Self-efficacy of older people using technology to self-manage COPD, hypertension, heart failure or dementia at home: An overview of systematic reviews

Garuth Chalfont, PhD (corresponding author)

Centre for Ageing Research, Division of Health Research, Faculty of Health and Medicine, Health Innovation 1, Lancaster University, Lancaster LA1 4YG, UK Email: g.chalfont@lancaster.ac.uk

Céu Mateus, Professor

Health Economics, Division of Health Research, Faculty of Health and Medicine, Health Innovation 1, Lancaster University, Lancaster LA1 4YG, UK Email: c.mateus@lancaster.ac.uk

Sandra Varey, PhD

Centre for Ageing Research, Division of Health Research, Faculty of Health and Medicine, Health Innovation 1, Lancaster University, Lancaster LA1 4YG, UK Email: s.varey@lancaster.ac.uk

Christine Milligan, Professor

Centre for Ageing Research, Division of Health Research, Faculty of Health and Medicine, Health Innovation 1, Lancaster University, Lancaster LA1 4YG, UK Email: c.milligan@lancaster.ac.uk

Abstract

Background and Objectives

Although telehealth research among the general population is voluminous, study quality is low and results are mixed. Little is known specifically concerning older people and their self-efficacy to engage with and benefit from such technologies. This paper reviews the evidence for which self-care telehealth technology supports the self-efficacy of older people with long-term conditions (LTCs) living at home.

Research Design and Methods

Following PRISMA guidelines, this overview of systematic reviews focused on four LTCs and the concept of 'self-efficacy'. Quality was appraised using R-AMSTAR and study evaluation was guided by the PRISMS taxonomy for reporting of self-management support. Heterogeneous data evidencing technology-enhanced self-efficacy were narratively synthesised.

Results

Five included papers contained 74 primary studies involving 9,004 participants with chronic obstructive pulmonary disease (COPD), hypertension, heart failure or dementia. Evidence for self-care telehealth technology supporting self-efficacy of older people with LTCs living at home was limited. Self-efficacy was rarely an outcome, also attrition and drop-out rates and mediators of support or education. The pathway from telehealth to self-efficacy depended on telehealth modes and techniques promoting healthy lifestyles. Increased self-care and self-monitoring empowered self-efficacy, patient-activation or mastery.

Discussion and Implications

Future research needs to focus on the process by which the intervention works and the effects of mediating variables and mechanisms through which self-management is achieved. Self-efficacy, patient-activation, and motivation are critical components to telehealth's adoption by the patient, and hence to the success of self-care in self-management of LTCs. Their invisibility as outcomes is a limitation.

Keywords: telehealth, self-management, self-care, long-term conditions, living at home

Background

Despite the progress in diagnosis and treatment of chronic LTCs, the prevalence in LTCs such as COPD, heart failure, hypertension and dementia continues to rise (George & Martin, 2016). Pressures on health and social care systems are increasing as a result, with wait times in the UK for routine and emergency care the highest in a decade, including accident and emergency services, further driving up demand for hospital beds (KingsFund.org.uk, 2018). Meanwhile, healthcare costs are also rising as UK local authorities face budget reductions (LGA, 2018) and half of National Health Service (NHS) providers forecast a financial deficit (KingsFund.org.uk, 2018). Such trends disproportionately affect older people, especially those with multiple LTCs and from lower socio-economic backgrounds (Allen & Daly, 2016; KingsFund.org.uk, 2019). Governments, particularly in high-income countries are seeking technological 'solutions' to address the rising patient numbers and costs associated with LTCs (Hanlon et al., 2017; Parati, Pellegrini, & Torlasco, 2019). In order to reduce the pressure on healthcare services, particularly in relation to older people, the use of telemedicine, telemonitoring, telehealth and other technological configurations, applications, devices and platforms is becoming more prevalent for patient-provider communication to support self-management.

This overview was stimulated by our work in the area of health technologies for LTCs as part of the Lancashire and Cumbria Innovation Alliance (LCIA) Testbed (Varey et al., 2018). An initial survey of the evidence-base for healthcare technology and older people with LTCs revealed two points. Firstly, the plethora of work that has emerged in recent years around healthcare technology has given rise to a somewhat confusing set of terms used to describe it. Terminology tended to complicate rather than clarify the topic. To address this, Murphy, Harrington, Taylor, Teljeur, Smith, Pinnock, & Ryan (2017) suggested using the single term 'telehealth' to encompass all 'health-based IT-based care' and the term 'self-management' as 'the provision of interventions to increase patients' skills and confidence, empowering the individual to take an active part in their disease management' (p. 276). Their goals of self-management include optimizing and preserving physical health; reducing symptoms and functional impairments in daily life, increasing emotional and social-well-being, establishing effective alliances with healthcare professionals as well as friends, family and others in the community, as well as improving overall quality of life.

Secondly, it became clear that whilst there is voluminous published evidence on different forms of telehealth, we sought evidence for which telehealth might support self-efficacy and self-management amongst older people. This is important given government and health policy is placing increasing emphasis on enhancing self-efficacy and the self-management of care, not just to facilitate older people's ability to remain at home for longer but also to reduce hospital admissions and GP visits. Furthermore, many LTCs affect a broad age range of people (diabetes and asthma studies focused on participants >18 years). Technology adoption (Mitzner et al., 2019) and task performance by older adults (Schmidt & Wahl, 2019) are receiving much-needed attention in individual studies. Given there were already a number of papers reviewing telehealth, we chose to undertake a review of reviews (an overview) in order to bring together knowledge and insights already synthesised within these published papers rather than undertaking yet another review of single studies. Therefore, we chose to provide an overview of evidence on telehealth, older people and self-efficacy. Hence, this study focuses on our objective stated below and the four specific LTCs most prevalent among our Testbed participants.

Objective

Our primary objective for undertaking this overview of systematic reviews is to understand what the existing evidence base is for how health technology can support self-efficacy of older people with specific LTCs. Hence, we aimed to collect, appraise and synthesize existing evidence from multiple systematic reviews on the extent to which self-care telehealth technology supports self-efficacy of older people with LTCs (specifically hypertension, COPD, heart failure and dementia) living at home.

DESIGN and METHODS

We undertook a thorough search of the literature, adhering to methodological guidance for quality reviews (CRD, 2009; Heyn, Meeks, & Pruchno, 2019) and formulated the scope of the research using PICOS. A scoping of the literature was first performed to identify key papers, refine inclusion/exclusion criteria, identify keywords and develop a search strategy. Based on the quantity of existing literature we decided to conduct an 'overview of systematic reviews', including only papers that comprised systematic reviews or meta-analyses. Use of a theoretical framework is recommended for guiding the development and implementation of health interventions (Craig, Dieppe, Macintyre, Michie, Nazareth, & Petticrew, 2013). Since self-efficacy is a feasible framework to guide intervention development for chronic health conditions (Tougas, Hayden, McGrath, Huget, & Rozario, 2015) we focused on this concept as well as associated terms such as motivation, patient-activation, mastery and empowerment are also used in describing a person's resiliency towards adversity and perseverance against obstacles. We therefore sought these as outcome measures. (Further details of Design and Methods can be found in Table 1.)

The LICA Testbed implemented innovative combinatorial technologies and practices. Objectives were to use a combination of health technologies and services to better support frail older people living with a range of LTCs, to improve patient activation (NHS, 2019) and their ability to self-care at home. Because we reviewed literature with complex interventions in mind, we felt that the PRISMS taxonomy provided a useful framework for identifying the quality of reporting. The Practical Reviews in Self-Management Support (PRISMS) study responded to the poor standard of reporting of complex interventions, specifically those for self-management support by developing a useful descriptive taxonomy (Pearce, Parke, Pinnock, Epiphaniou, Bourne, Sheikh, & Taylor, 2016; Taylor et al., 2014). PRISMS' dimensions (Mode of delivery; Personnel delivering support; Targeting; and Intensity, frequency and duration of the intervention) were incorporated into Table 2. Characteristics.

Selection criteria

Eligible studies met the following inclusion criteria:

- ***P****articipants* - Older adults 50 years and older with LTCs (heart failure, COPD, hypertension or dementia), living at home. Reviews of chronic diseases in general (rather than just one of the specified four listed above) are included if >50% of the studies have subgroup analysis relevant to the 4 included LTCs. (See Table 1)
- ***I****nterventions* – Telehealth technology or device interventions to support or improve self-management / self-care at home
- ***C****omparators* - Usual care or alternative means of delivering the intervention (e.g., face-to-face, paper-based). A comparator was not essential for inclusion.
- ***O****utcomes* - Self-efficacy, patient-activation, mastery, components of supported self-management
- ***S****tudy design* - Systematic reviews of any study design. No date limits. English only.

Ineligible studies included:

- Tracking or passive monitoring (patient not involved in measuring and communicating data with practitioner), implantable devices, surveillance, smart homes, home health care by an agency, physical activity promotion, robotics, AI or virtual reality.

Search strategy and process

Keywords with the combination of AND, OR and NOT and medical subject heading terms were used for searching the concepts of chronic disease, technology, self-efficacy and systematic review. The search strategy and terms were peer-reviewed by subject experts on the Testbed project and refined in team meetings (See Supplemental file 1. Search strategy). Ten electronic databases were searched. Manual searching of journals, reference lists of all eligible reviews searched, and backwards and forwards citation searching was performed for all included systematic reviews.

Publications were selected and reporting guided by The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) flow diagram (Liberati et al., 2009; Moher, Liberati, Tetzlaff, Altman, & Prisma Group, 2009) and checklist (Supplemental file #3). The first author screened all titles and abstracts for relevance. It was necessary in about 5% of cases to review the full text publication as the abstract was incomplete or unclear. After removal of duplicates and screening of titles and abstracts, 22 publications from 6,719 citations were identified by the lead author for possible inclusion. To cross-check the accuracy of the title and abstract screening process, a list of papers representing 10% of the total that were excluded by the lead author were screened, considered and confirmed by a second author. A search of forward citations of the 22 potential inclusions resulted in the identification of one further paper for inclusion, giving a total of 23 systematic reviews potentially fulfilling the inclusion and exclusion criteria.

All 23 papers for potential inclusion went forward to full paper screening to be rated by the lead author as included, excluded or maybe. The other three authors independently assessed a subset of 7-8 papers each. Disagreements arose during this process concerning 4 papers and investigators deliberated and achieved final agreement. Six papers were included in the overview prior to quality assessment (Ciere, Cartwright, & Newman, 2012; Guo & Albright, 2018; Ma, Cheng, H. Y., Cheng, L. & Sit, 2019; McCabe, McCann, & Brady, 2017; Milavec Kapun, Sustersic, & Rajkovic, 2016; Tyack & Camic, 2017). Seventeen papers were excluded (See Table 1).

The PRISMA diagram (Figure 1) details the search and selection process.

Figure 1. PRISMA Diagram (insert about here)

Quality appraisal

We chose to adopt R-AMSTAR to assess the quality of the studies after reviewing a number of potential tools (GRADE, RE-AIM, MMAT and AMSTAR). The first three are designed for primary studies, mixed-methods studies and randomized controlled trials (RCTs). AMSTAR is a measurement tool, with good content validity, for the assessment of multiple systematic reviews (Shea et al., 2007). As each component of the score measures a different domain of quality, the summary score is meaningful (Conway et al., 2013). AMSTAR was created for systematic reviews of RCTs, making it less appropriate for our overview. R-AMSTAR is a revised version of AMSTAR (Pollock, Fernandes, & Hartling, 2017; Shea et al., 2007). It detracts nothing from its content and construct validity and using the criteria originally employed in its development, it “yields numbers based upon generally agreed upon criteria of excellence, which can be transformed into a standardized grading system of the quality of the evidence presented in any given systematic review” (Kung et al., 2010) (p. 88). It has also been used by other overviews in self-management of LTCs and telehealth (Captieux et al., 2018; Hanlon et al., 2017). (Details in Table 1.)

The quality appraisal process was undertaken by the full research team in a standard manner by running blind critical R-AMSTAR assessments of the same systematic review and comparing the outcomes (See Table 1). A team decision was taken to exclude Milavec Kapun et al. (2016) based on a 15/44 (34%) quality rating. Uncertainty remained as to whether this scoring resulted from the paper's poor methodology or reporting. It was unclear, for example, whether there was duplicate study selection and data extraction, and no list of included or excluded papers or table of characteristics were provided, among other limitations.

