Resuscitation 107 (2016) 25–30

Contents lists available at ScienceDirect

Resuscitation

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

Clinical paper

Ventilation fraction during the first 30 s of neonatal resuscitation☆,☆☆,★

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ARTICLE INFO

Article history:
Received 20 January 2016
Received in revised form 6 July 2016
Accepted 17 July 2016

Keywords:
Neonatal resuscitation
Positive pressure ventilation
Education

ABSTRACT

Aim: Approximately 5% of newborns receive positive pressure ventilation (PPV) for successful transition. Guidelines urge providers to ensure effective PPV for 30–60 s before considering chest compressions and intravenous therapy. Pauses in this initial PPV may delay recovery of spontaneous respiration. The aim was to find the ventilation fraction during the first 30 s of PPV in non-breathing babies.
Methods: Prospective observational study in two hospitals in Norway. All newborns receiving PPV immediately after delivery were included. Cameras with motion detectors were installed at every resuscitation bay capturing both expected and unexpected compromised newborns. We determined the cumulative number of seconds with PPV efforts excluding pauses in infants without spontaneous breathing and reported ventilation fraction during the first minute. Data are presented as median (IQR).
Results: 110 of 3508 (3%) newborns received PPV and were filmed in the resuscitation bays. PPV started 42 (18–78) s after arrival at the resuscitation bay and median duration was 100 (35–225) s. Forty-eight infants (44%) were ventilated continuously, or with minimal pause (ventilation fraction >90%) during the first 30 s of PPV. For the remaining 62 infants ventilation fraction was 60% (39–75). PPV was interrupted due to adjustments, checking heart rate, stimulation, administration of CPAP and suctioning.
Conclusion: In 56% of the neonatal resuscitations interruptions in ventilation are frequent with 60% ventilation fraction during the first 30 s of PPV. Eliminating disruption for improved quality of PPV delivery should be emphasized when training newborn resuscitation providers.

Introduction

Immediately after birth, the newborn child transitions from placenta-based oxygenation to pulmonary-based oxygenation with the onset of lung aeration and spontaneous respiration.[1] This transition is uncomplicated for most infants, however approximately 5% receive ventilatory support to facilitate liquid movement out of the airways.[2] Most depressed neonates respond to applied positive end-expiratory pressure or positive pressure ventilation (PPV) to increase functional residual capacity.[3] International guidelines in neonatal resuscitation recommend providers ensure effective PPV for at least 30 s before considering chest compressions and intravenous therapy.[4,5]

Video recordings have been suggested to be a valuable tool to evaluate resuscitation performance and outcome during neonatal resuscitations.[6–9] Difficulties with mask leak, head position, obstructed airways or inappropriate airway pressures have been reported even when highly experienced and skilled neonatologists resuscitate infants.[10–13] These previous studies have mainly

Abbreviations: PPV, positive pressure ventilation; CPAP, continuous positive airways pressure; NICU, newborn intensive care unit; ERC, European Resuscitation Council; ILCOR, International Liaison Committee of Resuscitation; OUH, Oslo University Hospital; AUH, Akershus University Hospital.

☆ 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.2016.07.231.

☆☆ The clinical trial registration number: NCT02347241.

★ The institutional reference numbers: 2013/12769 (OUH) and 14-032 (AUH).

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http://dx.doi.org/10.1016/j.resuscitation.2016.07.231
0300-9572/

focused on anticipated neonatal resuscitations, however the need for neonatal resuscitation is often unrecognized prior to delivery.[14] To improve overall quality of neonatal resuscitation, evaluation and training efforts should include every healthcare provider who responds to unexpected compromised newborns, not just the highly experienced and skilled teams that care for preterm or high risk deliveries.

In this prospective observational study we evaluated the quality of PPV and resuscitation during the first minutes of both expected and unexpected compromised newborns and explored factors impacting on quality of ventilatory support. Our primary objective was to document the cumulative proportion of time with ventilation efforts (ventilation fraction) during the first 30 s of PPV in non-breathing babies by analysing video recordings of all consecutive newborns receiving ventilatory support in our delivery units.

Methods

This prospective observational study was performed in two Norwegian delivery units from January 2014 to March 2014 at Oslo University Hospital, Ullevål (OUH), and from December 2014 to May 2015 at Akershus University Hospital (AUH). All newborns placed on the open incubator in the resuscitation bay during the three month study period were video recorded and assessed for eligibility. All newborns receiving PPV within the first minutes after delivery were included for further analysis.

