Dose of Telehealth to Improve Community-Based Care for Adults Living with Multiple Chronic Conditions: A Systematic Review

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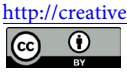

Abstract

The purpose of this systematic review is to identify evidence of the appropriate dose of telehealth intervention services provided to community dwelling adults experiencing chronic illness or disability related to effectiveness, quality, safety, and cost. Academic Search Complete, CINAHL, MEDLINE, Cochrane, and JBI were searched using combinations of "telehealth or telemedicine or telemonitoring or telepractice or telenursing or telecare AND chronic illness or chronic disease". Of the identified 449 articles, 47 articles met the inclusion criteria. Most study designs were quasi-experimental one group pre-test post-test (N = 16) with few Randomized Controlled Trials (N = 12). Twenty-three published articles studied the effect of telehealth for one chronic condition (49.9%) while 24 (51.1%) examined the effectiveness of telehealth for multiple chronic conditions. Measurement of telehealth outcomes varied and included efficacy, healthcare utilization, quality, adherence, cost, and safety. No standard measure of dose could be extrapolated. Length of intervention was measured and reported differently in each study. The dose of telehealth services that improve care effectiveness, quality, safety, and cost is still unknown for community dwelling adults experiencing chronic illness. The findings from this systematic review do indicate that longer duration of telehealth services (51 weeks), regardless of modality, produced positive outcomes as opposed to those with shorter durations (37 - 38 weeks) that produced neutral or mixed results. Collecting and reporting data related to clinical workflow such as dose of intervention specific to disease and type of modality is recommended. Rigorous study design including standard measure-

ment at the RCT and Comparative Effectiveness level is still needed.

Keywords

Telehealth, Telemonitoring, Telenursing, Chronic Illness, Multiple Chronic Conditions, Workflow, Dose

1. Introduction

Living with Multiple Chronic Conditions (MCC) increases the likelihood of premature death, disability, and cost of care [1]. Currently, six in ten adults in the United States have a chronic illness and four in ten adults have two or more chronic conditions [2]. People with MCC account for most of healthcare spending, placing them at the center of initiatives to improve health system performance [3]. However, patients who experience MCC often delay or decline care due to transportation costs to multiple visits to clinicians at different care sites, which increases the risks of errors and poor care coordination [4]. Hence, well-coordinated, cost-effective, and safe care is critical for patients with chronic illnesses, especially those with MCC. Initiatives to improve outcomes and decrease cost for care of people with MCC often seek to alter care from intervening only after complications arise to maintaining health with an emphasis on productive healthcare teams, use of technology, access to community resources and patient engagement; known as the Chronic Care Model [5].

Users of the Chronic Care Model have long recognized the benefit of effective use of home and community-based services to improve the health of individuals wanting to live in their own homes instead of long-term care facilities [6]. Evidence shows that keeping individuals in their homes, instead of long-term care facilities, requires multiple essential components including: a knowledgeable, proactive interprofessional team; dynamic communication between caregivers, patients, healthcare system members and community resource providers; establishing mutual goals of care; tailored coordinated consistent education for both the patient and caregivers; and, use of evidence-based practice [7]. In rural areas, this level of care coordination is challenging due to social determinants of health including poor access to care due to cost, inadequate numbers of primary care providers and specialists, transportation difficulties worsened by decreased functional ability, and lack of knowledge of available community resources [8]. Thus, persons living with MCC in rural states require additional interventions to stay in their communities. Telehealth has been used as a solution to deliver care to patients with MCC with limited access to healthcare, while eliminating barriers of access, distance, and transportation [9].

Telehealth, for the purposes of this article, is the provision of remote health care, directly to the patient, using a variety of technology, including telephones, smartphones, and mobile wireless devices, with or without a video connection

[10]. The most consistently published benefits of the use of telehealth interventions include increased communication with healthcare providers who provide education, counseling, or remote monitoring of chronic conditions to improve health outcomes [11]. In addition, telehealth has been shown to improve health, reduce costs, and holds promise for scalability to a larger population [12]. While the current evidence supports moving from research that investigates the effectiveness of telehealth to implementation and practice-based research, little evidence can be found related to the dose of telehealth intervention needed to improve outcomes or reduce costs [11]. Hence, there is a gap in knowledge when designing rigorous implementation projects related to the dose of telehealth intervention needed.

The purpose of this review is to identify evidence of the appropriate dose of telehealth intervention services provided to community dwelling adults experiencing chronic illness or disability related to effectiveness, quality, safety, and cost. The question being addressed is, "In community dwelling adults experiencing chronic illness or disability, what dose of telehealth services improve care effectiveness, quality, safety, and cost?".

