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Original Article

Non Invasive Ventilation in patients with Type 2 Respiratory Failure, Predictors of Success and Failure

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Abstract
Aim of Study: *Assess the use of non-invasive ventilation as an alternative way for ventilation in acute respiratory failure, determine factors that can predict the successful use of NIV, evaluate factors hindering success of NIV.*
Materials and Methods: *Thirty hospitalised patients fulfilling inclusion criteria, diagnosed with Type II Respiratory Failure on ABG were recruited after obtaining an informed written consent. Complete history and detailed physical examination was followed by routine investigations.*
Result: *Comparison of the pH on admission with the pH after 1st hour of NIV, the latter showed statistically significant improvement. Drop in PaCo2 and rise in PaO2 on ABG from admission and after stopping NIV was statistically significant.*
Patients with lower MMRC grade and severe cough showed significant improvement in pH, however patient with higher emergency visits and past hospitalisation showed less improvement in pH, after 1 hour of NIV therapy.
Total 4 patients were intubated, with mean pH of 7.22, 3 out of them had higher emergency visits, 2 out of them had ICU admission.
Conclusion: *NIV treatment for COPD with type II respiratory failure avoids intubation, reduces complications and should be considered as first line therapy instead of ET intubation. Lower mMRC grade, lesser hospitalizations, lesser emergency visits, higher BMI, symptoms like cough, can have a positive predictive value for the outcome of NIV.*

Background

NIV is one of the treatment modalities for type 2 respiratory failures.

This study was done with the aim to-Assess the use of non-invasive ventilation as an alternative way for ventilation in acute respiratory failure, determine factors that can predict the successful use of NIV, evaluate factors hindering success of NIV.

NIV has been used successfully to treat acute respiratory failure in postoperative patients, in those with pulmonary edema, COPD and

obstructive sleep apnea. It has also been used to facilitate weaning,[1]. However, NIV appears to be particularly effective in patients with an exacerbation of COPD, who are alert and cooperative, [2].

Methods

- Thirty hospitalized patients fulfilling inclusion criteria, diagnosed with Type II Respiratory Failure on ABG, having symptoms of breathlessness, cough, use of accessory muscles of respiration, associated findings of increased PaCO2 like malaise, drowsiness, asterexis, anxiety, restlessness, confusion were recruited after obtaining an informed written consent.
- Complete history and detailed physical examination was followed by routine investigations like chest x-ray, ECG, complete blood count, renal function test, liver function test, PFT, 2D ECHO and CT scan of the chest when required
- The patients were started on NIV therapy, along with the standard symptomatic medical therapy as appropriate

ABG was done on admission and after 1 hour

Success was considered when the pH returned to normal, along with normalizing of the Patients physical and bio-chemical parameters, i.e. normalizing of the pH on ABG, reduction in the Respiratory rate, reduction in the Pulse rate, and decrease in the patient's sensation of Dyspnoea.

Patients were put on a Biphasic/Bilevel ventilation (BIPAP) machine with an initial setting of IPAP of 12 cm of H_2O and an EPAP of 6 cm of H_2O. The setting were stepped up, in required cases

Indications of NIV

- Acute hypercapnic exacerbations of COPD in preventing intubation of end-stage COPD patient. [3]
- OSA: caused by airflow obstruction, is defined as a temporary pause in breathing that lasts at least 10 sec during sleep. Central sleep apnoea - loss of neurologic breathing effort (CSA), or a combination of both mixed sleep apnoea (MSA). [4]
- Reduction of respiratory workload in obesity.
- Acute pulmonary oedema.

Contraindications for use of NIV

- Apnoea due to neuromuscular causes and progressive hypoventilation.
- Inability to handle secretions by the patient.
- Hypotension and fatigue of respiratory muscles.
- Claustrophobia and facial trauma.

Inclusion Criteria

All patients of age 18 years or greater after consent, indoor patients of Padmashree Dr.D.Y.Patil Hospital & Research Center diagnosed as being in Type II Respiratory failure after Arterial Blood gas studies

Exclusion Criteria

1) Facial surgery, trauma or deformity.
2) Cardiac or respiratory arrest.
3) Inability to cooperate.
4) Presence of upper airway obstruction.
5) Hypotension (systolic BP <90 mmHg).
6) Uncontrolled arrhythmia.
7) Severe upper gastrointestinal bleeding.
8) Inability to clear respiratory secretions with high risk for aspiration and
9) Other non-respiratory organ failure: e.g. Severe encephalopathy (e.g. GCS < 10)

Results

The aim of this study was to evaluate various factors for predicting the success or failure of a NIV trial. The mean age was 59.9+-10.13 with a Male pre-dominance, 3:2 (n=30) (tab1). The mean BMI was 22.9+-3.97 kg/m^2.Out of 30 patients, 13 were smokers, 10 were cigarette smokers and 3 were bidi smokers. (Tab2).

