EXPERIENCE WITH NON-INVASIVE VENTILATION IN TYPE II RESPIRATORY FAILURE AT DEPARTMENT OF PULMONARY MEDICINE, KURNOOL MEDICAL COLLEGE, KURNOOL

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ABSTRACT: BACKGROUND: Non-invasive ventilation (NIV) is the delivery of positive pressure ventilation through an interface to upper airways without using the invasive airway. Use of NIV is becoming common with the increasing recognition of its benefits. OBJECTIVES: This study was done to evaluate the feasibility and outcome of NIV (BiPAP) in Type II Respiratory Failure in Department of Pulmonary Medicine, Kurnool Medical College. Materials and Methods: An observational study conducted over a period of 18 months in Department of pulmonary medicine, Kurnool Medical College in 40 patients who were treated by NIV (BiPaP). Patients were stratified on basis of set of exclusion and inclusion criteria. NIV was given in accordance with the arterial blood gas (ABG) parameters defining Type II respiratory failure. RESULTS: In the present study NIPPV was successful in 34(85%) and failed in 6(15%) patients. The most common indication of NIV in our hospital was acute exacerbation of chronic obstructive pulmonary disease (AE-COPD) 90% and 88% of AE-COPD patients were improved by NIV. Application of NIV resulted in significant improvement of pH and blood gases in COPD patients. Kyphoscoliosis, Obstructive Sleep Apnea (OSA) patients with Type II Respiratory failure also showed significant improvement in partial pressure of oxygen and carbon dioxide. CONCLUSION: This study demonstrates and encourages the use of NIV as the first-line ventilator treatment in AE-COPD patients with Type II respiratory failure. It also supports NIV usage in other causes of type II Respiratory failure as a promising step toward prevention of mechanical ventilation.

KEYWORDS: Non-invasive ventilation, AE-COPD, OSA, Kyphoscoliosis, Type II Respiratory Failure.

INTRODUCTION: The term non-invasive ventilation (NIV) refers to the application of artificial ventilation without any conduit access to the airways i.e., without an endotracheal or tracheostomy tube. Earlier negative pressure ventilation was used but in the modern era positive-pressure ventilation has supplanted negative-pressure ventilation as the dominant mode of delivery of noninvasive ventilation. Recently, NIV has assumed a prominent role in the management of acute respiratory failure.¹⁻⁴ By avoiding endotracheal intubation, NIV prevents complications associated with invasive ventilation like airway problems, nosocomial pneumonia (21%) and sinusitis (5-25%).⁵⁻⁹ In addition, the patient with an intact upper airway retains the ability to eat, swallow and verbalize. Epidemiologic studies suggest that respiratory failure will become more common as the population ages, increasing by as much as 80 percent in the next 20 years.¹⁰ Two recent publications from India suggested that NIV was beneficial in cohorts of
patients presenting with chronic obstructive pulmonary disease (COPD), as well as respiratory failure of varied etiology.\textsuperscript{11,12} NIV is becoming the preferred method of treatment for patients with Neuro Muscular Disorders including daytime ventilator support\textsuperscript{13}

**AIMS AND OBJECTIVES:**

1. To study the role of Non-invasive positive pressure ventilation in patients with Type II Respiratory Failure.
2. To assess and compare the clinical and physiological parameters before and after the application of NIPPV in the study population.
3. To determine the outcome of non-invasive ventilation in the study population.

**PATIENTS & METHODS:** A Prospective Observational Study that was conducted among 40 patients with Type II Respiratory failure admitted to The Department of Pulmonary Medicine, Government general hospital affiliated to Kurnool medical college, Kurnool during the period of January 2013 to August 2014.

**INCLUSION CRITERIA:** Moderate to severe dyspnoea lasting <2 weeks plus any two of the following Respiratory rate >25/min, pH < 7.35 – 7.25, Partial pressure of carbon dioxide (PaCO\textsubscript{2}) >45 mmHg, Partial pressure of Oxygen (PaO\textsubscript{2}) <60mm Hg, oxygen saturation (SpO\textsubscript{2}) <92% with oxygen by mask.

**EXCLUSION CRITERIA:** Cardiac/respiratory arrest, claustrophobia, Severe upper gastrointestinal bleeding, Hemodynamic instability: Shock (either cardiogenic or septic) with a systolic blood pressure of <90 mm Hg despite fluid challenge or need for pressor agents, Unstable arrhythmias, Encephalopathy, Glassgow Coma Score (GCS) <8, Recent Myocardial infarction, Facial surgery/trauma/deformity, Severe co-morbidity, Upper airway obstruction, non-cooperative, copious respiratory secretions, Seropositive for HIV, active Tuberculosis and Life threatening hypoxia.

