

ASSOCIATION OF ARTERIAL HYPERCAPNIA IN ACUTE HEART FAILURE PATIENT WITH EARLY NEED OF INTUBATION IN EMERGENCY DEPARTMENT- A COHORT STUDY CONDUCTED AT TERTIARY CARE SETUP IN PAKISTAN.

Abdullah Dayo¹, ShamimUddin Siddiqi², Lal Shehbaz³, Shua Shehbaz⁴, Muhammad Asim Shaikh⁵, Abdul Samee Jatoi⁶

ABSTRACT

INTRODUCTION: Acute respiratory distress is often observed in patients with acute heart failure that is common cause of hospitality, especially in the elderly, and also has a high mortality rate. **OBJECTIVE:** Acute respiratory distress is a common finding among individuals who have acute heart failure significantly contributing to increased mortality rate. This studies aim to examine and access the association of respiratory acidosis (PaCO₂>45 mmHg), a condition known as arterial hypercapnia with the need of early intubation. **METHODS:** It is a retrospective cohort study conducted at Dr. Ziauddin University Hospital. Data was abstracted from the online database of the institute- software known as EMR of the patients who gave consent. After the application of the inclusion and exclusion criteria only 88 patients out of the 15,400 clinical records initially recorded were further sent for analysis. **RESULT:** Of the 88 patients, 74.8% presented with acute diastolic heart failure (ADHF), 2.6% presented with right ventricular heart failure, 5.6 % presented with hypertensive heart failure, 0.5% presented with left ventricular heart failure and the remaining 16.5% presented with acute pulmonary edema. 41.3% had prior hospitalization due to heart failure. Mean age for the overall cohort is 70.2 +/- 8.0, out of which 60.6 % were male. Patients who manifested pre-hospital hypercapnia and were not ventilated in a pre-hospital setup (n=76) were managed mostly through early intubation (78.5 %) and those had did not have hypercapnia prior to admission (i.e. a pre-hospital setup) only required intubation in 12.6% of the cases. **CONCLUSION:** Through the study results and statistical analysis it can be concluded that there is positive correlation between the severity of respiratory distress and need of early intubation, as it could trigger hypoxemia if not treated hence cardiogenic shock is possible.

KEY WORDS: Hypercapnia, Acute Heart Failure, Emergency Department, Early Intubation

1. Resident Emergency Medicine, Dr. Ziauddin University Hospital, Karachi.
2. Consultant Cardiologist, Dr. Ziauddin University Hospital, Karachi.
3. Assistant Professor, Dr. Ziauddin University Hospital, Karachi.
4. Assistant Professor, Dr. Ziauddin University Hospital, Karachi.
5. Clinical Fellow, NICVD, Hyderabad.
6. Resident Emergency Medicine, Dr. Ziauddin University Hospital, Karachi.

For Correspondence: Dr. Abdullah Dayo, Flat 104, Safety Homes Apartment, Dr. Daud Pota Road, Civil Lines, Karachi. Email: dr.dayoabdullah@gmail.com

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INTRODUCTION:

Acute respiratory distress is often observed in patients with acute heart failure that is common cause of hospitality, especially in the elderly, and also has a high mortality rate. Many patients are required to be intubated due to unconsciousness, however, intubation is mostly associated with serious and life threatening complications that may result such as arterial hypercapnia (respiratory acidosis) ^{1, 2, 3}. In conditions as such, non-invasive ventilation (NIV) proves to improve the symptoms of acute heart failure rapidly compared to other techniques like provision of diuretics or oxygen alone⁴. There are two main modalities used as NIV: positive

pressure ventilation (NPPV) and continuous positive airway pressure (CPAP), both of which are equally effective as the outcomes in both the techniques are same, however continuous positive airway pressure (CPAP) being a simpler technique is widely preferred in areas that have poor infrastructure or are low-equipped for example in a pre-hospital setting ^{5,6,7,8}. Many studies favor the use of CPAP in patients with acute heart failure as it decreases the intubation rate and improves the survival rate of such patients⁹. Since in patients with acute heart failure, arterial hypercapnia is found to be a common finding, early intubation is required to

improve the gas exchange abnormalities and pH in such patients¹⁰.

