Non-invasive ventilation is less efficient in pneumonia than in chronic obstructive pulmonary disease exacerbation

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ABSTRACT

INTRODUCTION: Non-invasive ventilation (NIV) is especially valid for acute exacerbation in chronic obstructive pulmonary disease (COPD), but the trend has been to use it for all types of patients with acute respiratory failure (ARF). Recent data suggest that treatment failure occurs more often in patients with ARF from pneumonia than from COPD.

MATERIAL AND METHODS: This was a retrospective study using data from patients with ARF admitted into the intensive care unit in a university-affiliated hospital in the period from 1 January 2009 to 31 December 2012 and treated with NIV. Patients with ARF due to acute exacerbation in COPD or ARF due to pneumonia were included. The primary end-point was treatment failure (intubation). The secondary end-point was in-hospital mortality. A total of 107 patients were included, 42 in the COPD group and 65 in the pneumonia group.

RESULTS: We found no significant difference between the two groups with regard to age (mean 65 ± 8 years (COPD) versus mean 64 ± 16 years (pneumonia)), sex (male/female 23/19 (COPD) versus male/female 26/39 (pneumonia)) or New Simplified Acute Physiology Score (SAPS II) (mean 47 ± 11 (COPD) versus mean 51 ± 15 (pneumonia)). Treatment failure occurred in five patients in the COPD group (12%) and in 32 patients in the pneumonia group (49%), $p < 0.00001$. In-hospital mortality occurred in six patients in the COPD group (14%) and in 21 patients in the pneumonia group (32%), $p = 0.01$.

CONCLUSION: NIV is less effective in the treatment of ARF due to pneumonia than in the treatment of ARF due to acute exacerbation in COPD.

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Non-invasive ventilation (NIV) is a standard first choice of mechanical ventilation for patients with acute respiratory failure (ARF) in our intensive care unit. It is seen as a ventilation method by which patients avoid the problems inherent in endotracheal intubation (ETI). This includes the risk of the intubation itself, sedation during intubation and the risk of ventilator-associated pneumonia. When used with the correct indications and in the absence of contraindications, NIV is a safe and reliable method of ventilation in patients with ARF. As described by Ambrosino & Vagheggini [1], NIV is especially efficient for acute exacerbation in chronic obstructive pulmonary disease (COPD), acute pulmonary oedema and immunosuppressed patients with pneumonia [2-4], but the trend has been to use it for all types of ARF patients [5, 6]. The data concerning ARF due to pneumonia have not been as significant as is the case for COPD. Accordingly, no recommendations are in place on the use of NIV in patients with severe community-acquired pneumonia and no prior history of COPD [7].

The aim of this study was to examine the effectiveness of NIV in patients with ARF due to acute exacerbation of COPD compared with patients with ARF due to severe pneumonia. We assumed that trying to use NIV in patients with severe pneumonia might not be advisable due to a high degree of treatment failure and that it could potentially serve to postpone ETI.

MATERIAL AND METHODS

This is a retrospective observational study using data from patients admitted into the intensive care unit (ICU) of a university-affiliated hospital. We evaluated all patients with ARF in the period from 1 January 2009 to 31 December 2012, aged > 18 years and treated with NIV. During the study period, a total of 424 patients were treated with NIV in our ICU.

Patients with a previously known diagnosis of COPD were allocated to the COPD group, defined as an annotation of COPD in the medical journals. The patients were allocated to the pneumonia group if they did not have a COPD diagnosis and fulfilled the international criteria for pneumonia [8].

All patients with ARF due to a combination of COPD and pneumonia were excluded. None of the patients in the pneumonia group therefore had COPD, and none of the patients in the COPD group had pneumonia. Patients with acute respiratory distress syndrome (ARDS), septic shock, cardiogenic pulmonary oedema or ARF of unknown origin were excluded, as were patients with a do-not-intubate order.

A total of 107 patients were included, 42 in the COPD group and 65 in the pneumonia group.

The local review board approved the study after

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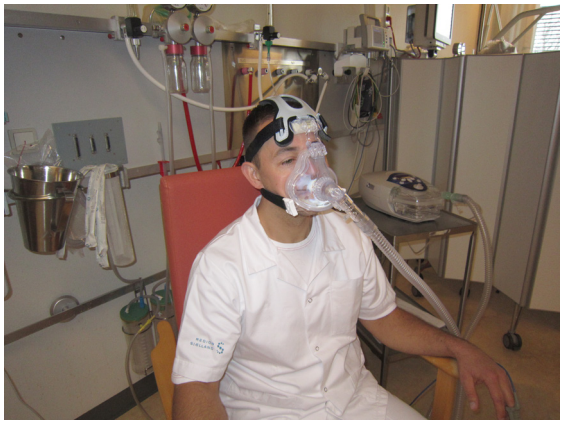

Non-invasive ventilation in the intensive care setting.

finding neither need for ethics committee approval nor any need for informed consent from the patients, both according to Danish law.

All patients were ventilated with either a designated bi-level NIV ventilator VPAP III (ResMed and Maribo Medico, Denmark) (104 patients) or a Dräger EVITA XL on NIV settings (three patients). The decision to intubate was at the discretion of the physician in charge, but Danish national guidelines were followed.

The primary end-point was treatment failure leading to endotracheal intubation. The secondary end-point was in-hospital mortality. We analysed the data using the χ^2-test, Student's t-test and the Mann-Whitney rank sum test, as appropriate.

Trial registration: not relevant.

