

High Flow Nasal Cannula and Other Non-Invasive Neonatal Respiratory Support Methods for Premature Infants; Systematic Review

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Abstract

Study aim: This review's objective is to evaluate HFNC against alternative non-invasive respiratory support techniques for neonates.

Method: PRISMA criteria were followed in the conduct of this investigation. Crossover trials and other studies that employ randomization or quasi-randomization were taken into consideration. Studies that were published in abstract form were not found in the search. The interventions included preterm infants without a history of IPPV who received postpartum respiratory support, either as a preventive treatment or for respiratory distress syndrome. Infants that require respiratory care during an IPPV phase and were delivered before 37 weeks of pregnancy. We looked through internet databases (PubMed, Scopus and Google scholar) for papers released between 2006 and 2014.

Result and Conclusion: In this systematic review we included 4 randomized controlled trials. In one study, two approaches of administering high-flow gas therapy by nasal cannula—applied just after scheduled endotracheal extubations of NICU patients—were compared. Patients who were in the NICU with an endotracheal tube in place for mechanical ventilation and who received a doctor's order to extubate to a highflow nasal cannula were considered eligible to take part in the trial. The Woodhead et al. study concentrated on issues that arise once mechanical ventilation is stopped, and they hypothesized that Vapotherms would be more effective than a typical high-flow nasal cannula for newly extubated newborns. The nasal mucosa's appearance, breathing rate, respiratory effort score, and extubation failure were the particular performance metrics they used. Vapotherms appear to have done better than a standard high-flow nasal cannula in maintaining the natural look of the nasal mucosa, lowering breathing effort, and avoiding reintubation among NICU patients, all without any known adverse effects. When used with EEP, HFNC can decrease ventilator days without seeming to increase adverse outcomes.

Keywords: High Flow Nasal Cannula, Non-Invasive Respiratory Support, Premature Infants

Introduction

Preterm newborns with apnea or parenchymal lung disease can get breathing assistance in a number of non-invasive techniques. These consist of nasal CPAP, NIPPV, and oxygen through a head box or nasal cannula.

Two tiny, tapered, thin tubes that fit just inside the nostrils without blocking them are called nasal cannulae, and they are used to provide oxygen or a combination of oxygen and air (1). When oxygen is administered by "low flow" nasal cannulae (HFNC), flow rates of less than or equal to 1 L/minute are usually used. Typically, unblended, unheated, and non-humidified gas is utilized. Although HFNC have historically not been believed to significantly assist the infant's pulmonary function (aside from the provision of oxygen), they are often used in convalescing preterm newborns, frequently with chronic lung illness (2).

On the other hand, the term HFNC describes the use of nasal cannulae to administer oxygen or a combination of oxygen and air to newborns at higher flow rates than with LFNC. HFNC will be defined as the utilization of flow rates more than 1 L/minute for the purposes of this review. PEEP may be administered to premature newborns by the use of high flow rates (3–5). Although a pressure relief valve is frequently utilized in HFNC systems, the circuit pressure is not regularly checked, and circuit flow is modified based on clinical impact. According to Waugh (2004)(6), oxygen delivered by HFNC is typically mixed with air, heated, and humidified.

Nasal continuous positive airway pressure, or CPAP, is a common and safe substitute for endotracheal intubation in both preterm and term infants (7). It has been demonstrated to treat respiratory distress syndrome, apnea, and extubation failure. It may also lessen chronic lung disease by reducing the amount of time spent on mechanical ventilation (8). Short binasal prongs are the most common and efficient way to deliver CPAP (7). The purpose of these prongs is to minimize leaking by fitting securely into the infants nostrils. On the other hand, nasal cannulae often do not block the nostrils and may cause a significant leak around them. Nasal masks and singlenasal prongs are two more widely used techniques for administering CPAP to the nose (9). This review's objective is to evaluate HFNC against alternative non-invasive respiratory support techniques for neonates.

Method

This study was conducted according to PRISMA guidelines. Studies that uses randomization or quasi-randomization, including crossover trials were considered. The search doesn't contained studies that were reported in abstract form. Preterm infants (less than 37 weeks gestation) who received postpartum respiratory assistance, either as a preventative measure or for respiratory distress syndrome without a history of IPPV, were among the interventions. 2. Infants born before 37 weeks of pregnancy who need respiratory care after an IPPV phase.