**INITIATION OF NIV:** once eligibility verified and after taking the consent patients were included in the study. The mention of "noninvasive ventilation" (NIV) will refer to Noninvasive Positive-Pressure Ventilation (NIPPV) delivery in this study. Noninvasive ventilation was administered by the use of portable noninvasive ventilator BiPAP (Phillips Respironics) delivered to patients in bed at an angle of 30–45 and in all patients a well-fitting oro nasal mask was used as an interface for delivery of positive pressure. Procedure was explained to the patient and started on an IPAP of 8 and EPAP of 4 cm H2O. The pressures were gradually adjusted as tolerated. Adjustments were made based on continuous pulse-oximetry, arterial blood gases, alleviation of patient’s dyspnea and decrease in respiratory rate. Humidified oxygen, antibiotics, bronchodilators and steroids were given along with NIV. Arterial blood gas analysis, at the end of 1 hour of application of NIPPV and at subsequent intervals as required, including, at the time of weaning and 6 hours after weaning were done. Parameters that were recorded include dyspnoea by modified Borg dyspnoea score, respiratory rate (RR), heart rate (HR), arterial blood quantitated gas analysis.
(ABG). Presence of sustained clinical improvement with reduction of RR <24/ min, HR <100/ min and presence of normal pH and O$_2$ saturation >90% on ABG analysis were required before patients were considered for weaning from NIPPV. If there was clinical and/or laboratory evidence of deterioration at any point during NIPPV endotracheal intubation was considered.

The outcome of NIV usage was measured in terms of 1. NIPPV Failure: The need for endotracheal intubation 2. NIPPV Success: Improvement of patient condition. Successful weaning from the NIPPV 3. Patients taking discharge against medical advice.

The variables collected in the study included clinical (dyspnoea score, RR, HR), ABG parameters (pH, PaCO$_2$, and PaO$_2$), the mean duration of NIPPV application, duration of hospital stay and any complications related to the procedure. Any complications developed during the procedure were treated adequately. Statistical analysis was done using standard methods. A p value <0.05 is considered significant and p value <0.001 is considered extremely significant.

RESULTS:

<table>
<thead>
<tr>
<th>Age</th>
<th>No. of patients (n = 40)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41 – 50</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>51 – 60</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>61- 70</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>71- 80</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 1: Age distribution

The mean age of study cohort was 60.7 years with an age range of 40-80 years.

<table>
<thead>
<tr>
<th>Gender</th>
<th>No. of patients (n=40)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>36</td>
<td>90</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2: Sex Distribution

The present study group has a male preponderance (36/40) of 90%.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Males</th>
<th>Females</th>
<th>No. of patients (n=40)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE COPD</td>
<td>34</td>
<td>2</td>
<td>36</td>
<td>90</td>
</tr>
<tr>
<td>Kyphoscoliosis</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Obstructive sleep apnea</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 3: Causes of Type II Respiratory Failure

Causes of Type II Respiratory Failure were Acute exacerbation of COPD in 36, Kyphoscoliosis in 2 and as Obstructive Sleep Apnea in 2.
Dyspnoea score | 0 hr (n=40) | 1 hr (n=40) | 6 hrs (n=34) | 24 hrs (n=34) | Discharge (n=34) |
--- | --- | --- | --- | --- | --- |
5 | 3.2±0.02* | 2.32±0.47* | 2.12±0.38* | 1.4±0.07* |
Heart rate (per min) | 102.4±10.9 | 97.2±9.39* | 88.23±8.12* | 77.47±8.62* | 77.1±9.65* |
Respiratory rate (breaths/min) | 34.8±4.4 | 26.9±5.66* | 16.64±1.73* | 15.47±1.2* | 13.82±1.96* |

Table 4: Changes in the clinical parameters before, during and after NIPPV

*p value less than <0.0001 from baseline. The Borg dyspnoea score improved from 5 at baseline to 1.4±0.07 at discharge. (p <0.0001). The mean respiratory rate dropped from 34.8±4.4 before NIV to 13.82±1.96 (p <0.0001) at discharge.

| 0 hr (n=40) | 1 hr (n=40) | 24 hrs (n=34) | Discharge (n=34) |
--- | --- | --- | --- |
PH | 7.29±0.02 | 7.31±0.02* | 7.37±0.02* | 7.40±0.03* |
PaCO₂ mm Hg | 67.3±5.61 | 62.8±5.74 * | 51.8±3.7* | 50.02±4.08* |
PaO₂ mm Hg | 54.6±8.85 | 61.7±7.17* | 70.3±9.19* | 75.14±9.71* |

Table 5: Changes in the ABG parameters before, during and after NIPPV

*p <0.0001 from baseline the mean pH changed from 7.29±0.02 at baseline to 7.4±0.03 at discharge (p <0.0001). There was also a marked improvement in mean PaCO₂ and PaO₂ which changed from, 67.3±5.61, 54.6±8.85 at baseline to 50.02±4.08, 75.1±9.71 at the time of discharge respectively(p<0.0001 for both parameters).

