



# Telehealth and telemedicine in the management of adult patients after hospitalization for COPD exacerbation: a scoping review

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## ABSTRACT

**Objective:** A substantial number of people with COPD suffer from exacerbations, which are defined as an acute worsening of respiratory symptoms. To minimize exacerbations, telehealth has emerged as an alternative to improve clinical management, access to health care, and support for self-management. Our objective was to map the evidence of telehealth/telemedicine for the monitoring of adult COPD patients after hospitalization due to an exacerbation. **Methods:** Bibliographic search was carried in PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science, Scopus, *Biblioteca Virtual de Saúde*/LILACS and Cochrane Library databases to identify articles describing telehealth and telemonitoring strategies in Portuguese, English, or Spanish published by December of 2021. **Results:** Thirty-nine articles, using the following concepts (number of articles), were included in this review: telehealth (21); telemonitoring (20); telemedicine (17); teleconsultation (5); teleassistance (4); telehomecare and telerehabilitation (3 each); telecommunication and mobile health (2 each); and e-health management, e-coach, telehome, telehealth care and televideo consultation (1 each). All these concepts describe strategies which use telephone and/or video calls for coaching, data monitoring, and health education leading to self-management or self-care, focusing on providing remote integrated home care with or without telemetry devices. **Conclusions:** This review demonstrated that telehealth/telemedicine in combination with telemonitoring can be an interesting strategy to benefit COPD patients after discharge from hospitalization for an exacerbation, by improving their quality of life and reducing re-hospitalizations, admissions to emergency services, hospital length of stay, and health care costs.

**Keywords:** Pulmonary disease, chronic obstructive; Symptom flare up; Telemedicine; Patient discharge.

## INTRODUCTION

COPD is one of the major causes of morbidity and mortality worldwide, causing substantial economic and social burden. People with COPD suffer from this disease for years and die prematurely from the disease or its complications.<sup>(1)</sup> The WHO has predicted that COPD will be the third leading cause of death worldwide, being responsible for approximately 6% of total deaths.<sup>(2)</sup>

A substantial number of people with COPD suffer from exacerbations, which are defined as an acute worsening of respiratory symptoms that require a change in treatment. Exacerbations are an important health problem and are related to worse survival.<sup>(3)</sup>

As a result of the high prevalence of COPD in adults and the advances in the treatment of COPD, the demand for health services has increased.<sup>(4)</sup> To alleviate the burden,

telehealth has emerged as an alternative for improving clinical management in chronic respiratory diseases.<sup>(5)</sup>

According to the WHO, telemedicine and telehealth can be used as synonyms to encompass a wide definition of remote care. Telemedicine is defined as the delivery of health care services by health care professionals, where distance is a critical factor, using communication technologies for the exchange of valid information for diagnosis, treatment, and prevention of disease and injuries, as well as for research, evaluation, and continuing education of health care providers, aiming at the interests of individuals and communities. Some authors distinguish telemedicine from telehealth by considering the former to be restricted to physicians and the latter to comprise health professionals in general.<sup>(6)</sup>

Telehealth/telemedicine can be delivered by different technologies such as terrestrial and wireless

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communication, wearable devices, videoconferencing, internet platforms, mobile applications, among others.<sup>(7)</sup> These technologies can operate synchronously (e.g., real-time video conferencing or telephone call) or asynchronously (e.g., remote consultation using e-mail, smartphone messages, notifications, and recording and communicating symptoms to health care providers).<sup>(4)</sup>

In people with COPD, telehealth/telemedicine has a wide range of applicability, such as to increase accessibility to health care for patients living in remote areas, to decrease the demand on hospital and health care services, to promote health education, to deliver and to manage treatment, to measure treatment adherence, and to identify disease worsening rapidly.<sup>(8)</sup>

The COVID-19 pandemic drew attention to the necessity of incorporating telehealth/telemedicine into the usual clinical management in chronic respiratory diseases. Special attention should be given to exacerbations in chronic respiratory diseases, which are responsible for the increased demand for health care services and are related to worse outcomes. Therefore, it is important to know which strategies have been used in telehealth/telemedicine, how they have been used, and what effects they have had on the management of a COPD exacerbation.

The objective of this scoping review was to map the evidence of telehealth/telemedicine for the monitoring of adult COPD patients after hospitalization due to an exacerbation.

## METHODS

### Search strategy and selection of telehealth/telemedicine applications

This scoping review is registered on Open Science Framework (<https://osf.io/d8gp7>). It was based on

the Preferred Reporting Items for Systematic Reviews and Meta-Analyses—Scoping Review (PRISMA-ScR10) Statement<sup>(9)</sup> and was conducted according to the Joanna Briggs Institute Manual.<sup>(10)</sup> This method allows mapping the concept and clarifying definitions used in the literature.<sup>(11)</sup>

The research question was defined based on the Population, Concept and Context framework<sup>(10)</sup> as follows: population—adult patients hospitalized for COPD exacerbation; concept—telehealth/telemedicine strategies; and context—discharge after hospitalization. The guiding question was: “What is the scientific evidence on telehealth/telemedicine strategies for the management of adult patients after hospital stay for a COPD exacerbation?”

Bibliographic search was carried in PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science, Scopus, *Biblioteca Virtual de Saúde/LILACS* and Cochrane Library databases between August and September of 2020 and later, in December of 2021. The search strategy was customized for each database, and the respective keywords, descriptors, and combinations are presented in Chart 1.

### Assessment criteria

The eligibility criteria were studies that have used telehealth/telemedicine, describing the strategies applied in detail. The articles should describe telehealth/telemedicine strategies delivered to adult patients after hospitalization due to a COPD exacerbation, be electronically available, and have been published in Portuguese, English, or Spanish by December of 2021. Exclusion criteria were articles not available in full, and dissertations, theses, end-of-course works, texts from the Internet, editorials, theoretical essays, and reflective texts.

