The role of telehealth interventions in pulmonary rehabilitation programs for patients with chronic obstructive pulmonary disease (COPD)

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Abstract. Background: Telehealth interventions in chronic obstructive pulmonary disease (COPD) management have garnered attention for their potential to enhance access to care and improve patient outcomes. Various studies have explored the effectiveness of telerehabilitation programs, innovative telemedicine platforms, and home-based PR initiatives in addressing the needs of COPD patients. Methods and materials: A selection criterion was determined after a thorough literature review across search engines and databases. SANKA guidelines were followed to draft the manuscript. Objectives: Exploring the impact of telehealth interventions on the effectiveness and the outcomes of pulmonary rehabilitation programs for patients with COPD. Discussions: The discussions revolve around the positive impact of telehealth interventions on exercise capacity, self-efficacy, and quality of life for COPD patients. Studies highlight the convenience and accessibility offered by telemedicine platforms as well as the effectiveness of in-home telerehabilitation programs. However, challenges such as technical issues, data security concerns, and disparities in access to technology need to be addressed for successful implementation.

Keywords: chronic obstructive pulmonary disorder, resuscitation, telemedicine, pulmonary rehabilitation
**Introduction**

Chronic Obstructive Pulmonary Disease (COPD) a heterogeneous respiratory condition characterized by symptoms emanating from persistent albeit progressive airflow obstruction is said to kill 3 million people the world over annually [1, 2].

Nevertheless, treatment strategies exist to improve exercise capacity, muscle weakness, and the quality of life at large[3, 4]. These primarily refer to Pulmonary rehabilitation (PR), which is deemed the most effective management strategy. It brings about improvements in the physical and psychosocial sphere, by an increase in VO2 max, desensitization to anxiety, and breathlessness among many changes in cardiopulmonary physiology [5, 6, 7]. Regrettably, a mere fraction of all COPD patients receive PR services[8, 9].

With the objective of enhanced implementation and use of Respiratory rehabilitation services, the American Thoracic Society and European Respiratory Society have stressed the need to investigate alternative approaches, of which Tele-rehabilitation interventions form an integral part[10]. Tele-rehabilitation services employ the use of the modern era information and communication technologies for clinical purposes where distance and cost constraints exist [11].

It is a well-known fact that such services were widely employed during the COVID-19 pandemic owing to convenience and safety [12, 13, 14]. Despite the advantages of PR, adherence to services and completion of the program remains a factor that hinders its success [15].

Keeping this in mind, it is necessary to explore the role of telerehabilitation services, instead of the fact that growing evidence suggests that such services are viable, efficient as well as cost-effective, all while also improving patients' compliance and treatment success rates of PR. Some systematic reviews and meta-analyses have demonstrated the superiority of home-based telerehabilitation services over conventional care, concerning their impact on maximum exercise capacity and quality of life in COPD patients[16, 17, 18].

Thereby, in this study, we aim to investigate the role of telehealth interventions in Pulmonary rehabilitation programs
The role of telehealth interventions in chronic obstructive pulmonary disease (COPD) management is a burgeoning area of interest with promising implications for patient care. Various studies have underscored the potential benefits of telehealth interventions in enhancing access to pulmonary rehabilitation (PR) programs, improving patient outcomes, and optimizing healthcare delivery for individuals with COPD.

Studies demonstrated the effectiveness of an in-home telehealth PR program, incorporating telemonitoring, telehealth consultations, and virtual supervision of exercise sessions. This comprehensive approach resulted in improved exercise capacity, self-efficacy, and mood among COPD patients, highlighting the value of telehealth in promoting physical activity and overall well-being.

Moreover, innovative telemedicine platforms like PeR and the 'my-PR' program offer convenient alternatives to traditional face-to-face PR sessions, with comparable efficacy in improving physical performance and quality of life for COPD patients. These platforms leverage technologies such as WeChat and real-time interactive sessions to deliver personalized care and empower patients to manage their symptoms.

