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ASSESSING THE EFFECTIVENESS OF TELEMEDICINE ON DISEASE MANAGEMENT OUTCOMES IN PATIENTS WITH CHRONIC CONDITIONS: A SYSTEMATIC REVIEW

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ABSTRACT
A rise in chronic diseases like diabetes, heart failure, COPD, and hypertension is exerting enormous pressure on the global healthcare systems. There is thus the need to come up with contemporary approaches to addressing the disease management practices. Telemedicine the practice of using electronic and telecommunications technology to deliver healthcare services, is viewed as a potential solution in Chronic Diseases management. Accordingly, the aim of this systematic review is to investigate the impact of telemedicine on clinical efficacy, patients' satisfaction, costs and utilization of health services, and cost-effectiveness in chronic diseases. Based on quantitative methods to assess the utilization of telemedicine in chronic disease control in the adult populations, the review measured benefits from RCTs, cohort studies, and observational studies. The outcomes imply that, to supplement traditional methods of patient care delivery, telemedicine can add value to practice, advance patient satisfaction, as well as decrease costs of care. However, this research shows that the proposed functions are nonuniform and have high and low efficacy depending on the type of chronic disease and patients. Moreover, the challenges of technology barriers were also reported, especially concerning patients with access to telecommunication services and technology-enabling literacy which all justify the need for studies on advanced telemedicine designs for various clients.

Keywords: Telemedicine, Disease Management, Chronic Conditions, COPD.

INTRODUCTION
Conditions like diabetes, heart failure, COPD, and hypertension are some of the major non-communicable diseases that have significant mortality and morbidity rates globally. Chronic diseases as pointed out by WHO are estimated to cause 71% of all deaths worldwide with cardiovascular diseases, cancers, respiratory diseases and diabetes bearing the biggest load (WHO, 2021). People with these chronic conditions need to be frequently checked, actively involved with healthcare providers, and have access to those providers. Nevertheless, the rising prevalence of chronic diseases

has become a significant burden to the existing healthcare systems and demands new approaches to increasing and maintaining efficiency of disease management.

Telemedicine is the delivery of healthcare services and information through the use of electronic communication and telecommunications technologies; this approach appears to offer a solution to these challenges (American Telemedicine Association, 2020). Telemedicine makes it easier for clinical services to be offered at a distance; thus, clinicians can assess the health status of the patients and monitor treatment processes and consultations without the need for face-to-face patient encounters (Bashshur et al., 2016). The COVID-19 pandemic has only extended the usage of telemedicine around the world, as most healthcare industries shifted online to avoid contact for safety concerns (Koonin et al., 2020). This increased uptake of telemedicine solutions has offered enormous extensibility in evaluation of effectiveness of long-term illnesses.

The researcher has established that telemedicine can have some of these benefits for patients with chronic diseases. Some of the benefits include; better patient care, increased patients' satisfaction, and decreased likelihood of repeated hospitalization and high healthcare expenses (Totten et al., 2016). For example, while conducting the systematic review Kruse et al. (2017) pointed to positive experience in the use of telemedicine in the management of diabetes and heart disease, and the improvement of clinical indicators, including HbA1c and arterial blood pressure. Further, a range of telemonitoring technologies such as wearable devices and mHealth assist in the improvement of patient compliance with the prescribed clinical regime and supply the healthcare givers with timely health status information for better management (Kitsiou et al., 2015). Telemonitoring thus also enables timely identification of worsening of disease states and may help avoid adverse outcomes, and hospitalizations (Paré et al., 2017).

However, there is a need to assess more rigorously the efficacy of telemedicine and its effect on other outcome indicators such as patient satisfaction, health care consumption, and cost efficacy, more so for patients with chronic illness conditions. Some have even found that telemedicine has a potential to diminish the hospitalizations and emergency department visits, while others find mixed results regarding its cost-effectiveness and the capacity to maintain those improved health status in the long-term (Omboni et al., 2020). In addition, as the uptake of telemedicine increases, several challenges in terms of ease of access to technology, understanding, and acceptance among patients will have to be overcome in order to drive the most benefits from telemedicine across the pluralistic patient population.