**Chart 1.** Search strategies (keywords, descriptors, and combinations).

Database	Search strategy
Scopus Cochrane Library Web of Science PubMed-Medline CINAHL	(“Pulmonary Disease, Chronic Obstructive” OR “Airflow Obstruction, Chronic” OR “Airflow Obstructions, Chronic” OR “COAD” OR “COPD” OR “Chronic Airflow Obstruction” OR “Chronic Airflow Obstructions” OR “Chronic Obstructive Airway Disease” OR “Chronic Obstructive Lung Disease” OR “Chronic Obstructive Pulmonary Disease” OR “Lung Diseases”) AND (“Telemonitoring” OR “Telemedicine” OR “Remote Consultation” OR “Cell Phone” OR “Mobile Applications”) AND (“Patient Discharge” OR “Hospitalization”)
BVS/LILACS	(“Pulmonary Disease, Chronic Obstructive” OR “Enfermedad Pulmonar Obstrutiva Crónica” OR “Doença Pulmonar Obstrutiva Crônica” OR “COAD” OR “COPD” OR “DPOC” OR “Doença Obstrutiva Crônica Pulmonar” OR “Doença Obstrutiva Crônica das Vias Aéreas” OR “Doença Obstrutiva Crônica do Pulmão” OR “Obstrução Crônica do Fluxo Respiratório” OR “Obstrução do Fluxo Respiratório Crônica” OR “Airflow Obstruction, Chronic” OR “Airflow Obstructions, Chronic” OR “Chronic Airflow Obstruction” OR “Chronic Airflow Obstructions” OR “Chronic Obstructive Airway Disease” OR “Chronic Obstructive Lung Disease” OR “Chronic Obstructive Pulmonary Disease” OR “Lung Diseases” OR “Enfermedades Pulmonares” OR “Pneumopatias”) AND (“Telemonitoring” OR “Telemonitorización” OR “Telemonitoramento” OR “Telemedicine” OR “Telemedicina” OR “Remote Consultation” OR “Consulta Remota” OR “Cell Phone” OR “Teléfono Celular” OR “Telefone Celular” OR “Mobile Applications” OR “Aplicaciones Móviles” OR “Aplicativos Móveis”) AND (“Patient Discharge” OR “Alta del Paciente” OR “Alta do Paciente” OR “Alta Hospitalar” OR “Alta do Hospital” OR “Planejamento da Alta” OR “Hospitalization” OR “Hospitalización” OR “Hospitalização”)

CINAHL: Cumulative Index to Nursing and Allied Health Literature; and BVS: *Biblioteca Virtual de Saúde*.

### Selection and data extraction

Initially, the studies were compiled in the EndNote software, and two independent reviewers read the titles and abstracts. Full-text articles were reviewed using the selection criteria. The reviewers compared their selections, and disagreements were discussed and resolved by consensus.

Data from the included studies were extracted independently by the reviewers using a structured data extraction form. The data recorded were country of origin, study design, professionals responsible to deliver telehealth/telemedicine, study aims, and outcomes.

### RESULTS

A total of 1,250 articles were selected, and 39 articles were included in this review. Reasons for exclusion were nature of publication, different populations from that investigated in this study, and lack of description of the telehealth/telemedicine intervention delivered (Figure 1).

#### Characteristics of included studies

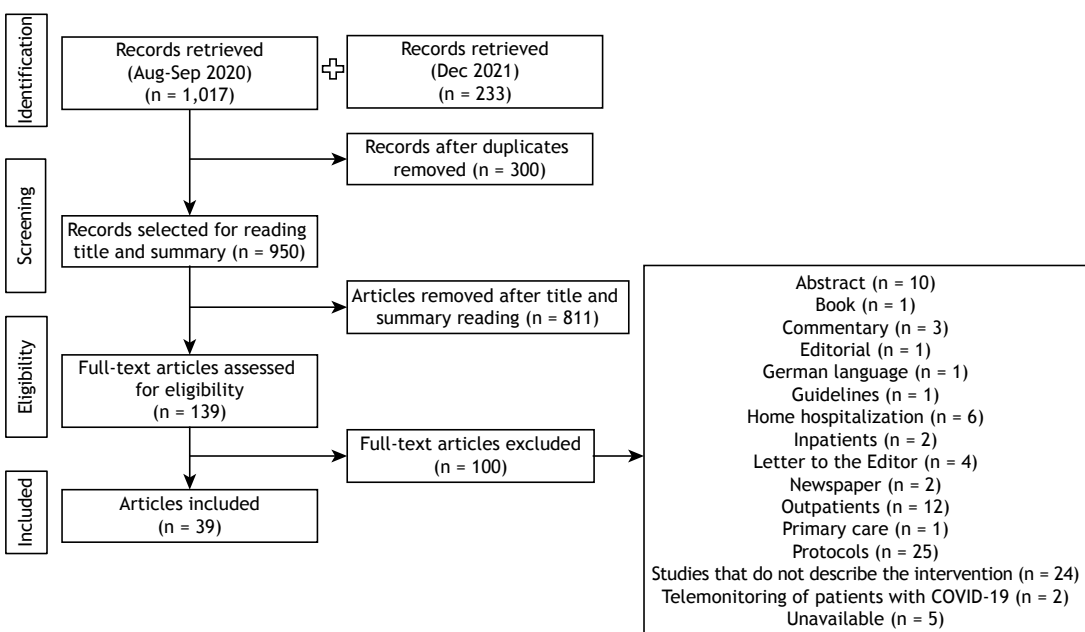
The studies included comprised 21 clinical trials, 14 observational studies, 2 qualitative studies, and 2 feasibility studies. The concepts used were telehealth, in 21 studies; telemonitoring, in 20; telemedicine, in 17; telecare, in 4; teleconsultation, in 5; teleassistance, in 4; tele homecare, in 3; telerehabilitation, in 3; telecommunication, in 2; mobile health in 2; e-health-management, in 1; e-coach, in 1; tele home, in 1; telehealth care, in 1; and tele-video-consultation, in 1. The objectives and outcomes of each study are summarized in Chart 2.<sup>(8,12-49)</sup>

