Treatment of Patients with Acute Cardiogenic Pulmonary Edema A Comparison of Routine Oxygen Therapy and Continuous Positive Airway Pressure Ventilation

Tauseef Ali Memon[1], Inayat Ali Khan[2], Nawaf Fahad Dehrab[3], Kamil Ziad Rajper[4], Faima Rani Memon[5], Sumera Mahar[6]

[1.] Tauseef Ali Memon, Senior Registrar Emergency Medicine, Sabah Alahmed Emergency Centre Kuwait.Email: drtsfali@gmail.com (Corresponding author)

[2.] Inayat Ali Khan, Consultant Neurosurgeon, Ziauddin University Hospital Karachi Pakistan.Email: inayatbrain@yahoo.com

[3.] Nawaf Fahad Dehrab, Head of Department Emergency Medicine, Al-Adan Hospital Kuwait.Email: Oncall_forlife@yahoo.com

[4.] Kamil Ziad Rajper, Assistant Professor Emergency Medicine, PAQSJIMS Gambat Pakistan.Email: rajperkamil@gmail.com

[5.] Faima Rani Memon, Lecturer Physiology, Bilawal Medical College Kotri, Jamshoro Pakistan Email: faima.rani@lumhs.edu.pk

[6.] Sumera Mahar, Registrar Emergency Medicine, University Hospital Kerry Ireland Email: Maharsumera@gmail.com

Abstract

Background: Acute cardiogenic pulmonary edema (ACPE) is known to be the most common presenting case in the emergency department that requires prompt assessment and management. The rate of mortality due to this condition is 10-20%. ACPE is also a common reason for acute respiratory distress in patients landing in the emergency departments as well as intensive care units (ICU). Hypoxemia is a common clinical feature in the patients of ACPE that warrants ventilation support. However, non-invasive ventilation (NIV) is preferred over invasive ventilation due to complications of intubation followed by invasive ventilation.Objectives: The study aims at comparing the clinical outcomes of standard oxygen therapy and continuous positive pressure (CPAP) ventilation in patients with ACPEStudy design: A comparative studyPlace and Duration this study was conducted in Sabah Alahmed Emergency Centre Kuwait from December 2021 to December 2022.Methodology: A total of 104 patients were considered in the present study from the emergency department of the hospital and ICU. All the patients had presented with ACPE. The patients were divided into two groups having 52 patients in each group. One group was called as control group and the patients in this group were treated with conventional oxygen therapy through an oxygen mask. The other group was called the study group and the patients in this group were given CPAP ventilation employing a full-face CPAP mask. All the patients were given standard treatment as per the protocols of the emergency departmentResults: There was a significant decline in the heart rate (HR) and respiratory rate (RR) and an increase in the oxygen saturation in the CPAP group. The difference between the CPAP and control groups is statistically significant ($p < 0.001$). The study of CPAP showed a higher average decrease in the HR and RR. The studies also showed a higher average increase in oxygen saturation compared to the other group ($p < 0.001$).Conclusion: The study shows that CPAP has better clinical outcomes compared to standard oxygen therapy. It is a more favourable technique in patients with ACPE. However, close monitoring of $PaCO_2$ is essential.

Keywords: Continuous positive air pressure, standard oxygen therapy, acute cardiogenic pulmonary edema, oxygen, ventilation

Introduction

ACPE is one of the commonest conditions present in the emergency department. It warrants prompt assessment and management, otherwise, it leads to fatality [1]. The rate of mortality associated with ACPE is 10-20% [2]. Pulmonary edema can be defined as the accumulation of fluid in the spaces outside the alveoli. It can also advance resulting in the shift of the fluid from interstitial spaces to alveoli [3]. The accumulation of fluid results from a rise in the trans-vascular pressure as happens in ACPE [4]. It also results from microvascular permeability towards solutes in the other types of pulmonary edema [5].

