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Clinical Profile of Patients Presenting To the Emergency Room Requiring Non-Invasive Ventilation in a Tertiary Care Hospital

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Abstract

Respiratory Distress is one of the common presentation seen in the Emergency Room (ER) which can be managed by different pathways ranging from simple oxygen therapy to complex endotracheal intubations based on the severity. Our goal in the settings of ER is to have a conscious, cooperative patient with reduction of respiratory distress. Non-invasive Ventilation (NIV) creates such an atmosphere for the patient in ER. Use of non-invasive ventilation in the intensive care unit and the operating room has been well documented in the literature over the past few decades.

Hence reviewing NIV, its use and its failures in ER will help us to risk stratify any patient with respiratory distress. This will help in reducing the need for Endotracheal Intubation, long term morbidity and mortality. There have been several studies conducted to study the clinical profile of NIV in an ICU. Limited studies are available in an Indian setting in the ER. This study was an attempt in this direction.

We intended to determine the clinical profile of patients presenting to the ER requiring NIV, rate of NIV failure and contributing factors for failure.

Our study was a Cross sectional study conducted at Emergency department at Bangalore Baptist hospital.

117 patients were included in our study. NIV was successful in 102 patients. Most common indication for NIV use in our study was lower respiratory tract infection (43.6%).

Conclusion: Our study showed a wide variety of indications for use of NIV in ER, with success rate of 87.2%. We concluded that NIV initiated earliest from the ER can benefit by reducing the need for endotracheal intubation, decreased ICU stay and decreased mortality.

Keywords: Non-Invasive Ventilation, Emergency Room, Respiratory failure

Introduction

Respiratory distress is one of the most common presentation of patients presenting to Emergency room, [1] most common etiology being acute exacerbations of COPD or a viral illness with non-cardiogenic pulmonary oedema. Management of this distress can be approached by different pathways ranging from oxygen therapy to endotracheal intubations.

Our goal in the settings of Emergency room (ER) is to have a conscious, cooperative patient with attenuation of his respiratory distress. Non-invasive ventilation is one such modality.

NIV provides ventilator support through the patient's upper airway through mask or similar devices. It has a provision of intermittent ventilator assistance allowing gradual weaning, normal eating, drinking and communication. [2]

NIV benefits by reducing work of breathing, enhances alveolar gas exchange, reduces respiratory muscle fatigue, improves ventilation-perfusion mismatch and diaphragmatic contractility. [3]

NIV has been proven to be able to reduce necessity of endotracheal intubation, in-hospital mortality and duration of the stay in hospital.

NIV should be considered early in the emergency setting to avoid patient deterioration.

The Emergency physician (EP) is the first to review any case with respiratory distress in the hospital. Hence, a right place to initiate NIV.

There have been several studies conducted prospectively to study the indication, outcome and risk factors for failure of NIV in an ICU.

Limited studies are available in an Indian setting in the ER. This study is an attempt in this direction.

We intended

1. To determine the clinical profile of patients presenting to the Emergency Room requiring non-invasive ventilation.
2. To determine the rate of NIV failure among same patients.
3. To determine the contributing factors for the failure.

Materials And Methods

Study Design:

Cross sectional study

Study Site:

Emergency Department (Bangalore Baptist hospital)

Study Period:

August 2018-September 2020

Study Population:

Adult patients presenting with respiratory failure.

Inclusion Criteria: [4]

1. Respiratory rate > 25bpm
2. $PaCO_2$ > 45mmHg
3. Moderate-severe dyspnea (rest)
4. Use of accessory muscles
5. pH< 7.35 (> 7.10)
6. Age>18yrs

Exclusion Criteria: [4]

1. Respiratory arrest
2. Unconscious, non-cooperative patient
3. GCS < 13
4. Hemodynamically unstable (SBP< 90mmHg)
5. Trauma
6. Surgical conditions

Study Definition:

Acute respiratory failure is defined as the inability of respiratory system to meet the oxygenation, ventilation or metabolic requirements of the patient. [5]

