

Oxygen Treatment for Patients with Chronic Obstructive Pulmonary Disease: A Systematic Review

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Introduction and Background

Chronic Obstructive Pulmonary Disease (COPD) is one of the biggest threats to public health of the twenty-first century according to estimates placing it third only to heart diseases and cancer as a killer. This progressive respiratory condition is present in about 384 million people worldwide with prevalence rates increasing because of the aging of the population and environmental exposures. The disease burden is not just limited to the mortality rates but the disease tends to be complicated resulting in more admissions to hospitals and bringing a huge economic burden in terms of health care costs and family expenses. Oxygen therapy has become one of the mainstays in the treatment of COPD, especially in patients with severe COPD and chronic hypoxemia. The basis of oxygen therapy is aimed at reversing hypoxemia, decreasing the work of breathing, and refers to the reduction of the burden on the cardiovascular system (Zhang et al., 2023). The evidence for using oxygen therapy in COPD patients started from the Medical Research Council and Nocturnal Oxygen Therapy Trial conducted in the 1980s which testified oxygen therapy as one of the few treatments that can raise life expectancy in COPD patients with severe hypoxemia. Today's clinical practice guidelines, including the GOLD document, urge doctors to prescribe long-term oxygen therapy to patients with specific criteria. These recommendations have been established from research findings showing that properly chosen patients suffering from heart failure benefit from such approaches through increased life span, less hospitalization, and improved quality of life. However, it is clear that oxygen therapy is patient and context-specific and that there are several potential barriers to the optimal use of oxygen therapy.

Objectives and Research Questions

The primary objective of this systematic review is to evaluate the effectiveness and safety of different oxygen therapy modalities in the management of COPD. This review aims to address several critical questions regarding patient outcomes, implementation strategies, and therapeutic considerations.

Using the PICO framework, we can structure our research questions as follows:

Population: The studies included in the systematic review involve only adult patients with COPD across different COPD disease progression stages. This broad inclusion underlines the fact that COPD is a heterogeneous disease and patients are not only at a different point in disease development but also common comorbidities that can serve as additional predictors of exacerbation. The population inclusion covers outpatients, inpatients, users of rehabilitation facilities, as well as patients under home care; this makes capture of how oxygen therapy influences COPD beneficiaries in numerous settings possible (Vitacca et al., 2020). This approach makes it possible to make a

comprehensive analysis of how oxygen therapy is effective for various subgroups of patients and compare the outcomes based on the degree of the disease, and the type of care that is being offered.

Interventions: The present review considers a range of oxygen therapies and offers a critical assessment of all potential treatment approaches. LTOT is the most essential procedure and is usually for the continuous use of 15 hours or more every day. Concentrating on oxygen carriers for movement, ambulatory oxygen therapy is the one that helps patients continue oxygen supply during various tasks or movements (Lacasse et al., 2020). Continuous oxygen therapy is characterized by oxygen use for more than 15 hours per day, or for the purpose of resolving shortness of breath episodes in the shortest time possible, usually within 10-20 minutes. CHAPTER C Nocturnal oxygen therapy focuses on the oxygen requirement of the patient during the night because patients have oxygen desaturation problems while asleep. Such a number of considerations guarantees that all possible delivery options for oxygen are considered based on their advantages in COPD cases.

Comparators: The review develops the right pairs of comparisons to use in assessing the outcome of oxygen therapy interventions. Static ambulatory oxygen administration without active standard care acts as the control group to compare with standard COPD management plus supplemental oxygen. It allows the comparison of what types of systems or approaches appear to be more beneficial to particular patients or in certain conditions (Zheng et al., 2020). The assessment of different prescription regimens enables the determination of specific parameters such as flow rates, duration of use of prescribers, and the time at which these are most effective. These comparisons support clinical decision-making regarding the inferability or relative efficacy of competing approaches.

