BMJ Open

Acceptance, adherence, and dropout rates of individuals with COPD approached in telemonitoring interventions: A protocol for systematic review and meta-analysis.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-026794
Article Type:	Protocol
Date Submitted by the Author:	19-Sep-2018
Complete List of Authors:	Alghamdi, Saeed ; McGill University, School of Physical and Occupational Therapy; Umm Al-Qura University College of Applied Sciences, Department of Respiratory Care Janaudis-Ferreira, Tania; McGill University, School of Physical and Occupational Therapy; McGill University Health Center, Center for outcome research and evaluation (CORE) Alhasani, Rehab; McGill University, School of Physical and Occupational Therapy; Centre de recherche interdisciplinaire en réadaptation, Centre de Réadaptation Constance-Lethbridge, CIUSSS du Centre-Ouest-de-d'île-de-Montréal Boruff, Jill; McGill University, Schulich Library of Science and Engineering Ahmed, Sara; McGill University, School of Physical and Occupational Therapy; Centre de recherche interdisciplinaire en réadaptation, Centre de Réadaptation Constance-Lethbridge, CIUSSS du Centre-Ouest-de-d'île-de-Montréal
Keywords:	Systematic review, Meta-analysis, Telemonitoring, Telehealth, Chronic obstructive pulmonary disease, COPD

Title: Acceptance, adherence, and dropout rates of individuals with COPD approached in telemonitoring interventions: A protocol for systematic review and meta-analysis.

Authors
Saeed Alghamdi[1,2], Tania Janaudis-Ferreira[1,4,5], Rehab Alhasani[1,3], Jill Boruff[6], Sara Ahmed[1,3,4]

Affiliations
1 School of Physical and Occupational Therapy, McGill University, Montreal, QC, Canada
2 College of Applied Health Science, Umm Al Qura University, Department of Respiratory Care, Makkah, Saudi Arabia
3 Centre de recherche interdisciplinaire en réadaptation, Centre de Réadaptation Constance-Lethbridge, CIUSSS du Centre-Ouest-de-d'île-de-Montréal, Montreal QC, Canada
4 Center for outcome research and evaluation (CORE), McGill University Health Center, Montreal, QC, Canada
5 Translational Research in Respiratory Diseases program, Research Institute of the McGill University Health Centre, Montreal, Canada
6 Schulich Library of Science and Engineering, McGill University, Montreal, QC, Canada

Corresponding author
Dr Sara Ahmed, School of Physical and Occupational therapy, Faculty of Medicine, McGill University Health Center, Montreal, Quebec, H3G 1Y5, Canada.
Tel: 1 514 3984400 ext. 00531
Fax: 1 514 398 6360
Email: sara.ahmed@mcgill.ca

Keywords
Systematic review, meta-analysis, telemonitoring, telehealth, chronic obstructive pulmonary disease, COPD

Word count
2599

Registration ID number
International Prospective Register for Systematic Reviews (PROSPERO) ID number: CRD42017078541

Abstract

Introduction: Telehealth and/or telemonitoring (TM) interventions have the potential of improving exacerbation and health outcomes for individuals with Chronic Obstructive Pulmonary Disease (COPD), by delivering care in between clinical visits. However, the precise impact on avoiding exacerbation and reducing the incidence of hospital readmissions remains inconclusive. This lack of knowledge on the effectiveness of telehealth and telemonitoring for COPD care might be due to non-adherence or partial adherence to the intervention and/or the withdrawal of participants over the course of previous studies.

Objectives: To conduct a systematic review of experimental and non-experimental studies to: (1) estimate the acceptance, adherence, and dropout rates in experimental and observational studies; (2) identify the reasons for dropout from TM interventions among individuals with COPD; (3) evaluate the impact of trial-related, sociodemographic, and intervention-related factors on the acceptance, adherence, and dropout rates; and (4) estimate the extent to which the acceptance, adherence, and dropout rates impact outcomes in comparison with usual monitoring.

Methods and analysis: A systematic literature review of four databases will be carried out using CINAHL, Medline (Ovid), Cochrane Library, and Embase. Randomized and non-randomized control studies will be included, in addition to pre-post observational studies comparing telehealth and/or telemonitoring with standard monitoring among individuals with COPD only. Two independent reviewers will screen all relevant abstracts and full-text studies to determine eligibility, assess the risk of bias, and extract the data using structured forms. If the included studies are sufficiently homogenous in terms of interventions, populations, and objectives, a meta-analysis will be performed.

Ethics and dissemination

Ethical considerations are not required for this research.

Registration

This systematic review and meta-analysis is registered in the Prospero Registry (CRD42017078541)

Word count

250

Strengths and limitations

- This systematic review aims to objectively estimate the acceptance, adherence, and dropout rates of people with COPD enrolled in telehealth and/or telemonitoring interventions, and the associated variables that potentially impact or are impacted by these rates.
- This systematic review will update existing knowledge on trial-related, patient-related, and intervention-related factors potentially influencing the acceptance, adherence, and dropout rates.
- Exploring acceptance, adherence, and dropout rates in COPD telehealth care and the associated factors will allow future researchers to design prospective clinical trials, while increasing the validity and generalizability of their results.
- The exclusion of papers written in languages other than English might leave relevant studies out of the review.

INTRODUCTION

According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD), *chronic obstructive pulmonary disease (COPD) is a common disease characterized by the persistent limitation of airflow to the lungs. It can be prevented and treated; furthermore, it is progressive in nature and associated with enhanced chronic inflammatory responses (in the airways and lungs) to noxious gases* [1]. Airflow limitations in COPD can lead to respiratory exacerbation which is defined as *an acute worsening of respiratory symptoms* [1]. Exacerbations can negatively impact an individual's health status, often resulting in hospitalization [2, 3]. COPD is a major public health problem, and individuals with COPD require appropriate management strategies to minimize the likelihood of hospitalization [4].

Telemonitoring is a component of telehealth interventions used to deliver COPD care; it can help detect exacerbations at an early stage, consequently minimizing emergency admissions and facilitating self-management (Table 1) [5–8]. Telemonitoring is also used for remote monitoring of a patient's clinical data, such as their vital signs; this enables healthcare teams to identify disease deterioration at an early stage and provide the requisite care in a timely manner. This has the effect of helping individuals control their diseases and for facilitating early detection of disease exacerbation [9]. There is evidence that telehealth and/or telemonitoring is a useful tool for minimizing hospital admissions due to respiratory exacerbations, particularly in the case of individuals who are constrained by geographical barriers, or have limited access to healthcare services [8, 10]. Clinical trials show that individuals with COPD have positive attitudes towards participating in telehealth and/or telemonitoring interventions [11–16]. However, the precise impact of telehealth and telemonitoring on avoiding exacerbation and reducing hospital readmissions remains inconclusive [8]. The lack of knowledge might be due to non-adherence or partial adherence to intervention techniques as well as the withdrawal of participants over the course of previous studies [17]. Dropout rates for telehealth and telemonitoring vary across clinical trials [5, 18–21]. It is unclear which variables are most strongly associated with non-adherence and withdrawal, although possible factors may be related to participant characteristics, intervention characteristics, and the context and environment in which the intervention is delivered. Understanding the characteristics of individuals with COPD, features of the interventions undertaken, and the environment of clinical trials is essential for reducing dropout rates in future studies. Such understanding will help with designing prospective clinical trials, while also increasing the validity and generalizability of their results [22, 23]. Evaluating the reasons that prevent individuals with COPD from enrolling and completing telehealth and telemonitoring interventions may help clinicians appropriately tailor interventions to the individuals' needs and limit dropout rates [17, 22]. Moreover, researchers can explore individual's preferences and use them to develop more desirable and feasible telehealth and telemonitoring interventions.

