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Implementing oxygen saturation-based criteria for discontinuation of long-term oxygen therapy in nursing home residents with chronic respiratory disease

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ABSTRACT

Background: Chronic respiratory diseases represent a significant global health burden, affecting millions of individuals. Long-term oxygen therapy (LTOT) has been a key treatment for patients with chronic hypoxemia due to these conditions, demonstrating benefits for survival and quality of life.

Methods: An observational, analytical, retrospective cohort study was conducted to evaluate clinical indicators for safely discontinuing oxygen therapy in 36 patients aged 50 years or older with chronic respiratory diseases residing in five nursing homes. Data included sociodemographic and clinical variables, such as comorbidities, oxygen saturation levels, and treatment details. A cohort of 36 nursing home residents with chronic respiratory diseases was analyzed.

Results: The study revealed that 83.3% of patients had at least one comorbidity. Most patients (80.6%) used a nasal cannula for oxygen delivery, with a mean flow rate of 2.06 L/min. Approximately 80.6% achieved oxygen saturation >92% without supplemental oxygen. None of the patients who discontinued oxygen required readmission or oxygen reinstatement within the 4-week follow-up period.

Conclusions: This study provides preliminary evidence that achieving oxygen saturation >92% at rest or in exertion may represent a potential clinical indicator for safely discontinuing supplemental oxygen in patients with chronic respiratory diseases. However, given the retrospective design and small sample size, these findings should be interpreted cautiously and validated in larger, prospective studies.

Key words: oxygen inhalation therapy, respiratory tract diseases, respiratory therapy

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Introduction

Chronic respiratory diseases represent a significant global health burden, affecting millions of individuals [1]. Chronic respiratory diseases such as Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) are leading causes of morbidity and mortality worldwide [2,3]. Long-term oxygen therapy (LTOT) improves survival and functional outcomes in patients with severe chronic hypoxemia [4,5].

Approximately five million adults live with chronic respiratory disease in the United States, with more than one million prescribed LTOT defined as oxygen prescribed for at least 15 hours per day [5]. LTOT has been extensively studied as a treatment for COPD and due to the lack of studies, its use has been extrapolated to other diseases, including ILD. Recent evidence suggests that LTOT may not be necessary for all patients, especially those whose hypoxemia stabilizes over time or who exhibit only moderate hypoxemia [5]. For instance, studies confirm that LTOT effectively reduces hospitalization rates and readmissions, particularly in patients with severe resting hypoxemia ($PaO_2 \leq 55$ mm Hg or $SpO_2 \leq 88$), but theses benefits does not extend to patients with milder or intermittent oxygen desaturation [5-7].

Effective oxygen therapy management tailors prescriptions to individual patient needs by accounting for physiological mechanisms, lifestyle, treatment preferences, and the differing hypoxemia causes in obstructive versus restrictive lung diseases [4,7]. Similar outcomes have been observed in patients with chronic bronchitis and severe asthma, where LTOT helps mitigate hypoxemic episodes, though the evidence is less extensive than in COPD [6].

Despite these benefits, oxygen therapy remains challenging due to risks associated with unnecessary oxygen use, which can result in physical limitations, financial burden, and even increased hospital admissions if improperly administered [5-7]. Accordingly, systematic reviews suggest that oxygen therapy protocols should include regular reassessment to determine ongoing need, especially as hypoxemia may resolve post-hospitalization in a subset of patients [6,8]. Notably, recent evidence highlight that physiological differences between obstructive and restrictive diseases leading to hypoxemia underscores the importance of personalized approaches in oxygen therapy management, as the criteria for discontinuing oxygen may vary depending on the underlying pathology [5-8]. In this study, successful oxygen discontinuation was defined as maintaining saturation ≥92% without supplemental oxygen or clinical deterioration for at least four weeks.

While LTOT guidelines are well-established for COPD, less guidance is available for its use in other chronic respiratory diseases, particularly in managing disease-specific oxygen needs and discontinuation criteria, particularly in patients within nursing home settings [8]. This lack of standardized guidelines often leads to prolonged and potentially unnecessary oxygen use, which can burden patients with physical restrictions and healthcare systems with increased costs. Addressing these gaps, this study seeks to identify reliable clinical indicators for safely discontinuing oxygen therapy, providing a framework to guide healthcare providers in managing LTOT more effectively.

This study aims to evaluate clinical indicators for safely discontinuing oxygen therapy among chronic respiratory patients in nursing home settings, with a

focus on reducing unnecessary oxygen dependency while maintaining patient health outcomes.

