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Clinical characteristics and outcome of patients admitted to a medico-surgical ICU requiring non invasive ventilation (NIV) for hypercapnic respiratory failure

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Abstract

Introduction

Because it decreases intubation rate and mortality, NIV has become first-line treatment in case of hypercapnic acute respiratory failure (HARF). Whether this approach is equally successful for all categories of HARF patients is however debated. We assessed if any clinical characteristics of HARF patients were associated with NIV intensity, success, and outcome, in order to identify prognostic factors.

Methods

Retrospective analysis of the clinical database (clinical information system and MDSi) of patients consecutively admitted to our medico-surgical ICU, presenting with HARF (defined as $PaCO_2$ > 50 mmHg), and receiving NIV between May 2008 and December 2010. Demographic data, medical diagnoses (including documented chronic lung disease), reason for ICU hospitalization, recent surgical interventions, SAPS II and McCabe scores were extracted from the database. Total duration of NIV and the need for tracheal intubation during the 5 days following the first hypercapnia documentation, as well as ICU, hospital and one year mortality were recorded. Results are reported as median [IQR]. Comparisons were carried out with Chi^2 or Kruskal-Wallis tests, $p<0.05$ (*).

Results

Two hundred and twenty patients were included. NIV successful patients received 16 [9-31] hours of NIV for up to 5 days. Fifty patients (22.7%) were intubated 11 [2-34] hours after HARF occurence, after having receiving 10 [5-21] hours of NIV. Intubation was correlated with increased ICU (18% vs. 6%, $p<0.05$) and hospital (42% vs. 31%, $p>0.05$) mortality. SAPS II score was related to increasing ICU (51 [29-74] vs. 23 [12-41]%, $p<0.05$), hospital (37% [20-59] vs 20% [12-37], $p<0.05$) and one year mortality (35% vs 20%, $p<0.05$). Surgical patients were less frequent among hospital fatalities (28.8% vs. 46.3%, $p<0.05$, RR 0.8 [0-6-0.9]). Nineteen patients (8.6%) died in the ICU, 73 (33.2%) during their hospital stay and 108 (49.1%) were dead one year after HARF.

Conclusion

The practice to start NIV in all suitable patients suffering from HARF is appropriate. NIV can safely and appropriately be used in patients suffering from HARF from an origin different from COPD exacerbation. Beside usual predictors of severity such as severity score (SAPS II) appear to be associated with increased mortality. Although ICU mortality was low in our patients, hospital and one year mortality were substantial. Surgical patients, although undergoing a similar ICU course, had a better hospital and one year outcome.

Key-words

Non-invasive ventilation – Chronic Obstructive Pulmonary Disease –Acute Respiratory Failure –Intensive care– Intubation, Intratracheal.

Introduction

As the use of non invasive ventilation (NIV) decreases intubation rate, morbidity, duration of ICU stay and hospital mortality in case of acute exacerbation of chronic obstructive pulmonary disease (COPD) [1], NIV has become the first treatment modality in this situation. The interest of using NIV in case of acute respiratory failure in non-COPD patients is much more controversial [2]. Even though little information is available regarding the interest of using NIV as a first treatment modality in case of hypercapnic acute respiratory failure (HARF) of various origins, NIV is widely used in our intensive care unit in this situation essentially because NIV is an easy to initiate and non invasive treatment. The main aim of the present study was to assess if any clinical characteristics of the patients treated with NIV because of hypercapnic acute respiratory failure in our medico-surgical ICU were related to NIV success or failure on one hand and to patients' outcome on the other hand. The second aim of the study was to assess whether there was a relationship between these clinical characteristics and the intensity of NIV treatment (namely total duration of NIV during the 5 days following treatment initiation).

The main hypothesis was that, based on our findings, some prognostic factors could be identified and provide new information to improve the global management of patients suffering from hypercapnic acute respiratory failure of various origins. For instance, such information could help the clinician to better define if a specific patient should be intubated and when is the most optimal timing to perform the intubation.

