Effect of Post-Extubation Noninvasive Ventilation on Weaning Outcomes in Patients with Respiratory Failure Due to Chronic Obstructive Pulmonary Disease

Thesis

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Karim El-Oraby

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List of abbreviations

ABG : Arterial blood gas

ACS : Airway Care Score

AECOPD : Acute exacerbation of chronic obstructive pulmonary disease

AMP : Adenosine monophosphate

ANOVA : Analysis of variance

APACHE II: Acute physiology and chronic health evaluation

ARF : Acute respiratory failure

ATC : Automatic tube compensation

ATS) : The American Thoracic Society

BIPAP : Bi-level Positive Airway Pressure

Ca : Calcium

CHF : Congestive heart failure

CHRF : Chronic hypercapnic respiratory failure

CKD : Chronic kidney disease

CLD : Chronic liver disease

CO2 : Carbon dioxide

COLD : Chronic obstructive lung disease

COPD : Chronic obstructive lung disease

CPAP : Continuous positive airway pressure

Cr : Creatinine

CS : Corticosteroid

DKA : Diabetic ketoacidosis

DM : Diabetes

e.g : For example

ECG : Electrocardiogram

EPAP : Expiratory peak airway pressure

ETT : Endotracheal tube

F : Frequency

FEV1 : Forced expiratory volume

FEV_1 : Forced expiratory volume

FiO_2 : Fraction of inspired oxygen

FM : Face mask

GCS : Glasgow Coma Scale

GOLD : The Global Initiative for Chronic Obstructive Lung Disease

Hb : Hemoglobin

HCO_3 : Bicarbonate

HF : Heart failure

HR : Heart rate

HTN : Hypertension

ICU : Intensive care unit

IHD : Ischemic heart disease

IMV : Intermittent mandatory ventilation

IPAP : Inspiratory peak airway pressure

K : Potassium

Kpa : Kilopascal

L : Litre

LABA : Long-acting beta2-agonists

Lac : Lactate

LAMAs : Long-acting antimuscarinic antagonists

MAP : Mean Arterial Blood Pressure

MEP : Maximal expiratory pressure

Mg : Magnesium

MICU : Medical ICU

MIP : Maximal inspiratory pressure

mmHg : Millimeter of mercury

MV : Mechanical ventilation

N : Number

Na : Sodium

NIV : Noninvasive ventilation

NPV : Negative-pressure ventilators

NS : Non-significant

NSAIDS : Non-steroidal anti-inflammatory drugs

O_2 : Oxygen

P : p-value

PaCO2 : Arterial carbon dioxide tension

PaO2 : Arterial oxygen tension

PAP : Peak airway pressure

PEEP : Positive end expiratory pressure

PEEPi : Intrinsic positive end-expiratory airway pressure

Po4 : Phosphorus

PP : Plateau pressure

PSV : Pressure support ventilation

RCTs	: Randomized controlled trials
RR	: Respiratory rate
SABA	: Short-acting beta agonist
SAMAs	: Short-acting antimuscarinics
SBI	: Shallow breath index
SBP	: Systolic blood pressure
SBT	: Spontaneous breathing trial
SD	: Standard deviation
SIMV	: Synchronized intermittent mandatory ventilation
SPO2	: Pulse oximetry
SPSS	: Statistical Program for Social Science
TTT	: Treatment
VT	: Tidal volume
WOB	: Work of breathing

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Introduction

Noninvasive ventilation (NIV) has been recently developed for the management of weaning/extubation from invasive mechanical ventilation (MV) and post-extubation acute respiratory failure (ARF) ***(Nava et al., 2009)***, the main goal being to shorten intubation time and to prevent or avoid reintubation and subsequent complications. The weaning/extubation period represents an important clinical issue for clinicians and patients, and prediction of its outcome may be difficult in most weak patients.

Difficult weaning requiring a progressive withdrawal from MV may occur, in fact, in 25% of intensive care unit (ICU) patients ***(Brochard et al., 2014)*** and in 40 to 60% of patients with chronic obstructive pulmonary disease (COPD) ***(Nava S et al., 2009)***. The weaning time may also account for up to 40% of the total invasive MV duration. Moreover, reintubation may be necessary within 48 to 72 hours in 5 to 25% of planned extubation, even if a spontaneous breathing trial (SBT) has been successful ***(Esteban et al., 2005)***. Reintubation represents an independent risk factor for nosocomial pneumonia, increasing ICU and hospital stay as well as mortality. So, the ICU clinician has to find the optimal compromise between the risks of undesired prolonged intubation and those of too early weaning and extubation process ***(Boles et al., 2007).*** Therefore, any strategy with the aim of reducing morbidity and mortality of prolonged invasive MV or reintubation appears relevant and should be developed to improve patient prognosis.