The most common comorbidities in our patients were hypertension, diabetes mellitus and ischemic

heart disease. The PH improvement was more in patients who did not have these comorbidities. (Tab3).

Table 1: Age Distribution

Age Group	Frequency
<50	3
>=80	1
50-60	13
61-70	10
71-80	3

Table 2: Profile of Smokers

	Active Smokers	Quit Smoking	Total
Cigarate Smokers	4	6	10
Bidi Smokers	1	2	3
Total	8	5	13

Table 3: Mean and Standard Deviation of pH difference with respect to HTN, DM, IHD

HTN	**Mean**	**S.D.**
Yes	0.031	0.038
No	0.044	0.023
DM	**Mean**	**S.D.**
Yes	0.036	0.031
No	0.061	0.039
IHD	**Mean**	**S.D.**
Yes	0.014	0.040
No	0.043	0.027

14(46.6%) of the patients had dyspnoea on exertion Grade 2 MMRC, 11 (36.6%) had MMRC Grade 1 and less 5, (16.6%) had grade 3. The pH improvement was better in patients who presented with low MMRC grade.(tab4a,4b) (diag1). Out of 30, 28 patients had cough and the pH improvement had a positive correlation with duration of cough. (tab5a, 5b) (diag2). Eighty eight percentage (n=16) of patients had fever and the pH improvement had a negative correlation with fever (tab6a, 6b) (diag3).

Table 4a: mMRC grade prior to exacerbation

mMRC grade	Frequency
0	1
1	10
2	14
3	5
4	0

Diag: 1

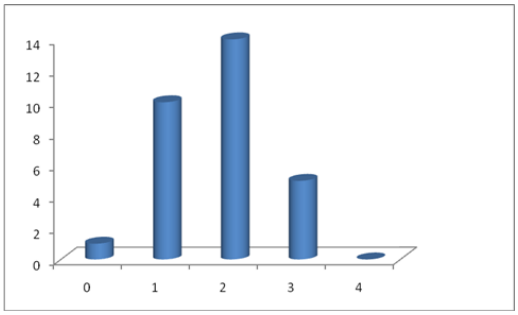


Table 4b: Correlation between pH difference and mMRC grade

		mMRC grade	pH difference
mmrc grade	Pearson Correlation	1	-0.316
pH difference	Pearson Correlation	-0.316	1

Correlation Coefficient between mMRC grade and pH difference is negative i.e. if mMRC grade was higher prior to exacerbation then pH difference was less

Table 5a: Duration of Cough

Duration of Cough	No. Of Cases	Percentage
1-10 Days	10	35.71
11-15 Days	9	32.14
16-20 Days	3	10.71
21-25 Days	3	10.71
More than 25 Days	3	10.71
Total	28	100.00

Diag: 2

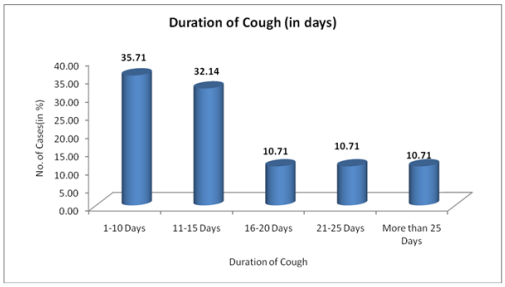


Table 5b: Correlation between pH difference and duration of cough

		Duration of cough	pH difference
Duration of cough	Pearson Correlation	1	0.199
pH difference	Pearson Correlation	0.199	1

Correlation Coefficient between duration of cough and pH difference is positive i.e. if duration of cough is more, then pH improvement was more.

Table 6a: Duration of fever

Duration of fever	No. Of Cases	Percentage
1-3 Days	9	50.00
4-6 Days	5	27.78
>6 Days	2	11.11
Total	16	88.89

Diag 3

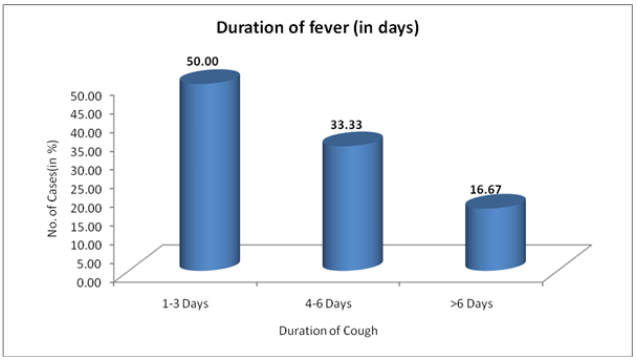


Table 6b: Correlation between pH difference and duration of fever

		Duration of fever	pH difference
Duration of fever	Pearson Correlation	1	-0.094
pH difference	Pearson Correlation	-0.094	1