OBJECTIVES

The objectives of this systematic review are to:

(1) estimate acceptance, adherence, and dropout rates in experimental and observational studies;
(2) identify the reasons for dropout from the intervention;
(3) estimate the impact of trial-related factors, sociodemographic factors, and intervention-related factors on acceptance, adherence, and dropout rates;
(4) estimate the extent to which acceptance, adherence, and dropout rates affect patient's

outcomes.

METHODS

This systematic review and meta-analysis is registered with the Prospero Registry (CRD42017078541). This systematic review will be conducted according to the Preferred Reporting Items for Systematic reviewer and Meta-Analysis Protocols (PRISMA-P).

Inclusion criteria

(1) Study type: randomized or non-randomized control trials, observational single arm pre-post trials, and crossover clinical trials;
(2) Population: studies including individuals diagnosed with COPD based on reported FEV1% will be considered for this review;
(3) Type of intervention: this review includes telehealth interventions in which patients receive telehealth and/or telecare, telehomecare, e-health, telemonitoring, telerehabilitation, telemedicine, home monitoring, digital monitoring, web-based monitoring, or internet-based monitoring as part of a COPD-management plan. In principal, any information technology tool designed for the clinical support of patients with COPD involving the exchange of data remotely between the patient and health care professional will be considered;
(4) Type of outcome: outcomes include health-related quality of life, adherence to the action plan, exacerbations, duration of hospital stay, hospitalization or utilization of health services (including COPD related cost), and exercise capacity.

Exclusion criteria

(1) Trials not published in English;
(2) Studies that do not describe the telehealth and/or telemonitoring intervention researched, including delivery methods, mode of administration, and frequency of data transmissions;
(3) Studies that do not report the number of individuals who were approached, who gave their consent, and who dropped out.

SEARCH STRATEGY

Electronic databases

A systematic search of the following databases will be undertaken to identify relevant articles: CINAHL; Medline (Ovid); Cochrane Library, and Embase. The following Medical Subject Headings (Mesh terms)/Subject headings and/or keywords and combinations thereof will be used: telecare; telehomecare; telehealth; e-health; telemonitoring; telerehabilitation; telemedicine; home monitoring; digital monitoring; web-based monitoring; internet-based monitoring; Chronic Obstructive Pulmonary Disease; Chronic Obstructive lung disease, and COPD. The search strategy was developed in collaboration with a health sciences librarian (JB), to ensure the involvement of appropriate and necessary keywords in the review. Keywords and subject terms will be customized for each database. Further, all words with the prefix “tele-” will be searched both with and without a hyphen (e.g., both “tele-monitoring” and “telemonitoring”). The search strategies from Medline (Ovid) are presented in Appendix 1.

Manual literature search

We will perform manual searches of reference lists of all relevant primary studies and systematic reviews to identify any additional studies that were not captured by our original search.

Reference manager
All articles will be imported to EndNote software and any duplicates removed.

Search procedures
The search will be performed by two team members (SA, JB), after which all articles will be imported to EndNote version 7.7 and any duplicates removed. All article titles and abstracts will be screened by two independent reviewers. A manual search of the reference lists of relevant studies shall be undertaken, to identify any additional articles that were missed by the database search but that might be suitable for inclusion in the review. Subsequently a full-text review of all the included articles will be carried out. Disagreements between reviewers will be resolved through discussion. If no consensus can be reached, a third reviewer's decision will be considered. Any study that does not meet the inclusion criteria will be excluded and the reasons for exclusion recorded according to the PRISMA flowchart.

Study selection and data extraction
A data extraction form will be created using an Excel sheet. Two independent reviewers will perform the data extraction. First, reviewers will pilot the data extraction form based on ten included studies. Second, any disagreement between reviewers at this stage will be resolved by consensus. If no consensus can be reached, a third reviewer will make the decision. The first reviewer will then start extracting data. The second reviewer will check the consistency of the data and identify any errors. In case information is missing from an included study's published manuscript, its authors will be contacted and asked for clarification.

Data extraction and data management
Data related to the study characteristics, population characteristics, and intervention characteristics, as defined in the intervention Complexity Assessment Tool for Systematic Reviews (iCAT-SR), shall be extracted [24].
Study characteristics: authors' names; year of publication; country; research design, as well as recruitment methods.
Population characteristics: age; gender; level of education; GOLD grade and/or Forced Expiratory Volume in one second (FEV1%); smoking history; number of COPD patients who consented to participate, were approached, dropped out, and completed the study, as well as reasons for dropout.
Intervention characteristics: settings, methods, frequency and components of telehealth and/or telemonitoring (active elements, targeted behavior, targeted users, the degree of tailoring, health professional assistance), and duration of intervention.

OUTCOMES
All reported outcomes of COPD will be extracted, as will the effect size (ES) of telehealth and/or telemonitoring intervention on these outcomes. The ES will be calculated if it is not mentioned by the author(s). ES calculation will be performed according to results from the first post-interventional evaluation, which will reflect the impact of telehealth and/or telemonitoring interventions on outcomes.

Primary outcomes

All primary and secondary outcomes defined by each study will be extracted. These include, but are not limited to:

Hospitalization: admissions due to exacerbations and causes of hospitalization will be reported. Attention shall be paid to differences between count and dichotomous data (e.g., the count of participants in each group who experience at least one exacerbation event vs. number of events per intervention group).

Exacerbation rate is a commonly reported outcome [25]. As exacerbations can be reported in different ways, the data collection allows for the following numbers to be recorded: number of exacerbations or exacerbation rate (that may also be classified based on the patient disease severity), all-cause mortality, and number of patients per study group who died during the survey.

Adherence to the Action Plan: (including any measurement mentioned by the authors to report the adherence to the action plan – e.g., adherence to intervention, adherence to physiological monitoring, adherence to symptom monitoring, adherence to medication, adherence to exercise, and adherence telehealth and/or telemonitoring)

Health-related quality of life: disease-specific or non-disease-specific quality of life reported by a validated instrument.

Physical activity measurements (any type reported by a validated measurement system).