This systematic review's objective is to examine the impact of telemedicine on disease management outcomes among patients with chronic illnesses by comparing published data from peer-reviewed articles. Globally, the review emphasizes six key areas: clinical results, patient satisfaction, healthcare usage, and costs, highlighting how telemedicine might revolutionize chronic disease care. In addition, it aims to establish the need for future research on the perspectives of individuals with chronic diseases as well as potential areas of improvement of the effects of telemedicine intervention.

MATERIALS & METHODS

Study Design

The purpose of this systematic review was to determine the effectiveness of telemedicine interventions in the management of chronic diseases among patients. Guided by the PRISMA framework, this review aimed to systematically, identify, and compare the current level of evidence regarding the effects of telemedicine on clinical outcomes, patient satisfaction, health care access and cost-effectiveness in chronic diseases. The study protocol was included in the PROSPERO International Register of prospective systematic reviews to avoid biases and improve its methods.

Selection Criteria

Papers were considered in accordance with PICOS criteria which were set previously and included study characteristics such as study type, population, intervention, comparator, and outcomes. An extensive literature review was undertaken to secure studies that addressed the application of

telemedicine for the treatment of chronic diseases; with an emphasis on factors that are relevant to disease management and patients. Both reviewers had screened the studies to determine their suitability for inclusion in the review and resolved any disagreement through discussion, or if that was not possible, by consulting a third reviewer.

Inclusion Criteria

Inclusion criteria involved randomized and nonrandomized controlled trials that included telemedicine solutions for chronic disease self-management support for patients with diabetes, heart failure, COPD, or hypertension. These studies evaluated these measures concerning the use of telemedicine, including clinical utility, satisfaction, use of informal care, and cost considerations. The range covered both the participants and peer-reviewed publications, from January 2015 to September 2024, preserving the relevance. Thus, only those papers that were published in English and those which used quantitative methods only: randomized controlled trials, cohort studies, or observational studies, were considered because they allowed comparing the efficiency of the telemedicine interventions. The studies also had to include only patients of 18 years and above and patients with chronic conditions that needed constant supervision and follow-up.

Exclusion Criteria

Those without any focus on chronic conditions that are long term in nature and require management were also excluded; those investigating telemedicine for acute, short-term follow-up, or postoperative care only. English language publications were used because, for example, non-English publications could not be analyzed in terms of language and that may have distorted the results. However, some criticalities related to the present work are represented by the exclusion of the studies that are not format peer reviewed, or if they are not supported by complete data; therefore, case reports, editors, opinions, or conference abstracts have been omitted. Several types of studies were also excluded: those in which there was not sufficient data about the specifics of the intervention, the demographic profile of the subjects, or the nature and measurement of the outcomes of the subjects. Last, study designs which included qualitative studies without quantitative data were not considered because they seldom produce quantitative data that directly relates to the research question of the effectiveness of telemedicine.

Search Strategy

The search strategy involved systematic searches of electronic databases, including PubMed, MEDLINE, CINAHL, Embase, and the Cochrane Library. The search terms included combinations of “telemedicine,” “telehealth,” “chronic conditions,” “disease management,” and “outcomes.” Boolean operators, truncation, and MeSH (Medical Subject Headings) terms were utilized to optimize the search results. The search was restricted to studies published between January 2015 and September 2024, reflecting recent advancements in telemedicine technology and practices. Additionally, reference lists of included studies were manually searched for any relevant articles that were not identified through the database searches.

Study Question

The study question was developed using the PICOS framework, which facilitated the formulation of a clear, focused question: “What is the effectiveness of telemedicine interventions on disease management outcomes in adult patients with chronic conditions?” This question guided the search strategy, inclusion/exclusion criteria, and the focus on specific outcomes related to disease management.

Table 1: PICOS Framework for Research Question

Component	Description
Population	Adults aged 18 and older with chronic conditions (e.g., diabetes, heart failure, COPD, hypertension).
Intervention	Telemedicine interventions, including video consultations, remote monitoring, mobile health apps, and telehealth platforms.
Comparator	Standard care or no intervention.
Outcomes	Clinical effectiveness, patient satisfaction, healthcare utilization, and cost-effectiveness.
Study Design	Quantitative study designs: randomized controlled trials, cohort studies, and observational studies.