### Variation among terms used to deliver remote care

The most commonly used terms to describe the delivery of remote health care were "telehealth"<sup>(13,17,19,21,22,23,29,31,32,33,34,36,37,38,39,40,42,43,44,46,48)</sup> and "telemonitoring."<sup>(15,16,18,21,22,24,25,29,30,32,33,34,35,37,38,40,41,42,43,48)</sup> The terms "telemedicine",<sup>(8,12,13,14,16,17,18,20,23,24,26,28,30,37,38,47,48)</sup> "telecare," "teleassistance," "tele homecare," "teleconsultation," or "telecommunication" were used as interchangeable terms. All of these concepts were used in order to describe strategies that use telephone and/or video calls for coaching, data monitoring, and health education leading to self-management or self-care. "Telemonitoring" was used with the terms "home monitoring", "monitoring intervention," and "monitoring system" to refer to the monitoring of signs and symptoms for prevention of exacerbations. The term "telerehabilitation" was specifically used for pulmonary rehabilitation.<sup>(19,28)</sup> The term "mobile health" (mHealth) referred to medical or health care interventions delivered through mobile technology (e.g., smartphones) in the studies.<sup>(45,49)</sup>

#### Remote care interventions

The most common interventions were health education to support self-management improvement, rehabilitation, and monitoring of signs/symptoms by treatment management, counseling, motivation, and prevention of exacerbations. The main key concepts related to remote consultations of COPD patients after discharge focused on providing remote integrated home care with or without the use of telemetry devices (Figure 2).



**Figure 1.** Flow chart of study selection process for inclusion in the systematic review and meta-analysis in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses diagram.

**Chart 2.** Overview of selected studies. Scoping review, 2022.

Author, country, year	Study design	Professionals responsible for delivering telehealth	Objective of the study	Sample size	Concept	Strategy	Outcomes
Vitacca et al, Italy, 2018 <sup>(6)</sup>	Observational study	Nurse, physician.	To test the feasibility of and patient satisfaction with an advanced care plan for severe COPD patients followed by teleassistance at home for six months, focusing on monitoring patient's palliative topics by means of a dedicated checklist	N = 10	Telemedicine Teleassistance	Phone call	High level of satisfaction of the service
Ratner et al., USA, 2001 <sup>(12)</sup>	Clinical trial	Nurse, doctor	To describe the Wealth from Health program, which utilizes current and future technologies to help the health care system become a leader in health care delivery and to assist many communities at an affordable cost	N = 78 Intervention vs. control groups <sup>a</sup>	Telemedicine Telecommunication	Phone call	Reduction in re-hospitalizations and medical costs  Improvement in quality of life
Vontetsianos et al., Greece, 2005 <sup>(13)</sup>	Clinical trial	Nurse, doctor, physiotherapist, social worker, clinical psychologist, dietician, and pharmacist	To evaluate the clinical utility of an advanced system of e-health services in home-based integrated care for patients suffering mainly from COPD	N = 18 Intervention vs. control groups <sup>a</sup>	Telehealth Telemedicine	Video call	Reduction in hospitalizations, emergency department visits, and use of health services  Improvement in disease knowledge, self-management, and perception of the quality of life
Finkelstein et al, USA, 2006 <sup>(14)</sup>	Clinical trial	Nurse	To identify and document the benefits of a telemedicine application compared with standard care for homebound patients receiving home health services after an acute hospitalization for a long-term condition	N = 53 Intervention (n = 35) vs. control (n = 18) groups	Telemedicine Telehomecare Telecommunication	Telemetry/ Data sending Video call	Total costs were lower after study period Reduction in costs to deliver home healthcare
Vitacca et al., Italy, 2006 <sup>(15)</sup>	Observational study	Nurse, doctor	To test the feasibility of telemedicine out of hospital use	N = 45	Telemonitoring Teleassistance Teleconsultation	Telemetry/ Data sending	Feasibility of home monitoring

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**Chart 2.** Overview of selected studies. Scoping review, 2022. (Continued...)

Author, country, year	Study design	Professionals responsible for delivering telehealth	Objective of the study	Sample size	Concept	Strategy	Outcomes
Trappenburg et al., Netherlands, 2008 <sup>(16)</sup>	Clinical trial	Respiratory nurse, general practitioner, pulmonary physician	To determine the effects of a home-based telemonitoring device, the Health Buddy, on health consumption and HRQoL in patients with moderate to severe COPD	N = 115 Intervention (n = 59) vs. control (n = 56) groups	Telemedicine Telemonitoring	Phone call Message	Reduction in the number of exacerbations and hospitalizations
Cardozo & Steinberg, USA, 2010 <sup>(17)</sup>	Observational study	Nurse, physiotherapist, occupational therapist, social work, and dietician	To evaluate whether case-managed telemedicine as a care delivery system is practical and accepted by elderly patients and could lead to a reduction of costs to the health system, lower emergency care and readmission rates, and provide improved clinical outcomes	N = 851	Telehealth Telemedicine	Telemetry/ Data sending	Reduction in re-hospitalizations and emergency visits  improvement in disease, knowledge, and quality of life
Sorknaes et al., Denmark, 2011 <sup>(18)</sup>	Clinical trial	Respiratory nurse	To investigate the effect of telemedicine/video consultations between respiratory nurses at the hospital and patients with exacerbated COPD after hospital discharge on early readmissions	N = 100 Intervention (n = 50) vs. control (n = 50) groups	Telecare Telehome Telemedicine Telemonitoring Teleconsultations	Video call Phone call Telemetry/ Data sending	Reduction in hospitalizations and median length of stay
Dinesen et al., Denmark, 2012 <sup>(19)</sup>	Clinical trial	Nurse and general practitioner	To test whether preventive home monitoring of COPD patients would reduce hospital admission rates and hospitalization costs	N = 105 Intervention (n = 57) vs. control (n = 48) groups	Telehealth Telerehabilitation	Telemetry/ Data sending Video call	Reduction in admissions during the 10-month follow-up period
Sorknaes et al., Denmark, 2013 <sup>(20)</sup>	Clinical trial	Nurse	To investigate the effect of daily real-time teleconsultations	N = 100 Intervention (n = 50) vs. control (n = 50) groups	Telemedicine Teleconsultation	Telemetry/ Data sending Video call	No significant difference in re-hospitalizations and mortality rate
Bentley et al., England, 2014 <sup>(21)</sup>	Clinical trial	Specialist nurse, specialist physiotherapist, and community matron.	To report the results of a pilot randomized controlled trial of telehealth-supported care within a community-based COPD supported-discharge service	N = 63 Intervention (n = 32) vs. control (n = 31) groups	Telehealth Telemonitoring	Telemetry/ Data sending	Reduction in the proportion of hospitalizations and improvement in quality of life