While telehealth interventions show promise in addressing barriers like transportation limitations, financial constraints, and accessibility issues associated with traditional rehabilitation programs, challenges remain. These include ensuring secure platforms, addressing connectivity issues, and enhancing technical skills among healthcare providers and users, particularly in low- and middle-income countries (LMICs) and high-income countries (HICs) alike. Furthermore, the cost-effectiveness and accessibility of telerehabilitation must be carefully evaluated, balancing the benefits of reduced travel burden and increased schedule flexibility with the importance of maintaining quality healthcare interactions and delivering core components of PR effectively. Overall, the evolving landscape of telehealth interventions in COPD management underscores the need for continued research, innovation, and collaborative efforts to harness the full potential of telemedicine in optimizing care for COPD patients.
pathways and improving outcomes for individuals living with COPD.

**Methodology**

A research question was created using the PICO framework. The studies identified through a systematic search were comprehensively read to assess their appropriateness for incorporation into the review based on the following criteria.

**Inclusion Criteria**

- **Participants:**
  - Adults diagnosed with COPD.
  - Participants engaged in pulmonary rehabilitation programs.

- **Interventions:**
  - Studies evaluating telehealth interventions as part of pulmonary rehabilitation programs.
  - Various telehealth forms include video consultations, remote monitoring, and mobile applications.

- **Comparators:**
  - Studies with a comparison group may include traditional in-person pulmonary rehabilitation programs or standard care without telehealth.

- **Outcomes:**
  - B. Patient satisfaction. Healthcare utilization related to COPD.

**Study Types:**

- Randomized controlled trials (RCTs), non-randomized controlled trials, observational studies, and systematic reviews.

**Exclusion Criteria**

- **Participants:**
  - Individuals without a confirmed diagnosis of COPD.
  - Participants not engaged in pulmonary rehabilitation programs.

- **Interventions:**
  - Studies focusing solely on telehealth interventions outside the context of pulmonary rehabilitation.

- **Comparators:**
  - Studies without a relevant comparison group.
Outcomes:
- Studies not reporting on the specified outcomes.

Study Types:
- Irrelevant study types (e.g., case reports, letters, editorials).

The manuscript has been drafted based on SANRA guidelines to search, compile, contemplate, and extract data. Investigators independently searched PubMed, and Google Scholar following the protocol mentioned in the literature.

Telehealth Interventions
Telehealth interventions in pulmonary rehabilitation programs for patients with chronic obstructive pulmonary disease (COPD) have shown promise in improving outcomes and increasing access to care for this patient population [19]. A prospective, randomized control study found that real-time interactive telehealth sessions through SKYPE effectively taught dyspnea self-management to patients with COPD. The study highlighted that telehealth can improve healthcare access, provide adequate health education, and enhance self-management programs for patients with chronic diseases like COPD [20]. Innovative telemedicine platforms like PeR offer promising solutions for home-based pulmonary rehabilitation in COPD management. Developed on WeChat, PeR aims to improve patient quality of life, alleviate symptoms, and enhance exercise self-efficacy. A randomized trial demonstrated comparable outcomes between PeR and face-to-face interventions, highlighting the significance of integrating telemedicine with behavioral strategies to empower COPD patients and improve overall care [21].

The 'my-PR' program represents a novel approach to pulmonary rehabilitation (PR) for patients with COPD, offering an online alternative to conventional face-to-face sessions. Through a meticulously designed two-arm parallel single-blind randomized controlled trial, 'my-PR' aimed to enhance physical performance and alleviate symptoms in COPD patients. The study's findings revealed that 'my-PR' was non-inferior to traditional PR methods, as evidenced by comparable improvements in 6-minute walk distance and COPD assessment test scores.

This innovative online platform presents a convenient and potentially effective option, particularly beneficial for
patients facing limitations in accessing traditional rehabilitation facilities [22].

Tsai et al. conducted a randomized controlled trial of 37 COPD patients that compared an in-home telehealth PR program to a no-PR control group. This intervention included telemonitoring, telehealth Pulmonary Rehabilitation, and telehealth consultations. The telehealth PR program included in-home virtual supervision of walking, cycling on an exercise bike, and strength training. The telehealth PR group had improved exercise capacity, self-efficacy, and mood at the end of the intervention, as compared to the non-PR control group. However, clinically and statistically significant improvements in Health-related quality of life were not observed, which may indicate that some aspects of the intervention environment do not mimic that of traditional institution-based PR [18, 23].