Successful group (n=34) | Failure group (n=6) | 0 hr | 1 hr | p value | 0 hr | 1 hr | p value |
--- | --- | --- | --- | --- | --- | --- | --- |
Age | 60.8±8 | 61.1±5.48 | 0.94 | |
RR | 34.2±4.4* | 25.02±3.1† | <0.001 | 38.3±2.4* | 36.6±4.7† | 0.44 | |
Dyspnoea score | 5 | 3.03±0.17 | <0.001 | 5 | 4.4±0.89 | 0.13 | |
HR | 102.6±11.2 | 97.8±9.1 | <0.001 | 101.33±9.93 | 95.6±14.2 | 0.26 | |
pH | 7.29±0.02 | 7.31±0.01† | <0.001 | 7.29±0.01 | 7.29±0.01† | 1.0 | |
PaCO₂ | 67.2±5.8 | 61.2±5.2† | <0.001 | 70.3±5.7 | 73.8±4.6† | 0.26 | |
PaO₂ | 54.6±9.1 | 62.7±6.8ψ | <0.001 | 54.3±7.24 | 56.3±5.8ψ | 0.44 | |

Table 6: Clinical & ABG status 1 Hour after NIPPV in Successful group Vs Failure group

Success defined by avoidance of ETI, *p value significant (<0.05) between failed and successful groups at baseline, †p value significant (<0.001) between failed and successful groups at 1 hr, ‡p value <0.05 between failed and successful groups at 1 hr. Respiratory rate at baseline was significantly higher in the patients who failed to respond to NIV and there was a significant improvement in the clinical and blood gas parameters within the 1st hour of NIV in the successful group whereas no such improvement was observed in the failure group.
Table 7: Outcome of NIPPV

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success</td>
<td>34</td>
<td>85</td>
</tr>
<tr>
<td>Failure</td>
<td>6</td>
<td>15</td>
</tr>
</tbody>
</table>

NIPPV was successful in 34 patients (85%) and 6 patients (15%) failed to respond and required intubation.

**DISCUSSION:** The mean age of study cohort was 60.7 years with an age range of 40-80 years similar to other studies.\(^{14,15}\) (Table 1)

The present study group has a male preponderance (36/40) of 90% similar to other studies.\(^{15,16,17}\) (Table 2). The most common indication of NIV in our Study was acute exacerbation of chronic obstructive pulmonary disease (AE-COPD)90% (Table 3) as in other studies.\(^{14,15,18}\) NIV was successful in 83.3% of patients in our study cohort of Acute exacerbation of COPD. The results obtained in the study were consistent with previous studies.\(^{14,18,19,20}\) Two patients of kyphoscoliosis with Type II Respiratory failure were put on NIV and both survived with improvement in PaO\(_2\) and PaCO\(_2\).\(^{18,21}\) Two patients with Obstructive sleep apnea with Type II Respiratory failure treated with NIV and these patients survived with significant improvement in PaO\(_2\), PaCO\(_2\).\(^{22}\) The results obtained in the present study are comparable to the previous studies.\(^{18,21,22}\)

In our study a significant improvement was observed in the clinical and the blood gas parameters within 1hr of application of NIPPV. (Table 4, 5). The dyspnoea score has improved from 5 at baseline to 3.2±0.02 (p<0.0001) at 1 hr. The results obtained in the study regarding improvement in dyspnoea score and RR were comparable with the other studies.\(^{23,24,25}\) The RR has fallen from a baseline of 34.8±4.4 to 26.9±5.66 (p<0.0001).