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**Chart 2.** Overview of selected studies. Scoping review, 2022. (Continued...)

Author, country, year	Study design	Professionals responsible for delivering telehealth	Objective of the study	Sample size	Concept	Strategy	Outcomes
Segrelles Calvo et al., Spain, 2014 <sup>(22)</sup>	Clinical trial	Nurse, pulmonary physician	To assess the efficacy and effectiveness of a home telehealth program for COPD patients with severe airflow obstruction by measuring the number of emergency room visits, number of hospitalizations, length of hospital stay, and mortality	N = 60 Intervention (n = 30) vs. control (n = 30)	Telehealth Telemonitoring	Phone call Telemetry/ Data sending	Reduction in the number of emergency room visits, number of hospitalizations, length of hospital stays, need for noninvasive ventilation, and number of days to first exacerbation requiring hospitalization
Gottlieb et al., Denmark, 2014 <sup>(23)</sup>	Observational study	Nurse, pulmonary physician	To assess the feasibility of a telehealth care solution when offered in connection with discharge from a pulmonary ward at a university hospital	N = 72	Telecare Telehealth Telemedicine Telehealth care	Video call	No significant difference in re-hospitalizations
Salen et al., Norway, 2014 <sup>(24)</sup>	Observational study	Specialist respiratory nurse	To assess the impact of telemedicine video consultations on the length of re-admission stays within 6 and 12 months of follow up after telemedicine video-consultations	N = 99	Telemedicine Telemonitoring Tele-video-consultation	Video call	Reduction in the number of patients readmitted due to COPD exacerbations
Davis et al, USA, 2015 <sup>(25)</sup>	Observational study	Nurse	To determine the feasibility of a transitional care program that integrated mobile health technology and home visits for underserved COPD and chronic heart failure patients and to evaluate preliminary program outcomes related to acute care utilization	N = 149	Telemonitoring	Phone call Interactive voice Telemetry/ Data sending	Reduction in re-hospitalizations
Dyrvig et al., Denmark, 2015 <sup>(26)</sup>	Observational study	Nurse	To investigate the effectiveness of a telemedicine intervention in COPD patients during, before, and after an RCT while adjusting for age and gender	N = 11,303	Telemedicine	Video call	Increased risk of re-hospitalizations  Reduction in the risk of death
Mierdel & Owen, Canada, 2015 <sup>(27)</sup>	Observational study	N/R	To evaluate pre- and post-enrollment and post-discharge data captured by the William Osler Health System's telehomecare host	N = 466	Telehomecare	Phone call Telemetry/ Data sending	Reduction in emergency department use, hospitalizations, and mean length of stay

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**Chart 2.** Overview of selected studies. Scoping review, 2022. (Continued...)

Author, country, year	Study design	Professionals responsible for delivering telehealth	Objective of the study	Sample size	Concept	Strategy	Outcomes
Rosenbek Minet et al., Denmark, 2015 <sup>(28)</sup>	Clinical trial	Nurse, physiotherapist	To assess the feasibility of an individualized home-based training and counseling program via videoconference to patients with severe COPD after hospitalization, including assessment of safety, clinical outcomes, patients' perceptions, organizational aspects, and economic aspects	N = 50 Intervention vs. control groups <sup>a</sup>	Telemedicine Telerehabilitation	Video call	Improvement in the continuity of the rehabilitation program
Chatwin et al., England, 2016 <sup>(29)</sup>	Clinical trial	Study team	To assess the impact of home telemonitoring on health service use and quality of life in patients with severe chronic lung disease	N = 175 Intervention (n = 114) vs. control (n = 61) groups	Telecare Telehealth Telemonitoring Teleassistance	Phone call Telemetry/ Data sending	No difference in the median number of days to the first admission  Increased hospital admission rate, and home visits  Improvement in depression rate  No improvement in quality of life
Cordova et al., USA, 2016 <sup>(30)</sup>	Clinical trial	Nurse, pulmonologists	To investigate whether telemedicine-based daily symptom reporting plus optimal medical therapy decreases hospitalizations and COPD-related mortality, as well as the frequency and severity of acute COPD exacerbation symptoms, in high-risk patients	N = 67 Intervention (n = 34) vs. control (n = 33) groups	Telemedicine Telehomecare Teleassistance Telemonitoring	Phone call	Improvement in daily peak flow and dyspnea scores  No differences in hospitalization and mortality rates
Fitzsimmons et al., Canada/UK, 2016 <sup>(31)</sup>	Qualitative study	Nurse, physician	To explore qualitatively the experiences of patients with COPD who had received either a telehealth-supported or a specialist nursing intervention following hospital discharge after an admission for a COPD exacerbation	N = 29	Telehealth	Phone call Telemetry/ Data sending	Reduction in home visits by clinicians

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**Chart 2.** Overview of selected studies. Scoping review, 2022. (Continued...)

