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Original Research Article

A Study of Indications and Outcome in 100 Cases of Non Invasive Ventilation in ICU

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Abstract:

Background: Over the past two decades, the use of non-invasive ventilation by mask has increased substantially for acutely ill patients. Growing evidence indicates that NIV is the standard first-line therapy for many respiratory emergencies. The major concern of our study is to highlight the indications of non-invasive ventilation (NIV), their outcome and certain parameters which decide the outcome of non-invasive ventilation (NIV).

Methods: A Prospective and observational study was carried out in ICU of PDU medical college and hospital, Rajkot from January to December 2019 where total 100 patients both male and female, above 13 years of age on non-invasive ventilation were included. Patients with invasive mode of ventilation were not included. The indication of non-invasive ventilation, its outcome in each patient was studied along with parameters on admission (pH, pCO2, pO2, Respiratory rate) which could predict the outcome of non-invasive ventilation in individual patient.

Results: 100 cases of NIV that were studied had different underlying aetiology and diagnosis. The patients who seemed to have maximum benefit from non-invasive means were the patients with acute pulmonary oedema secondary to cardiac failure, acute exacerbation of COPD and uncomplicated pneumonitis. Certain admission parameters like pH, pCO2, pO2 and respiratory rate were found to determine the outcome of patient. Patients were categorised in two groups-successful NIV and failed NIV. The overall success rate of NIV was around 80% in our study. Patients like COPD and acute pulmonary oedema required minimum number of hours to wean off to room air from the ventilator. Thus NIV application for mere few hours can do wonders by preventing mortality in patients of respiratory failure.

Conclusion: NIV offers favourable outcome for many emergency respiratory conditions, thus remains the modality of choice for treating acute illness like exacerbation of COPD and cardiogenic pulmonary oedema. While it is less preferred for respiratory failure due to acute lung injury/ARDS. Certain parameters like pH, pO2, pCO2 and respiratory rate on admission helps in predicting the outcome of NIV.

Keywords: Mechanical ventilation, NIV, ARDS, COPD, Acute LVF.

Introduction

Mechanical ventilation is a useful modality for patients who are unable to sustain the level of ventilation necessary to maintain the gas exchange functions (oxygenation and carbon dioxide elimination)1. Mechanical ventilation is used to assist or replace spontaneous breathing. It is implemented with special devices that can support ventilatory function and improve oxygenation through the application of high oxygen content gas and positive pressure. The primary indication for initiation of mechanical ventilation is respiratory failure, of which there are two basic types2: [1] hypoxemic, which is present when arterialO_2 saturation (Sao2) <90% occurs despite an increased inspired O2 fraction and usually results from ventilation-perfusion mismatch or shunt; and [2] hypercarbic, which is characterized by elevated arterial carbon dioxide partial pressure (PCO2) values (usually >50 mmHg) resulting from conditions that decrease minute ventilation or increase physiologic dead space such that alveolar ventilation is inadequate to meet metabolic demands.[2] The most common reasons for instituting mechanical ventilation are acute respiratory failure with hypoxemia (acute respiratory distress syndrome, heart failure with pulmonary oedema, pneumonia, sepsis, complications of surgery and trauma), which

accounts for ~65% of all ventilated cases, and hypercarbic ventilatory failure—e.g., due to coma (15%), exacerbations of chronic obstructive pulmonary disease (COPD; 13%), and neuromuscular diseases (5%)[2]. The primary objectives of mechanical ventilation are to decrease the work of breathing, thus avoiding respiratory muscle fatigue, and to reverse life-threatening hypoxemia and progressive respiratory acidosis. NIV has gained acceptance because it is effective in conditions such as acute or chronic respiratory failure, and is associated with fewer complications-like tracheo laryngeal trauma, ventilator associated pneumonia, and decreases the length of intensive care unit (ICU) stay and mortality. The most important group of patients who benefit from a trial of NIV are those with exacerbations of COPD and acute cardiogenic pulmonary oedema. However, NIV is not successful in all patients with acute respiratory failure. NIV has controversial role in respiratory failure due to pneumonia and Acute Respiratory Distress Syndrome (ARDS). Experience from several randomized trials has shown that, in patients with ventilator failure characterized by blood pH levels between 7.25 and 7.35, NIV is associated with low failure rates (15–20%) and good outcomes (as judged by intubation rate, length of stay in intensive care, and—in some series—mortality rates).