Of the 5 included reviews, the quality of 3 (Ciere et al., 2012; Ma et al., 2019; McCabe et al., 2017) was high and 2 (Guo & Albright, 2018; Tyack & Camic, 2017) were of low quality (but only by 4 points or less). The overall review was of high impact given that the total participants approached 10,000. Two papers (Ma et al., 2019; McCabe et al., 2017) both scoring 40/44 (91%) stood out from the other reviews as they included hand-searching of the literature, had no language restriction and sufficiently stated the reasons for exclusion of articles seriously considered. Of these two reviews, McCabe et al. also provided the most comprehensive literature search, included grey literature, was unique in providing details of excluded records and articles, showed appropriate methods for combining studies, and addressed publication bias, conflict of interest and support statements most fully.

The R-AMSTAR quality assessment is Additional file 2.

Figure 2. Frequency distribution of R-AMSTAR scores (Insert about here)

Data extraction

Data extraction was carried out by one author and then checked and agreed by another. Extracted characteristics included: author (year, country), number of studies, study design, participant numbers and conditions, interventions/types of technologies, follow-ups, author's conclusions, age, gender, patient population, condition details, sample sizes, interventions/control, research question, outcomes of interest, risk of bias assessment, evaluation of quality, drop-out rate and self-efficacy outcomes reported (patient activation, motivation, mastery, etc.). In case a review lacked study data, primary studies were consulted. Failing that, the investigators and the journal were contacted.

Synthesis

Data from the findings and discussions sections of all included papers were synthesized narratively and no statistical or meta-analysis was carried out. There was one overlap of research groups in the primary studies within the reviews. McCabe et al. (2017) cited Tabak et al. (Tabak, Vollenbroek-Hutten, van der Valk, van der Palen, & Hermens, 2014) and Guo and Albright (2018) cited Tabak et al. (2014) for different papers concerning two pilot studies for patients with COPD.

RESULTS

The results section is descriptively analytical. We first describe each review study's characteristics, quality of primary studies, participant characteristics, intervention and technology characteristics, and follow-ups, attrition and drop outs. Outcomes of the research question are given and illustrated graphically.

1. *Individual review study characteristics*

The characteristics of the 5 individual reviews are summarized in Table 2. They were published between 2012 and 2019 with 3 conducted in the UK, one in the USA and one in Hong Kong. They reported a total of 74 studies of mixed design (17 RCTs, 31 clinical trials with experimental or quasi-experimental designs, 7 controlled design studies comparing 2 groups, 4 RCTs comparing a CG with either 2 or 3 IGs, 1 pre-post observational design study, 14 mixed methods studies) involving 9,004 participants.

The average number of primary studies included in the reviews was 14.8 (range 3-31). The 5 included reviews each addressed one of the included LTCs: heart failure (Ciere et al., 2012), hypertension (Ma et al., 2019), COPD (McCabe et al., 2017), dementia (Tyack & Camic, 2017) or a number of chronic conditions (Guo & Albright, 2018) which included one of these LTCs in enough studies to satisfy the 50% +1 rule (See Table 1).

Table 2. Characteristics of Included Systematic Reviews (Insert about here)

2. Quality of primary studies

Authors of included reviews carried out their own quality check of their primary studies to determine risks of bias, evaluation of quality and attrition or drop-out rates. We summarize them here.

Ciere et al. (2012) quality assessed using an adapted version of the Effective Public Health Practice Project's (EPHPP) Quality Assessment Tool for Quantitative Studies (2019). The adapted tool included 26 items assessing seven of the EPHPP's eight domains plus three domains taken from Downs and Black's checklist (Downs & Black, 1998). They reported that the overall quality of studies was poor with only a single study achieving a global rating of moderate. Weaknesses related to statistical power, blinding, selection bias, data collection, attrition, intervention integrity and statistical analyses.

Guo & Albright (2018) referred to Cochran's quality of evidence guideline and cited Littell (2008). They predominantly found biases to be low, unclear or high risk. The majority of included studies reported all studies' pre-specified outcomes and were marked low risk for reporting bias. They found that a few studies ignored some selective outcomes and evaluated them as high risk.

Ma et al. (2019) reported according to the PRISMA statement (Moher et al., 2009) and quality assessed one RCT with the Randomized Controlled Trial Checklist of Joanna Briggs Institute (Tufanaru, Munn, Aromataris, Campbell, & Hopp, 2017) and the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green (Eds.), 2011). Meta-analysis conducted using Review Manager 5.3 for at least two studies reporting the same outcome. Otherwise, narrative synthesis was performed. They found "suboptimal quality and some methodological weakness, such as lack of clear information on randomised and allocation concealment and absence of blinding the outcome assessors" (p. 44).

McCabe et al. (2017) assessed with the Cochrane Handbook of Systematic Reviews of Interventions and found low, unclear or high risk. GRADE (Grading of Recommendations, Assessment, Development and Evaluations) offers an informative, transparent and structured system for rating quality, and developing and presenting summaries of evidence for systematic reviews and recommendations in health care (G. Guyatt et al., 2011; G. H. Guyatt et al., 2008). Using the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness, and publication bias), reviewers assessed overall low evidence quality of studies that contributed data to the meta-analysis.

Tyack & Camic (2017) assessed quality using Pluye and Hong's (2014) Mixed Methods Appraisal Tool (MMAT) checklist and reported variable results - 25% (6 papers), 50% (1 paper), 75% (5 papers) and 100% (5 papers).

3. Participant characteristics

All reviews (or 50% +1 of their included studies) focused on older people. The mean age of participants was lowest for hypertension (50-68), followed by chronic conditions (average 55 years), heart failure (mean ages 61-78), COPD (average 64) and dementia (mean ages 74.3 - 84.5). Only one review met inclusion criteria for each of the chronic LTCs.

All participants in the included reviews were either community-dwelling (living at home, which includes sheltered accommodation) or mostly involved people living at home (at least 50% +1 of the studies). Concerning setting, although telehealth by definition connects people from home with healthcare providers (HCPs) located elsewhere, Tyack (2017) reviewed studies of people with dementia and their carers at day centers or unspecified locations (only one specified that it was an 'in-home pilot study'), and this technology was not connecting to remote HCPs. As paid (formal) and unpaid (informal) carers, an art therapist and a facilitator were involved in the interventions, the devices facilitated connection with on-site social care providers.

4. Interventions and technology characteristics

Similar to study design, technology interventions found in the review papers were highly heterogeneous and spanned 3 broad categories:

- Transfer of clinical information from patient home-health monitoring of signs and symptoms using long-distance communication technologies: via a home telehealth system (Ciere et al., 2012; Guo & Albright, 2018), Health Buddy (Ciere et al., 2012), smartphone (Guo & Albright, 2018; Ma et al., 2019; McCabe et al., 2017), computer (Guo & Albright, 2018; Ma et al., 2019; McCabe et al., 2017), TV (Guo & Albright, 2018), tablet (Ma et al., 2019; McCabe et al., 2017), touchscreen devices (Tyack & Camic, 2017), iPad (McCabe et al., 2017; Tyack & Camic, 2017), website (Ciere et al., 2012; Ma et al., 2019), apps (Ma et al., 2019; McCabe et al., 2017), videophone/Skype (Ciere et al., 2012; Guo & Albright, 2018; McCabe et al., 2017), personal digital assistance tools (Ma et al., 2019), compliance monitoring device (Ciere et al., 2012), 'system generating feedback by using automated email reminders' (Ma et al., 2019) (and telephone as part of a combined strategy) (Ciere et al., 2012).
- Interventions comprising behavioral change through education dissemination, tele-education or home nurse visits (as part of a combined strategy): 'health care providers supporting individualized goal-directed feedback through multiple media (website, SMS, email, mobile apps such as WeChat, and telephone call)' (Ma et al., 2019); network applications accessible over the internet, including blogs, discussion boards, online multimedia and online surveys (Guo & Albright, 2018)
- A telehealth program applying multiple telehealth technologies (Guo & Albright, 2018)

Telehealth intervention strategies included monitoring of signs or symptoms (Ciere et al., 2012; Guo & Albright, 2018; Ma et al., 2019), lifestyle modification techniques such as goal-setting and decision-making (Ma et al., 2019), motivation (Ma et al., 2019), engagement (Guo & Albright, 2018; Tyack & Camic, 2017), education (Ciere et al., 2012; Guo & Albright, 2018; Ma et al., 2019) and maintenance (Ma et al., 2019).

Some studies required participants to use the device in a stated frequency (Ciere et al., 2012; Guo & Albright, 2018) such as 2 or 3 times a week, or did not specify frequency of use (Ciere et al., 2012). One fully-automated system specified the level of email interaction required and one system generated automated emails (Ma et al., 2019).

Comparator interventions included standard/routine/usual care (Ciere et al., 2012); home nurse visits (Ciere et al., 2012); face-to-face and/or hard copy digital documentary education/self-management support (McCabe et al., 2017); regular visits to outpatient clinics (Ciere et al., 2012); hospital follow-up by nurse and cardiologist (Ciere et al., 2012); counselling, training, education or information on disease-specific self-care behavior (Ciere et al., 2012); care as directed by primary care provider (Ciere et al., 2012); keep paper-based record of blood pressure (Ma et al., 2019); and Nurse Standard hypertension care, check BP 3-5 times a week, communication through office visit, phone calls, email (Ma et al., 2019).

5. *Follow-ups and attrition/drop outs*

Attrition or drop-out rates were not specifically reported in all 5 papers, hence it was not possible to compare. However, attrition bias was addressed in terms of the quality of the reviews. Attrition bias is caused by the amount, nature or handling of missing outcome data or failure of follow-up. A rule of thumb states that <5% attrition leads to little bias, whilst >20% poses serious threats to validity (Schulz & Grimes, 2002). We summarize follow-ups, attrition and drop-out rates in Table 3 (further detailed characteristics in Supplemental file #4)

Table 3. Follow-ups, attrition and drop-out rates (insert about here)

6. *Outcomes*

Research questions and outcomes sought mentioned 'self-efficacy' or related terms, or investigated a general topic containing the concept. These are summarized in Table 2.

We found that evidence for self-care telehealth technology supporting self-efficacy of older people with LTCs living at home was limited. Given the paucity of research that fit the inclusion criteria, it was not surprising to find such heterogeneity of data and study design, a common finding among systematic reviews of healthcare interventions in real-world settings. Lack of standardization does represent a factor that hampers the possibility of summarising quantitative data and drawing general assumptions because heterogeneity rules out the pooling of studies. In this case, a meta-analysis was inappropriate due to the heterogeneity of the data and study designs, hence a narrative synthesis was conducted.

Perhaps due to the heterogeneity, each paper offered an interesting contribution to the question. Figure 3 graphically illustrates the main findings which are addressed in more detail below.

Figure 3. Main Findings (insert graphic about here)

7. *Findings on self-efficacy*

Ciere et al. (2012) examined whether improvements in clinical outcomes and quality of life (QoL) are mediated by increases in knowledge, self-efficacy and self-care behavior in patients with heart failure. Two plausible pathways (increased monitoring by HCPs and improved self-care by patients) were suggested by which telehealth achieves apparent improvements. A model of self-care behavior and two of its cognitive precursors (knowledge and self-efficacy) was proposed with 6 pathways by which telehealth might lead to improved outcomes. In 12 studies, 2 self-efficacy pathways were reported, but none robustly.

- *Relationships between telehealth and self-efficacy* – 6 of the 12 studies assessed the effect of telehealth on self-efficacy or confidence relating to the performance of self-care behaviors; 3 reported no change over time; 3 found improvements across both intervention and control groups; 5 RCTs analyzed group differences at follow-up (one found improved self-efficacy relative to controls; two found no group differences; and two studies comparing multiple intervention arms found some group differences but none between telehealth and controls)

- *Relationships between self-efficacy and self-care behavior* – One RCT examined associations between self-efficacy and seven self-care behaviors separately for telehealth and a control group at 6 weeks and 3 months. Only two of 28 associations tested were significant and none were significant at 3 months. A second RCT assessed the relationship between confidence to perform self-care behaviors and (self-reported) performance of nine self-care behaviors. Associations involving five self-care behaviors were significant at 120 days but associations for the remaining four behaviors were non-significant.