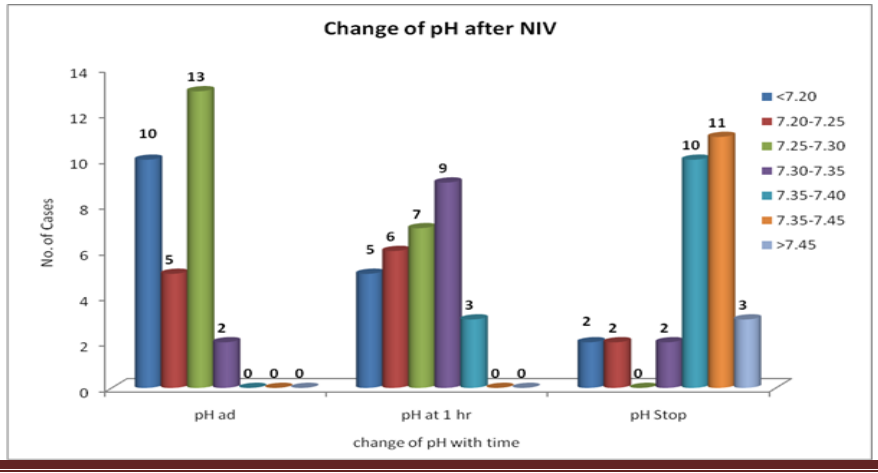
Correlation Coefficient between duration of fever and pH difference is negative i.e. if duration of fever was more than Ph improvement was less.

Out of 30 patients, 28 patients on admission had pH<7.30, and 18 patients had pH<7.30 even after one hour of NIV therapy (tab7) (diag4). 4 patients continued to have pH<7.30 and they were taken for invasive ventilation. The pH after 1st hour of NIV showed statistically significant improvement as compared to pH on admission. The ABG values showed statistically significant improvement in paO2 and decrease in paCO2 after NIV therapy (diag 5, 6, 7). Total 4 patients were intubated, with mean pH of 7.22, 3 out of them had previous emergency visits, and 2 out of them had previous ICU admission. (tab8)

Tab7: Change of pH after NIV

Ph	pH adm N=30	pH at 1 hr	pH at 1 hr (%)	pH Stop	pH stop (%)
<7.20	10	5	16.67	2	6.67
7.20-7.25	5	6	20.00	2	6.67
7.25-7.30	13	7	23.33	0	0.00
7.30-7.35	2	9	30.00	2	6.67
7.35-7.40	0	3	10.00	10	33.33
7.35-7.45	0	0	0.00	11	36.67
>7.45	0	0	0.00	3	10.00
			p- Value =0.00(<0.05)		p- Value =0.30(>0.05)