2. Methods

2.1. PRISMA Methods

This review was performed and reported according to the PRISMA-P 2015 checklist [13]. The eligibility criteria for the review included the following databases: Academic Search Complete, CINAHL, MEDLINE, Cochrane, and JBI. The MeSH Terms/Key Words used were "telehealth or telemedicine or telemonitoring or telepractice or telenursing or telecare AND chronic illness or chronic disease". The search mode chosen was "Find all search terms" and the limitations set were: Scholarly Journals, English, Human, Outpatients, All Adult. This search resulted in 449 abstracts and this initial search was replicated by 2 authors (JM, AJ). All information obtained was only from what was presented in the published article. All records were maintained using separate Endnote Libraries for included and excluded articles and an Excel database of findings that were imported into SPSS version 26.

Each of the 449 abstracts was reviewed for the following inclusion criteria: quantitative analysis of data that involved adults greater than the age of 18, at least 1 chronic illness, direct to patient telehealth services, and community dwelling participants. Exclusion for review included studies with qualitative design, only participants under age 18, or no chronic illness addressed. In addition, articles that were preliminary communications, meeting updates, conference abstracts, study protocols, case studies, obtained no outcome measures, telehealth was not the intervention, telehealth provided is not in the home (*i.e.*, provider to provider), participants were non-community dwelling (*i.e.*, nursing home), review articles, and technology methodology papers with no patient participants were excluded.

After the initial review of abstracts, 373 were excluded and 76 full text articles were identified as meeting the above criteria for inclusion and were retrieved for further review. Reasons for further exclusion included: no mention of telehealth, the only use of telephones was to collect study data, review article, pediatric population, editorial, for education purposes or commentary, only provider to provider communication, study protocol, surgically implanted telecommunications, technology development process evaluation, and qualitative design. Each of the 76 full-text articles was separately reviewed by 2 authors for inclusion/exclusion criteria. If the article met inclusion criteria, the article was critiqued and placed into a literature matrix developed a priori for congruence of interpretation. If a differing opinion occurred, the article was reviewed by a third author (SD or JH) for consistency and resolution. See **Figure 1** for the full literature review flow chart according to PRISMA guidelines [14].

The review matrix included the authors' location, year published, study aims, design, total sample size, telehealth intervention sample size, sample description, number of chronic illnesses studied, type of chronic illness, measures, type of telehealth (Remote Patient Monitoring (RPM), asynchronous, synchronous, mixed), length/dose of intervention, results, and study limitations. The Cochrane Collaboration's tool for assessing risk of bias across studies and presented in the limitations section [15]. Since meta-analysis of the findings will not be performed, grading the body of evidence is not appropriate.

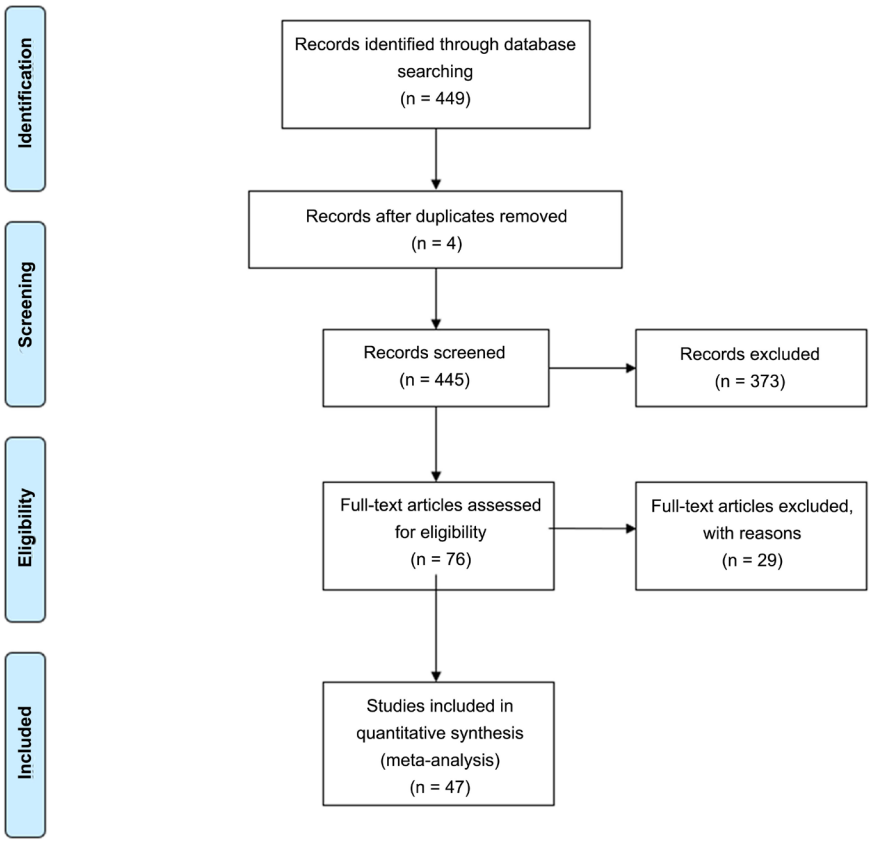

Figure 1. PRISMA literature review flow chart.

