MedJEM
DOI: 10.52544/2642-7184(1)1005
Original Research

Non-Invasive Ventilation in the Elderly in the Emergency Department: Epidemiological Data and Results

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ABSTRACT

Introduction: Non-invasive ventilation (NIV) could be a good alternative in elderly people with acute respiratory failure (ARF), to procure them a respiratory support while avoiding as much as possible the complications of invasive ventilation.

Methods: This is an observational retrospective study conducted in the emergency department (ED) of a tertiary care, university-based teaching hospital. Data of elderly patients (≥ 65 years) admitted to the ED between January 2017 and April 2018 for ARF who required NIV were collected and analyzed using SPSS 22 software.

Results: Sixty six patients (≥ 65 years) requiring NIV for acute respiratory failure (ARF) were included. The mean age was 76 years (± 7), the median Charlson index was 5. Acute respiratory failure was related to acute heart failure in 68%, acute exacerbation of chronic obstructive pulmonary disease in 53% and pneumonia in 39% of cases. Forty eight percent had more than one etiologic diagnosis. Hypercapnic acute respiratory failure was observed in 61%. On initiation of NIV, the average pH was 7.31 (± 0.11) and $PaCO_2$ 56 mmHg (± 21), After NIV, the average pH was 7.38 (± 0.11) and $PaCO_2$ 53 mmHg (± 26). Improvement of pH was significant ($p < 0.05$). 61% of patients were discharged at home, 9% were admitted to intensive care unit. Invasive ventilation was performed in 4%, of which 23% died. Success of NIV was observed in 68% of patients.

Conclusion: NIV can be of a great interest in elderly patients with acute respiratory failure. Our study showed that it can be used successfully in the certain settings.

Key words: acute respiratory failure, elderly, emergency, non-invasive ventilation

INTRODUCTION

Emergency departments are receiving a growing up number of elderly patients with acute respiratory failure (ARF).[1] As the prevalence of chronic respiratory and cardiovascular diseases increases with age[2], it is common that elderly patients often present to the emergency department (ED) for an exacerbation of their chronic pathologies manifested by an ARF in most serious cases.[1,2]

The therapeutic approach with ARF must be rapid and effective because of the life-threatening nature of the condition. This usually consist of the initiation of an adapted ventilatory treatment, the aim of which is to improve gas exchange while reducing respiratory work. This treatment is also combined with a drug treatment depending on the etiology of ARF.[2]

Among the means of respiratory support that can be provided to elderly with ARF, non-invasive ventilation (NIV) could be a good alternative, avoiding as much as possible the complications of invasive ventilation, more likely to occur in this group of patients.[2-4]

The use of this technique is more and more frequent in settings outside the intensive care unit (ICU) as in ED due to the limited ICU beds available for critical patients and particularly for

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critical elderly.[2,5]

According to the literature and current guidelines, NIV represents a first choice ventilatory technique to be considered in the management of some diseases which have a high prevalence in the elderly and this concerns particularly acute heart failure (AHF) and acute exacerbation of chronic obstructive pulmonary diseases (AECOPD) for which NIV has widely established effectiveness.[1,2,6] These causes of ARF are frequent in the elderly and often more than one cause is present, which can complicate their therapeutic management.[2,7,8] Specific data regarding the effectiveness of this technique in the Middle East and North Africa (MENA) region remains limited in this population.[3] So, the aim of this study was to identify the epidemiological aspects of NIV in elderly patients admitted to the emergency room for ARF and to assess its clinical results.

MATERIALS & METHODS

Study Design and Population

This was a retrospective observational study. We identified all medical records of patients aged 65 years and older admitted to our ED between January 2017 and April 2018 for ARF and who required NIV at admission.

Patients who received NIV for preoxygenation before intubation or as part of weaning from invasive ventilation were not included. We also did not include patients in whom the NIV had a palliative indication as for a neoplastic pathology or an advanced fibrosis. Otherwise, all patients whose medical records contained missing data were excluded from our study.

Study Settings

The study was carried out in the ED of a tertiary care, university-based teaching hospital. This department is used to receive a number of around 110,000 adult patients per year and includes a hospital unit with a capacity of twenty-two beds. Patients with ARF are admitted to an intermediary ICU for evaluation, stabilization and management with the possibility of invasive or non-invasive ventilation. Non-invasive ventilation has been performed for ten years in our department.