Risk of bias assessment

Two team members (SA, RA) will independently assess the risk of bias for each study included in the review; the Cochrane Collaboration Risk of Bias criteria will be used for randomized clinical trials (RCTs), and SIGN checklist will be used for observational studies. Reviewers will independently report justifications and comments for their decisions. A third team member will be consulted to resolve any discrepancies. The AMSTAR II tool will be used to assess this systematic review's risk of bias.

DATA ANALYSIS

Outcomes of this review are acceptance, adherence, and dropout rates. The acceptance rate will be calculated by taking the total number of participants who accepted, agreed, and consented to participate in this study and dividing it by the number of participants who were approached for involvement in telehealth intervention. The adherence rate will be calculated as the total number of participants who completed the telehealth intervention according to the study protocol divided by the number who started the intervention. The dropout rate will be calculated as number of participants who withdrew from or did not continue with the intervention divided by the number of participants who consented to participate on the study. All rates will be presented using an overall average.

Statistical Analysis System (SAS) software will be used to run regression models. Possible variables associated with rates will be categorized and tested using the univariate analysis model. Subsequently, a random effect meta regression analysis will be used to estimate the effects of the

participant, study, and intervention characteristics on acceptance, adherence, dropout rates. A separate model analysis will be conducted for each rate.
Heterogeneity for the meta-analysis will be tested using the I2 statistic. The reliability of the I2 estimation will be confirmed using a 95% confidence interval. If the interventions, populations, and outcomes are homogenous, a meta-analysis will be performed. If we are restricted in this regard and unable to perform a meta-analysis, we will synthesize and summarize the results narratively.

Dealing with missing data
Authors will be contacted to obtain any unreported data.

DISCUSSION

This systematic review aims to objectively estimate the acceptance, adherence, and dropout rates of COPD populations enrolled in telehealth and/or telemonitoring and the associated variables that might affect or be affected by these rates. It will help identify the extent to which associated variables can be used for an improved design of clinical trials, to suggest the characteristics of associated target populations, and to recommend elements for inclusion in telehealth intervention to support self-management.

To the best of our knowledge, this will be the first systematic review estimating acceptance, adherence, and dropout rates of COPD populations participating in telehealth and/or telemonitoring, as well as the associated factors influencing these rates. Previous systematic reviews and meta-analyses were unable to provide information about effective elements contributing to better acceptance and adherence rates; in contrast, our current study will try to explore elements of telehealth and/or telemonitoring that impact acceptance, adherence, and dropout rates [26, 27]. We will provide specific information about the trials' characteristics (RCTs vs. observational), population characteristics (i.e. mild severity vs. moderate severity), and intervention characteristics (i.e., primary care settings vs. specialty care settings), as well as how such information may facilitate users' adherence to telehealth interventions.

Our systematic review will analyze the literature using meta-analysis, and in doing so provide the advantage of having an opportunity to investigate and understand the correlation between pertinent factors and acceptance, adherence, and dropout rates. Furthermore, existing evidence on acceptance, adherence, and dropout rates will inform methods for designing future telehealth projects focusing on COPD. This study may also be beneficial for the management of grants for research in the field [28]. It will contribute to future research by identifying the target populations among which telehealth and/or telemonitoring are accepted, and identify feasible interventions. Finally, this systematic review will help tailor technological interventions to more effectively meet the needs of COPD patients.

Ethics and dissemination
This systematic review requires no ethics approval. This research will use no confidential or personal patient data. Findings will be disseminated through publication in a peer-reviewed specific journal.

Funding

The main author disclosed receipt of the following financial support for the research, authorship, and/or publication of this article. This study was supported by a scholarship from Umm Al Qura University in Saudi Arabia, Sara Ahmed is supported by an Fonds de recherché Santé (FRQS) career award.

REFERENCES

1. GOLD, G.I.f.C.O.L.D. Diagnosis of Disease of Chronic Airflow Limitation: Asthma,COPD and Asthma-COPD Overlap Syndrome (ACOS). Global Initiative for Chronic Obstructive Lung Disease GOLD. 2017:18.
2. Fletcher MJ, Upton J, Taylor-Fishwick J, et al. COPD uncovered: an international survey on the impact of chronic obstructive pulmonary disease [COPD] on a working age population. BMC Public Health. 2011;**11**(612):1-13
3. Halbert RJ, Natoli JL, Gano A. Badamgarav E, Buist AS, Mannino DM. Global burden of COPD: systematic review and meta-analysis. Eur Respir J. 2006;**28**(3):523-532.
4. Yang F, Xiong ZF, Yang C, et al. Continuity of Care to Prevent Readmissions for Patients with Chronic Obstructive Pulmonary Disease: A Systematic Review and Meta-Analysis. COPD. 2017;**14**(2):251-261.
5. Chau JP, Lee DT, Yu DS, et al. A feasibility study to investigate the acceptability and potential effectiveness of a telecare service for older people with chronic obstructive pulmonary disease. Int J Med Inform. 2012;**81**(10):674-682.
6. Cox NS, Oliveira CC, Lahham A, Holland AE. Pulmonary rehabilitation referral and participation are commonly influenced by environment, knowledge, and beliefs about consequences: a systematic review using the Theoretical Domains Framework. J Physiother. 2017;**63**(2):84-93.
7. Paré G, Jaana M, and C Sicotte. Systematic review of home telemonitoring for chronic diseases: the evidence base. J Am Med Inform Assoc. 2007;**14**(3):269-277.
8. Selzler AM, Wald J, Sedeno M, et al. Telehealth pulmonary rehabilitation: A review of the literature and an example of a nationwide initiative to improve the accessibility of pulmonary rehabilitation. Chron Respir Dis. 2018;**15**(1):41-7.
9. Crist TM, Kaufman SB, Crampton K.R. Home telemedicine: a home health care agency strategy for maximizing resources. HHCMP. 1996;**8**(4):1-9.
10. McKinstry B. The use of remote monitoring technologies in managing chronic obstructive pulmonary disease. QJM. 2013;**106**(10):883-5.
11. Almojaibel AA. Delivering pulmonary rehabilitation for patients with chronic obstructive pulmonary disease at home using telehealth: A review of the literature. SJMMS. 2016;**4**(3):164-171.
12. Burkow TM, Vognild LK, Østengen G, et al. Internet-enabled pulmonary rehabilitation and diabetes education in group settings at home: a preliminary study of patient acceptability. BMC Med Inform Decis Mak. 2013;**13**(33):1-10.
13. Holland AE, Hill CJ, Rochford P, Fiore J, Berlowitz DJ, McDonald CF. Telerehabilitation for people with chronic obstructive pulmonary disease: feasibility of a simple, real time model of supervised exercise training. Journal of telemedicine and telecare. 2013;**19**(4):222-6.
14. Paneroni M, Colombo F, Papalia A, et al. Is telerehabilitation a safe and viable option for patients with COPD? A feasibility study. COPD. 2015;**12**(2):217-225.
15. Tabak M, Brusse-Keizer M, van der Valk P, Hermens H, Vollenbroek-Hutten M. A telehealth program for self-management of COPD exacerbations and promotion of an active lifestyle: a pilot randomized controlled trial. Int J Chron Obstruct Pulmon Dis. 2014;**9**:935-44.

