Impact of High-flow Nasal Cannula Therapy in Quality Improvement and Clinical Outcomes in a Non-invasive Ventilation Device-free Pediatric Intensive Care Unit

Fulya Kamit Can, Ayse Berna Anil, Murat Anil, Neslihan Zengin, Alkan Bai, Yuksel Bicilioglu, Gamze Gokalp, Fatih Durak and Gulberat Inci

From Pediatric Intensive Care Unit, Izmir Tepecik Training and Research Hospital, Turkey.

Objective: To analyze the change in quality indicators due to the use of high-flow nasal cannula therapy as a non-invasive ventilation method in children with respiratory distress/failure in a non-invasive ventilation device-free pediatric intensive care unit. Methods: Retrospective chart review of children with respiratory distress/failure admitted 1 year before (period before high-flow nasal cannula therapy) and 1 year after (period after high-flow nasal cannula therapy) the introduction of high-flow nasal cannula therapy. We compared quality indicators as rate of mechanical ventilation, total duration of mechanical ventilation, rate of reintubation, pediatric intensive care unit length of stay, and mortality rate between these periods. Results: Between November 2012 and November 2014, 272 patients: 141 before and 131 after high-flow nasal cannula therapy were reviewed (median age was 20.5 mo). Of the patients in the severe respiratory distress/failure subgroup, the rate of intubation was significantly lower in period after than in period before high-flow nasal cannula therapy group (58.1% vs. 76.1%; P <0.05). The median pediatric intensive care unit length of stay was significantly shorter in patients who did not require mechanical ventilation in the period after than in the period before high-flow nasal cannula therapy group (3d vs. 4d; P<0.05). Conclusions: Implementation of high-flow nasal cannula therapy in pediatric intensive care unit significantly improves the quality of therapy and its outcomes.

Keywords: Endotracheal intubation, Mechanical ventilation, Respiratory distress/failure.

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the standard care, the admission criteria, the decision for intubation and the respiratory support methods given other than HFNC were similar in these periods.

In the protocol, the oxygen flow rates used were 5-50 L/min depending on the patient response (respiratory rate, heart rate, SpO₂, perfusion, comfort) with a FiO₂ between 0.3 and 1. The inspired oxygen concentration was titrated to achieve SpO₂ > 94%. SpO₂/FiO₂ ratio was used to determine the requirement for oxygen. The flow rate was set at 5 L/min for infants or 15 L/min for children at the beginning, and was titrated (±5 L/min) to achieve reduction of the oxygen requirement to FiO₂ of 30% and to improve the work of breathing, respiratory rate, and heart rate. The flow rate used in infants was 5-20 L/min and for children, 15-50 L/min. HFNC was discontinued if there was clinical deterioration (oxygen requirement, work of breathing, respiratory rate, or heart rate) in the first 30 min and the patients were intubated and ventilated mechanically. If there was no change in the first 30 min, the patients were followed for 30 min longer. The HFNC system (Fisher & Paykel Healthcare Airvo 2) comprises a humidifier (MR290) and a continuous flow circuit (900PT531 for infants, 900PT501 for children). We selected the nasal prong size that best fitted the nostrils (Optiflow, OPT318, OPT842, OPT844, OPT846).

We evaluated whether the clinical outcomes improved due to using HFNC therapy. We chose five quality measurements that indicate success, failure or ineffectiveness: the rate of MV, total duration of MV, rate of re-intubation, PICU length of stay (LOS) and rate of mortality. The patients with respiratory distress or failure between 1 month to 18 years of age who stayed more than 24 h in the PICU were included to the study. The definition of “respiratory distress” was hypoxemia (SpO₂<94%), tachypnea, increased work in breathing (chest wall retraction, use of accessory respiratory muscles, nasal flaring/grunting, feeding difficulties). Poor perfusion (cyanosis, mottling, poor neurological status, reduced muscle tonus), apnea or PaO₂ < 50 mmHg in room air, respiratory acidosis (pH<7.35), PaO₂<60 mmHg when FiO₂ 60%, and PaCO₂ > 60 mmHg in arterial blood gas analysis were deemed “respiratory failure”. The patients admitted between November 1, 2012 and November 1, 2014 to our PICU were evaluated. Thus, 1 year before HFNC therapy was defined as the period before HFNC and 1 year after the introduction of HFNC therapy was defined as the period after HFNC. Patients were excluded if they had had a tracheostomy, if they were intubated before PICU admission, or if they stayed less than 24 h in the PICU. We estimated the severity of respiratory distress by using a score, which can be used for a large range of ages and etiologies of respiratory distress [16]. Pediatric index of mortality 2 (PIM 2) and pediatric risk of mortality (PRISM) scores were routinely used in the PICU. Calculations of these scores were made using web-based calculators (http://www.sfar.org/article/316/scoring-systems-for-icu-and-surgical-patients).

![Study Algorithm](image)

PBHFNC: Period before high-flow nasal cannula therapy, PAHFNC: Period after high-flow nasal cannula therapy, PICU: Pediatric intensive care unit.

**FIG. 1** Study algorithm.