Outcomes: To determine the overall effectiveness of oxygen therapy, the review looks at primary and secondary consequences. Primary outcomes focus on crucial measures of treatment success: Mortality rates, on the other hand, measure the therapy's ability to improve survival; utility measures consider how the treatment improves patients' lives; and hospitalization rates reflect the disease course alteration by the treatment. Secondary endpoints expand the assessment to exercise tolerance – functional gain, symptom enhancement referencing the therapy's role on the subject's general discomfort due to COPD, the mental health impact of the therapy, and the economic implication of the treatment respectively (Plotnikow et al., 2021). Thus, this comprehensible outcome assessment results in sufficient insight regarding both the clinical and practical modulations of oxygen in COPD.

This review includes published randomized controlled trials, and observational, and systematic review studies carried out and published in peer-reviewed journals within the past two decades. Some limitations are or should be borne in mind, including differences in the study sample, in definition of the outcomes, and the issue of publication bias. The review also discusses the difficulties of blinding in enrolled trials of oxygen therapy because of the nature of the intervention.

Methodology

The approach for the current systematic review was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist. The search strategy was put in place to ensure the initial examination was done using multiple EBSCO electronic resources such as Medline, Embase, Cochrane Library, and CINAHL. The search terms include MeSH terms and free text words for COPD, oxygen therapy, and related outcomes. The inclusion criteria specified: Sample inclusion criteria were as follows: (1) participants with adult COPD patients, (2) The use of any form of supplemental oxygen therapy, (3) a comparison with usual care or different oxygen delivery devices and/or modes, (4) reporting of at least one primary outcome, and (5) the articles were published in English only (Yang et al., 2023). The criteria for exclusion include studies involving only acute exacerbations, non-COPD-related respiratory diseases, and children. Risk of Bias (RoB) in the included trials is assessed by the Cochrane Risk of Bias tool for RCTs only while non-randomized trials are assessed by the Newcastle-Ottawa Scale tool. Two independent researchers conduct a quality assessment of the studies, where discrepancies are solved by reaching a consensus or with the help of the third researcher. The basic form of data extraction is pre-specified and covers features of the studies and their authors, participants, interventions, outcomes, and follow-up. Again, meta-analysis is conducted where possible and with consideration of the random-effects model to assess study variability.

Types of Oxygen Therapy in COPD

LTOT is the most investigated and substantiated type of oxygen administration in COPD. It consists of the constant application of additional oxygen for not less than 15 hours in one day; it is usually prescribed in the form of nasal prongs or masks. Trials of LTOT have shown improved survival in patients with severe resting hypoxemia especially if the LTOT is given for more than 15 hours on a daily basis. Using ambulatory oxygen therapy solves the problem of those patients who are desaturated during physical activities. Portable oxygen delivery systems are used by this modality so that the patient can continue with oxygen therapy during their day-to-day activities or even a workout. It has been postulated for selected patients, that ambulatory oxygen can enhance the capacity to exercise as

well as minimize shortness of breath though the effects of long-term use have not yet been ascertained. Short-burst oxygen therapy refers to supplemental oxygen administration in short duration usually 10-20 minutes for episodic alleviation of air hunger (Sami et al., 2023). Though normally considered as effective this drug's utility remains quite disputed, especially concerning specific outcomes within the framework of symptoms' alleviation and exercise performance repair. NNTOM aims at the hypoxia during the night, which exists in the majority of COPD patients. This modality is supposed to protect cardiovascular function and sleep quality from the detrimental impact of overnight desaturation but further research is needed to identify a role of this modality for LTOT beyond its primary objectives.

Clinical Indications and Patient Selection

Therefore there is a crucial need for choosing proper candidates for oxygen therapy based on measured data of arterial blood gases. According to current standards, LTOT should be performed in patients with a resting PaO₂ of no more than 55 mmHg or SaO₂ of no more than 88%. Again oxygen therapy may be recommended in case the patient's PaO₂ ranges between 55-60 mmHg but he or she has cor pulmonale, polycythemia, or peripheral edema. Ambulatory oxygen prescription is another criterion that can be redeemed using exercise desaturation. This is due to the exercise tolerance improvement that patients with falls in SpO₂ ≤ 88% Who was able to have improved exercise performance by use of ambulatory oxygen therapy. Issues dependent on disease severity are not limited to hypoxemia only. Accompanying the data of GOLD staging, the assessment of the presence of symptoms and factors unfavorable for exacerbation contributes to the decisions on oxygen therapy (Naranjo-Rojas et al., 2023). The chances of needing oxygen therapy go up particularly when the disease is in its advanced form, stage III and IV according to GOLD. Co-morbidity factors are very important in patient selection and to achieve the best results in the treatment. Providing oxygen therapy depends on cardiovascular diseases, pulmonary hypertension, and sleep-disordered breathing; indication and parameter.