METHODS:

Study design:

This is a retrospective cohort study conducted at a Tertiary care setup in Pakistan, whereby hospital based database was utilized, containing information about the patients who were admitted to acute care unit due to acute heart failure. Additionally, surveillance data were also collected from pre-hospital settings: ambulance, medical mobile unit and a physician certified to emergency-medicine. The study was approved by ethics review committee of the institution- Dr. Ziauddin University Hospital.

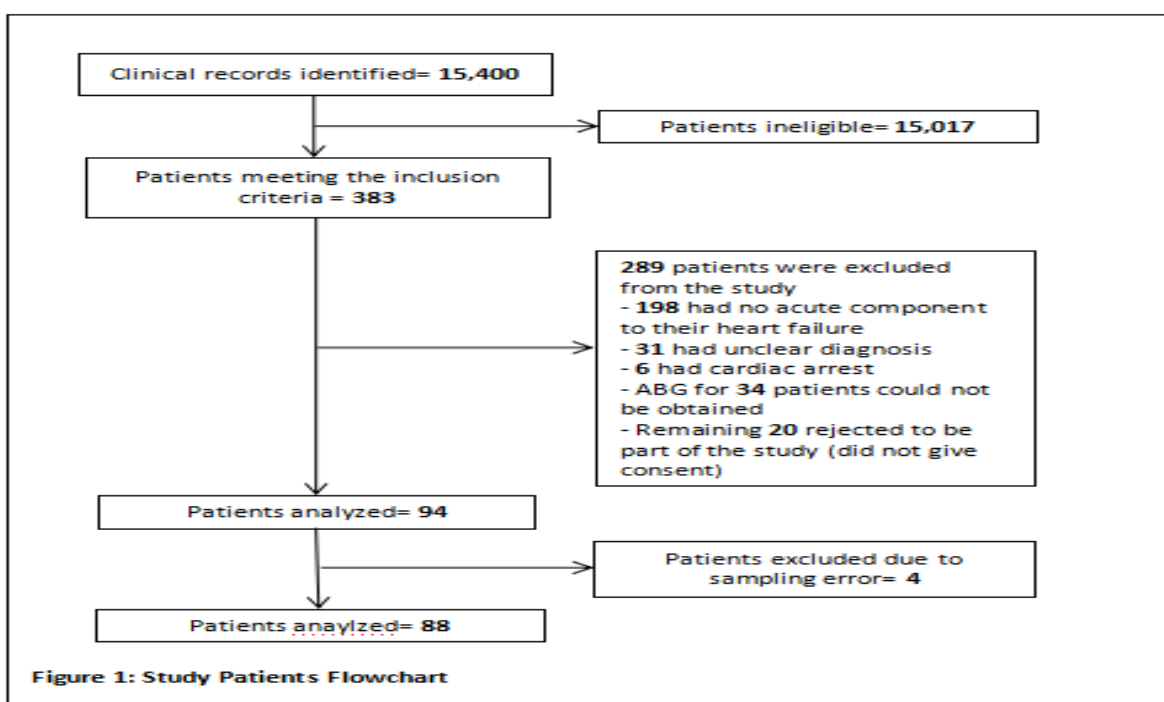
Setting:

This study was conducted abstracting centralized medical records from tertiary care setup- Dr. Ziauddin University Hospital in Pakistan, a teaching institute/organization. Pre-hospital setups had paramedic staff and emergency-medicine certified physician, from which respective data on patients who had acute heart failure was extracted. These medical records and patients' reports (arterial blood gas- ABG, medications prior to admission, laboratory findings etc.) were reviewed to study the association of arterial hypercapnia in patients with acute heart failure with early need of intubation. As the ABG's of the patient determines the severity

of the respiratory distress on the basis of which the paramedic staff and emergency-medicine physician can initial necessary treatment before reaching the acute care unit- which includes initiation of non-invasive ventilation (NIV), especially continuous positive airway pressure (CPAP)^{11,12,13,14,15}

Participants:

In this study, patients who had acute heart failure and acute pulmonary edema and provided written consent were included. For patients, who were unconscious at the time of admission, consent was taken after they gained consciousness. 94 such patients who were diagnosed with acute heart failure and provided written consent were included in the study, and subsequently arterial blood gases (ABG) were analyzed in all. Patients with absence of acute heart failure, for whom arterial blood gases before and at the time of admission could not be obtained. Who had cardiac failure (arrest) before reaching the hospital and those for whom a clear diagnosis could not be made were excluded from the study. Patients who had sampling error ($n=6$) were excluded from the original sample, and so data for the remaining ($n=88$) participants was analyzed. The initiation of airway intervention and intubation was decided by the physician as per the established guidelines.