16. Zanaboni P, Lien LA, Hjalmarsen A, Wootton R. Long-term telerehabilitation of COPD patients in their homes: interim results from a pilot study in Northern Norway. J Telemed Telecare.2013;**19**(7)425-9.
17. Cruz J, Brooks D, and Marques A. Home telemonitoring in COPD: a systematic review of methodologies and patients' adherence. Int J Med Inform. 2014;**83**(4)249-63.
18. Antoniades NC, Rochford PD, Pretto JJ, et al. Pilot study of remote telemonitoring in COPD. Telemed J E Health. 2012;**18**(8):634-40.
19. Kim J, Kim S, Kim H, et al., Acceptability of the consumer-centric u-health services for patients with chronic obstructive pulmonary disease. Telemed J E Health. 2012;**18**(5):329-38.
20. Sund Z, Powell T, Greenwood R, Jarad NA. Remote daily real-time monitoring in patients with COPD–a feasibility study using a novel device. Respir Med. 2009;**103**(9):1320-8.
21. Trappenburg JC, Niesink A, de Weert-van Oene GH, et al. Effects of telemonitoring in patients with chronic obstructive pulmonary disease. Telemed J E Health. 2008;**14**(2):138-46.
22. Rozenfeld Y, Hunt JS. Effect of patient withdrawal on a study evaluating pharmacist management of hypertension. Pharmacotherapy. 2006;**26**(11):1565-71.
23. Wittes J. Missing inaction: preventing missing outcome data in randomized clinical trials. J Biopharm Stat. 2009;**19**(6):957-68.
24. Lewin S, Hendry M, Chandler J, et al. Assessing the complexity of interventions within systematic reviews: development, content and use of a new tool (iCAT_SR). BMC Med Res Methodol. 2017;**17**(76):1-13.
25. Cazzola M, MacNee W, Martinez FJ, Rabe KF. Outcomes for COPD pharmacological trials: from lung function to biomarkers. Rev Port Pneumol. 2008;**14**(4):579-83.
26. Almojaibel A., Delivering pulmonary rehabilitation for patients with chronic obstructive pulmonary disease at home using telehealth: A review of the literature. SJMMS. 2016;**4**(3):164-171.
27. Cruz J, Brooks D, Marques A. Home telemonitoring in COPD: a systematic review of methodologies and patients' adherence. Int J Med Inform. 2014;**83**(4):249-63.
28. Maeder A, Poultney N, Morgan G, Lippiatt R. Patient compliance in home-based self-care telehealth projects. J Telemed Telecare. 2015;**21**(8):439-42.
29. Arafah AM, Bouchard V, Mayo NE. Enrolling and keeping participants in multiple sclerosis self-management interventions: A systematic review and meta-analysis. Clin Rehabil. 2017;**31**(6):809-23.
30. Sieverink F, Kelders SM, van Gemert-Pijnen JE. Clarifying the Concept of Adherence to eHealth Technology: Systematic Review on When Usage Becomes Adherence. J Med Internet Res. 2017;**19**(12):1-15.

Table 1: Telehealth applications and definitions

Terminology	Definitions
Telehealth	Using electronic information and communication technologies to support distance healthcare, which allows healthcare professionals and long-distance patients to exchange information and support access to healthcare services [8].
Telemonitoring	Using electronic technologies, equipment, and sensors to transfer clinical data from patient settings to the healthcare providers at the clinical settings [8].
Teleconsultation	Using videoconferencing and webcams to connect the healthcare provider with patients, allowing the healthcare provider to assess, diagnose, and treat patients [8].
Tele-education	Using web-based platforms to educate patients about the patient disease management [8].
Telehealth PR	Using telehealth to deliver pulmonary rehabilitation to COPD patients via communication technologies, and maintain connections between patients and healthcare professionals [8].
Dropout rate	The number of participants who dropout divided by the number of participants who consented to participate [29].
Acceptance rate	The number of participants who consented to participate divided by the number of eligible participant [29].
Adherence definition	The ability to measure telehealth use and observe the intention to use telehealth technology [30].

Appendix 1: Medline (Ovid)

Searches	Results	
1	telecare.mp.	657
2	tele home care.mp.	11
3	telehealth.mp. or telehealth/	18768
4	telemonitoring.mp. or telemonitoring/	1197
5	telerehabilitation.mp. or telerehabilitation/	614
6	telemedicine.mp. or telemedicine/	21271
7	home monitoring.mp. or home monitoring/	1477
8	digital monitoring.mp.	44
9	web-based monitoring.mp.	38
10	internet-based monitoring.mp.	29
11	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10	24365
12	limit 11 to English	22898
13	Chronic Obstructive Pulmonary Disease.mp. or chronic obstructive lung disease/	52167
14	Chronic Obstructive Lung Disease.mp. or chronic obstructive lung disease/	34901
15	COPD.mp. or chronic obstructive lung disease/	47721
16	13 or 14 or 15	60027
17	12 and 16	450
18	limit 17 to English	450

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	8

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	8
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	N/A
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	N/A
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	N/A
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	N/A
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	N/A
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	N/A
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	10

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

BMJ Open

Acceptance, adherence, and dropout rates of individuals with COPD approached in telehealth interventions: A protocol for systematic review and meta-analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-026794.R1
Article Type:	Protocol
Date Submitted by the Author:	18-Dec-2018
Complete List of Authors:	Alghamdi, Saeed ; McGill University, School of Physical and Occupational Therapy; Umm Al-Qura University College of Applied Sciences, Department of Respiratory Care Janaudis-Ferreira, Tania; McGill University, School of Physical and Occupational Therapy; McGill University Health Center, Center for outcome research and evaluation (CORE) Alhasani, Rehab; McGill University, School of Physical and Occupational Therapy; Centre de recherche interdisciplinaire en réadaptation, Centre de Réadaptation Constance-Lethbridge, CIUSSS du Centre-Ouest-de-d'île-de-Montréal Boruff, Jill; McGill University, Schulich Library of Science and Engineering Ahmed, Sara; McGill University, School of Physical and Occupational Therapy; Centre de recherche interdisciplinaire en réadaptation, Centre de Réadaptation Constance-Lethbridge, CIUSSS du Centre-Ouest-de-d'île-de-Montréal
Primary Subject Heading:	Respiratory medicine
Secondary Subject Heading:	Rehabilitation medicine, Health informatics
Keywords:	Systematic review, Meta-analysis, Telemonitoring, Telehealth, Chronic obstructive pulmonary disease, COPD

