Facilitators and Barriers to the Adoption of Telemonitoring to Manage COPD: A Systematic Literature Review

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Abstract

Background
Chronic Obstructive Pulmonary Disease (COPD) is a leading cause of death throughout the world. Telemedicine has been utilized for many diseases, and its prevalence is increasing in the U.S. Telemonitoring of patients with COPD has the potential to help patients manage disease and predict exacerbations. The objective of this review is to evaluate the effectiveness of telemonitoring to manage the chronic disease of COPD. Researchers want to look at how telemonitoring has been used to observe COPD, and we’re hoping this will lead to more research in telemonitoring of this disease.

Methods
The review was conducted and reported in accordance with Assessment for Multiple Systematic Reviews (AMSTAR) and Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), respectively. Authors performed a systematic review of Cumulative Index to Nursing and Allied Health Literature (CINAHL) and PubMed databases to obtain relevant articles. Then, articles were accepted or rejected by group consensus. Each article was read and authors identified barriers and facilitators to effectiveness of telemonitoring of COPD.

Results
The review’s results indicate that conflicting information exists for the effectiveness of telemonitoring of patients with COPD. Primarily, 13 of 29 articles stated that patient outcomes were improved overall with telemonitoring, while 11 of 29 indicated no improvement. For facilitators, authors recognized reduced need for in-person visits, better disease management, and bolstered patient-provider relationship. Important barriers included low-quality data, increased workload for providers, and cost.

Conclusion
The high variability between the articles and the ways they provided telemonitoring services created conflicting results from the literature review. Future research should emphasize standardization of telemonitoring services and predictability of exacerbations.

Keywords: Telemedicine, COPD, chronic disease
Background

Rationale

The most recent estimate of the world prevalence for Chronic Obstructive Pulmonary Disease (COPD) is 64 million, and 3 million deaths from the disease in 2015 alone [1]. The World Health Organization (WHO) estimates that COPD will be the third leading cause of death in the world by 2030, and that 90% of its victims live in middle to low-income countries [1]. It is primarily caused by cigarette smoke (primary or secondary) and exacerbated by long-term asthma. The United States addressed the increase in prevalence by penalizing reimbursement for public-health beneficiaries if a hospital readmitted the patient for the condition within 30 days[2].

The US also passed the Health Information Technology for Economic and Clinical Health (HITECH) Act in 2009 which incentivizes the adoption of health information technology up until 2015, and penalizes the lack of adoption thereafter [3]. The HITECH Act served as a catalyst for the diffusion of telemedicine in the US, which is important because the US lagged behind other western nations in the use and acceptance of telemedicine. There are many facets to telemedicine, but we will start with a general definition.

The World Health Organization defines telemedicine as “The delivery of health care services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities [4].”
We choose this definition for our review, and, also following the WHO’s example, we do not distinguish between telemedicine and telehealth.

US national attention on telemedicine services for rural and other low-access populations has steadily increased in the past decade. As the US continues to determine how best to fund these services and how to legislate accreditation across state borders and specialties, much research is being conducted on the efficacy of various telemedicine services [5]. While the bulk of US research attends to clinical interventions provided for mental health and chronic diseases, chronic diseases also require regular monitoring of health parameters.

Telemedicine, in its modern form, developed through rapid advancement in communication technology and innovation on the part of healthcare professionals [6]. Naturally, physicians treating chronic diseases, such as COPD, required methods to track patient health factors, and telemonitoring was the solution. Telemonitoring is defined as the distance monitoring of components of a patient’s health as part of a larger chronic care model [7]. These methods, when applied to patients with COPD, can utilize caregiver review of data to assess disease state and health status [8]. Telemonitoring of COPD even has the potential to predict exacerbations before onset [9].

**Objective**

The objective of this review is to evaluate the effectiveness of telemonitoring to manage the chronic disease of COPD. We want to look at how telemonitoring has been used to observe COPD, and we’re hoping this will lead to more research in telemonitoring of this disease. We use the Assessment for Multiple Systematic Reviews (AMSTAR) and the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) [10].
Methods

Neither patients, service users, carers, nor lay people were used in the design or execution of this review. The development of outcome measures was not informed by patients’ priorities, experience, or preferences. Neither patients, carers, nor lay people were involved in the recruitment to and conduct of this review. Results will not be disseminated to study participants because there were no human participants. The development of the research question and outcome measure was not informed by patients’ priorities, experience, or preferences.

This systematic literature review followed the AMSTAR standard to obtain and evaluate, and the PRISMA standard to report the analysis conducted on the articles in the review. Authors queried the PubMed and CINAHL (managed by Ebsco) databases using the search terms “telemonitoring” and “COPD” and all associated MeSH terms (telemonitoring, COPD, Chronic Obstructive Pulmonary Disease, COAD, Chronic Obstructive Airway Disease, Chronic Obstructive Lung Disease, Airflow Obstruction, Chronic or Airflow Obstructions, Chronic or Chronic Airflow Obstruction, and Chronic Airflow Obstruction). Databases were searched during the time frame of 1 Feb, 2011 through 1 Feb, 2017. Originally, we planned to limit our search to a five-year span for analysis because of the rapid advancement of technology, but this did not yield a suitable number of articles to analyze. As
115a result, we expanded our search to six years. Boolean operators were used during searches to obtain the desired search parameters. 

