Noninvasive ventilation in treatment of acute respiratory failure in ICU

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ABSTRACT

In the last years noninvasive ventilation (NIV) is used increasingly worldwide in treatment of acute respiratory failure (ARF). The evidence strongly supports NIV use in patients with ARF, especially for chronic obstructive pulmonary disease (COPD) exacerbations and acute cardiogenic pulmonary edema. The efficacy of NIV depends on several factors like the experience of medical team, adequate selection of patient and interface and appropriate ventilator settings.
This is a retrospective analysis of patients with ARF treated by NIV in the medical intensive care unit (ICU), University Hospital Sveti Duh, between January 2015 and January 2016.
Analysis of statistical hospital data showed steady increments in NIV utilization from year 2011 (7%) to 2015 (15.7%). The mean age of studied patients was 69.8 years, 58.3% were male and 41.7% female. Four major causes for applying NIV were: COPD (41.7%), pneumonia (25%), acute cardiogenic pulmonary edema (19.4%) and other reasons (13.9%). Of 108 patients 93 (86.1%) were successfully treated with NIV and 15 (13.9%) were intubated.
A number of randomized clinical trials support the use of NIV in patients with ARF and beside the beneficial role in reducing patients symptoms it showed reduction in morbidity, mortality and length of stay in ICU. Failure rates of NIV still range from 25% to 40%, and optimization of NIV success rates requires careful patient selection and knowledge of proper application and monitoring techniques. If a patient fails to improve sufficiently, prompt endotracheal intubation should be performed without delay.

Key words: noninvasive ventilation, respiratory failure, chronic obstructive pulmonary disease, pulmonary edema

INTRODUCTION

Acute respiratory failure (ARF) is a common reason for admission to intensive care unit (ICU). ARF is a complex syndrome, caused by a wide range of diseases and conditions, in which respiratory system fails in gas exchange function and is characterized with life-threatening derangements in arterial blood gases and acid-base status. According to arterial blood gas abnormality ARF can be divided in two categories - hypoxemic and hypercapnic. Hypoxemic or type I is characterized by oxygen arterial pressure (PaO2) lower than 60 mmHg with normal or lower carbon dioxide arterial pressure (PaCO2). This is the most common form of ARF and is seen in almost all acute lung diseases like pneumonia and acute cardiogenic pulmonary edema. Hypercapnic or type II is characterized by PaCO2 higher than 50 mmHg and is usually accompanied with hypoxemia. This type of ARF is seen in patients with chronic obstructive pulmonary disease (COPD) and neuromuscular diseases. (1)
Therapy of ARF is directed to both the correction of blood gas abnormality as well as treatment of underlying disease. Mechanical ventilation, both noninvasive (NIV) and invasive, plays an important role in therapy of ARF. In the last years NIV is used increasingly worldwide in ARF treatment and is currently mostly used in treatment of COPD exacerbations and acute cardiogenic pulmonary edema. In NIV, the patient breathes through a face mask against a continuous flow of positive airway pressure. In COPD exacerbations NIV decreases PaCO2 by unloading the respiratory muscles and supplementing alveolar ventilation while in cardiogenic pulmonary edema NIV maintains the patency of the fluid-filled alveoli and prevents them from collapsing during exhalation and consequently improves oxygenation, reduces work of breathing, and may increase cardiac output. A number of randomized clinical trials (RCTs) support the use of NIV in patients with theese diseases and in addition to the beneficial role in reducing patients' symptoms it showed reduction in morbidity and mortality and length of ICU and total hospital stay. Also, because NIV avoids airway invasion it has less infectious complications like ventilator associated pneumonia (VAP) and therefore it is beneficial in immunocompromised patients with ARF. (2,3)
The aim of this study was to analyse NIV utilization in a medical ICU, characteristics of patients with ARF treated by NIV, the rate of NIV failure and patient outcome.

MATERIALS AND METHODS

This retrospective single centre cohort study was conducted in a fourteen bed, adult medical ICU at a university hospital in Zagreb, Croatia. During a one-year period, from January 2015 to January 2016, all consecutive patients admitted to the ICU that received NIV were included in this study. Also, annual hospital statistical data from year 2011 to 2015 were used to assess trends in NIV utilization.
NIV was delivered by a total face mask, secured with head straps, coupled to a ventilator (StellarTM 150, ResMed). All ventilator settings were adjusted by

the attending physician and by a chest physiotherapist, based on the results of continuous oximetry, measurements of arterial blood gases and ventilator parameters (expiratory tidal volume, respiratory rate, and mask leakage) as well as on patients' comfort. A baseline arterial blood gas analysis was performed after patient's stabilization on NIV. Each patient was evaluated regularly according to the institutional protocol by the attending physician and by a respiratory physiotherapist in order to access the possibility of NIV continuation/ discontinuation and evaluation of NIV failure.