Title: Acceptance, adherence, and dropout rates of individuals with COPD approached in telehealth interventions: A protocol for systematic review and meta-analysis

Authors
Saeed Mardy Alghamdi[1,2,4], Tania Janaudis-Ferreira[1,4,5], Rehab Alhasani[1,3,6], Jill Boruff[1], Sara Ahmed[1,3,4]

Affiliations
1 School of Physical and Occupational Therapy, McGill University, Montreal, QC, Canada
2 College of Applied Health Science, Umm Al Qura University, Department of Respiratory Care, Makkah, Saudi Arabia
3 Centre de recherche interdisciplinary en réadaptation, Constance-Lethbridge Rehabilitation Center, CIUSSS Montréal West, Montréal QC, Canada
4 Center for Outcome Research and Evaluation (CORE), McGill University Health Center, Montreal, QC, Canada
5 Translational Research in Respiratory Diseases Program, Research Institute of the McGill University Health Centre, Montreal, Canada
6 College Of Health and Rehabilitation Sciences, Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia

Corresponding author
Dr. Sara Ahmed, School of Physical and Occupational therapy, Faculty of Medicine, McGill University Health Center, Montreal, Quebec, H3G 1Y5, Canada
Tel: 1 514 398 4400 ext. 00531
Fax: 1 514 398 6360
Email: sara.ahmed@mcgill.ca

Keywords
Systematic review, meta-analysis, telehealth, chronic obstructive pulmonary disease, COPD

Word count
2599

Registration ID number
International Prospective Register for Systematic Reviews (PROSPERO) ID number: CRD42017078541

Abstract

Introduction: Telehealth interventions have the potential of improving exacerbation and health outcomes for individuals with Chronic Obstructive Pulmonary Disease (COPD), by delivering care in between clinical visits. However, the precise impact on avoiding exacerbation and reducing the incidence of hospital readmissions remains inconclusive. This lack of knowledge on the effectiveness of telehealth for COPD care might be due to non-adherence or partial adherence to intervention programs and/or the withdrawal of participants over the course of previous studies.

Objectives: To conduct a systematic review of trials of telehealth interventions (including Randomized Control Trials, crossover, and pre-post studies) to: (1) estimate the acceptance, adherence, and dropout rates; (2) identify the reasons for dropout from telehealth interventions among individuals with COPD; (3) evaluate the impact of trial-related, sociodemographic, and intervention-related factors on the acceptance, adherence, and dropout rates; and (4) estimate the extent to which the acceptance, adherence, and dropout rates impact outcomes in comparison with usual monitoring.

Methods and analysis: A systematic literature review of four databases from earliest records to November 2018 will be carried out using CINAHL, Medline (Ovid), Cochrane Library, and Embase. Randomized and non-randomized control studies will be included, in addition to crossover and pre-post studies comparing telehealth with standard monitoring among individuals with COPD only. Two independent reviewers will screen all relevant abstracts and full-text studies to determine eligibility, assess the risk of bias, and extract the data using structured forms. If the included studies are sufficiently homogenous in terms of interventions, populations, and objectives, a meta-analysis will be performed.

Ethics and dissemination

Ethical considerations are not required for this research.

Registration

This systematic review and meta-analysis is registered in the Prospero Registry (CRD42017078541)

Word count

248

Strengths and limitations

- This systematic review aims to objectively estimate the acceptance, adherence, and dropout rates of people with COPD enrolled in telehealth interventions, and the associated variables that potentially impact or are impacted by these rates.
- This systematic review will update existing knowledge on trial-related, patient-related, and intervention-related factors potentially influencing acceptance, adherence, and dropout rates.
- Exploring acceptance, adherence, and dropout rates in COPD telehealth care and the associated factors will allow future researchers to design prospective clinical trials, while increasing the validity and generalizability of their results.
- The exclusion of papers written in languages other than English might leave relevant studies out of the review.

INTRODUCTION

According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD), *chronic obstructive pulmonary disease (COPD) is a common disease characterized by the persistent limitation of airflow to the lungs. It can be prevented and treated; furthermore, it is progressive in nature and associated with enhanced chronic inflammatory responses (in the airways and lungs) to noxious gases* [1]. Airflow limitations in COPD can lead to respiratory exacerbation which is defined as *an acute worsening of respiratory symptoms* [1]. Exacerbations can negatively impact an individual's health status, often resulting in hospitalization [2, 3]. COPD is a major public health problem, and individuals with COPD require appropriate management strategies to minimize the likelihood of hospitalization [4].

Telehealth refers to the use of electronic information and communication technologies to support distance healthcare, which allows healthcare professionals and long-distance patients to exchange information and enable access to healthcare services. Various terms are used throughout the medical industry to reference specific applications and use cases for telehealth – these are presented in Table 1 [5]. For example, telehealth interventions with COPD could be used to deliver care and it can help to detect exacerbations at an early stage, minimizing the potential for emergency admissions and facilitating self-management [5-8]. Telehealth is also used for remote monitoring of a patient's clinical data, such as their vital signs; this enables healthcare teams to identify disease deterioration at an early stage and provide the requisite care in a timely manner. This has the effect of helping individuals manage their diseases and for facilitating early detection of disease exacerbation [9]. There is growing evidence that telehealth may be a useful tool for minimizing hospital admissions due to respiratory exacerbations, particularly in the case of individuals who are constrained by geographical barriers, or have limited access to healthcare services [5, 10]. Clinical trials have shown that individuals with COPD have positive attitudes towards participating in telehealth and that telehealth can promote patients' independence toward self-management [11-17]. However, the precise impact of telehealth on avoiding exacerbation and reducing hospital readmissions remains inconclusive [5]. The uncertainty about the impact of telehealth may be due to non-adherence or partial adherence to intervention techniques as well as the withdrawal of participants over the course of previous studies [18]. Dropout rates for telehealth vary across clinical trials [6, 19-22]. It is unclear which variables are most strongly associated with non-adherence and withdrawal, although possible factors may be related to participant characteristics, intervention characteristics, and the context and environment in which the intervention is delivered. Understanding the characteristics of individuals with COPD, features of the interventions undertaken, and the environment of clinical trials is essential for reducing dropout rates in future studies. Such understanding will help with designing prospective clinical trials, while also increasing the validity and generalizability of their results [23, 24]. Evaluating the reasons that prevent individuals with COPD from enrolling and completing telehealth interventions may help clinicians appropriately tailor interventions to the individuals' needs and limit dropout rates [18, 23]. Moreover, researchers can explore individual's preferences and use them to develop more desirable and feasible telehealth interventions.

OBJECTIVES

The objectives of this systematic review are to:

(1) estimate acceptance, adherence, and dropout rates in trials of telehealth interventions (including Randomized Control Trials, crossover, and pre-post studies);

(2) identify the reasons for dropout from the intervention;
(3) estimate the impact of trial-related factors, sociodemographic factors, and intervention-related factors on acceptance, adherence, and dropout rates;
(4) estimate the extent to which acceptance, adherence, and dropout rates affect patient's outcomes.

