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Research Article

Profile and Outcome of Patients with Acute Cardiogenic Pulmonary Edema Treated with Non-Invasive Ventilation in the Critical Care Unit of DAX Hospital Center

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Abstract

Introduction: Acute cardiogenic pulmonary edema is one of the reasons for admission to intensive care units. Our objective was to describe the epidemio-clinical and evolutionary profile of patients with acute cardiogenic lung edema under non-invasive ventilation and to assess the association between these different epidemio-clinical parameters with the evolution of the patients.

Methods: Acute cardiogenic pulmonary edema is one of the reasons for admission to intensive care units. Our objective was to describe the epidemio-clinical and evolutionary profile of patients with acute cardiogenic lung edema under non-invasive ventilation and to assess the association between these different epidemio-clinical parameters with the evolution of the patients.

Results: The median (IQR) age was 80 years (72 - 87) and the median (IQR) duration of hospitalization 5,8 ± 1 days with an in-hospital mortality of 22.03%. Arterial hypertension was the most common risk factor (61.41%). Acute coronary syndrome accounted for only 18.64% of etiologies. The majority of patients had a preserved left ventricular ejection fraction (50.85%). Non-invasive ventilation sessions lasting more than 24 hours were necessary in 47.46% of patients. The readmission rate during follow-up was 36.96%. A significant association was found between arterial hypertension (p = 0.046); right ventricular dysfunction (p = 0.005), the need for NIV sessions lasting more than 24 hours (p = 0.04) with hospital mortality.

Conclusion: The epidemio-clinical profile of the patients remains identical to the literature. Despite NIV, mortality is not negligible.

Keywords: *Characteristics; Non-Invasive Ventilation; Heart Failure*

Introduction

Acute pulmonary oedema (APO) is one of the clinical manifestations of acute heart failure, and account for one of the reasons for hospitalization in terms of cardiovascular pathology [1,2]. It is a therapeutic emergency because it is life-threatening in the short term in the absence of immediate and adequate management. Over the past ten years, the use of non-invasive ventilation (NIV) during an acute pulmonary oedema has begun to take its place in the hospital environment. In fact, NIV by reducing veinous return and LV afterload leads to a reduction in LV filling pressures of LV, thus making it possible to limit pulmonary oedema [3]. Studies have also highlighted its interest

in improving mortality related to APO [4,5]. This has earned its place in the latest recommendations of the European Society of Cardiology on heart failure where non-invasive ventilation must be considered in APO patients with a level of evidence B [1].

Methods

This is a single-center descriptive longitudinal retrospective study carried out in the intensive care unit of the Dax hospital center.

Patient recruitment was carried out in 2018 and then follow-up was performed over 2 years.

The coding used by the Medical Information Department to include patients was the ICD 10 code I50.1 and a CCAM act starting with GLLD. Subsequently, incomplete files were not retained, as were coding errors.

The variables studied were demographic characteristics, cardiovascular risk factors and comorbidities such as arterial hypertension and diabetes; non-cardiovascular comorbidities including the presence of neoplastic disease as well as chronic respiratory disease. The different etiologies of cardiogenic APO were also taken into account, notably acute coronary syndrome (ACS), infections, and supraventricular arrythmias.

Echocardiographic parameters were also analyzed such as left ventricular ejection fraction (LVEF) assessed by the Simpson biplane method; the different classes of LVEF; and the presence or absence of dilatation of the left atrium (LA) and dysfunction of the right ventricle (RV) defined by a TAPSE < 17 mm or a RV S' wave < 9.5 m/sec [6].

The data were collected and analyzed by Epi info 7.2.5.0 software. Fisher's test was used for comparison of proportions; a p value less than 0.05 was considered statistically significant.

Continuous variables are expressed as median and interquartile range (IQR) or mean with standard deviation depending on the distribution while categorical variables as percentage.

Results

The general characteristics as well as the evolution of the patients are represented respectively in the table 1 and 2.