In more severely ill patients with a blood pH <7.25, the rate of NIV failure is inversely related to the severity of respiratory acidosis, with higher failure rates as the pH decreases. The major limitation to the widespread application of NIV has been patient intolerance: the tight-fitting mask required for NIV can cause both physical and psychological discomfort. In addition, NIV has had limited success in patients with acute hypoxemic respiratory failure, for whom endotracheal intubation and conventional MV remain the ventilatory method of choice. NIV is not useful in certain cases of respiratory failure and is contraindicated in patients with the conditions like cardio-respiratory arrest, hemodynamically instability, facial trauma, high risk of aspiration and altered sensorium. Once NIV is initiated, patients should be monitored for respiratory rate, pO_2 and pCO_2.

A reduction in respiratory frequency and a decrease in the use of accessory muscles (scalene, sternocleidomastoid, and intercostal) are good clinical indicators of adequate therapeutic benefit. Arterial blood gases should be determined at least within hours of the initiation of therapy to ensure that NIV is having the desired effect. Also patients on NIV must be monitored closely for signs of NIV failure and should be intubated promptly before a crisis develops. Therefore, there is a need to identify prognostic factors for the outcome of NIV. Here in our study we have tried to elicit importance of NIV in acute respiratory illness, their outcome and parameters which helps in determining the outcome.

Results

In present study, out of 100 cases on NIV, 57 (57%) patients were male and 43 (43%) patients were female, with Male: Female ratio of 1.32:1 (Figure 1). So respiratory failure leading to NIV use was more seen in males than females. Since males are more exposed to outdoor activities, have personal habits like smoking, there were more admissions due to various etiologies like COPD, seasonal flu.

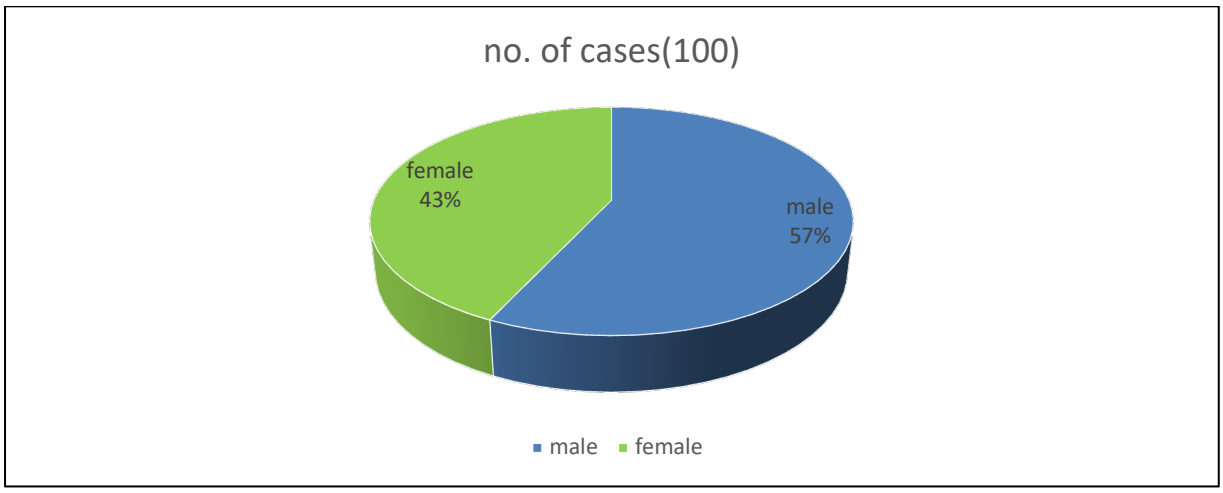

Figure1: sex distribution

Majority of the patients who were admitted had complained of breathlessness (100%), thus making it the most common presenting complains. Second most common complaint was cough, cold (59%), followed by fever

(48%), chest pain (19%), and other gastrointestinal complain like vomiting, hematuria and decreased urine output (Figure 2).