ACPE is also a common reason for acute distress of respiration in patients presenting to ICUs and emergency departments [6]. Standard medical

doi.org/10.31838/hiv23.03.315 Received: 22.11.22, Revised: 20.12.22, Accepted: 17.01.23.

management of such cases includes vasodilators, diuretics, inotropes, etc. Nonetheless, the basic support is given by the delivery of oxygen using a face mask [7]. Many patients show a positive result to the standard treatment, yet some patients advance to respiratory distress. Such severe sequel of the diseases needs invasive ventilation by intubation [8].

Non-invasive ventilation techniques are preferred over invasive ones due to their complications such as trauma to the pharynx, trachea, and larynx. Other complications are hypotension, arrhythmias, aspiration of gastric contents, pneumonia, inability to speak, inability to eat, and sinusitis [9].

The present study is meant to compare the clinical outcomes of standard oxygen therapy and CPAP ventilation in patients with ACPE.

Methodology

The present study is a prospective comparativestudy for the evaluation of the clinical outcomes of standard oxygen therapy and CPAP ventilation in patients with ACPE. A total of 104 patients with ACPE were added to the present study after evaluation as per our inclusion and exclusion criteria. According to the inclusion criteria, patients with the diagnosis of ACPE, conscious and more than 20 years old, were added to the study. According to the exclusion criteria, patients who were pregnant had a previous cardiac or respiratory attack, were hemodynamically unstable, unconscious, need emergency intubation, had severe hypoxemia, and were diagnosed with non-cardiogenic pulmonary edema, were not added to the group.

The patients were divided into two groups having 52 patients in each group. One group was called as control group and the patients in this group were treated with conventional oxygen therapy through an oxygen mask. The other group was called the study group and the patients in this group were given CPAP ventilation employing a full-face CPAP mask. All the patients were given standard treatment per the emergency department protocols. They were given standard pharmacological drugs for the treatment including intravenous furosemide, intravenous nitroglycerin, Morphine, and intravenous or subcutaneous heparin.

The pressure support was initiated at 10 cmH_2O. The pressure was increased up to 5 cmH_2O after every 10 minutes. The maximum pressure given was 20 cmH_2O. The target RR was less than 20 per minute. Slight PEEP was also used to increase the partial pressure of oxygen, and oxygen saturation, and for the prevention of atelectasis. The patients in the study group were given CPAP for one day. The mask was removed for 20 minutes after every 2 hours for the facilitation of drinking, eating, and talking. Clinical stability was said to be established when the partial pressure of oxygen was more than 60 mmHg, oxygen saturation was more than 90%, RR was less than 25 breaths per minute and HR was less than 110 beats per minute with the normal pattern of breathing.

Results

A total of 104 patients were included in the present study and they were randomly divided into two equal groups. One group was treated with CPAP and one was treated with standard oxygen therapy. The mean age of the patients in the control group was 57.36±10.95 years and the mean age of the patients in the study group was 61.65±13.24 years. The demographic and clinical data of both groups have been compared in Table 1.

Table 1. Comparison of the demographic data and clinical data of control and study groups

Variables		Numbers (Percentage)	Study Group (n=52)	Control Group (n=52)	P-value
Gender	Female	52 (50%)	20 (38.46%)	32 (61.54%)	0.673
	Male	52 (50%)	32 (61.54%)	20 (38.46%)	
Heart Failure	Present	67 (64.42%)	35 (67.31%)	32 (61.54%)	0.831
	Absent	37 (35.57%)	17 (32.69%)	20 (38.46%)	
Myocardial Infarction	Present	41 (39.42%)	26 (50%)	15 (28.84%)	0.667
	Absent	63 (60.57%)	26 (50%)	37 (71.15%)	
Hypertension	Present	47 (45.19%)	26 (50%)	21 (40.38%)	0.954
	Absent	57 (54.81%)	26 (50%)	31 (59.61%)	
Arrhythmia	Present	36 (34.61%)	26 (50%)	10 (19.23%)	0.834
	Absent	68 (65.38%)	26 (50%)	42 (80.76%)	
Unrestricted salt intake	Present	41 (39.42%)	20 (38.46%)	21 (40.38%)	1.0
	Absent	63 (60.57%)	32 (61.54%)	31 (59.61%)	

The table shows a comparison of both regards and the results demonstrate that there is no significant difference between both the groups in terms of gender, hypertension, arrhythmia, Myocardial infarction, heart failure, and restriction of dietary salt. The average follow-up

vital data of the patients have been compared in Table 2.

