Outcomes of non-invasive ventilation in 'very old' patients with acute respiratory failure: a retrospective study

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ABSTRACT

Background Non-invasive ventilation (NIV) is increasingly used to support very old (aged ≥85 years) patients with acute respiratory failure (ARF). This retrospective observational study evaluated the impact of NIV on the prognosis of very old patients who have been admitted to the intermediate care unit (IMC) of the Emergency Department of the University Hospital Policlinico-Vittorio Emanuele of Catania for ARF.

Methods All patients admitted to the IMC between January and December 2015 who received NIV as the treatment for respiratory failure were included in this study. Outcomes of patients aged ≥85 years were compared with lower ages. The expected intrahospital mortality was calculated through the Simplified Acute Physiology Score (SAPS) II and compared with the observed mortality.

Results The mean age was 87.9±2.9 years; the M:F ratio was approximately 1:3. The average SAPS II was 50.1±13.7. The NIV failure rate was 21.7%. The mortality in the very old group was not statistically different from the younger group (20% vs 25.6%; d=5.6%; 95% CI −8% to 19%; p=0.404). The observed mortality was significantly lower than the expected mortality in both the group ≥85 (20.0% vs 43.4%, difference=23.4%; 95% CI 5.6% to 41.1%, p=0.006) and the younger group (25.6% vs 38.5%, difference=12.9%; 95% CI −0.03% to 25.8%, p=0.046). In both age groups, patients treated with NIV for chronic obstructive pulmonary disease had lower mortalities than those treated for other illnesses, although this was statistically significant only in the younger group.

Conclusion In very old patients, when used with correct indications, NIV was associated with mortality similar to younger patients. Patients receiving NIV had lower than expected mortality in all age groups.

What is already known on this subject:

- A large number of elderly patients hospitalised in an intensive care unit die in hospital, often after a prolonged hospital stay, while continuing to receive aggressive life-sustaining interventions.
- Non-invasive ventilation (NIV) is increasingly used to support very old (aged ≥85 years) patients and those with a do-not-intubate order with acute respiratory failure, yet little is known about their outcome.

What this study adds

- The in-hospital mortality observed in patients >85 years, who received NIV, was comparable with the younger group and half that of expected mortality.
- Patients with chronic obstructive pulmonary disease treated with NIV had lower mortality than patients with other indications although this was only significantly different in the younger 'old' group.

INTRODUCTION

A large number of elderly patients hospitalised in an intensive care unit (ICU) often die in hospital, after a prolonged hospital stay, while continuing to receive aggressive life-sustaining interventions.[1] Several authors have raised the question about the use of critical care resources at the end of life for very old patients.[2] Indeed, the impact of age on survival of patients receiving intensive care is well recognised. Several studies have evaluated the outcome of very old patients after intensive care. A Canadian multicentre study, recruiting patients >80 years, reported a mortality of 14% in ICU, 26% in hospital and 44% at 12 months after admission. Furthermore, only 25% of the survivors returned to their pre-ICU physical function. For this reason, major intensive care mortality prediction scores, including Simplified Acute Physiology Score (SAPS) II, confer a prominent priority to age.

Non-invasive ventilation (NIV) is increasingly used to support very old (aged ≥85 years) patients and those with a do-not-intubate (DNI) order, admitted to emergency departments (ED) with acute respiratory failure (ARF).[3] NIV improves work of breathing and symptoms, so reducing mortality as well as the need for intubation, compared with oxygen supplementation alone.[4]

The percentage of elderly persons admitted to the ED is growing rapidly, particularly for chronic heart failure and lung diseases, which are the most frequent causes of respiratory failure. Furthermore, the incidence of ARF or acute exacerbation of chronic respiratory failure increases exponentially with age.[5] Although these particularly frail patients may be potentially good candidates for less invasive

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management of ventilatory support, a clear position on the appropriateness of this treatment for these patients has not been established.[6]

This retrospective observational study, therefore, evaluates the prognosis of very old patients receiving NIV in the intermediate care unit (IMC) of an ED in Italy. Their outcomes are compared with their expected survival and the outcomes of younger patients treated with NIV.

