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Association of Low body Mass Index with Respiratory Failure in Chronic Obstructive Pulmonary Disease

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ABSTRACT

Background: Various studies have shown that low body mass index co-relates with the severity of Chronic obstructive pulmonary disease. The reduced body mass index in these patients is thought to be due to nutritional abnormality and raised circulating inflammatory markers. The study is aimed to find the association of body mass index with respiratory failure in patient with chronic obstructive pulmunory disease.

Methods: 142 patients who attended emergency /out-patient-department in Sir Sundarlal Hospital from August 2018 to July 2020 were enrolled for the study. 81 patients in respiratory failure group had chronic obstructive pulmonary disease exacerbation with Type II respiratory failure. Among this group low and normal body mass index subgroup was categorized.61 patients in non-respiratory failure had chronic obstructive pulmonary disease. Non-invasive ventilation was applied to case group. Categorization of body mass index was done <18.5(Low BMI) and 18.5-24.9 (Normal BMI).

Results: The mean age of the study group was (63.53±9.021). There was a significant difference in the body mass index between the groups (p=<0.001,t=15.40). Severity of respiratory failure was compared using ph and pco2 in the between the groups which showed no significant difference (p=1,chi square 0.000), (p=0.40,chi square=0.72) however it did affect the outcome.

Conclusions: Our study shows that overall respiratory failure was common in low body mass index cases compared to Control. Nevertheless there was no difference among severity of respiratory failure among low and normal body mass index subgroups and however it did affect the outcome.

Keywords: Brain natriuretic peptide; chronic obstructive pulmonary diseases; non-invasive ventilation

INTRODUCTION

COPD is the third leading cause of death worldwide with an estimated 3 million deaths(5.3%) with a large regional variation.

Malnutrition is a systemic manifestation of COPD.There is increased metabolic demand due to basal oxygen consumption.[1,2] Various markers of inflammation like (TNF-∞) and IL-6 is raised which causes muscle apoptosis and protein degradation.

An idle lifestyle is an identified feature in COPD patients because of limitation in activities due to respiratory complains and in later stage of diseases due to increasing dyspnea. Inactivity has profound effects on peripheral skeletal muscle function. The disuse affects type I fibers, type II fiber atrophy in COPD.

Cachexia is characterized by rapid weight-loss, primarily caused by loss of muscle with or without loss of fat.[3] Studies have shown increased mortality in patients with COPD and cachexia.[4,5] They have also shown that patients with low BMI are at risk of developing more severe disease.[6]

The study is aimed to find the association of body mass index with respiratory failure in patient with chronic obstructive pulmunory disease.

METHODS

This was a cross-sectional comparative study. In the respiratory failure (RF) group patient with acute exacerbation of COPD with type II respiratory failure as per Gold Initiative for Obstructive Lung Disease guidelines [7]

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The study was conducted in Sir Sundarlal hospital, Banas Hindu University (BHU),Varanasi from August 2018 to July 2020. Approval of the ethical committee was obtained in July 2018.

The inclusion criteria was adult aged >40 years with diagnosis of COPD as per GOLD guidelines,COPD patient on Indian population, respiratory rate (RR) > 30 breaths per min or <12/min, signs of increased work of breathing or paradoxical respiration, partial pressure of (PC02) > 45 mmHg, arterial pH <7.35. The exclusion criteria was patient not giving consent, unconscious patient, need for endotracheal intubation on admission to protect the airways or to manage respiratory secretions, inability to properly fit the facemask due to skeletal deformity.

COPD patients more than 40 years of age, having acute exacerbation and presenting to Sir Sundarlal Hospital were screened and those meeting the inclusion criteria were selected for the study. Diagnosis of COPD was made based on history, physical examination, chest x-ray and spirometry results as per standard guidelines set by Global Obstructive Lung Disease 2018.

In total142 patients were enrolled for this study. Eighty one patients were in respiratory failure group and 61 patients were in non-failure (NF) group. The study was planned to include 100 patients in each group however due to pandemic and time limit we had to conclude our study. During hospital admission all patients were treated with standard protocol including oxygen support, oral or intravenous antibiotics and oral or intravenous steroids as recommended by treating physician. Non-invasive ventilation and Invasive ventilation were done whenever mandated and possible. Patient in NIV were shifted to High dependency Unit (HDU). Patients were ventilated using oro-nasal mask. The ventilator settings that were used are :BPAP, S/T, AVAPS mode with an IPAP min/max 16/30 cm H_2O,EPAP 6-8 cm H_2O, respiratory backup rate was 16/min,target volume of 5-7 ml/kg.Ajdustment of these parameters were done on the basis of ABG analysis,oximetry,patients tolerance,patient ventilator synchrony as per our protocol.NIV was initially administered as long as necessary to maintain pH ≥ 7.35,followed by gradual decrease over time.

Initial ABG was done immediately after admission in Chest Ward following standard guidelines.BMI of the patient was taken after stabilization in the case group.