Data collection:

Data of all the patients ($n=88$) was extracted from the EMR software- online database used by the paramedics, physician and front-line healthcare workers to record the cases of the patients. Data regarding patient medical history, symptoms, and treatments were manually imported from the software to the

excel sheet. Arterial blood gases, hematology and biochemistry reports were obtained both in a pre-hospital setup and upon admission in order to study of association of arterial hypercapnia with need of early intubation.

Measurements:

Hypercapnia is defined as $\text{PaCO}_2 > 45$ mmHg and hypocapnia as $\text{PaCO}_2 < 35$ mmHg. Many

patients, who had raised partial pressure of CO₂ were given oxygen in a pre-hospital setup i.e. ambulance by the paramedic staff^{16, 17, 18}. In order to avoid hypoxia and hypercapnia which both can lead to increased pulmonary vascular resistance (PVR), oxygenation and ventilation was preferred and considered appropriate given the risks of intubation¹⁹. Arterial blood gases (ABG) before and after ventilation were also collected in a pre-hospital setup. On some patients, non-invasive ventilation was also tried as needed, which carries a risk of positive intrathoracic pressure. Those patients with hypercapnia at the time of admission underwent a second assessment of ABG at the time of discharge. Patients who were severely ill, were intubated with mechanical ventilation. Intubation with mechanical ventilation is a supportive measure that aims to optimize oxygenation while also removing carbon dioxide from the body^{20, 21, 22}.

Statistical analysis:

The data collected are presented as values of the means +/- standard deviation. In addition to these, values of medians along with the inter-quartile ranges and frequencies were also presented. In order to compare the values of ABG in the two groups: pre-hospital setup and intra-hospital setup, Student's *t*-test and Mann-Whitney Wilcoxon test were used. Chi-squared test was used to analyze differences between the categorical variables. In order to analyze and assess the association between the characteristics. Multivariate analyses was used to assess the association between hypercapnia and other clinical manifestations and early need of interventions: intubation, non-invasive ventilation, mechanical ventilation. Odd ratio and confidence interval for intubation, non-invasive ventilation: positive pressure ventilation (NPPV) and continuous positive airway pressure (CPAP), and mechanical ventilation were calculated. Variables to be analyzed included: age. Body mass index, gender, past medical history (e.g. hypertension, prior hospitalization, atrial fibrillation), smoking status and packs per year, comorbidities, right and left ventricular ejection fraction on electrocardiograph and electrocardiography, biochemistry reports: serum creatinine, oxygen saturation, etc. To determine the inclusion and exclusion of the data, significance level was set to 0.05 and 0.10 respectively. The *p*-values that were less than 0.05 were considered to be significant in terms of indicating statistical difference. One group contained individuals for whom the

hypercapnia was corrected before admission into the acute care setup, and the other group had patients with respiratory distress (disrupted ABG) upon arrival to the emergency- for whom early intubation was required.

RESULTS

As presented in Figure 1. Participants' study flowchart, 15,400 clinical records were identified in the online database of Dr. Ziauddin University Hospital, among whom 15,017 were ineligible to be included in the study, hence remaining 2.48% (383 patients) of the total reported cases met the inclusion criteria. Out of these 383 patients, only 88 were at last selected for further analysis. Table 1. summarizes the multivariate analysis of patient characteristics.

Of the 88 patients, 74.8% presented with Acute diastolic heart failure (ADHF), 2.6% presented with right ventricular heart failure, 5.6 % presented with hypertensive heart failure, 0.5% presented with left ventricular heart failure and the remaining 16.5% presented with Acute pulmonary edema. 41.3% had prior hospitalization due to heart failure. Mean age for the overall cohort is 70.2 +/- 8.0, out of which 60.6 % were male. Patients who manifested pre-hospital hypercapnia and were not ventilated in a pre-hospital setup (n=76) were managed mostly through early intubation (78.5 %) and those who did not have hypercapnia prior to admission (i.e. a pre-hospital setup) only required intubation in 12.6% of the cases.