2.2. Variables, Analysis, and Interpretation

2.2.1. Study Description

Year published was extracted from each article and is analyzed and presented in the findings as a range and mode.

Location was normalized to the Country of the location of the interventions as well as the number of interventions occurring in each country.

Only quantitative study design studies were included. Type of trials was collected as Randomized Controlled Trial (RCT), quasi-experimental 1 group, quasi-experimental 2 group, quasi-experimental pre/post, retrospective, and descriptive is presented via mode of use. Types of trials are presented via mode of use.

The total number of intervention participants in each study and the total number of participants receiving telehealth in each intervention, the number of participants receiving telehealth across all studies, and the mean and standard deviation of telehealth participants are presented.

2.2.2. Participant Description

The sample description of age was collected from each article as mean age for each study. Income, where reported, was abstracted from each article in US dollars and is reported as frequencies. Education, where reported, was collected as the mode from each study and is reported as frequency. Urban or Rural, was recorded from the article when reported and is reported as frequency. Race of participants was abstracted from each article when available as percentage of non-white participants. Gender of participants was recorded when available in each article and is reported as percent male and female.

Chronic illness number and type were collected from each article. If an article included multiple chronic conditions, each individual condition was noted and included as both an individual chronic condition and as MCC. Number of chronic illness described in each article was recorded as a continuous variable and is reported using mean and standard deviation. Types of chronic illness are reported as frequencies.

2.2.3. Study Measures

Study measures were normalized into types of measures and included adherence, cost, efficacy, healthcare utilization, quality, and safety are reported as frequencies.

The type of telehealth services evaluated in each study is reported as frequencies. The type of telehealth offered was normalized into the three major types of telehealth, synchronous, asynchronous, and remote patient monitoring (RPM).

Due to differing ways dose was collected in each study, the dose of intervention collected from each article was transformed into weeks, and is reported in range, mean, and standard deviation.

2.2.4. Study Results & Limitations

The results of each study were reviewed. If the aims of the study were reached

the results were recorded as positive. If the aims of the study were not achieved, the results were recorded as negative. If no change was found between telehealth and usual care, the results were recorded as neutral. If the aims of the study were partially met, or not fully achieved, the findings were recorded as mixed. All results are reported in frequencies. The limitations for each study will be presented in a table.

The relationship between dose, type of telehealth intervention, and results (positive, negative, mixed, and neutral) was examined. Differences between types of chronic illness and telehealth and dose (in weeks) were assessed using analysis of variance techniques with an alpha threshold of 0.05. All analyses were performed using SPSS version 26. The authors held no preformed assumptions of the findings. Hence, power was not calculated prior to analysis.

3. Results

After reviewing the 76 full-text articles, 47 articles met the inclusion criteria for this systematic review. See Table 1 for full literature matrix. The year of publication ranged from 2006 to 2020 with most articles being published in or before 2016 (57.4%) and the most observed year of publication was 2018 (n = 12). The studies were conducted in 19 different countries, with one study conducted in more than one country. The United States of America had the most published articles (N = 20), followed by the United Kingdom (N = 5). The number of participants in the telehealth intervention ranged from 8 - 17,319 and a sum of 37,713 participants across all studies. The most used study designs were quasi-experimental one group pre-test post-test (N = 16) and Randomized Controlled Trials (N = 12). Two of the RCT studies recruited participants from two different countries (with the US being one of the two countries) and three were located solely in the US. In half of RCT designed studies, MCC was the focus of the intervention (N = 6). Efficacy was the most common type of measure to examine (N = 8). The weeks of intervention for the RCTs ranged from 4 - 36 weeks and all but one RCT study had positive findings.

Table 1. Literature matrix by year of publication.

Authors/Year	Country	Design	Main Type of Telehealth	Main Chronic Illness	# of Chronic Illness	Type of Measure	% Non-White	% Female	Urban/ Rural	Age (mean)	Weeks of Telehealth	Results
Kim, Kim *et al.* 2006 [19]	South Korea	Quasi 1 group pre post	Async	Diabetes	1	Adherence, Efficacy		57.60	Urban	43.5	12.00	Positive
Sarkar, Handley *et al.* 2008 [20]	USA	Quasi 1 group pre post	Mixed	Diabetes	2	Safety		65.00		55.3	36.00	Positive
Fursse, Clarke *et al.* 2008 [21]	UK	OBS 1 group	RPM	MCC	4	Efficacy, Quality		58.60	Rural	70	12.00	Positive
Hamar, Wells *et al.* 2010 [22]	Germany	Quasi 1 group pre post	Sync	MCC	4	Quality, Utilization		50.80	Urban	71.2	52.00	Positive

