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ROLE OF EARLY CPAP THERAPY IN ACUTE DECOMPENSATED HEART FAILURE IN EMERGENCY SETTING

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Abstract

Objective:

To evaluate the impact of early Continuous Positive Airway Pressure (CPAP) therapy on clinical outcomes in patients with Acute Decompensated Heart Failure (ADHF) in an emergency setting.

Methods:

A prospective, observational study was conducted in a tertiary care Emergency Department over six months. Patients with ADHF were divided into two groups: the Early CPAP group (CPAP initiated within 30 minutes of presentation) and the Standard Therapy group (conventional management without early CPAP). Baseline characteristics, respiratory parameters, intubation rates, hospital stay, mortality, and 30-day readmission rates were compared. Statistical analysis was performed using SPSS, with significance set at $p < 0.05$.

Results:

The study included 158 patients (79 per group) with comparable baseline characteristics. The Early CPAP group showed significant improvements in respiratory parameters within two hours: higher SpO_2 (95% vs. 89%, $p < 0.001$), lower respiratory rate (20 vs. 24 breaths/min, $p < 0.001$), and improved pH (7.38 vs. 7.32, $p < 0.001$). Intubation rates were lower in the Early CPAP group (5% vs. 15%, $p = 0.03$), and both ED stay (5.8 vs. 7.1 hours, $p < 0.001$) and hospital stay (6.5 vs. 8.0 days, $p < 0.001$) were shorter. Mortality and readmission rates were lower but not statistically significant.

Conclusion:

Early CPAP therapy significantly improves respiratory function and reduces intubation rates and hospital stays in ADHF patients, supporting its use as an effective intervention in emergency settings. Further studies are needed to assess long-term outcomes.

INTRODUCTION

Heart failure (HF) is a life-threatening disease and is a growing public health concern[1,2].Despite recent advances in pharmacological management of HF, the morbidity and mortality from HF remain high[3,4]. Therefore, non-pharmacological approaches to HF, including cardiac resynchronization therapy, and left

ventricular (LV) assist devices, are increasingly utilized. However, most non-pharmacological approaches are invasive, have limited indication and are considered only for advanced HF. Accordingly, the development of less invasive, non-pharmacological approaches that may improve outcomes for patients with HF is important. [4]. Mainstay of the AHF treatment is medications (e.g. diuretics, vasodilators, and inotropes) and/or devices, such as non-invasive ventilation (NIV) or temporary mechanical circulatory support devices. Various large-scale randomized controlled trials were conducted to test novel treatments; however, none yielded solid evidence in AHF management, while only a few being clinically useful. Given the dearth of quality evidence on acute treatment approaches, there remains a lack of a universally recognized treatment protocol for AHF management. Overall consensus among the experts is that, excluding the variation in regional and societal clinical guidelines, not many changes were added in the recommended AHF management guidelines during the past few decades.[5-7].In the United States, approximately 1 million patients per year are treated by paramedics for acute congestive heart failure (CHF). The associated morbidity and mortality are significant, as is the overall cost on the health care system. The most optimal prehospital management protocol of these patients is not clear and remains a work in progress. Prehospital management of acute CHF and cardiogenic pulmonary edema has historically centered on the use of oxygen, nitrates, diuretics, and morphine. Recent advances in non-invasive ventilation and its use in the management of acute CHF in the inpatient population have proven to be beneficial [8,9]. Primarily, the hospitalization and acute-phase management of HF, especially of acute HF (AHF), presents challenges to healthcare systems while necessitating substantial efforts in achieving favourable outcomes.[10]

Methodology

This was a prospective, observational, comparative study conducted in the Bahria International Hospital, on 158 patients.The study aimed to evaluate the impact of early initiation of Continuous Positive Airway Pressure (CPAP) therapy on clinical outcomes in patients presenting with Acute Decompensated Heart Failure (ADHF).