General characteristics of the patients	**Number Median (IQR) or n (%)**
Age (years)	80 (72 - 87)
Age > 75	40 (67,8)
Age < 50	2 (3,4)
Sex ratio	1,1
Risk factors and cardiovascular comorbidities	
Arterial hypertension	38 (61,4)
Diabetes mellitus	23 (38,9)
Smoking	17 (28,9)
Atrial fibrillation	16 (27,1)
Dyslipidemia	16 (27,1)
Obesity	14 (23,7)
OSA (obstructive sleep apnea)	6 (10,2)
Non cardiovascular comorbidities	

Anemia	19 (32,2)
Chronic respiratory disease	15 (25,4)
Hyponatremia	15 (25,4)
Neoplastic disease	15 (25,4)
Chronic renal failure	13 (22,0)
Underlying cardiac disease	
Ischemic heart disease	18 (30,5)
Arrythmia induced cardiomyopathy	10 (16,9)
Valvular heart disease	4 (6,8)
Etiologies	
Sepsis	18 (30,5)
Arrythmia	14 (23,6)
ACS	11 (18,6)
Clinical parameters	
Right heart failure signs	17 (24,8)
Biological parameters	
NTproBNP (pg/ml)	3647 (1138 - 7428)
Troponin (ng/l)	65 (30 - 213)
Haemoglobin (g/dl)	12,2 (10,5 - 13,8)
GFR (CKD-EPI) (ml/mn/1,73m^2)	56 (40 - 79)
Natremia (mmol/l)	138 (134 - 141)
CRP (mg/l)	36 (10 - 126)
Lactate (mmol/l)	2 (1 - 3)
Arterial blood gas under oxygen therapy at admission	
pCO_2 (mmHg)	37 (31 - 108)
PO_2 (mmHg)	68 (58 - 80)
Ph	7,34 (7,23 - 7,57)
Treatment received	
NIV > 24 hour n (%)	28 (47,5)
Furosemide n (%)	57 (96,6)
Nitrates n (%)	27 (45,8)
Morphine n (%)	6 (10,2)

Table 1: *General characteristics of the study population.*

OSA: Obstructive Sleep Apnea; ACS: Acute Coronary Syndrome; GFR: Glomerular Filtration Rate; CRP: C Reactive Protein; NIV: Non Invasive Ventilation; pCO_2: Partial Pressure of Carbon Dioxide; pO_2: Partial Pressure of Oxygen.

Evolution	Number
Death during hospitalization n (%)	13 (22,0)
Days of hospitalization (days)	5,8 +/- 1
Readmission n (%)	17 (36,9)
Cause of readmission	
ACS n (%)	3 (5,1)
Sepsis n (%)	7 (11,9)
Arythmia n (%)	2 (3,4)
Death during follow-up n (%)	16 (34,0)

Table 2: *Evolution of patients.*

ACS: Acute Coronary Syndrome.

Of 82 patients included, 59 were retained (Figure 1), The median age (IQR) of our study population was 80 (72 - 87) years with a slight male predominance (Sex ratio 1.1). The main cardiovascular risk factor was arterial hypertension (61.41%) while non-cardiovascular comorbidities were mainly represented by anemia (32.20%).

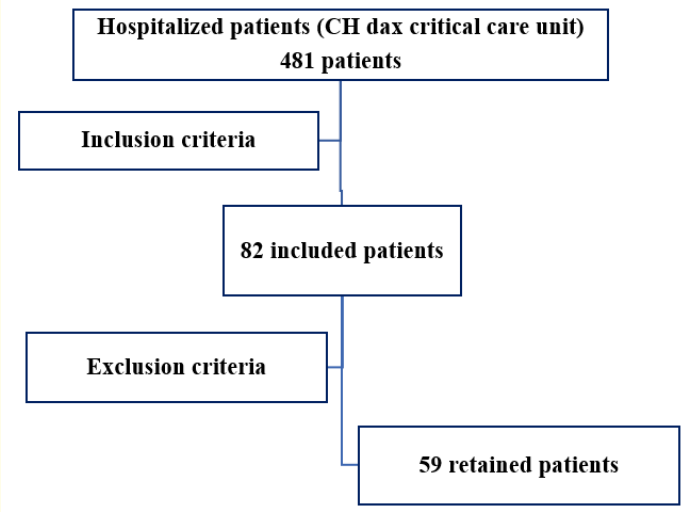

Figure 1: *Inclusion of patients.*

More than half of the patients already had an underlying heart disease, with an ischemic origin in 30.51% of cases. The main etiology of APO was infection (30.51%) and ACS represented only 18.64% of causes. NIV sessions lasting more than 24 hours were necessary in 47.46% of patients.