The bedside management of patients with ARF in the ED is usually provided by a medical team of two residents, (including one enrolled in the emergency medicine specialty training program) as well as a senior physician who is available 24 hours a day remotely by phone or within the ED premises.

Prescription and choice of NIV mode are indicated by the bedside emergency team depending on the clinical judgment and current guidelines considering the NIV contraindications and the etiology of ARF.[6,9]

The NIV contraindications considered for each patient are cardiac arrest or peri-arrest, imminent intubation, shock, severe arrhythmia, undrained pneumothorax, tamponade, upper digestive hemorrhage, intractable vomiting, swallowing disorders, craniofacial trauma or burns, upper airway obstruction, non-hypercapnic coma and patient's non-cooperation.[9,10]

NIV Protocol Used during the Study Period

NIV was performed in two modes during the study period which were the Bilevel and the CPAP (continuous positive airway pressure) mode. The interface used was an NIV tight-seal face mask.

The Bilevel mode used was the PSV (pressure support ventilation) mode via Taema, and Newport type respirators. For ventilator settings: PS (pressure support level) was initially delivered at 10-12 cmH_2O and increased by 2 cmH_2O depending on the clinical response of the patient. The monitored parameters had as targets: 6 to 8 ml/kg of ideal body weight for the exhaled tidal volume and a respiratory rate below or equal to 30 breaths per minute. The maximum PS allowed was 20 cmH_2O. PEEP (positive end-expiratory pressure) was set initially at 4 cmH_2O and adjusted according to causal pathology and arterial oxygen saturation with a maximum of 10 cmH_2O.

FiO_2 (fraction of inspired oxygen) was administered to provide an oxygen saturation above 90% in pulse oximetry and arterial blood gas. The target was adjusted according to clinical presentation.

The CPAP which provides continuous PEEP was applied by means of a Boussignac valve with a minimal PEEP of 5 cmH_2O and a maximal level of 30 cmH_2O.

The PSV mode was indicated when an AECOPD was clinically considered in patients with a history of chronic obstructive pulmonary disease as well as when the diagnosis of AHF or pneumonia was suspected in presence of severe clinical signs as thoracoabdominal swing or hypercapnic encephalopathy. The CPAP mode was indicated in the other cases.

Data Collection and Measurements

Socio-demographic, clinical and paraclinical data were collected from medical records and entered by two experienced clinicians into a computerized database.

Socio-demographic data included age, sex, history and Charlson comorbidity index. Charlson comorbidity index was calculated for all patients in order to assess comorbidities.[11]

Clinical parameters were: pleuropulmonary, cardiovascular, neurological and general examination data at admission

The paraclinical parameters were provided by the results of biological analysis.

Arterial blood gas including pH, Oxygen blood pressure (PaO_2) and capnia were collected before and after NIV practice with calculation of PaO_2/FiO_2 ratio. The blood gas data after NIV were collected from blood gas taken at the end of the hospital stay. ARF type, etiological diagnoses, NIV mode and duration were gathered on all patients included.

Hypoxaemic ARF was defined by an arterial oxygen tension PaO_2 of less than 8 kPa (60 mmHg) with normal or low arterial carbon dioxide tension ($PaCO_2$).[12]

Hypercapnic ARF was considered when $PaCO_2$ was greater than 6 kPa (45 mmHg) and PaO_2 less than 8 kPa (60 mmHg) and/or when there was an acute respiratory acidosis, defined by a pH less than 7.35 and a $PaCO_2$ higher than 6 kPa (45 mmHg).[9,12]

We also collected patients' issue data including occurrence of death, use of invasive ventilation, transfer to ICU or to other department, discharge at home and duration of stay.

Outcomes

NIV failure was defined by need of intubation, transfer to ICU or occurrence of in-hospital death. The need of intubation was defined when there was no improvement or deterioration in distress respiratory signs and blood gas exchanges. The decision of "do not intubate" was taken depending on the physiological age of the patient and the severity of its comorbidities. Transfer to ICU was considered when patients required prolonged duration of NIV (more than 4 hours) or invasive ventilation. However, the transfer to ICU was also depending on prognosis' patients and available beds.