DURATION OF STUDY: Nine months March-2024 to Dec-2024

Inclusion Criteria:

o Adult patients (≥18 years) presenting to the ED with signs and symptoms suggestive of ADHF (e.g., dyspnea, orthopnea, peripheral edema).
o Diagnosis confirmed by clinical evaluation, chest X-ray, elevated BNP/NT-proBNP levels, and echocardiography where feasible.
o Hemodynamically stable patients (SBP ≥90 mmHg) without need for immediate intubation.

Exclusion Criteria:

- Age < 18 years
- Any other Indication of CPAP therapy
- Patients with urgent need for intubation e.g Low GCS, Respiratory Arrest
- Any Contraindication to CPAP therapy

Intervention

Patients will be divided into two groups:

1. **Early CPAP Group**: CPAP initiated within 30 minutes of ED presentation.
2. **Standard Therapy Group**: Treated with conventional medical management (oxygen, diuretics, vasodilators) without early CPAP, with CPAP used only if clinical deterioration occurs.

- CPAP settings: Initial pressure of 5–10 cm H_2O, titrated based on patient tolerance, oxygen saturation, and respiratory rate.

Data Collection

- Age, sex, comorbidities, vital signs, oxygen saturation, BNP levels, and echocardiographic findings.
- Improvement in respiratory parameters (respiratory rate, SpO_2, blood gases) within first 1–2 hours.
- **Secondary Outcomes**:

o Need for intubation or escalation to invasive ventilation.
o Length of ED/hospital stay.
o In-hospital mortality.
o 30-day readmission rate.
o

Statistical Analysis

- Data will be analyzed using **SPSS.**.
- Continuous variables will be expressed as mean ± standard deviation and compared using Student's t-test or Mann-Whitney U test.
- Categorical variables will be expressed as percentages and compared using Chi-square test.
- A **p-value < 0.05** will be considered statistically significant.
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Results

The study evaluated the impact of early CPAP therapy in patients with Acute Decompensated Heart Failure (ADHF) in an emergency setting. Below are the key findings presented in tables, followed by conclusions.

Table 1: Baseline Characteristics of Patients

Characteristic	Early CPAP Group (n=79)	Standard Therapy Group (n=79)	p-value
Age (years)	68.5 ± 10.2	67.9 ± 11.1	0.65
Male (%)	58 (73%)	56 (71%)	0.78
Diabetes Mellitus (%)	30 (38%)	32 (40%)	0.74
Hypertension (%)	45 (57%)	47 (59%)	0.81
Baseline SpO_2 (%)	84 ± 5	83 ± 6	0.30
Baseline RR (breaths/min)	28 ± 4	29 ± 5	0.22
BNP (pg/mL)	1250 ± 320	1280 ± 350	0.50

The table indicates that the Early CPAP and Standard Therapy groups had comparable baseline characteristics, with no significant differences in age, gender, comorbidities (such as diabetes and hypertension), or initial clinical measures like oxygen saturation (SpO_2), respiratory rate (RR), and BNP levels. Since all p-values exceeded 0.05, this confirms that the groups were statistically similar at the outset. This comparability ensures that any observed differences in outcomes can be reliably linked to the effects of early CPAP therapy rather than pre-existing disparities between the groups.

Table 2: Primary Outcome – Respiratory Parameters Improvement

Parameter	Early CPAP Group	Standard Therapy Group	p-value
SpO_2 after 2 hours (%)	95 ± 2	89 ± 3	<0.001
RR after 2 hours (breaths/min)	20 ± 3	24 ± 4	<0.001
pH after 2 hours	7.38 ± 0.04	7.32 ± 0.05	<0.001

The table highlights the significant and rapid improvements in patients who received early CPAP treatment. Within the first two hours, this group demonstrated higher oxygen saturation (SpO_2) and lower respiratory rates (RR), indicating enhanced respiratory function. Additionally, their improved pH levels reflected better blood gas status, suggesting reduced acidosis and more effective ventilation. The highly statistically significant p-values (<0.001) further confirm that early CPAP delivers swift and measurable respiratory benefits compared to other treatments.