This study highlighted plausible pathways between telehealth and outcomes specific to self-efficacy and knowledge, but these are poorly theorised and rarely investigated in the literature. This impedes our understanding of how telehealth might achieve beneficial outcomes.

Guo & Albright (2018) found studies suggesting self-care success in heart failure (medication adherence), chronic diseases (health-problem skills, self-care efficacy and medication compliance knowledge), COPD (QoL) and hypertension (improving health-care management skills).

- Fourteen studies of long-distance communication technologies (LDCs - programs or technologies supporting interactions/communications between HCPs and patients over distances, e.g. cellphone/videophone); an efficient strategy for HCPs to mentor and assist patients, saving time and cost for both.
- Three studies of web-based technologies (WBTs - network applications accessible via Internet: blogs, discussion boards, online multimedia/surveys); effective in improving self-care skills, empowering patients and improving self-efficacy.
- Nine studies of home-health monitoring systems (HHMSs - patients monitor health factors like blood pressure from home, sharing information electronically with HCPs); suggested to be effective on promoting medication adherence and QoL.
- Four studies of tele-education technologies (TETs – HCPs deliver patient education via the TV); effective at promoting non-medical self-care behaviours, e.g. mind–body exercises
- One study of a telehealth programme applied all the above (LDC, WBT, HHMS and TET).

Telehealth technologies improved self-monitoring and hence were effective at helping heart failure patients control weight and COPD patients increase daily physical activity. Evidence was found for the linkage between consistent communication between patients and HCPs and telehealth effectiveness. Poor persistence of telehealth's effectiveness was also found and attributed to waning enthusiasm over time.

Ma et al. (2019) reported lifestyle modification techniques (goal-setting, decision-making, provision of feedback, self-monitoring and motivational interviewing) which can achieve a healthy lifestyle for hypertensive patients, decrease sodium intake and increase medication adherence and maintenance. Interventions involved a website, a blood pressure (BP) home-telemonitoring system for uploading readings, an individualized BP goal and telephone calls with a pharmacist. Electronic health charts were used for decision-making about medication, diet, exercise and stress management. Goal-setting used an ehealth device and website which promoted patients' motivation and knowledge by providing programmed feedback. Technologies such as personal accounts and individualized reminders facilitated patient motivation and maintenance whether health care providers were involved or not. A combination of these components was effective and recommended to promote adherence.

While **McCabe** et al. (2017) sought self-efficacy outcomes in COPD, they found that no studies measured self-efficacy (nor cost-effectiveness, functional capacity, lung function, or anxiety and depression).

Tyack & Camic (2017) sought psychological well-being outcomes broadly (rather than the self-efficacy of the person with dementia specifically), including related outcomes such as carer burden and independence of the person with dementia. They found evidence for benefits in mental stimulation, mood and mental health, greater engagement and quality of interaction, increased activity levels, improvement in quantitative well-being, social interaction, relationships and wider social impacts, as well as self-mastery, which maps most closely to self-efficacy. Evidence for empowerment, increasing usage frequency, improvement in participants' performance, confidence in cognitive abilities, more able to express feelings, spontaneous touching of the screen and interacting with the device all point to engagement and mastery of the intervention. One study found no significant impact on depressive symptoms or on QoL. When used with appropriate planning and support, touchscreen interventions were able to support the personhood of the person with dementia by engaging in meaningful activities, sharing social interactions and mastering new skills independently. Important procedural aspects included provision of support. Clinical implications that further the potential for self-efficacy included challenging prevailing beliefs of clinicians and others that people with dementia are unable to use touchscreen technologies, and offering the technology earlier on in the progression of dementia.

Main findings

1. Self-efficacy was rarely included in outcomes of telehealth interventions for older people, or it was characterized and measured without underlying mediators such as support or education.
2. There is a plausible pathway from telehealth to self-efficacy but patient benefits for LTCs are dependent on telehealth modes (either individually or in combination) and techniques.
3. Increased self-care and self-monitoring empower patient-activation, motivation or mastery.

DISCUSSION and IMPLICATIONS

To our knowledge, the present overview of systematic reviews is the first to synthesize systematic reviews of the extent to which telehealth supports self-efficacy of older people with LTCs living at home. By using the Revised-AMSTAR tool for quality assessment we found 3 high quality reviews (initially out of 6). This overview "relies on the quality of the reporting found in not only the reviews themselves, but also the primary research studies included within them" (McBain, Shipley, & Newman, 2015) (p. 8). Quality was variable as evidenced with standardized tools. What follows is a critical reflection of the relevance of these findings to studies in the literature.

A review by Wonggom et al. (2019) on avatar-based technology in patient education showed improved self-efficacy in 3 of 8 studies of patients with chronic diseases, but like other excluded studies it did not specifically address older people with the included LTCs.

Health outcomes and efficacy for persons with MCI, Alzheimer disease, and dementia have been likewise under-investigated. Bateman et al. (2017) found only cognition, function, mood, and quality of life for mHealth app interventions. Whilst 58% of 24 studies showed some degree of efficacy, self-efficacy was examined in only one study showing no improvement in outcome. Even though we found no systematic review examining interventions considering the self-efficacy of the person with dementia as a specific outcome, numerous reviews focused on the caregiver. These included a meta-analysis by Huis In Het Veld, Verkaik, Mistiaen, van Meijel and Francke (2015) reporting evidence for the effectiveness of self-management support interventions targeting psychological wellbeing and information.

The nature of dementia is starkly different from other LTCs in terms of the declining ability of the person to activate and motivate independently. Hence, this overview reflects that distinction by including care partners, for whom health-promoting self-care behavior may be limited by several factors which in turn affect their own health (Oliveira, Zarit, & Orrell, 2019), but still keeping the focus on the person with dementia themselves. Similarly to Tyack & Camic (2017), a review by Joddrell & Astell (2016) found that people with dementia were able to use touchscreen technology independently, to navigate the screen, store and charge the device. Seven of 45 studies reported positive factors associated with independent use.

Mediating factors supporting self-care are now better understood generally (Fredericks, Martorella, & Catallo, 2015), in heart failure (Clark et al., 2016), hypertension (Band et al., 2017; Saksena, 2010; Shahaj et al., 2019) and COPD (Murphy et al., 2017). However, whilst Guo and Albright (2018) found a linkage between communication and telehealth effectiveness, the usual absence of such mediating factors underscores Ciere et al.'s lack of pathway findings (2012), especially as they relate to self-efficacy in older people. It is important to measure and report if and how self-efficacy mediates clinical outcomes, because as McBain et al. (2015) suggest, "engaging and empowering patients with a chronic condition to adjust their treatment and lifestyle themselves in response to monitored data, may be a more successful route to improving outcomes as opposed to the healthcare professional leading this decision" (p.8).

Furthermore, in a dissertation in which telemonitoring was associated with improved self-efficacy for patients with COPD and heart failure, West-Frasier (2008) urged the inclusion of emotional well-being and self-efficacy measures so practitioners are able to provide interventions that improve emotional health, "and empower patients to improve self-care management" (pg. 152). Lastly, our findings support those of Gaveikaite et al. (2019) in identifying the need to include such outcomes in future empirical research reporting and in advocating for improved telehealth trial designs by "focusing on the entire intervention's adoption process evaluation" (p. 78).

Limitations of the current study

This overview found a common disparity between quantitative papers examining and reporting clinical outcomes and qualitative papers delving into the reasons (barriers, facilitators, etc.) underlying actions of patients. Such papers are often published separately in different journals making comprehensive understanding of an intervention and its outcomes challenging for reviewers who wish to draw together conclusions about self-management of a chronic condition for a particular demographic.

Overviews of systematic reviews have unique features requiring different or additional methods (Lunny, Brennan, McDonald, & McKenzie, 2018). Within an overview if there is substantial overlap of included primary research studies this may introduce bias into the reviewing process. This was not evident here given that only one cross-over was found - one study in two different papers. Also, quality and risk of bias were assessed and there were no discordant results across reviews.

However, selection bias may have been introduced during the first stage of article selection carried out by one author, even though a percent of the excluded papers were considered and confirmed by a second author. A further limitation is the inclusion of studies which reported average/mean age as this probably includes people <50 years old. Due to a lack of consensus on the terminology for self-efficacy and telehealth, papers may have been missed. Lastly, limiting selection to English only papers may have introduced bias and reduced the representativeness of our findings.

CONCLUSIONS

We aimed to understand what the existing evidence-base was for how health technology can support self-efficacy of older people with specific LTCs. Although there is a plausible pathway from telehealth to self-efficacy, patient benefits depend on telehealth modes and techniques. We identified self-efficacy, patient-activation or mastery as critical for empowering patients to adopt telehealth, and hence to the success of self-care in LTCs. We therefore conclude that the invisibility of self-efficacy, patient-activation or mastery as outcomes is a limitation, with implications for policy, practice and research.

Implications for policy and practice – With the shift towards more widespread use of TH there is increasing evidence that supporting self-management underlies patient self-efficacy. However, if the means whereby this has been achieved is missing in research reports, or is obscured across several publications, then clinicians, technologists and interventionists remain unclear about how exactly to improve or enhance self-managed healthcare using telehealth. Meanwhile, in the UK and many high-income countries, telehealth is being seen by governments as key in helping to address the rising costs of care for older people. While substantial investments are being made in telehealth, and the NHS promotes a key role for patient-activation in supported self-management of personalised care, our overview has shown that the evidence base for self-care telehealth technology supporting self-efficacy of older people with LTCs living at home is relatively thin.

Implications for research – To address these gaps in knowledge and to inform a better understanding of what works well, research needs to report:

- Detailed information about the logistics of intervention implementation, including the degree of intensity, duration and type of interventionist contact using PRISMS taxonomy (Pearce et al., 2016; Taylor et al., 2014)
- Attrition and drop-out rates along with insight into the ‘why’ of the numbers
- Impact of intervention over an extended timeframe, including follow-ups

In this way, useful findings may be included in future research reporting and in advocating for improved telehealth trial designs with enhanced process evaluation. In conclusion, greater integration between research and practice will potentially benefit both, and ultimately keep patients at the center of care.

Supplemental files

1. Search strategy

2. R-AMSTAR Quality assessment

3. PRISMA Checklist

4. Further characteristics of reviews

Funding

The work that underpins this paper was funded through an NHS England Testbed grant**.**

Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

CMi and GC led on the conception and design of the study. GC was responsible for the acquisition of the data. GC, CMi, SV and CMa were involved in the analysis and interpretation of the data, and have read and approved the final manuscript.

Acknowledgements

We wish to acknowledge all members of the LCIA partnership and in particular Dr Tom Palmer, Dr Mandy Dixon and Ms Alexandra Hernandez for their contribution to the overall LCIA Testbed Evaluation.

Author details

[1]Division of Health Research, Faculty of Health and Medicine, Health Innovation 1, Lancaster University, Lancaster LA1 4YG, UK. Email: g.chalfont@lancaster.ac.uk

REFERENCES

Allen, J., & Daly, S. (2016). *Briefing paper: Older people and the social determinants of health*: UCL Institute of Health Equity.

Band, R., Bradbury, K., Morton, K., May, C., Michie, S., Mair, F. S., . . . Yardley, L. (2017). Intervention planning for a digital intervention for self-management of hypertension: a theory-, evidence- and person-based approach. *Implement Sci, 12*(1), 25. doi:10.1186/s13012-017-0553-4

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. . *Psychological Review, 84*, 191–215. doi:10.1037/0033-295X.84.2.191

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. NJ: Prentice-Hall: Englewood Cliffs.

