

Evaluation of the outcomes of noninvasive ventilation in acute heart failure patients at Cardiovascular Center – E hospital

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ABSTRACT

Background: Noninvasive ventilation is indicated in patients with acute respiratory failure, especially in acute heart failure. The study aimed to evaluate the effectiveness of noninvasive ventilation in patients with acute heart failure.

Methods: The descriptive study on 23 patients with acute heart failure and respiratory failure who were applied non-invasive ventilation at Cardiovascular Center, E Hospital.

Results: The mean age of the patients was relatively high (74 years old), the rate of male accounted for 56.5%. The main causes were ischemic heart disease accounting for 82.6% and acute myocardial infarction accounting for

43.5%. Non-invasive ventilation improved the respiratory failure condition: gradually reducing respiratory rate, increasing SPO₂, PaO₂, and P/F ratio. In addition, it improved the hemodynamic status: increasing mean blood pressure, reducing heart rate and increasing tissue perfusion by reducing lactate level. The successful rate of noninvasive ventilation is 65.2% and the mortality rate is 21.7%.

Conclusion: Non-invasive ventilation is a simple respiratory support, easy to apply in many facilities to help improve respiratory condition and hemodynamic status.

Keywords: *Ventilation, noninvasive ventilation, acute heart failure.*

INTRODUCTION

Heart failure is one of the cardiovascular syndromes with high morbidity and mortality rates. In Europe, the prevalence of symptomatic heart failure is approximately 0.4–2% [1]. In the United States, acute heart failure accounts for about 1 million hospital admissions annually and is the leading cause of hospitalization among individuals over 65 years old [2].

Acute heart failure is characterized by the sudden onset of signs and symptoms of heart failure. Acute respiratory failure in the context of acute heart failure is commonly observed in patients

with acute cardiogenic pulmonary edema or cardiogenic shock. Non-invasive ventilation (NIV) is indicated for patients with acute respiratory failure and has been proven to reduce respiratory effort, improve respiratory status, and decrease the rate of endotracheal intubation compared to conventional oxygen therapy. It is effective in treating moderate to severe heart failure [3].

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Therefore, we conducted this study to describe the clinical characteristics of acute respiratory failure in patients with acute heart failure and to evaluate the effectiveness of non-invasive ventilation in these patients.

SUBJECTS AND METHODS

Study Design

A cross-sectional descriptive study.

Subjects, Time, and Location:

The study was conducted on 23 patients with acute respiratory failure in the context of acute heart failure, who were indicated for non-invasive positive pressure ventilation (NIPSV) at the Cardiology Center – E Hospital from January 2023 to November 30, 2023.

Exclusion Criteria

Patients with contraindications to non-invasive ventilation were excluded from the study.

Procedures and Standards Used in the Study

• Acute Heart Failure Diagnosis Criteria:

According to the 2021 European Society of Cardiology (ESC) guidelines.

• Acute Cardiogenic Respiratory Failure Diagnosis Criteria

Indications for Non-Invasive Ventilation

(NIV): Patients diagnosed with acute respiratory failure in the context of acute heart failure [4]:

Acute cardiogenic pulmonary edema.

Other indications: Patients with acute heart failure but also suffering from other conditions such as COPD, bronchial asthma, pneumonia, pleural effusion, pulmonary embolism.

Contraindications to Non-Invasive Ventilation [5]:

Absolute Contraindications:

- Cardiac or respiratory arrest.
- Anatomical abnormalities preventing the use of a mask.
 - Inability to maintain airway patency: uncontrolled agitation, coma, severe mental deterioration.
 - Refractory hypotension.

Relative Contraindications:

- Mild agitation or poor cooperation.
- Mild hypotension.
- Upper gastrointestinal bleeding or vomiting.
- Inability to clear secretions.
- Recent gastrointestinal or airway surgery.
- Isolated right heart failure.

Criteria for Discontinuing NIV:

NIV is discontinued when adequate recovery is achieved:

- The underlying cause of acute heart failure is resolved.
 - The patient no longer requires NIV.
 - Improvement in respiratory status: Respiratory rate < 20 breaths per minute, SpO₂ > 95%, PaO₂ > 60 mmHg, PaCO₂ < 45 mmHg, P/F ratio > 300 mmHg.
- Or when there are signs of NIV failure, necessitating endotracheal intubation:
- Cardiac or respiratory arrest.
 - Decreased consciousness.
 - Agitation or NIV intolerance with progressive respiratory failure.
 - Signs of progressive muscle fatigue during NIV.
 - Worsening pH, PaO₂, PaCO₂ despite NIV.
 - Persistent hemodynamic instability.

