Available online at www.sciencedirect.com

ScienceDirect

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

Original research article/Artykuł oryginalny

Time for noninvasive ventilation in children with acute respiratory failure

Ilirjana Bakalli [1,*], *Ermela Celaj* [1], *Elmira Kola* [1], *Sashenka Sallabanda* [1], *Artan Simaku* [1,2]

[1] *PICU, UHC "Mother Theresa", Tirana, Albania*
[2] *Statisticien, UHC "Mother Theresa", Tirana, Albania*

ARTICLE INFO

Article history:
Received: 27.04.2016
Accepted: 03.06.2016
Available online: 16.06.2016

Keywords:
- Hypoxemia
- Hypercapnia
- Barotrauma

ABSTRACT

Introduction: Given that invasive ventilation (IV) is associated with many complications, recently there is an increased interest to noninvasive ventilation (NIV). **Objective:** To assess the efficacy of NIV in children with acute respiratory failure (ARF) and to compare PICU stay, hospital stay and the mortality rate in children with ARF treated with IV and NIV. **Methods:** This is a prospective study and includes all patients diagnosed with ARF (hypoxemic or hypercapnic) of different causes, requiring ventilator support during two years. Clinical and physiological criteria for inclusion and exclusion have been determined according ESPNIC recommendations. The study is divided into two periods: first period – all children with ARF who meet the criteria for ventilator support are placed on IV; second period – as the first line of treatment was applied NIV. **Results:** The study included a total of 79 children with ARF. IV was avoided in 73.8% of cases by using NIV. Compared with the IV group, both hospital stay and PICU stay in the NIV group were lower (9.5 *vs* 12.6 and 7.4 *vs* 11.2 days), leading to a significant reduction in the ARF treatment costs (1.9 times higher in IV than NIV). Complications in NIV group were reduced by 9.5% *vs* 40.5% in IV group, and mortality rate also resulted significantly lower in the NIV group (16% *vs* 40%); OR = 3.4, 95% CI (1.20–9.68). **Conclusion:** IV can be avoided in 70% of children with ARF by using NIV, with a significant reduction of complications, PICU stay and mortality rate.

Introduction

Acute respiratory failure (ARF) is the primary diagnosis in the Pediatric Intensive Care Unit (PICU) and the most common cause of cardiopulmonary arrest in children. In the past, the standard management of patients with respiratory failure in PICU was endotracheal intubation and invasive ventilation (IV). However, being an invasive intervention, IV is associated with many complications [1–3], related to the process of intubation and the loss of the protective mechanisms of the airways or extubation. Children who are intubated for more than four days can develop granulomas on their vocal chords or present ischemic lesions in their

* *Corresponding author at*: Pediatrician, PICU, UHC "Mother Theresa", Tirana, Albania. Tel.: +355 672055359; fax: +355 42363644.
E-mail addresses: ilirjanabakalli@yahoo.com (I. Bakalli), tansimaku@yahoo.com (A. Simaku).
http://dx.doi.org/10.1016/j.pepo.2016.06.004

Table I – Inclusion and exclusion criteria for NIV support[a]

Inclusion criteria	Exclusion criteria
Clinical criteria:	**Respiratory arrest**
Moderate or severe dyspnea	**Neurologic**
High respiratory frequency (based on age)	Glasgow coma scale <8 points, compromised bulbar function, paralysis of the vocal chords
Increased use of accessory muscles	**Craniofacial alterations** that affect the acceptance and fit of the mask (facial trauma or burns, facial surgery).
Paradoxical breathing	**Hemodynamic instability** (arrhythmias, hypotensive shock)
Physiological criteria:	**Respiratory**
$PaCO_2 > 45$ mmHg	Upper airway surgery
$pH < 7.35$	Abundant heavy secretions
$PaO_2/FiO_2 < 300$ mmHg	Undrained pneumothorax
$SatO_2 < 97\%$ for ambient air	**Gastrointestinal**
	Upper digestive tract surgery
	Profuse vomiting
	Active digestive hemorrhage

[a] NIV is indicated if two criteria are applicable.

tracheal mucosa that produce clinically relevant tracheal stenosis in fewer days of mechanical ventilation than in adult patients. Children's lungs are much more prone to barotrauma, volutrauma and atelectrauma than those of adults. The child's lungs also require earlier ventilatory support to avoid the threat of pulmonary collapse as soon as the child goes into hypoventilation.

Recently there is an increased interest to the use of noninvasive ventilation (NIV), with the desire to avoid the complications of invasive ventilation.

In the past five years the number of pediatric centers that apply NIV has increased significantly [4–11]. Use of noninvasive ventilation is widely applied not only in PICU, but also in other units including hospital and home for chronic diseases. However, it's role, as an alternative to conventional IV, remains controversial. From the current controlled and randomized studies, due to the small number of cases, there is no strong evidence to establish grade A and B recommendations.

Our aim was to assess if we can use NIV as the first line treatment in children with ARF instead of IV and to analyze the differences for the PICU stay, hospital stay and the mortality rate in both groups: children with ARF treated with IV and those treated with NIV.

Methods

Design and setting

This is a prospective study. Data are collected in the PICU, Department of Pediatrics, a multidisciplinary 15-bed setting, during the period from January 2011 to December 2012. The study is divided into two periods:

- In the first period (January 2011–December 2011) all children with ARF who met the criteria for ventilator support were placed on IV.
- In the second period (January 2012–December 2012) all children who required respiratory support, were applied NIV as the first line of treatment.

In both periods we tried to improve the clinical situation with O_2 therapy, medications (salbutamol, adrenaline inhalation), posture, aspiration.

Inclusion criteria and exclusion criteria

Patients included were diagnosed with ARF (hypoxemic or hypercapnic) of different causes and required ventilator support. We used inclusion and exclusion criteria of NIV for both periods, in order to obtain meaningful comparative data in terms of severity of the condition of the patients (Table I).

Criteria for NIV failure

Lack of improvement, worsening of gasometric parameters or deterioration in the clinical status of the patient.

Data collection

Estimation included NIV efficacy for both types of ARF (hypoxemia and hypercapnia), day hospital stay, PICU stay, complications and mortality rate for both groups (IV and NIV). To assess the severity of ARF we used PaO_2/FiO_2 ratio (as an indicator of gas exchange and one of the main evaluators of respiratory failure gravity) and Pediatric Risk of Mortality (PRISM) score.

Ethics

The study has been approved by the National Medical Ethics Committee (ref. number 073). Written informed consent to participate in the study and for publication of their clinical details have been obtained for all participants (from their parents) in line with the consent form approved by the National Medical Ethics Committee.

Statistical analysis

The data were analyzed by MedCalc statistical software, version 10.2.0 (1993–2009, licensed to CodeRipper).

Kolmogorov–Smirnov test is used to test the distribution of continued variables.