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RAPID COMMUNICATION

Shrinking the room for invasive ventilation in hypercapnic respiratory failure

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Abstract: Noninvasive ventilation (NIV) was introduced as an alternative to invasive mechanical ventilation for acute respiratory failure caused from exacerbations of chronic obstructive pulmonary disease in the 1980s, and its use gradually rose worldwide. Seventy-eight patients (57 males, mean age 78.3 ± 9.2 years) undergoing NIV were evaluated. Of them, 48 (62.3%) had acute hypercapnic respiratory failure because of a chronic obstructive pulmonary disease exacerbation, and the remaining 30 had acute hypercapnic respiratory failure from other causes, mainly cardiac failure. All patients were treated by NIV using the bi-level positive airway pressure set up at high pressure/high backup rate. NIV was successful in 67 subjects (85.9%) and the patients were discharged, 57 of whom continued NIV at home and ten had spontaneous breathing. NIV was unsuccessful in eleven patients, ten of whom died and one was successfully treated by invasive mechanical ventilation. Significant differences were detected for a higher basal Glasgow Coma Scale score in successfully treated patients ($P = 0.007$), a higher basal Acute Physiology and Chronic Health Evaluation score in unsuccessfully treated patients ($P = 0.004$), and a lower pH after 1 hour in unsuccessfully treated patients ($P = 0.015$). These findings show a very high rate of success of NIV in patients with acute hypercapnic respiratory failure not only from chronic obstructive pulmonary disease but also from cardiac failure. This suggests that the use of invasive mechanical ventilation may be further reduced, with a decrease in its known complications as well.

Keywords: invasive ventilation, noninvasive ventilation, acute respiratory failure

Introduction

The use of invasive mechanical ventilation by endotracheal intubation in acute respiratory failure is long known.[1] Noninvasive ventilation (NIV) began to be considered as an alternative to invasive mechanical ventilation in acute respiratory failure caused from exacerbations of chronic obstructive pulmonary disease (COPD) in the 1980s, and its use gradually rose worldwide. In 1998, an international prospective survey reported that about one-third of patients initially treated with NIV had to undergo endotracheal intubation,[2] but 6 years later another large international prospective study reported a better outcome.[3] Also, NIV effectiveness is supported by results of systematic reviews,[4] and this has led to an increase in the application of this treatment, even in complicated situations such as a do-not-intubate order in elderly patients.[5] However, in 2010, Manuel et al reasoned that "there is little convincing evidence for the use of NIV in severe, but stable COPD" and that "what is less clear, however, is the quality of how NIV is delivered to patients."[6] Indeed, a recent study focused its attention on the kind of NIV setup, which can be based on high inflation pressure and high backup rate

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(high-intensity NIV) or high pressure and low backup rate (high-pressure NIV). The authors reported that the pivotal role in managing by NIV hypercapnic respiratory failure in COPD patients is the high-pressure component.[7]

Results

Seventy-eight patients (57 males, mean age 78.3 ± 9.2 years) undergoing NIV were evaluated. Of them, 48 (62.3%) had acute hypercapnic respiratory failure because of a COPD exacerbation and the remaining 30 had acute hypercapnic respiratory failure from other causes, mainly cardiac failure. All patients were treated by NIV using the bi-level positive airway pressure set up at high pressure/high backup rate. NIV was successful in 67 subjects (85.9%) and the patients were discharged, 57 of whom continued NIV at home and ten were in a state of spontaneous breathing. NIV was unsuccessful in eleven patients, ten of whom died and one was successfully treated by invasive mechanical ventilation. The mean age of successfully treated (77.7 ± 9.4 years) and unsuccessfully treated (82.1 ± 8.1 years) patients was not significantly different. Table 1 reports the characteristics of the two groups of patients. Significant differences were detected for a higher basal Glasgow Coma Scale score in successfully treated patients ($P = 0.007$), a higher basal score of the Acute Physiology and Chronic Health Evaluation score in unsuccessfully treated patients ($P = 0.004$), and a lower pH after 1 hour in unsuccessfully treated patients ($P = 0.015$).

Discussion

Among the risk factors for failure of NIV, the pH value seems particularly important,[8] which corresponds with the current data. Also, the Acute Physiology and Chronic Health Evaluation confirmed the predictive value of a score higher than 29, which was detected in patients with a negative outcome. Overall, the current data, obtained in a pneumology unit, show that NIV is able to manage the large majority of patients (86%) with acute respiratory failure from COPD exacerbations and also from other causes. A randomized study found that the use of NIV as rescue therapy was associated with a lower number of patients meeting the endotracheal intubation criteria and with a lower mortality rate compared with endotracheal intubation.[9] The factors underlying a negative outcome of NIV warrant investigation in studies in large populations of patients. In particular, the impact of comorbidities is an important issue. A recent study reported that patients with COPD and obesity hypoventilation syndrome treated with NIV because of acute hypercapnic respiratory failure had a response to treatment similar to patients with only COPD.[10] Moreover, a low rate of endotracheal intubation need was recently reported in patients with acute respiratory failure from heart failure treated with NIV,[11] and this observation is pertinent for the patients in the current study.

Table 1 Considered parameters in patients responding or not to noninvasive ventilation

	Patients responding to NIV (n = 67)	Patients not responding to NIV (n = 11)
GCS score	9.7 ± 2.9	7.2 ± 1.5
APACHE score	28.9 ± 4.7	33.2 ± 2.9
pO_2/FiO_2	174.8 ± 44.9	156.5 ± 40.1
pCO_2	98.9 ± 14.6	98.2 ± 15.5
pH	7.13 ± 0.1	7.11 ± 0.1
pO_2/FiO_2 after 1 hour	175.3 ± 70.6	160.8 ± 48.2
pCO_2 after 1 hour	75.4 ± 14.8	81.4 ± 25.8
pH after 1 hour	7.25 ± 0.08	7.18 ± 0.12
PO_2/FiO_2 after 12 hours	198.1 ± 81.6	185.9 ± 94.2
pCO_2 after 12 hours	59.6 ± 11.1	58.3 ± 7.6
pH after 12 hours	7.36 ± 0.06	7.37 ± 0.04

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; FiO_2, fraction of inspired oxygen; GCS, Global Coma Scale; NIV, noninvasive ventilation; pCO_2, carbon dioxide partial pressure; pO_2, oxygen partial pressure.

Conclusion

The findings show a very high rate of success of NIV in patients with acute hypercapnic respiratory failure from COPD as well as from other causes, including cardiac failure. This suggests that the use of invasive mechanical ventilation may be further reduced, with a decrease in its known complications as well.

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Disclosure

The authors report no conflicts of interest in this work.

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