Continued

Rai, Prichard *et al.* 2011 [23]	USA	Quasi 1 group pre post	Async	MCC	2	Quality, Utilization		55.00			24.00	Positive
Vinson, McCallum *et al.* 2011 [24]	USA	OBS 1 group	Mixed	Diabetes	1	Quality					12.00	Positive
Gellis, Kenaley *et al.* 2012 [25]	USA	RCT	RPM	MCC	6	Efficacy, Quality		62.10	Urban	80.1	12.00	Positive
Akematsu and Tsuji 2012 [26]	Japan	Quasi 2 group	Mixed	MCC	4	Cost, Utilization		40.90	Rural	75	520.00	Positive
Steventon, Bardsley *et al.* 2012 [27]	UK & USA	RCT	Mixed	MCC	3	Utilization				69.7	24.00	Positive
Jaglal, Haroun *et al.* 2013 [28]	Canada	Quasi 2 group	Sync	MCC	6	Efficacy		74.20	Rural	67	6.00	Positive
Balato, Megna *et al.* 2013 [29]	Italy	Quasi 1 group pre post	Async	Psoriasis	1	Adherence, Efficacy, Quality		50.00			12.00	Positive
Baker, Macaulay *et al.* 2013 [30]	USA	Retrospective 2 group	RPM	MCC	3	Efficacy, Quality, Utilization		46.30		76	104.00	Positive
Chung, Kim *et al.* 2013 [31]	USA	Quasi 1 group pre post	Mixed	MCC	3	Efficacy	65.00	63.00	Urban	59	8.00	Neutral
Surate Solaligue, Hederman *et al.* 2014 [32]	Ireland	Quasi 1 group pre post	Mixed	MCC	6	Utilization					52.00	Neutral
Cecil 2014 [33]	USA	Retrospective	Sync	MS	1	Utilization	25.00	75.00		50.1	416.00	Positive
Gellis, Kenaley *et al.* 2014 [34]	USA	RCT	Mixed	MCC	2	Efficacy, Utilization				79	12.00	Positive
Hui-Lung, Chung-Hung *et al.* 2015 [35]	Taiwan	Quasi 1 group pre post	Mixed	MCC	5	Efficacy		56.00	Rural			Positive
Leboeuf-Yde, Jensen *et al.* 2015 [36]	Denmark	Quasi 1 group pre post	Async	Back Pain	1	Efficacy					52.00	Neutral
Chatwin, Hawkins *et al.* 2016 [37]	UK	RCT crossover	RPM	Lung disease	5	Utilization			Urban	61.8	24.00	Negative
Doñate-Martínez, Ródenas *et al.* 2016 [38]	Spain	Descriptive	RPM	MCC	4	Efficacy, Quality				67.95	52.00	Positive
Gonçalves, Ciol *et al.* 2016 [39]	Brazil	RCT	Sync	Burns	1	Efficacy			Urban	40.4	24.00	Positive
Kekäle, Söderlund *et al.* 2016 [40]	Finland	RCT	Mixed	Chronic myeloid leukemia	1	Adherence		50.00		58.3	36.00	Positive
Schougaard, Larsen *et al.* 2016 [41]	Denmark	OBS 1 group	RPM	MCC	1	Utilization					84.00	Positive
Hamad, Crooks *et al.* 2016 [42]	UK	OBS 1 group	RPM	COPD	1	Efficacy, Utilization		51.90		69.5	16.00	Positive
Dhillon, Wünsche *et al.* 2016 [43]	Malaysia	Quasi 1 group pre post	Mixed	MCC	1	Quality				79	6.00	Positive