Methods

An observational, analytical, retrospective cohort study was conducted to evaluate the clinical indicators for safely discontinuing oxygen therapy in 36 patients aged 50 years or older with chronic respiratory diseases residing in nursing homes in Florida. Eligible patients had been on oxygen therapy for at least three months and had documented medical follow-up between May and September 2024. All eligible patient records from the five participating nursing homes that met inclusion criteria during the study period were included. No records were excluded due to missing or incomplete data. Data abstraction was conducted by two independent investigators using a structured data collection form designed specifically for this study. The form included predefined fields for all variables of interest.

The study population consisted of 36 patients over 50 years old residing in nursing homes from five facilities in Florida, with chronic respiratory diseases that had used oxygen therapy for at least three months. The selection of participants was based on the total files archived at the different facilities with a diagnosis of chronic respiratory diseases that met the criteria for patient selection. It included: patients aged 50 years or older, regardless of sex, residing in nursing homes during the study period, with a diagnosis of chronic respiratory diseases such as COPD, asthma, or interstitial lung disease, or other similar pulmonary conditions. Eligible patients had an oxygen saturation level of ≥92% at rest without supplemental oxygen, had been using oxygen therapy for at least three months prior to data collection, and had documented medical follow-up during the study period, including relevant respiratory and functional assessments.

The instrument collected sociodemographic and clinical data such as: gender, age, race, primary diagnosis (COPD, asthma, interstitial lung disease), comorbidities, treatment (inhaled steroids, LAMA, LABA, SABA, etc.), hemoglobin level, baseline oxygen saturation, oxygen saturation without oxygen, oxygen delivery method, oxygen flow rate, decision on oxygen use. A non-probabilistic sample was used throughout the data collection, a total of 36 records were included in the study.

The data analysis focused on using descriptive statistics for each of the study variables. Categorical variables, such as gender, primary diagnosis, and comorbidities (e.g., COPD, heart failure, diabetes mellitus), were summarized using absolute frequencies and percentages. This will provide a clear overview of the distribution of patients according to each of these characteristics.

This study is limited by a small sample size (n=36), which reduces statistical power and limits the generalizability of findings. However, the study was designed as a preliminary, exploratory analysis in a specific nursing home population. Despite its size, the sample was sufficient to identify clinically relevant patterns related to oxygen discontinuation, which can inform future prospective studies with larger cohorts.

For numerical variables, such as age, hemoglobin level, and oxygen flow rate (LPM), measures of central tendency and measures of dispersion were calculated. The normality of numerical variables was assessed using the Kolmogorov Smirnov and histograms. Numerical variables that involve proportions, such as baseline oxygen saturation and oxygen saturation without supplemental oxygen, were reported with appropriate measures of central tendency and dispersion.

This study was reviewed and granted exemption by the BeyondBound IRB (IRB ID#: BB2411SR-051) under 45 CFR 46.104(d), Category 4, as it involves a retrospective analysis of de-identified patient records with no direct interaction with participants. Given that all data were pre-existing and fully anonymized, the requirement for informed consent was waived by the IRB, as the study posed minimal risk and did not involve the collection of new personal or identifiable health information. All patient data were fully de-identified prior to analysis, and no patient-identifiable information (e.g., names, medical record numbers, addresses) was collected or accessed at any point. Data confidentiality was strictly maintained throughout the study. No minors were included in the dataset, and no parental or guardian consent was required. All procedures adhered to ethical guidelines, including the Declaration of Helsinki, ensuring patient confidentiality and compliance with applicable regulations.

Results

A cohort of 36 patients residing in nursing homes, all diagnosed with chronic respiratory diseases and receiving supplemental oxygen therapy for at least three months, was analyzed (Table 1). The cohort included both male and female participants, with a mean age of 73.1 years (SD: 11.4) and an age range of 50 to 97 years. The 83.3% of patients were over 65 years of age, while 16.7% were younger than 65 years. Regarding gender distribution, 55.6% were male, and 44.4% were female. In terms of racial composition, 47.2% identified as African American, 33.3% as White, and 11.1% as Caucasian.