METHODS

This systematic review and meta-analysis is registered with the Prospero Registry (CRD42017078541). This systematic review will be conducted according to the Preferred Reporting Items for Systematic reviewer and Meta-Analysis Protocols (PRISMA-P).

Patient and Public Involvement

Patients and or public were not involved in this systematic review.

Inclusion criteria

(1) Study type: randomized or non-randomized control trials, observational single arm pre-post trials, and crossover clinical trials;
(2) Population: studies including individuals diagnosed with COPD based on reported FEV1% will be considered for this review;
(3) Type of intervention: this review includes any information technology tool designed for the clinical support of patients with COPD involving the remote exchange of data between a patient and a health care professional. This includes, for example, telehealth, telecare, telehomecare, e-health, telemonitoring, telerehabilitation, telemedicine, home monitoring, digital monitoring, web-based monitoring, or internet-based monitoring as part of a COPD-management plan.
(4) Type of outcome: outcomes include health-related quality of life, adherence to the action plan, exacerbations, duration of hospital stay, hospitalization or utilization of health services (including COPD related cost), and exercise capacity.

Exclusion criteria

(1) Trials not published in English;
(2) Studies that do not describe the telehealth intervention researched, including delivery methods, mode of administration, and frequency of data transmissions;
(3) Studies that do not report the number of individuals who were approached, who gave their consent, and who dropped out.

SEARCH STRATEGY

Electronic databases

A systematic search of the following databases from earliest records to November 2018 will be undertaken to identify relevant articles: CINAHL; Medline (Ovid); Cochrane Library, and Embase. The following Medical Subject Headings (MeSH terms), subject headings, and keywords or combinations thereof will be used: telecare; telehomecare; telehealth; e-health; telemonitoring; telerehabilitation; telemedicine; home monitoring; digital monitoring; web-based monitoring; internet-based monitoring; Chronic Obstructive Pulmonary Disease; Chronic Obstructive lung disease, and COPD. The search strategy was developed in collaboration with a health sciences

librarian (JB), to ensure the involvement of appropriate and necessary keywords in the review. Keywords and subject terms will be customized for each database. Further, all words with the prefix "tele-" will be searched both with and without a hyphen (e.g., both "tele-monitoring" and "telemonitoring"). The search strategies from Medline (Ovid) are presented in Appendix 1.

Manual literature search

We will perform manual searches of reference lists of all relevant primary studies and systematic reviews to identify any additional studies that were not captured by our original search.

Reference manager

All articles will be imported to EndNote software and any duplicates removed.

Search procedures

The search will be performed by two team members (SA, JB), after which all articles will be imported to EndNote version 7.7 and any duplicates removed. All article titles and abstracts will be screened by two independent reviewers. A manual search of the reference lists of relevant studies shall be undertaken, to identify any additional articles that were missed by the database search but that might be suitable for inclusion in the review. Subsequently a full-text review of all the included articles will be carried out. Disagreements between reviewers will be resolved through discussion. If no consensus can be reached, a third reviewer's decision will be considered. Any study that does not meet the inclusion criteria will be excluded and the reasons for exclusion recorded according to the PRISMA flowchart.

Study selection and data extraction

A data extraction form will be created using an Excel sheet. Two independent reviewers will perform the data extraction. First, reviewers will pilot the data extraction form based on ten included studies. Second, any disagreement between reviewers at this stage will be resolved by consensus. If no consensus can be reached, a third reviewer will make the decision. The first reviewer will then start extracting data. The second reviewer will check the consistency of the data and identify any errors. In case information is missing from an included study's published manuscript, its authors will be contacted and asked for clarification.

Data extraction and data management

Data related to the study characteristics, population characteristics, and intervention characteristics, as defined in the intervention Complexity Assessment Tool for Systematic Reviews (iCAT-SR), shall be extracted [25].

Study characteristics: authors' names; year of publication; country; research design, as well as recruitment methods.

Population characteristics: age; gender; level of education; GOLD grade and/or Forced Expiratory Volume in one second as a percentage of predicted (FEV1%); smoking history; number of COPD patients who consented to participate, were approached, dropped out, and completed the study, as well as reasons for dropout.

Intervention characteristics: settings, methods, frequency and components of telehealth (active elements, targeted behavior, targeted users, the degree of tailoring, health professional assistance), and duration of intervention.

OUTCOMES

All reported outcomes of COPD will be extracted, as will the effect size (ES) of telehealth intervention on these outcomes. The ES will be calculated if it is not mentioned by the author(s). ES calculation will be performed according to results from the first post-interventional evaluation, which will reflect the earliest impact of telehealth interventions on outcomes. Any results after the first post-interventional evaluation (e.g., results from multiple follow-up points) will not be considered in the ES calculation. Also, the ES on the main outcome will be included in the analysis if the studies have more than one outcome.

Outcomes

Outcomes extracted form each study:

All primary and secondary outcomes defined by each study will be extracted. These include, but are not limited to:

Hospitalization: admissions due to exacerbations and causes of hospitalization will be reported. Attention shall be paid to differences between count and dichotomous data (e.g., the count of participants in each group who experience at least one exacerbation event vs. number of events per intervention group).

Exacerbation rate is a commonly reported outcome [26]. As exacerbations can be reported in different ways, the data collection allows for the following numbers to be recorded: number of exacerbations or exacerbation rate (that may also be classified based on the patient disease severity), all-cause mortality, and number of patients per study group who died during the survey.

Adherence to the Action Plan: (including any measurement mentioned by the authors to report the adherence to the action plan – e.g., adherence to intervention, adherence to physiological monitoring, adherence to symptom monitoring, adherence to medication, adherence to exercise, and adherence telehealth and/or telemonitoring)

Health-related quality of life: disease-specific or non-disease-specific quality of life reported by a validated instrument.

Physical activity measurements (any type reported by a validated measurement system).

Outcome of adherence for this review:

Outcomes of this review are acceptance, adherence, and dropout rates. When these outcomes are not reported in the original studies, we will calculate the rates as follows:

The acceptance rate will be calculated by taking the total number of participants who accepted, agreed, and consented to participate in this study and dividing it by the number of participants who were approached for involvement in telehealth intervention. The adherence rate will be calculated as the total number of participants who completed the telehealth intervention according to the study protocol divided by the number who started the intervention. The dropout rate will be calculated

as number of participants who withdrew from or did not continue with the intervention divided by the number of participants who consented to participate on the study. All rates will be presented using an overall average.

Risk of bias assessment

Two team members (SA, RA) will independently assess the risk of bias for each study included in the review; the Cochrane Collaboration Risk of Bias criteria will be used for randomized clinical trials (RCTs), and SIGN checklist will be used for observational studies. Reviewers will independently report justifications and comments for their decisions. A third team member will be consulted to resolve any discrepancies. The AMSTAR II tool will be used to assess the risk of bias for the systematic review.