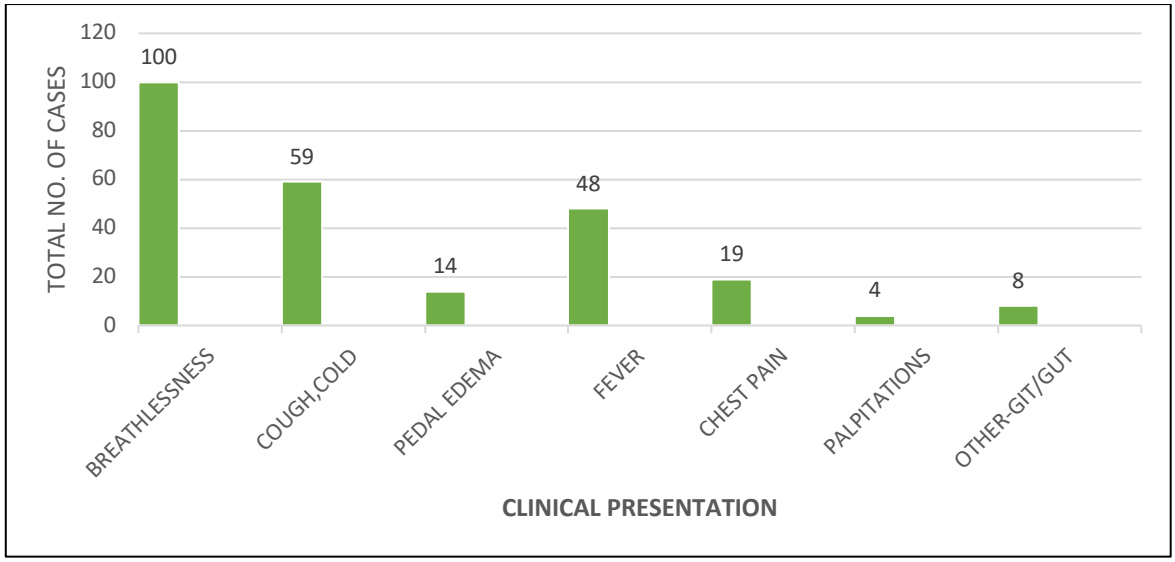

Figure 2: clinical presentation

Out of all the patients who were admitted with respiratory failure and required NIV, maximum of them were diagnosed with pneumonitis (46%), which included both seasonal flu and bacterial pneumonitis.

It was because the study was conducted in the period having high prevalence of seasonal flulike H1N1. Second most common indication was acute pulmonary edema secondary to acute LVF (35%).

Third most common indication among the admitted patients was acute exacerbation of COPD (22%), followed by acute lung injury/ARDS (18%), and other causes like aspiration and post extubation NIV (Table 1).

Table 1: Primary indications of non-invasive ventilation and diagnosis

Indication of NIV	Total No*
Acute exacerbation of COPD	22
Acute lung injury, ARDS(acute respiratory distress syndrome)	18
Acute pulmonary edema, acute LVF	35
Pneumonia(seasonal viral and bacterial)	46
Aspiration	3
Post extubation	1

*The total number adds up to more than 100 as some patients had more than 1 diagnosis and cause for respiratory failure.

Considering the admission parameters of all patients, it was found that respiratory rate was more (mean 30, range 24-40) in patients of acute lung injury/ARDS. Blood pH was lower in group of acute exacerbation of COPD (mean 7.33, range 7.21-7.42) and acute LVF (mean 7.33, range 6.64-7.45), possible due to co2 retention and acidosis secondary to cardiac failure which reduces oxygenation of organs (Table 2).