The initial search in PubMed, “(telemonitoring) AND (COPD)” returned 88 articles. Restricting the articles further by date eliminated 12 articles, and limiting by academic journals and English-only eliminated 21 more. The initial search in CINAHL generated a total of 38 articles. Restricting the publication date range minimized this number to a total of 35 articles and removing any articles that were not from academic journals and not written in English resulted in 16 remaining articles.

Authors created a literature matrix detailing the title, author, year, journal, and other pertinent information of the 61 articles in preparation for final screening. To eliminate the possibility for bias, two authors read each abstract and came to a consensus regarding whether the article was germane to the topic. Once all abstracts had been read, the authors used a consensus meeting to make final determination on whether to eliminate articles that were not germane to the specific topic and remove any duplicate articles. Through this process, the authors noticed a common reference that had not been caught in their query of the databases. The final number of articles gathered from PubMed and CINAHL totaled 21 and 8, respectively, bringing the final combined total to 29 articles for analysis in the literature review.

Authors read each article closely and made independent notes of common themes. These were shared at a second consensus meeting and
138through a brief discussion of content and findings, detailed notes were
139highlighted about barriers and facilitators to the adoption of telemonitoring
140for the management of COPD. Frequency of occurrence of each of the
141barriers and facilitators were captured in affinity matrices for further
142analysis.

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Results

144From the original 136 articles resulting from the initial search, 97 were screened out due
145to date of publication, nature of publication, and whether the topic was germane to our research
146(possibly indexed improperly). The list of germane studies was narrowed to 29. The literature
147search process is listed below in Figure 1.

148Figure 1: Literature search process with inclusion and exclusion criteria
A list of all studies and a summary of each topic is listed in Table 1.

Table 1: Summary of articles analyzed and applicable observations.

The results were mixed on the efficacy of telemonitoring to reduce complications associated with COPD. Any clear positive relationship with the use of telemonitoring to manage COPD was obscured. Our second consensus meeting helped us identify the 12 barriers and 13 facilitators to the acceptance and feasibility of telemonitoring to manage COPD, summarized in Tables 2 and 3, respectively.
Table 2: Barriers to the adoption of telemedicine to manage COPD.

Table 3: Facilitators to the adoption of telemedicine to manage COPD.

Facilitators for telemonitoring were comprised of improved patient outcomes, reduced need for in-person visits, better disease management, bolstered patient-provider relationship, high-quality data, patient empowerment, ease of use, predictability of exacerbations, provision of additional services, patient engagement, access to patient data, and communication. Barriers included reduced patient outcomes or no improvement, low-quality/limited data, increased workload for providers, cost, heterogeneity of care, lack of service standardization, uncomfortable with technology, exacerbations are highly variable, less patient autonomy, time-consuming, staff shortages/overworked, user perception/perceived lack of usefulness, and user resistance, listed in order of prevalence. Facilitators and barriers are sorted by frequency of occurrence. We do not suggest that frequency equates to importance; we highlight only the probability that each theme occurred in the literature.

Discussion

Throughout this review, the value of telemonitoring to manage COPD symptoms has been intensively evaluated. Authors identified key barriers and facilitators related to the effectiveness of telemonitoring. The prevalence of factors can be reviewed in Table 2 and 3. Conflicting data was found detailing the efficacy of telemonitoring services for managing COPD. Some articles cited improvements in patient outcomes, satisfaction, anxiety and depression, and hospitalization rates in the facilitator “Improved patient outcomes, satisfaction” [8,9,11,12,19,24-]
while others stated that no significant improvement occurred under the
barrier “Reduced patient outcomes or no improvement” [11,12,13,15,23,26,33-37]. Articles discuss various causes for improvement of the COPD disease state or perceptions of the disease state. Fifteen percent of articles stated that telemonitoring reduced the number of in-patient visits required for patients engaged in telemonitoring care, including primary care visits and emergency department visits [8,9,11,12,17,25,27,30,31]. Pinnock [32] and Venter [35] found that enhanced access to care was especially useful in rural areas where access to care may be greatly restricted. As a dominant facilitator for telemonitoring of COPD, the review suggests that telemonitoring interventions have potential to achieve the main goal of telemedicine services.

A common reason for patient improvements included that providing telemonitoring services to traditional COPD management added underlying services lines to patient resources [27,29,36]. As more service options were added, including videoconferencing and phone support, articles noted reductions in admissions related to exacerbations. McKinstry [29] found that more successful programs were associated with service lines unavailable to regular COPD management programs. Constant access to a respiratory nurse should logically increase patient education and outcomes. Regardless of the number of added service lines provided through telemonitoring of COPD, patients were regularly satisfied with the provided telemonitoring services. Other facilitators, such as higher-quality patient data and ease of use, provide better self-management for patients and more information to caregivers.