MATERIALS AND METHODS

This is a retrospective chart review study based on data extracted from the Margherita-PROSAFE project database, created by GiViTI – Mario Negri Institute.[7] Patient data were originally obtained from clinical notes, both on paper (in the ward) and electronic medical records (in the ED) and entered into an existing database containing demographics and other basic information on each patient seen in our IMC. The clinical data were entered into the database during the patient admission by two experienced clinicians working together. Illegible or unclear data were clarified according to the following entry on the same day. Erroneous entries were prevented by the range limits within the database and the oversight of the second investigator. Missing information was assumed to not have been present on the examination and charted as a negative; however, all necessary information for the SAPS II calculation was routinely recorded and available for each patient. Moreover, patients would be excluded if there was not sufficient information gathered by the two researchers to adjudicate the type of respiratory failure or their outcome. All patients who received NIV as the treatment for hypoxemic or hypercapnic ARF were included in the study. The patient population was divided into patients ≥85 (older group) and <85 years (younger group). The project was approved by the ethical committee of the University Hospital Policlinico-Vittorio Emanuele of Catania.

Participants were evaluated on the basis of the type of respiratory disorder on admission: type I, PaO_2 <60 mm Hg and/or PaO_2/FiO_2 ratio <300, and $PaCO_2$ ≤45 mm Hg, considered as acute hypoxemic respiratory failure; type II, pH <7.35 and $PaCO_2$ >45 mm Hg, associated with signs of respiratory distress (dyspnoea or respiratory rate >25 acts/min or use of the accessory muscles or paradoxical breath or drowsiness or agitation) considered as acute hypercapnic respiratory failure.

The outcome of interest was NIV failure (i.e need for intubation and/or death) in each age group, as well as the expected versus actual mortality in each age group.

Expected mortality

The expected inhospital mortality was calculated through the Simplified Acute Physiology Score (SAPS) II),[8] a largely used and validated scoring system, including 12 physiological variables and 3 disease-related variables. The most severe physiological variables were collected within the first 24 hours of IMC admission.

The intrahospital mortality rate was calculated from the SAPS II[6] using logistic regression: logit=−7.7631+0.0737·(SAPS II)+0.9971· 1 n ((SAPS II)+1).

To calculate the probability of hospital death (p), the following formula was used: $P=e^{logit}/1+e^{logit}$

The expected mortality of the sample was calculated by performing a weighted average of every single probability of hospital death, derived from the SAPS II value of each patient enrolled.

Table 1 Characteristics of NIV-treated patients

	≥85 years (n=60)	<85 years (n=113)
Age, years	87.9±2.9	72.0±11.7
Male n (%)	15 (25.0%)	71 (62.8%)
SAPS II	50.1±13.7	47.8±18.5
Observed mortality n (%)	12 (20.0%)	29 (25.6%)
	(95% CI 11.8% to 31.8%)	(95% CI 18.5% to 34.4%)
Expected mortality n (%)	26 (43.4%)	43 (38.5%)
	(95% CI 31.6% to 55.9%)	(95% CI 29.6% to 47.3%)
Glasgow Coma Scale	12	13
Respiratory failure type (%)		
Type I ARF	17 (28.3%)	50 (44.2%)
Type II ARF	42 (70.0%)	63 (55.7%)
Respiratory failure causes n (%)		
Exacerbation of COPD	14 (23.3%)	31 (27.4%)
Acute pulmonary oedema	14 (23.3%)	18 (15.9%)
Pneumonia	10 (16.6%)	26 (23.0%)
Sepsis	16 (26.6%)	29 (25.6%)
Other	6 (10.0%)	9 (7.9%)

ARF, acute respiratory failure; COPD, chronic obstructive pulmonary disease; NIV, non-invasive ventilation; SAPS, Simplified Acute Physiology Score.

Statistical analysis

The $\chi 2$ test was used to compare both the observed mortality rates in the study versus control group and the observed versus the expected mortality. $p<0.05$ was considered statistically significant.

RESULTS

Between January 2015 and December 2015, 747 patients were admitted to the IMC: 162 were ≥85 years old and 41% (66/162) required NIV; of the 585 patients younger than 85, 24% (139) required NIV.

Out of the 205 patients treated with NIV, 173 received ventilatory support for hypoxemic or hypercapnic ARF, while the remaining 32 were ventilated for other causes (eg, postextubation weaning and chronic respiratory failure). No patients were excluded due to a lack of information determining the type of respiratory failure or outcome. Thus, 173 patients were included in the study: 60 (35%) were >85 years and 113 (65%) were younger (table 1).