Methods

After having obtained the approval of the ethics committee of the Faculty of biology and Medicine, we conducted a retrospective study. Patients hospitalized in the Lausanne university hospital medico-surgical ICU between May 2008 and December 2010, who suffered from hypercapnic acute respiratory failure and received NIV as first treatment modality were identified from the ICU clinical information system (Metavision, iMDsoft, Needham, MA, USA). Hypercapnic respiratory failure (HARF) was defined as an association of clinical characteristics of acute respiratory failure (tachypnoea, respiratory distress, hypoxemia, tachycardia) and of documented hypercapnia defined as a $PaCO_2$ value above 50 mmHg. Hypercapnic episodes obviously due to sedative and/or analgesic administration or occurring immediately after extubation were excluded from the analysis.

Patients' data were collected from the ICU clinical information system and from the medical report. Age, past medical history (including documented chronic lung disease and non respiratory co-morbidities), reason for ICU admission, the occurrence of a recent surgical intervention, SAPS II [3] and MacCabe [4] scores were recorded. Blood gas analyses upon ICU admission and during the first diagnosed hypercapnic episode were also recorded from the clinical information system. Total duration and number of sessions of NIV during the five days following the initial hypercapnic episode were also recorded as well as the need for tracheal intubation and total duration of mechanical ventilation. Additionally, as other outcome parameters, ICU mortality and in-hospital mortality were recorded. Finally, one year mortality was recorded for most patients, based on the "Registre d'Etat Civil du Canton de Vaud".

Statistical analysis

Statistical analysis was performed using JMP 8 (SAS Institute Inc., Carey, North Carolina). For descriptive statistics, categorical variables are reported as percentages and continuous values as median (IQR) because of non-normal distribution.

To explore the relationship between various clinical characteristics and the occurrence of different outcomes, we performed Chi2 tests for categorical variables and Kruskal-Wallis tests for continuous variables. A p-value of less than 0.05 was considered as statistically significant.

Results

Patients' demographic and clinical characteristics are displayed in Table A. Two hundred and twenty patients were included in the study. Median age was 70 [59-77] years, mortality prediction according to SAPS II score was 25 [13-44] %. Forty-five patients (20.5%) were classified as suffering from a rapidly fatal condition according to McCabe's classification.
Half of the patients (114) suffered from a previously diagnosed obstructive pulmonary disease. Eighty-nine (40.5%) patients underwent a recent surgery before becoming hypercapnic after a delay of 19 [12-60] hours.

Blood gas analyses and respiratory outcomes (namely intubation, time to intubation, NIV and invasive ventilation (IV) durations are presented in table B. All patients suffered from severe respiratory failure attested by the presence of respiratory acidosis in all of them. Among the 220 patients, 50 (22.7%) were intubated, after a duration of HARF of 11 [2-34] hours. Patients requiring intubation received 10 [5-20] hours of NIV beforehand. Patients successfully treated with NIV received 16 [9-31] hours of NIV during the 5 days of the study.

Figure A details the evolution of daily respiratory management and outcomes during the first 5 days following the first documented episode of hypercapnia. The various columns indicate the daily cumulative number of events by order of severity. The majority of deaths and intubations occurred in the first two days. The number of patients requiring prolonged NIV sessions (defined as more than 6 hours per day) decreased over time, ranging from 129 on day 1 to 19 on day 5. At that time, 7 patients were deceased, 48 were intubated and, as already said, 19 required NIV during more than 6 hours per day. The 146 patients remaining were either weaned from NIV or already discharged from the ICU on day 5.

Patient's mortality during the whole ICU stay, during hospital stay and one year after HARF episode is presented in Figure B. The information regarding living status was available for all patients at hospital discharge and for 197 patients one year after HARF. Among the 220 patients studied 19 (8.6%) died in the ICU, 73 (33.2%) during their hospital stay and 108 (49.1%) were dead one year after HARF. Hence, although ICU mortality was relatively modest, half of the included patients were dead one year after HARF.

In Tables C and D, various clinical characteristics are compared in relationship to the occurrence or non occurrence of the following outcomes, NIV failure (i.e., intubation), ICU death (Table C), hospital death and one year mortality (Table D).

NIV duration was shorter in intubated patients. Intubation was correlated with increased SAPS II score, while all other variables were not different.

The 19 (8.6%) patients who died during ICU stay had a higher SAPS II predicted mortality (51 [29-74] vs. 23 [12-41]%, $p<0.05$) and a higher intubation rate (47.4% vs 20.4% RR 1.5 [1.0-2.3], $p<0.05$). The other clinical variables were not different.