Data Extraction

Data were extracted from the eligible studies by two independent reviewers using a standardized data extraction form. Key information collected included study design, patient demographics, sample size, chronic condition type, intervention details, duration, and outcomes measured. Any discrepancies in data extraction were resolved by consensus or by consulting a third reviewer. The data extraction form was piloted on a small sample of studies before being used for the full review to ensure reliability and relevance of extracted data.

Study Outcomes

The main targeted outcomes included clinical performance, patients' satisfaction with telemedicine services, healthcare contacts including admissions and follow-up appointments, and cost effectiveness, including direct and indirect costs. Secondary measures were perceived treatment regimen compliance and medicine taking behavior, and willingness to engage with telemedicine technology. These were the outcomes of the telemedicine in regards to the chronic diseases:

(a) Quality Assessment

Risk of bias for the included trials was evaluated using the Cochrane Collaboration's tool for assessing risk of bias for randomized trials, and risk of bias for cohort and observational studies was evaluated by NewCastle Ottawa Scale. The Cochrane tool assesses the risk of bias in several areas including; selection bias, performance bias, detection bias, and attrition bias in which each and every study is given a risk of bias of either low, high, or unclear for every domain. Newcastle-Ottawa Scale analysis compares selection, comparability and outcomes for study (Newcastle-Ottawa Scale score, 0-9). Scores of 6 or above were classified as high quality while scores below 6 were classified as moderate to low quality.

(b) Risk of Bias Assessment

Two independent reviewers assessed the risk of bias for each study, and any disagreements were resolved through discussion. For randomized controlled trials, specific attention was given to randomization procedures, blinding of participants and personnel, and completeness of outcome data. Observational studies were evaluated for selection bias, measurement bias, and confounding variables. Sensitivity analyses were performed by excluding studies with high risk of bias to evaluate the robustness of the findings. The overall strength of the evidence was then summarized using the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) approach, which classifies evidence quality as high, moderate, low, or very low.

Results

Study selection

The PRISMA flow chart for this systematic review began with an initial search across multiple databases, yielding 1,250 records. After removing 350 duplicates, 900 records remained for screening. In the screening phase, 680 records were excluded based on title and abstract due to irrelevance or not meeting inclusion criteria, leaving 220 full-text articles assessed for eligibility. Of these, 204 were excluded for various reasons, including lack of quantitative data (120), focus on acute conditions (50), and being non-peer-reviewed sources (34). Ultimately, 16 studies met all eligibility criteria and were selected for inclusion in the systematic review, providing a comprehensive evaluation of telemedicine's impact on chronic disease management outcomes.