The median length of hospitalization (IQR) was 3 (2 - 8) days during which almost a quarter of the patients died (22.03%). A proportion of discharged patients (36.96%) were readmitted to the emergency room for recurrence during follow-up.

Regarding echocardiographic parameters (Table 3).

Echocardiographic parameters	Number Median (IQR) or n (%)
LVEF (%)	50 (40 - 60)
Altered LVEF	19 (32,2)
Preserved LVEF	30 (50,8)
LV dilatation	16 (27,1)
LV wall motion	
Global hypokinesia	12 (20,3)
Segmental hypokinesia	16 (27,1)
RV dysfunction	11 (18,6)
SPAP (mm Hg)	45 (35 - 60)
Dilatation	34 (57,63)

Table 3: *Echocardiographic parameters.*

LVEF: Left Ventricle Ejection Fraction; LV: Left Ventricle; RV: Right Ventricle; SPAP: Systolic Pulmonary Artery Pressure.

The majority of patients had preserved LVEF (50.85%), with a significant proportion of cases presenting LV dilatation (27.12%). RV dysfunction was found in 18.64% of patients and more than half of the cases had dilatation of the LA (57.63%).

A significant association was found between hypertension (p = 0.046); RV dysfunction (p = 0.005) and hospital mortality.

Patients requiring more than 24 hours of NIV session were also associated with high mortality (p = 0.04). While there was no statistically significant association between hospital mortality and anemia (p = 0.22); chronic respiratory disease (p = 0.31), chronic renal failure (p = 0.27) and ischemic causes (p = 0.39) (Table 4).

Cardiovascular risk factors and comorbidities	Death during hospitalization n (%)		P
	Yes	No	
Chronic renal failure	2 (15,4)	11 (84,6)	0,27
Arterial hypertension	11 (84,6)	2 (15,4)	0,046
Diabetes mellitus	5 (1,7)	18 (78,3)	0,48
Obesity	2 (14,3)	12 (85,7)	0,23
Atrial fibrillation	5 (31,3)	11 (68,8)	0,16
Smoking	3 (17,7)	14 (82,4)	0,32
Dyslipidemia	2 (12,5)	14 (87,5)	0,15
Anemia	3 (15,8)	16 (84,2)	0,22
Neoplastic disease	4 (26,7)	11 (73,3)	0,31
Chronic respiratory disease	4 (26,7)	11 (73,3)	0,31
Etiologies			
Hypertensive emergencies	1 (20)	4 (80)	0,48
Sepsis	4 (22,2)	14 (77,1)	0,48
Supraventricular arrythmias	5 (35,7)	9 (64,3)	0,09

ACS	2 (18,2)	9 (81,8)	0,39
Echocardiography			
Altered LVEF	4 (33,3)	8 (66,7)	0,16
RV dysfunction	6 (54,6)	5 (45,4)	0,005
LV dilatation	4 (25)	12 (75)	0,36
Treatments			
More than 24h NIV	9 (69,2)	4 (30,8)	0,04
Nitrates	8 (29,6)	19 (70,4)	0,10

Table 4: *Association between patients characteristics and hospital mortality.*

ACS: Acute Coronary Syndrome; LVEF: Left Ventricle Ejection Fraction; RV: Right Ventricle; LV: Left Ventricle; NIV: Non Invasive Ventilation.

The same finding was seen for readmission where there was no statistically significant association.

Patients characteristics	Readmission n (%)		P
	Yes	No	
Arterial hypertension	11 (40,7)	16 (59,3)	0,27
Anemia	7 (43,8)	9 (56,3)	0,25
Hyponatremia	3 (25,0)	9 (75,0)	0,17
Chronic renal failure	3 (25,0)	9 (75,0)	0,17
Ischemic heart disease	6 (40,0)	9 (60,0)	0,38
Altered LVEF	4 (50,0)	4 (50,0)	0,21
Elevated Nt-proBNP > 3000 ng/L at discharge	13 (43,3)	17 (56,7)	0,12

Table 5: *Association between patients characteristics and emergency readmission for APO recurrence.*

APO: Acute Pulmonary Oedema; LVEF: Left Ventricle Ejection Fraction.

