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Original Research Article

A Retrospective Study on Oxygen Saturation Trends in COPD Patients During Hospitalization

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Abstract:

Background: Chronic Obstructive Pulmonary Disease (COPD) is a chronic respiratory disease that is associated with limitation of airflow and gas exchange that causes a decreased oxygen saturation (SpO_2), especially during acute exacerbations that necessitate inpatient care.

Aim: To examine oxygen saturation trends and related clinical variables in COPD patients in the hospital in a retrospective manner.

Methodology: The Department of Physiology, Shri Ramkrishna Institute of Medical Sciences and Sanaka Hospital, Durgapur, carried out a retrospective observational study in a period of one year. One hundred and twenty patient records of COPD were examined. Demographic information, oxygen saturation, comorbidity and treatment intervention data were gathered and analyzed through descriptive and inferential statistics.

Results: Most of the patients were 55-70 years (50%) of age and mostly male (62.5%). The mean oxygen saturation at admission was 85.9 ± 4.5 and this steadily increased to 92.4 ± 3.3 at discharge. Patients having comorbid conditions had slower improvement. Significant improvement in SpO_2 levels ($p < 0.05$) was seen linked with oxygen therapy.

Conclusion: With proper treatment, there is an improvement in oxygen saturation during hospitalization in COPD patients. SpO2 continuous monitoring is crucial to clinical management and prognosis.

Keywords: COPD, Oxygen Saturation, SpO_2 Trends, Hospitalization, Hypoxemia, Retrospective Study.

Introduction

COPD is a disabling, nonreversible and progressive respiratory disease that ends up being a significant health issue among the world population. It has now been recognized as one of the most common causes of morbidity and mortality in the world and it will grow to be even higher within the next few decades as the risk factor exposures and other demographic alterations such as population aging increase [1]. The low- and mid-income countries are predominant carriers of COPD because biomass fuel exposure, air pollution, and access to health care contribute to making the disease even more widespread and worsened. COPD is characterized by chronic airflow limitation due to a complex of small airway disease (chronic bronchitis) and parenchymal destruction (emphysema) which leads to impaired ventilation, and reduced efficiency of gas exchange [2].

Chronic airway inflammation, lung parenchymal inflammation, and lung vasculature inflammation to long-term exposure to harmful particles or gases (the most common of which is tobacco smoke) characterize the pathophysiology of COPD. Due to this inflammatory process, structural remodelling of the airways, bronchiolar constriction, the loss of elastic recoil and alveolar wall destruction occur [3]. These alterations are then converted to ventilation perfusion mismatch and reduction in diffusion capacity that eventually leads to hypoxemia. Airflow obstruction is also caused by secretion of mucus, and dysfunction of the cilia, which also makes patients susceptible to infections and exacerbations.

One of the common clinical presentations of COPD is Hypoxemia or low oxygen in blood. Oxygen saturation (SpO2) is one of the most crucial parameters to be measured to assess respiratory functioning, as well as the severity of the disease, and can be non-invasively measured using pulse oximetry. It is a rapid and precise approximate of arterial oxygenation and is commonly used in

outpatient and inpatient clinical practice [4]. The saturation of oxygen in COPD that is hospitalized, particularly in patients with acute exacerbation, is likely to decrease significantly due to the worsening of the airflow limitation and ventilation-perfusion imbalance [5]. This needs urgent treatment and close monitoring to make sure that the condition does not deteriorate [6].

Oxygen saturation changes of COPD patients at the time of their hospitalization are usually dynamic and are determined by different factors, such as severity of the disease, response to treatment, and comorbidities [7]. Acute exacerbations of COPD are associated with sudden exacerbation of respiratory symptoms, augmented airway inflammation and augmented hypoxemia and usually triggered by respiratory infections or environmental pollutant [8]. Such exacerbations are highly relevant to the disease course, as lung performance is getting worse more rapidly, increasing the number of hospitalizations and the mortality rates [9]. Therefore, oxygen saturation changes during the hospitalization is a vital clinical tool that might be applied to monitor the progression of diseases, identify the treatment efficacy, and predict patient outcomes [10].