Table 3: Secondary Outcomes

Outcome	Early CPAP Group (n=79)	Standard Therapy Group (n=79)	p-value
Need for intubation (%)	4 (5%)	12 (15%)	0.03
Length of ED stay (hours)	5.8 ± 1.2	7.1 ± 1.4	<0.001
Length of hospital stay (days)	6.5 ± 2.1	8.0 ± 2.5	<0.001
In-hospital mortality (%)	2 (2.5%)	6 (7.6%)	0.08
30-day readmission rate (%)	8 (10%)	14 (18%)	0.12

The findings demonstrate that the Early CPAP group showed significantly reduced intubation rates and shorter durations in both the emergency department and hospital compared to the control group. Although mortality and 30-day readmission rates were lower with early CPAP, these differences did not reach statistical significance ($p > 0.05$), likely due to the limited sample size. Despite this, the overall trend across secondary outcomes consistently favored early CPAP, indicating that its use may lead to better clinical prognosis for patients. These results suggest that early CPAP intervention could be beneficial in improving key healthcare outcomes.

Discussion:

Our study on early CPAP therapy in patients with Acute Decompensated Heart Failure (ADHF) demonstrated significant improvements in respiratory parameters, including increased oxygen saturation (SpO_2: 95% vs. 89%), reduced respiratory rate (20 vs. 24 breaths/min), and improved pH levels (7.38 vs. 7.32), all with highly significant p-values ($p<0.001$). These findings align with prior research showing similar physiological benefits, such as a 9% increase in SaO_2 and a reduction in respiratory rate (5.63 vs. 4.09 breaths/min) in heart failure patients receiving CPAP [12]. Notably, our results are consistent with studies highlighting the critical role of CPAP in managing ADHF-related respiratory distress, particularly in patients with comorbid sleep-disordered breathing (SDB), which affects up to 94% of heart failure patients [13, 14].

While our intubation rate (5%) was lower than the standard therapy group (15%) and fell within the upper range of national registry data (5.0–13.9%), it markedly exceeded the 0.23% reported in ADHF clinical trials [17]. This discrepancy underscores the underreporting and lack of detailed outcomes in earlier studies, where only 0.09% of patients had described clinical results [17]. Although mortality and 30-day readmission rates did not reach statistical significance, the consistent trends favoring early CPAP—such as shorter hospital stays (6.5 vs. 8.0 days, $p<0.001$)—support its role in improving acute outcomes [15].

Overall, our findings reinforce the utility of early CPAP in emergency settings, aligning with broader registry data and physiological studies [11, 12, 16] while contrasting with the limited scope of ADHF trial reporting [17]. The collective evidence, including the high prevalence of SDB in this population [13, 14], suggests that CPAP not only enhances respiratory stability but may also reduce healthcare burdens, warranting further investigation into its long-term

impact. The findings of our study on early CPAP therapy in patients with Acute Decompensated Heart Failure (ADHF) are consistent with the broader principles of heart failure management, supporting the concept that early intervention leads to improved outcomes, even though the therapeutic mechanisms—respiratory support versus pharmacological treatment—may differ[18]. Moreover, our results closely parallel those of an earlier study conducted between 1995 and 1997, which similarly highlighted the benefits of early CPAP intervention in this patient population [19]. These findings further underscore the growing emphasis on evidence-based strategies for the early management of ADHF.

Conclusion:

The study demonstrated that early initiation of CPAP therapy in patients with Acute Decompensated Heart Failure (ADHF) led to significant improvements in respiratory parameters, including higher oxygen saturation, lower respiratory rates, and better blood gas levels within the first two hours, compared to standard therapy. Additionally, the Early CPAP group exhibited reduced intubation rates and shorter ED and hospital stays, though in-hospital mortality and 30-day readmission rates did not reach statistical significance. These findings suggest that early CPAP intervention is effective in enhancing respiratory function and may improve clinical outcomes, supporting its use as a beneficial treatment strategy in the emergency management of ADHF.

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