Bateman, D. R., Srinivas, B., Emmett, T. W., Schleyer, T. K., Holden, R. J., Hendrie, H. C., & Callahan, C. M. (2017). Categorizing Health Outcomes and Efficacy of mHealth Apps for Persons With Cognitive Impairment: A Systematic Review. *J Med Internet Res, 19*(8), e301. doi:10.2196/jmir.7814

Bialy, L., Fenton, T., Shulhan-Kilroy, J., Johnson, D. W., McNeil, D. A., & Hartling, L. (2020). Vitamin D supplementation to improve pregnancy and perinatal outcomes: an overview of 42 systematic reviews. *BMJ Open, 10*(1), e032626. doi:10.1136/bmjopen-2019-032626

Captieux, M., Pearce, G., Parke, H. L., Epiphaniou, E., Wild, S., Taylor, S. J. C., & Pinnock, H. (2018). Supported self-management for people with type 2 diabetes: a meta-review of quantitative systematic reviews. *BMJ Open, 8*(12), e024262. doi:10.1136/bmjopen-2018-024262

Choi, M. S., Dabelko-Schoeny, H., Lee, M. Y., & Bunger, A. C. (2020). Does Self-Efficacy and Team Leader Equity Matter for Older Workers' Mental Health? *Gerontologist*. doi:10.1093/geront/gnz191

Ciere, Y., Cartwright, M., & Newman, S. P. (2012). A systematic review of the mediating role of knowledge, self-efficacy and self-care behaviour in telehealth patients with heart failure. *J Telemed Telecare, 18*(7), 384-391. doi:10.1258/jtt.2012.111009

Clark, A. M., Wiens, K. S., Banner, D., Kryworuchko, J., Thirsk, L., McLean, L., & Currie, K. (2016). A systematic review of the main mechanisms of heart failure disease management interventions. *Heart, 102*(9), 707-711. doi:10.1136/heartjnl-2015-308551

Conway, A., Inglis, S. C., Chang, A. M., Horton-Breshears, M., Cleland, J. G., & Clark, R. A. (2013). Not all systematic reviews are systematic: a meta-review of the quality of systematic reviews for non-invasive remote monitoring in heart failure. *J Telemed Telecare, 19*(6), 326-337. doi:10.1177/1357633X13503427

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2013). Developing and evaluating complex interventions: The new Medical Research Council guidance. *International Journal of Nursing Studies, 50*, 587-592. doi:10.1016/j.ijnurstu.2012.09.009

CRD. (2009). Systematic Reviews: CRD's guidance for undertaking reviews in health care. In. York: Centre for Reviews and Dissemination, University of York.

de Jong, C. C., Ros, W. J., & Schrijvers, G. (2014). The effects on health behavior and health outcomes of Internet-based asynchronous communication between health providers and patients with a chronic condition: a systematic review. *J Med Internet Res, 16*(1), e19. doi:10.2196/jmir.3000

Dosenovic, S., Jelicic Kadic, A., Vucic, K., Markovina, N., Pieper, D., & Puljak, L. (2018). Comparison of methodological quality rating of systematic reviews on neuropathic pain using AMSTAR and R-AMSTAR. *BMC Med Res Methodol, 18*(1), 37. doi:10.1186/s12874-018-0493-y

Downs, S. H., & Black, N. (1998). The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health, 52*, 377-384.

EPHPP. (2019). Effective Public Health Practice Project: Quality Assessment Tool for Quantitative Studies. Retrieved from http://www.ephpp.ca/tools.html

Fredericks, S., Martorella, G., & Catallo, C. (2015). A systematic review of web-based educational interventions. *Clin Nurs Res, 24*(1), 91-113. doi:10.1177/1054773814522829

Gaveikaite, V., Grundstrom, C., Winter, S., Chouvarda, I., Maglaveras, N., & Priori, R. (2019). A systematic map and in-depth review of European telehealth interventions efficacy for chronic obstructive pulmonary disease. *Respir Med, 158*, 78-88. doi:10.1016/j.rmed.2019.09.005

George, J., & Martin, F. (2016). *Briefing paper: Living with long term conditions*. Retrieved from www.bma.org.uk/-/media/files/pdfs/collective%20voice/policy%20research/public%20and%20population%20health/supporting-healthy-ageing-briefings-final.pdf

Guo, Y., & Albright, D. (2018). The effectiveness of telehealth on self-management for older adults with a chronic condition: A comprehensive narrative review of the literature. *J Telemed Telecare, 24*(6), 392-403. doi:10.1177/1357633x17706285

Guyatt, G., Oxman, A. D., Akl, E. A., Kunz, R., Vist, G., Brozek, J., . . . Schunemann, H. J. (2011). GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol, 64*(4), 383-394. doi:10.1016/j.jclinepi.2010.04.026

Guyatt, G. H., Oxman, A. D., Kunz, R., Vist, G. E., Falck-Ytter, Y., & Schünemann, H. J. (2008). What is “quality of evidence” and why is it important to clinicians? *BMJ, 336*(7651), 995-998. doi:10.1136/bmj.39490.551019.BE

Hanlon, P., Daines, L., Campbell, C., McKinstry, B., Weller, D., & Pinnock, H. (2017). Telehealth Interventions to Support Self-Management of Long-Term Conditions: A Systematic Metareview of Diabetes, Heart Failure, Asthma, Chronic Obstructive Pulmonary Disease, and Cancer. *J Med Internet Res, 19*(5), e172. doi:10.2196/jmir.6688

Heyn, P. C., Meeks, S., & Pruchno, R. (2019). Methodological Guidance for a Quality Review Article. *Gerontologist, 59*(2), 197-201. doi:10.1093/geront/gny123

Higgins, J. P. T., & Green (Eds.), S. (Producer). (2011). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0. Retrieved from www.handbook.cochrane.org

Huis In Het Veld, J. G., Verkaik, R., Mistiaen, P., van Meijel, B., & Francke, A. L. (2015). The effectiveness of interventions in supporting self-management of informal caregivers of people with dementia; a systematic meta review. *BMC Geriatr, 15*, 147. doi:10.1186/s12877-015-0145-6

Joddrell, P., & Astell, A. J. (2016). Studies Involving People With Dementia and Touchscreen Technology: A Literature Review. *JMIR Rehabil Assist Technol, 3*(2), e10. doi:10.2196/rehab.5788

KingsFund.org.uk. (2018). *How is the NHS performing? King's Fund Quarterly Monitoring Report - QMR27*. Retrieved from https://www.kingsfund.org.uk/publications/how-nhs-performing-december-2018

KingsFund.org.uk. (2019). Long-term conditions and multi-morbidity. *Time to Think Differently*. Retrieved from https://www.kingsfund.org.uk/projects/time-think-differently/trends-disease-and-disability-long-term-conditions-multi-morbidity

Kung, J., Chiappelli, F., Cajulis, O. O., Avezova, R., Kossan, G., Chew, L., & Maida, C. A. (2010). From Systematic Reviews to Clinical Recommendations for Evidence-Based Health Care: Validation of

Revised Assessment of Multiple Systematic Reviews (R-AMSTAR) for Grading of Clinical Relevance. *The Open Dentistry Journal, 4*, 84-91. doi:10.2174/1874210601004020084

Lancaster, K., Abuzour, A., Khaira, M., Mathers, A., Chan, A., Bui, V., . . . Dolovich, L. (2018). The Use and Effects of Electronic Health Tools for Patient Self-Monitoring and Reporting of Outcomes Following Medication Use: Systematic Review. *J Med Internet Res, 20*(12), e294. doi:10.2196/jmir.9284

Lee, S. M., Choi, H. C., & Hyun, M. K. (2019). An Overview of Systematic Reviews: Complementary Therapies for Cancer Patients. *Integr Cancer Ther, 18*, 1534735419890029. doi:10.1177/1534735419890029

LGA. (2018). Adult social care funding and integration survey research report. Retrieved from https://www.local.gov.uk/adult-social-care-funding-and-integration-survey-research-report-july-2018

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gotzsche, P. C., Ioannidis, J. P., . . . Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS Med, 6*(7), e1000100. doi:10.1371/journal.pmed.1000100

Littell, J. H. (2008). Evidence-based or Biased? The Quality of Published Reviews of Evidence-based Practices *Children and Youth Services Review, 30*(11), 1299-1317. doi:10.1016/j.childyouth.2008.04.001

Lunny, C., Brennan, S. E., McDonald, S., & McKenzie, J. E. (2018). Toward a comprehensive evidence map of overview of systematic review methods: paper 2-risk of bias assessment; synthesis, presentation and summary of the findings; and assessment of the certainty of the evidence. *Syst Rev, 7*(1), 159. doi:10.1186/s13643-018-0784-8

Ma, Y., Cheng, H. Y., Cheng, L., & Sit, J. W. H. (2019). The effectiveness of electronic health interventions on blood pressure control, self-care behavioural outcomes and psychosocial well-being in patients with hypertension: A systematic review and meta-analysis. *Int J Nurs Stud, 92*, 27-46. doi:10.1016/j.ijnurstu.2018.11.007

Maeder, A., Poultney, N., Morgan, G., & Lippiatt, R. (2015). Patient Compliance in Home-Based Self-Care Telehealth Projects. *J Telemed Telecare, 21*(8), 439-442. doi:10.1177/1357633x15612382

McBain, H., Shipley, M., & Newman, S. (2015). The impact of self-monitoring in chronic illness on healthcare utilisation: a systematic review of reviews. *BMC Health Serv Res, 15*, 565. doi:10.1186/s12913-015-1221-5

McCabe, C., McCann, M., & Brady, A. M. (2017). Computer and mobile technology interventions for self-management in chronic obstructive pulmonary disease. *Cochrane Database Syst Rev, 5*, Cd011425. doi:10.1002/14651858.CD011425.pub2

Milavec Kapun, M., Sustersic, O., & Rajkovic, V. (2016). The Integrated Patient's Self-Care Process Model. *Stud Health Technol Inform, 225*, 108-112.

Milligan, C., Neary, D., Payne, S., Hanratty, B., Irwin, P., & Dowrick, C. (2015). Older men and social activity: a scoping review of Men's Sheds and other gendered interventions. *Ageing and Society, 36*(5), 895-923. doi:10.1017/s0144686x14001524

Mitzner, T. L., Savla, J., Boot, W. R., Sharit, J., Charness, N., Czaja, S. J., & Rogers, W. A. (2019). Technology Adoption by Older Adults: Findings From the PRISM Trial. *Gerontologist, 59*(1), 34-44. doi:10.1093/geront/gny113

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med, 6*(7), e1000097. doi:10.1371/journal.pmed.1000097

Morton, K., Dennison, L., May, C., Murray, E., Little, P., McManus, R. J., & Yardley, L. (2017). Using digital interventions for self-management of chronic physical health conditions: A meta-ethnography review of published studies. *Patient Educ Couns, 100*(4), 616-635. doi:10.1016/j.pec.2016.10.019