The 73 (33.2%) patients who died during hospital stay (including ICU deaths) underwent longer mechanical ventilation (31 [12-112] vs. 20 [9-56] hours, $p<0.05$). They were also older than those who survived (75 [67-81] versus 66 [56-76] years old, $p<0.05$) and were more often male patients (69.9% vs. 53.7%, $p<0.05$, RR 1.5 [1.0-2.3]). Patients deceased in the hospital had also a higher SAPSII probability of death (37% [20-59] vs 20% [12-37], $p<0.05$) and higher rapidly fatal McCabe score (31.5% vs 15.0%, $p<0.05$, RR 1.24 [1.0-1.5]). Of note, surgical patients were less frequent among hospital fatalities (28.8% vs. 46.3%, $p<0.05$, RR 0.8 [0-6-0.9]). Surgical patients who survived developed HARF more rapidly after their procedure (20 [15-50] vs. 43 [19-152] hours, $p<0.05$). The other clinical variables were not different.

Clinical characteristics related to one year mortality were basically comparable to clinical characteristics related to hospital mortality: Deceased patients were older (75 [66-80] vs. 64 [54-73] years old, $p<0.05$) and more frequently male patients (67.6% vs. 46.3%, $p<0.05$, RR 1.7 [1.2-2.3]). They had higher SAPS II probabilities of death (35% vs 20%, $p<0.05$) and had more often rapidly fatal McCabe scores (28.4% vs 12.6%, $p<0.05$, RR 1.2 [1.1-1.4]). Additionally, they underwent less often surgery (28.7% vs. 51.8%, $p<0.05$) and suffered more frequently from chronic pulmonary disease (74.1% vs. 68.8%, $p>0.05$). Hence, for the 29 patients who died during the year after their episode of HARF, we found the same clinical pattern characteristics than the one associated with hospital mortality.

Considering the whole population, need for intubation was associated with a higher mortality during ICU stay (18% vs 5.9%, $p<0.05$) (Table F). In the population of patients suffering from COPD, intubation was more strongly related to an increasing ICU and hospital mortality (Table G).

Discussion

In the present study, we assessed both the process of care and various outcomes for ICU patients requiring NIV for HARF of different origins in a group of 220 consecutive patients.

Globally, 50/220 (22.7%) patients had to be intubated. Regarding the timing of intubation, most (32) occurred during the first day after the diagnostic of HARF, 10 during the second day, and 5 during the third day. Such timing is coherent with Brochard's seminal study [1]. This confirms the general feeling that the first day(s) are critical for the success of NIV in case of HARF. Likewise, the number of patients requiring high-intensity NIV decreased almost by half every day. Overall, these results suggest that the process of NIV, which requires both efficient technology equipments (ventilators, interfaces) and technical skills among ICU nurses and respiratory therapists, is efficient in our unit.

Intubation rate

In the present study, the intubation rate amounted to 22.7%. This figure is similar to the 16.4% intubation rate reported in the Cochrane review for patients with COPD exacerbations [5]. In a prospective study which included both COPD patients (about 50%) and non COPD patients (about 50%) suffering from HARF, intubation rate was 19% for COPD exacerbation and 47% for other causes of HARF [6]. We could not confirm this observation as in our study intubation rate was correlated neither with COPD nor with surgical admission (Table C). Indeed, the only variable significantly correlated with intubation was SAPS score. This latest observation is coherent with existing literature, which clearly indicates that intubation is correlated with ICU scores of severity [6,7]. Of note, the absence of correlation between intubation and factors previously associated with increased intubation rate, such as surgical admission [7], presence of COPD [6] or more severe blood gas alterations may appear surprising. We have no clear explanation for this finding, and can only speculate that as in our study, only patients suffering from severe respiratory acidosis were included, the range of arterial gas alteration was too low to show a statistically significant correlation.

ICU mortality

ICU mortality remained low, amounting to 8.6%. We could not find published data on ICU mortality for comparison. The major reason is that ICU mortality may be markedly influenced by ICU discharge policies and specificities of hospital organisation. In most studies, hospital mortality is considered as a more robust outcome [3]. In our study, besides SAPS score, the only variable correlated with mortality was intubation which is consistent with published data [5]. As more severe patients are more likely to be intubated and to die in the ICU or in the hospital, it is not possible from our study to determine whether intubation is a causal factor or a covariate of mortality.