Continued

Aivaliotis, Lee *et al.* 2017 [44]	USA	Quasi 2 group	Async	Chronic pancreatitis	1	Efficacy, Quality				52.9	4.00	Positive
Albert, Dinesen *et al.* 2017 [45]	Multicenter USA	Descriptive, Cross-sectional	Mixed	CHF	1	Quality	16.50			63.5	0.06	Positive
Cobos-Campos, Fernández de Larrinoa *et al.* 2017 [46]	Spain	RCT	Async	Smoking	1	Efficacy				44.9	24.00	Positive
Dario, Saccavini *et al.* 2017 [47]	Italy	Quasi 1 group pre post	RPM	Diabetes	1	Efficacy		43.00		73.05	52.00	Negative
Guilkey, Draucker *et al.* 2018 [48]	USA	OBS 1 group	Mixed	Pain	1	Quality	28.00	12.00		55	52.00	Positive
Kotsani, Antonopoulou *et al.* 2018 [49]	Greece	RCT	Sync	Diabetes	1	Efficacy		47.90			12.00	Positive
Kurland, Anna *et al.* 2018 [50]	USA	Quasi 1 group pre post	Mixed	Stroke	1	Efficacy		38.00		66.4	24.00	Positive
Kamei, Yamamoto *et al.* 2018 [49]	Japan	Quasi 1 group pre post	Mixed	MCC	3	Adherence, Efficacy, Quality		55.60	Urban	76.1	12.00	Positive
Oddone, Gierisch *et al.* 2018 [51]	USA Multicenter	RCT	Sync	MCC	3	Efficacy, Utilization		15.00		56	24.00	Positive
Taylor, Oddone *et al.* 2018 [52]	USA	Quasi 1 group pre post	Sync	Arthritis	1	Efficacy	50.00	9.30		61.1	52.00	Positive
Hamar, Coberley *et al.* 2018 [53]	Australia	Retrospective Matched	Sync	MCC	7	Utilization		50.90			0.00	Positive
Harnett, Jones *et al.* 2018 [54]	UK	Quasi 2 group	RPM	Chronic Kidney Disease	1	Efficacy, Utilization		45.00		78.5	52.00	Positive
Cameron, Voth *et al.* 2018 [55]	Canada	Retrospective	Sync	MCC	1	Efficacy		70.20			6.00	Positive
Litke, J., *et al.* 2018 [56]	USA	Quasi 2 group	Sync	MCC	4	Efficacy				62	19.00	Positive
Bakas, Sampsel *et al.* 2018 [57]	USA	Quasi 2 group	Sync	MCC	7	Efficacy	0.00	71.00	Urban	82.7	19.20	Positive
Herold, van den Berg *et al.* 2018 [58]	Germany	Retrospective Matched	RPM	CHF	5	Efficacy		45.86	Mixed	74.44	104.00	Positive
Herold, Hoffmann *et al.* 2018 [59]	Germany	Retrospective	Mixed	CHF	1	Cost		45.00	Mixed	73.7	104.00	Positive
Walker, Pompilio *et al.* 2018 [60]	UK	RCT	RPM	MCC	1	Efficacy, Cost, Utilization		71.00			36.00	Positive
Frederix, Vanderlinden *et al.* 2019 [61]	Belgium	RCT	RPM	CHF	1	Efficacy, Cost, Utilization		51.00		76	24.00	Positive
Brain, Reynolds *et al.* 2019 [63]	USA	Quasi 1 group pre post	Sync	Diabetes	1	Efficacy, Quality, Utilization	26.00	64.00	Urban		65.00	Positive
Piette, Striplin *et al.* 2020 [63]	USA	RCT	Async	MCC	5	Utilization	53.70	60.70		80.2	4.00	Positive

Async = Asynchronous; MCC = Multiple Chronic Conditions; RPM = Remote Patient Monitoring; Sync = Synchronous.

3.1. Participant Description

Mean age of telehealth participants was found in 34 of the articles and ranged from 40 - 83 with mean age at 66.1 (SD, 11.48). Income was reported in 7 articles. Two studies reported income as "comfortable", two studies reported income as less than $14,000 and two studies reported income between $20,000 - $40,000. The remaining study reported that 25% of the participants had an income that was "inadequate to cover bills." Eleven reported the education level of participants with eight of the eleven reporting a high school education or less. Of the 15 studies that published rural or urban status of participants, 9 were in urban areas, 4 were in rural areas and 2 included participants from both rural and urban areas. Eight articles presented the race of participants. Across all studies, the mean of non-white participants was 33.0% (SD, 21.5%) with a range of 0% - 65%. Thirty-two of the studies contained descriptive data about the gender of participants with the mean percent of female participants at 51.6% (SD, 16.2%) with a range of 9.3% - 75.0%.

The studies differed in the number and type of chronic illness included. Twenty-three studied the effect of telehealth for one chronic condition (49.9%) while 24 (51.1%) examined the effectiveness of telehealth for multiple chronic conditions. Number of chronic illnesses described in each article ranged from 1 - 7 with a mean of 2.5 (D = 1.92). Type of chronic illness included diabetes (n = 25), cardiovascular disease, hypertension or congestive heart failure (n = 21), chronic obstructive pulmonary disease (COPD) or lung disease (n = 17), cancer (n = 4), stroke (n = 3), smoking (n = 2), amyotrophic lateral sclerosis (n = 2), epilepsy (n = 2), pain (n = 2), aphasia (n = 1), arthritis (n = 1), burn (n = 1), deep vein thrombosis (n = 1), multiple sclerosis (n = 1), osteoarthritis (n = 1), pancreatitis (n = 1), and psoriasis (n = 1). When examining type of chronic illness and dose, there were no significant differences between heart disease, lung disease, diabetes, multiple chronic conditions, and other conditions ($F(4, 41) = 0.20$, $p = 0.94$). Nineteen studies (40.4%) measured more than one outcome.

3.2. Study Measures & Outcomes

Efficacy was measured by the majority of studies (61.8%, n = 29) followed by Healthcare Utilization (34.0%, n = 16), Quality (31.9%, n = 15), Adherence (10.6%, n = 5), Cost (8.5%, n = 4), and Safety (2.1%, n = 1). See **Figure 2** for a visual of dose of telehealth in weeks with the type of telehealth and chronic illness type.

Figure 3 displays the type of telehealth services evaluated in each study.

The types of measures varied for each category in all articles. Asynchronous telehealth was used by 7 studies (14.9%) for a mean of 18.85 weeks (SD, 16.77), synchronous by 12 (25.5%) for a mean of 57.93 weeks (SD, 114.62), remote monitoring by 13 (27.7%) for a mean of 44.92 weeks (SD, 33.79), and mixed telehealth interventions were used by 15 studies (31.9%) for a mean of 64.15 weeks (SD, 50.20).