NIV success was defined as the achievement of a clinical and functional condition, stable enough to allow patient discharge to the ward. [6]

NIV failure is defined as the need for endotracheal intubation. [7]

Methodology:

Patient presenting to ED with respiratory distress was triaged to red area immediately (connected to monitors). The EP in the red zone evaluates the subjective and objective parameters of the patient. Patient fulfilling the inclusion criteria were included in the study. Informed and written consent was taken after addressing the patient's condition. Before starting NIV, an arterial blood gas (ABG) sample was collected and sent. After explaining the patient about the need for the non-invasive ventilation, NIV was initiated and the patient was closely monitored for adaptability to NIV. ABG analysis were repeated at 1st and 12th hour after initiation of NIV (For reassessment). Patient was observed for 1 hour and shifted to ICU and followed up. Outcomes of the patient were noted during the stay in ICU i.e., NIV failure/NIV success/length of ICU stay and mortality.

Study Performa included the general details of patient, history, past medical illness, vital monitoring, ABG analysis, diagnosis, LIPS score [8] (Lung injury prediction score of 7 or higher indicates an increase in risk of developing ARDS [9]), time of NIV initiation, and complications following initiation of NIV and contributing factor for failure of NIV.

Measurement and testing: Clinical measurements were done every ten minutes in ER with the multipurpose monitor. BP, RR, HR, electrocardiogram and SpO2 were monitored. ABG

samples were taken as soon as the respiratory distress was identified and thereafter at 1st and 12th hour after initiation of NIV.

Method of Statistical Analysis: The following methods of statistical analysis were used in this study. The Excel and SPSS software packages were used for data entry and analysis respectively

The results were averaged for each parameter for continuous data, numbers and percentage for categorical data. The Normality of data was accessed using Shapiro Wilk test.

Student 't' test (Used to determine whether there was a statistical difference between groups in the parameters measured)

Mann-Whitney Test (A non-parametric test used to compare two independent groups of sampled data)

Proportions were compared using Chi-square test of significance

Ethical issues of this study were addressed by informed consent and adhering to the standard protocol to all. In case of emergency first the patient was addressed then consent was taken later. Written informed consent was sought from relatives of the patient.

The privacy and confidentiality of the research participants was protected.

Results

Our study was conducted over a period of 2 years from August 2018- September 2020. 117 patients who satisfied the inclusion criteria were initiated on NIV. Among them 66 (56.4%) were males and 51 (43.6%) were females as seen in Table 1. Table 2 shows the baseline characteristics of the study subjects with acute respiratory failure treated with NIV.

Clinical indications to initiate NIV in our ER included lower respiratory tract infections (LRTI) (43.6%), acute cardiogenic pulmonary oedema (ACPE) (7.7%), acute exacerbation of COPD (12.0%), acute exacerbation of bronchial asthma (9.4%), ARDS (10.3%), volume overload [acute on chronic kidney disease (CKD)] (11.1%) and others (6.0%) which included sepsis, pulmonary embolism (Table 3).

NIV was successful in 102 patients (87.17%). Out of which 41 patients (40.2%) were diagnosed as LRTI, 7 patients (6.9%) as acute cardiogenic pulmonary oedema, 13 patients (12.7%) as acute exacerbation of COPD, 11 patients (10.8%) as acute exacerbation of bronchial asthma, 10 patients (9.8%) as ARDS, 13 patients (12.7%) as volume overload (Acute on CKD), and 7 patients (6.9%) were diagnosed as other condition (sepsis, pulmonary embolism).

Among the 15 patients who had NIV failure, 13 patients (86.7%) had worsening of respiratory distress, 1 patient (6.7%) had hypotension (requiring inotropic supports), and 1 patient (6.7%) had drop in GCS.

Out of NIV failure group, 2 patients (13.3%) had obesity, 2 patients (13.3%) were chronic smokers, 2 patients (13.3%) were known COPD, 6 patients (40%) were diabetic and 3 patients (20%) had IHD (ischemic heart disease) which were the contributing factors (Figure 1).