DISCUSSION

From the presented data, it is evident that hypercapnia is a common finding and most frequently seen in patients with acute heart failure. Hypercapnia (raised partial pressure of carbon dioxide) is also observed to be an important determining factor for immediate airway intervention: non-invasive positive partial pressure ventilation (NPPV), mechanical ventilation, non-invasive continuous positive airway pressure (CPAP), and intubation²³. Majority of patients were hypercapnic before the time of admission- i.e. they had disrupted ABG prior to hospitalization, and had been oxygenated in a pre-hospital setup to prevent worsening of symptoms²⁴. Regarding intubation, the outcome collected were expected as the guidelines recommend to intubate patients with acute heart failure only if severe hypoxemia is observed along with increased effort of respiration, given the adverse effects associated with intubation²⁵.

Table: 1 Multivariate analysis of patient characteristics.

		Overall cohort (n=88)	No pre-hospital hypercapnia (n=12)	Pre-hospital hypercapnia (n=76)	P-value
	Mean age (years)	70.2 +/- 8.0	68.6 +/- 8.1	71.6 +/- 7.9	0.63
	Sex-male (%)	60.6	58.5	61.7	0.77
	Body mass index (BMI)/ kg/m ²	23.7 +/- 4.8	23.3 +/- 4.6	23.9 +/- 4.9	0.41
Patient medical background					
	Hypertension, %	74.2 +/- 6.0	72.6 +/- 5.8	80.2 +/- 6.3	0.29
	Atrial fibrillation, %	28.6 +/- 3.9	35.2 +/- 4.8	21.4 +/- 4.1	0.07
	Prior hospitalization	41.3	36.2	38.6	0.87
	Coronary artery disease, %	60.1	57.6	62.6	0.44
	Current smoking status (positive/yes %)	29.6	26.0	37.1	0.13
	Pack years of smoking	30.0	28.0	31.0	0.62
Medications prior to admission into the acute care unit (ACU)					
	Loop diuretic, %	38.6	37.5	39.6	>0.99
	Spironolactone, %	18.3	20.1	16.7	0.69
	Angiotensin converting enzyme (ACE) inhibitor	48.6	46.2	42.8	0.64
	Digoxin, %	10.5	13.8	4.3	0.08
	Beta Blocker, %	35.0	38.9	31.6	0.62
Lab reports					
	Systolic blood pressure, mmHg	167 +/- 12	156 +/- 13.2	188 +/- 12.3	<0.001
	Diastolic blood pressure, mmHg	98 +/- 15	105 +/- 18.3	112 +/- 17.8	<0.001
	Heart rate, beats/min	110 +/- 7.2	108 +/- 6.9	116 +/- 8.2	0.03
	Respiratory rate, times/min	27.0	26.0	28.0	0.19
	Hemoglobin, g/dL	12.4 +/- 2.3	12.4 +/- 2.4	12.1 +/- 2.2	0.97
	Serum creatinine, mg/dL	1.60	1.63	1.55	0.81
	Estimated glomerular filtration rate (GFR), mL/min/1.72 m ²	48.0	49.0	46.0	0.54
Management after admission					
	Non-invasive positive pressure ventilation and intubation, %	34.7	12.6	78.5	<0.001
	Non-invasive continuous positive airway pressure	27.3	11.7	58.5	<0.001

Lesser patients needed intubation who had no signs of hypercapnia prior to admission (i.e. in a pre-hospital setup), i.e. only 12.6% as compared to those who were hypercapnic prior to admission (78.5%). The difference is

primarily because hypercapnic is a worsened clinical state which requires early intervention.

CONCLUSION

From the results and statistical analysis, it can be concluded that there is positive correlation between the severity of respiratory distress and need of early intubation, as it could trigger hypoxemia if not treated hence cardiogenic shock is possible. As in our study, there is no significant difference in the smoking status of the two groups: hypercapnic before time of admission and not hypercapnic in the pre-hospital setup, hence, it can be concluded onset of hypercapnia is not related to the current smoking status of an individual.

ETHICS APPROVAL: The ERC gave ethical review approval

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin

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CONFLICT OF INTEREST: No competing interest declared.

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