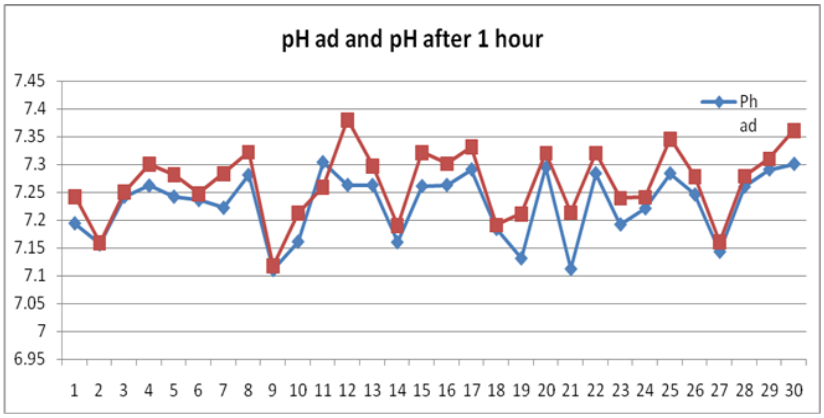
Diag: 4



Observation

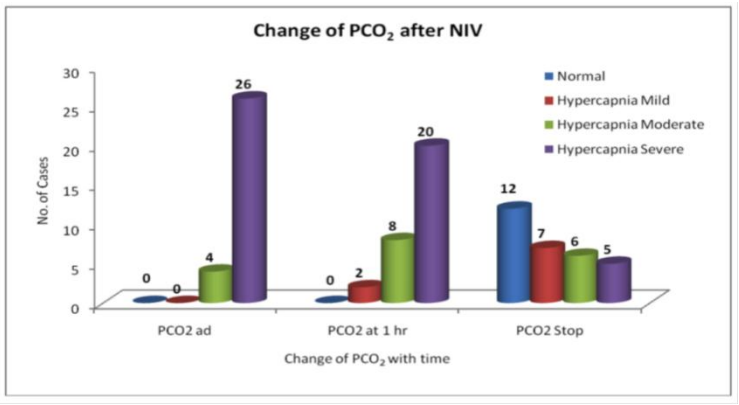
- As p-Value of pH on admission (pH ad) with pH at 1 hour is 0.00 (paired t-test) there is significant difference between pH on admission and pH at 1 hour
- As p-Value of pH on admission with pH stop is 0.30 (paired t-test) there is no significant difference between pH on admission and pH at stop

Diag 5



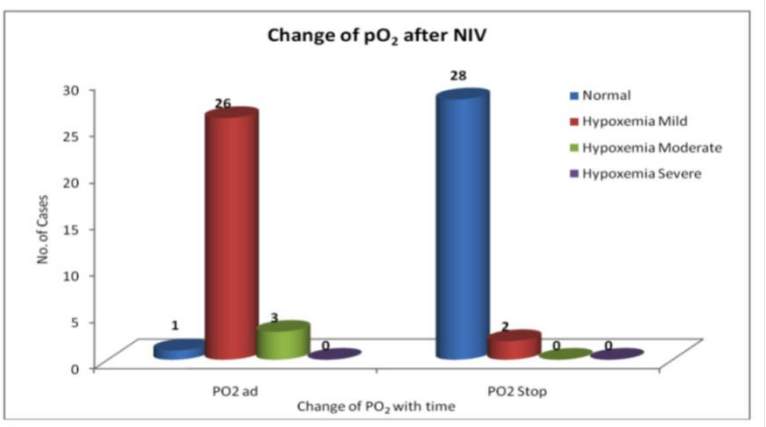
The circles show the PATIENTS who had failure of NIV and had to be Intubated

Dig 6



Drop in PaCo2 on ABG from admission and after stopping NIV was statistically significant (p value<0.0001)

Diag 7



Rise in PaO2 on ABG from admission and after stopping NIV was statistically significant

Table: 8 Diagnosis

Diagnosis			Ph Difference		Duration	
	Frequency	Percent	Mean	SD	Mean	SD
acute excab of copd	7	23.3%	0.042	0.022	2.661	1.46
infexcab of copd	15	50.0%	0.031	0.016	4.008	2.22
infexcab of lLD	1	3.3%	0.102	-	4.000	-
Obesity hypoventilation	3	10.0%	0.047	0.031	4.333	2.08
Others	4	13.3%	0.034	0.069	4.625	2.29
Total	30	100.0%				

Discussion

The mean duration of BiPAP use was 4.03 days +- 2.11 days. Out of the 30, 10 were cigarette smokers and 3 were bidi smokers out of which 4 were still active in the cigarette smoking group and 1 was active in the bidi smoking group.

6 had been exposed to chulla smoke, out of which 2 still had continued exposure.

Out of the 30 patients, all survived, and 4 had to be intubated, and hence were considered as failure of the NIV trial. The mean pH difference after 1 hour of NIV in the 26 patients was +0.07, while the mean pH difference after 1hr in the patients who had to be intubated was -0.0005.

Prior studies have shown that the change in pH in the initial period of the NIV trial, is an indicator for the outcome of the trial, i.e. higher the change, it's more likely that the NIV trial will succeed.[5] Hence for the purpose of our study, the change in the value of pH after 1 hour, was considered as an outcome 5, and the various factors were statistically analysed with the change in pH after 1 hour and results observed were that factors such as compliance with medications, lower number of hospitalizations in last 5 years, lower number of emergency visits in last 6 months, lower mMRC grade prior to exacerbation showed more change in pH in the first hour as compared to otherwise.

28 patients had cough out of which 21 had expectoration, 16 had complaints of fever and 29 patients had complaints of Dyspnoea for some duration. The profile of the symptoms are mentioned in tables. While the duration of fever and duration of dyspnoea were found to be inversely proportional to the improvement in the pH in the first hour, patients with longer duration of cough showed more improvement in ph. This might be attributed to the fact that patients with a longer duration of cough, might have taken medications prior to admission.

The smoking duration and the chulla exposure duration were found to have an inverse relation to the change in the pH in the first hour.