In our study, duration of NIV usage varied according to the clinical conditions. Patients with ARDS had a longer NIV duration with a mean period of 48.7 hours, in LRTI – 33.5 hours, in ACPE- 14.9 hours, in COPD- 18 hours, in asthma – 18.5 hours, volume overload (acute on CKD) – 17.2 hours and others – 24.6 hours (Figure 2).

Mean length of ICU stay among NIV failure group was 12.2 days when compared to NIV success group which was 4.2days (Figure 3). Patients with NIV failure had mean LIPS of 5.7 when compared to NIV success group with 5.5.

Discussion

NIV has proven evidence-based wide-ranging capabilities in ER for various disorders as seen in the critical care unit also. ER is the ideal place for initiation of NIV at the earliest in patient with acute respiratory failure.

Usage of NIV in ER requires adequately staffed, trained, and well experienced doctors, which managing in a developing country is challenging.

The criteria for initiation of NIV in ER can be subjective or objective based on the Emergency physician's assessment. There are no laid guidelines from any clinical societies.

The indications for initiation of NIV have been set through different guidelines from different clinical societies.

We included the following set of criteria for initiation of NIV as shown above [4]

These criteria are subjective in nature and can vary from individual to individual and hence identifying the needy patient will be difficult. So, initiation of NIV in ER is challenging.

Objective criteria include a wide variety of diseases ranging from acute hypoxic/acute hypercapnic respiratory failure, acute cardiogenic pulmonary oedema, pulmonary contusions, CAP (community acquired pneumonia), immunocompromised patients, do-not intubate patients and obstructive sleep apnoea. [10]

Our study included LRTI (43.6%), acute exacerbation of COPD (12.0%), acute cardiogenic pulmonary oedema (7.7%), acute exacerbation of asthma (9.4%), ARDS (10.3%), volume overload (Acute on CKD) (11.1%), and others (6.0%) including sepsis and pulmonary embolism. Most common indication of NIV according to other studies: Antro et al (2005) [11] – Cardiogenic Pulmonary oedema, Groff et al (2008) [4] - Acute exacerbation of COPD, Verma et al (2013) [12] - Acute exacerbation of COPD, Correa et al (2015) [3] – Community Acquired Pneumonia.

Our study also shows similar results. The preference of use of NIV depends on the physician. Hence, the results may differ from one study to another.

In our study, the overall success rate of NIV was 87.2%, which is similar to other studies: Kshatriya et al (2019) [13] – 85%, Nizami et al (2019) [14] - 74.67%, Correa et al (2015) [3] - 69.4%, Ibrahim et al (2014) [15] – 78%.

NIV success rate according to the studies ranged from 65- 85%. Hence NIV for acute respiratory failure can be considered at the earliest in the ER to prevent patient deterioration.

LRTI was the most common indication for NIV usage in our study. NIV has been used in CAP with good clinical results and outcomes according to our study. Ferrer in their review deemed that NIV is not an absolute treatment for CAP but a bridge before intubation. [16] In study conducted by Domenighetti et al, NIV was highly promising in patients with cardiogenic pulmonary oedema (>90% success rate), while in patients with CAP, NIV had a lower success rate (62%). In ACPE, NIV also acts by increasing the intrathoracic pressure that acts by reducing the right and left ventricular preload and afterload, which instead helps to increase cardiac output. [17]

In our study, patient with ARDS had the higher failure rate (27.2%) when compared to the other clinical indication for which NIV was used and mortality rate accounted for 66.66% in NIV failure group. In 2015 Singh et al conducted an observational prospective study to profile the use of NIV in ARDS patients. They found that NIV in mild to moderate ARDS could help avoiding intubation in 44% of the patients, mortality accounted to 82.6% in NIV failure group. NIV in ARDS should be considered judiciously to avoid intubation and mortality. [18]

NIV duration in CAP was longer with a mean duration of 33.5hours with little longer in patient with ARDS with a mean duration of 48.7hours and shorter duration of 14.9 in ACPE. Study conducted by Verma et al was similar with a longer duration in ARDS, CAP and shorter in pulmonary oedema. [12] According to Ibrahim et al, mean duration of NIV usage for CAP was longer with a mean duration of 2.88 days, which was similar to our study. [15]

ARDS may be due to different pathologies – lung disease, ventilation-perfusion mismatch and diffusion abnormalities. In this patient the high respiratory drive leads to high TV further leading to lung injury and contributing to NIV failure. [19] Hence NIV usage is usually prolonged in this group of patients.