Hypoxemia of COPD is a clinical manifestation as well as a significant prognostic and survival variable [11]. Prolonged hypoxia can result in serious issues, including acute or chronic respiratory failure, pulmonary hypertension, right-sided heart failure (cor pulmonale), neurocognitive impairment, and reduced quality of life. In severe cases, the hypoxemia that is not treated contributes significantly to the mortality risk [12]. Early detection and effective treatment of COPD-related hypoxemia is, therefore, a valuable facet of COPD treatment. The long-term oxygen therapy (LTOT) evidence is that it improves the quality of life and survival of patients with chronic hypoxemia and hence continuous and precise measurement of oxygen saturation is critical [13].

The patterns of oxygen saturation by COPD patients in hospital depend on a number of factors. Demographic factors that contribute to the differences in oxygenation status are age and gender, smoking history and exposure to the environment, and severity, duration and frequency of exacerbations of the disease. In addition, comorbidities, particularly hypertension, diabetes mellitus, and cardiovascular diseases can significantly influence the respiratory system functioning and delay the recovery [14]. These comorbidities are likely to lead to systemic inflammation, cardiovascular dysfunction, and reduction in the supply of oxygen to the tissues, making it more complicated to treat and clinically follow COPD.

Hospital-based treatment of COPD involves a complicated treatment regimen that aims at increasing airflow, reducing inflammation, and treating hypoxemia. Treatment primarily consists of oxygen therapy, especially where the patient presents with severe desaturation. Pharmacological interventions, bronchodilators, are used to relieve airway obstruction, corticosteroids are applied to reduce airway inflammation, and antibiotics are used in case of a suspected or confirmed infection. The other supportive care which involves hydration, nutrition support and physiotherapy is also conducive to recovery. The interventions tend to be effective, since they can be observed to increase the oxygen saturation levels gradually with time [15].

Even though the processes of diagnoses and therapeutic approaches have improved significantly, variability in the oxygen saturation levels of patients with COPD in hospital is a clinical problem. The difference in the nature of individual patients, underlying comorbidities, the severity of the disease and treatment response may result in the heterogeneous nature of the outcomes. This kind of variability highlights the need to perform constant monitoring and tailored treatment with references to the clinical characteristics of the particular patients.

In this respect, the given study will retrospectively analyze the trend in the oxygen saturation of COPD patients in the hospital and determine how various demographic and clinical factors may influence the trend. It is hoped that the study will help to better understand the pathophysiology of the disease, clinical decision-making process, and evidence-based approach to disease management, which will eventually lead to better patient outcomes and quality of care in COPD management by providing a full assessment of SpO_2 patterns.

Methodology

Study Design: The present study was designed as a retrospective observational research design that aims to investigate the patterns in oxygen saturation (SpO2) in COPD patients in hospital. The retrospective design allowed the researchers to access previous recorded clinical records, and hence, to provide an effective, systematic analysis of patient records without the need to contact the patients. It was necessary to include more patients in a given time, which was made possible through this method, thus increasing the representativeness and reliability of the findings. By analyzing the existing hospital records, which constitute vital parameters, treatment records, and demographics of the patients, the study could establish the trend and the variation in oxygen saturation rates according to the different clinical conditions and the different stages of severity of the diseases.

Moreover, the retrospective characteristic of the research reduced time and resource limitations but still provided a possibility to conduct a thorough analysis of data. It allowed testing connections between SpO_2 levels and different clinical and demographical variables including age, gender, disease severity, comorbidities, and clinical interventions. The design was also useful in familiarizing with real-life clinical conditions since the data represented real patient management during the hospitalization. On the whole, the study framework offered some useful data on oxygen saturation patterns in COPD patients that help to understand better the development of the disease, monitor patients, and the possibility to optimize clinical decision-making and patient outcomes.