DATA ANALYSIS

Statistical Analysis System (SAS) software will be used to run regression models. Possible variables associated with rates will be categorized and tested using the univariate analysis model. Subsequently, a random effect meta regression analysis will be used to estimate the effects of the participant, study, and intervention characteristics on acceptance, adherence, dropout rates. A separate model analysis will be conducted for each rate. If we are restricted in this regard and unable to perform a meta-analysis, we will synthesize and summarize the results narratively.

Dealing with missing data

Authors will be contacted to obtain any unreported data.

DISCUSSION

This systematic review aims to objectively estimate the acceptance, adherence, and dropout rates of COPD populations enrolled in telehealth and the associated variables that might affect or be affected by these rates. It will help identify the extent to which associated variables can be used for an improved design of clinical trials, to suggest the characteristics of associated target populations, and to recommend elements for inclusion in telehealth intervention to support self-management.

To the best of our knowledge, this will be the first systematic review estimating acceptance, adherence, and dropout rates of COPD populations participating in telehealth , as well as the associated factors influencing these rates. Previous systematic reviews were unable to provide information about effective elements contributing to better acceptance, adherence and dropout rates using meta-regression analysis; in contrast, the current study will try to explore elements of telehealth that impact acceptance, adherence, and dropout rates [27, 28]. Our systematic review will analyze the literature using meta-analysis, and in doing so provide the advantage of having an opportunity to investigate and understand the correlation between pertinent factors and acceptance, adherence, and dropout rates. We will provide specific information about the trials' characteristics (RCTs vs. non-RCTs), population characteristics (i.e. mild severity vs. moderate severity), and intervention characteristics (i.e., primary care settings vs. specialty care settings), as well as how such information may facilitate users' adherence to telehealth interventions.

Furthermore, existing evidence on acceptance, adherence, and dropout rates will inform methods for designing future telehealth projects focusing on COPD. This study may also be beneficial for the management of grants for research in the field [29]. It will contribute to future research by identifying the target populations among which telehealth are accepted, and identify feasible interventions. Finally, this systematic review will help tailor technological interventions to more effectively meet the needs of COPD patients.

Ethics and dissemination

This systematic review requires no ethics approval. This research will use no confidential or personal patient data. Findings will be disseminated through publication in a peer-reviewed specific journal.

Authors' contributions

SM, SA, TF, RA developed the idea and designed the study protocol. SM, SA, JB designed and wrote the search strategy and the first protocol draft; SM, SA, RA planned the data extraction and statistical analysis; SA, TF, RA, JB, provided critical insights. All authors have approved and contributed to
the final written manuscript

Acknowledgements

The authors thank the reviewers of the manuscript for their constructive feedback.

Funding

The main author disclosed receipt of the following financial support for the research, authorship, and/or publication of this article. This study was supported by a scholarship from Umm Al Qura University in Saudi Arabia, Sara Ahmed and Tania Janaudis-Ferreira are supported by Fonds de recherche Santé (FRQS) career award.

Competing Interests

There are no competing interests for any author

REFERENCES

1. GOLD, G.I.f.C.O.L.D., *Diagnosis of Disease of Chronic Airflow Limitation: Asthma, COPD and Asthma-COPD Overlap Syndrome (ACOS)*. 2017: Global Initiative for Chronic Obstructive Lung Disease GOLD. p. 18.
2. Fletcher, M.J., et al., *COPD uncovered: an international survey on the impact of chronic obstructive pulmonary disease [COPD] on a working age population.* BMC Public Health, 2011. **11**(1): p. 612.
3. Halbert, R., et al., *Global burden of COPD: systematic review and meta-analysis.* European Respiratory Journal, 2006. **28**(3): p. 523-532.
4. Yang, F., et al., *Continuity of Care to Prevent Readmissions for Patients with Chronic Obstructive Pulmonary Disease: A Systematic Review and Meta-Analysis.* COPD, 2017. **14**(2): p. 251-261.
5. Selzler, A., et al., *Telehealth pulmonary rehabilitation: A review of the literature and an example of a nationwide initiative to improve the accessibility of pulmonary rehabilitation.* Chronic Respiratory Disease, 2018: **15**(1): p. 41-47.
6. Chau, J.P.-C., et al., *A feasibility study to investigate the acceptability and potential effectiveness of a telecare service for older people with chronic obstructive pulmonary disease.* International Journal of Medical Informatics, 2012. **81**(10): p. 674-682.
7. Cox, N.S., et al., *Pulmonary rehabilitation referral and participation are commonly influenced by environment, knowledge, and beliefs about consequences: a systematic review using the Theoretical Domains Framework.* Journal of Physiotherapy, 2017. **63**(2): p. 84-93.
8. Paré, G., M. Jaana, and C. Sicotte, *Systematic review of home telemonitoring for chronic diseases: the evidence base.* Journal of the American Medical Informatics Association, 2007. **14**(3): p. 269-277.
9. Crist, T.M., S.B. Kaufman, and K.R. Crampton, *Home telemedicine: a home health care agency strategy for maximizing resources.* Journal of Home Health Care Practice, 1996. **8**(4): p. 1-9.
10. McKinstry, B., *The use of remote monitoring technologies in managing chronic obstructive pulmonary disease.* QJM: An International Journal of Medicine, 2013. **106**(10): p. 883-885.
11. Almojaibel, A.A., *Delivering pulmonary rehabilitation for patients with chronic obstructive pulmonary disease at home using telehealth: A review of the literature.* Saudi Journal of Medicine and Medical Sciences, 2016. **4**(3): p. 164.
12. Burkow, T.M., et al., *Internet-enabled pulmonary rehabilitation and diabetes education in group settings at home: a preliminary study of patient acceptability.* BMC Medical Informatics and Decision Making, 2013. **13**(1): p. 33.
13. Holland, A.E., et al., *Telerehabilitation for people with chronic obstructive pulmonary disease: feasibility of a simple, real time model of supervised exercise training.* Journal of Telemedicine and Telecare, 2013. **19**(4): p. 222-226.
14. Paneroni, M., et al., *Is telerehabilitation a safe and viable option for patients with COPD? A feasibility study.* COPD: Journal of Chronic Obstructive Pulmonary Disease, 2015. **12**(2): p. 217-225.