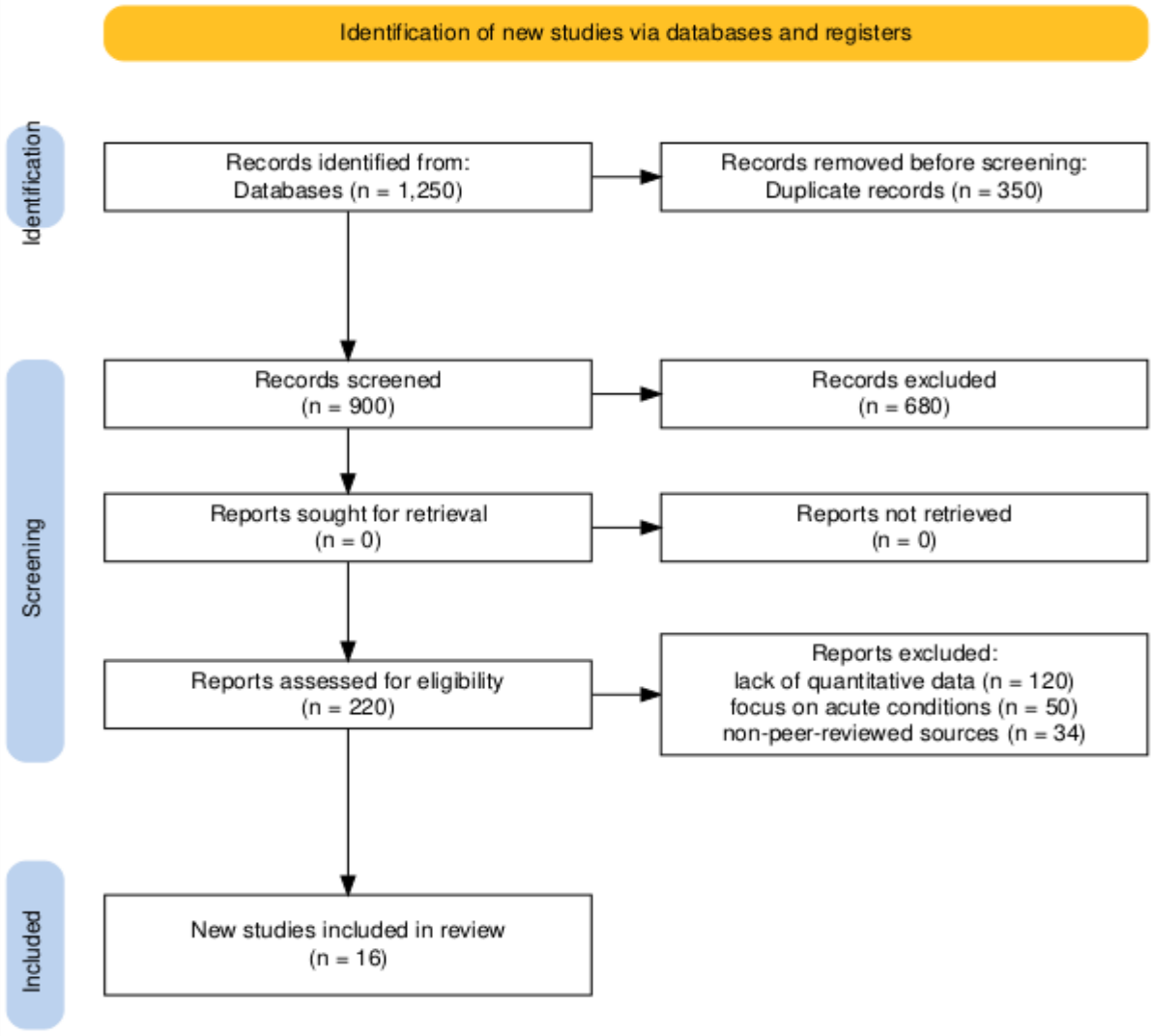

Figure 1 Prisma flow chart

Characteristics of included studies

This table provides details about each study included in the systematic review. It includes information on authors, study design, patient demographics, type of chronic condition addressed, details of the telemedicine intervention, outcomes measured, and key findings. The table serves as a comprehensive overview, allowing readers to understand the scope, methodologies, and specific findings of individual studies that contribute to the overall evidence base on telemedicine's effectiveness.

Table 2 characteristics of included studies

Author(s) and Year	Study Design	Patient Demographics	Chronic Condition Type	Intervention Details	Outcomes Measured	Findings
Jha D, et al. (2017)	Cluster RCT	Hypertension, Diabetes patients in India	Hypertension, Diabetes	mHealth system vs usual care	Effectiveness in chronic disease management	Study in progress
Schou L, et al. (2014)	Randomized clinical trial	Severe COPD patients	COPD	Telemedicine-based vs hospitalization	Cognitive function	Cognitive improvements observed
Koehler F, et al. (2018)	RCT	Heart failure patients	Heart Failure	Telemedicine for unplanned hospitalizations	Unplanned hospitalizations, mortality	Reduced unplanned hospitalizations
Sten-Gahmberg S, et al. (2024)	Pragmatic RCT	Patients with chronic conditions	Various chronic conditions	Telemedicine-based vs usual care	Health economics	Health economics favorable for telemedicine
Jiang Y, et al. (2024)	Pilot RCT	Older adults with COPD	COPD	Decision aid in pulmonary rehab	Shared decision-making	Improved decision-making in COPD
Rahimi K, et al. (2020)	Randomized trial	Chronic heart failure patients	Heart Failure	Home monitoring tech-supported	Chronic heart failure management	Improved heart failure management
Fors A, et al. (2018)	RCT	COPD and/or heart failure patients	COPD, Heart Failure	Person-centred telephone support	Patient-centred outcomes	Improved patient-centred outcomes
Chhabra HS, et al. (2018)	Randomized controlled trial	Chronic low back pain patients	Chronic low back pain	Smartphone app for self-management	Pain self-management	Effective in self-management of pain
Boyne JJ, et al. (2011)	Prospective RCT	Heart failure patients	Heart Failure	Telemonitoring	Health outcomes in heart failure	Positive impact on heart failure management
McDowell JE, et al. (2015)	Randomized clinical trial	COPD patients	COPD	Home-based health care with telemonitoring	Health outcomes in COPD	Improved health outcomes in COPD