Study Area: The research was carried out in the Department of Physiology, Shri Ramkrishna Institute of Medical Sciences and Sanaka Hospital, Durgapur, West Bengal, India.

Study Duration: The research was conducted within a time frame of one year.

Study Participants

Inclusion Criteria:

- The patients who were diagnosed with COPD according to clinical and spirometric findings.
- Patients who were hospitalized within the specified study time.
- Patients whose oxygen saturation (SpO_2) is fully recorded during hospitalization.

Exclusion Criteria:

- Patients who have other severe respiratory disease like pulmonary fibrosis or lung malignancy.
- Incomplete or missing medical records of patients.
- Patients with acute respiratory conditions that were not related to COPD, and may confound the assessment.

Sample Size: The study contained 120 patient records which had been selected on the basis of the pre-established inclusion criteria which meant that only pertinent and suitable cases were incorporated in the study. This sample size was considered adequate in terms of attaining statistical power that would be enough to detect meaningful patterns and associations in the data. The addition of a relatively more number of patient records to the study made it more reliable and accurate and minimized the chances of random error, as well as increased the consistency of the findings. Moreover, the sample size also led to the validity of the study, as it was possible to have a more comprehensive representation of the target population, which would enhance the generalizability of the results. All in all, the fact that 120 eligible patient records were included enhanced the strength of the analysis and contributed to the validity of the conclusions made based on the study.

Data Collection Procedure: Medical records department of the hospital used a structured approach to retrieve the needed patient data in the medical records department of the hospital. To achieve consistency, accuracy and uniformity in extracting data, the data collection proforma was standardized. The following variables were measured: demographic data, including age and gender; clinical data, especially the SpO_2 levels upon admission and at different periods of hospital stay; comorbidities, including hypertension, diabetes mellitus, and cardiovascular diseases; and treatment options, including oxygen therapy, bronchodilators, corticosteroids, and antibiotics. Any patient identifiers were eliminated to ensure high levels of confidentiality and anonymity. The study had an ethical approval of the study by the Institutional Ethics Committee of the hospital before data collection began.

Statistical Analysis: Data obtained were tabulated and processed with the SPSS version 25.0. To sum up the demographic and clinical features of the study population, descriptive statistics mean, standard deviation, frequency, and percentage were calculated. Inferential statistical analysis was done by Pearson correlation coefficient to evaluate the relationship of oxygen saturation levels with variables associated. A p-value below 0.05 was regarded to be statistically significant, which means that there is a significant relationship between the variables being studied.

Results

There were 120 patients who were diagnosed with COPD and were admitted during the given research time. The obtained data was thoroughly analyzed in order to assess various parameters of the clinical picture of the patients and their development of the disease. The findings have been categorized and placed under major areas in order to give a coherent and orderly explanation of the findings. The demographic details are used to define the distribution of the patients in terms of age and gender that provides the understanding of the population that is most affected by COPD and needs to be hospitalized. The oxygen saturation patterns represent the evolution of the SpO_2 level since the admission until the discharge and several periods of hospitalization as the reaction to the therapeutic interventions. The comorbidity profile suggests the high incidence of the related systemic conditions such as hypertension, diabetes mellitus and cardiovascular diseases, which may influence the severity of the disease and the recovery outcome.

