Post-Resuscitation Care for Neonates Receiving Positive Pressure Ventilation at Birth

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**KEY WORDS** resuscitation, positive-pressure ventilation, infant, birth

**ABBREVIATIONS**

NRP—Neonatal Resuscitation Program

PPV—positive pressure ventilation

PRC—postresuscitation care

REB—Research Ethics Board

SNCU—special (intermediate/intensive) neonatal care unit

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**abstract**

**OBJECTIVES:** To investigate if postresuscitation care (PRC) is indicated for all infants ≥35 weeks’ gestation who receive positive pressure ventilation (PPV) at birth, explore the aspects of this care and the factors most predictive of it.

**METHODS:** Our hospital admits any infant who requires PPV at birth to special (intermediate/intensive) neonatal care unit (SNCU) for observation for at least 6 hours. All infants ≥35 weeks’ gestation born between 1994 and 2013, who received PPV at birth, were reviewed. We examined perinatal factors that could predict the need for PRC after short (<1 minute) and prolonged (≥1 minute) PPV, admission course, neonatal morbidities, and the aspects of care given.

**RESULTS:** Among 87,464 infants born, 3,658 (4.2%) had PPV at birth with 3,305 (90%) admitted for PRC. Of those, 1,558 (42.6%) were in the short PPV group and 2,100 (57.4%) in the prolonged PPV group. Approximately 59% of infants who received short PPV stayed in the SNCU for ≥1 day. Infants who received prolonged PPV were more likely to have morbidities and require special neonatal care. Multiple logistic regression analysis revealed the risk factors of placental abruption, assisted delivery, small-for-dates, gestational age <37 weeks, low 5-minute Apgar score, and need for intubation at birth to be independent predictors for SNCU stay ≥1 day and need for assisted ventilation, central lines, and parenteral nutrition.

**CONCLUSIONS:** Our data support the need for PRC even for infants receiving short PPV at birth. *Pediatrics* 2014;134:e1057–e1062
Approximately 10% of newborn infants require some assistance to begin breathing at birth; <1% require extensive resuscitative measures.1–3 Infants who require resuscitation at birth (have depressed breathing, activity, and/or require supplemental oxygen) are recommended to be transferred to an environment where close monitoring and anticipatory care can be provided once adequate ventilation and circulation have been established.4,5 There is no clear distinction in the Neonatal Resuscitation Program (NRP) guidelines between those who receive short period of positive pressure ventilation (PPV) at birth and those who require prolonged and more extensive resuscitation in terms of the postresuscitation care (PRC) needed. The nature and duration of this PRC may vary significantly after different degrees of perinatal depression. Although some of these infants can be at high risk for further deterioration, others may be able to receive routine neonatal care.6–8 Indiscriminate inclusion of initially depressed low risk infants in the general NRP recommendation for the need of PRC may cause unnecessary separation of the infants from their mothers, compromise bonding and breastfeeding, and increase parents’ anxiety. In addition, the high number of resulting admissions of term and late preterm infants for PRC can add a significant burden to hospital resources and health care system.

Because the policy of our institution has been to admit all infants who require PPV at birth for observation in a special care unit for at least 6 hours, we were in a position to audit this practice and explore the details of the care required.

OBJECTIVES

The main objectives of this study were to investigate if PRC is indicated for all infants ≥35 weeks’ gestation who receive PPV at birth, explore the aspects of the care needed, and characterize the perinatal risk factors most predictive of the need for this care.

We hypothesized that not all of these infants need to be admitted to the neonatal special care unit after restoration of their cardiorespiratory status in the delivery suites.

METHODS

Study Design and Population

This retrospective study was conducted by reviewing the database of all infants born at the IWK Health Centre between April 1994 and December 2013 at a gestational age ≥35 weeks. All infants who received PPV at birth were identified. Those with recognized major congenital anomalies were excluded. We defined PPV as any resuscitation intervention at birth that provided intermittent PPV. In this study, PPV was described as “short” if it was less than 1 minute in duration and “prolonged” if it was provided for ≥1 minute. We examined maternal and infant characteristics, delivery, and resuscitation data, as well as the admission course, neonatal morbidities, and the level of care given.