An nasal cannula with high flow For the purposes of this evaluation, oxygen was defined as the administration of oxygen or a mixture of oxygen and air using a nasal cannula at flow rates exceeding one liter per minute. Outcomes include, chronic lung disease, mortality and treatment failure. We searched electronic databases (PubMed, Scopus and Google scholar) for articles published in the period from 2006 to 2014.

All controlled studies that met the selection criteria outlined in the preceding section, both randomized and quasi-randomized, were included. After going over the search results, the writers chose the research for inclusion on their own. Any difference was settled by discussion among the review writers.

Each review author carried out trial searches, methodological evaluations, and data extraction independently, comparing and resolving any discrepancies discovered along the way. Data on the intervention, outcome measures, blinding of randomization, and follow-up completeness were gathered for each study. Only the first period's data were utilized for crossover studies. The authors of the study were contacted if there were any questions or if further information was needed.

Result and discussion

In this systematic review we included 4 randomized controlled trials (10–13). In one study(10), two approaches of administering high-flow gas therapy by nasal cannula—applied just after scheduled endotracheal extubations of NICU patients—were compared. Patients who were in the NICU with an endotracheal tube in place for mechanical ventilation and who received a doctor's order to extubate to a highflownasal cannula were considered eligible to take part in the trial.

The Woodhead et al. study concentrated on issues that arise once mechanical ventilation is stopped, and they hypothesized that Vapotherms would be more effective than a typical high-flow nasal cannula for newly extubated newborns. The nasal mucosa's appearance, breathing rate, respiratory effort score, and extubation failure were the particular performance metrics they used(10).

Unmeasured end-expiratory distending pressures and the associated worry that, in some situations, extremely high continuous positive end-expiratory pressures may be unintentionally given are the main problems with Vapotherms(5,14,15). According to Finer's recent comments(15), when employing high-flow rates with a nasal cannula, efforts are required to quantify and monitor uncontrolled CPAP. Although this was not particularly sought as part of the research design, Woodhead et al. did not notice any incidences of pneumothorax or pulmonary interstitial emphysema on any study patient between study entrance and release home.

In very low birthweight infants, prolonged intubation is linked to higher morbidity, such as an increased risk of infection and BPD. Many centers promote a noninvasive approach to ventilation employing NCPAP as the preferred method of extubation or as the primary mode of breathing for RDS, both with and without prophylactic surfactant, in an attempt to reduce ventilator-induced lung damage. In preterm newborns, NCPAP effectively prevents extubation failure and eliminates the need for mechanical ventilation (16,17). However, common CPAP device issues, including as nasal trauma, blockage by secretions that need to be removed often for suctioning, kinking of the pharyngeal prongs, and general patient discomfort, have limited its usage in some newborns (16).

Vapotherm warms and humidifies breathed gas to avoid drying out the nasal mucosa (6). Vapotherm is being utilized in several NICUs as an alternative to NCPAP, despite the fact that there aren't any published randomized studies assessing it in a NICU context. Its apparent greater patient tolerance and simplicity of usage are two possible explanations for its adoption. Many people are reluctant to utilize VT until possible dangers are examined, even though the broad adoption of an experimental therapy is not new to neonatology. The VT HFNC in the NICU is still not widely accepted because the impossibility to monitor the CPAP produced by VT, and the risk of infection (18).

There is a risk of infection whenever a water source is attached to a respiratory support device or when nasal cannulae or prongs that might harm mucosal tissue are utilized. However, Woodhead et al.(10)recently discovered that VT outperformed regular HFNC in maintaining a nasal mucosa that seemed normal. Holleman et al. (12)found no increase in the overall frequency of late-onset sepsis or Gram-negative sepsis using the HFNC, despite Graham et al.18 describing a strong connection between the use of nasal cannula CPAP and Gram-negative bloodstream infections in very low birthweight infants. Additionally, Holleman et al. (12)showed a lower incidence of ventilator-associated pneumonia, which is a predicted outcome of fewer ventilator days.