Author, country, year	Study design	Professionals responsible for delivering telehealth	Objective of the study	Sample size	Concept	Strategy	Outcomes
Ho et al., Taiwan, 2016 <sup>(32)</sup>	Clinical trial	Nurse, pulmonologists	To investigate the effectiveness of telemonitoring in improving COPD patient outcomes	N = 106 Intervention (n = 53) vs. control (n = 53) groups	Telehealth Telemonitoring	Phone call Telemetry/ Data sending	Increase in the time to first re-hospitalization for COPD exacerbation  Reduction in the number of all-cause readmissions and emergency room visits
Ritchie et al., USA, 2016 <sup>(33)</sup>	Clinical trial	Nurse	To evaluate the impact of a technology-supported care transition support program on hospitalizations, days out of the community, and mortality	N = 478 Intervention vs. control groups <sup>a</sup>	e-coach Telehealth Telemonitoring	Phone call Interactive voice response Telemetry/ Data sending	No difference in re-hospitalizations  Reduction in length of hospital stay
Vianello et al., Italy, 2016 <sup>(34)</sup>	Clinical trial	Nurse, pulmonologist, and general practitioner	To investigate the benefits of a telemonitoring system in managing acute exacerbations in advanced-stage COPD patients to improve their HRQoL and to reduce utilization of healthcare services	N = 334 Intervention (n = 230) vs. control (n = 104) groups	Telehealth Telemonitoring	Phone call Telemetry/ Data sending	No significant difference in hospitalizations  Reduction in readmission rate for acute exacerbations of COPD or for any cause  No significant differences in anxiety and depression  No significant difference in HRQoL
Crooks et al., UK, 2017 <sup>(35)</sup>	Observational study	Study team	To describe a novel monitoring system used to record cough continuously for up to 45 days during acutely exacerbated COPD convalescence	N = 16	Telemonitoring	Telemetry/ Data sending	Improvement in early identification of exacerbations

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**Chart 2.** Overview of selected studies. Scoping review, 2022. (Continued...)

Author, country, year	Study design	Professionals responsible for delivering telehealth	Objective of the study	Sample size	Concept	Strategy	Outcomes
Kargiannakis et al., UK, 2017 <sup>(36)</sup>	Clinical trial	Nurse, doctor	To undertake the first analysis of system data to determine whether telehealth monitoring can identify a COPD exacerbation, giving clinicians an opportunity to intervene with timely treatment and prevent hospital readmission	N = 23	Telehealth	Phone call Telemetry/ Data sending	No significant reduction in the re-hospitalizations
Scalvini et al., Italy, 2018 <sup>(37)</sup>	Observational study	Nurse- and physician-directed	To describe a personal experience at the Centre for Telehealth and Telecare in providing continuity of care for patients with a chronic illness	N = 1,635	Telecare Telehealth Telemedicine Telemonitoring e-health management	Video call Phone call Telemetry/ Data sending	Reduction in re-hospitalization rate and costs  Improvement in quality of life and patient satisfaction with the service
Barken et al., Norway, 2018 <sup>(38)</sup>	Qualitative study	Nurse	To describe the lived experiences of quality of life among a group of patients living with COPD who had been included in a telemedical intervention after hospitalization for disease exacerbation	N = 10	Telehealth Telemedicine Telemonitoring	Video call Phone call Telemetry/ Data sending	Increased accessibility to health care services and improvement in quality of life
Fors et al., Sweden, 2018 <sup>(39)</sup>	Clinical trial	Nurse	To evaluate the effects of person-centered support via telephone in two chronically ill patient groups: COPD and/or heart failure	N = 221  Intervention (n = 103) vs. control (n = 118) groups	Telehealth	Phone call	No significant difference in the composite score consisted of general self-efficacy, re-hospitalization, and death
Soriano et al., Spain, 2018 <sup>(40)</sup>	Clinical trial	Nurse	To clarify the impact of telehealth on outcomes and costs over a 12-month time frame, and in a large sample of COPD patients	N = 169  Intervention (n = 87) vs. control (n = 82) groups	Telehealth Telemonitoring	Phone call Telemetry/ Data sending	No significant difference in COPD-related emergency room visits or hospitalizations
Walker et al., Spain, UK, Slovenia, Estonia, and Sweden, 2018 <sup>(41)</sup>	Clinical trial	Nurse	To evaluate the efficacy of home monitoring of lung mechanics by the forced oscillation technique and cardiac parameters in older patients with COPD and comorbidities	N = 312  Intervention vs. control groups <sup>a</sup>	Telemonitoring	Phone call Telemetry/ Data sending	No significant difference in quality of life and hospitalization rate  Fewer re-hospitalizations

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**Chart 2.** Overview of selected studies. Scoping review, 2022. (Continued...)

Author, country, year	Study design	Professionals responsible for delivering telehealth	Objective of the study	Sample size	Concept	Strategy	Outcomes
Bohingamu Mudiwanselage et al., Australia, 2018 <sup>(42)</sup>	Clinical trial	Nurse, doctor	To assess the impact of home-based telehealth monitoring on health outcomes, quality of life, and costs over 12 months in patients with diabetes and/or COPD who were identified as being at high risk of hospital readmission	N = 171 Intervention (n = 86) vs. control (n = 85) groups	Telehealth Telemonitoring	Message Video call Phone call	No significant difference in the number of re-hospitalizations  Reduction in length of hospital stay  Improvement in anxiety, depression, and health literacy  Improvement in quality of life at no additional costs
Lyth et al., Sweden, 2019 <sup>(43)</sup>	Observational study	Nurse, doctor	To investigate the effects of the intervention on healthcare costs, number of hospitalizations, and other care required in patients with COPD and heart failure	N = 94 COPD patients (n = 36) and heart failure patients (n = 58)	Telehealth Telemonitoring	Message Telemetry/ Data sending	Reduction in hospitalization costs, but total health care costs was not significantly different from the expected costs
Arcilla et al., USA, 2019 <sup>(44)</sup>	Clinical trial	Nurse	To prove that the implementation of transitional care interventions in high-risk patients with COPD, heart failure, or diabetes mellitus after hospital discharge can reduce the number of readmissions	N = 102  Intervention vs. control groups <sup>a</sup>	Telehealth	Phone call Interactive voice Telemetry/ Data sending	Reduction in the number of hospitalizations and 30-day re-hospitalization rates
Bentley et al., UK, 2020 <sup>(45)</sup>	Randomized feasibility study	Physiotherapist	To determine the feasibility and acceptability of the SMART-COPD intervention for the self-management of physical activity and to explore the feasibility of conducting a future RCT to investigate its effectiveness	N = 63  Intervention (n = 31) vs. control (n = 31) groups	mHealth	Telemetry/ Data sending	Feasibility of home monitoring  (mHealth shows promise in helping people with COPD self-manage their physical activity levels)

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**Chart 2.** Overview of selected studies. Scoping review, 2022. (Continued...)