15. Tabak, M., et al., *A telehealth program for self-management of COPD exacerbations and promotion of an active lifestyle: a pilot randomized controlled trial.* International Journal of Chronic Obstructive Pulmonary Disease, 2014. **9**: p. 935.
16. Zanaboni, P., et al., *Long-term telerehabilitation of COPD patients in their homes: interim results from a pilot study in Northern Norway.* Journal of Telemedicine and Telecare, 2013. **19**(7): p. 425-429.
17. Pinnock, H., et al., *P33 'Light Touch'Telemonitoring For People With COPD In Lothian: A Pilot Evaluation With Nested Qualitative Study*. 2014, BMJ Publishing Group Ltd.
18. Cruz, J., D. Brooks, and A. Marques, *Home telemonitoring in COPD: a systematic review of methodologies and patients' adherence.* International Journal of Medical Informatics, 2014. **83**(4): p. 249-263.
19. Antoniades, N.C., et al., *Pilot study of remote telemonitoring in COPD.* TELEMEDICINE and e-HEALTH, 2012. **18**(8): p. 634-640.
20. Kim, J., et al., *Acceptability of the consumer-centric u-health services for patients with chronic obstructive pulmonary disease.* Telemedicine and e-Health, 2012. **18**(5): p. 329-338.
21. Sund, Z., et al., *Remote daily real-time monitoring in patients with COPD–a feasibility study using a novel device.* Respiratory Medicine, 2009. **103**(9): p. 1320-1328.
22. Trappenburg, J.C., et al., *Effects of telemonitoring in patients with chronic obstructive pulmonary disease.* Telemedicine and e-Health, 2008. **14**(2): p. 138-146.
23. Rozenfeld, Y. and J.S. Hunt, *Effect of patient withdrawal on a study evaluating pharmacist management of hypertension.* Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy, 2006. **26**(11): p. 1565-1571.
24. Wittes, J., *Missing inaction: preventing missing outcome data in randomized clinical trials.* Journal of Biopharmaceutical Statistics, 2009. **19**(6): p. 957-968.
25. Lewin, S., et al., *Assessing the complexity of interventions within systematic reviews: development, content and use of a new tool (iCAT_SR).* BMC Medical Research Methodology, 2017. **17**(1): p. 76.
26. Cazzola, M., et al., *Outcomes for COPD pharmacological trials: from lung function to biomarkers.* European Respiratory Journal, 2008. **31**(2): p. 416-69.
27. Almojaibel, A., *Delivering pulmonary rehabilitation for patients with chronic obstructive pulmonary disease at home using telehealth: A review of the literature.* Saudi Journal of Medicine and Medical Sciences, 2016. **4**(3): p. 164-171.
28. Cruz, J., D. Brooks, and A. Marques, *Home telemonitoring in COPD: a systematic review of methodologies and patients' adherence.* International Journal of Medical Informatics, 2014. **83**(4): p. 249-263.
29. Maeder, A., et al., *Patient compliance in home-based self-care telehealth projects.* Journal of Telemedicine and Telecare, 2015. **21**(8): p. 439-442.
30. Sood, S., et al., *What is telemedicine? A collection of 104 peer-reviewed perspectives and theoretical underpinnings.* Telemedicine and e-Health, 2007. **13**(5): p. 573-590.
31. Huniche, L., et al., *Empowering patients with COPD using tele-homecare technology.* Studies in Health Technology and Informatics, 2010. **155**: p. 48-54.
32. Arafah, A.M., V. Bouchard, and N.E. Mayo, *Enrolling and keeping participants in multiple sclerosis self-management interventions: A systematic review and meta-analysis.* Clinical Rehabilitation, 2017. **31**(6): p. 809-823.

33. Sieverink, F., S.M. Kelders, and J.E. van Gemert-Pijnen, *Clarifying the Concept of Adherence to eHealth Technology: Systematic Review on When Usage Becomes Adherence.* Journal of Medical Internet Research, 2017. **19**(12): e402.

Table 1: Telehealth applications and definitions

Terminology	Definitions
Telehealth	Using electronic information and communication technologies to support distance healthcare, which allows healthcare professionals and long-distance patients to exchange information and support access to healthcare services [5].
Telemonitoring	Using electronic technologies, equipment, and sensors to transfer clinical data from patient settings to the healthcare providers at the clinical settings [5].
Telemedicine	Using e-health and communications networks for the delivery of healthcare services and medical education from one geographical location to another [30]
Telehomecare	Using electronic information and communication technologies to support care and treatment between a patient's home and professional healthcare settings [31].
Teleconsultation	Using videoconferencing and webcams to connect the healthcare provider with patients, allowing the healthcare provider to assess, diagnose, and treat patients [5].
Tele-education	Using web-based platforms to educate patients about the patient disease management [5].
Telehealth PR	Using telehealth to deliver pulmonary rehabilitation to COPD patients via communication technologies, and maintain connections between patients and healthcare professionals [5].
Dropout rate	The number of participants who dropout divided by the number of participants who consented to participate [32].
Acceptance rate	The number of participants who consented to participate divided by the number of eligible participant [32].
Adherence definition	The ability to measure telehealth use and observe the intention to use telehealth technology [33].

Appendix 1: Medline (Ovid)

Searches	Results	
1	telecare.mp.	657
2	tele home care.mp.	11
3	telehealth.mp. or telehealth/	18768
4	telemonitoring.mp. or telemonitoring/	1197
5	telerehabilitation.mp. or telerehabilitation/	614
6	telemedicine.mp. or telemedicine/	21271
7	home monitoring.mp. or home monitoring/	1477
8	digital monitoring.mp.	44
9	web-based monitoring.mp.	38
10	internet-based monitoring.mp.	29
11	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10	24365
12	limit 11 to English	22898
13	Chronic Obstructive Pulmonary Disease.mp. or chronic obstructive lung disease/	52167
14	Chronic Obstructive Lung Disease.mp. or chronic obstructive lung disease/	34901
15	COPD.mp. or chronic obstructive lung disease/	47721
16	13 or 14 or 15	60027
17	12 and 16	450
18	limit 17 to English	450

PRISMA-P 2015 Checklist

This checklist has been adapted for use with protocol submissions to *Systematic Reviews* from Table 3 in Moher D et al: Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews* 2015 **4**:1

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
Title					
Identification	1a	Identify the report as a protocol of a systematic review	☐	☐	3
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	☐	☐	
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	☐	☐	37 -39
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	☐	☐	23-28
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	☐	☐	401 -409
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	☐	☐	
Support					
Sources	5a	Indicate sources of financial or other support for the review	☐	☐	399 -403
Sponsor	5b	Provide name for the review funder and/or sponsor	☐	☐	399-403
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	☐	☐	399-403
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	☐	☐	133 -142
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	☐	☐	151- 174
METHODS					

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review	☐	☐	181 -193
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage	☐	☐	204 -206
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	☐	☐	214
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	☐	☐	231 - 239
Selection process	11b	State the process that will be used for selecting studies (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis)	☐	☐	241 -248
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	☐	☐	250 -265
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications	☐	☐	250 -265
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	☐	☐	270 - 313
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	☐	☐	228 – 333
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	☐	☐	337 – 342
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2, Kendall's tau)	☐	☐	337 – 342
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	☐	☐	337 – 342
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	☐	☐	337 – 342
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective reporting within studies)	☐	☐	337 – 342
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE)	☐	☐	333