- Need to protect the airway.

• **Complications of Non-Invasive Ventilation:**

- Dry respiratory mucosa due to lack of humidification of the inspired air.
- Discomfort from the airflow: earache, sinus pain.
- Air leaks from an ill-fitting mask causing dry eyes, red eyes.
- Skin redness, facial sores: common at the nose bridge, chin.
- Gastric distention from air entry into the stomach.

- Pulmonary barotrauma, pneumothorax.

Data Management

Data were collected through a research questionnaire and processed using SPSS 20 software.

Ethical Considerations

The study was conducted in accordance with ethical research standards and was approved at the institutional level by E Hospital.

RESULTS

Table 1. Characteristics of Study Subjects

Characteristics	Number of patients (N = 23)	Percentage (%)
Age	74 ± 12	
Sex	Male: 13	56.5
	Female: 10	43.5
Acute Myocardial Infarction	10	43.5
Non-Ischemic Heart Disease	6	26.1
Congestive Heart Failure	19	82.6
Valvular Heart Disease	5	21.7
Hypertension	2	8.7
Chronic Lung Disease	4	17.4

The average age is high: 74 ± 12 years. The male rate is 56.5%, and female rate is 43.5%. Common causes of acute heart failure include acute myocardial infarction, chronic coronary artery disease, chronic heart failure, valvular heart disease, hypertension, and acquired lung diseases. Among these, acute myocardial infarction is the most frequent cause, affecting 43.5% of patients. The second most common cause is localized ischemic heart disease, accounting for 26%

of cases. The least common cause is hypertensive crisis leading to acute heart failure, affecting 8.7% of patients.

Table 2. Characteristics of Ventilator Parameters during NIV Implementation

Parameters	After NIV					
	01h	02h	03h	06h	12h	24h
IPAP	10	10	9.7	9.1	8.5	8.8
EPAP	5	5	5	5	5	5
FiO2	0.83	0.69	0.6	0.56	0.51	0.56

In our study, the average inspiratory positive airway pressure (IPAP) was 9.2 cm H₂O, with a maximum of 14 cm H₂O. The average positive end-expiratory pressure (PEEP) was 5 cm H₂O, with a maximum of 8 cm H₂O. IPAP and FiO₂ levels decreased gradually over the course of NIV ventilation.