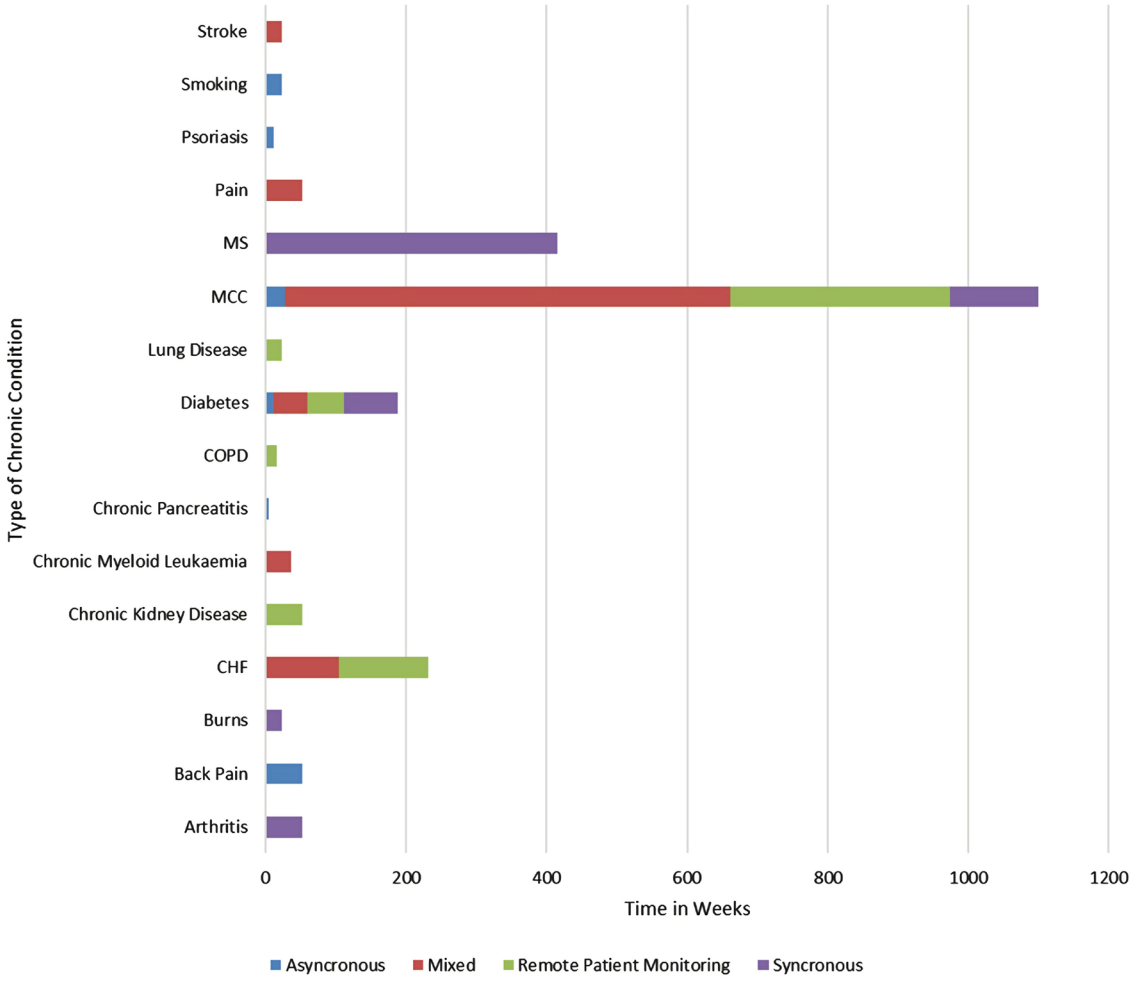

Figure 2. Dose of telehealth in weeks for chronic illness and type of telehealth.

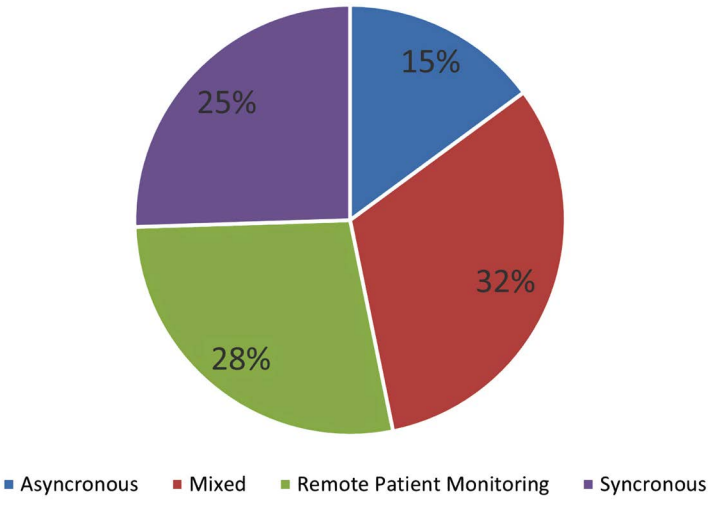

Figure 3. Percent of type of telehealth.