Data analysis was done using version of SPSS software. Patient characteristics were described using means and SD for continuous variables and frequency with percentages for categorical variables.

Analysis was done using Student t-test (quantitative variables-Age, BMI, pH, pCo2, Length of hospital stay both groups), Chi-square test (was used for qualitative variables,case group). Since there was not equal distributed Yates correction was done Variables with p-value <0.05 were considered statistically significant.

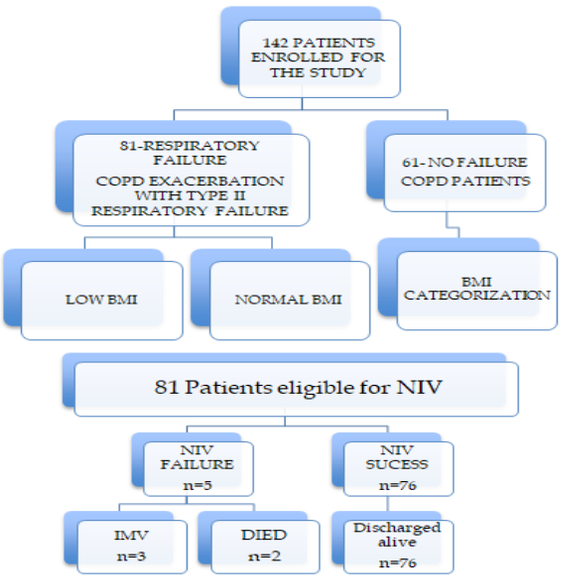

Figure1.Schematic flowchart of the study.

RESULTS

A total of 142 patients were included in the study.81 patients were in the Respiratory failure group and 61 patients were taken as Non-failure group. Eighty one patients in Case group were kept in non-invasive ventilation.The mean age of the study group was (63.53±9.021). The baseline characteristics of two groups are shown in Table 1.

Table 1. Patient Characteristics among respiratory failure and non-failure group.

Variables	Respiratory failure group (n=81)	Non-failure group (n=61)	p-value	t-value
Age in years (Mean±SD)	64.02±9.97	62.87±7.60	0.45	0.75
Gender (n=%)				
Males	39 (48.1%)	35(57.4%)	0.28	1.19
Females	42 (51.9%)	26(42.6%)		
BMI (Mean±SD)	17.08±0.84	19.77±1.24	<0.001	15.40
Length of hospital stay (LOS)	6.20±1.25	2.64± 0.83	<0.001	19.27

pH	7.28±0.061	7.41±0.039	<0.001	13.38
pCo_2	73.81±14.20	41.46±8.11	<0.001	15.9

The mean BMI among the RF group was (17.08 +0.84) and among the NRF group was (19.77+1.24) (p=<0.001,t=15.40). There was a significant difference among BMI in RF and NRF groups.Patients the case group had a low average BMI and more severe disease and respiratory failure requiring intervention using Non-invasive ventilation.However the control groups had an average normal BMI. The incidence of severity was more in Case group .

There was a significant difference of pH among RF and NRF groups. The RF group had a mean a pH(7.28+0.06) and the NRF group had (7.41+0.03) which was the determing factor for intervention with Non-invasive ventilation along with pCO_2signifying severity.The difference was significant (p=<0.001,t=13.38).The mean pco2 among the RF group was 73.81+14.20 and NRF was 41.46+8.11 (p<0.001,t=15.93).

The average length of hospital stay in the RF group was 6.20+1.25 and in the NRF group was 2.64+0.83 (p=<0.001,t=19.27).

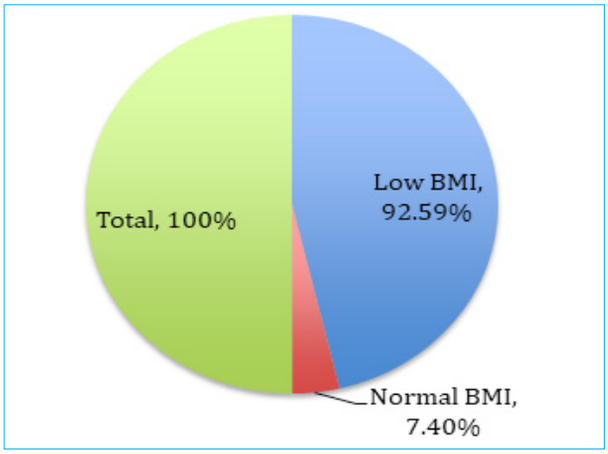

Figure 2. Percentage distribution of BMI in Cases (Low BMI subgroup,Normal BMI subgroup).

Table 2. Association of pH, pCo_2 and length of hospital stay according to BMI status in the case subgroups g (n=81).