Description of the delivery units

OUH and AUH services over 12,500 deliveries per year and provides care for newborn babies from 24 weeks of gestational age. Both hospitals are equipped with foetal monitoring and resuscitation cribs with radiant heaters, pulse oximeters, oxygen blenders, suction devices, self-inflating bags, T-piece resuscitators and instruments for endotracheal intubation and intravenous access.

Description of the resuscitation team and guideline implementation

Midwives are responsible for all stages of labour and the obstetrician is present only when a complicated birth is anticipated. If the infant is below 35 weeks of gestation, imminent asphyxia is suspected, or delivery is obstructed, a paediatrician will be present prior to delivery. If a baby is in unexpectantly poor condition at birth, a neonatal resuscitation team is called after birth. The team consists of a paediatric resident, a consultant neonatologist (or paediatrician) and a nurse from the neonatal intensive care unit (NICU). All providers have basic training in ventilation and the algorithm in neonatal resuscitation. The resuscitation teams follow the Norwegian Resuscitation Council guidelines for neonatal resuscitation adapted from International Liaison Committee on Resuscitation (ILCOR)[15] and European Resuscitation Council (ERC)[4] guidelines. These guidelines recommend effective PPV with a T-piece resuscitator or a self-inflating bag for non-breathing or gasping newborns with a heart rate <100 beats per minute (bpm) for 30–60 s before starting with chest compressions. Routine application of sustained inflation is not recommended.

Data collection

Video cameras activated by motion sensors (Hikvision 2 megapixel IP camera, Hangzhou, China) were installed under the radiant heaters at all resuscitation bays at OUH and AUH. The video recordings were downloaded to a computer along with digital data from the pulse oximeter (Masimo Radical, Masimo Corporation, CA, USA) and reviewed after each resuscitation. The video recorder displayed a continuous date and time recording allowing timing of performed actions. Values of heart rate and pulse oximetry were stored every second. The videos were analysed by an independent researcher not taking part in the resuscitation. Due to resource limitations, we prospectively decided to review a random selection of 25 videos by a second investigator to ensure consistency. All time points are from arrival on the resuscitation crib and time intervals are reported in seconds. Cameras captured the infant, the providers' hands and audio. Demographics and clinical characteristics of study infants were recorded from medical records. Cameras did not capture the oxygen flowmeter, and information about delivered oxygen concentration was included if found in the medical record or gathered from the conversation on the video.

Data analysis

We determined the cumulative pause in PPV efforts in non-spontaneous breathing infants and calculated the ventilation fraction as the fraction of time with PPV efforts without pauses during the first 30 s. All data were entered and stored in a database (Filemaker Pro11, Inc., CA, USA) on a secure server designated for clinical research data. The outcome data are presented separately for three gestational age strata (<32, 32–35 and ≥36 weeks). Statistical calculations were performed in SPSS 22.0 (SPSS Inc., IL, USA). Values are given as numbers with percentages or medians with interquartile range (IQR). Categorical outcome data were analysed using Pearson Chi-Square for more than two categories or Fisher's test for two categories. Comparisons of continuous data were done with independent samples Mann–Whitney *U* test for two groups or Kruskal Wallis Test for more than two groups. *P*-values are two-sided and p-values ≤ 0.05 are considered significant.

Ethical considerations

The ethical and legal aspects of video recording are challenging and have been discussed previously by others.[16,17] Video recording and evaluation were considered quality assurance with minimal additional risk and our institutional review board approved presumed consent from parents. All mothers planning to give birth at the respective hospitals received written information about the study with an exclusion form they could bring along to the hospital, and also had the opportunity to opt out verbally at any time-point if they did NOT want the baby to be enrolled in the study and have the video deleted before review. Any oral requests to health care providers were relayed to the study coordinator to ensure prompt exclusion and deletion of the video. A webpage with additional information was publicly available. Additionally, all involved health care providers were informed of the study in advance and had the opportunity to opt-out and have the video recording erased without review. The video recordings were not available to anyone outside the research group. Approval from the institutional review board was contingent on deletion of all videos after review.

Results

During the three month study period 3524 infants were delivered at the two hospitals, and 110 (3%) infants were treated with PPV and captured on video. The cohort is described in Fig. 1 and Table 1 provides demographical information of the infants receiving PPV. The frequencies of resuscitative measures of these infants are provided in Table 2.