PaCo2 was more in group of acute exacerbation of COPD (mean 58, range 39-118), due to retention of co2 in COPD patients. Thus classifying COPD as respiratory failure type2. Pao2 was seen low in group with pneumonitis (mean 70.6, range 45-150) and acute lung injury/ARDS (mean 76.8, range 45-168) classifying them in respiratory failure type1(Table 2). The patients were categorized according to their outcome into two groups-successful NIV (those weaned to room air successfully with NIV use) and failed NIV (those worsened during the course and required invasive means or deceased). pH, pCO2, pO2 and respiratory in success group were 7.37, 40.07mmHg, 76.3mmHg and 27, respectively. While failed group had pH, pCO2, pO2 and respiratory rate of 7.26, 53.21mmHg, 73.02mmHg and 30, respectively. Considering above findings it was seen that low pH, low pO2, high pCO2 and high respiratory rate on admission were associated with bad outcome. Thus these parameters can

predict the outcome of NIV, either success or failure (table 3).

Table 2: Study of various parameters in individual diagnosis

Parameter on admission(normal value)	AECOPD Mean(range)	ALI/ARDS Mean(range)	Acute LVF Mean(range)	PNEUMONIA Mean(range)
RR (16-20)	26(22-34)	30(24-40)	28(22-40)	28(22-46)
PaO2 (83-108)mmHg	83.2(54-90)	76.8(45-168)	86.4(60-249)	70.6(45-150)
Paco2 (32-45)mmHg	58(39-118)	34.02(19.4-44.6)	38.6(15.9-144.9)	37.8(19.4-58)
PH (7.35-7.45)	7.33(7.21-7.42)	7.34(7.21-7.47)	7.33(6.64-7.45)	7.39(7.16-7.47)

Table 3: Study of parameters in success and failure group

Characteristics	NIV Successful (Total-80)	NIV Failed (Total-20)
Age(years)(mean)	53	49
Admission Ph.(mean)	7.37	7.26
Admission Pco2(mean)	40.07	53.21
Admission Pao2(mean)	76.3	73.05
Respiratory rate(mean)	27	30

Out of all the patients who were put on NIV, it was found that hypertension (42 patients) was the most common associated comorbidity (Figure 3). Second most common comorbidity that was associated with respiratory failure was diabetes (35 patients), followed by ischemic heart disease (25 patients), chronic obstructive pulmonary disease (21patients) and other lung diseases (5 patients). Thus concluding that diabetes and hypertension are the most prevalent comorbidities among patients of respiratory failure who require NIV. In both the groups, NIV failure and NIV successful, hypertension and diabetes were found to be more prevalent, followed by ischemic heart disease. Thus these two comorbidities have a significant impact on outcome of illness.