Hospital mortality

To our surprise, hospital mortality amounted to 33.2% in our group of patients, meaning that 24.6% of our patients died in the hospital after ICU discharge. This result is in sharp contrast with the hospitality mortality of the whole population of patients discharged alive from the

ICU which amounts to only about 6%. The hospital mortality documented in our patients is also much higher than the 10% mortality reported in the Cochrane review for patients suffering from acute COPD exacerbation [5], but is rather similar (26%) to the value reported in a British audit of 2500 patients [8]. This apparent discrepancy may reflect the difference between patients enrolled in a randomised control study and patients included in “real life” studies considering all patients.

Besides disease severity (SAPS II), patients dying in the hospital were older and more frequently male patients. They were also more likely classified as suffering from a rapidly fatal pre-existing disease (McCabe). Of note, intubation was not correlated with increased hospital mortality. All these variables suggest that such patients were likely suffering from more advanced chronical diseases. Since resuscitation status was not readily available from the patient’s file, it is not possible to know how many patients died while receiving palliative care in our study population. However, the limited number of ICU readmission for these patients indirectly suggests that there could have been treatment limitations in a large proportion of them.

Another surprising finding was the correlation between surgical admission and reduced hospital mortality. Such effect is not directly mediated by a better outcome of NIV for surgical patients, since there was no difference for intubation rate (see above). There was even a trend toward more surgical patients intubated (50.0% vs. 37.7%, p=0.12). This suggests that surgical patients may endure a process leading to a severe acute respiratory failure that might be more reversible than medical patients.

One year mortality

One year living status was available for 93% of our patients, indicating that at least 29 supplementary deaths had occurred after hospital discharge. A similar increment of deaths in elderly patients discharged alive after successful NIV treatment has recently been described by Nava et al [9]. In that study about half of the patients had a do-not-resuscitate–order.

The same clinical factors correlated with hospital mortality were also found for one year mortality. This suggests that such correlations are robust, and that the “protective” effect of the surgical admission was long lasting. This reinforces the assumption that surgical patients are more likely to recover, once they have overcome acute respiratory failure.

Study limitations

We must acknowledge the following study limitations.

First, our study is a mono-centric study and therefore reports intubation rate, treatment modalities and outcomes related to the local treatment practices and beliefs. This means that other centres could possibly find different results related to different practices. Second, our study is a retrospective one. Although many technical and physiological aspects of patient’s condition and management are well documented in the clinical information system, more subtle aspects such as treatments limitations may not appear and could have influence some of the results, especially hospital mortality. Third, our definition of HARF with a $PaCO_2$ above

50 mmHg can be contested as it selected relatively severe patients which could also have influenced our results. Finally, the exclusion of hypercapnic episodes obviously due to sedative and/or analgesic administration or occurring immediately after extubation could also be contested.

Conclusion

As there were no differences in patient's respiratory management, especially intubation rate, or ICU outcome between patients suffering from COPD or from hypercapnic acute respiratory failure of any origin, we can conclude that the practice to start NIV in all suitable patients suffering from HARF is appropriate. Hence, NIV can safely and appropriately be used in patients suffering from HARF from an origin different from COPD exacerbation. Although ICU mortality was low in our patients, hospital and one year mortality were substantial. This late mortality appears more related to the irreversibility of underlying chronical disease rather that to the treatment modality of acute respiratory failure. Surgical patients, although undergoing a similar ICU course, had a better hospital and one year outcome.

References

1. Brochard L, Mancebo J, Wysocki M, Lofaso F, Conti G, Rauss A, et al. Noninvasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. N Engl J Med. 1995 Sep 28; 333 (13):817-22.

2. Demoule A, Girou E, Richard JC, Taille S, Brochard L. Benefits and risks of success or failure of noninvasive ventilation. Intensive Care Med. 2006;32: 1756-65.

3. Le Gall JR, Lemeshow S, Saulnier F. A new simplified acute physiology score (SAPS II) based on a European/North American multicenter study. JAMA. 1993 Dec 22/29;270 (24):2957-63.