Efficacy Outcomes

Survival advantages stand as the soundest data that has been used as the basis for oxygen therapy in chronic obstructive pulmonary disease. Several long-term analyses have shown a low rate of mortality and a mortality rate decrease, especially in hypoxemia patients using LTOT. The measure of survival advantage appears to be proportionally associated with daily utilization time; the most striking outcome is obtained for patients using oxygen for longer than 15 hours daily. An increase in quality has been reported in the course of the studies and is shown overall quality of life. While using a range of generic measures such as the St. George's Respiratory Questionnaire and COPD Assessment Test, there are particular improvements in physical functioning, social roles, and mood scores. Signs of improvements in exercise capacity and tolerance are evident with the correct oxygen support (Shibata et al., 2023). The intervention of supplemental oxygen improves the 6MWT and ESWT distance and reduces dyspnoea scores established by trials that involve standardized assessments. Hospital admission rates are usually lower after the implementation of correct oxygen therapy especially in patients with serious illness. These lowered hospitalizations amount to huge healthcare costs and enhanced patients' health.

Safety and Adverse Effects

The risk analysis of oxygen and its toxicity is a rather nuanced matter of the subjects' physiology, practical applicability, and certainly economic factors that the caretakers must take into consideration. Leading these issues is the potential for extreme oxygen concentrations, especially acute oxygen toxicity which remains a key during therapy for COPD where patients may not have strong CO₂ receptors responsive to their respiratory drive. Due to this physiological quirk, over-oxygenation can cause CO₂ buildup, which results in respiratory acidosis: something that requires strict dosing, and continued surveillance of blood gases. The technicality of oxygen delivery systems brings in additional concerns which are as follows The superficial problems related to the oxygen delivery system the skin rashes and pressure sores from the usage of facial masks or cannulas for prolonged duration The severe problem relating to oxygen delivery systems are tripping over the oxygen tubing which leads to falls and mobility impaired patient. In addition, enclosed high concentration of oxygen poses a risk of fire because oxygen is an irritator and this requires some specific safety precautions such as no smoking is allowed and constant checks on static electricity dangers (Nielsen et al., 2024). Unfortunately, these safety considerations are marred by blistering adherence issues because many patients find it hard to adhere to the recommended usage patterns due to a myriad of factors that include physical discomfort emanating from the disease, psychological pressure arising from perceived dependency on CPAP therapy, social shame, especially when using the device in public places; and practical factors such as mobility restrictions and the analysis' conclusion that their oxygen concentrators require constant access to power sources. These adherence issues not only influence individual patient outcomes but also program outcomes of oxygen therapy and healthcare resource economies.

This paper reveals the economic benefits and burdens of oxygen therapy across the short and long term and the special blend that makes the subject challenging to healthcare systems and policymakers. Although there are no

significant consumable costs with used in home oxygen therapy, the direct costs are fairly high: the cost of the delivery equipment, which may range from oxygen concentrators, liquid oxygen systems, or compressed gas cylinders, the costs of the actual oxygen supply, the maintenance requirements for equipment and monitoring devices, and the titration equipment (Jacobs et al., 2020). Such start-up costs may act as a barrier to access, especially with regard to technology-enhanced learning in developing countries or for patients with poor health insurance. At the same time, the costs should be compared to the potential economic effects of efficient oxygen therapy programs revealed by research carried out in the course of this investigation. Recurrent observational analyses and controlled trials have substantiated that appropriate oxygen therapy can enhance the hospitalization rate for respiratory exacerbations, also reduce emergency department visits, and enhance general well-being measures that underlie decreased healthcare use (Yu et al., 2024). The much-needed inclusion of adequate oxygen therapy to prevent acute exacerbations means a reduction of overall costs since one admission saves not only the direct medical costs but also keeps off the complications and functional deterioration that characterize long hospital stays. However, successful oxygen therapy is distinguishing aspects with improved functional status and reduced disability resulting in increased productivity and reduced caregivers' burden though such are more difficult to measure in economic terms. In the longer perspective, which includes both direct costs of healthcare consumption and social costs arising from potential benefits, the investment is most frequently economically justified, if directed at those who meet the criteria for inappropriately indicated oxygen therapy and are adherent to the prescribed protocols.