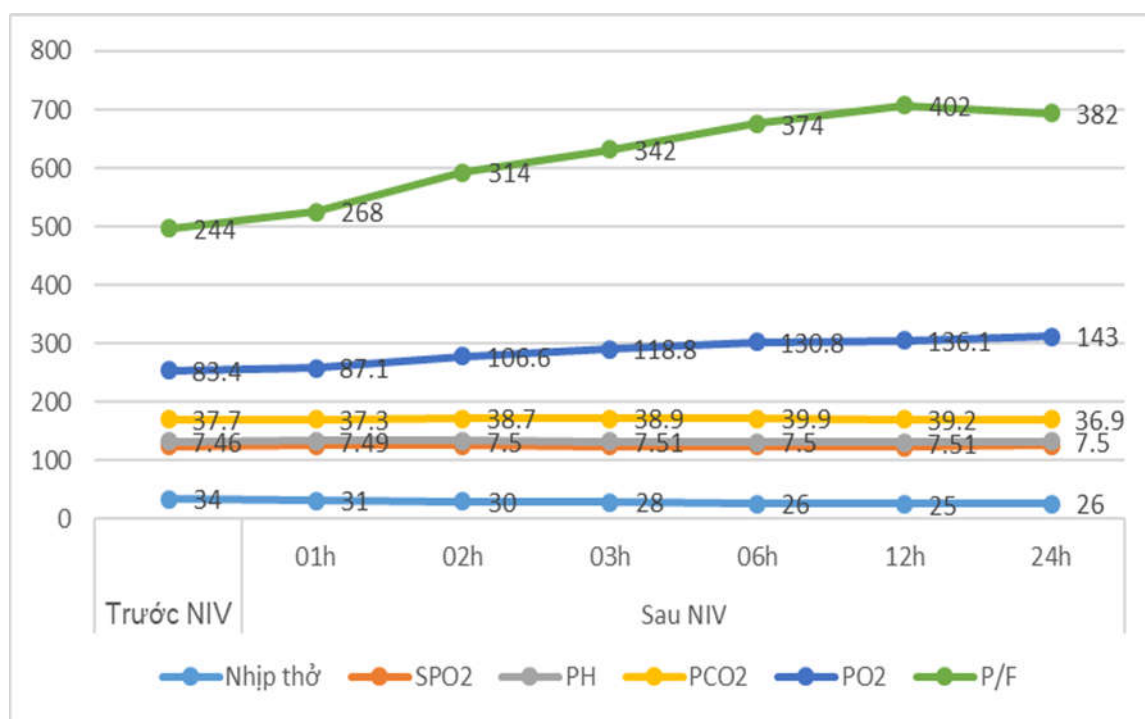


Figure 1. Respiratory Improvement over Time after NIV

Comments: The average respiratory rate before NIV support was 34 breaths per minute, decreased to 31 breaths per minute after 1 hour, and further decreased to 26 breaths per minute after 24 hours. PaO₂ increased gradually over the course of NIV ventilation. The P/F ratio increased from 244 mmHg to 388 mmHg after 24 hours of NIV ventilation.

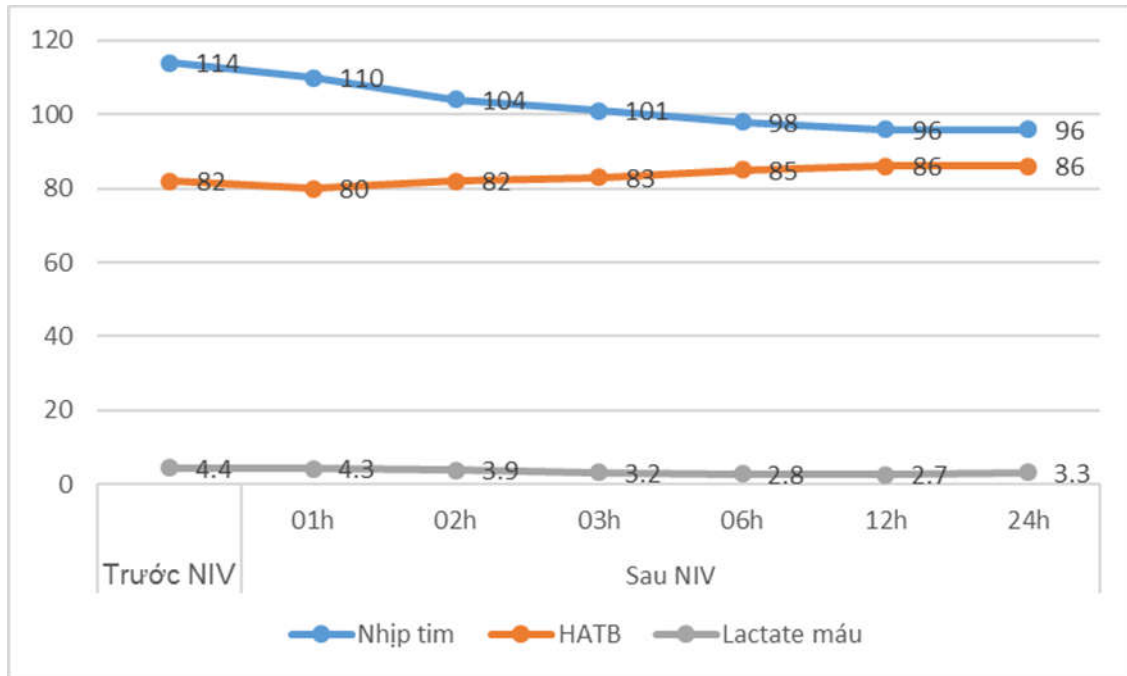


Figure 2. Hemodynamic Improvement over Time after NIV

Comments: The average heart rate before NIV ventilation was 114 beats per minute, decreasing gradually to 96 beats per minute after 24 hours of NIV ventilation. The average blood pressure of patients before mechanical ventilation was 82 mmHg, which increased to 86 mmHg after 24 hours of NIV ventilation. The blood lactate level decreased from 4.4 mmol/l to 3.3 mmol/l after 24 hours of ventilation.

Table 3. Treatment Outcomes after NIV

Characteristic		Value
Duration of NIV (hours)		32 ± 27 giờ
Length of hospital stay (days)		15 ± 8.9 ngày
Treatment Outcome	Successful NIV	15 (65.2%)
	Intubation required	8 (34.8%)
	Mortality	5 (21.7%)

Comments: The average duration of non-invasive ventilation (NIV) was 32 hours, with an average hospital stay of 15 days. 15 patients (65.2%) successfully discontinued NIV support. The failure rate of non-invasive ventilation was 34.8%, and the mortality rate in the patient group was 21.7%.