4. McCabe WR, Jackson GG. Gram-negative bacteremia. Archives of internal medicine. 1962 Dec;110:847-55.

5. Ram FSF, Picot J, Lightowler J, Wedzicha JA. Non-invasive positive pressure ventilation for treatment of respiratory failure due to exacerbations of chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2004;(3):CD004104.

6. Phua J, Kong K, Lee KH, Shen L, Lim TK. Noninvasive ventilation in hypercapnic acute respiratory failure due to chronic obstructive pulmonary disease vs. other conditions: effectiveness and predictors of failure. Intensive Care Med. 2005 Apr;31(4):533-9.

7. Antonelli M, Conti G, Moro ML, Esquinas A, Gonzalez-Diaz G, Confalonieri M, et al. Predictors of failure of noninvasive positive pressure ventilation in patients with acute hypoxemic respiratory failure: a multi-center study. Intensive Care Med. 2001 Nov;27(11):1718-28.

8. Roberts CM, Stone RA, Buckingham RJ, Pursey NA, Lowe D. Acidosis, non-invasive ventilation and mortality in hospitalised COPD exacerbations. Thorax. 2011 Jan; 66(1):43-8.

9. Nava S, Grassi M, Fanfulla F, Domenighetti G, Carlucci A, Perren A, et al. Non-invasive ventilation in elderly patients with acute hypercapnic respiratory failure: a randomised controlled trial. Age Ageing. 2011 Jul;40(4):444-50.

Table A. Demographic and pulmonary history

	N = 220	
Age (y)	70	[59-77]
Male	130	59.1%
BMI (kg/m^2)	24	[23-28]
BMI less than 18	16	7.3%
BMI more than 30	42	19.1%
SAPS II Points	40	[32-49]
SAPS II Probability (%)	25	[13-44]
McCabe rapidly fatal	45	20.5%
Chronical pulmonary disease	157	71.4%
Obstructive pulmonary disease	114	51.8%
Restrictive pulmonary disease	18	8.2%
Mixed obstrucive and restrictive pulmonary disease	25	11.4%
No chronical pulmonary disease	18	8.2%
Tobacco use**	86	39.5%
NIV or O_2 at home	38	17.3%
Surgical ICU admission	89	40.5%
Recent surgery to HARF (hours) (n=89)	21	[16-69]

* *Current users.

SAPS = simplified acute physiology score, ICU = Intensive Care Unit, BMI = Body Mass Index, NIV = Non Invasive Ventilation

Table B. Clinical features and total ventilation for 120 hours

pHa during HARF (n=220)	7.29	[7.24-7.34]
$PaCO_2$ during HARF (mmHg) (n=220)	62	[54-68]
PaO_2 during HARF (mmHg) (n=220)	79	[69-98]
PaO_2/FiO_2 during HARF (n=220)	191.4	[145.9-261.4]
Hb during HARF (n=220)	116	[101-133]
Intubated	50	22.7%
Time to intubation (hours) (n=50)	11	[2-34]
NIV duration (hours) (n=220)	15	[8-30]
VI duration (hours) (n=50)	109	[86-118]
Total V duration (hours) (n=220)	23	[10-70]
Tracheotomia during ICU stay	13	5.9%

pHa = Arterial pH, HARF = Hypercapnic Acute Respiratory Failure, Hb = Hemoglobin, NIV = Non-Invasive Ventilation, VI = Invasive Ventilation, V = Ventilation, ICU = Intensive Care Unit

Figure A. Respiratory management and outcomes during the five days following the hypercapnia: The various columns indicate the daily cumulative number of events by order of severity (from discharge to death).