Author, country, year	Study design	Professionals responsible for delivering telehealth	Objective of the study	Sample size	Concept	Strategy	Outcomes
Wang et al., China, 2020 <sup>(46)</sup>	Clinical trial	Nurse	To investigate the effects of a mobile health smartphone application to support self-management programs on quality of life, self-management behavior, exercising, and smoking cessation behavior in patients with COPD	N = 78 Intervention (n = 39) vs. control (n = 39) groups	Telehealth	Telemetry (Application smartphone)	Improvement in the quality of life and self-management behavior
Leonard et al., USA, 2020 <sup>(47)</sup>	Observational study	Respiratory therapist, pulmonary physician	To investigate the effect of home non-invasive ventilation plus the implementation of a call center following hospitalization for acute exacerbations	N = 20	Telemedicine	Phone call	No significant reduction in the re-hospitalizations  Statistically significant difference to adherence to noninvasive ventilation
Marcos et al., Spain, 2020 <sup>(48)</sup>	Observational study	Pulmonologist, nurse	To demonstrate if a telemonitoring system after hospital admission for a COPD exacerbation could have a favorable effect in 1-year readmissions and mortality in a real-world setting	N = 843 Intervention (n = 351) vs. control (n = 495) groups	Telehealth Telemedicine Telemonitoring Teleconsultation	Video call Telemetry/ Data sending	Reduced mortality and readmission after 12 months
Kooij et al., Netherlands, 2021 <sup>(49)</sup>	Feasibility study	Pulmonary nurse, pulmonologist	To evaluate the effects of a mobile health and self-management application in clinical practice for recently discharged patients with COPD	N = 39	mHealth	Video call Telemetry/ Data sending	Knowledge and coping increased significantly over time  No significant changes in recognition and management of symptoms, or adherence to treatment  Readmission rate showed that 13% (5/39) of patients were readmitted within 30 days

N/R: not reported; RCT: randomized controlled trial; SMART-COPD: Self-Management supported by Assistive, Rehabilitative, and Telehealth technologies-COPD; HRQoL: health-related quality of life; and mHealth: mobile health. <sup>a</sup>Numbers not mentioned by the authors.

### **Professionals responsible to deliver remote care**

The professionals majorly involved in telehealth delivery were nurses (in 35 studies) alone or together with multidisciplinary teams (Chart 2).

### **Remote applications and frequency of delivery of remote care**

Most studies that described the remote monitoring of COPD patients after discharge from hospitalization for a COPD exacerbation used multiple strategies, different frequencies, and different applications. These strategies were organized into four groups: telephone calls, video calls, telemetry (alone or in combination with interactive voice response), and text messages (Figure 2). In the study by Wang et al.,<sup>(46)</sup> the patient, whenever necessary, used an application installed in the smartphone (Chart 2).

### **Effectiveness of remote care**

The outcome investigated in 27 articles was hospital readmissions. Of these, 18 showed a reduction in the number of re-hospitalizations,<sup>(12,13,16,17,18,19,21,22,24,25,27,32,34,37,43,44,48,49)</sup> although no significant differences in the number of re-hospitalizations were found in 13 studies using telehealth/telemedicine strategies.<sup>(20,23,24,29,30,33,34,36,39,40,41,42,47)</sup> Quality of life was an outcome investigated in 13 studies, 9 of which showing favorable results with the use of telehealth/telemedicine.<sup>(12,13,17,21,37,38,39,42,46)</sup> In addition, factors associated with health literacy were pointed out as positively affecting the health of COPD patients.<sup>(13,17,42)</sup> Feasibility of home monitoring for self-management was reported in 2 studies (Chart 2).<sup>(15,45)</sup>

## **DISCUSSION**

The main findings of this scoping review were as follows: i) the great majority of strategies demonstrated a positive effect on improving health care and quality of life in patients after hospitalization for COPD; ii) remote care involved an extensive variety of health service practices for different purposes, such as exchange of information, treatment, and exacerbation prevention; iii) most studies used two or more strategies, and phone calls and devices with or without telemetry were the most common ones; and iv) a substantial number of terms described the use of remote care, and the most common terms were telehealth, telemonitoring, and telemedicine.

It was observed that telehealth/telemedicine was effective for early detection and proactive intervention in patients at home after an acute exacerbation of COPD. It seems likely that adopting telehealth/telemedicine in everyday clinical practice could substantially improve the care of chronically ill patients.<sup>(13)</sup> Telehealth/telemedicine is a type of remote intervention that involves the delivery of care through various communication modalities,

aiming at connecting patients to a health care professional and exchanging information to support self-management programs, which has shown to be effective in improving health-related quality of life and self-management behavior in patients with COPD.<sup>(46)</sup> For COPD patients, the use of telehealth/telemedicine may offer an opportunity to improve disease management and access to pulmonary rehabilitation programs.<sup>(2,8,12,17,26,45)</sup>