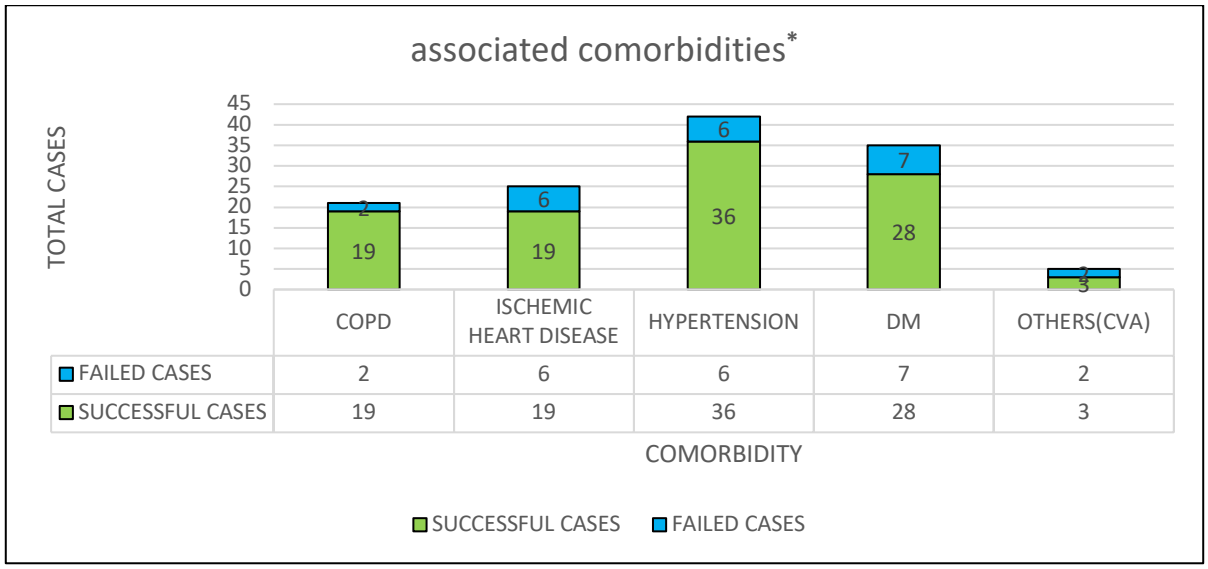

Figure 3: Associated comorbidities in patients on non-invasive ventilation

*The total number adds up to more than 100 as some patients had more than 1 comorbidity condition. In our study, total cases were 100, out of which 80 patients (80%) were weaned to room air, while 20 of them (20%) gradually worsened and required invasive means of ventilation or expired. It could have been due to complications of associated illness or comorbidities. Thusin our study there was a success rate of 80% of non-invasive ventilation. This shows that NIV plays and important role in reducing mortality in patients with respiratory failure (figure 4).

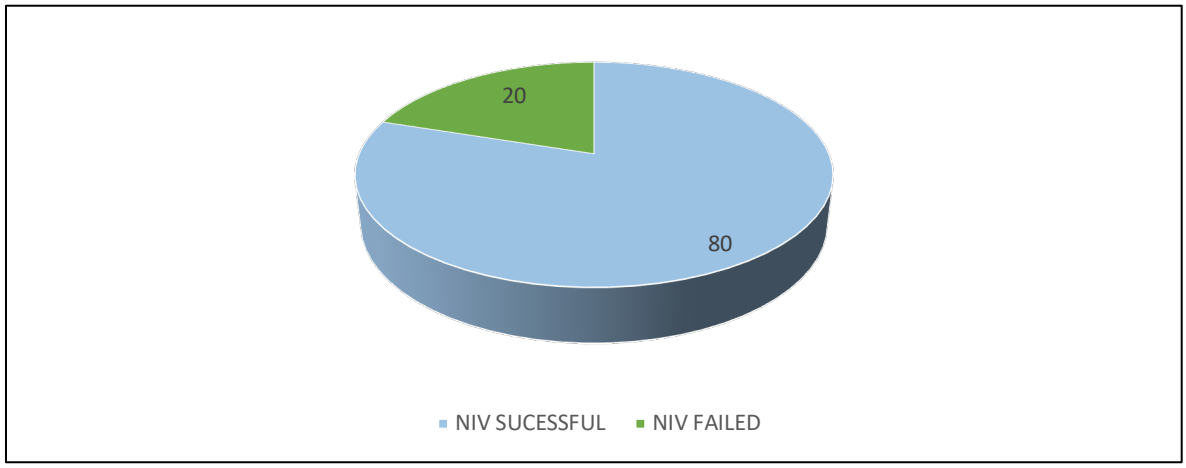

Figure 4: Outcome of NIV Total Cases (100)

Considering the success rate in different groups, the maximum success rate was in the group of COPD (90.9%), followed by patients of pneumonitis (80.4%), acute LVF (77.14%), acute lung injury/ARDS (50%) and aspiration pneumonitis (33.4%). Thus NIV is most successful and favors great reduction in mortality in patients of respiratory failure due to COPD, acute pulmonary edema secondary to acute LVF and pneumonitis.