Table 1: Demographic Characteristics of Study Participants (n = 120)		
Parameter	**Frequency (n)**	**Percentage (%)**
Age (years)		
40–54	36	30
55–70	60	50
>70	24	20
Gender		
Male	75	62.5
Female	45	37.5

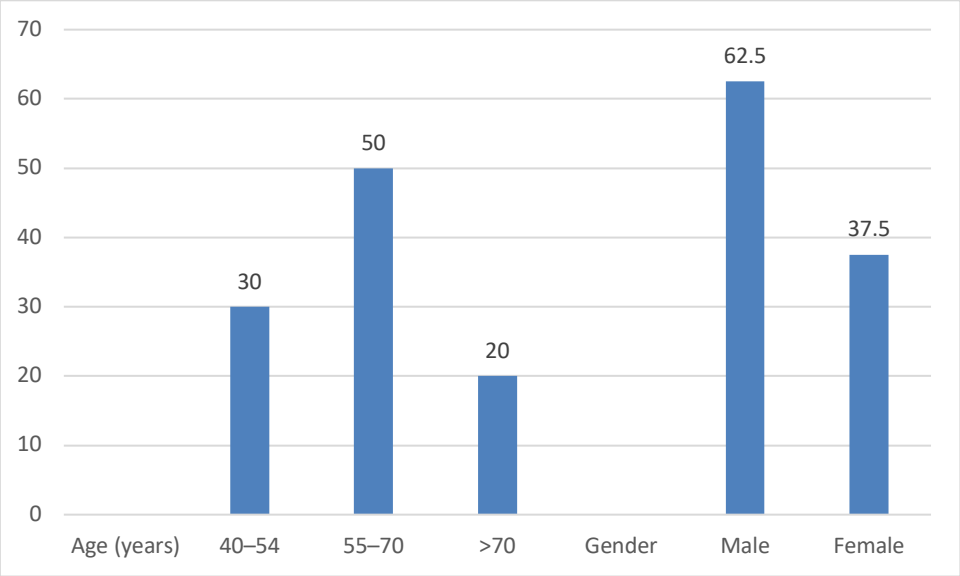

Figure 1: Graphical presentation of Demographic Characteristics of Study Participants

Table 1 describes the demographic characteristics of the participants of the study. Most of the patients (50%) were aged 55–70 years, which means that older adults are more likely to be hospitalized with COPD. This was preceded by 30 percent of the patients in the 40-54 years age group and 20 percent in the more than 70 years category. Gender wise, male patients (62.5) outnumbered female patients (37.5), implying a greater COPD burden among the male patients which could be explained by greater exposure to risk factors like smoking, occupational risks and environmental pollution.

Table 2: Oxygen Saturation Trends During Hospitalization	
Parameter	**Mean ± SD**
SpO_2 at admission	85.9 ± 4.5
Day 3 SpO_2	88.7 ± 4.0
Day 5 SpO_2	90.5 ± 3.7
SpO_2 at discharge	92.4 ± 3.3

Table 2 shows the tendency of oxygen saturation (SpO_2) levels during hospitalization. Mean SpO_2 on admission was 85.9 4.5 which represents that patients had severe hypoxemia during the admission. Oxygen saturation steadily improved throughout the days with the levels rising to 88.7 ± 4.0% on day three, 90.5 ± 3.7% on day five, and 92.4 ± 3.3% on discharge. This slow recovery is an indication of the effectiveness of the treatment interventions, particularly oxygen therapy and pharmacological management to normalise the oxygen levels.

Table 3: Comorbidities in COPD Patients (n = 120)		
Condition	**Frequency (n)**	**Percentage (%)**
Hypertension	50	41.7
Diabetes Mellitus	38	31.7
Cardiovascular Disease	20	16.7
No Comorbidity	35	29.2

