Comparison between Continuous positive Airway Pressure (CPAP) and High Flow Nasal Cannula (HFNC) in Management of Bronchiolitis and pneumonia in Infants and Young Children

Thesis

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By

Sarah Ali El Sayed

M.B.B.Ch., Faculty of Medicine, Ain Shams University

Under Supervision of

Prof. Dr. Tarek ahmed abdel gawad

Professor of Pediatrics

Faculty of Medicine, Ain Shams University

Dr. Ahmad Mostafa Allam

Lecturer of Pediatrics

Faculty of Medicine, Ain Shams University

Faculty of Medicine

Ain Shams University

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بسم الله الرحمن الرحيم

﴿وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا﴾

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List of Abbreviations

Abb.	Full term
ABG	Arterial blood gas
BIPAP	Biphasic positive airway pressure
CAP	Community acquired pneumonia
CO_2	Carbon dioxide
CPAP	Continuous positive airway pressure
EPAP	Expiratory positive airway pressure
ETT	Endotracheal tube
HFNC	High-flow nasal cannula
IPAP	Inspiratory positive airway pressure
NCPAP	Nasal Continuous Positive Airway Pressure
NIPPV	Non-invasive positive pressure ventilation
NIV	Noninvasive ventilation
NP	Nasopharyngeal
O_2	Oxygen
$PaCO_2$	Partial pressure of CO_2
PaO_2	Pressure of arterial O_2
PEEP	Positive end-expiratory pressure
PICU	Pediatric Intensive Care Unit
PO2	partial pressure of oxygen
RSV	Respiratory syncytial virus
SaO2	Oxygen Saturation
TT	Tracheostomy tubes
V/Q	Ventilation and perfusion

INTRODUCTION

Noninvasive ventilation (NIV) refers to the delivery of mechanical ventilation to the lungs using techniques that do not require an invasive artificial airway (ETT, TT).NIV is a form of life support measure for patients with acute respiratory failure. The primary desired effect of NIV is to maintain adequate levels of PO2 and PCO2 in arterial blood while also unloading the inspiratory muscles ***(Ganu, 2012).***

Severe respiratory failure develops in infants with bronchiolitis and Community acquired pneumonia (CAP) because of hypoxemia due to mismatch between ventilation and perfusion. Nasal CPAP and high-flow nasal cannula (HFNC) oxygen improve the work of breathing and oxygenation ***(Swanson, 2015).***

Continuous positive airway pressure (CPAP) is a type of positive airway pressure, where the air flow is introduced into the airways to maintain a continuous pressure to constantly open airway, in patients who are breathing spontaneously ***(Brown, 2017).***

CPAP maintains PEEP, that decrease atelectasis, increases the surface area of the alveolus, improves V/Q matching, and hence, improves oxygenation. It can also indirectly aid in ventilation, although CPAP alone is often inadequate for supporting ventilation, which requires additional

pressure support during inspiration (IPAP on BiPAP) for non-invasive ventilation ***(Gupta, 2016).***

Recently, high-flow humidified nasal cannula (HFNC) therapy has been tested for the management of acute respiratory failure in adults and children. It delivers heated, humidified gas with a constantly higher flow than a standard cannula ***(Roca, 2010).***

Over the last decade, high-flow nasal cannula(HFNC) has increasingly been used for oxygen delivery in neonatology departments, gradually replacing nasal continuous positive airway pressure (CPAP). Its use in pediatrics departments is more recent and generally is restricted to children with moderate Community acquired pneumonia and bronchiolitis ***(Cochrane, 2014).***

High flow nasal cannula (HFNC) oxygen delivery, also sometimes called heated humidified high flow nasal cannula (HHHFNC), is a relatively new non-invasive ventilation therapy that seems to be well tolerated in neonates and adults with hypoxemic respiratory failure. High flow is usually defined as flow rate ≥2 L/min, the flow rate depending on the type of cannula used, but ranging from 4 to 70 L/min. Debate is ongoing as to whether HFNC may reduce the use of less tolerated and more invasive ventilator supports, such as continuous positive airway pressure (CPAP) and mechanical ventilation ***(Essouri, 2015).***

AIM OF THE WORK

The aim of this study is to compare the effectiveness, toerence and outcomes,the of Heated Humidified High Flow Nasal Cannula (HFNC) versus Nasal Continuous Positive Airway Pressure (NCPAP), as a primary mode of respiratory support, in patients with acute respiratory distress due to pneumonia or bronchiolitis at PICU.