Table 2. Comparison of the average follow-up data of both the groups

Variables	Control group (N=52) Mean±SD	Study group (n=52) Mean±SD	p-value
Systolic BP (mmHg)	136.43±27.53	149.65±24.57	0.268
Diastolic BP (mmHg)	85.27± 11.31	90.71±10.44	0.272
Heart rate (beats/min)	97.28±0.92	88.72± 0.34	<0.001
Respiratory rate (breaths/min)	28.52±0.9	25.65±1.10	<0.001
Oxygen saturation (%age)	90.63± 0.7	93.9±0.32	<0.001
Mean arterial pressure (mmHg)	110.32±19.76	120.10±17.67	0.252

The comparison of both groups shows that there was a statistically significant decrease inHR and RR as well as an increase in oxygen saturation in the study group. It also shows non-significant differences in the average blood pressure and mean material pressure. A comparison of the ABGs of the patients in both groups has been shown in Table 3.

Table 3. Comparison of the ABGs data between the study and control group

Variable	Control group (N=52) Mean±SD	Study group (n=52) Mean±SD	P value
pH	7.69±0.05	7.68±0.08	0.465
PaO_2 (mmHg)	64.95±0.88	81.02±1.27	<0.001
$PaCO_2$ (mmHg)	39.63±6.18	41.82±9.18	0.576
HCO_3 (mmHg)	25.58±2.34	26.66±3.46	0.377

The table shows that the oxygen saturation has significantly and comparatively increased in the study group. The difference in the pH, partial pressure of carbon dioxide, and bicarbonate level is not significant.

Discussion

ACPE usually shows up with sudden hypoxemia and respiratory failure. Such data conditions need to be assessed and managed immediately. Hypoxemia can also be seen as a result of myocardial ischemia, and chronic heart failure. Such patients are usually present with acidosis, laboured breathing, hypertension, and tachycardia. The acidosis could be both metabolic and respiratory factors. Diastolic dysfunction plays an important role in raising the hydrostatic pressure leading to pulmonary edema [10]. Ventilator assistance is always needed despite medical therapy by nitrates, diuretics, and oxygen. Non-invasive ventilation is a common regimen used in the patients of ACPE and it has shown rapid relief from dyspnea.

Many researchers have compared the effectiveness of CPAP and standard oxygen therapy, however, the comparison for both regarding ACPE is scarce. Aliberti conducted a study to compare invasive and non-invasive ventilation in patients with ACPE. Their study was a prospective study enrolling adult patients with ACPE. They evaluated the treatment outcomes of all the 1293 patients enrolled in their study/. They divided the patients into three groups and they treated the groups with CPAP, oxygen therapy, and BiPAP. They concluded that CPAP should be relied on as the first line of treatment in the management of acute respiratory failure in ACPE. The effectiveness of CPAP was higher compared to the other two techniques [11].

Mariani et al conducted a meta-analysis of 34 studies comprising 3041 patients. They compared standard oxygen therapy and CPAP in patients with ACPE. The results showed an overall reduction in mortality and risk of death. Nonetheless, CPAP proved more efficient results, and the reduction in mortality was seen more in the patients treated with CPAP [12].

The study of Foti et al did not compare CPAP with standard therapy, although they studied the outcomes of ACPE when treated with CPAP. They concluded that CPAP therapy can be used as the first-line therapy for ACPE. This treatment has the potential to reduce the mortality risk of the patient even in the absence of drug therapy [13]. Brambilla et al and Bradley et al compared CPAP with standard oxygen therapy in other diseases such as pneumonia and COVID-19. Their studies support using CPAP as the first line of treatment [14, 15]

Conclusion

CPAP must be considered in patients having respiratory failure because of ACPE. However, the partial pressure of carbon dioxide must be monitored along with the therapy to look for the effectiveness of the treatment. This technique can prevent the patients from deteriorating and passing through all the pain of intubation.

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