Resuscitation 115 (2017) 102–109

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Incidence and characteristics of positive pressure ventilation delivered to newborns in a US tertiary academic hospital☆

Dana E. Niles[a,*], Courtney Cines[a], Elena Insley[a], Elizabeth E. Foglia[a,b], Okan U. Elci[c], Christiane Skåre[d], Theresa Olasveengen[d], Anne Ades[a], Michael Posencheg[a,b], Vinay M. Nadkarni[a], Jo Kramer-Johansen[d]

[a] The Children's Hospital of Philadelphia, Philadelphia, PA, USA
[b] The Hospital of the University of Pennsylvania, Philadelphia, PA, USA
[c] Westat-Biostatistics and Data Management Core, The Children's Hospital of Philadelphia, USA
[d] Norwegian National Advisory Unit on Prehospital Emergency Medicine (NAKOS) and Department of Anaesthesiology, Oslo University Hospital and University of Oslo, Norway

ARTICLE INFO

Article history:
Received 2 December 2016
Received in revised form 24 March 2017
Accepted 28 March 2017

Keywords:
Neonatal resuscitation
Positive pressure ventilation
Newborn
Delivery room
Birth asphyxia
Epidemiology
Adherence
Guidelines
Quality improvement

ABSTRACT

Introduction: The Neonatal Resuscitation Program (NRP) guidelines recommend positive pressure ventilation (PPV) in the first 60 s of life to support perinatal transition in non-breathing newborns. Our aim was to describe the incidence and characteristics of newborn PPV using real-time observation in the delivery unit.

Methods: Prospective, observational, quality improvement study conducted at a tertiary academic hospital. Deliveries during randomized weekday/evening 8-h shifts were attended by a trained observer. Intervention data were recorded for all newborns with gestational age (GA) ≥34 wks that received PPV. Descriptive summaries and Kruskal-Wallis test for continuous variables and Fisher's exact test for categorical variables were used to compare characteristics.

Results: Of 1135 live deliveries directly observed over 18mos, 64 (6%) newborns with a mean GA 39 ± 2 wks received PPV: Median time from birth to warmer was 20 s (IQR 15–22 s); PPV was initiated within 60 s of life in 29 (45%) and between 60 and 90 s of life in 17 (27%). PPV duration was <120 s in 38 (60%). Seven/21 (33%) newborns that received PPV after vaginal delivery were not pre-identified and resuscitation team was alerted after delivery. We found no association between PPV start time and duration of PPV ($p = 0.86$).

Conclusion: We observed that most (94%) term newborns spontaneously initiate respirations. In over half observed deliveries receiving PPV, time to initiation of PPV was greater than 60 s (longer than recommended). Compliance with current NRP guidelines is difficult, and it's not clear whether it is the recommendations or the training to achieve PPV recommendations that should be modified.

Background

Globally, the cause of over 1 million neonatal deaths each year is birth asphyxia, or failure for the baby to breathe on its own after birth [1–3]. Birth asphyxia is a life-threatening emergency in newborns that requires prompt resuscitative action in approximately 3–6% of otherwise healthy babies [2,4–6]. Basic neonatal resuscitation with a bag-and-mask to provide positive pressure ventilation (PPV) is required to support the perinatal transition until the newborn's control of breathing improves. If not performed adequately or in a timely manner, the progression of asphyxia to cardiovascular collapse and death may ensue [7]. Furthermore, for those that do survive an asphyxia event, the extended periods of hypoxia in the initial minutes of life can effect long-term developmental outcomes [8].

Neonatal Resuscitation Program (NRP) guidelines recommend that PPV be initiated within the first 60 s of life if the initial resuscitative measures (drying and stimulating) fail to restore adequate spontaneous respiratory effort [9,10]. Birth asphyxia is a low-frequency, high-risk event where implementing prompt, effective care in the delivery room is of paramount importance. International resuscitation councils typically derive their recommendations from

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2017.03.035.

* Corresponding author.
E-mail address: niles@email.chop.edu (D.E. Niles).

http://dx.doi.org/10.1016/j.resuscitation.2017.03.035
0300-9572/

The International Liaison Committee on Resuscitation (ILCOR) evidence evaluation process and publication of consensus on science with treatment recommendations [9–12]. Efforts to establish an evidence base for delivery room resuscitation has grown over the past decade [13], and although each subsequent release of recommendations has become more data-driven, large gaps in our knowledge remain [14]. Current data about the actual incidence, characteristics, timing and duration of interventions during newborn resuscitations is still lacking. Thus, this quality improvement (QI) study aims to describe the incidence and characteristics of newborn PPV in a tertiary academic hospital utilizing novel real-time observation. A secondary aim is to compare those characteristics with NRP recommended guidelines for PPV.

Methods

This prospective, observational, descriptive QI study was reviewed by the Institutional Review Board of the University of Pennsylvania and met criteria for exemption from IRB oversight (45CRF §46.102(d)). Data collection procedures were completed in compliance with the guidelines of the Health Insurance and Portability and Accountability Act to ensure subject confidentiality.