Murphy, L. A., Harrington, P., Taylor, S. J., Teljeur, C., Smith, S. M., Pinnock, H., & Ryan, M. (2017). Clinical-effectiveness of self-management interventions in chronic obstructive pulmonary

disease: An overview of reviews. *Chron Respir Dis, 14*(3), 276-288. doi:10.1177/1479972316687208
NHS. (2019). Patient activation and PAM FAQs. Retrieved from https://www.england.nhs.uk/personalisedcare/supported-self-management/patient-activation/pa-faqs/
Oliveira, D., Zarit, S. H., & Orrell, M. (2019). Health-Promoting Self-Care in Family Caregivers of People With Dementia: The Views of Multiple Stakeholders. *Gerontologist, 59*(5), e501-e511. doi:10.1093/geront/gnz029
Parati, G., Pellegrini, D., & Torlasco, C. (2019). How Digital Health Can Be Applied for Preventing and Managing Hypertension. *Curr Hypertens Rep, 21*(5), 40. doi:10.1007/s11906-019-0940-0
Pare, G., Jaana, M., & Sicotte, C. (2007). Systematic review of home telemonitoring for chronic diseases: the evidence base. *J Am Med Inform Assoc, 14*(3), 269-277. doi:10.1197/jamia.M2270
Pearce, G., Parke, H. L., Pinnock, H., Epiphaniou, E., Bourne, C. L., Sheikh, A., & Taylor, S. J. (2016). The PRISMS taxonomy of self-management support: derivation of a novel taxonomy and initial testing of its utility. *J Health Serv Res Policy, 21*(2), 73-82. doi:10.1177/1355819615602725
Pluye, P., & Hong, Q. N. (2014). Combining the power of stories and the power of numbers: mixed methods research and mixed studies reviews. *Annu Rev Public Health, 35*, 29-45. doi:10.1146/annurev-publhealth-032013-182440
Polanin, J. R., Maynard, B. R., & Dell, N. A. (2017). Overviews in Education Research. *Review of Educational Research, 87*(1), 172-203. doi:10.3102/0034654316631117
Pollock, M., Fernandes, R. M., & Hartling, L. (2017). Evaluation of AMSTAR to assess the methodological quality of systematic reviews in overviews of reviews of healthcare interventions. *BMC Med Res Methodol, 17*(1), 48. doi:10.1186/s12874-017-0325-5
Saksena, A. (2010). Computer-based education for patients with hypertension: A systematic review. *Health Education Journal, 69*(3), 236–245. doi:10.1177/0017896910364889
Schmidt, L. I., & Wahl, H. W. (2019). Predictors of Performance in Everyday Technology Tasks in Older Adults With and Without Mild Cognitive Impairment. *Gerontologist, 59*(1), 90-100. doi:10.1093/geront/gny062
Schulz, K. F., & Grimes, D. A. (2002). Sample size slippages in randomised trials: exclusions and the lost and wayward. *The Lancet, 359*(9308), 781-785. doi:10.1016/s0140-6736(02)07882-0
Shahaj, O., Denneny, D., Schwappach, A., Pearce, G., Epiphaniou, E., Parke, H. L., . . . Pinnock, H. (2019). Supporting self-management for people with hypertension: a meta-review of quantitative and qualitative systematic reviews. *J Hypertens, 37*(2), 264-279. doi:10.1097/hjh.0000000000001867
Shea, B. J., Grimshaw, J. M., Wells, G. A., Boers, M., Andersson, N., Hamel, C., . . . Bouter, L. M. (2007). Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol, 7*, 10. doi:10.1186/1471-2288-7-10
Shepherd, E., Salam, R. A., Middleton, P., Han, S., Makrides, M., McIntyre, S., . . . Crowther, C. A. (2018). Neonatal interventions for preventing cerebral palsy: an overview of Cochrane Systematic Reviews. *Cochrane Database Syst Rev, 6*, Cd012409. doi:10.1002/14651858.CD012409.pub2
Smith, V., Devane, D., Begley, C. M., & Clarke, M. (2011). Methodology in conducting a systematic review of systematic reviews of healthcare interventions. *BMC Med Res Methodol, 11*(1), 15. doi:10.1186/1471-2288-11-15
Stellefson, M., Chaney, B., Barry, A. E., Chavarria, E., Tennant, B., Walsh-Childers, K., . . . Zagora, J. (2013). Web 2.0 chronic disease self-management for older adults: a systematic review. *J Med Internet Res, 15*(2), e35. doi:10.2196/jmir.2439
Tabak, M., Vollenbroek-Hutten, M. M., van der Valk, P. D., van der Palen, J., & Hermens, H. J. (2014). A telerehabilitation intervention for patients with Chronic Obstructive Pulmonary Disease: a randomized controlled pilot trial. *Clin Rehabil, 28*(6), 582-591. doi:10.1177/0269215513512495
Taylor, S. J. C., Pinnock, H., Epiphaniou, E., Pearce, G., Parke, H. L., Schwappach, A., . . . Sheikh, A. (2014). A rapid synthesis of the evidence on interventions supporting self-management for people with

long-term conditions: PRISMS - Practical systematic Review of Self-Management Support for long-term conditions. *Health Services and Delivery Research*. doi:10.3310/hsdr02530

Tougas, M. E., Hayden, J. A., McGrath, P. J., Huguet, A., & Rozario, S. (2015). A Systematic Review Exploring the Social Cognitive Theory of Self-Regulation as a Framework for Chronic Health Condition Interventions. *PLoS One, 10*(8), e0134977. doi:10.1371/journal.pone.0134977

Tufanaru, C., Munn, Z., Aromataris, E., Campbell, J., & Hopp, L. (2017). Systematic Reviews of Effectiveness. Chapter 3. In *Joanna Briggs Institute Reviewer's Manual*. Adelaide, SA.

Tyack, C., & Camic, P. M. (2017). Touchscreen interventions and the well-being of people with dementia and caregivers: a systematic review. *Int Psychogeriatr, 29*(8), 1261-1280. doi:10.1017/s1041610217000667

Van der Roest, H. G., Wenborn, J., Pastink, C., Droes, R. M., & Orrell, M. (2017). Assistive technology for memory support in dementia. *Cochrane Database Syst Rev, 6*, Cd009627. doi:10.1002/14651858.CD009627.pub2

van Santen, J., Droes, R. M., Holstege, M., Henkemans, O. B., van Rijn, A., de Vries, R., . . . Meiland, F. (2018). Effects of Exergaming in People with Dementia: Results of a Systematic Literature Review. *J Alzheimers Dis, 63*(2), 741-760. doi:10.3233/JAD-170667

Varey, S., Hernandez, A., Palmer, T. M., Mateus, C., Wilkinson, J., Dixon, M., & Milligan, C. (2018). How effective and cost-effective are innovative combinatorial technologies and practices for supporting older people with long-term conditions to remain well in the community? An evaluation protocol for an NHS Test Bed in North West England. *BMJ Open, 8*(2), e017268. doi:10.1136/bmjopen-2017-017268

West-Frasier, J. (2008). *The Impact of Telemonitoring on Self-Efficacy, Emotional Well-Being, and Clinical Outcomes in Patients with Chronic Obstructive Pulmonary Disease or Heart Failure.* (PhD PhD). Western Michigan, Kalamazoo, Michigan. Retrieved from https://scholarworks.wmich.edu/dissertations/3445 (3445)

Wonggom, P., Kourbelis, C., Newman, P., Du, H., & Clark, R. A. (2019). Effectiveness of avatar-based technology in patient education for improving chronic disease knowledge and self-care behavior: a systematic review. *JBI Database System Rev Implement Rep, 17*(6), 1101-1129. doi:10.11124/jbisrir-2017-003905

Zhong, D., Xiao, Q., Xiao, X., Li, Y., Ye, J., Xia, L., . . . Jin, R. (2020). Tai Chi for improving balance and reducing falls: an overview of 14 systematic reviews. *Ann Phys Rehabil Med*. doi:10.1016/j.rehab.2019.12.008

Figure 1. PRISMA Diagram

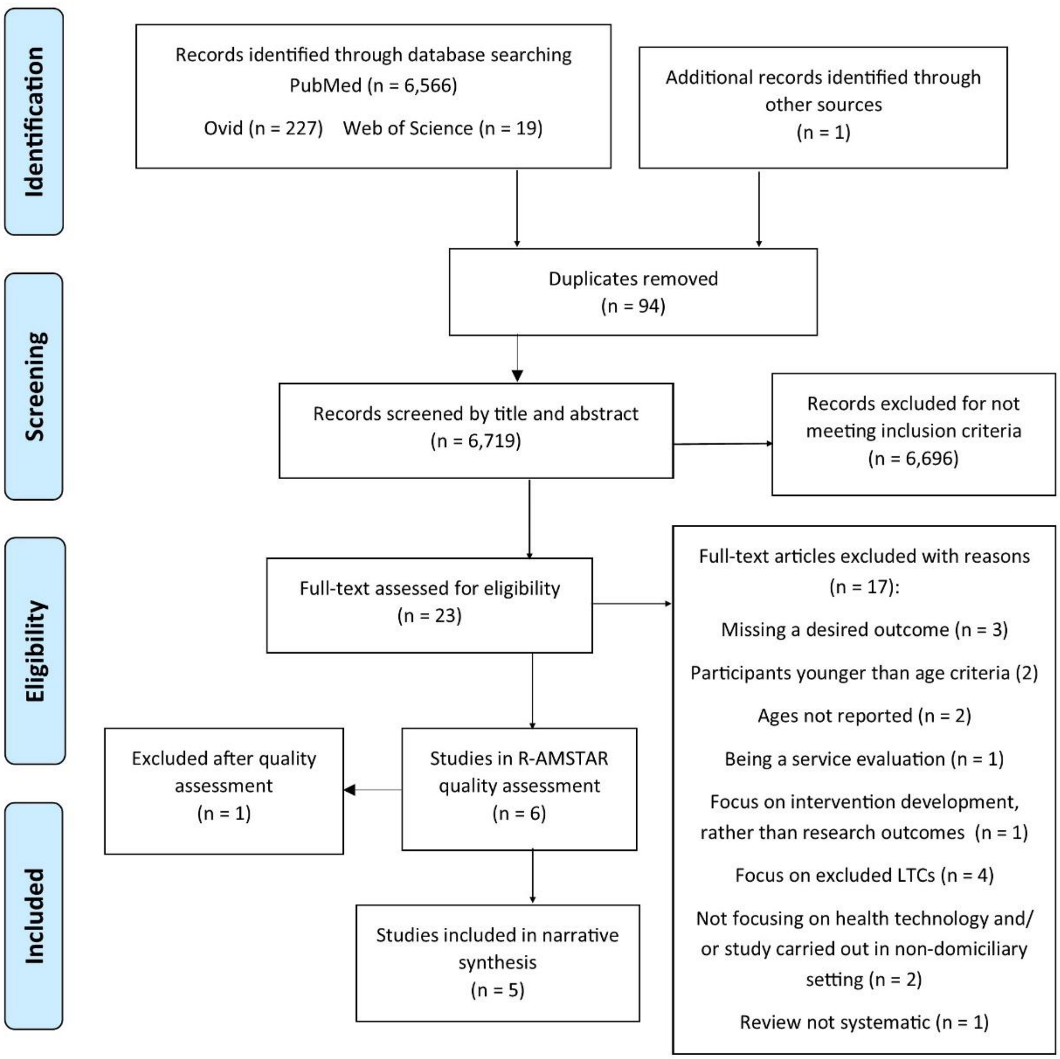


Figure 2. Frequency distribution of R-AMSTAR scores

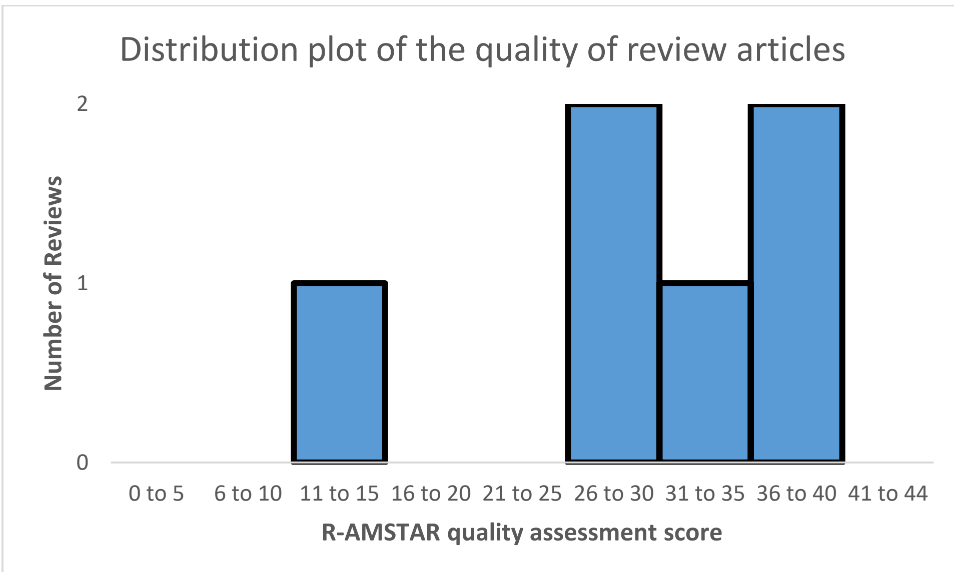


Table 1. Design and Methods

LITERATURE SEARCH	
Use of PICOS	In formulating the scope, use of PICOS "can help the reviewers to delineate clearly… to compare and summarise systematic reviews that address the same treatment comparison or a particular intervention for a population or condition, or a range of interventions for people with a specific condition" (Smith, Devane, Begley, & Clarke, 2011). Polanin, Maynard and Dell (2017) also recommend, "the research question should follow the PICOS format, specifying the population, intervention, comparison condition, outcomes, and study design" (p.191).
Decision to conduct an 'overview' based on the initial scoping	This phrase, adopted by the Cochrane Database of Systematic Reviews as early as 2011 is increasingly used in healthcare (Bialy et al., 2020; Lee, Choi, & Hyun, 2019; Shepherd et al., 2018; Zhong et al., 2020) and methodology (Lunny et al., 2018; Polanin et al., 2017). Smith, et al. (2011) stated, "conducting a systematic review of reviews highlights the usefulness of bringing together a summary of reviews in one place, where there is more than one review on an important topic".
Theoretical framework and self-efficacy	Proposed by Bandura (1977; 1986), self-efficacy influences the amount of effort put forth and the choice to act while facing obstacles and failure. If people lack belief, they lack incentive to act (West-Frasier, 2008). Expectations of self-efficacy determine whether an individual will be able to exhibit coping behavior, and in the face of obstacles, how long effort will be sustained. A recent study by Choi, Dabelko-Schoeny, Lee and Bunger (2020) illustrated "the importance of individuals' self-efficacy and reveal the positive mediating role of engagement when promoting older workers' mental health", further supporting "the active role older adults play in enhancing their overall well-being" (p. 6).
Selection criteria: Explanation and use of "50% + 1" rule	*>50% criteria explained* – During the searches we did not limit by age as many reviews included a mixed demographic and we did not want to miss key papers. We found a paucity of reviews in which the demographic was limited exclusively to older people. Where different age groups were involved in a study, to be included there needed to be clearly written up results that were specific to the age cohorts and LTCs we were looking at. Hence, we took an evidence-based decision to include studies that had older people forming the *majority* of the sample. 'Majority' has been defined in the literature (Milligan et al., 2015) as fifty per cent plus one (50% +1) of participants in the sample, regardless of sample size. This became the age criteria. We could therefore include studies in which at least 50% +1 of the primary studies included people 50 years or older. The 50% +1 rule was also applied to the LTCs (at least 50% +1 of the LTCs in the