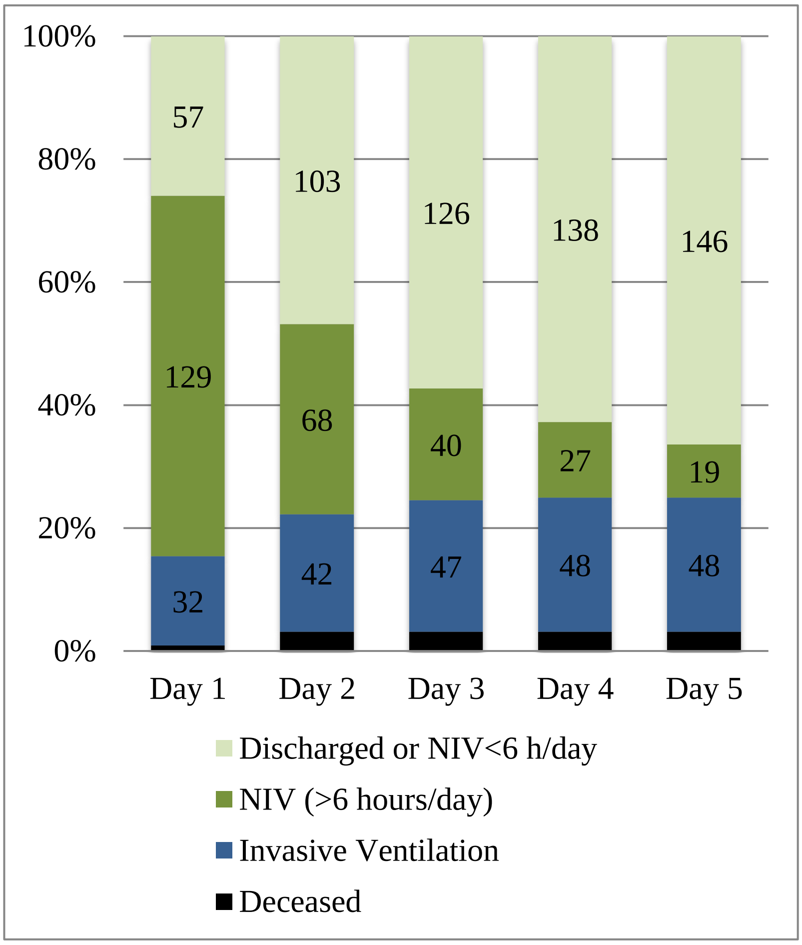

Figure B: Short- and long-term mortality

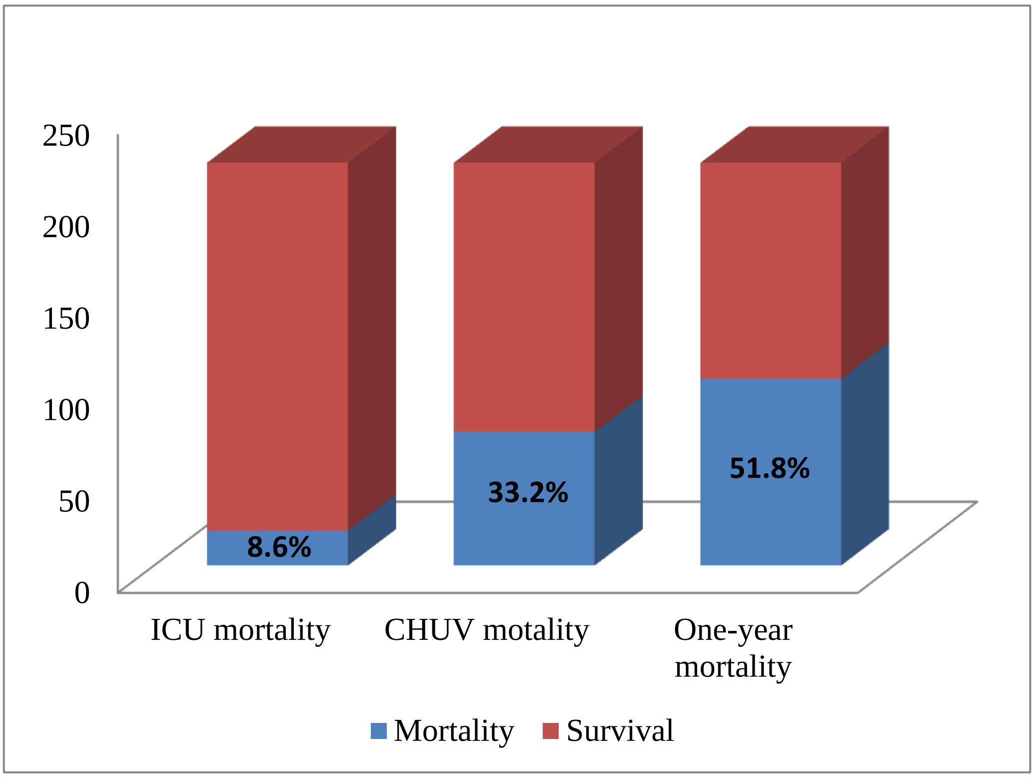

Table C. Clinical characteristics and short-term outcomes

	Intubated within 120 hours						ICU death							
	Yes		*No*		*p*	*RR*	*Yes*		*No*		*p*	*RR*
Number of patients	50	22.7%	170	77.3%			19	8.6%	201	91.4%		
Age	70	[60-78]	69	[56-96]	0.24		71	[64-75]	70	[59-77]	0.74	
Male	35	70.0%	95	55.9%	0.07		14	73.7%	116	57.7%	0.17	
BMI (kg/m^2)	24	[22-29]	24	[23-28]	0.80		25	[23-27]	24	[22-29]	1.00	
BMI less than 18 kg/m^2	4	8.0%	12	7.0%	0.82		0	0%	16	8.0%	0.08	
BMI more than 30 kg/m^2	11	22.0%	31	18.2%	0.55		3	15.8%	39	19.4%	0.70	
SAPS II points	43.5	[32-60.5]	39	[31-47]	---		52	[42-63]	39	[31-48]	---	
SAPS II (%)	32	[13-69]	23	[12-39]	<0.05		51	[29-74]	23	[12-41]	<0.05	
McCabe rapidly fatal	13	26.0%	32	18.8%	0.27		12	63.1%	33	16.4%	<0.05	2.3 [1.3-4.1]
Chronic pulmonary disease	33	66.0%	124	72.9%	0.34		11	57.9%	146	72.6%	0.18	
Tabacco use	17	34.0%	69	41.1%	0.60		7	36.8%	79	39.7%	0.81	
NIV/O2 at home	9	18.0%	29	17.1%	0.88		3	15.8%	35	17.4%	0.86	
Surgical ICU admission	25	50.0%	64	37.7%	0.12		4	21.1%	85	42.3%	0.07	