Primary diagnoses

The primary diagnoses reflected the severity and diversity of respiratory conditions in this population. Respiratory failure, primarily caused by acute exacerbations of chronic obstructive pulmonary disease (COPD), pneumonia, and cardiovascular complications such as heart failure and pulmonary hypertension, was the most common diagnosis, affecting 33.4% of patients, followed by chronic obstructive pulmonary disease (COPD) with acute exacerbation, which accounted for 22.2% of cases. Other frequent conditions included chronic respiratory failure with hypoxia (11.1%) caused by progressive and long-standing diseases such as COPD, interstitial lung disease (ILD), and the cumulative impact of comorbidities like heart failure and diabetes mellitus and combined acute and chronic respiratory failure with hypoxia (8.3%). Less common diagnoses included uncomplicated asthma (8.3%), and cardiovascular diseases, such as heart failure and pulmonary hypertension, each with a prevalence of 2.8%. Additional conditions such as chronic sinusitis (2.8%) and pneumonia (2.8%) were also documented. Among patients with a diagnosis of uncomplicated asthma (8.3%), treatment included the use of short-acting beta-2 agonists (SABA) as rescue therapy and inhaled corticosteroids (ICS) for the chronic management of inflammation.

Table 1. Baseline demographic and clinical characteristics of the study population.

Characteristic	Discontinued Oxygen (n=29)	Continued Oxygen (n=7)
Age, mean (SD)	72.0 (11.6)	77.7 (10.0)
Age ≥65 years, n (%)	23 (79.3%)	7 (100.0%)
Age <65 years, n (%)	6 (20.7%)	0 (0.0%)
Sex, n (%)		
Male	14 (48.3%)	6 (85.7%)
Female	15 (51.7%)	1 (14.3%)
Race, n (%)		
African American	17 (58.6%)	0 (0.0%)
White	12 (41.4%)	0 (0.0%)
Caucasian	0 (0.0%)	7 (100.0%)
Primary diagnosis, n (%)		
Respiratory failure	8 (27.6%)	3 (42.9%)
COPD with acute exacerbation	8 (27.6%)	0 (0.0%)
Chronic respiratory failure with hypoxia	4 (13.8%)	0 (0.0%)
Acute and chronic respiratory failure with hypoxia	2 (6.9%)	1 (14.3%)
Uncomplicated asthma	3 (10.3%)	0 (0.0%)
Heart failure	3 (10.3%)	1 (14.3%)
Pulmonary hypertension	1 (3.4%)	0 (0.0%)

Characteristic	Discontinued Oxygen (n=29)	Continued Oxygen (n=7)
Chronic sinusitis	0 (0.0%)	1 (14.3%)
Pneumonia	0 (0.0%)	1 (14.3%)
Comorbidities, n (%)		
Stroke	10 (34.5%)	2 (28.6%)
COPD	8 (27.6%)	2 (28.6%)
Congestive heart failure	6 (20.7%)	2 (28.6%)
Diabetes mellitus	6 (20.7%)	2 (28.6%)
Dialysis	7 (24.1%)	1 (14.3%)
Asthma	4 (13.8%)	1 (14.3%)
Coronary artery disease	1 (3.4%)	0 (0.0%)
Oxygen delivery method, n (%)		
Nasal cannula	22 (75.9%)	7 (100.0%)
Tracheostomy	7 (24.1%)	0 (0.0%)
Oxygen flow rate (L/min), mean (SD)	1.11 (0.15)	2.55 (0.61)
Oxygen use mode, n (%)		
PRN	22 (75.9%)	6 (85.7%)
Continuous	7 (24.1%)	1 (14.3%)
Baseline oxygen saturation (%), mean (SD)	97.54 (1.35)	96.35 (0.16)
Oxygen saturation without oxygen (%), mean (SD)	94.85 (2.37)	91.62 (0.41)
Stable respiratory rate, n (%)	29 (100.0%)	0 (0.0)
Frequent respiratory decompensations, n (%)	2 (22.2%)	7 (77.8%)

Values are presented as number (percentage) unless otherwise specified. Percentages may not total 100 due to rounding. COPD, chronic obstructive pulmonary disease; PRN, pro re nata (as needed); SD, standard deviation.

Comorbidities

A total of 83.3% of patients presented with at least one documented comorbidity, while 16.7% had no comorbid conditions recorded. The most frequent comorbidities included stroke (40%), COPD (33.3%), congestive heart failure (26.7%), and diabetes mellitus (26.7%). Other significant conditions included dialysis, observed in 23.3% of patients, and asthma, present in 16.7%. Coronary artery disease was less common, affecting only 3.3%. These findings highlight the clinical complexity and burden of chronic conditions in this population.

Oxygen administration methods and physiological parameters

80.6% of patients utilized nasal cannula as the primary method of oxygen delivery, while 19.4% received oxygen through tracheostomy. The mean supplemental oxygen flow rate was 2.06 L/min (SD: 1.0), with a range of 1 to 4 L/min. Regarding the mode of oxygen use, 77.8% of patients used oxygen on a PRN (as needed) basis, while 22.2% required continuous oxygen therapy.