	review must be heart failure, COPD, hypertension or dementia or a combination of these).
Electronic database search	These were searched in June 2016 and updated in October 2019: • PubMed • EMBASE • CINAHL, PsycINFO • Cochrane Database of systematic Reviews • Web of Science • Science Citation Index Expanded (SCI-EXPANDED) • UK NHS Health Technology Assessment • University of York Centre for Reviews and Dissemination database • JBI Database of Systematic Reviews and Implementation Reports
Screening: Papers excluded with reasons	These 17 were excluded following full paper screening of 23 papers: (Band et al., 2017; Clark et al., 2016; de Jong, Ros, & Schrijvers, 2014; Fredericks et al., 2015; Hanlon et al., 2017; Joddrell & Astell, 2016; Lancaster et al., 2018; Maeder, Poultney, Morgan, & Lippiatt, 2015; Morton et al., 2017; Pare, Jaana, & Sicotte, 2007; Saksena, 2010; Shahaj et al., 2019; Stellefson et al., 2013; Van der Roest, Wenborn, Pastink, Droes, & Orrell, 2017; van Santen et al., 2018; Wonggom et al., 2019) were excluded due to: • missing a desired outcome (Fredericks et al., 2015; Van der Roest et al., 2017; van Santen et al., 2018); • participants being younger than age criteria (Lancaster et al., 2018; Saksena, 2010); • ages not being reported (Morton et al., 2017; Shahaj et al., 2019); • being a service evaluation (Maeder et al., 2015); • a focus on intervention development, rather than research outcomes (Band et al., 2017); • focusing on excluded LTCs, often diabetes (Hanlon et al., 2017; Pare et al., 2007; Stellefson et al., 2013; Wonggom et al., 2019); • not focusing on health technology and/or the study was carried out in a non-domiciliary setting (e.g. a hospital or clinic) (Clark et al., 2016; de Jong et al., 2014); • review was not systematic (i.e. no dual data-extraction) (Joddrell & Astell, 2016).
Quality appraisal: Use of R-AMSTAR	AMSTAR was argued by Kung, et al. (2010) to not produce quantifiable assessments of systematic review quality and clinical relevance. To clarify, this means that R-AMSTAR can *quantify the quality* of systematic reviews resulting in a scoring of quality components. In this way, study quality can be easily compared. Although both AMSTAR and R-AMSTAR produced comparable quality ratings (Dosenovic et al., 2018), the research team took the view that R-AMSTAR was more appropriate for our heterogeneous study designs, had a clear and greatly enlarged set of appropriate questions (11 separate domains with a total possible score of 44 instead of 11), an effective quality scoring system - a quality rating of low (<30) and high (≥30), and a quantitative definition of lower impact studies (i.e. participants <1000).
Blind critical assessments	Three investigators each scored 2 papers whilst the first author scored all 6 papers. Scoring was shared in a team meeting and any divergent response

	was discussed until consensus was reached and final scores were agreed upon.

Table 2. Characteristics of Included Systematic Reviews - incorporating PRISMS (2016) (Further Characteristics in Supplemental file #4)

(Author year) country	Participants, Patient population, age & gender (mean, median or range)	Number of studies, study design; intervention group (IG); control group (CG)	Mode of delivery; Personnel delivering support; Intensity, frequency & duration	Research question, outcomes of interest	Self-efficacy outcomes reported (patient activation, motivation, mastery, etc)
(Ciere et al., 2012) UK	888 adults with heart failure, mostly mild/ moderately impaired; Some w/ none or severe impairment; Sample sizes 18 to 284 (median age 74, mean age 61–78); 3 studies focused on older heart failure patients; 1 on coronary artery bypass graft surgery patients.	12 studies: 11 w/ comparator: 6 w/ standard, usual or routine care; 7 controlled studies reported baseline severity of heart failure (TH IG vs. standard care) Remainder were RCTs comparing CG w/ 2 or 3 IGs. One study: pre-post observational design.	Three w/ home nurse visits; variable content of care in other 9. Duration: 6 wks - 12 mos (median 3 mos); clinical info transferred via home TH system, telephone, website, videophone or a compliance monitoring device; patients mostly used technology daily; patient monitoring of signs and symptoms; nine studies also involved education.	Evidence for mediating role of knowledge, self-efficacy or self-care in relationship between TH and patient outcomes. Measures of association directly or indirectly reflecting 6 pathways: TH and knowledge; knowledge and self-care; TH and self-efficacy; self-efficacy and self-care; TH and self-care; self-care and patient outcomes (HRQoL or clinical markers).	Nine studies reported effect of TH on self-reported self-care behaviour. In 6, TH improved self-care behaviour from 4 weeks to 12 months. Most frequently they were group or pre-post intervention differences on knowledge, self-efficacy, self-care or patient outcomes. Six assessed self-efficacy or confidence relating to performance of self-care behaviours. Three found no change; 3 improved self-efficacy across IG and CGs. One RCT examined associations between self-efficacy and 7 self-care behaviours: 2 out of 28 were significant, none at 3-months. One examined confidence to perform self-care behaviours finding 5 significant at 120 days.
(Guo & Albright, 2018) USA	4137 Older adults w/ heart failure, hypertension, diabetes, pain, COPD, lung disease, rheumatoid arthritis or other chronic conditions. Avg age 55+ years.	31 Clinical trials (experimental designs or quasi-experimental designs); Sample sizes (20 - 478; median 101; only 2 CGs are mentioned.	Studies: 14 long-distance communication technologies (LDCs), 3 web-based technologies (WBTs), 9 home-health monitoring systems (HHMSs), 4 tele-education technologies (TETs) and 1 TH programme applying multiple technologies.	Effects of TH technologies on self-management: improving self-care skills, self-monitoring behaviours or clinical outcomes	Findings document the feasibility of TH technologies in benefitting participants' self-care, including self-care efficacy, health-care knowledge and adherence to self-care behaviours. Studies suggested success in heart failure (medication adherence), chronic diseases (health-problem skills, self-care efficacy and medication compliance knowledge), COPD (QoL) and hypertension (improving health-care management skills).
(Ma et al., 2019) Hong Kong	3998 with Hypertension, mean age 50-68, eight studies had >50% men	14 RCTs; Sample size ranged from 44-778. IG total = 2,148; CG total = 1,948	eHealth interventions - devices featuring interactive wireless communication capability, operating web-based applications with high portability; eHealth interventions - self-care, SM, self-care behavioural change or education dissemination; eHealth strategies - blood pressure monitoring, lifestyle modification techniques, motivation and maintenance. Four studies stated device usage frequencies and dosages. Others encouraged 2-3x/wk. A fully-automated system set patient-device interaction ≥ 8 emails.	Delivery modes and strategies of eHealth and effectiveness on physical outcomes (systolic/diastolic BP, BP control, body mass index/weight/cholesterol), self-care behavioural (medication adherence, sodium intake, healthy diet, physical activity, smoking, alcohol consumption) and psychosocial well-being (anxiety, stress, depression and quality of life).	Regarding self-care behavioural outcomes, the pooled results show that eHealth interventions significantly reduced the sodium intake. In comparison with blood pressure control results, self-care behavioural outcomes were inconclusive. Their effectiveness on self-care behavioural change and psychosocial well-being is insufficient. A few studies measured behavioural outcomes probably because of limited interventions and functions employed for lifestyle modification.

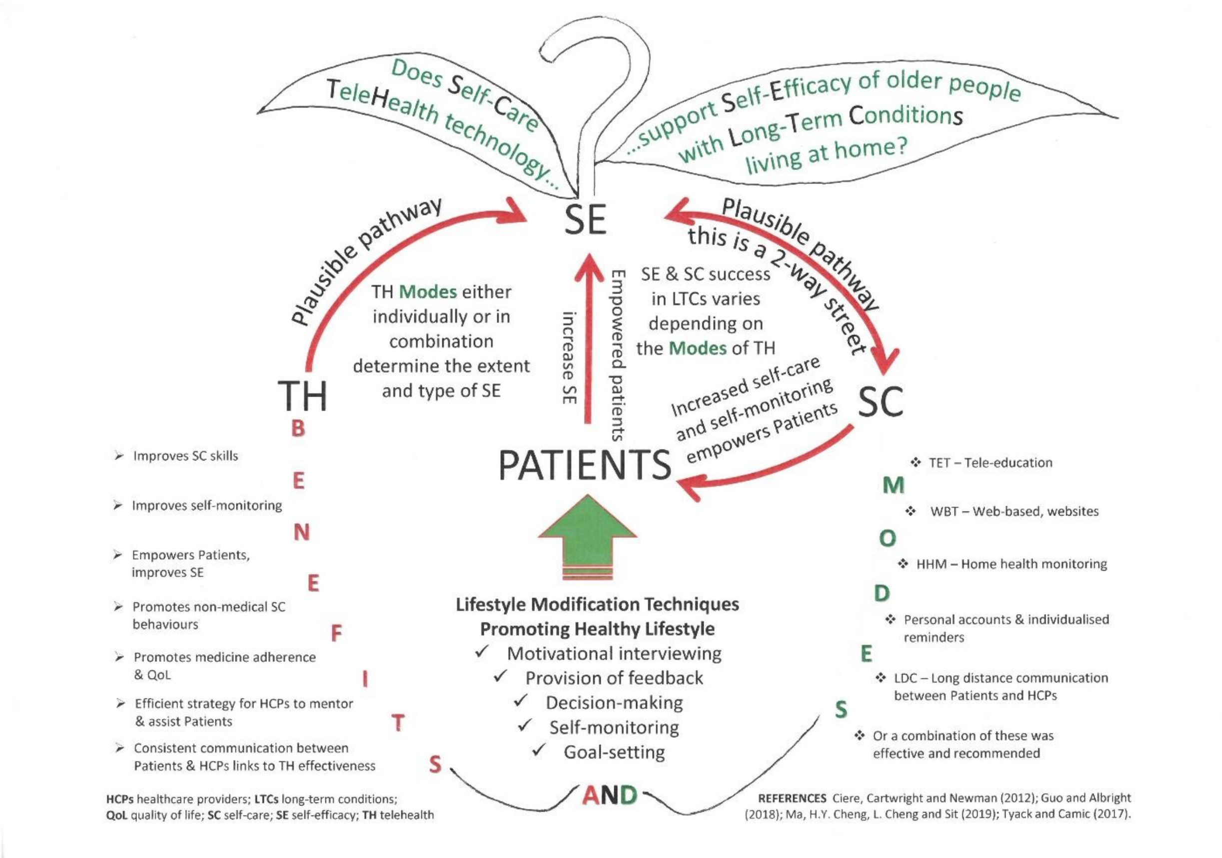
(McCabe et al., 2017) UK	557 participants with COPD Avg age 64 years; 64.9% men	3 RCTs; IG: 319 people received smart technology to support SM; CG: 238 received face-to-face verbal/written or digital information and education about SM	RCTs were included that measured effects of remote and Web 2.0-based interventions: technologies included personal computers (PCs) and applications for mobile technology (iPad, Android tablets, smart phones, Skype, etc.) on behavioural change towards SM of COPD. Comparator interventions included face-to-face and/or hard copy/ digital documentary educational/self-management support.	Effectiveness of computer and mobile technology versus face-to-face or hard copy/digital documentary-delivered interventions, or both, in facilitating, supporting, and sustaining SM. Primary: hospital admissions; acute exacerbations; health-related HRQoL; Secondary: self-efficacy; cost-effectiveness; functional capacity; lung function; anxiety and depression; sustained behaviour changes	This review had nine defined outcomes and found only five. None of these studies included outcomes such as self-efficacy, cost-effectiveness, functional capacity, lung function or anxiety and depression.
(Tyack & Camic, 2017) UK	312 people with dementia Mean ages 74.3 - 84.5, ages reported in half of the studies; People with dementia and/or their carers (informal carers, care staff, art therapists or facilitators). Sample sizes 2-40 (median 12)	16 papers, 14 interventions: qualitative explorations; system or informal evaluations; repeated measures; effectiveness evaluation; case-control design; interviews; case/pilot studies; group sequential quasi-experimental design; pragmatic mixed methods concurrent nested; pre-post and mixed methods field tests	Touchscreen-based interventions designed for use by people with dementia, with a specific focus in assessing their impact on well-being.	Psychological well-being impact or outcomes of touchscreen-based interventions (including carer burden and independence of people with dementia); Identifying relevant theories and key aspects of these interventions	Existing research is small-scale; touchscreen-based interventions can improve psychological well-being of people with dementia; reportedly benefits mental health, social interaction and sense of mastery; reportedly benefits informal carers' perceived burden and quality of relationship. Key aspects: user interface, support provision, learning style, tailored content, appropriate challenge, ergonomics and users' dementia progression. Intervention delivery and outcome measurements inconsistent.