3.3. Dose

Length of intervention was measured and reported differently in each study.

Most articles listed the amount of time that the intervention was funded, measured, or observed. The amount of time each participant received the intervention, or the amount of time spent engaging with telehealth was not reported. Hence, dose of intervention was normalized to weeks participants received telehealth. The weeks of telehealth evaluated in each study ranged from 0 - 520 (mean of 50.2 weeks, SD, 94.7). There were no significant differences between the type of telehealth offered in a study and the mean length of time telehealth was provided ($F(3, 42) = 0.38$, $p = 0.77$). Nearly all of the studies (89.4%, n = 42) reported positive outcomes from telehealth interventions. Studies with positive outcomes were offered for a mean of 51 weeks (SD, 100.16). Those with neutral outcomes were provided for a mean of 37.33 weeks (SD, 25.40) and studies with mixed outcomes for a mean of 38.00 weeks (SD, 19.80). The frequency, percent, dosage in weeks, and number of positive findings for each type of measure can be seen in Table 2.

3.4. Limitations

Of the 47 articles reviewed, a small number were RCT designs (N = 12). Of the RCT designs, limitations were vast. Lack of standard quality measurement across studies suggests that intervention effect estimates are inconsistent and unpredictable. Small sample sizes, short duration of the intervention, lack of fidelity to intervention, self-report survey response, convenience samples, lack of generalizability, and participants lost to follow-up lead to a high risk of bias. The quality of reporting in articles and the details of the intervention were often not described, hence replication would be difficult. A matrix table of the RCT studies can be seen in Table 3.

4. Discussion

In community dwelling adults experiencing chronic illness, the dose of telehealth services that improve care effectiveness, quality, safety, and cost is still unknown. Dose of intervention based on these domains of measurement cannot be determined from this review. Dose is recorded and reported inconsistently across studies. In the literature the most information is based on weeks of delivery

Table 2. Frequency of measures, dose, & findings.

TYPE OF MEASURE	FREQUENCY (%)	MEAN DOSE IN WEEKS (SD)	N POSITIVE FINDINGS
ADHERENCE	5 (10.6)	16.8 (10.73)	5
EFFICACY	29 (61.7)	30.4 (27.10)	26
COST	4 (8.5)	171.0 (235.32)	4
QUALITY	15 (31.9)	28.7 (29.59)	15
SAFETY	1 (2.1)	36.0 (NA)	1
UTILIZATION	18 (38.3)	85.17 (143.01)	16

Table 3. RCT design.

Authors/Year	Country	Sample Size	Aims	Design	Main Chronic Illness	# Illness	Type of Measure	Weeks	Results	Limitations
Gellis, Kenaley *et al.* 2012 [25]	USA	115	To examine the impact of a multifaceted telehealth intervention on health, mental health, and service utilization	RCT	MCC	6	Efficacy, Quality	12.00	Positive	Unable to determine specific influence of telehealth versus nurse interactions. No data on cost outcomes. May not be generalizable to non-Medicare certified agencies or other chronic conditions.
Gellis, Kenaley *et al.* 2014 [34]	USA	102	Evaluate the integrated telehealth intervention to improve chronic illness in the home healthcare setting.	RCT	MCC	2	Efficacy, Utilization	12.00	Positive	Factors such as dose, adherence, and effect of antidepressants not addressed. The amount of interaction with the team nurse and participants was not examined.
Chatwin, Hawkins *et al.* 2016 [37]	UK	61	To assess the impact of home telemonitoring on health service use and quality of life in patients with severe chronic lung disease.	RCT crossover	Lung Disease	5	Utilization	24.00	Negative	Results not generalizable to milder chronic respiratory disease. Possibility of a type II error. Slightly missed sample size calculation. Not blinded. No washout period.
Gonçalves, Ciol *et al.* 2016 [39]	Brazil	108	To compare the perceived health status and self-efficacy between two groups of burn victims.	RCT	Burns	1	Efficacy	24.00	Positive	No blinding of the measurements. Lost to follow-up, especially at 12 month point. No information on perceived health status prior to burns.
Kekäle, Söderlund *et al.* 2016 [40]	Finland	86	To evaluate the influence of tailored patient education on medication adherence.	RCT	Chronic Myeloid Leukemia	1	Adherence	36.00	Positive	Small sample size. Subjective measure of the primary outcome. Patients were least satisfied text messaging and most satisfied with face-to-face counseling.
Cobos-Campos, Fernández de Larrinoa *et al.* 2017 [46]	Spain	320	To evaluate the effectiveness of text messaging added to a health advice program on smoking cessation.	RCT	Smoking	1	Efficacy	24.00	Positive	Only 148 (78 I, 70 C) made it to 6 months.
Kotsani, Antonopoulou *et al.* 2018 [64]	Greece	94	To evaluate the effect of telenursing on T1DM patients' compliance with glucose self-monitoring and glycemic control	RCT	Diabetes	1	Efficacy	12.00	Positive	Short duration; the two groups were not matched for fasting glucose at baseline