Length of ICU stay was longer in NIV failure group when compared to NIV success group. A study conducted by Ibrahim et al found that the duration of ICU stay in NIV failure group (10.5days) and NIV success group (4 days) which was similar to our study. [15] NIV allows many of the complications associated with IMV (invasive mechanical ventilation) to be avoided. Hence decreasing the time of ICU and hospital stay.

In our study, clinical improvement of patient with NIV was confirmed by ABG parameters. There was improvement in the pH and pO_2 according to our study. According to Verma et al, patients with COPD, had change in the values of pH, pO2 and pCO2 from the baseline after 24 hours of NIV

initiation, but non- COPD patients showed changes only in pO2 from baseline which was statistically significantly. [12]

Our study showed that patient with higher LIPS score (>7) at the admission were prone to have increased morbidity during hospital stay. [8, 9]

In this study, out of 117 patients, 22.5% were found obese. Obesity with fat deposition in the mediastinum and abdominal cavities reduces the compliance of the entire respiratory system. Hence obesity is associated with various respiratory problems. [20] Qasrawi et al told that use of NIV in obese patients helps to prevent deterioration. [21]

Endotracheal intubation rate was 12.8% according to our study. Most common reason for NIV failure was worsening of respiratory distress, followed by drop in GCS and hemodynamic instability. In a study conducted by Correa et al (2015) the main reason for endotracheal intubation included progression of hypoxemia - 65.4%, neurological deterioration - 19.2%, gastric distension - 7.7%, hemodynamic instability - 3.8% and patient's agitation - 3.8 %. [3]

Limitations

Our study is a Single-Centre based study. Our study considered only ABG analysis for reassessment and did not include the vital parameters reassessment. Objective criteria assessment for initiation of NIV was not strictly adhered among the doctors.

Conclusion

Our study showed a wide variety of uses of NIV in ER, with a success rate of 87.2%. Previous comorbidities, lung pathology of the patient, oxygen therapy at home, snoring and obesity are the common factors contributing to the failure of NIV. We conclude that NIV can be used in ER with safety and good clinical outcomes. An NIV trial in LRTI at the earliest can avoid intubation, prolonged morbidity and mortality.

NIV initiated earliest at Emergency Room benefits by reducing the endotracheal intubation rate, decreased ICU stay and decreased mortality.

In resource limited situations and peripheral emergency rooms, NIV should be made available so that early initiation can be done. Regular training and simulation processes will improve the confidence of the staff managing the ventilators.