Acronyms: **BP** – Blood pressure; **CCQ** - Clinical COPD Questionnaire; **CG** - control group; **HCP** - health care provider; **HHMS** - home-health monitoring system; **HRQoL** - health-related quality of life; **HT** - Hypertension; **IG** - intervention group; **LDC** - long-distance communication technology; **MTP** - telehealth programme applying multiple telehealth technologies; **PA** - Physical activity; **PRISMS** - Practical Reviews in Self-Management Support; **RCT** - randomised controlled trial; **SM** - Self-management; **TET** - tele-education technology; **TH** - Telehealth; **WBT** - web-based technology

Table 3. Follow-ups, attrition and drop-out rates

Study	Follow-ups	Attrition / drop-out rates
(Ciere et al., 2012)	2 to 12 months after trial started	Studies rated poor for reporting of attrition
(Guo & Albright, 2018)	1/3rd reported follow-ups; from 3 to 12 months	Attrition bias rated Low-Risk (20 studies), Unclear Risk (7) and High-Risk (4)
(Ma et al., 2019)	4 out of 14 completed follow-up	Drop-out rates: 0.67% to 20.67% which influenced the attrition bias.
(McCabe et al., 2017)	Completeness of follow-up ranged from 75% to 86%	IG rates: 6% to 25%; CG rates: 0% to 17%
(Tyack & Camic, 2017)	Generally, neither follow-ups not drop-outs were reported	

Figure 3. Main Findings



Supplemental file 1 – Search strategy

After the scoping review exercise using PICOS (Participants, Interventions, Comparators, Outcomes and Study design) we decided not to include a search for Person or their Location (ie older people, 50+ living at home) as it missed too many relevant papers, but to focus instead on (#1) condition, (#2) intervention, (#3) study design (systematic review) and (#4) desired outcome, and then to (#6) exclude with NOT.

Key text and MeSH (Medical Subject Headings) terms; Boolean/phrase in Title/Abstract; No limit on publication dates.

PubMed

#1	in [Title/ Abstract]	chronic disease* OR "chronic illness*" OR COPD OR hypertension OR "heart failure" OR dementia OR "chronic obstructive pulmonary disease" OR chronic disease[MeSH Terms] OR diseases category/therapy[MeSH Terms] OR "prevention and control"[MeSH Subheading] OR "therapeutic use"[MeSH Subheading] OR monitoring, physiologic[MeSH Terms]

#2	in [Title/ Abstract]	application OR apps OR "assistive technology" OR "blood pressure" OR CANTAB OR "CANTAB Mobile" OR "cardiac rehabilitation" OR "cell phone" OR "cellular phone" OR "chronic disease management" OR "computer-assisted instruction" OR device OR devices OR "digital biomarkers" OR "digital tool" OR ehealth OR E-health OR "electronic health" OR "Florence" OR gerontechnology OR "healthcare technology" OR "health behavior" OR "health behaviour" OR "health care" OR healthcare OR "healthcare technology" OR "healthcare technologies" OR "health promotion" OR "Health Watch" OR "heart rate" OR "House of Memories" OR "information technology" OR interface OR internet OR ICT OR iPad OR "mhealth" OR M-health OR "memory assessment" OR "memory test" OR "mobile application" OR "mobile health" OR "mobile technology" OR monitor* OR "Motiva" OR "NHS simple" OR online OR "online intervention" OR "patient education" OR prompt OR pulse OR remind* OR "smart phone" OR smartphone OR "social network" OR SMS OR "social networking" OR technologies OR technology OR telecare OR telehealth OR tele-health OR telemedicine OR telemetry OR telemonitor* OR "text message" OR "text messaging" OR thermometer OR "uMotif" OR video OR wearables OR "wearable technology" OR wifi OR wireless OR "consumer health information technology" OR CHIT OR assistive technology[MeSH Terms] OR "communications media/therapeutic use"[MeSH Terms] OR "self management"[MeSH Terms] OR home care services[MeSH Terms] OR "self help devices/therapeutic use"[MeSH Terms] OR "prevention and control"[MeSH Subheading] OR "monitoring, physiologic/methods"[MeSH Terms]

#3	in [Title/ Abstract]	"systematic review" OR meta-analysis OR "systematically reviewed" OR systematic* OR "umbrella review" OR review* OR metareview OR meta-review OR review literature as topic[MeSH Terms]

#4	in [Title/ Abstract]	"participant engagement" OR "patient knowledge" OR "patient skills" OR "confidence" OR "self activation" OR self-care OR "self care" OR self-help OR "patient activation" OR "self-management" OR self-efficacy OR "self efficacy" OR "self management" OR self-management OR mastery OR motivation OR "self-activation" OR empowerment OR self efficacy[MeSH Terms] OR empowerment[MeSH Terms]

#5		#1 AND #2 AND #3 AND #4

#6	#5 NOT in [Title]	robot OR robotic OR Paro OR "smart home" OR surveillance OR alarm OR alarms OR CCTV OR "falls detection" OR "fall detection" OR safety OR "baby monitor" OR webcam OR "scoping review" OR "integrative review" OR "realist review" OR drug OR drugs OR "risk reduction" OR guidelines OR corrigendum OR fractures OR depression OR alcohol OR stroke OR pain OR cancer OR constipation OR obesity OR "sleep apnea" OR "sleep apnoea" OR ulcers OR HIV OR HIV/AIDS OR diabetes OR diabetic OR wounds OR "adverse effects" OR "macular degeneration" OR toolkit OR reflux OR bleeding OR incontinence OR insomnia OR conference OR osteoporosis OR angina OR statement OR smoking OR screening OR statin OR statins OR influenza OR vaccine OR vaccines OR vaccination OR abortion OR hospital OR hospitalised OR hospitalized OR memorandum OR renal OR kidney OR liver OR "critical care" OR "data set" OR subcommittee OR diarrh* OR oncology OR sepsis OR "physical activity" OR supplements OR "combination therapy" OR hepatitis OR walking OR therapy OR therapies OR eating OR treatment OR treatments OR hernia OR acne OR cardiomyopathy OR oncology OR dental

R-AMSTAR - Revised AMSTAR - a measurement tool to assess the methodological quality of systematic reviews

Taylor, S. J. C., et al. (2014). A rapid synthesis of the evidence on interventions supporting self-management for people with long-term conditions: PRISMS - Practical systematic Review of Self-Management Support for long-term conditions. Health Services and Delivery Research Southampton (UK), NIHR Journals Library

Pearce, G., et al. (2016). "The PRISMS taxonomy of self-management support: derivation of a novel taxonomy and initial testing of its utility." J Health Serv Res Policy 21(2): 73-82.

Kung, J., et al., 2010. "From Systematic Reviews to Clinical Recommendations for Evidence-Based Health Care: Validation of Revised Assessment of Multiple Systematic Reviews (R-AMSTAR) for Grading of Clinical Relevance." The open dentistry journal 4:84-91. doi: 10.2174/1874210601004020084.

Shea, B. J.,et al., 2007. "Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews." BMC Med Res Methodol 7:10. doi: 10.1186/1471-2288-7-10.

	Ciere, 2012	Ma, 2019	McCabe, 2017	Milavec Kapun, 2016	Tyack, 2017	Guo, 2018	
1. Was an ‘a priori’ design provided?							
Criteria:							
(A) ‘a priori’ design	1	1	1	1	1	1	
(B) statement of inclusion criteria	1	1	1	1	1	1	
(C) PICO/PIPO research question (population, intervention, comparison, prediction, outcome)	1	1	1	0	0	0	
Satisfies 3? score 4 2?=score 3 1?=score 2 0?=score 1	4	4	4	3	3	3	21
2. Was there duplicate study selection and data extraction?							
Criteria:							
(A) There should be at least two independent data extractors as stated or implied.	1	1	1	0	1	1	
(B) Statement of recognition or awareness of consensus procedure for disagreements.	1	1	1	0	0	1	
(C) Disagreements among extractors resolved properly as stated or implied.	1	1	1	0	0	1	
Satisfies 3? score 4 2?=score 3 1?=score 2 0?=score 1	4	4	4	1	2	4	19

3. Was a comprehensive literature search performed?							
(A) At least two electronic sources should be searched.	1	1	1	1	1	1	
(B) The report must include years and databases used (e.g. Central, EMBASE, and MEDLINE).	1	1	1	1	1	1	
(C) Key words and/or MESH terms must be stated AND where feasible the search strategy outline should be provided such that one can trace the filtering process of the included articles.	0	1	1	1	1	1	
(D) In addition to the electronic databases (PubMed, EMBASE, Medline), all searches should be supplemented by consulting current contents, reviews, textbooks, specialized registers, or experts in the particular field of study, and by reviewing the references in the studies found.	0	0	1	0	1	0	
(E) Journals were “hand-searched” or “manual searched” (i.e. identifying highly relevant journals and conducting a manual, page-by-page search of their entire contents looking for potentially eligible studies)	0	1	1	0	0	0	
Satisfies 4-5? score 4 3?=score 3 2?=score 2 1 or 0?=score 1	2	4	4	3	4	3	20

4. Was the status of publication (i.e. grey literature) used as an inclusion criterion? (Grey literature is literature produced at all levels of government, academia, business and industry in print and electronic formats, but is not controlled by commercial publishers. Examples can be but not limited to dissertations, conference proceedings.)							
(A) The authors should state that they searched for reports regardless of their publication type.	0	0	1	0	0	0	
(B) The authors should state whether or not they excluded any reports (from the systematic review), based on their publication status, language etc.	1	1	1	0	1	1	
(C) “Non-English papers were translated” or readers sufficiently trained in foreign language	0	1	1	0	0	0	
(D) No language restriction or recognition of non-English articles	0	1	1	0	0	0	
Satisfies 3-4? score 4 2?=score 3 1?=score 2 0?=score 1	2	4	4	1	2	2	15