While aspiration pneumonitis, acute lung injury/ARDS had least successful rate.

These patients seemed to have better outcome with invasive means of ventilation (Figure 5).

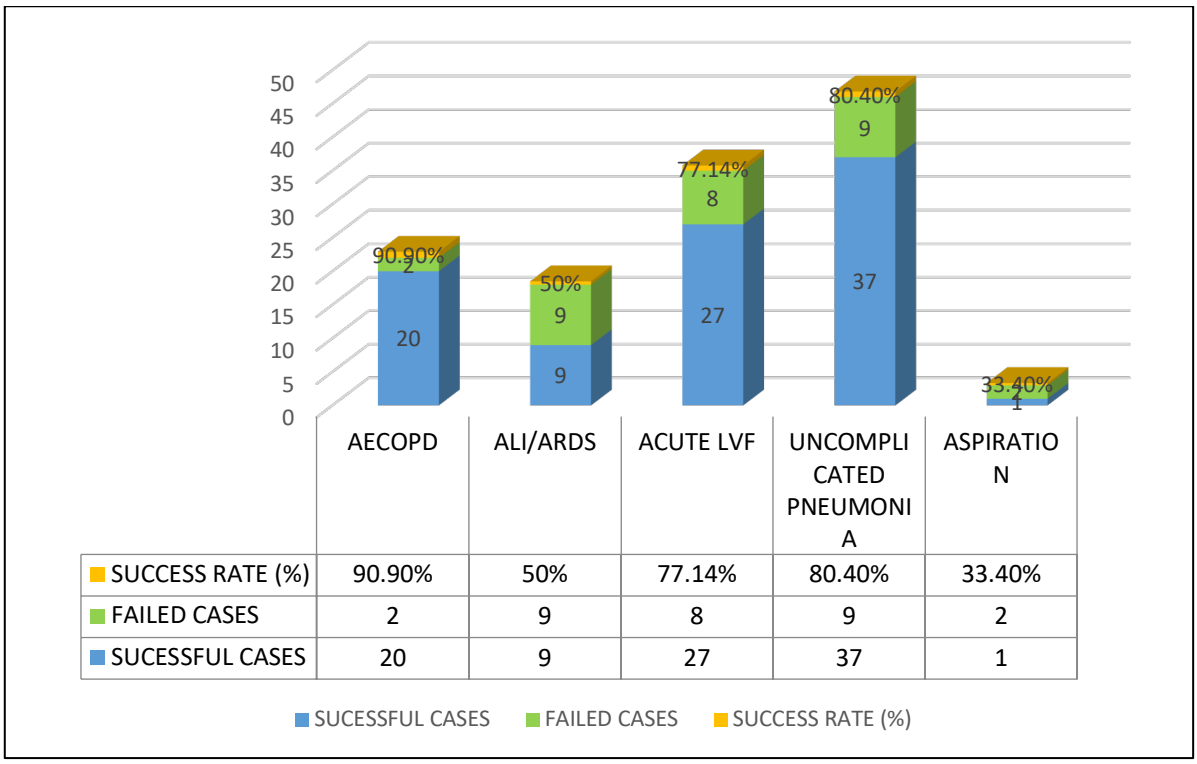

Figure 5: Outcome in Individual Diagnosis

After studying all the groups it was seen that COPD patients required the minimum number of hours to wean from NIV. The duration of NIV in these patients was about 36 hours (ranging from 24-48 hours). While patients of pneumonitis, acute lung injury/ARDS required longer duration to wean (4-5 days average) (Figure 6)