RESULTS

The demographic data and other baseline characteristics are presented in **Table 1**. Outcome data are indicated in **Table 2**. There were no significant differences between the two groups concerning demographic data and New Simplified Acute Physiology Score (SAPS II). There were significant differences between $PaCO_2$ and the arterial concentration of HCO_3^-. These differences were expected due to differences in pathology. The pneumonia group included both patients with community-acquired pneumonia and patients who were admitted to a surgical ward before showing signs of pneumonia. All of the patients in the COPD group were admitted either directly to the ICU or had a short stay at the medical ward before being admitted to the ICU.

DISCUSSION

This study shows a significant difference in the efficiency of NIV in COPD patients and patients with severe pneumonia. Previous studies have shown a similar tendency with failure rates of up to 66% in patients with ARF due to severe community-acquired pneumonia (CAP) [9]. A randomised controlled trial that compared NIV as treatment for patients with ARF due to different aetiologies showed that the technique was very unsuccessful in patients with pneumonia [10]. However, another study showed that patients with both COPD and pneumonia had a better outcome with regards to the need for endotracheal intubation and two-month mortality than patients with pneumonia only [11].

There are certain limitations to the present study. It is a retrospective study, so we were unable to use a formalised study protocol. Some details regarding the patients were unavailable during the review of the medical journals. Because of the machine used for NIV in most of the patients, we were unable to calculate a PaO_2/FiO_2 ratio, which therefore had to be estimated in most of the patients. Also, we were unable to distinguish between CAP and hospital-acquired pneumonia from the acquired records. There are no records of other comorbidities than the ones recorded for SAPS II (HIV/AIDS, metastatic cancer and haematological malignancies). On the other hand, there were no significant differences between the two groups with regard to their pathophysiological status at admission (SAPS II). The study population was too small to justify the calculation of confidence intervals with regards to treatment time before failure in the COPD group. Had a larger population

TABLE 1

Baseline characteristics of the study groups. There were statistically significant differences between the two groups concerning the ratio of non-invasive ventilation failure and in-hospital mortality. Due to the small number of patients with treatment failure in the chronic obstructive pulmonary disease group, no confidence limits were calculated.

Characteristic	COPD (N = 42)	Pneumonia (N = 65)	p-value
Age, yrs, mean (± SD)	65 (± 8)	64 (± 16)	n.s.
Female/male, n	23/19	26/39	n.s.
SAPS II, mean (± SD)	47 (± 11)	51 (± 15)	n.s.
$PaCO_2$, kPa, median (90% CI)	10.5 (6-15)	6,1 (3-11)	< 0.00001
a[HCO_3^-], mmol/l, median (90% CI)	25 (13-35)	21 (13-28)	0.01

a[HCO_3^-] = arterial concentration of HCO_3^-; CI = confidence interval; n.s. = non-significant; SAPS II = New Simplified Acute Physiology Score; SD = standard deviation.

TABLE 2

Study outcomes.

Outcome	COPD (N = 42)	Pneumonia (N = 65)	p-value
Failure of NIV, n (%)	5 (12)	32 (49)	< 0.00001
Time before failure, h, median (90% CI)	62[a]	10 (1-44)	n.s.
In-hospital mortality, n (%)	6 (14)	21 (32)	0.01

CI = confidence interval; COPD = chronic obstructive pulmonary disease; NIV = non-invasive ventilation; n.s. = non-significant.
a) Too small number of patients for confidence limits.

been available, we might have been able to see a tendency towards shorter treatment times for patients with pneumonia, but this did not have any consequence for the end-points in this study, and the statistics therefore remains unchanged. Two more groups would have been interesting to study: a group consisting of patients with both COPD and pneumonia and a group with pneumonia which bypasses NIV and goes directly to ETI. Due to the retrospective design of the study, it was not possible to include these groups, but it would be relevant to investigate these groups in a prospective randomised controlled study.

The fact that the patients in the COPD group seem to have a better outcome than the patients in the pneumonia group may indicate that the latter group was in a more acute respiratory failure, but there was no difference between the groups with regards to SAPS II score and this serves to counter this assumption. The reason for the observed difference is more likely the difference in pathophysiology between the two diseases.

In our hospital, we treat patients with acute exacerbation in COPD in both a general ward and at the ICU, depending on the degree of respiratory failure. This means that a large group of patients eligible for this study was not included because we did not have access to their data. The criteria for treatment in the general ward are ARF due to acute exacerbation in COPD and pH < 7.35. The admission criterion for treatment in the ICU is a pH < 7.25. This invites the assumption that the patients treated in the ICU have more severe respiratory failure and thus a higher risk of treatment failure. Therefore, should we include the patients from the general ward, our results would most likely be even more significant.

CONCLUSION

ARF is a possible endpoint for both acute exacerbation in COPD and severe pneumonia although the pathophysiology of the two conditions is fundamentally different. NIV is excellent for treating hypercapnia and increases alveolar ventilation, but less efficient in the treatment of hypoxia due to increased secretion and atelectasis of the lungs. The airway pressure required for proper treatment of this condition could often be higher than generally recommended without ETI. This means that trying to use the same treatment for both conditions would not have the same effect. However, the general consensus in our hospital has been to use NIV in the treatment of both groups.

We found that in the pneumonia group, both NIV failure (49%) and mortality (32%) were significantly higher than in the COPD group. Such poor outcomes suggest a need for caution when applying NIV in these patients. There is also a need for further investigation comparing patients with pneumonia who go directly to ETI with those who receive NIV first to determine if the ETI delay has an effect on their mortality and morbidity.

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