The IWK Health Centre is a tertiary referral center in Nova Scotia, Canada, with ~5000 annual birth rate and 1000 NICU admissions. In our hospital, all healthy infants who are born at ≥35 weeks’ gestation receive routine neonatal care while staying with their mothers in the Family and Newborn Unit. The medical care in this unit is given by the family physicians rather than pediatricians. The nurses there, being busy with the care of postpartum mothers and their healthy infants, cannot provide close observation for those infants who require PRC. After conducting an audit and considering the nature of newborn care given in our institution, a policy of admitting all newborn infants who require PPV at birth to special (intermediate/intensive) neonatal care unit (SNCU) for observation for at least 6 hours was established. This practice aimed at optimizing the PRC of the at-risk infants and was reinforced by the recent NRP guidelines.

Delivery room resuscitation practice in our hospital is as follows: For low risk deliveries, a designated NRP-certified obstetrical nurse provides the infant’s care. High risk deliveries are attended by an “Alpha Team” which is composed of an experienced NICU nurse and respiratory therapist and/or by “Beta Team” if there is a need for backup or in situations requiring more senior and experienced individuals as neonatal nurse practitioners, NICU fellows, or neonatologists.

The decision to provide PPV at birth is made by the team leader and is based on NRP guidelines (if the infant has apnea, gasping breathing, or heart rate <100 beats per minute after 30 seconds of positioning, stimulation, and clearing the airway). A resuscitation record is usually completed by the team leader and becomes part of the patient’s permanent chart. All perinatal data are collected by trained dedicated database abstractors.

This study was approved by the Research Ethics Board Committee of the IWK Health Centre.

Source of Data Collection

Study data were obtained from Nova Scotia Atlee Perinatal Database, which is a comprehensive and validated population-based provincial electronic storage system that collects maternal and newborn information at the time of discharge. Variables recorded in the Nova Scotia Atlee Perinatal Database include demographic maternal and newborn data, medical conditions, labor and delivery events, procedures and interventions, and maternal and newborn morbidity and mortality for all pregnancies and births occurring among Nova Scotia residents. A data
quality assurance program, data abstraction studies, and a validation study have shown the data to be of high quality.2

Statistical Analysis

Descriptive statistics was used for clinical characteristics of the population with representation as mean (+/−SD) or median (range). Significance was defined as $P < .05$. $\chi^2$ and Fisher’s exact tests were used to compare categorical variables in the groups. Multiple logistic regression analysis was performed to determine the factors predictive for the need of long (∣=1 day) SNCU stay, as well as different neonatal morbidities. Statistical analysis was performed by using SPSS version 14.0 (IBM SPSS Statistics, IBM Corporation).

RESULTS

Of 87 464 infants born at the IWK Health Centre during the 20-year study period, 3658 (4.2%) had PPV at birth with 3305 (90%) admitted to the SNCU for PRC and 3658 (4.2%) had PPV at birth with 3305 (90%) admitted to the SNCU for PRC (Fig 1). Of those admitted to the SNCU, 1429 (43%) were in the short PPV group (gestational age 39.3 ± 1.7 weeks and birth weight 3.5 ± 0.6 kg) and 1876 (57%) were in the prolonged PPV group (gestational age 39.2 ± 1.8 weeks and birth weight 3.4 ± 0.6 kg). Infants who required prolonged PPV were more likely to be born after placental abruption, have cord arterial pH ≤7 and 5-minute Apgar score ≤3 ($P < .0001$) as compared with those who required short PPV (Table 1). Among those who received short PPV for <1 minute at birth, 911 infants (58.5%) stayed in SNCU for ≥1 day (Table 2).

Infants who received any PPV at birth were more likely to have neonatal morbidities and require special care measures (assisted ventilation and/or parenteral nutrition) even if PPV was for <1 minute ($P < .0001$). Similarly, infants who received prolonged PPV were more likely to develop complications and require assisted ventilation, central venous catheters, and longer stay in SNCU ($P < .0001$, Table 3). The same outcomes remained significant after comparing the 2 groups during 2 different epochs: 1994–2003 and 2004–2013 (Table 4).

Multiple regression analysis indicated that placental abruption, assisted vaginal delivery/cesarean delivery, small for gestational age, gestational age <37 weeks, longer duration of PPV, need for intubation at birth, and 5-minute Apgar score ≤3 were independent predictors of SNCU stay ≥1 day, need for assisted ventilation, central lines, and parenteral nutrition.