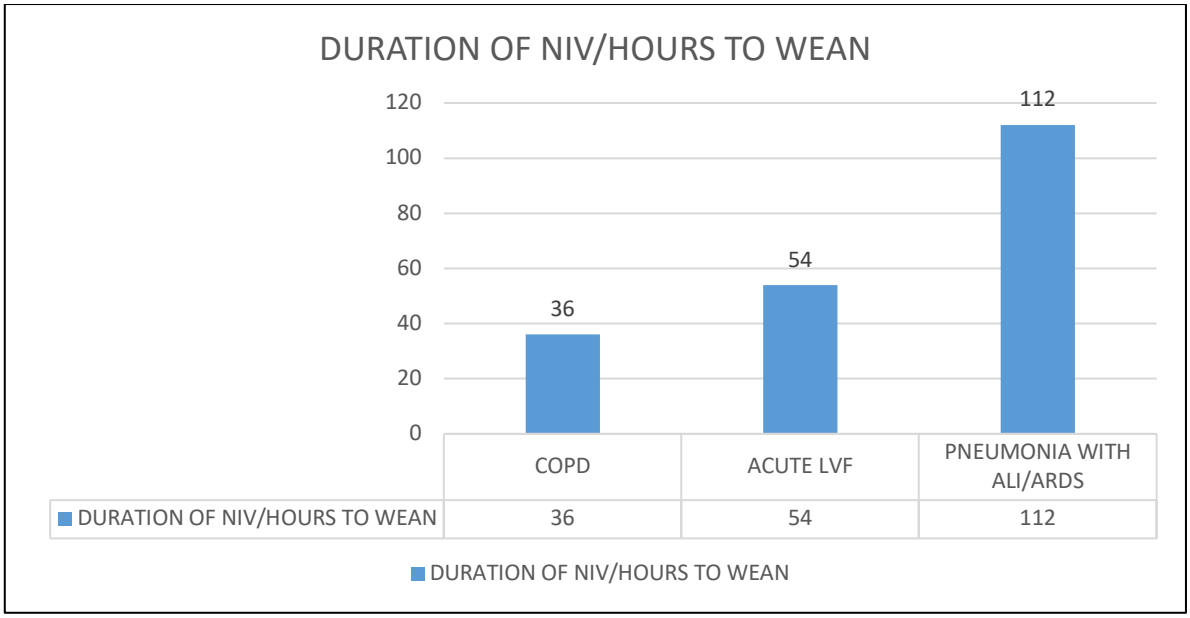

Figure 6: Duration of non-invasive ventilation to wean

Discussion

The present findings of our study indicates that out of all the patients who were admitted with respiratory failure and require NIV, maximum of them had pneumonitis (46%), which included both seasonal influenza like H1N1 and bacterial pneumonitis, followed by acute LVF (35%) and COPD (22%), acute lung injury/ARDS (18%), others like OP poisoning (4%). Our study had majority patients of pneumonitis because of high prevalence of seasonal flu (H1N1) in our study area.

In Ige Abraham Georgeet al.[3] study, most of the patients who were put on NIV were acute exacerbation of COPD, followed by pneumonia while in C antro et al.[4] the majority patients were of cardiogenic pulmonary oedema, followed by COPD and pneumonia. In study by Kshatriya et al.5the most common indication was COPD, followed by pneumonia. Many Indian publications like Khilnani GC et al [6], SINGH VK et al[7]. also suggested that non-invasive positive pressure ventilation was beneficial in patients presenting with copd as well as respiratory failure of varied aetiology. Considering all above studies, major indication of NIV use remain to be COPD, cardiogenic pulmonary oedema and pneumonitis. Thus NIV has a promising result in acute respiratory failure due to COPD, cardiogenic pulmonary oedema and pneumonitis. While Conditions like ARDS/acute lung injury and poisoning demands invasive ventilation. Thus non-invasive is not a good option for these conditions. Admission parameters that were studied were pH, pCo2, pO2 and respiratory rate. It was found that COPD group (type 2 respiratory failure) had low pH and high pCO2 due to the fact that co2 retention occurs in these group of patients. While acute lung injury/ARDS group (type 1 respiratory failure) had low pO2 and high respiratory rate. A study conducted by AGE IBRAHAM GEORGE et al. [3] also shows similar findings of low pH, high pCO2 in acute respiratory failure due to copd and low pO2 in respiratory failure due to ARDS/Acute lung injury.