Setting

The study was conducted in the Labor and Delivery Unit (LDU) of a tertiary academic hospital. The Obstetric (OB) service manages over 4000 deliveries per year. There are 14 beds for vaginal deliveries and each room is fully equipped with an infant warmer. All infant warmers are provisioned with basic NRP-recommended resuscitation equipment. Additionally, there are three OB operating rooms; two operating rooms are equipped with two infant warmers; the third has one infant warmer. In addition, there is a highly-advanced Infant Resuscitation Room adjacent to the OB operating rooms in which there are three infant warmers utilized mainly for extremely preterm and the most critical newborns. The hospital standard clinical procedure for newborn resuscitation in late preterm and term newborns is to use a flow-inflating bag (Model E191, Anesthesia Associates, San Marcos, CA) for provision of PPV and CPAP in the labor and delivery and operating rooms. The bag is set with an initial flow rate of 10 l/min and initial oxygen concentration of 21% (which is subsequently blended as needed). Each ventilation system has a built-in pressure manometer.

Newborns who need intensive care are admitted to the 36-bed level III Intensive Care Nursery (ICN) that has over 800 admissions a year.

Staff

Each birth in the LDU is attended by at least two obstetricians (one attending and/or one fellow and an obstetric resident) and at least one OB registered nurse who is also responsible for assessment and care of newborns who are considered low-risk.

The ICN is staffed by 38 neonatal faculty (attending physicians), 16 neonatal-perinatal medicine fellows, 10 advanced practice clinicians (APC, defined as nurse practitioner or physician assistant), 120 pediatric residents and more than 150 ICN registered nurses. The neonatal resuscitation team consists of at least 2 neonatal medical providers and an ICN nurse, which may be expanded as needed by increased risk level of delivery. Prior to delivery, the neonatal resuscitation team is called to attend all cesarean section deliveries, and vaginal deliveries that are pre-identified as high risk for potential complications based on defined maternal, fetal, or perinatal risk factors (Appendix A). In addition, the resuscitation team is called post-vaginal delivery for unanticipated newborn complications.

If a newborn requires PPV, one provider is positioned at the head of the infant warmer to place and maintain proper bag-valve-mask (BVM) position on the face of the newborn. The second provider is positioned at the side of the infant warmer to deliver the ventilations via a flow-inflating bag. In rare instances, one provider provides PPV independently.

Staff training

All staff in the LDU and ICN are required to maintain active NRP status and complete an NRP training program every two years [15]. In addition, simulation trainings and supplementary skills trainings are offered for both the LDU and ICN nurses 6–12 times/year and are completed as allowed by staffing and census. All neonatal fellows and APCs complete monthly simulation trainings in neonatal resuscitation and neonatal critical care topics as allowed by staffing and census. Pediatric residents have current NRP status and are Pediatric Advanced Life Support (PALS) certified. In addition, residents complete a one-day NRP skills refreshing and neonatology orientation on the first day of their one-month Neonatology rotation.

Data collection

All births in the LDU and obstetrical operating rooms were attended by a trained observer (DN, DK, CC) during randomized weekday 8-h shifts (6 a.m.–2 p.m. or 2 p.m.–10 p.m.). Real-time data was collected on all PPV events (newborns who received PPV in the delivery room). Time was recorded from moment of birth (when body delivered) and all reported times (time of life) included the transport time from moment of birth to infant warmer. Delayed cord-clamping was not standard practice during the time period of this study. Data on each PPV event was collected in real-time by the trained observer using the study data collection form (Fig. 1). Pre-defined interval ranges for heart rate (HR), time of PPV initiation, and duration of interventions was utilized to simplify data collection and better categorize results. Data was then reviewed with the resuscitation team at the conclusion of each PPV event for confirmation and supplemented with patient clinical notes and quality improvement (QI) forms, as needed. Overall incidence was reported according to neonatology QI and resuscitation records.

Study data were entered into and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at The Children's Hospital of Philadelphia under an agreement with the software's development consortium, led by Vanderbilt University.

Analysis

Descriptive statistics were expressed as mean and standard deviation for normally distributed data and median with interquartile range (IQR) for continuous variables that were not distributed normally; and as frequencies and percentages for categorical variables. The a priori main outcome of interest was time to PPV newborns with a gestational age (GA) of $\geq$34 weeks. Kruskal-Wallis test for continuous variables and Fisher's exact test and chi-square analysis for categorical variables were used to compare characteristics. To compare provider/team discipline, we combined all unique provider roles for all PPV events (number of PPV events multiplied by number of unique provider roles) for first round of PPV. Statistical analyses were performed using Stata 14.1 (StataCorp, College Station, TX).

Results

Over the 18-month data collection period, there were 6812 live deliveries and 401 (6%) newborns that received PPV. For this study,