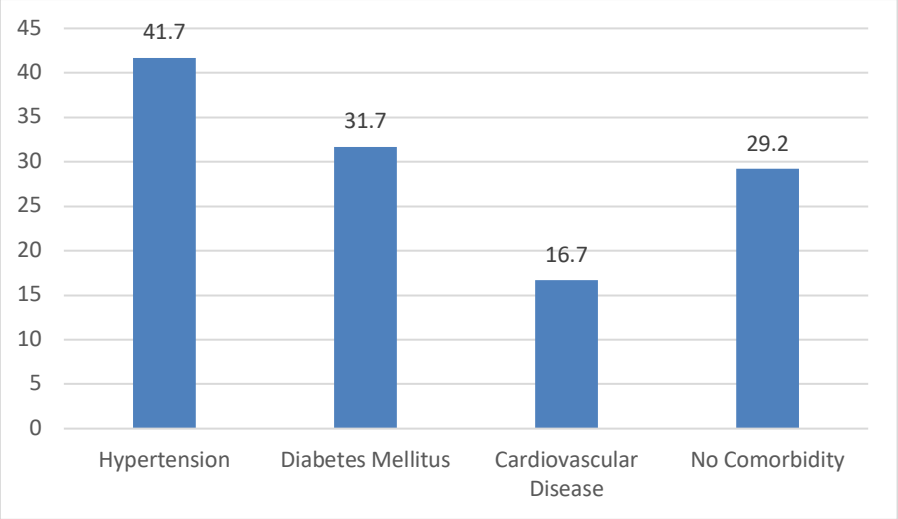

Figure 2: Graphical presentation of Comorbidities in COPD Patients

Table 3 shows the comorbidity prevalence of COPD patients. Hypertension (41.7%), followed by diabetes mellitus (31.7%), and cardiovascular disease (16.7%), were the most common comorbidities. Interestingly, 29.2 percent of the patients lacked comorbid conditions and this means that majority of COPD patients had either one or more associated systemic illnesses. The comorbidity levels are quite high, which means that COPD is often comorbid with other chronic illnesses, which may complicate the development of the disorder, and can impact the treatment outcomes.

Table 4: Treatment Modalities (n = 120)

Treatment	Frequency (n)	Percentage (%)
Oxygen Therapy	102	85%
Bronchodilators	95	79.2%
Corticosteroids	80	66.7%
Antibiotics	62	51.7%

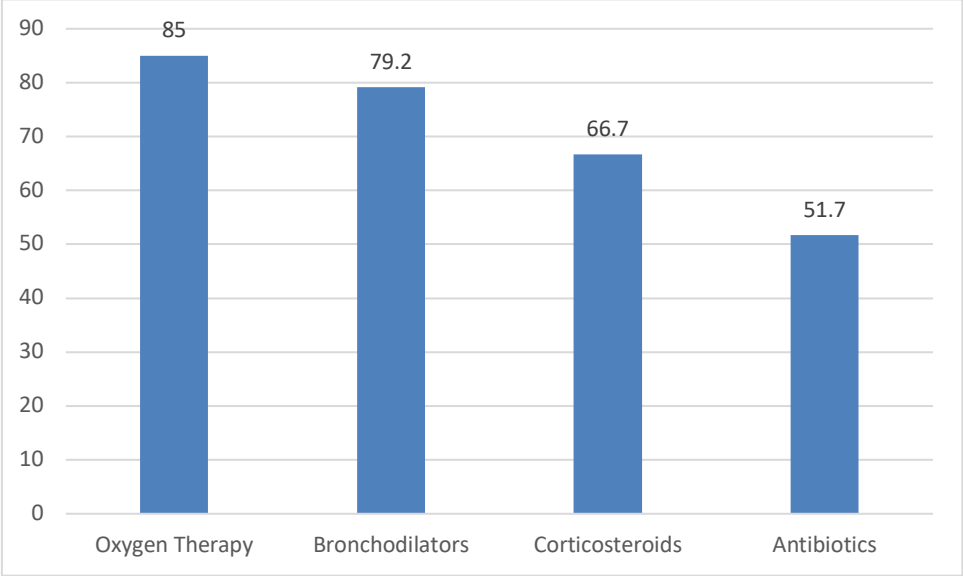

Figure 3: Graphical presentation of Treatment Modalities

Table 4 describes the treatment modalities that were given to the study participants. The intervention most commonly employed was oxygen therapy (85%), which is why it is the center stage in the management of hypoxemia in COPD patients. This was closely followed by bronchodilators (79.2%), which aid in the relaxation of airway obstruction and corticosteroids (66.7%), which inhibit the airways inflammation. The use of antibiotics was 51.7 %, which indicates the influence of infections in causing COPD exacerbations. In general, the

treatment pattern is consistent with usual clinical treatments of COPD.