Special Considerations

Oxygen therapy in palliative care and certain other clinical circumstances means a very different approach to handling COPD patients compared with conventional guidelines. Depending on the patients' condition in palliative care, Saturation targets are less of a concern in managing the patient, rather, nurses' goal includes; improving the patient's comfort as well as the patient's quality of life, where oxygen plays an important role in the alleviation of the patient's dyspnea and anxiety. In general, during acute exacerbations, healthcare providers solve the dilemma of protecting patients from hypoxic hypoxemia and simultaneously risking hyperoxic hypoxemia with close monitoring of PEP and PEEP levels and frequent dynamic changes in the flow rates. The above features add a level of difficulty when managing patients who either travel or live at high altitudes because the pressure in the atmosphere reduces the underlying insufficiency of breathing (Geng et al., 2020). They face many considerations different from other ventures since they involve the coordination with airlines and additional oxygen suppliers to continue with therapy during flights. Another thing that was highlighted and which must be religiously observed is the psychological effect of oxygen dependence, as this might decrease compliance due to the feeling of stigma and restriction of liberty due to the therapy or lead to social isolation.

It is essential to go things beyond the clinical applications of oxygen therapy and to think through how this treatment could be properly integrated into a patient's life, given their specific characteristics and limitations. This integration is the choice of the right delivery systems and is associated with the patient's lifestyle engaging with the working people requiring mobile solutions, active senior citizens, busy with managing social appointments, or patients that need to solve most of the problems at home (Tan et al., 2020). Today, there are many choices in oxygen delivery, including conventional high-pressure gas cylinders and newly developed, lighter, and compact portable oxygen concentrators with functions such as pulse dose delivery and connectivity with smart devices for usage analysis. It is crucial to: their physical state and condition, cognitive state, social support, and their capability to navigate the physical environment in which they live, and their regular life routines.

Implementation and Monitoring

As for treatment initiation, escalated protocols should involve; assessment, selection of treatment equipment, and more importantly patient education. Identification of optimal internal flow rates during the initial titration must be done in conjunction with monitoring of both oxygen saturation and symptoms. Outcome measures should also be implemented to monitor treatment efficacy and to identify any new concerns. Assessment of quality of life measures including, detail adherence, and blood gases should be reviewed regularly (Cuevas et al., 20203). Care must be taken constantly on the equipment because they can develop faults affecting the delivery of oxygen. Hazard checks of delivery systems, backup stock, and safety components should always form part of care. This process reveals that patient education and support are core implementation tasks. The content of the training should also include knowledge on usage of tools necessary for prevention measures, and solutions to possible challenges.

Conclusion

In this systematic review, oxygen therapy is central to the management of COPD though several research gaps are also pointed out. More research should be conducted about the best time to begin the therapy, the adjustment of the treatments, and the long-term consequences of the therapies for different patients. Availability of advanced Portable Drug delivery systems and intelligent monitoring devices is the prominent opportunities of the treatment for improved effectiveness and patient compliance. Perhaps such ideas will partially compensate for the

existing shortcomings and enhance the general results. New evidence is being published frequently, especially concerning patient eligibility and best practice approach. The frequency of updating clinical references is thus crucial to suit the present trends and findings in practice. The health policy relevance of skin disease prevention and management goes beyond the ability to impact patient outcomes at the micro level to macro level issues such as resource distribution and patterns of service delivery. The key challenge has therefore remained on how to make the availed oxygen therapy model both effective and affordable to ensure all patients who require it can access it as needed.

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