DISCUSSION

There is little information in literature to describe the need and the nature of PRC that should be provided for term and late preterm infants after substantial resuscitation. The current NRP recommendation of providing PRC for those who have depressed breathing at birth does not differentiate between those who need extensive resuscitation and those who recover quickly after birth. Despite this, the current NRP recommendations are based on the assumption that birth asphyxia occurs in more than 2% of live births in North America and is a major cause of neonatal morbidity and mortality.3

TABLE 1 Maternal and Infantile Baseline Characteristics (Admitted Infants)

<table>
<thead>
<tr>
<th></th>
<th>PPV &lt;1 min, $N = 1429$</th>
<th>PPV ≥1 min, $N = 1876$</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age, mean (SD)*</td>
<td>29.5 (5.6)</td>
<td>29.2 (5.6)</td>
<td>0.9 (0.7–1.1)</td>
</tr>
<tr>
<td>Assisted vaginal delivery, n (%)</td>
<td>213 (15.2)</td>
<td>250 (13.8)</td>
<td>1.1 (0.95–1.3)</td>
</tr>
<tr>
<td>Cesarean delivery, n (%)</td>
<td>410 (31.5)</td>
<td>612 (53.7)</td>
<td>1.1 (0.95–1.3)</td>
</tr>
<tr>
<td>PROM ≥ 24 h, n (%)</td>
<td>43 (3.1)</td>
<td>72 (4)</td>
<td>1.3 (0.9–1.9)</td>
</tr>
<tr>
<td>Antenatal steroids, n (%)</td>
<td>44 (3.2)</td>
<td>89 (4.9)</td>
<td>1.58 (1.1–2.3)</td>
</tr>
<tr>
<td>Gestational diabetes, n (%)</td>
<td>44 (3.2)</td>
<td>83 (4.6)</td>
<td>1.47 (1–2.2)</td>
</tr>
<tr>
<td>Preexisting hypertension, n (%)</td>
<td>24 (1.7)</td>
<td>36 (2)</td>
<td>1.2 (0.7–2)</td>
</tr>
<tr>
<td>Severe PIH, n (%)</td>
<td>48 (3.4)</td>
<td>89 (4.9)</td>
<td>1.5 (1–2.1)</td>
</tr>
<tr>
<td>Placental abruption, n (%)</td>
<td>22 (1.5)</td>
<td>68 (3.5)</td>
<td>2.5 (1.5–4.1)</td>
</tr>
<tr>
<td>Gender, % boy</td>
<td>58.5</td>
<td>60.8</td>
<td>1.2 (1–1.4)</td>
</tr>
<tr>
<td>Gestational age, mean (SD)**</td>
<td>39.3 (1.7)</td>
<td>39.2 (1.8)</td>
<td>—</td>
</tr>
<tr>
<td>Birth weight in grams, mean (SD)**</td>
<td>3454 (611)</td>
<td>3392 (634)</td>
<td>—</td>
</tr>
<tr>
<td>SGA, &lt;3rd percentile, n (%)</td>
<td>49 (3.4)</td>
<td>81 (4.3)</td>
<td>1.3 (0.9–1.9)</td>
</tr>
<tr>
<td>5-min Apgar score ≤5, n (%)</td>
<td>9 (0.6)</td>
<td>71 (3.5)</td>
<td>6.2 (5–13.3)</td>
</tr>
<tr>
<td>Cord arterial pH ≤7, n (%)</td>
<td>24 (2.2)</td>
<td>100 (7.6)</td>
<td>3.75 (2.3–6.1)</td>
</tr>
</tbody>
</table>

CI, confidence interval; OR, odds ratio; PIH, pregnancy-induced hypertension; PROM, prolonged rupture of membranes; SGA, small for gestational age. * $P = .15$; ** $P = .02$; *** $P = .005$. 

FIGURE 1
Study flowchart.
short PPV. The nature, duration, and level of PRC provided are left to clinician's discretion. This can be difficult in the delivery room where the prediction will largely depend on the experience of the care provider and may lead to marked variability in practice and different adherence to NRP guidelines. In this study, we examined the evidence behind the NRP recommendation to elaborate more on this less-studied area of resuscitation practice where the main attention is usually directed to the acute resuscitation phase and to the care of very preterm infants.