At follow-up, 20% of patients died within the first 50 days (Figure 2).

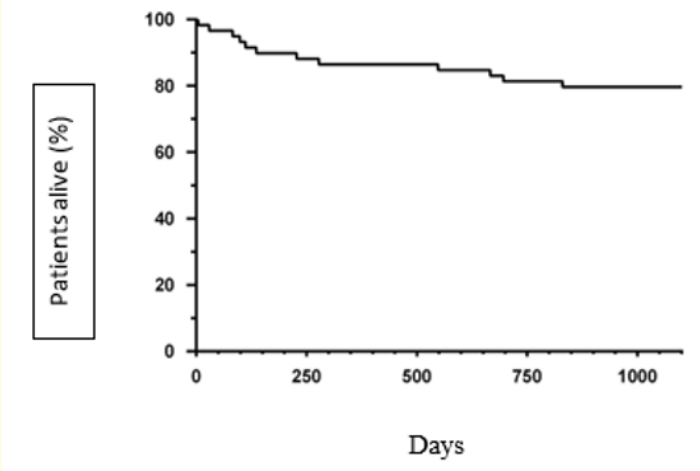

Figure 2: *Patients survival curve.*

Discussion

A slight male predominance was found in our study population. This result varies depending on the literature; in fact a male predominance can be found as well as the opposite [7,8].

Arterial hypertension (61%) was the main cardiovascular risk factor found in our study population, which is consistent with the literature [7-9]. This predominance may be linked to the fact that it is the main modifiable cardiovascular risk factor in the world. With a prevalence of 60% in patients over 60 years old [10].

In addition, high blood pressure plays a role in the development of APO through its impact on the LV. Indeed, left ventricular hypertrophy and the reduction in myocardial contractility are responsible for a reduction in the stroke volume of the LV leading to an imbalance between the stroke volumes of the LV and the RV, the RV being spared from this remodeling hence the APO [11,12].

Regarding the etiology, in our study ACS represents only 5% of the causes of APO while according to Belenguer-Muncharaz A., *et al*. it represents (51%) [7] and 26% for Masip J., *et al*. [8]. The low prevalence of ACS can be explained by the absence of a coronary angiography room at the Dax hospital center, therefore any suspected ACS is transferred or sent directly to centers owning a coronary angiography room [13,14].

From a therapeutic point of view, loop diuretics and nitrates are among the essential treatments for APO despite patients being placed on NIV [1]; which explains the high prevalence of the use of these drugs in our study population as well as in the literature (furosemide 91% and nitrates 89%) [9].

In our study there was a significant association between high blood pressure and hospital mortality. While in Parissis JT., *et al*. study, low systolic blood pressure was associated with mortality ($P < 0.001$) [15]. Likewise, the study evaluating the APO prognostic score also seems to find a consistent result with a SBP ≤ 130 mmHg associated with high hospital mortality ($p = 0.000003$) [16]. The discrepancy between our result and that of the literature can be explained by the sample size 59 vs 276 [16].

Hospital mortality is slightly higher than that of Alasdair Gray., *et al*. (22% vs 15%) [9]. This difference could be explained by the fact that our patients were in critical conditions, which is why they were admitted to the intensive care unit, while Alasdair Gray., *et al*. patients were not.

The RV plays an important role in the constitution of an APO by participating in the elevation of LV filling pressures [17]. The presence of RV dysfunction regardless of LVEF is associated in the literature with mortality in patients with heart failure [18]. This could explain the presence of a statistically significant association between hospital mortality and RV dysfunction in our study ($p = 0.005$).

In general, NIV rapidly improves symptoms within a few hours of its initiation [19]. The need for several NIV sessions exceeding 24 hours reflects the seriousness of APO which can result in high hospital mortality in these patients.

However, the statistically significant associations found in this study must be interpreted with caution, given the observational, retrospective nature of the study and its small sample size.

Conclusion

APO is a frequent emergency in cardiology, with an epidemiological-clinical profile identical to the literature and a significant mortality especially in intensive care despite therapeutic progress through the use of NIV. A larger study may be necessary to better highlight the different prognostic factors influencing this pathology in order to further improve its management.

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