A lower BMI was found to have a lower change in the pH after 1 hour, this is concurring with a study published in BMC Pulmonary medicine in 2014.[6]

Our study also showed that, when comparing the pH on admission with the pH at 1st hour and pH on withdrawal of NIV, the pH after 1 hour was statistically significant(p value<0.0001), which is consistent with other studies on NIV, but when compared to the pH at withdrawal it was found to be statistically not relevant.[7]

The $PaCO_2$ after 1 hour and at withdrawal, both were found to be statistically significant (p value <0.0001) when compared to the $PaCO_2$ on admission.

This study shows that factors such as presence of co-morbidities, MMRC grade prior to the exacerbation episode, compliance of patients with medications, history of hospitalizations in last 5 years, history of emergency visits, duration of dyspnoea, smoking history, history of chulla exposure, can be considered a prognostic factor for the success of the NIV trial.

The profile of the NIV failure cases, which had to be intubated have been mentioned in table 9, the mean pH was 7.22, with the mean duration of NIV trial was 13.5 hours, which is consistent with other studies showing that the majority of NIV failure occur within 48 hours. Out of the 4 patients, 3 had a higher number of emergency visits and a higher no hospitalizations, with 2 having Intensive Care Unit admissions and also all had some findings on the 2D-echo.

Table 9: Profile of NIV failure cases

Mean Age	68.75	Mean BMI	19.25 kg/m^2
Sex M:F	4:0	Mean of pH ad	7.22
Diabetes Mellitus	25%	Mean of pH after 1hr	7.22
HTN	75%	Mean of pH diff after 1 hr	-0.0005
IHD	50%	Mean of PCO_2 ad	79.13
h/o Ptb	50%	Mean ofPCO_2 after 1 hr	75.18
Mean duration of dyspnoea	12.75 years	Mean duration of NIV	13.5 hrs

In our study we found that the maximum pH improvement in the first hour was seen in the case of the patient with the diagnosis of ILD. She was a 60/F, with 20 years of chulla exposure, a good BMI, with no co-morbidities and had no emergency visits and only one incidence of hospitalization, and these factors could be the reason behind her better improvement. She had come to us with a HRCT Chest showing ILD changes but her history and symptoms were more consistent with COPD.

The pH improvement was more in OBESITY-HYPOVENTIALTION group, followed by ACUTE EXCABERATION OF COPD then OTHERS. The poorest improvement was seen in the INFECTIVE EXCABERATION OF COPD group. In Obesity-Hypoventilation, there is no lung pathology as such and hence NIV helps in improving the ventilation.

The minimum duration of use of the NIV was found to be in the Acute exacerbation of COPD group, while the others had approximately the same mean duration of use. When comparing Acute exacerbation of COPD vs Infective exacerbation of COPD, the first group had a greater improvement in the pH after 1 hour and also the mean duration of the NIV was lesser (almost half as that of the infective group).This could be because the infective group was more likely to have a more severe illness.

Conclusion

ABG values after 1 hour of institution of NIV therapy, is very significant and can be used as a predictor of outcome of NIV.

Lower mMRC grade, lesser hospitalizations, lesser emergency visits, higher BMI, also have a positive predictive value for NIV outcomes.

NIV treatment for COPD with type II respiratory failure avoids intubation, reduces complications and should be considered as first line therapy instead of ET intubation

By avoiding endotracheal intubation, NIV prevents complications associated with invasive ventilation like airway problems, nosocomial pneumonia (21%) and sinusitis (5-25%) [6]

References

1. Brochard, L., J. Mancebo, M. Wysocki, F. Lofaso, G. Conti, A. Rauss, *et al.*, 1995. Noninvasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. N Engl J Med. 333: 817-822.
2. Conventional Vs Non Invasive Ventilation In Acute Respiratory Failure.-- Australian Journal of Basic and Applied Sciences, 3(3): 2232-2242, 2009
3. Ward-based non-invasive ventilation for hypercapnic exacerbations of COPD: a 'real-life' perspective-K.M. McLaughlin et al
4. Chang DW, Non-Invasive Positive Pressure Ventilation, Clinical Application of Mechanical Ventilation, 3rd ed, Chapter 7, p 194-95
5. Noninvasive Positive-Pressure Ventilation To Treat Hypercapnic Coma Secondary to Respiratory Failure, *CHEST 2005; 127:952–960,GumersindoGo´nzalezDı´az et all*
6. Ozyilmazet al. BMC Pulmonary Medicine 2014, 14:19
7. Pingleton SK. Complications associated with mechanical ventilation. In: Tobin MJ (ed) Principles and Practice of Mechanical Ventilation. McGraw-Hill Inc, New York pp 1994;775-792.