5. Was a list of studies (included and excluded) provided?						
(A) Table/list/or figure of included studies, a reference list does not suffice.	1	1	1	0	1	1
(B) Table/list/figure of excluded studies* either in the article or in a supplemental source (i.e. online). (Excluded studies refers to those studies seriously considered on the basis of title and/or abstract, but rejected after reading the body of the text) [*It is worth to have a brief overview of the excluded studies, since they do present relevant clinical information.]	0	0	1	0	0	0
(C) Author satisfactorily/sufficiently stated the reason for exclusion of the seriously considered studies.	0	1	1	0	0	0

(D) Reader is able to retrace the included and the excluded studies anywhere in the article bibliography, reference, or supplemental source.	0	0	0	0	0	0	
Satisfies 4? score 4 3?=score 3 2?=score 2 1 or 0?=score 1	1	2	3	1	1	1	9

6. Were the *characteristics* of the included studies provided?

(A) In an aggregated form such as a table, data from the original studies should be provided on the participants, interventions AND outcomes.	1	1	1	0	1	1	
(B) Provide the ranges of relevant characteristics in the studies analyzed (e.g. age, race, sex, relevant socioeconomic data, disease status, duration, severity, or other diseases should be reported.)	1	1	0	0	1	1	
(C) The information provided appears to be complete and accurate (i.e. there is a tolerable range of subjectivity here. Is the reader left wondering? If so, state the needed information and the reasoning).	1	1	1	0	1	0	
Satisfies 3? score 4 2?=score 3 1?=score 2 0?=score 1	4	4	3	1	4	3	19

7. Was the *scientific quality* of the included studies assessed and documented?

(A) 'A priori' methods of assessment should be provided (e.g., for effectiveness studies if the author(s) chose to include only randomized, double-blind, placebo controlled studies, or allocation concealment as inclusion criteria); for other types of studies alternative items will be relevant.	1	1	1	0	1	1	
(B) The scientific quality of the included studies appears to be meaningful.	1	1	1	0	1	1	
(C) Discussion/recognition/awareness of level of evidence	1	1	1	0	1	1	
(D) Quality of evidence should be rated/ranked based on characterized instruments. (Characterized instrument is a created instrument that ranks the level of evidence, e.g. GRADE [Grading of Recommendations Assessment, Development and Evaluation.])	1	1	1	0	1	1	
Satisfies 4? score 4 3?=score 3 2?=score 2 1 or 0?=score 1	4	4	4	1	4	4	21

8. Was the scientific quality of the included studies used appropriately in formulating conclusions?

(A) The results of the methodological rigor and scientific quality should be considered in the analysis and the conclusions of the review	1	1	1	0	1	0
(B) The results of the methodological rigor and scientific quality are explicitly stated in formulating recommendations.	1	1	1	0	1	0

(C) To have conclusions integrated/drives towards a clinical consensus statement	0	1	0	0	0	0	
(D) This clinical consensus statement drives toward revision or confirmation of clinical practice guidelines	0	1	0	0	0	0	
Satisfies 4? score 4 3?=score 3 2?=score 2 1 or 0?=score 1	2	4	2	1	2	1	12

9. Were the methods used to combine the findings of studies appropriate?

(A) Statement of criteria that were used to decide that the studies analyzed were similar enough to be pooled?	1	1	1	0	0	0	
(B) For the pooled results, a test should be done to ensure the studies were combinable, to assess their homogeneity (i.e. Chi-squared test for homogeneity, I⍰).	0	1	1	0	0	0	
(C) Is there a recognition of heterogeneity or lack of thereof	1	1	1	0	1	0	
(D) If heterogeneity exists a “random effects model” should be used and/or the rationale (i.e. clinical appropriateness) of combining should be taken into consideration (i.e. is it sensible to combine?), or stated explicitly	1	1	1	0	0	0	
(E) If homogeneity exists, author should state a rationale or a statistical test	0	0	1	0	0	0	
Satisfies 4? score 4 3?=score 3 2?=score 2 1 or 0?=score 1	3	4	4	1	1	1	14

10. Was the likelihood of publication bias (a.k.a. “file drawer” effect) assessed?

(A) Recognition of publication bias or file-drawer effect	1	1	1	0	0	1	
(B) An assessment of publication bias should include graphical aids (e.g., funnel plot, other available tests)	1	1	1	0	0	0	
(C) Statistical tests (e.g., Egger regression test).	0	0	1	0	0	0	
Satisfies 3? score 4 2?=score 3 1?=score 2 0?=score 1	3	3	4	1	1	2	14

11. Was the conflict of interest stated?

(A) Statement of sources of support	0	0	1	0	0	1	
(B) No conflict of interest. This is subjective and may require some deduction or searching.	0	1	1	0	1	1	
(C) An awareness/statement of support or conflict of interest in the primary inclusion studies	1	1	1	0	0	0	
Satisfies 3? score 4 2?=score 3 1?=score 2 0?=score 1	2	3	4	1	2	3	15

*In cases where part of the question is yes and part is no, we have rated it a 1.

Total possible score = 44 Total possible score for each section = 24

	Ciere, 2012	Ma, 2019	McCabe, 2017	Milavec Kapun, 2016	Tyack, 2017	Guo, 2018
Quality rating (low = < 30; high = ≥ 30)	31	40	40	15	26	27
	H	H	H	L	L	L

Supplemental file #3 - 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.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2
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.	Not registered
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.	3
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.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Additional file #1
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).	4-5
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.	5-6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	3-4
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.	6-7

Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6-7
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.	n/a

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).	5-6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
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.	4
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.	Table 2
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).	Add. file #2 Quality Assessment
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.	Tables 2 & 3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	9, 10 & 11
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	5-6
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).	11 & 12
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).	12 & 13
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	13
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.	13

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**.

Supplemental file #4 – Further Characteristics of Included Systematic Reviews

(Author, year) country	Participants, Patient population, age & gender (mean, median or range)	Risk of bias assessment; evaluation of quality	Follow-ups and attrition/drop-out rates	Authors' conclusions
(Ciere et al., 2012) UK	Adults with heart failure, mostly mild/ moderately impaired; Some w/ none or severe impairment; 888 with heart failure; Sample sizes 18 to 284 (median age 74, mean age 61–78); 3 studies focused on older heart failure patients; 1 on coronary artery bypass graft surgery patients.	Overall study quality was poor; one study rated moderate. Common weaknesses: reporting of statistical power and blinding of assessors. Approximately half rated poor for reporting potential selection bias, independence of data collection, attrition, intervention integrity and appropriateness of statistical analyses; Study authors insufficiently guarded against forms of experimenter bias including confirmation bias.	Between 2 to 12 mos after start of trial; 5 studies delayed follow-up for some/all outcome measures; Five RCTs analyzed group differences in self-efficacy at follow-up. 1 found TH improved self-efficacy over CG; 2 found no group differences; 2 comparing multiple arms found some group differences but none between IG and CG.	Individual studies were considered to have contributed confirmatory evidence if they reported findings that were statistically significant, internally consistent and in the direction hypothesized in our model. These studies provide insufficient evidence to robustly support or disprove any of the hypothesized relationships in the proposed model. Research on heart failure patients has failed to adequately examine cognitive and behavioral mediators that may account for the reported effects of TH.
(Guo & Albright, 2018) USA	4137 Older adults w/ heart failure, hypertension, diabetes, pain, COPD, lung disease, rheumatoid arthritis and other chronic conditions. Average age 55+ years.	Selection bias, performance bias, detection bias, attrition bias, and reporting bias were assessed for low, unclear or high risk. Attrition bias of the 31 studies was rated as LR (20), UR (7) and HR (4). The quality was evaluated with Cochran's quality of evidence guideline.	About a third of studies reported follow-ups which were completed anywhere from 3 months (Gellis (2012) chronic heart or respiratory failure - 3 mos for health condition, 12 mos for health care utilization) to 12 months (Pecina (2013) chronic conditions; De Lusignan (2001) heart failure). Drop-out rates were not reported.	TH technologies are generally effective (some reporting ineffective) on SM for older adults with a wide range of LTCs, hence their use is advisable; Consider racial diversity and culture-related acceptance differences; Promote consistent interaction between patients and HCPs; Use of LDCs is efficient to assist routine communication with HCPs who can mentor and assist patients' self-care effectively; Suggest future experimental design studies to examine HCPs performance on TH effectiveness.
(Ma et al., 2019) Hong Kong	3998 with Hypertension, mean age 50-68; Eight studies involved male participants at above 50%. Patients w/clinical diagnosis of HT, w/or w/o adequate BP control, w/inadequate BP control, or w/uncontrolled Hypertension w/kidney disease, obesity & type 2 diabetes.	9 reported random sequence generation details; 6 reported allocation concealment details, lack of which could increase the risk of selection bias. 10 unclearly reported blinding of outcome assessors, increasing concern of detection bias. 11 reported baseline similarity of 2 groups. Majority of studies used intention-to-treat analysis, reliable measurements and appropriate statistical analysis.	4 studies completed follow-up. Margolis (2013) conducted a 6-month post-intervention follow-up. Magid (2013) instructed participants to follow up with their primary care physician. The drop-out rate of the included studies ranged from 0.67% to 20.67% which influenced the attrition bias. Total drop-outs 358; 1 study didn't report.	eHealth interventions are conducive to hypertension control; could be a potential mean to promote hypertension self-care; significantly affected the reduction of systolic and diastolic blood pressure; significantly decreased the proportion of patients within adequate blood pressure control and their body weight and could be a promising alternative in the management of hypertension. Authors call for rigorous experimental design on hypertension self-care to provide a robust evidence for a wide population and to address the increasing health care needs. Implications for research recommended long-term follow-ups.

(McCabe et al., 2017) UK	557 participants with COPD Avg age 64 years; 64.9% men	An overall low quality was reported. Included studies rated unclear or low risk on selection bias; high on risk of detection bias; risk of reporting bias was low; selection and attrition bias was high or unclear. Authors concluded that all 3 studies were of high risk of bias.	All three studies had incomplete outcome data. Intervention group and control group rates of 25% and 17%, 6% and 3.5%, and 22% and 0% were attributed to failure to complete surveys or follow-up measurements, death, exclusion from analysis with reason not given, participation burden and technical failure.	Interventions aimed at facilitating, supporting and sustaining SM in people with COPD and delivered via smart technology significantly improved HRQoL and levels of activity up to 6 mos compared with interventions given through face-to-face/digital and/or written support; No firm conclusions drawn; Evidence is of poor quality and insufficient for advising on health benefits of using smart technology for supporting, encouraging, and sustaining SM of COPD. Further research should focus on outcomes relevant to different stages of COPD; provide clear information on how SM is assessed; include longitudinal measures that allow comment on behavioral change.
(Tyack & Camic, 2017) UK	312 people w/ Dementia Mean ages 74.3 - 84.5, ages reported in half of the studies; People with dementia (any type) and/or their carers (informal carers, care staff, art therapists or facilitators). Total PWD/carers is unclear as participants/cohorts in study phases may overlap. Sample sizes 2-40 (median = 12)	Variable quality results were reported ranging from 25% to 100%.	Generally, neither follow-ups not drop-outs were reported in Table 3. Study Characteristics. One study did mention interviews with people with dementia "after 2 weeks about their experiences with PG" device, but no results were given.	Touchscreen-based interventions can confer a wide range of benefits to the well-being of PWD in relation to their mood and mental health and their sense of mastery. Important procedural aspects besides support included involving potential users in the development process, an errorless learning method for training, requiring motor-action during training and the ability to use the intervention with little preparation. Introduction of interventions earlier in the progress of users' dementia facilitated uptake. Hardware considerations included ergonomics, screen quality, consistency and a conspicuous location.

Acronyms: **BP** – Blood pressure; **CG** - control group; **HCP** - health care provider; **HHMS** - home-health monitoring system; **HRQoL** - health-related quality of life; **HT** - Hypertension; **IG** - intervention group; **LDC** - long-distance communication technology; **MTP** - telehealth program applying multiple telehealth technologies; **PA** - Physical activity; **PRISMS** - Practical Reviews in Self-Management Support; **PWD** - People with dementia; **RCT** - randomized controlled trial; **SM** - Self-management; **TET** - tele-education technology; **TH** - Telehealth; **WBT** - web-based technology