Recent surgery to HARF (hours)	30	[12-187]	20	[16-64]	0.68		55	[18-143]	20	[16-66]	0.37	
pHa during HARF	7.31	[7.24-7.35]	7.29	[7.24-7.34]	0.34		7.25	[7.18-7.32]	7.29	[7.24-7.34]	0.22	
PaCO2 during HARF	61	[54-66]	62	[54-68]	0.54		61	[56-66]	62	[54-69]	0.71	
PaO2 during HARF	86	[68-108]	77	[69-96]	0.30		76	[73-86]	79	[68-102]	0.47	
PaO2/FiO2 during HARF	184	[148-244]	196	[146-264]	0.45		186	[146-264]	194	[1468-263]	0.84	
Hb during HARF	116	[102-130]	117	[100-133]	0.64		107	[93-125]	117	[102-133]	0.09	
Intubated	---	---	---	---	---	---	9	47.4%	41	20.4%	<0.05	1.5 [1.0-2.3]
Time to intubation (hours)	11	[2-34]	---	---	---		2	[2-28]	11	[2-37]	0.50	
NIV duration (hours)	10	[5-20]	16	[8-31]	<0.05		12	[7-18]	16	[8-30]	0.29	
VI duration (hours)	109	[86-118]	---	---	---		118	[92-118]	109	[83-118]	0.50	
Total V duration (hours)	118	[108-121]	16	[8-31]	<0.05		97	[13-119]	22	[10-59]	<0.05	

SAPS = simplified acute physiology score, ICU = Intensive Care Unit, BMI = Body Mass Index, NIV = Non Invasive Ventilation, pHa = Arterial pH, HARF = Hypercapnic Acute Respiratory Failure, Hb = Hemoglobin, NIV = Non-Invasive Ventilation, VI = Invasive Ventilation, V = Ventilation