Holland et al. examined the effectiveness of a home-based PR program in patients with moderate COPD. Readily available telehealth equipment was installed in patients' homes to allow for videoconferencing, along with an exercise bicycle and pulse oximeter. During the in-home exercise sessions, patients monitored their symptoms and an HCP monitored the patient, their heart rate, and SpO2 via videoconferencing. All participants who completed the 8-week program had clinically significant improvements in exercise capacity and the dyspnea subscale of the Chronic Respiratory Questionnaire. However, participants using hospital networks faced significant technical problems related to data network capability [24].

Jangalee et al. conducted a study at Vancouver Coastal Health to assess the effectiveness of remote monitoring with a video-based exercise program among COPD patients. This real-time monitoring system automatically collects sleep data, physical activity, vital signs, weight, temperature, maintenance of medical adherence, and rescue inhaler usage without the need for manual data entry. This provided access to data over long periods as well as access to real-time data of participants' HR and SpO2 during exercise sessions. Few participants preferred remote monitoring as it overcame challenges with transportation. A few limitations of the study were the safety of participants in regards to objectively
measuring physiological responses to exercise, privacy issues, and the need for Wi-Fi connectivity for Zoom meetings, especially in remote areas [25].

**Pulmonary Rehabilitation Outcomes**

Evidence from randomized controlled trials (RCTs) was evaluated using Grading of Recommendations Assessment, Development, and Evaluation (GRADE) criteria. The results indicated moderate-quality evidence supporting the benefits of pulmonary rehabilitation (PR) for chronic obstructive pulmonary disease (COPD) patients in stable conditions and after exacerbations.

This was particularly evident in the improvement of health-related quality of life (HRQOL) and exercise capacity. To tackle statistical challenges, terms were clearly defined, and solutions were proposed for handling missing data, which are crucial for meta-analysis. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) COPD stage criteria, which determine COPD progression based on airflow limitation and symptoms, were taken into account. This emphasized how the severity of COPD impacts quality of life (QOL) and exacerbation rates. Studies conducted from 1990 to 2009 showcased the effectiveness of PR across diverse settings and countries. These programs typically lasted 6 to 12 weeks and involved multidisciplinary teams. However, research on maintenance programs following exacerbations yielded mixed results.

Low-quality evidence suggested limited impacts on HRQOL and hospitalizations, although there was some improvement in exercise capacity. Further studies are necessary to clarify these findings, particularly concerning the different stages of COPD severity and the long-term effectiveness of maintenance programs. Overall, pulmonary rehabilitation appears to be beneficial for COPD management, but there's a need for optimization strategies and targeted interventions to enhance outcomes. [33].

PR is a widely recognized and effective treatment for COPD patients. However, issues like low participation, inadequate attendance, and high dropout rates are common. It's important to explore alternative methods like pulmonary telerehabilitation to understand their potential benefits.
The outcomes of a multicentre, single-blinded, randomized clinical trial compare supervised pulmonary telerehabilitation (PTR) with conventional hospital-based pulmonary rehabilitation (PR) in patients with chronic obstructive pulmonary disease (COPD). The study found that while more patients completed PTR than PR, PTR was not superior to PR in terms of improving walking capacity (6-minute walk distance, 6MWD).

These findings contrast with previous studies that showed clinically relevant improvements in 6MWD from supervised PTR or home-monitored exercise programs compared to no intervention. The study's population had lower lung function, higher symptom burden, and more exacerbations than those in previous PTR studies, which could explain the lack of improvement in 6MWD. Notably, only one-third of eligible patients were willing to participate in the study, highlighting patient preferences and motivation as factors influencing outcomes. The study also discusses challenges in achieving meaningful clinical improvements in COPD patients, emphasizing the need for personalized approaches and broader outcome measures beyond traditional exercise and quality of life metrics in future research on both PR and PTR [32].