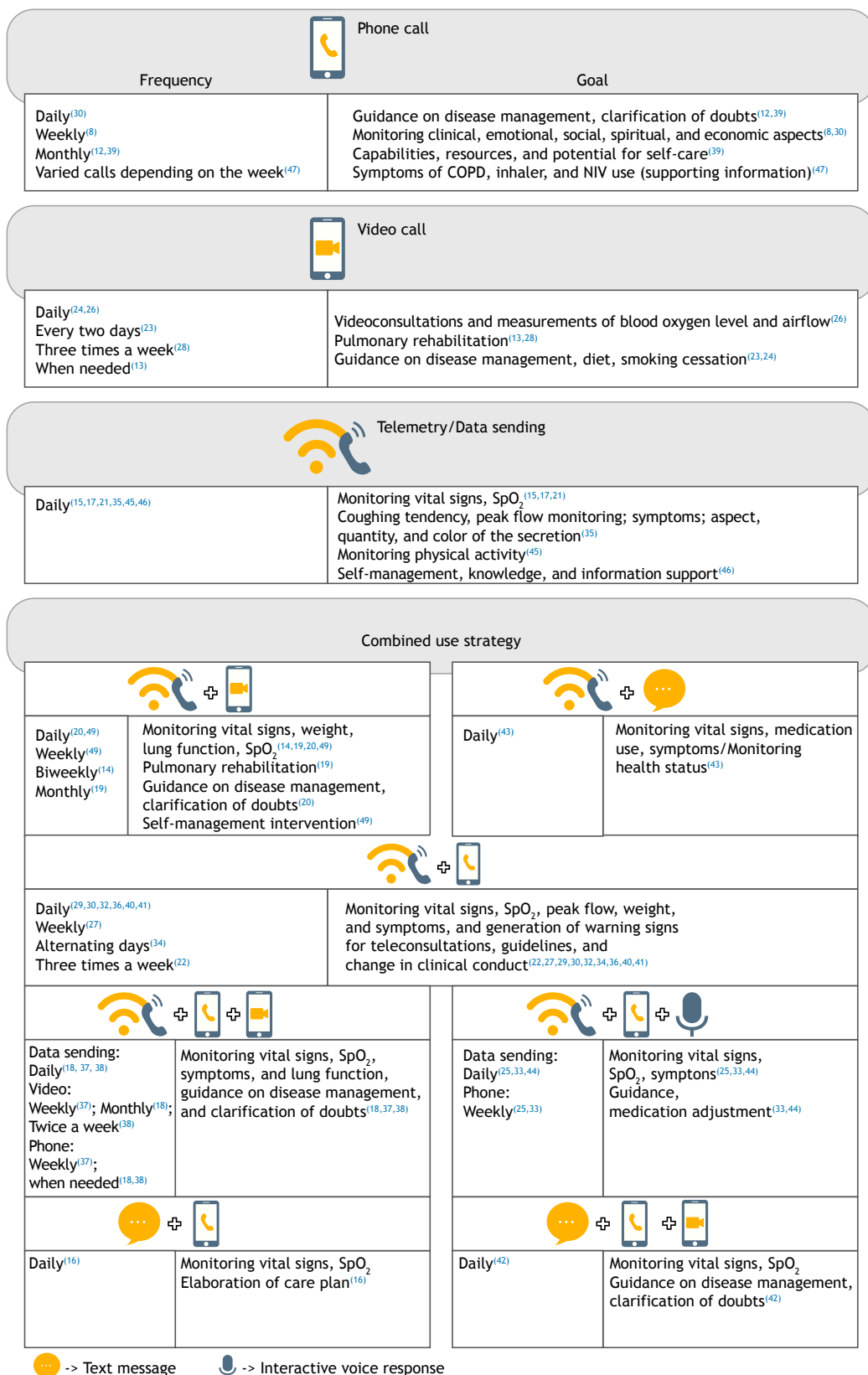
In order to improve telemonitoring effectiveness in COPD, parameters need to be well defined, easily available, and associated with COPD symptomatology.<sup>(40)</sup> Therefore, it is essential to identify the target populations among which telehealth is accepted and identify feasible interventions.<sup>(50)</sup> Defining parameters, as well as identifying and knowing the target population, leads to patient and physician satisfaction and, consequently, to the effectiveness of the proposed telemonitoring strategies.<sup>(8,40)</sup>

It is important to highlight that telemonitoring can be carried out and analyzed with or without telemetry. A telemetry system allows monitoring of physiological parameters with the use of smart wearable device systems to monitor health. A smart wearable device system may include a wide range of wearable or implantable devices, such as sensors, actuators, smart fabrics, power supplies, and wireless communication networks.<sup>(51)</sup>

Data transmitted by the devices were, in general, physiological measures (vital signs, SpO<sub>2</sub>, lung function parameters, temperature, and weight) and reported symptoms, such as shortness of breath; aspect, quantity, and color of sputum; wheezing; and cough. In this regard, telemedicine has the potential to enhance the detection of true deterioration in clinical state.<sup>(44)</sup>

Among the terms identified to refer to remote care, telehealth was used for electronic technologies that transmit or receive data.<sup>(52)</sup> Telemedicine can be effective for detecting the worsening of clinical status and reducing morbidity, mortality, and health costs due to exacerbations.<sup>(53-55)</sup>

Telehealth is a term used interchangeably with telemedicine. Telemedicine uses e-health networks to provide health services and health education at a distance.<sup>(56)</sup> The term e-health refers to a self-management web platform designed to support patients to improve self-management of exacerbations at an early stage.<sup>(47)</sup> Tele-education utilizes web-based platforms to deliver information and services that pertain to the management of patient conditions.<sup>(52)</sup> Education intervention through telehealth/telemedicine is characterized by interventions to achieve a healthy lifestyle through the practice of physical activities, correct use of medications, smoking cessation, and emotional control, as well as to enhance patient self-management.<sup>(6,14,25,26,28,34)</sup> Telehealth/telemedicine showed positive effects on COPD patients after a hospitalization for an exacerbation, playing a central



**Figure 2.** Telemonitoring strategies identified in the studies included, according to technologies used, frequency, and intervention goals. NIV: noninvasive ventilation.

