form of resuscitation at the time of delivery. The majority of preterm, very low birth weight (VLBW) infants require respiratory assistance at birth. Even if the most extremely premature infants breathe or cry at birth, many of these infants need help with breathing support shortly after birth due to an inability to maintain adequate spontaneous respiratory effort [1]. Providing effective positive pressure ventilation (PPV) remains the key element in the successful management of these infants before as well as during the transport to the neonatal intensive care unit (NICU). Adequate respiratory support not only improves the aeration of the lungs but also helps with circulatory transition. Historically, majority of the premature infants with respiratory distress were intubated in the delivery room to secure a definitive airway. Recent meta-analysis of four large randomized controlled trials has shown that the infants less than 32 weeks of gestation who received non-invasive respiratory support at birth have better survival without bronchopulmonary dysplasia (BPD) when compared to the infants intubated in the delivery room [2].

PPV is most commonly provided via face mask placed over the mouth and nose connected to a T-piece resuscitator, a flow-inflating resuscitation bag, or a self-inflating device. Success of the ventilation in the delivery room depends on generating adequate

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tidal volume and maintaining positive end expiratory pressures (PEEP) in a timely fashion. Even though face masks are commonly used in the Neonatal Resuscitation Program (NRP) training as well as in the real time delivery room resuscitations, problems such as mask leak and airway obstruction are frequent especially in the premature infants [3]. In the crucial first two minutes of life the mask leak could be as high as 75% [4]. A mask may need to be adjusted several times to overcome these obstacles before effective breaths can be provided. One such study performed in a simulation setting showed a significant mask leak prior to training for optimal mask handling. However, the same study noted moderate airway obstruction after the efforts were made to minimize the leak [5]. These complications related to the mask placement may cause a significant delay in achieving adequate ventilation. This delay may consequently contribute towards hypoxia eventually leading to bradycardia that would necessitate chest compressions, and emergent intubation. Further, nasal interface has been widely used to provide noninvasive ventilation in NICU as well as during transports by inter-hospital transport teams. A simple, yet effective, interface is needed to provide PPV especially in these vulnerable infants right from the delivery room.

A study by Capasso et al has shown improvement in the outcomes such as a decrease in delivery room intubation and chest compression rates after the use of nasal interface for resuscitation of larger newborn infants [6]. Recent studies using a nasal tube and or a single nasal prong to provide PPV did not show any difference in the intubation rates either in the delivery room or in the NICU when compared to a face mask [7,8]. Both studies have shown comparable results between a uni-nasal tube and a face mask. Use of a nasal interface has been recommended in the NRP for infants needing prolonged respiratory support in the delivery room, but the majority of centers rely on the face mask to provide PPV in the delivery room settings. At our center, modified nasal cannula has been successfully used to provide nasal intermittent positive pressure ventilation (NIPPV) in the NICU since 2009. Since a majority of low birth weight infants require prolonged PPV in the delivery room we introduced NIPPV instead of face mask after recommendation by NRP [10].

In the present study we evaluated the safety and efficacy of using NIPPV in the delivery room in VLBW infants (NIPPV Group). Infants receiving NIPPV were compared with the infants who historically received PPV via face mask (Face mask group) prior to the introduction of NIPPV at our center.

Method

Study setting

This study was carried out in a single level III NICU. Data on all VLBW infants who required PPV in the delivery room were retrospectively reviewed querying our database for infants delivered between 01/2009 and 12/2014. In our previous study we presented initial limited data on all infants who had received NIPPV from June 2011 to October 2012 [10]. The current study included some of those infants. Institutional Review Board approval was obtained to review the data.

Inclusion and exclusion criteria

All infants with birth weight less than 1500 g born at our institution who were resuscitated with PPV at the time of delivery during the study period were included. Infants receiving only CPAP without PPV in the delivery room were excluded. Infants with multiple congenital anomalies, cyanotic heart disease, congenital diaphragmatic hernia as well as pulmonary hypoplasia were also excluded. Additionally infants were excluded if they were intubated without receiving PPV by non-invasive method. All nonviable infants and the ones who received only comfort care at the delivery room were also excluded.

Delivery room intervention

All VLBW infant deliveries were attended by NRP certified personnel including neonatal perinatal medicine fellows with or without neonatologists, neonatal nurse practitioners, pediatric residents, neonatal respiratory therapists or neonatal nurses. A minimum of 3 members of the resuscitation team attended all high risk deliveries. The NRP algorithm was followed for all the patients requiring resuscitation at birth. Nasal interface (Neotech RAM Cannula ® by Neotech™, Valencia, CA, USA) was substituted for a face mask after it was introduced to provide NIPPV for the delivery room resuscitation. An appropriate size cannula was used to provide PPV depending on the size of the premature infant in the delivery room. Details of the application of the nasal interface for the delivery room resuscitation have been described before [10]. All the study personnel had received simulation based training in the use of NIPPV for delivery room resuscitation at the time of NRP certification prior to making this change. A T piece was connected to the nasal or facial interface for provision of PPV. The decision to intubate in the delivery room was based on recurrent episodes of apnea, ineffective PPV and worsening cardiopulmonary status adhering to NRP algorithm. Chest compressions and epinephrine were administered as per NRP guidelines. Infants who were stabilized on NIPPV were transported using the same mode. Infants were then placed on ventilator based on the support required at the time of admission to NICU.

Study outcomes

The primary outcome was the need for endotracheal intubation in the delivery room. Intubation was considered an emergency only if it was required during the active resuscitation phase of NRP. It was considered as necessary for transport if the intubation was done to secure the airway prior to transporting the infant but after initial phase of resuscitation to NICU. Other outcomes included chest compressions in the delivery room, epinephrine administration in the delivery room, 1 and 5 min Apgar scores, air-leak syndromes on the first radiograph, surfactant treatment, invasive mechanical ventilation rates at 24 h of age, severe (Grade III or IV) intraventricular hemorrhage (IVH) diagnosed by a pediatric radiologist using Papile classification, patent ductus arteriosus (PDA) confirmed by an echocardiogram prior to treatment and deemed as clinically significant by a pediatric cardiologist either treated medically or surgically, Stage II or higher necrotizing enterocolitis (NEC) diagnosed by modified Bell's staging, duration of invasive ventilation, length of stay in the NICU, retinopathy of prematurity (ROP) as diagnosed by a pediatric ophthalmologist, and bronchopulmonary dysplasia (BPD) defined as requirement of oxygen at 36 weeks of postmenstrual age, and death in the delivery room or prior to discharge from the NICU.

Statistical analysis

The data are presented as mean ± standard deviation (SD) for normally distributed continuous variables and median and interquartile range (IQR) when the distribution was skewed. Categorical variables are expressed as numbers and percentages. The clinical characteristics and outcome parameters were compared by using Student's *t*-test for parametric and Mann–Whitney *U* test for nonparametric comparisons of continuous variables, and Chi Square Test and Fisher's Exact Test for categorical variables. A p value of <0.05 was considered statistically significant. Statistical