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Figure And Table Legends

Figure 1: Contributing factors among the study subjects

Figure 2: Mean NIV duration according to clinical indication

Figure 3: Mean ICU stay among the study group

Table 1: Age and gender distribution among study subjects

Table 2: Baseline characteristics of the study subject

Table 3: Clinical indications for NIV usage among study subjects

Figure 1: Contributing factors among the study subjects

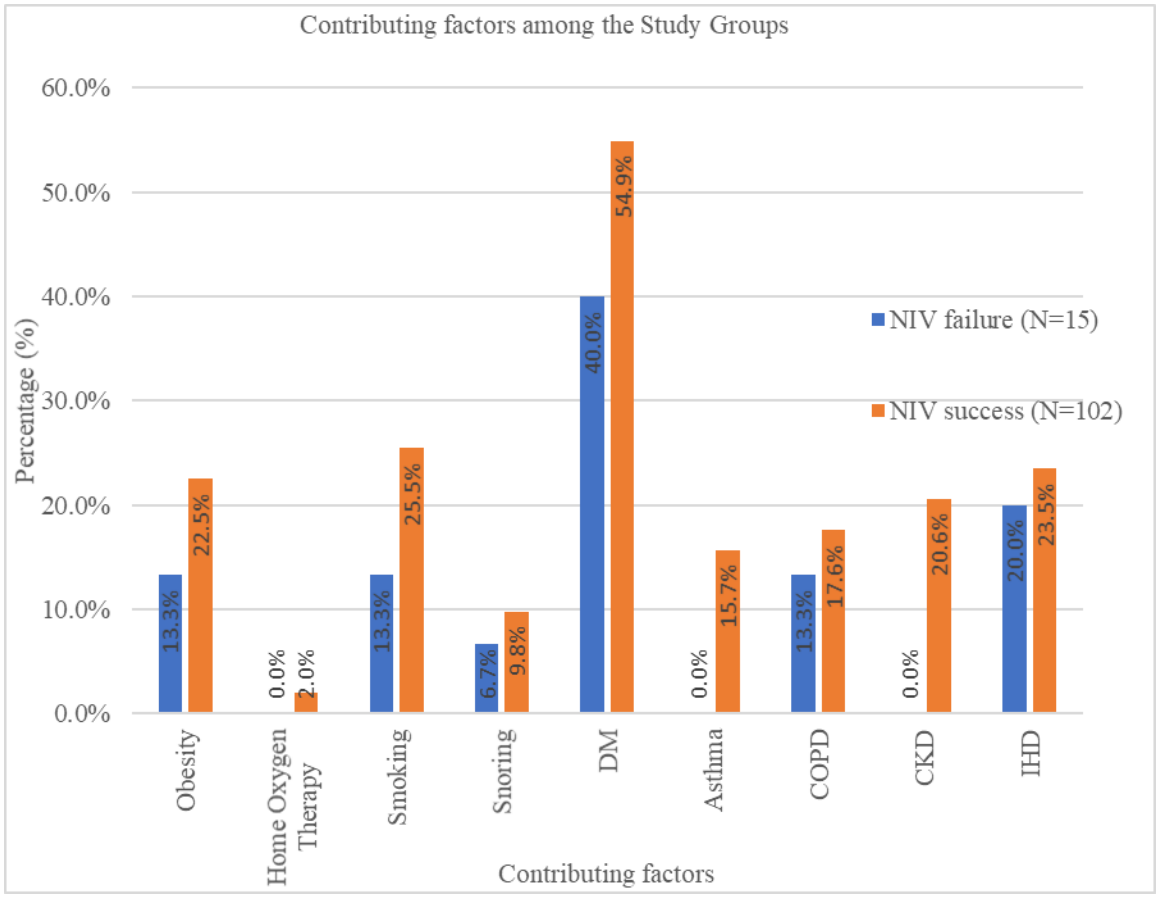

Figure 2: Mean NIV duration according to clinical indication

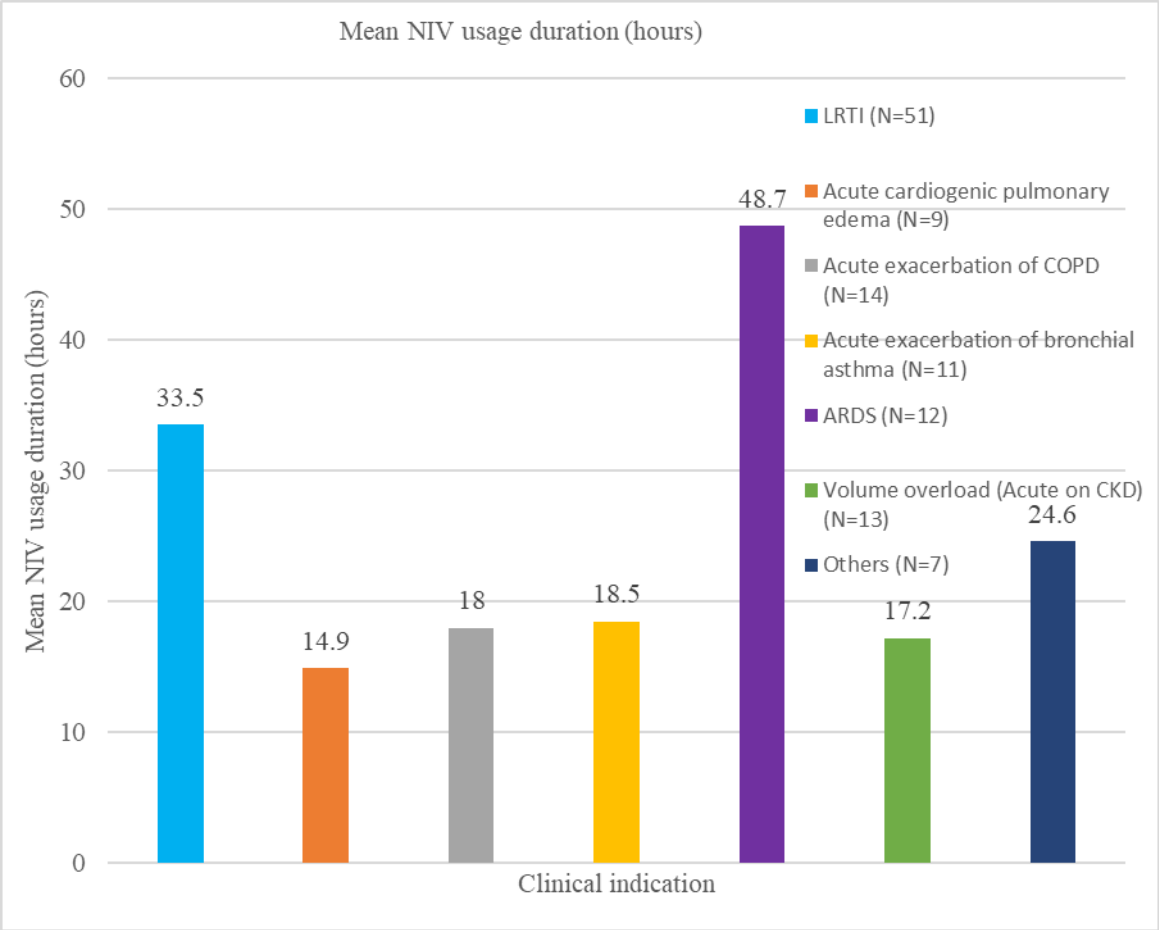

Figure 3: Mean ICU stay among the study group

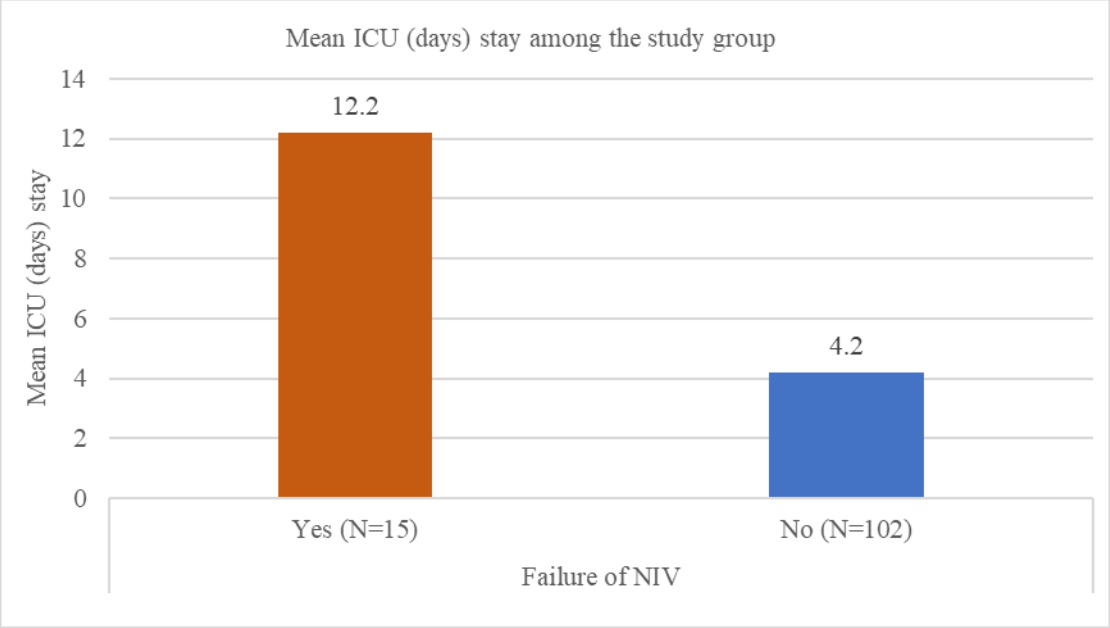

Table 1: Age and gender distribution among study subjects

		NIV				Total (N=117)		p value*
		NIV failure (N=15)		NIV success (N=102)				
		N	%	n	%	N	%	
Age	18-45 years	4	26.7%	18	17.6%	22	18.8%	0.655