In the present study there was a significant improvement (P<0.0001) in the average PaCO\(_2\) levels within 1hr from 67.3± 5.61 to 62.8±5.74. The results obtained are comparable with the other studies\(^{14,16,26}\) which showed significant decrease in PaCO\(_2\) after 1hr of administration of NIV. The change in PaCO\(_2\) also reflected in pH with improvements from 7.29±0.02 to 7.31±0.02 (p<0.001). The PaO\(_2\) has also changed from 54.6±8.85 to 61.7±7.17. Brochard et al\(^{19}\) found that in the NIV group RR has fallen from 35±7 to 25±8, pH improved from 7.27±0.1 to 7.31±0.09 (p<0.001) in 1hr whereas PaCO\(_2\) improved significantly at 3 hrs. Plant et al\(^{27}\) in their study noted that NIV led to a significant improvement in pH in 1st hr whereas PaCO\(_2\) RR changed significantly at 4 hrs. In the current study, the clinical improvement of patients on NIV was corroborated with improvements in the physiological variables. These physiological improvements are similar to that reported in literature in similar cohorts of patients.\(^{11,28}\)

In the present study further significant improvement was obtained at 24 hrs and it maintained up to the time of discharge. The pH, PaCO\(_2\) and PaO\(_2\) changed from baseline of 7.29±0.02, 67.3±5.61, 54.6±8.85 to 7.4±0.03, 50.02±4.08, 75.1±9.71 at the time of discharge respectively. The above results were very close to the results obtained in the Verma et al\(^{18}\) study.
Although the PaCO\textsubscript{2} of patients who failed NIPPV was higher than the patients who succeeded this did not reach statistical significance. After 1 hr of NIPPV, pH was significantly higher and PaCO\textsubscript{2} was significantly lower in the success group as compared to failed group (7.31±0.01 vs 7.29±0.01, 61.2±5.2 vs 73.8±4.6, p<0.0001) (Table 6). When compared to baseline values there was a significant increase in pH and fall in PaCO\textsubscript{2} in the success group. Garpested et al\textsuperscript{29} have shown that an improvement in pH and PaCO\textsubscript{2} within 1hr to be associated with success of NIPPV. Whereas there was no change in pH and PaCO\textsubscript{2} deteriorated in the failure group (Table 6).

These findings suggests that respiratory rate at admission and an improvement in gas exchange parameters within the 1\textsuperscript{st} hour of NIPPV could possibly be used to predict response to NIPPV.\textsuperscript{29} However other determinants of success (like comorbidities, BMI etc.) NIPPV were not evaluated in the present study.

In the present study NIPPV was successful in 34 (85%) and failed in 6 (15%) patients (Table 7) RR at baseline was significantly higher in the patients who failed NIPPV (p value 0.03). Although the PaCO\textsubscript{2} of patients who failed NIPPV was higher than the patients who succeeded this did not reach statistical significance. (70.3±5.7 vs 67.2±5.8, p 0.19 NS) No other differences were observed in baseline characteristics of patients who failed versus those who succeeded.

The mean duration of hospital stay in our study was 10.32 days similar to other studies.\textsuperscript{23,27} Majority of patients discharged within the 2\textsuperscript{nd} week. The shorter hospital stay may be due to rapid reversal of blood gases, absence of sedation, less complications and shorter weaning time.

In the present study the success rate with NIPPV was 85%, with 34 patients weaned off successfully and discharged. Of the six patients who failed NIPPV, 2 patients did not consent for intubation and left against medical advice. The other 4 were intubated and mechanically ventilated. Out of these 4 patients 2 patients eventually expired, 1 due to ventilator associated pneumonia, 1 from gram negative sepsis and multi organ dysfunction syndrome. No mortality was observed in the patients improved and continued on NIPPV. The success rate in the present study is comparable with the previous studies\textsuperscript{14,15,16,27,30}

In our study NIPPV was used for a mean duration of 38.5±13 hrs. In the study of Umberto Meduri et al\textsuperscript{31} it was 23±17 hrs.

Only 4 (10%) complications occurred in our study similar to the complication rate in Umberto Meduri et al\textsuperscript{31} One (2.5%) was aspiration pneumonia\textsuperscript{19} treated with antibiotics, two (5%) patients experienced irritation of eyes treated with adjustment of mask and lubricant eye drops, and one (2.5%) patient experienced dryness of mouth treated with mouth care.

**CONCLUSION:** The results of the present study showed that NIPPV is a promising therapeutic modality for management of selected patients with exacerbations of COPD who have respiratory failure. The protocol is simple to implement and monitor. In the present study a relatively lower respiratory rate at baseline and a significant improvement in clinical and blood gas parameters within the 1\textsuperscript{st} hr of NIPPV indicated a favourable response. However further studies are required to establish this and to evaluate other potential predictors of success for better outcomes with NIPPV. Proper selection of patients, proper interface & proper monitoring to recognize complications is the corner stone in success of NIPPV.
REFERENCES:


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