Table D. Clinical characteristics and long-term outcomes

	Hospital death						One-year death					
	Yes		*No*		*p*	*RR*	*Yes*		*No*		*p*	*RR*
Number of patients	73	33.2%	147	66.8%			102	51.8%	95	48.2%		
Age	75	[67-81]	66	[56-76]	<0.05		75	[66-81]	66	[58-75]	<0.05	
Male	51	69.9%	79	53.7%	<0.05	1.5 [1.0-2.3]	69	67.7%	44	46.3%	<0.05	1.7 [1.2-2.3]
BMI (kg/m^2)	25	[23-28]	24	[22-29]	0.28		24	[23-28]	25	[23-29]	0.48	
BMI less than 18 kg/m^2	3	4.1%	13	8.8%	0.20		7	6.9%	3	3.2%	0.24	
BMI more than 30 kg/m^2	16	21.9%	26	17.7%	0.45		18	17.7%	21	22.1%	0.43	
SAPS II points	46	[37-56]	37	[31-46]	---		45	[37-54]	37	[31-43]	---	
SAPS II (%)	37	[20-59]	20	[12-37]	<0.05		35	[20-56]	20	[12-31]	<0.05	
McCabe rapidly fatal	23	31.5%	22	15.0%	<0.05	1.24 [1.0-1.5]	29	28.4%	12	12.6%	<0.05	1.2 [1.1-1.4]
Chronic pulmonary disease	52	71.2%	105	71.4%	0.98		75	73.5%	68	71.6%	0.76	
Tabacco use	23	31.5%	63	43.5%	0.19		34	33.3%	45	47.9%	0.12	
NIV/O2 at home	16	21.9%	22	15.0%	0.20		23	22.6%	15	15.8%	0.23	
Surgical ICU admission	21	28.8%	68	46.3%	<0.05	0.8[0.6-0.9]	28	27.5%	45	47.4%	<0.05	0.7 [0.6-0.9]
Recent surgery to HARF (hours)	43	[19-152]	20	[15-50]	<0.05		20	[17-116]	23	[15-64]	0.71	
pHa during HARF	7.29	[7.23-7.32]	7.29	[7.24-7.34]	0.33		7.29	[7.24-7.33]	7.27	[7.24-7.33]	0.88	
PaCO2 during HARF	61	[53-67]	61.8	[55-68]	0.47		61	[54-69]	62	[55-68]	0.51	
PaO2 during HARF	75	[70-88]	80	[68-110]	0.07		77	[69-90]	79	[65-99]	0.76	
PaO2/FiO2 during HARF	184	[149-261]	200	[144-266]	0.53		188	[148-261]	185	[142-253]	0.91	
Hb during HARF	113	[99-131]	118	[101-135]	0.28		116	[100-131]	121	[101-140]	0.19	
Intubated	21	28.7%	29	19.7%	0.13		25	24.5%	17	17.9%	0.26	
Time to intubation (hours)	4	[2-26]	18	[3-46]	0.08		7	[2-29]	7	[2-51]	0.36	
NIV duration (hours)	16	[8-32]	15	[8-30]	0.55		16	[9-30]	15	[8-31]	0.68	
VI duration (hours)	116	[94-118]	102	[74-117]	0.08		112	[91-118]	113	[69-118]	0.36	
Total V duration (hours)	31	[12-112]	20	[9-56]	<0.05		22	[12-98]	20	[9-50]	0.20	

SAPS = simplified acute physiology score, ICU = Intensive Care Unit, BMI = Body Mass Index, NIV = Non Invasive Ventilation, pHa = Arterial pH, HARF = Hypercapnic Acute Respiratory Failure, Hb = Hemoglobin, NIV = Non-Invasive Ventilation, VI = Invasive Ventilation, V = Ventilation

Table F. Outcomes related to intubation

	Intubated		Not intubated			
					p	*RR*
Nombre de patients	50	22.7%	180	77.3%		
ICU death	9	18.0%	10	5.9%	<0.05	1.1 [1.0-1.3]
CHUV death	21	42.0%	52	30.6%	0.13	
One-year death	25	59.5%	77	49.7%	0.26	

NIV = Non-Invasive Ventilation, ICU = Intensive Care Unit

Table G. Outcomes related to intubation in COPD patients

	COPD with intubation		COPD without intubation			
					p	*RR*
Nombre de patients	27	12.3%	87	39.5%		
ICU death	6	22.2%	3	3.5%	<0.05	6.4 [1.7-24.1]
CHUV death	14	51.9%	26	29.9%	<0.05	1.7 [1.1-2.8]
One-year death	17	68.0%	42	51.2%	0.14	

COPD = Chronic Obstructive Pulmonary DiseaseNIV = Non-Invasive Ventilation, ICU = Intensive Care Unit