Our study also shows that 80 patients with failed NIV had low admission blood pH value as compared to the 20 patients with successful NIV, thus making admission pH a determinant of success/failure of NIV. Similarly, NIV failure group had higher admission pCO2, and lower admission pO2 and higher respiratory rate as compared to that of successful NIV group. These findings when compared to the study done by M. Confalonieri et al. [8], where total 1033 patients were studied (table 4) showed similar findings. Also a study done by Ravish M. Kshatriya et al. [5] shows that predictors of positive outcome of NIV are improvement in pH, PCO2, and PO2 within 24 h of NIV support. Study by VK Singh et al. [7] also supports that determination of baseline clinical factors such as heart rate and respiratory rate, at the time of initiation, can predict the likelihood of success or failure of NIPPV. As a result, delay in intubation can be avoided which itself is associated with significant mortality.

Thus studying certain parameters like pH, pO2, pCO2 and respiratory rate on admission and their monitoring in next few hours helps us in determining the outcome of the patient on NIV.

Table 4: Study of Parameters in Successful and Failed NIV Groups

Characteristic	Present Study(Total 100)		M. Confalonieri G. Garuti Et Al. [8] Italian Non-Invasive Positive Pressure Ventilation (NPPV) Study Group. Total Cases-1033)	
	NIV successful (80 patients)	NIV failed (20 patients)	NIV successful (797)	NIV failed (236)
Admission Ph.(mean)	7.37	7.26	7.29	7.25
Admission Pco2(mean)	40.07	53.21	78.8	86.0
Admission Pao2(mean)	76.3	73.05	54.7	53.9
Respiratory rate(mean)	27	30	28	32

In our study, total cases were 100, out of which 80 patients (80%) were successfully weaned to room air, while 20 of them (20%) gradually worsened and required invasive means of ventilation or expired. It could have been due to complications of associated illness or comorbidities.

Thus success rate of NIV in our study was 80%.In IGE ABRAHAM et al. [3] study also, out of total 40 patients who were on NIV, 34 patients were successfully weaned to room air, showing up to 85% success rate of NIV and a failure rate of 15%.SimilarlyM. Confalonieri. G. Garuti et al. [8]study had NIV success rate of 77.15% and NIV failure rate was around 22.8%. Others study like V. K. Singh et al. [7] shows success rate of 76%.

Studying the various groups, it was found that success rate was highest in copd group (90.90%) In our study, 22 patients of acute respiratory failure due to COPD were put on NIV, out of which 20 were successfully weaned to room air. Thus reflecting success rate of 90.99%.While comparing above results to Kshatriya, et al.5study(n=68) success rate was 85.22%, and in study by Ritesh Agarwal, et al.9(n=24), success rate was 87.5%. Non-invasive ventilation thus proves to be a ventilator support of choice for copd, acute pulmonary oedema and pneumonia with cop having highest success rate.

In our study, it was seen that patients belonging to success NIV group required mere few hours to wean off to room air. COPD patients required minimum number of hours to wean from NIV which was about 36 hours. Maximum number of hours of NIV was in patients of pneumonitis with acute lung injury/ARDS (4-5 days average). Similar results were seen in Kshatriya et al study [5], where duration of NIV was less than 3 hours for copd patients.

Conclusion

Our study concludes that NIV is more successful in acute respiratory illness due to copd, acute pulmonary oedema and pneumonitis with a great positive outcome Overall success rate of NIV was 80% in patients presenting with acute respiratory failure. The highest success rate of 90.90% was seen in COPD patients who required minimum hours to wean off to room air from NIV. Predictors of positive outcome of NIV are better values (close to normal range) of parameters like pH, PCO2, and PO2 and respiratory rate on admission.

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