	46-60 years	3	20.0%	28	27.5%	31	26.5%	
	>60 years	8	53.3%	56	54.9%	64	54.7%	
	Mean ± SD	56.1±19.894		60.5±17.129				0.367
	Min.-Max.	18-84		18-95				
Gender	Male	10	66.7%	56	54.9%	66	56.4%	0.391
	Female	5	33.3%	46	45.1%	51	43.6%	

*Chi Square Test, Student t test

Table 2: Baseline characteristics of the study subject

Characteristic	Number (%)
Age (years) Mean ± SD	
NIV failure group	56.1+/-19.894
NIV success group	60.5+/-17.129
18-45yrs	22(18.8%)
45-60yrs	31(26.5%)
>60yrs	64(54.7%)
Females	51(43.6%)
Males	66(56.4%)
Physiological parameters	
Pulse rate (beats/min)	
NIV failure group	110.5 +/- 28.24
NIV success group	109.5 +/- 23.81
Respiratory rate (cycle/min)	
NIV failure group	31.3 +/- 5.885
NIV success group	30.1 +/- 6.131
SBP (mmHg)	
NIV failure group	123.3 +/- 21.269
NIV success group	134.1 +/- 34.243
DBP (mmHg)	
NIV failure group	77.3 +/- 16.242
NIV success group	77.8 +/- 17.040
SPO_2 (%)	