Health-Related Quality of Life (HRQoL)

Recent studies have emphasized the significant improvements in health-related quality of life (HRQoL) resulting from pulmonary rehabilitation programs. A recent systematic review summarizing 19 RCTs involving 1146 participants with COPD concluded that PR significantly improved the quality of life of patients with COPD with a clinically significant reduction in the SGRQ total score, Symptoms Score, Impacts Score, and activity score [26].

Another systematic review of 12 studies demonstrated that PR delivered conventionally or online had the same efficacy on physical activity and QOL with the advantage of simplicity, convenience, and hence sustainability [27].

Adherence and Engagement:

Though PR is proven to improve QOL, less than 3% of people with chronic lung diseases access PR programs. Adherence is crucial for the optimization of both short and long-term outcomes. The low participation rate and high dropout rates
could be alleviated by Home-based PR programs which could overcome transportation issues, financial difficulties, disruption of daily routines, and accessibility to rehabilitation in distant locations [28].

Tele-rehabilitation patients had a relatively higher exercise time, high adherence and patient satisfaction, and participation was risk-free. Tele-rehabilitation could be a viable alternative rehabilitation approach for COPD patients, as well as a potentially effective tool for increasing COPD-positive behavioral change toward a more physically active lifestyle.7. But the potential lack of knowledge and technical skills among TR providers and service users, lack of secure platform and resources with connectivity issues will have to be addressed both in LMICs and HIC before Tele rehab is used to its full potential [29].

Cost-effectiveness and Accessibility
Because of limited consultation time to address patient concerns, internet sources recommended by health care providers can be used to provide PR to patients according to their requirements. Smartphone applications have also demonstrated consistent improvement in PA and improved symptoms in patients with COPD at 6 months [30, 31].

Studies that compare telerehabilitation to center-based pulmonary rehabilitation primarily focus on people living with stable chronic obstructive pulmonary disease, where equivalent improvements in exercise capacity, health-related quality of life, and symptoms are seen.

Telerehabilitation may address travel burden, and improve schedule flexibility and geographic disparity, but the satisfaction of healthcare interactions and delivering core components of initial patient assessment and exercise prescription from a distance may be difficult. A balance between the two would make PR both cost-effective and accessible.

Discussions
The discussions surrounding telehealth interventions in chronic obstructive pulmonary disease (COPD) management highlight both the opportunities and challenges in leveraging technology to improve patient outcomes. Telehealth, including telemedicine and telerehabilitation, has emerged as a
promising approach to enhance access to care, deliver personalized interventions, and empower patients in managing their condition.

One key point of discussion is the effectiveness of telehealth PR programs in improving exercise capacity, self-efficacy, and quality of life for COPD patients. Wherein, in-home telehealth PR with virtual supervision, have demonstrated positive outcomes, indicating the potential of telerehabilitation to promote physical activity and well-being among COPD patients. Additionally, the accessibility and convenience offered by innovative telemedicine platforms present valuable alternatives to traditional face-to-face sessions, particularly for patients facing barriers such as transportation issues and limited access to rehabilitation facilities. These platforms leverage technologies such as real-time interactive sessions and mobile applications to deliver tailored interventions and enhance patient engagement.

However, discussions also highlight challenges and considerations in implementing telehealth interventions effectively. These include addressing technical issues, ensuring data security and privacy, enhancing healthcare provider and user knowledge of telehealth tools, and addressing disparities in access to technology, especially in resource-limited settings.

In conclusion, telehealth interventions have the potential to revolutionize COPD management by improving access to care, enhancing patient engagement, and optimizing healthcare delivery. While challenges exist, such as ensuring the quality and security of telehealth platforms and addressing technical and knowledge gaps, collaborative efforts between healthcare providers, technology developers, policymakers, and patients are essential to harnessing the full benefits of telemedicine in COPD care. Continued research, innovation, and investment in telehealth infrastructure are crucial to advancing the field and improving outcomes for individuals living with COPD.

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MEDICINE AND PHARMACY

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