Table 4. Causes of Failure

Cause	N
Cardiac arrest or respiratory arrest	1
Decreased consciousness	0
Poor tolerance to NIV	2
Need for airway protection	0
Worsening arterial blood gases	2
Chronic hemodynamic disorder	3

Comments: Out of 23 patients treated with non-invasive ventilation (NIV), 8 patients (34.8%) did not respond successfully. This includes 4 main reasons: chronic hemodynamic disorder, cardiac or respiratory arrest during NIV, poor tolerance to NIV, and worsening arterial blood gases.

DISCUSSION

Characteristics of the Study Population

Our study population had a relatively high average age of 74 ± 12 years, with a male-to-female ratio of 56.5% to 43.5%. This finding aligns with Gray et al.'s study [6]. Older patients tend to experience more cardiovascular events and severe complications [7]. Common causes of acute heart failure in our study included acute coronary syndrome, chronic coronary artery disease, chronic heart failure, valvular heart disease, hypertension, and various lung diseases (Table 1). Acute heart failure due to acute coronary syndrome was the most common cause, affecting 43.5% of patients. The second most common cause was localized myocardial ischemia, accounting for 26% of cases. The least common cause was acute aortic dissection causing acute heart failure, at 8.7%. Our findings are consistent with Gray's study [6], where ischemic heart disease was the most common cause in 64% of cases.

Improvement in Respiratory and Hemodynamic Status after NIV

In our study (Table 2), the average inspiratory pressure was 9.2 cm H₂O, with a

maximum of 14 cm H₂O. The average positive end-expiratory pressure (PEEP) was 5 cm H₂O, peaking at 8 cm H₂O in patients with a history of COPD. Inspiratory pressure (IPAP) and FiO₂ decreased gradually during NIV, indicating effective respiratory support and improvement in respiratory distress.

Our study demonstrated a gradual decrease in respiratory rate over time with NIV. The average respiratory rate decreased from 34 breaths per minute (bpm) initially to 31 bpm after 1 hour, and further to 26 bpm after 24 hours (Figure 1). This outcome is similar to Nicolas Berbenetz's study [8], where the initial respiratory rate was 27 bpm and decreased by an average of 1.87 bpm after one hour of NIV. Improvement in arterial oxygenation (PaO₂) over time was also observed, with our study showing a significant increase. This differs from Nicolas Berbenetz's findings of a mean increase of 16.19 mmHg in PaO₂ after 1 hour, with a mean PaO₂ of 133.9 mmHg. Initially, our study recorded a lower PaO₂ of 83.4 mmHg, compared to 115 mmHg in Nicolas's study. The improvement in PaO₂ indicates enhanced lung exchange in patients, with the P/F ratio increasing from 244 mmHg to 388 mmHg after 24 hours of NIV.

In our study (Figure 2), the average heart rate decreased from 114 bpm before NIV to 96 bpm after 24 hours. The average blood pressure before NIV was 82 mmHg, increasing to 86 mmHg after 24 hours of NIV. These findings are consistent with Nicolas's study [8], which reported a mean increase of 1.46 mmHg in blood pressure after 1 hour. Notably, blood lactate levels decreased from 4.4 mmol/L before NIV to 3.3 mmol/L after 24 hours of treatment. These results indicate that NIV not only improves hemodynamics by increasing blood pressure and reducing heart rate but also enhances tissue perfusion.

Outcome of NIV Treatment

Table 3 shows that the average duration of NIV in our study was 32 hours, with an average hospital stay of 15 days, higher than Nicolas's study where the average hospital stay was 9.65 days. Out of 23 patients treated with NIV, 15 patients (65.2%) showed significant improvement in respiratory and hemodynamic status and were successfully weaned off support (Table 4), similar to Gray's study where the success rate was 58.5%. The failure rate of NIV was 34.8%, and the mortality rate among patients was 21.7%, higher than Gray's study which reported a mortality rate of 16.8% [6].

Among the 23 patients treated with NIV, 8 patients (34.8%) did not respond adequately. The main reasons included chronic hemodynamic disorders, despite active NIV in 3 patients, cardiac arrest during NIV in 1 patient, a patient with acute coronary syndrome progressing to multiple ventricular tachycardia despite emergency treatment, and 2 patients with poor tolerance to NIV. These cases were promptly managed with proactive endotracheal intubation,

all procedures were successful.

CONCLUSION

Non-invasive ventilation (NIV) is a simple and relatively easy respiratory support method that improves respiratory status, enhances hemodynamics, and reduces the need for intubation in patients.

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