As our hospital policy has been to admit all survivors to SNCU for 6 hours, we used SNCU stay ≥1 day as a marker of morbidities and required SNCU admission for more than 1 day. This observation was relevant even for those who had short PPV (<1 minute) as ~59% of them required significant PRC. This finding indicates that quick recovery in the delivery room may not be a sign of normalization and does not exclude the risk of subsequent deterioration; hence the decision of providing PRC (or not) should not be based solely on the PPV duration. In one of the few studies addressing PRC, Frazier and Werthammer reviewed 33 depressed term infants who required short PPV at birth before having quick recovery (achieving a 5-minute Apgar score ≥8). Fifty-two percent of their study patients required NICU admission and 61% developed short-term complications as compared with 3% in the control group.

In our study, those who received prolonged PPV were significantly more likely to develop morbidities that required postresuscitation special care such as assisted ventilation, central venous lines, parenteral nutrition, in addition to longer stay in SNCU than those who received short PPV (P < .0001). The significant correlation remained even after excluding infants who required advanced resuscitation in the form of chest compression (6 infants in the short PPV group and 70 infants in the long PPV group). The longer duration of the immediate ventilatory support provided after birth may reflect a more difficult transition or ineffective support measures. After prolonged resuscitation, different organs like brain, lungs, heart, kidneys, and gut in addition to metabolic and
cardiovascular systems might be compromised. In a population-based study, Moster et al reported that infants with 5-minute Apgar scores ≤3 had a 386-fold increased risk for neonatal death when compared with those who had scores 7 to 10. Multivariate logistic regression analysis revealed the risk factors of placental abruption, assisted vaginal delivery or cesarean delivery, small-for-date, gestational age <37 weeks, longer duration of PPV, 5-minute Apgar score ≤3, and the need for intubation at birth to be independent predictors for special care unit stay >1 day and the need for assisted ventilation, central lines, and parenteral nutrition. This is in keeping with the previous studies; Aziz et al reported a significantly increased risk for NICU admissions/death in infants with intrauterine growth retardation but did not indicate an increased risk after the use of vacuum or forceps during delivery. Other reports revealed higher rate of neonatal complications after operative vaginal delivery with NICU admission rate up to 38% after forceps and 11% after vacuum assisted delivery of term infants. Birth trauma and concomitant fetal distress can provide an explanation.

Late preterm infants were repeatedly reported to have more complications and require more NICU admissions secondary to immaturity of their different systems. Endotracheal intubation may or may not be associated with prolonged resuscitation as in many cases it can be related to the presence of meconium stained amniotic fluid. The impact of intubation alone may be hard to tease out especially with the flexibility given in NRP guidelines regarding the timing of the decision when to intubate. However, the assumption that those who required intubation were sicker and could have required longer/more efficient PPV through endotracheal tube cannot be ignored.

To our knowledge, this is the first study to examine the evidence behind the recommendation of providing PRC to infants who receive PPV at birth and who otherwise (or at least most of them) would have stayed with their mothers receiving routine neonatal care. A major strength of the study is that we are able to report reliably collected data on a large cohort of neonates who had PPV at birth over a 20-year period. Our study focused on PRC for late preterm and full-term infants who received PPV at birth in a tertiary care hospital, so the generalizability to different level of care units may not be optimal. However, the experience and expertise of our tertiary care unit-resuscitation team, the high adherence to a standardized practice of providing PRC (90% compliance), and the presence of designated abstractors for the database enhance the validity of our results.

This study is not without limitations; a 20-year period is a long time that carries the potential of changes in clinical practice and differences in preferences after patient admission. The length of stay in the SNCU could have been affected by physician’s preferences, bed availability, and the different time of admission (late nighttime versus daytime). In an effort to reduce this effect, we restricted our study population to the era when NRP guidelines were well established in our institution (NRP was introduced in 1992 to our hospital). In addition, we compared our 2 study groups during older and recent epochs to examine the possible effect of changing practice with time without detecting significant differences in outcome. Finally, because this is a retrospective study, individual variations in clinical judgment and time assessment of birth events may have varied over time. The duration of PPV as documented cannot be verified with absolute certainty.

CONCLUSIONS

This study supports the need for PRC for infants receiving PPV at birth regardless to PPV duration. We recommend considering the outlined perinatal risk factors to achieve the balance between improving the care of these infants and achieving better utilization of hospital resources.

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