BMI	pH		p- value		PCO_2
	<7.35	≥7.35		45-89.9	≥90
Low BMI	88%(n=66)	12%(n=9)		88%(n=66)	12%(n=6)
Normal BMI	83.3%(n=5)	16.7%(n=1)	1	66.7%(n=4)	33.3%(n=2)

**Length of hospital stay*

BMI	**Length of hospital stay (in days)**		**p-value**
	<5	≥ 5	
Low BMI	37.14% (n=26)	62% (n=44)	0.85
Normal BMI	50%(n=3)	50%(n=3)	

**It indicates 5 death cases that have been excluded.*

The overall incidence of low BMI was 92.59%(n=75) and normal BMI 7.4%.(n=6) in the RF. Our study showed that overall requiremnt of non-invasive ventilation (n=81) was more in low BMI RF group n=75(92.59%) compared to normal BMI was n=6 (7.40%).

Respiratory acidosis is a disturbance in acid-base balance. pH is a marker of acidosis. In our study the overall incidence of respiratory failure requiring non-invasive ventilation (n=81) was more common in low BMI RF group n=75(92.59%) compared to normal BMI was n=6 (7.40%). However, when comparing association of pH among two BMI groups among RF group there was no statistical difference (p=1,chi square 0.000).

The raised PCO_2 signifies type II respiratory failure.The incidence of hypercapnea was seen in all the patients of RF group(n=81) irrespective of the BMI.There was no significant difference in the association among Low BMI and normal BMI subgroups of RF group (p=0.40,chi square=0.72)

There was no difference among the length of hospital stay among the subgroups of RF group low BMI and normal BMI requiring NIV (p=0.85,chi-quare=0.03)

Table 3. Outcome of Non-invasive ventilation.

BMI	Success	Failure	Total
Low BMI	70(93.3%)	5(6.6%)	75
Normal BMI	6(100%)	0(0%)	6

In our study among the patients who were kept in non-invasive ventilation for respiratory failure in the low BMI subgroup of RF success rate was 93.3% and the failure rate in the low BMI subgroup was 6.6%. However in the normal BMI subgroup of RF had a 100% success rate.

DISCUSSION

COPD is a multifactorial disease. The pathogenesis and course of disease is complex. It is characterized by systemic inflammation as evidenced by circulating Interleukins, cytokines and chemokines. Hence the outcome depends on many factors like oxygen saturation, BMI, duration of illness and concomittant co-morbidities. ABG parameters like pH and pCo2 are of utmost importance in the early identification of respiratory failure. It guides us to take prompt management decisions. In our study the mean age of the study group was (63.53±9.021). In our study the overall incidence of low BMI among respiratory failure was n=75(92.59%) and normal BMI was n=6 (7.40%) which means respiratory failure was more common in patients with Low BMI compared to patient with an average normal BMI. Low BMI has a prognostic indicator as it is associated with severity of disease. Our NRF group had a moreover normal average BMI which supports our statement. Since there wasnt equal distribution of sample based on BMI subgroups of RF so yates correction was applied. When the association of pH among two BMI groups of respiratory failure was compared there was no statistical difference (p=1,chi square 0.000) among the severity of respiratory failure. Our study also shows that irrespective of BMI in the respiratory failure disease severity was morever the same.

Hence our study suggested that patient with COPD with advanced age and low BMI have severe exacerbation with respiratory failure requiring hospitalization. The severity of respiratory failure was moreover same with low BMI subgroups as well as normal BMI subgroups. Similar to our finding, Schembri et al reported that increasing age and a low BMI were associated with poor outcome.[8] Our observations is also supported by (Hunter et al) who showed that older age patients and patients with low BMI presented an increased risk of first AECOPD admission after diagnosis.[9] They also observed that high BMI was associated with reduced risk of both first AECOPD admission and readmission. Similar results were reported by Oostenbrink et al.[10] Therefore, we conclude that patient with AECOPD with low BMI can also be used as a predictor for mortality.

Our study concluded that low BMI was associated with more failure rate compared to normal BMI subgroups of cases who were kept on non-invasive Ventilation. Failuire rate was 6.6% and 0% respectively. However the overall success rate of NIV was commendable. This observation was in contrast to study done by Steriade et al they concluded that BMI influenced NIV settings but not NIV failure or mortality, suggesting that NIV might be similarly effective irrespective of BMI values.[11]

Annemie et al. found that low BMI was significant independent predictor of increased mortality in 400 COPD patients.[12] Vestbo et al. followed 1898 COPD patients prospectively for 7 years and found that BMI and free fat mass index were significant predictors of mortality.[13] Sahebjami et al.[14] also demonstrated a correlation between BMI and pulmonary function tests and they recommended BMI as a criterion to evaluate the nutritional status of COPD patients. In our study, BMI influenced NIV settings but not NIV failure or mortality, suggesting that NIV might be similarly effective irrespective of BMI values.

The limitation of our study was that the sample size was small and it's a time bound study. Therefore the results cant be generalized. The result showed that low BMI is associated with increased severity of exacerbation but there was no impact on outcome of NIV.Thus to establish more strength to the study large sample size of study and long follow up study is required.

CONCLUSIONS

Our study showed that overall incidence of respiratory failure was more common with low Body mass Index. However there was no difference among severity of respiratory failure among low BMI subgroups and normal BMI subgroups of RF group.

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