Chapter 1

ACUTE RESPIRATORY FAILURE

As many as two-thirds of Pediatric Intensive Care Unit (PICU) patients are admitted with a diagnosis of respiratory failure, which represents a common end point to multiple pathologic processes, categorized as hypoxemic, hypercapnic, or mixed ***(Arikan et al., 2012).***

In 2012, primary infections of the lung were responsible for 2% of all mortalities in children younger than 5 years in the United States and 18% worldwide ***(WHO, 2012).***

Bronchiolitis is a common lower respiratory tract infection in infants and young children, and respiratory syncytial virus (RSV) is the most common cause of this infection ***(Meissner et al., 2016)***

Community Acquired Pneumonia can be defined as infection of airways and lung tissue caused by a viral and bacterial etiology, which has been acquired outside of the hospital ***(Eastham et al., 2015).***

Definition:

Acute respiratory failure describes impairment in oxygenation or ventilation in which the arterial oxygen tension falls below 60 mm Hg (acute hypoxemia), the carbon dioxide

tension rises above 50 mm Hg (acute hypercapnia) and the pH drops below 7.35, or both.

For patients who have underlying chronic respiratory failure, acute hypercapnia can be diagnosed by an increase in PCO_2 by 20 mm Hg from baseline.

From a functional standpoint, respiratory failure is defined as the inability of the respiratory system to meet the metabolic needs of the tissues ***(Nitu and Eigen, 2009).***

Types of respiratory failure

- Respiratory failure is classified as type 1 respiratory failure or type 2 respiratory failure:
    - Type 1 respiratory failure is defined by a PaO2 of <60mmHg with a normal or low PaCO2.
    - Type 2 respiratory failure is defined by a PaO2 of <60mHg and a PaCO2 of >50 mmHg.
    - Type 3 Respiratory Failure is defined Perioperative respiratory failure Increased atelectasis due to low functional residual capacity (FRC) in the setting of abnormal abdominal wall mechanics.
    - Type 4 Respiratory Failure: Type IV describes patients who are intubated and ventilated in the process of resuscitation for shock n Goal of ventilation is to

stabilize gas exchange and to unload is to stabilize gas exchange and to unload the respiratory muscles, lowering their oxygen consumption

- Respiratory failure is also classified as acute, acute on top of chronic or chronic ***(Vasilyer et al., 1995).***
    - Acutehypercarbic -respiratory failure is characterized by a patient with no, or minor, evidence of pre-existing respiratory disease and arterial blood gas tensions will show high PaCO2, low pH, and normal bicarbonate.
    - Acute on top of chronic hypercarbic respiratory failure is characterized by an acute deterioration in an individual with significant pre-existing hypercarbic respiratory failure, high PaCO2, low pH, and high bicarbonate.
    - Chronic hypercarbic respiratory failure is characterized by the evidence of chronic respiratory disease, high PaCO2, normal pH and high bicarbonate.

Epidemiology

Acute lung injury accounts for 12.8 cases per 100,000 persons in year, with an in-hospital mortality rate of 18% to 22% ***(Zimmerman et al., 2009),*** 10% of intubated children admitted to a European PICU had ALI, with a mortality rate of 27%. Of the patients with ALI, 54% had ARDS at presentation

and 80% progressed to ARDS at some point during their hospitalization ***(Dahlem et al., 2003).***

Bronchiolitis, both respiratory syncytial virus (RSV) and non-RSV, accounts for up to 16% of all hospital admissions, with RSV bearing responsibility for 1 of every 334 hospitalizations ***(Hall et al., 2009).*** From 7.4% to 28.0% of children with bronchiolitis require mechanical ventilation, while of all RSV admissions, for both bronchiolitis and pneumonia, 4% require intubation and mechanical ventilation ***(Stockman et al., 2012).***

Community-acquired pneumonia (CAP) is anther significant cause of respiratory morbidity and mortality in children, especially in developing countries. Worldwide, CAP is the leading cause of death in children younger than five years. Factors that increase the incidence and severity of pneumonia in children include prematurity, malnutrition, low socioeconomic status, exposure to tobacco smoke, and child care attendance ***(Hassid, 2010).***

Respiratory syncytial virus (RSV) was responsible of 29% of these infections while hemophilus influenza was the causative organism in 4% of those patients ***(Rudan et al., 2013).***

A study conducted in Egypt on children presenting with severe pneumonia isolated respiratory syncytial virus in 63% of patients included in the study ***(ElBasha et al., 2013).***