The clinical success was considered when patients no longer required oxygen and could be discharged at home or when patients needed to be transferred to another department after NIV weaning. The respiratory improvement was evaluated by improvement of clinical signs (dyspnea, respiratory rate, oxygen pulsed saturation) and paraclinical parameters (blood gas exchange).

Statistical Analysis

Data were analyzed using SPSS software (version 22). Cumulative data were described as mean ± standard deviation or median with minimal and maximal values for continuous variables and as percentage for binary or categorical variables.

Paired samples t-test was used for the analysis of gasometric data before and after performing NIV with a significance level of 0.05 ($p < 0.05$).

Results

Sixty-six old patients aged more than 65 years were included. The mean age was 76 years (± 7) with a ratio of 1.28. 59% of them were over 75 years old.

The most frequent chronic diseases present in patients' history were cardiovascular and pulmonary as shown in Figure 1 with a median Charlson comorbidity index of 5 (ranging from 3 to 9).

NIV was performed at the admission to the Emergency hospital unit. The baseline physiological parameters and blood test data of patients before NIV initiation are shown in Table 1.

Etiological diagnoses of ARF were AHF in 45 patients (68%), AECOPD in 35 (53%) and pneumonia in 26 patients (39%). Two patients (3%) presented with a pulmonary embolism (PE).

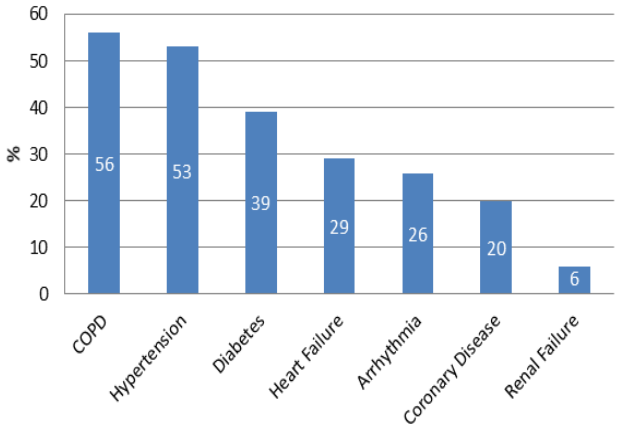

Figure 1 The elderly patients' history in the sample. *COPD: chronic obstructive pulmonary disease*

48% had more than one etiologic diagnosis. The etiological diagnoses are detailed in Table 2.

ARF was hypercapnic in 61% of patients and hypoxemic in 39%. PSV mode was applied in 83% of patients and CPAP mode in 17%. NIV was performed during a median period of 6 hours with a minimum of one hour and a maximum of 26 hours. Ninety five percent of patients with hypercapnic ARF (n = 38) were put on PSV mode and 5% (n = 2) on CPAP. The application of NIV mode related to ARF type is represented in Figure 2.

The gas exchange assessment before and after NIV showed a significant improvement of pH (p = 0.011) (Table 3).

NIV failure concerned 21 patients (32%), among them 15 patients (23%) died during their ED stay and 6 patients (9%) transferred to the ICU. Among the NIV failure group, three patients (4%) were intubated before they died.

Table 1 Baseline physiological parameters and blood test data in the study population

Baseline Parameters	Mean ± Standard Deviation
SpO_2 (%)	79 ± 10
Respiratory rate (c/mn)	31 ± 6
SAP (mmHg)	139 ± 34
DAP (mmHg)	77 ± 22
Heart rate (bpm)	104 ± 23
GCS	13 ± 3
pH	7.31 ± 0.11
Capnia (mmHg)	56 ± 21
PaO_2/FiO_2	238.3 ± 87.5
Uremia (g/L)	0.7 ± 0.5
Creatininemia (mg/L)	13.5 ± 6.1
Hemoglobinemia (g/dL)	11.9 ± 2.4
CRP (mg/L)	100 ± 122.4

SpO_2: oxygen pulsed saturation; c/mn: cycles per minute; SAP: systolic arterial pressure; DAP: diastolic arterial pressure; bpm: beats per minute; GCS: Glasgow coma score; CRP: C-reactive protein