In the older group, the mean age was 87.9±2.9 years; the M:F ratio was approximately 1:3. The average SAPS II was 50.1±13.7. Clinical signs of type II respiratory failure were present in 72% (43 patients) of the older study group. In the younger group, the mean age was 72±11.7 and the majority were men. Mean SAPS was 47.8±18.5% and 56% had type II respiratory failure.

In the older group, 13 patients did not respond to NIV; 1 was intubated and survived. Thus, the failure rate (including both intubation need and death) was 21.7%. The observed mortality was significantly lower than the mortality predicted by SAPS II both groups. In detail, in the very old group, the observed in-hospital mortality was 20.0%, while the total expected mortality, based on SAPS II, was 43.4% (difference=23.4%; 95% CI 5.6% to 41.1%; p=0.006). In the group of patients <85 years old, 29/113 (25.6%) died while the expected mortality was 38.5% (difference=12.9%; 95% CI −0.03% to 25.8%; p=0.046). The observed mortality in the very old group was lower than in the younger group (20.0% vs 25.6%), although it did not reach

Table 2 Mortality according to respiratory failure causes

	≥85 years (n=60)	<85 years (n=113)
Observed mortality n (%)	12 (20.0%)	29 (25.6%)
Exacerbation of COPD	2/14 (14.3%)	3/31 (9.68%)
Acute pulmonary oedema	2/14 (14.3%)	4/18 (22.2%)
Other	8/32 (25.0%)	22/64 (34.4%)

COPD, chronic obstructive pulmonary disease.

statistical significance (difference=5.6%; 95% CI −8.6% to 19.8%; p=0.404).

As shown in table 2, in the older group, patients who received NIV for acute cardiogenic pulmonary oedema (CPO) or COPD had lower mortality than those treated with NIV for other causes of respiratory failure (14.3%, vs 25.0%, respectively, p=0.41). Similarly, in the younger group, the mortality was lower for patients with COPD (9.68%) vs all other causes (31.7%; difference=22%; 95% CI 5.2% to 38.7%; p=0.016) including CPO, which took alone had a mortality of 22.2%.

DISCUSSION

In this retrospective, observational study of patients receiving NIV for ARF, the intrahospital mortality observed in very old patients was comparable with the younger group, despite higher predicted mortality. Additionally, the mortality was half of the expected hospital mortality, according to SAPS II. This corroborates the utility of NIV in these very old patients. It is noteworthy that the female–male ratio in very old patients was 3:1. This could be explained by the major life-expectancy reported in Europe for women.[9]

Although older age and high SAPS II have been listed as predictors of NIV failure,[10] some authors have previously demonstrated that elderly patients with ARF due to COPD exacerbations, restrictive thoracic disorders and multiorgan failure, with a DNI order, can be successfully treated by NIV.[3] Moreover, CPO and COPD are frequent reasons of admission to the ED, and, as confirmed by others,[10] in these cases, the NIV rate of success is higher than for other causes of respiratory failure. Our results demonstrate that this favourable trend still remains evident in very old patients, in which the mortality for CPO and COPD was lower, on the whole than in patients in whom NIV was used for other causes, even if this difference did not reach the conventional level of significance.

Very old patients are frequently admitted to EDs or ICUs for ARF, with consequent high mortality rate during the hospital stay and in the months following discharge.[3 11] In this context, invasive mechanical ventilation is considered a controversial intervention that deprives patients of their dignity and ability to recognise their family members.[12] Indeed, advanced age or the presence of significant comorbidities are indications for DNI status, and in these cases, the use of NIV represents an alternative treatment.

This study has several limitations. It is an observational retrospective study. However, data were included in the PROSAFE database during patients' admission, so this did not affect the SAPS II calculation. Moreover, we used only one predictive score to assess mortality risk. Although we did not adjust the outcomes for severity, the SAPS II provides a reasonable estimate of the severity of illness and would suggest the elderly patients were equally, if not more, severely ill. There was no comparator group of patients receiving intubation or no assisted ventilation. Our 'proof of concept' study, however, underscores the usefulness of NIV in both very old and younger patients to improve short-term prognosis. Further prospective studies are no doubt needed to corroborate our results and to assess the role of NIV for improving the prognosis of very old patients admitted with ARF.

CONCLUSIONS

In very old patients, NIV use was associated with mortality similar to younger patients. Additionally, the mortality was half of the expected hospital mortality, predicted by SAPS II. This suggests that the use of NIV in very old patients would result in meaningful improvement. This finding should be confirmed in larger prospective studies, also evaluating the outcomes of both NIV and intubation in this clinical setting.

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