role in self-management. The intangible benefits of the program include improvement in quality of life and in hospitalization rates.<sup>(44)</sup> These positive results support the importance of guidance and use of educational materials and methods to back a telephone call intervention. Teleconsultation might be used to change or adjust the pharmacological therapy, refer the patient to an emergency department, or even identify the need of a face-to-face home consultation.<sup>(50)</sup>

Teleconsultation, in which care is provided by videoconference and webcams connecting the healthcare practitioner with the patient, makes it possible to assess, diagnose, or treat patients remotely in addition to monitoring exercises and functional capacity in pulmonary rehabilitation.<sup>(52)</sup> Telemedicine consultations are agreed upon between the patient and the telemedicine nurse day to day. The nurse could advise the patient to consult with a general practitioner or contact a home care nurse.<sup>(18)</sup> Nurse telemedicine consultation seems to prevent early readmission and is associated with high patient and nurse satisfaction.<sup>(18)</sup>

Telerehabilitation by teleconsultation has a great potential for reducing the use of health care services, combining physical training at home, remote monitoring, health education, and promotion of self-management.<sup>(51)</sup> Telerehabilitation programs seem to be as effective as face-to-face sessions, which stimulates their use since they might solve the need for increasing access to health care.<sup>(53)</sup> The study by Rosenbek Minet et al.<sup>(28)</sup> showed that home-based supervised training and counseling via videoconference is safe and feasible and that telemedicine can help ensure more equitable access to supervised training in patients with severe COPD.

This review also highlights programs for the transition of care with the use of mobile health technologies to ensure safe coordination and continuity of care for patients with different health needs.<sup>(22,34)</sup> Transition of care is one of the pillars for integration of health systems, reducing hospitalizations, readmissions, and costs of health services, and it improves the quality of life of patients and their families.<sup>(57)</sup> Also, interventions capable of detecting and intervening on exacerbation signs at an early stage can minimize the need for emergency hospitalizations.<sup>(52)</sup> The combination of several strategies has better results. In addition, the integration of interactive telephone calls may result in higher rates of adherence to health care plans among patients with an exacerbation.<sup>(54)</sup> Telehealth/telemedicine interventions should consider individual factors that affect the usability, acceptability, and efficacy of the intervention.<sup>(45)</sup>

The limitations of the present review are related to the languages in which the studies were published, since we limited the research to those published in English, Portuguese, or Spanish. In addition, the fact that all of the studies included were carried out in developed countries might not reflect the reality in less developed countries.

### FINAL CONSIDERATIONS

Telehealth/telemedicine strategies seek to accompany and encourage COPD patients to self-manage their disease by identifying signs and symptoms that can lead to an exacerbation.

This review demonstrated that there is a growing body of evidence showing that telehealth/telemedicine and telemonitoring can be an interesting strategy to benefit COPD patients after discharge from hospitalization for

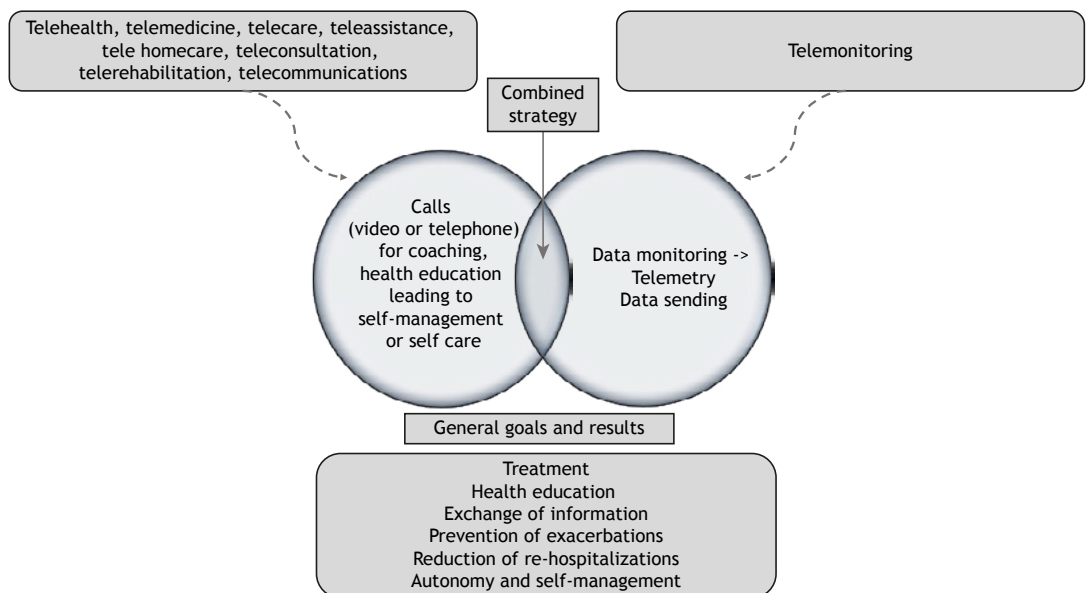


Figure 3. Telehealth mapping.

an exacerbation after being discharged by improving their quality of life and reducing re-hospitalizations, admissions to emergency services, hospital length of stay, and health care costs.

The terms to describe telehealth/telemedicine were varied and sometimes specific for different situations. The goals, the frequency of use, and the strategies adopted were also varied. Notwithstanding the differences, the great majority of studies showed that telehealth/telemedicine was beneficial regarding readmissions, quality of life, health literacy, and costs. The scope of this study is summarized in Figure 3.

## AUTHOR CONTRIBUTIONS

LCR, EGR, LCP, RAG, GMR, AFC, TBC, LPSM, VMA, and KLS: study conception, protocol design, and reference management. LCR, EGR, LCP, LPSM, VMA, and KLS: drafting of the manuscript. TBF, LPSM, VMA, and KLS: critical review of intellectual content of the manuscript. All of the authors approved the final version of the manuscript.

## CONFLICTS OF INTEREST

None declared.

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