Table 2 The etiological diagnoses of ARF in the sample

Etiological diagnoses of ARF	N = 66	%
One diagnosis		
AHF	17	26
AECOPD	12	18
Pneumonia	3	4.5
Pulmonary embolism	2	3
Two diagnoses		
AHF and AECOPD	9	13.6
AHF and pneumonia	9	13.6
AECOPD and pneumonia	4	6
Three diagnoses		
AHF, AECOPD and pneumonia	10	15

ARF: acute respiratory failure; AHF: acute heart failure; AECOPD: acute exacerbation of chronic obstructive disease.

A clinical success of NIV was observed in 68% of patients. 61% of them discharged at home and 7% were transferred to another department after their clinical improvement (Table 4). The mean hospital stay was 49 ± 40 hours.

There was no significant difference in NIV failure and in hospital mortality depending on the NIV mode used (p > 0.05). Furthermore, the NIV failure rate was significatively higher in the hypercapnic

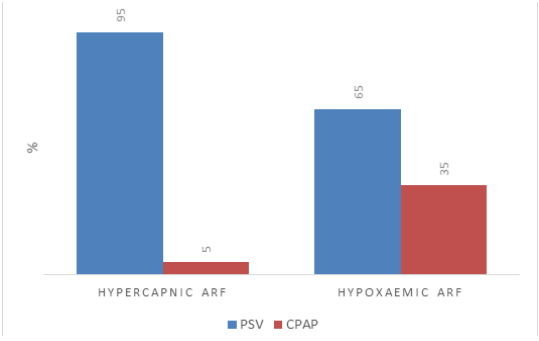

Figure 2: The application of Non invasive ventilation mode according to ARF type. *PSV: pressure support ventilation; CPAP: continuous positive airway pressure; ARF: acute respiratory failure*

Table 3 Blood gas data comparison by paired sample t-test before and after NIV (mean ± standard deviation)

Blood gas parameters	Before NIV	After NIV	p-value
pH	7.31 ± 0.11	7.38 ± 0.11	0.011
$PaCO_2$ (mmHg)	56 ± 21	53 ± 26	0.49
PaO_2/FiO_2	238.3 ± 87.5	274.4 ± 103	0.09

NIV: non invasive ventilation

Table 4 Patients' disposition after NIV implementation

Patients Discharge	N = 66	%
Discharged at home	40	61
Transferred to ICU	6	9
Transferred to cardiology department	2	3
Transferred to pneumology department	3	4.5
In-hospital mortality	15	23

ICU: intensive care unit

ARF subgroup as showed in Table 5.

DISCUSSION

NIV is often performed in the elderly in the ED despite the lack of specific data concerning its effectiveness.[3,5] We conducted an observational retrospective study to identify the epidemiological aspects of NIV and to assess its clinical results in the elderly with ARF in the ED. During the study period, NIV was performed in 66 old patients who met our inclusion criteria. The ARF was hypercapnic in 61% of patients and hypoxemic in 39%. The most frequent causes of ARF were AHF (68%), AECOPD (53%) and pneumonia (39%). The observed rates were associated to the frequent polypathology present in the elderly,[7] resulting in 48% of our patients who had more than one etiologic diagnosis. The polypathology commonly involved can make difficult the management of elderly patients with ARF and especially their ventilatory treatment. Although the effectiveness of NIV has been proven in AHF and AECOPD which were the most frequent etiologies observed in our population, outcomes could differ when these pathologies are associated.[2,7] Indeed, some studies showed that the occurrence of NIV failure after an initial favorable response may be related to severe comorbidities.[2,13] The third most observed diagnosis in our series was pneumonia for which current guidelines didn't issue specific recommendations.[6,14] However, isolated pneumonia is considered as an adverse prognosis factor of NIV in hypercapnic ARF.[14] Moreover, there is no recommendation on NIV for acute respiratory distress syndrome which can be a complication of pneumonia.[14,15]

Despite these potential difficulties in the management of elderly, our study showed a clinical success of NIV in 68% of our patients, 61% of whom were discharged at home and 7% transferred to the