Discussion

Current research examined the dynamics of oxygen saturation in patients hospitalized with COPD and revealed a substantial and steady increase in the level of oxygen saturation in the body after providing the appropriate treatment (Buekers et al., 2018) [16]. Most of the patients used in this study were 55-70 years of age, which is in line with the known epidemiological trend of COPD affecting older adults more than any other group because of cumulative exposure to risk factors like smoking, environmental pollution and because of age related worsening of lung functions.

On admission, the patients were markedly characterized by low oxygen saturation, which is indicative of underlying hypoxemia that is often linked with the acute exacerbation of COPD. This observation is in line with the available literature that shows hypoxemia to be a clinical finding in the exacerbation of the disease (Vold et al., 2015) [17]. A gradual and statistically significant improvement in SpO_2 levels was noted, however, over the period of hospitalization, and almost normal levels were achieved at discharge. This trend suggests the effectiveness of the management approaches introduced into hospitals to stabilize breathing and improve oxygenation.

The study also established that patients who had comorbidities in relation to the comorbidities, particularly hypertension and diabetes mellitus were in a comparatively slower response as regards to oxygen saturation levels (Dal Negro et al., 2012) [18]. This observation suggests that there is a detrimental effect of systemic conditions on pulmonary performance and the delaying of the recovery. Comorbidities are recognized to play a role in systemic inflammation and decreased cardiopulmonary efficiency, thus making the clinical course of COPD more complex and predisposing to poor outcomes.

Among the treatment modalities, oxygen therapy was the most crucial procedure, as it had a primary role in correcting hypoxemia and enhancing oxygen levels of saturation. The secondary intervention of bronchodilators and corticosteroids also led to better results as they increased airway clearance, decreased bronchial sphincter, and airway inflammation. The findings are consistent with the clinical guidelines currently existing, where a combination of pharmacological and supportive interventions is advised to manage COPD best.

The findings of the current study agree with the past studies that have highlighted the significance of constant observing oxygen saturation as one of the important aspects in the management of COPD patients. SpO_2 trends monitoring is not only helpful in evaluating the severity of the disease, but also benefit clients with information on their response to the treatment process and their progress (Gupta et al., 2014) [19]. Moreover, the identified differences in recovery patterns demonstrate the necessity of the personalized approach to treatment according to clinical characteristics of a patient and comorbidity.

All in all, the research highlights the clinical importance of monitoring oxygen saturation patterns in the course of hospitalization as an efficient and feasible measure of treatment efficacy. Regular use of SpO_2 to be added to the routine clinical practice might lead to improved decision-making, patient outcomes, and role in improved COPD management in hospitals (Stefan et al., 2015) [20].

Conclusion

The paper demonstrates that oxygen saturation in COPD patients improves significantly during hospitalization when the proper therapeutic interventions are performed, thus, constant monitoring of SpO_2 levels becomes one of the primary priorities in the evaluation of the severity of the disease, monitoring of treatment effects, as well as decision-making in the clinical setting. The outcomes also imply that the use of conventional management interventions, including oxygen therapy and bronchodilators, corticosteroids, and supportive care, may positively influence the oxygenation status but, once again, comorbid conditions, like hypertension, diabetes mellitus, and cardiovascular diseases, may influence the course of recovery and slow down progress. These results have shown the importance of holistic and individual approach to management of patients, which includes respiratory and control of the associated systemic diseases. Overall, continuous monitoring of the oxygen saturation patterns may be employed as an effective clinical tool in the improvement of patient outcomes, patient treatment plans, and quality of care among hospitalized COPD patients.

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