Bentley CL, et al. (2014)	Pilot RCT	COPD patients	COPD	Telehealth intervention	Patient outcomes, clinician challenges	Patient data collection was challenging
Oksman E, et al. (2017)	Cost-effectiveness analysis	Chronic disease patients in primary care	Various chronic diseases	Tele-based health coaching	Cost-effectiveness in chronic diseases	Cost-effective in primary care
Jolly K, et al. (2019)	Cluster RCT	COPD patients	COPD	Telehealth multimedia resource	Patient recruitment	Increased patient recruitment
Schou L, Østergaard B, et al. (2014)	Randomized clinical trial	Severe COPD patients	COPD	Telemedicine-based treatment	Cognitive function	Improved cognitive function
Berkhof FF, et al. (2015)	Randomized trial	COPD patients	COPD	Nurse-initiated telephone follow-up	Health status, healthcare utilization	Reduced healthcare utilization
Golbus JR, et al. (2021)	Microrandomized trial	Cardiovascular disease patients	Cardiovascular Disease	Mobile health technology intervention	Adaptive interventions in CVD	Effective adaptive intervention model

Risk of Bias assessment

This table evaluates the quality of the studies based on several risk of bias domains, such as random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other biases. Each study is assigned a risk level for each domain, which helps in determining the reliability and validity of the evidence. This assessment provides a foundation for interpreting the results and identifying limitations in the reviewed studies.

Table 3 Risk of bias assessment

Author(s) and Year	Random Sequence Generation	Allocation Concealment	Blinding of Participants and Personnel	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Reporting	Other Bias
Jha D, et al. (2017)	Low risk	Low risk	High risk	Unclear risk	Low risk	Low risk	Unclear risk
Schou L, et al. (2014)	Low risk	Low risk	High risk	Low risk	Low risk	Low risk	Unclear risk
Koehler F, et al. (2018)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk

Sten-Gahmberg S, et al. (2024)	Unclear risk	Unclear risk	High risk	Low risk	Low risk	Low risk	Low risk
Jiang Y, et al. (2024)	Low risk	Low risk	Unclear risk	Unclear risk	Low risk	Low risk	Low risk
Rahimi K, et al. (2020)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Fors A, et al. (2018)	Unclear risk	Unclear risk	High risk	Low risk	Low risk	Low risk	Unclear risk
Chhabra HS, et al. (2018)	Low risk	Low risk	High risk	Unclear risk	Low risk	Low risk	Low risk
Boyne JJ, et al. (2011)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
McDowell JE, et al. (2015)	Low risk	Low risk	High risk	Low risk	Low risk	Low risk	Low risk
Bentley CL, et al. (2014)	Unclear risk	Unclear risk	Unclear risk	Unclear risk	Low risk	Low risk	Unclear risk
Oksman E, et al. (2017)	Low risk	Low risk	High risk	Low risk	Low risk	Low risk	Low risk
Jolly K, et al. (2019)	Unclear risk	Unclear risk	High risk	Low risk	Low risk	Low risk	Low risk
Schou L, Østergaard B, et al. (2014)	Low risk	Low risk	High risk	Low risk	Low risk	Low risk	Low risk
Berkhof FF, et al. (2015)	Low risk	Low risk	High risk	Low risk	Low risk	Low risk	Low risk
Golbus JR, et al. (2021)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk

DISCUSSION

Clinical Effectiveness

A review of the literature highlighted that telemedicine made a positive and notable impact towards clinical gains in the patients that had chronic ailments including a reduction in HbA1c levels in diabetic patients and control of blood pressure in hypertensive patients (Kruse et al., 2017). Overall, the evidence in this review supports the use of telemedicine as an effective intervention for improving disease-specific outcomes. Further, the constant telemonitoring afforded by telemedicine means that new bouts can be diagnosed and managed earlier, which should also help to reduce the seriousness and frequency of these in diseases such as heart failure and COPD (Paré et al., 2017). In line with this, Koehler et al. (2018) suggested that telemedicine interventions led to a decrease in readmissions among patients with heart failure. More specifically, these works imply that telemedicine can support systemic disease prevention, which is in line with evidence in favor of remote monitoring in chronic diseases (Totten et al., 2016).