Table 5 NIV outcomes according to the performed mode and the ARF type

Clinical endpoints	Comparative parameters		p-value
	CPAP Mode	PSV Mode	
	n = 11 (%)	n = 55 (%)	
Occurrence of in-hospital death	1 (9)	14 (25)	0.43
NIV failure	1 (9)	20 (36)	0.15
	Hypercapnic ARF	Hypoxemic ARF	
	n = 40 (%)	n = 26 (%)	
Occurrence of in-hospital death	10 (25)	5 (19)	0.42
NIV failure	16 (40)	5 (19)	0.033

NIV: non invasive ventilation; CPAP: continuous positive airway pressure; PSV: pressure support ventilation; ARF: acute respiratory failure

pneumology or cardiology department after their clinical improvement. There was also a significant improvement of pH after NIV (p = 0.011); The in-hospital mortality was 23% and was higher in the hypercapnic ARF subgroup (25%). In the literature, the results of NIV during ARF from any cause and regardless of age, differ according to inclusion criteria showing an overall rate of NIV failure that can range from 20 to 30%.[16] Several studies tackled elderly patients with hypercapnic ARF[5,17,18]; our study also included hypoxaemic respiratory failure. Among these studies, that of Çiftci et al.[17] which enrolled prospectively patients aged more than 65 years old and which showed a mortality rate of 18% with a need for intubation concerning 24.6% of the patients. The differences in outcomes can be partialy explained by the settings of NIV practice, which was in ICU. Other studies conducted in respiratory monitoring unit and ED compared patients above and below 75 years.[5,18] These studies showed a mortality rate lower than ours for patients over 75 years old.[5,18] Additionally, the study of Nicolini et al.[5] showed a mortality rate of 19.8% and included only AECOPD requiring Bilevel ventilation. One other study was of Segrelles Calvo et al.[18] in which the mortality rate was 21.4%. We noted that patients in this study presented with a median Charlson comorbidity index of 3.27 at inclusion while it raised to 5 in our study.

Otherwise, in the view of data on NIV performed in the elderly, there seems to be no correlation between clinical outcomes and age factor. Indeed, the studies on NIV use in patients with ARF have shown no difference in success related to age.[5,18-20] In view of such encouraging data, NIV is increasingly advocated in the elderly with a wide range of clinical indications. The ventilatory treatment in the elderly is clearly associated with a decreasing use of invasive ventilation.[21,22] This trend is multifactorial due to a better management of AHF and AECOPD, but may also be attributed to limited therapeutic decisions which may be more easily taken in this age range group.[21] Our outcomes are consistent with this trend. Only 4% of patients were intubated with a mortality rate of 23% and an ICU hospitalization of 9%. These results can be explained by the frequent lack of available ICU beds and the importance of comorbidities in our patients, sustained by a median Charlson comorbidity index raised to 5, a factor which could have intervened in the decision of "do not intubate". The inclusion of patients with "do not intubate" order in case of no improvement or worsening respiratory state, had certainly an impact on our results but it was important to do it for analyzing the global epidemiological aspects of NIV practice in the elderly.

The retrospective nature of our study presents several limitations. First, the lack of a matched control sample that received a standard treatment constituted a significant limitation to assess NIV effectiveness in the elderly with ARF. Moreover, we should have compared old and young patients as other studies have done, in order to better appreciate peculiarities of NIV use in the elderly. Another limitation was the small size of the sample of patients enrolled in comparison to other studies. Indeed, we had to exclude many patients with missing data due to the absence of a computerized database during the study period. In our study, the delay to practice blood gas after NIV was variable, a factor which could have had a significant influence on gas exchange analysis. Finally, the prognosis of patients after their discharge and transfer to other departments could not be assessed.

CONCLUSION

Management of elderly patients with ARF is complex and related to the frequent comorbidities. Questions persist about the best ventilatory technique to apply in this group age. Despite the lack of randomized prospective studies concerning its effectiveness, NIV is widely performed in the elderly with ARF particularly in the ED. In some cases, it is the only alternative respiratory support proposed to this age group. The previous studies conducted in elderly reported no difference in NIV success related to age. Our study has shown that NIV could be of a great importance in this patient population.

Conflict of interest: the authors declare no conflict of interest or source of funding.

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