Consequently, NIV has been evaluated as an early weaning and extubation technique in difficult-to-wean patients ***(Prasad et al., 2007)***. Despite encouraging results regarding the incidence of reintubation, complications, and patient outcome, the role of NIV in this indication remains debated.

A recent meta-analysis found that post-extubation noninvasive weaning strategy could be of potential benefit as compared with conventional face mask, particularly in patients with COPD ***(Burns et al., 2009)***. However, these authors acknowledged that larger controlled trials were still needed. In addition, despite the negative results of NIV to treat post-extubation ARF (i.e., rescue post-extubation NIV) in medical patients ***(Keenan et al.,2012)***, the interest of this approach probably requires further evaluation in more selected medical populations.

We conducted a prospective randomized multicenter study to investigate the effectiveness of NIV as a post weaning/extubation technique in patients with chronic hypercapnic respiratory failure (CHRF) and also evaluated the role of rescue post-extubation NIV when a post-extubation ARF occurred in these patients.

Aim of the work

The primary objective of this study is to compare the efficacy of noninvasive ventilation (NIV) to conventional strategy with face mask (FM) in preventing reintubation, if NIV is used immediately after elective extubation, in patients with respiratory failure due to chronic obstructive lung disease (COPD) requiring mechanical ventilation for more than 72 hours. The secondary objectives are to evaluate the differences between the study groups concerning intensive care unit (ICU) length of stay and hospital mortality.

Respiratory failure in COPD

Chronic Obstructive Pulmonary Disease (COPD) represents an important public health problem and is a major cause of chronic morbidity and mortality all over the world. COPD is the fourth leading cause of death in the world and it is expected to be the 3rd leading cause of death by 2020. More than 3 million people died of COPD in 2012 accounting for 6% of all deaths globally ***(Lozano et al., 2012).***

Prognosis significantly worsens in case of additional respiratory failure occurring either chronically or temporarily during an acute exacerbation. Survival is particularly reduced when ventilatory support becomes necessary ***(Ai-Ping et al., 2005)***. These patients deserve special consideration not only because of poor outcome and survival rates but also in view of several therapeutical options.

Definitions and impacts:

The term **chronic obstructive pulmonary disease (COPD)**, or sometimes **chronic obstructive lung disease (COLD**), refers to a disease state characterized by the presence of incompletely reversible airflow obstruction. Current guidelines by the American Thoracic Society (ATS) and the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines recommend the use of the term COPD to encompass both chronic bronchitis and

emphysema. The ATS guidelines statement regarding COPD defines this entity as follows:

(Chronic obstructive pulmonary disease (COPD) is a preventable and treatable disease state characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases, primarily caused by cigarette smoking. Although COPD affects the lungs, it also produces significant systemic consequences).

Similarly, the GOLD guidelines define COPD as follows: (A disease state characterized by persistent airflow limitation that is usually progressive, and is associated with an enhanced inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patients).

An acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is a clinical diagnosis made when a patient with COPD experiences a sustained (e.g., 24–48 h) increase in cough, sputum production, and/or dyspnea. AECOPD has clinical consequences ranging from a self-limited illness to progressive respiratory failure ***(Celli et al., 2007)***.

The average patient with COPD experiences two episodes of AECOPD per year, and 10% of these episodes require hospitalization. The average duration of an episode is 7 days, although it may take several months for the

patient to return to baseline functional status ***(Sullivan et al., 2000)***.

Respiratory failure is usually defined by an arterial oxygen tension (PaO2) of less than 60 mmHg (8.0 kpa) (**hypoxemic** or **type I respiratory failure**) and/or an arterial carbon dioxide tension (PaCO2) greater than 45 mmHg (6.0 kpa) (**hypercapnic** or **type II respiratory failure**) ***(Roussos et al., 2003)***.

Etiology and Confounding Factors:

Bacterial infections are implicated in the majority of AECOPD episodes. This is because the patient with COPD has airways that are prone to infections, with impaired local defenses and frequent bacterial colonization. Sputum and bronchoscopy data have shown that *Moraxella catarrhalis, Haemophilus influenza*, and *Streptococcus pneumonia* are the most common organisms associated with AECOPD episodes. Other bacteria (e.g., *Pseudomonas and Staphylococcus*) have also been implicated. Many of these bacteria may be chronic airway colonizers that progress to infection after a simple viral upper respiratory infection or an environmental stress. On the other hand, a significant number of AECOPD infections may come from bacterial strains that are new to the patient ***(Papi et al., 2006)***.

Infectious AECOPD can be caused by other agents. *Rhinovirus* and *respiratory syncytial virus* have been implicated as causes for AECOPD in several studies. During the influenza season, the prevalent strain of influenza virus may also be an important viral cause,