The mean baseline oxygen saturation was 97.25% (SD: 1.5), whereas the mean oxygen saturation without supplemental oxygen was 95.22% (SD: 2.83). A total of 80.6% of patients achieved an oxygen saturation >92% without supplemental oxygen, a key criterion for evaluating readiness to discontinue therapy. However, 19.4% of patients failed to meet this threshold.

Clinical observations and oxygen therapy decisions

Respiratory stability plays a critical role in clinical decision-making. A stable respiratory rate, defined as

a consistent and normal range of respiratory breaths per minute with the absence of acute changes or distress that would indicate exacerbation or worsening conditions, was observed in 75% of patients during follow-up, whereas 25% experienced frequent respiratory decompensation, defined as two or more documented episodes during follow-up characterized by specific clinical signs such as increased respiratory rate, oxygen saturation <92%, or documented signs of hypoxemia or hypercapnia in nursing or medical records. These events were identified through objective measurements or explicit notations in patient charts, rather than subjective clinical impressions alone.

Among patients with oxygen saturation >92% without supplemental oxygen (n=29), 89.7% (n=26) were classified as suitable for oxygen therapy discontinuation, while 10.3% (n=3) continued with PRN oxygen due to other clinical considerations. Follow-up for 4 weeks confirmed that all patients who successfully discontinued oxygen therapy (n=26) maintained stability without requiring reinstatement of oxygen or experiencing desaturation events in resting conditions.

Conversely, all patients with oxygen saturation <92% (n=7) exhibited frequent respiratory decompensation and continued using PRN oxygen therapy. Those patients required reinstatement of oxygen within the first week due to acute exacerbations or progression of underlying comorbidities.

The mean hemoglobin level prior to oxygen discontinuation was 13.5 g/dL (SD: 1.2) in patients who successfully discontinued therapy, compared to 12.8 g/dL (SD: 1.3) in those who required oxygen reinstatement due to desaturation. Post-discontinuation, the mean hemoglobin increased to 13.8 g/dL (SD: 1.1) in successful cases, while it decreased to 12.5 g/dL (SD: 1.4) in patients who resumed oxygen therapy.

Discussion

Oxygen is an essential source for sustaining life, and long-term oxygen therapy (LTOT) plays a crucial role in managing advanced chronic respiratory conditions. The discontinuation of oxygen therapy should be approached with careful consideration of the patient's stability and adequate reassessment. The cost of medical oxygen in the United States varies based on factors such as delivery method, equipment type, and regional pricing. As of December 2023, the price of oxygen was approximately $229 per metric ton [9].

In the United States, more than 1.5 million individuals have been prescribed with LTOT for chronic respiratory diseases, accounting for approximately 5-10% diagnosed with COPD. Although it represents just a minimal proportion of patients, this therapy holds significant impact in healthcare costs. Medicare, for instance, spends over $2 billion annually on LTOT equipment [10]. According to Pelletier-Fleury et al. [11], oxygen therapy represents 73% of the total ambulatory respiratory care costs for COPD patients, accounting for at least $11,672 annually per patient. Studies suggest a single episode of COPD exacerbation could cost upon $88 to $7,757 for hospitalization [12]. These results highlight the necessity for reassessing oxygen therapy in nursing homes, identifying opportunities for safe discontinuation to reduce highly healthcare costs.

Supplemental oxygen is the first-line treatment for hypoxemic respiratory failure, typically delivered using conventional devices that provide a maximum flow of 15 L/min. However, patients with respiratory failure require an inspiratory flow range from 30-120 L/min, exceeding the capacity of these devices. High-flow nasal cannula systems address this limitation by delivering a higher flow rate with more consistent and predictable FiO_2 compared to traditional oxygen delivery systems [13]. In this study, 80.6% of patients relied on a nasal cannula as their primary oxygen delivery method. Notably, 80.6% of patients achieved oxygen saturation levels above 92% without supplemental oxygen, meeting a key criterion for evaluating readiness to discontinue therapy.