Conversely, numerous articles in this review also mentioned the inability for COPD telemonitoring to provide added value for patients [11-13,15,23,26,33-37]. Some of these articles referenced that sample selection did not allow for clear improvements; authors, in some
instances, selected patients with excellent self-management practices. Authors also reported that as telemonitoring services expanded, clinician and nurse workloads increased. As staffing is one of the most expensive parts of providing healthcare, increasing the amount of work required to care for patients can potentially increase costs.

Cost also factored into some of the studies examined. Results ranged from incremental cost-effectiveness ratios (ICER) of £203,900 to descriptions of increased cost of care. With 19.3% of studies referencing no improvement or reduced patient outcomes, the literature suggests that caregivers hesitate before providing telemonitoring care that is not cost-effective. Other barriers to consider are usability of devices, perceived lower autonomy of patients, and time required to obtain symptom data.

Three articles explained prediction methods to determine the onset of exacerbations. One article, Sanchez-Morillo, predicted 93.9% of exacerbations within 4.5 days of necessary medical interventions. Sanchez-Morillo displays that improved patient outcomes and reduced in-patient visits can be achieved even with high variability of exacerbations. This article illustrates the variety of telemonitoring interventions available and an ideal method of protecting patient health through telehealth services.

Limitations

Authors noted some minor limitations. The high variability between articles, patient samples, telemonitoring methods, and treatments may explain why 23.21% of articles found improved patient outcomes and 19.30% found no improvement in outcomes. With such differences between studied effects, external validity of the literature may be compromised. Further, because researchers were responsible for determining which articles were included in
the study, readers should be aware of selection bias. Biases were controlled by utilizing multiple
reviewers for each article who discussed inclusion or exclusion of articles. Analysis of inter-rater
agreement resulted in a Kappa score of 0.91.

Conclusions

Authors determined that many conflicting barriers and facilitators exist to the adoption of
telemonitoring for patients with COPD. Due to the high variability of patients monitored, service
types, technology, and severity of disease state, some studies do not relate well to others.
Future research should emphasize the importance of standardizing telemonitoring of COPD
techniques and the ability of technology to predict exacerbations. Predictability of exacerbations,
even with the large range of pre-exacerbation symptoms, will reduce in-person visits and provide
patients with useful warnings about their conditions. Through continued evaluation of COPD
efficacy, research may find a cost-effective and useful standard for monitoring COPD through
telehealth interventions.

List of abbreviations

AMSTAR – Assessment for Multiple Systematic Reviews
CINAHL – Cumulative Index to Nursing and Allied Health Literature
COPD – Chronic Obstructive Pulmonary Disease
HITECH – Health Information Technology for Economic and Clinical Health
PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analysis
WHO – World Health Organization

Declarations

Ethics approval and consent to participate – Not applicable
Consent to publish – Not applicable
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255-**Authors’ Contributions** -- CSK provided structure, guidance, and critical analysis. He analyzed 40% of articles and rewrote portions of the manuscript. BP provided project management of the research. He assigned tasks, analyzed 40% of articles, and wrote part of the methods and results. HC analyzed 30% of articles, wrote the introduction, and created the first version of the figure. KB analyzed 30% of articles and wrote the discussion section. MA served as the lead editor. She analyzed 30% of articles and wrote most of the results and reworded all to sound like one voice.

262**Declarations**

263- Ethics approval and consent to participate – not applicable (no human participants)

264- Consent to publish – corresponding author has consent to publish

265- Availability of data and materials – data and other materials are available upon request

266- Competing interests – The authors claim no conflicts of interests.

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268- Authors’ Contributions – HC contributed to the intro and methods section, and handled our Kappa score for the end. She analyzed 30% of the articles. MA contributed to the intro and methods sections as well. Megan analyzed 30% of the articles. MA and HC aligned barriers, facilitators, and themes for the articles. KB contributed to the intro and methods sections. He analyzed 30% of the articles and worked with BP to determine barriers, themes, facilitators. BP wrote abstract, some of the intro, some of the methods, analyzed 30% of the articles, contributed to the results, and discussion sections. He served as project manager. He created many of the tables and images for the paper. CSK served as chief editor and provided critical analysis to all work. He analyzed 30% of the articles to ensure overlap of analysis. He rewrote portions of the methods and discussion sections, and he serves as the corresponding author.

279- Authors’ Information – HC, MA, KB, and PB are graduate students at Texas State University. CSK is an Assistant Professor at Texas State University.
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TELEMONITORING OF COPD


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Figure Legends

Figure 1: Literature search process with inclusion and exclusion criteria

Tables

Table 1: Literature search process with inclusion and exclusion criteria

Table 2: Facilitators of Telemonitoring for COPD

Table 3: Barriers of Telemonitoring for COPD
Supplementary files

Individual conflicts of interest declarations for each author.