Continued

Oddone, Gierisch *et al.* 2018 [51]	USA Multicenter	4417	To evaluate a telephone-based health coaching on patient activation	RCT	MCC	3	Efficacy, Utilization	24.00	Positive	Conducted in 3 VA facilities not generalizable to other populations; self-reported; short duration
Walker, Pompilio *et al.* 2018 [60]	UK	312	To evaluate the efficacy of home monitoring of lung mechanics in older patients with COPD and comorbidities.	RCT	MCC	1	Efficacy, Cost, Utilization	36.00	Positive	National healthcare provided hence lacks generalizability of the findings to other systems of payers.
Frederix, Vanderlinden *et al.* 2019 [61]	Belgium	160	To evaluate the efficacy of home monitoring of lung mechanics by the forced oscillation technique and cardiac parameters in older patients with COPD and comorbidities.	RCT	CHF	1	Efficacy, Cost, Utilization	24.00	Positive	Limited evaluation of other measures. No standard measure of cost.
Piette, Striplin *et al.* 2020 [63]	USA	283	To evaluate automated phone calls, care giver support post discharge	RCT	MCC	5	Utilization	4.00	Positive	Variance in intervention, caregivers' roles differ, mostly white, large amount of patients were ineligible, small sample size, unable to record out of system events, unable to track care provider's response.

Async = Asynchronous; MCC = Multiple Chronic Conditions; RPM = Remote Patient Monitoring; Sync = Synchronous.

but not the time spent with the provider, in education, or interacting with the intervention. The findings from this systematic review do indicate that longer duration of telehealth services (51 weeks), regardless of modality, produced positive outcomes as opposed to those with shorter durations (37 - 38 weeks) that produced neutral or mixed results. As the use of telehealth due to COVID-19 increases, the main problem that remains is how to best implement telehealth in existing work structures and treatment protocols. Concentrated effort on workflow issues such as dose of intervention and clinical practice standards are necessary to ensure that telehealth is being used in the most appropriate ways to improve the patient and clinician experience. Without assessing for the appropriateness of offering telehealth, patient-centered, timely, efficient, and equitable telehealth provision is not possible.

The widespread international study locations found in this systematic review are a true indicator that telehealth is viewed as a global initiative to improve the care of people with MCC. Telehealth has been associated with having a positive impact on outcomes for all chronic conditions. Most frequently, telehealth was used for multiple chronic conditions using a mixed telehealth intervention; however, the studies presented in this review varied in quantitative design, me-

thodology, and quality. The evidence related to telehealth has been building for over 2 decades. At this point in knowledge development, study design should be RCT and Comparative Effectiveness. Additionally, while using telehealth for rural populations has been promoted [16], only 15 of the 47 articles in this review noted the location of their intervention. Of those 15, only four were in rural areas and none were a RCT design. Hence, rigorous evaluation of the use of telehealth for rural populations is still needed, especially in regard to dose of telehealth interventions.

This systematic review highlights that demographic information about participants is collected infrequently and inconsistently. Telehealth is often proposed as a solution to decrease health disparity such as a higher burden of illness, injury, disability, or mortality experienced by those with chronic conditions. However, health care disparity such as lack of insurance, access, and quality are rarely measured in telehealth research. In addition, large amounts of missing data in relation to the determinants of health, such as access to care, were observed. The digital divide makes accessing telehealth an issue [17]. Understanding the results of telehealth trials in the context of the population will continue to be important as we attempt to diminish health disparity in the context of the determinants of health. Age, gender, income, education, rurality, and race all impact efficacy of health interventions. Understanding these demographics in relation to the effectiveness, cost, cost-effectiveness, and the patient experience are domains of measurement suggested by the National Quality Forum guidelines for telehealth [18]. These domains must be present in all telehealth work moving forward and should be evaluated in the context of the determinants of health.

5. Conclusion

After completion of this review, drawing generalizations about dose and impact on outcomes of care is not yet possible. Collecting and reporting data related to clinical workflow such as dose of intervention specific to disease and type of modality is recommended. In addition, focus must be placed on patient-centered, timely, efficient, and equitable care. Rigorous study design at the RCT and Comparative Effectiveness level is still needed. Future rigorous studies must use a standardized tool to measure demographic information that includes individual person factors of the determinants of health so that future interventions can impact health disparity. Developing clinical implementation knowledge for community dwelling individuals who experience MCC in relation to the effectiveness, cost, cost-effectiveness, and the patient experience will be crucial to realizing the promise and potential of telehealth.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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