This study highlights the significant burden of comorbidities among patients with chronic respiratory disease receiving LTOT, with 83.3% presenting at least one documented comorbidity such as stroke (40%), COPD (33.3%), congestive heart failure (26.7%), and diabetes mellitus (26.7%). Similarly, Adler et al. [14], identified comorbidities as congestive heart failure (22.8%), obstructive sleep apnea (6.5%), and pulmonary hypertension (6.2%) as common in patients requiring oxygen therapy. Comorbid chronic conditions can lead

to poor clinical outcomes, higher rates of hospitalization, and increased mortality upon these patients. More than half of the patients in Adler's study had at least three major comorbidities which were later associated with higher hospital readmission rates or death, occurring in 46% of these patients [14]. Therefore, multidisciplinary approaches are needed for managing comorbidities in chronic respiratory patients to improve outcomes and reduce healthcare burdens [14,15].

LTOT improves functional capacity and survival in hypoxemic patients. According to the literature, the primary goal for COPD patients is to maintain oxygen saturation above 90% during sleep, rest, and activity [16,17]. In a study by Spece et al. [9], patients with SpO_2 >88% were considered eligible for oxygen discontinuation, resulting in 86.3% successfully discontinuing oxygen. Their work, conducted in a post-hospitalization context, demonstrated the potential of clinical reassessment in safely guiding oxygen withdrawal. Our study builds upon this concept by applying it to a non-hospitalized, long-term care population. By operationalizing a saturation threshold of >92% in nursing home residents, we demonstrate that structured reassessment protocols can also be safely implemented outside acute care settings. A key finding in our cohort was that 80.6% of patients met this threshold and successfully discontinued LTOT without complications. However, 19.4% did not meet the criterion, underscoring the importance of individualized clinical evaluation when considering oxygen discontinuation.

LTOT represents a cornerstone in the management of hypoxemic patients with chronic respiratory diseases, improving survival and quality of life. However, determining the need for LTOT, as well as the optimal timing for discontinuing therapy, requires careful consideration of the patients' medical stability. Despite the multiple benefits and advantages provided through LTOT, establishing clear clinical indicators for safely discontinuing oxygen therapy remains a challenge, mostly due to the need for individualized care among each patients' needs. Current studies only evidence and focus on post-discharge oxygen reassessment, leading to a gap in understanding how to assess and safely discontinue oxygen therapy during hospitalization.

The economic implications of long-term oxygen therapy are significant, impacting both healthcare systems and individual patients. Recent analyses reveal that the costs associated with LTOT extend beyond equipment acquisition. For example, the operation of oxygen concentrators alone incurs substantial electricity costs, varying widely across states due to differences in local energy rates. Beyond electricity expenses, the purchase, and rental costs of oxygen tanks further strain healthcare resources [18,19].

This study's findings, indicating that 80.6% of patients achieved oxygen saturation levels above 92% without supplemental oxygen, highlight the potential for reducing oxygen dependency in stable patients. By identifying reliable clinical indicators for safe oxygen discontinuation, healthcare providers can minimize unnecessary oxygen use, thus mitigating both physical and economic burdens.

Limitations

Several limitations should be acknowledged. First, the potential for confounding by comorbidities was not formally assessed due to the limited sample size and lack of multivariable analysis. These conditions may affect respiratory stability independently of oxygen saturation and could influence discontinuation outcomes. Second, the follow-up period was limited to 4 weeks, and no data were available beyond this window. While no adverse events or oxygen reinstatements were recorded during that time, longer-term outcomes remain unknown. Additionally, follow-up relied on retrospective review of nursing documentation and facility records, which may not capture all clinical events. Third, the study was conducted exclusively in five nursing homes in Florida, which may not reflect practices or patient demographics in other geographic areas or healthcare systems.

By integrating economic considerations into oxygen therapy protocols and promoting evidence-based discontinuation practices, this approach aligns with broader goals of resource optimization and patient-centered care. Further investigation into cost-effective strategies, coupled with the standardization of clinical criteria for oxygen discontinuation, represents a

critical step toward improving outcomes for patients with chronic respiratory diseases.

Future multicentric studies should focus on collecting data from diverse settings, including nursing homes, outpatient clinics, and hospitals. Such research would allow for the exploration of regional variations in oxygen therapy practices, cost structures, and patient outcomes. A larger, more diverse dataset could inform policy development and guide interventions to optimize LTOT use, ensuring equitable access while maintaining high-quality care.

Conclusion

In this retrospective cohort of nursing home residents, we observed that patients maintaining SpO_2 >92% without supplemental oxygen were more likely to remain stable after discontinuation of therapy. These results provide preliminary evidence that SpO_2 thresholds may serve as useful clinical indicators for guiding oxygen discontinuation. Nevertheless, the small sample size and retrospective nature of the study limit generalizability. Future prospective studies with larger populations are needed to confirm these findings and to develop standardized, evidence-based protocols for safely discontinuing oxygen therapy in nursing home settings.

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