The early extubation protocol (EEP) in Holleman et al. (12) study was created to give patients more consistent care and to make NICU team feel more at ease with early extubation. Doctors' practices regarding extubation criteria varied significantly prior to the start of EEP. When determining whether a newborn was ready for extubation, additional parameters including birthweight were taken into account in addition to ventilator settings. A very small percentage of newborns failed extubation, and 16 infants were successfully extubated from higher settings than those specified in the procedure, as expected based on anecdotal experience. Clinicians were increasingly at ease trying extubation from higher settings as it became clear during the trial that most infants were being extubated successfully from the settings specified in the protocol. Although it is difficult to determine whether this is due to EEP or better respiratory support from VT, the infants in the HFNC group spent an average of one week less on the ventilator (10).

Abdel-Hady et al. (11) sought to ascertain whether switching to a nasal cannula or not was the preferable method for weaning preterm newborns from NCPAP. The disadvantages of weaning premature infants from NCPAP to NC are highlighted in their study. During this one institutional experience, they found that infants weaned to NC had an average increase in oxygen therapy length of nine days and respiratory support duration of 7.5 days.

Premature lungs lack sufficient alveoli to carry out gas exchange on their own, in addition to having a surfactant shortage. CPAP maintains the alveoli open, enhances functional residual capacity, stents the diaphragm and airway, and lessens breathing effort (19). Furthermore, CPAP preserves surfactant by lowering the production of inflammatory mediators and superoxide in tracheal aspirates (20). More significantly, it has been demonstrated that prolonged CPAP pressure promotes lung development (21). According to an experimental study, exposing premature ferrets to a CPAP of 6 cmH₂O for two weeks was linked to increases in lung volume, lung weight, total lung protein, and lung DNA contents. This suggests that keeping preterm infants on NCPAP for extended periods of time, or "chronic CPAP," may have positive effects on lung growth.

The ratio of lung mass to lung volume remained steady, and the fractional increases in these several parameters were comparable, indicating cellular hyperplasia as opposed to hypertrophy. In addition to or instead of the tonic increase in end-expiratory lung capacity, the increased phasic strain may be caused by CPAP-induced lung growth (21). Thus, switching to NC to stop the positive benefits of CPAP will only hurt these premature lungs. Using NC frequently involves using oxygen concurrently, which can be more harmful. Animal research unequivocally demonstrated a connection between oxygen exposure and the loss of pulmonary vascular expansion, the stoppage of alveolar septum formation, and the upregulation of cytokines that enhance an inflammatory process that results in BPD (22).

The best way to wean premature infants off of NCPAP is up for debate. Weaning NCPAP is a common procedure despite the lack of proof. According to a survey conducted among neonatologists in Australia, 74% of participants employed a weaning approach that involved lowering airway pressure before stopping CPAP, and 70% of respondents reported utilizing a graded time off CPAP (23). The broad variety of BPD rates in newborns supported by CPAP, with some reports using CPAP solely and others using NC during the weaning off of CPAP, can be explained, at least in part, by the findings of this study. The weaning technique employed in this investigation was based on a previously published procedure that has been linked to a low incidence of BPD (19).

In order to prevent reintubation in preterm newborns, Campbell et al.'s study (13) compared the viability of using CPAP support produced by a high flow nasal cannula with traditional CPAP. According to their

findings, HF-CPAP is most likely not a suitable substitute for CPAP in premature newborns. HF-CPAP was linked to more extubation failures, greater oxygen use, and more apneas and bradycardias than IF-CPAP. This happened even though there was a tendency for more infants who were randomly assigned to the HF-CPAP arm to be on caffeine prior to extubation. They failed to find any nasal damage from either kind of CPAP, albeit this could have been because of the "study effect," where nurses and respiratory therapists were more cautious when keeping an eye on the infant's nares(13).

Conclusion

With no known side effects, Vapotherms seem to have outperformed a typical high-flow nasal cannula in preserving the nasal mucosa's natural appearance, reducing breathing effort, and preventing reintubation among NICU patients. HFNC combined with EEP can reduce ventilator days without appearing to raise unfavorable outcomes.

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