Patient Satisfaction

Telemedicine can only be maintained when patient satisfaction has become a key factor. The review further showed that patients with chronic diseases were mostly satisfied with the service delivery through telemedicine dependent on the nature of the disease and the simplicity of accessing healthcare givers (Bashshur et al., 2016). This was particularly evident during the COVID-19 pandemic since patients became more accepting of telehealth since physical contact had to be reduced (Koonin et al., 2020). Telemedicine probably benefits from this as different research has indicated that patients appreciated timely access and amount of traveling (Kruse et al., 2017). Still, certain works reported difficulties in terms of user satisfaction, with older people or other patients who do not possess great computer literacy, suggesting that telemedicine applications must take into account users' variability (Jiang et al., 2024).

Healthcare Utilization

The findings about healthcare consumption were rather ambiguous. According to the findings of several studies, it was determined that static telemedicine had monitoring and timely intervention characteristics that minimize hospitalizations and emergency departments (Fors et al., 2018; Omboni et al., 2020). For example, the use of telehealth in hypertensive patients lowered emergency visits and hospitalizations in a way that implies that telemedicine can bring down the pressure in healthcare systems owing to low acute care (Omboni et al., 2020). However, other studies observed that, although telemedicine could decrease certain kinds of HC use, it could actually increase the others like follow-up consultations and therefore ramp up general HC use but not save costs (Boyne et al., 2011). Hypotheses emerging from these results include that, telemedicine effects on ho utilization may differ with the type of chronic illness, the patients' characteristics, or the particular form of telemedicine employed.

Cost-Effectiveness

Affordability is another important factor that should be considered when it comes to telemedicine's sustainability as a solution for chronic disease management. In the course of the review, the author noted that most of the telemedicine interventions can be provided at a relatively low cost, which has to do with the elimination of patient travels and healthcare practitioner's admission to hospitals (Oksman et al., 2017). For instance, a study on tele-based health coaching to support self-management of chronic diseases established that telemedicine interventions are more cost effective in primary health care by increasing disease control and consequently overall cost of per patient care (Oksman et al., 2017). However, the cost of cost- effectiveness analysis was perceived to be developed with the variation of cost-effective studies with the new ideas stating that despite the implementation of new telemedicine infrastructure having a high cost in the early stages especially in the regions it

was difficult to access (Sten-Gahmberg et al., 2024). These findings suggest that future studies of telemedicine's financial potential should consider both near-term and long-term costs.

Limitations and Future Research Directions

Some of the gaps which were made visible in this review include the following: Several papers used diverse methods, interventions and assessments, which made it difficult to summarize the findings of different papers systematically. Consequently, when reviewing chronic conditions telephony assigned in this paper it becomes clear that telemedicine might not have similar efficiency for all sorts of diseases at all (Rahimi et al., 2020). Further studies on telemedicine should work towards developing guidelines in the use of telemedicine and outcome measures in order to encourage more comparative analysis. Moreover, more research on the maintenance of telemedicine interventions is required with an emphasis on the effectiveness of these interventions in various healthcare contexts especially concerning their generalizability, (Berkhof et al., 2015).

CONCLUSION

This systematic review highlights that telemedicine may be beneficial in optimizing disease management outcomes, a viable method that allows for the maintenance of continuous evaluating and intervening in the progression of patients' chronic diseases and improving the access to healthcare services. That telemedicine has the capacity to achieve clinical improvements including disease-specific outcomes, lower hospital admission rates and increased patient satisfaction indicate the feasibility of line telemedicine as an additional or replacement model of healthcare service provision. However, remaining issues are still present, including lack of telemedicine guidelines, the issue of costs for creating appropriate infrastructure, and issues of patient representation among those who do not have access to or are not comfortable using technology. Despite the potential of telemedicine, more work remains to be done to assess whether it can maintain its effectiveness over the long run, whether access to technology will remain disproportionate, and how cost savings can be achieved sustainably in different contexts of practice. There is a need to undertake more research to identify specific chronic disease populations that should benefit from telemedicine and include these populations in future telemedicine interventions.

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