NIV utilization rates, demographic data, causes of ARF, incidence of NIV failure, length of NIV and ICU mortality were assessed.

RESULTS

Analysis of statistical hospital data showed steady increments in NIV utilization, from 7% in year 2011 to 15.7% in 2015. (Figure 1)

Between January 2015 and January 2016, a total of 688 patients were hospitalized in ICU, and 108 (15.7%) of them were treated by NIV. At the same time a total of 200 patients were intubated (29%). The mean age of studied patients was 69.8 years (ranging from 32 to 92 years), 58.3% were male and 41.7% female.

In the studied period 4 major causes for applying NIV were: COPD (41.7%), pneumonia (25%), acute cardiogenic pulmonary edema (19.4%) and other reasons (neuromuscular disorders, obesity hypoventilation syndrome, do not intubate decision, etc.) (13.9%). (Figure 2)

In total, NIV was performed for 423 days. Of 108 patients 93 (86.1%) were successfully treated with NIV and 15 (13.9%) were intubated. Regarding outcome 22.2% patients treated with NIV died, 2.8% were transferred to the pulmology department because they needed long-term NIV, and 75% recovered and were discharged from the hospital. In 14.9% NIV was used after extubation.

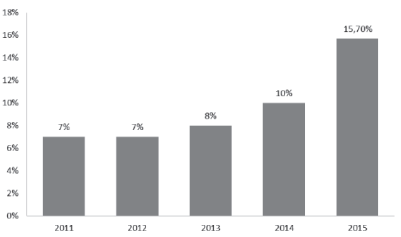

Figure 1. Increase in NIV (non invasive ventilation) utilization from year 2011 to 2015

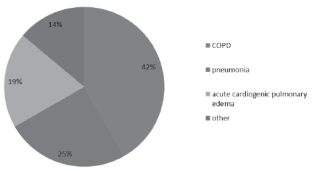

Figure 2. Causes for NIV (non invasive ventilation) therapy

COPD – chronic obstructive pulmonary disease

DISCUSSION

Today noninvasive ventilation is the standard therapy for patients with ARF. The efficacy of NIV depends on several factors like the experience of medical team, adequate patient selection, adequate selection of interface, appropriate ventilator settings and implementation of protocols. Most studies have used NIV as an intermittent rather than continuous mode of support with inspiratory pressures of 12-20 cm H2O and expiratory pressures of 0-6 cm H2O, and have excluded patients with hemodynamic instability, uncontrolled arrhythmia, or a high risk of aspiration. (4)

Multiple randomized studies showed benefit of this therapy in patents with ARF in particular in COPD exacerbations and congestive heart failure with mild-to-moderate pulmonary edema, and pulmonary edema from hypervolemia. (5,6)

In a Cochrane review including 14 RCTs for the treatment of COPD exacerbations it was reported that NIV and usual care compared with usual care alone decreased the need for intubation and mortality. (7) Chandra et al. reported the outcome of NIV for acute exacerbation of COPD covering a period of more than 10 years (1998–2008) and including over 7.5 million admissions in 1,000 hospitals in USA. They demonstrated a 4-fold increase in the use of NIV, which represented an increase from 1.0% to 4.5% of all admissions whereas the need for intubation and in-hospital mortality has declined. (8)

Use of NIV in acute cardiogenic pulmonary edema was evaluated in a Cochrane review including 21 studies and 1,071 subjects. It was reported that NIV, compared to standard medical care, significantly reduced the need for endotracheal intubation and there was also a significant reduction for hospital mortality. (9) Compared to standard medical care, there was no significant increase in the incidence of acute myocardial infarction with NIV. (10)

In a meta-analysis by Winck et al. 7 studies of NIV compared to CPAP in subjects with acute cardiogenic pulmonary edema showed a nonsignificant difference between the 2 therapies. (11)

NIV is also used in post-extubation, in immunocompromised patients, patients with pneumonia, obesity hypoventilation syndrome, with do not intubate or do not resuscitate order and in perioperative period. But evidence from studies for this indications are not so robust as for COPD exacerbation and acute cardiogenic pulmonary edema. (12)

Three Italian cohort studies with historical or matched control groups have suggested that long-term outcome of patients treated with NIV is better than that of patients treated with medical therapy and/or endotracheal intubation. (13-15)

It is important not only to know when to initiate NIV, but also when this therapy is failing. NIV failure has been defined as the need for endotracheal intubation (ETI) or death. Its rate greatly varies between five and 60%, depending on numerous factors, including the cause of ARF. (16)

The results of our study show an increase of NIV utilization in patients with ARF in ICU which is consistent with literature data. An educated and experienced medical team, careful patient selection and knowledge of proper application and monitoring techniques, as well as identification of risk factors for NIV failure, may improve NIV utilization and optimize NIV success rates.

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