NIV failure group	80.5 +/- 14.252
NIV success group	83.0 +/- 11.739
Basal arterial blood gas values	
pH	
NIV failure group	7.36 +/- 0.086
NIV success group	7.36 +/- 0.097
pO_2	
NIV failure group	62.83 +/- 12.917
NIV success group	59.87 +/- 10.933
pCO_2	
NIV failure group	34.49 +/- 8.702
NIV success group	37.22 +/- 12.078
Time of onset of symptoms to presentation in ER (hours)	
NIV failure group	57.5
NIV success group	66.0

Table 3: Clinical indications for NIV usage among study subjects

Clinical indications	NIV				Total (N=117)	
	NIV failure (N=15)		NIV success (N=102)			
	N	%	n	%	n	%
LRTI	10	66.7%	41	40.2%	51	43.6%
Acute cardiogenic pulmonary edema	2	13.3%	7	6.9%	9	7.7%
Acute exacerbation of COPD	1	6.7%	13	12.7%	14	12.0%
Acute exacerbation of bronchial asthma	0	0.0%	11	10.8%	11	9.4%
ARDS	2	13.3%	10	9.8%	12	10.3%
Volume overload (Acute on CKD)	0	0.0%	13	12.7%	13	11.1%
Others	0	0.0%	7	6.9%	7	6.0%