

BMJ Open Electronic, mobile and telehealth tools for vulnerable patients with chronic disease: a systematic review and realist synthesis

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ABSTRACT

Objectives The objective of this review was to assess the benefit of using electronic, mobile and telehealth tools for vulnerable patients with chronic disease and explore the mechanisms by which these impact patient self-efficacy and self-management.

Design We searched MEDLINE, all evidence-based medicine, CINAHL, Embase and PsychINFO covering the period 2009 to 2018 for electronic, mobile or telehealth interventions. Quality was assessed according to rigour and relevance. Those studies providing a richer description ('thick') were synthesised using a realist matrix.

Setting and participants Studies of any design conducted in community-based primary care involving adults with one or more diagnosed chronic health condition and vulnerability due to demographic, geographic, economic and/or cultural characteristics.

Results Eighteen trials were identified targeting a range of chronic conditions and vulnerabilities. The data provided limited insight into the mechanisms underpinning these interventions, most of which sought to persuade vulnerable patients into believing they could self-manage their conditions through improved symptom monitoring, education and support and goal setting. Patients were relatively passive in the interaction, and the level of patient response attributed to their intrinsic level of motivation. Health literacy, which may be confounded with motivation, was only measured in one study, and eHealth literacy was not assessed.

Conclusions Research incorporating these tools with vulnerable groups is not comprehensive. Apart from intrinsic motivation, health literacy may also influence the reaction of vulnerable groups to technology. Social persuasion was the main way interventions sought to achieve better self-management. Efforts to engage patients by healthcare providers were lower than expected. Use of social networks or other eHealth mechanisms to link patients and provide opportunities for vicarious experience could be further explored in relation to vulnerable groups. Future research could also assess health and eHealth literacy and differentiate the specific needs for vulnerable groups when implementing health technologies.

Strengths and limitations of this study

- ▶ The use of a comprehensive search and systematic process to identify both quantitative and qualitative data.
- ▶ The use of Rameses and Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting standards.
- ▶ Incorporation of theory and mapping against a theoretical framework and realist matrix.
- ▶ Limited data identified due to a lack of detailed context provided in the published studies.

BACKGROUND

Chronic conditions result in significant personal and social burden.¹ Electronic and telehealth tools are increasingly commonplace, can be provided at relatively low cost² and incorporate personally relevant health information.³ For those vulnerable and underserved community members with chronic or long-term conditions, electronic applications may enhance the reach of health services and the provision of tailored need-based services.^{4,5} The growing impetus to use these technologies is largely underpinned by their potential to intervene in the course of healthcare and influence the way people deal with their health issues.⁶ There is also an expectation that health technologies will engage consumers in appropriate self-care and self-management,⁷ which within the health delivery sphere, shifts the responsibility solely from the clinician to one that is jointly shared by the health provider and patient.

Electronic health (eHealth) tools incorporate many opportunities for patients to increase their engagement through focused disease-specific learning, options to receive regular feedback and frequent reinforcement (eg, peripheral monitoring devices).⁸



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Additional inbuilt support functions that assess progress, provide goal setting and problem solving, aim to increase the patient's skill and confidence in managing their health problems.⁹ Supplementary motivational interviewing and cognitive behavioural components can also be provided via the internet, mobile device or telephone.¹⁰

The claims made by health-related apps, websites and other electronic tools remain largely unverified, and more specifically, little is known about their value for vulnerable and marginalised groups. Within the Innovative Models Promoting Access-to-Care Transformation (IMPACT) programme, we aimed to assess, via a systematic review and realist synthesis, the perceived benefit of using electronic tools to enhance the engagement of vulnerable patients with chronic disease. We used realist methodology as a way of unpacking the complexity surrounding eHealth interventions.¹¹ This methodology explains the interplay between context, mechanisms and outcomes¹² where mechanisms are not activities within the intervention, but the responses by people that are triggered by changes in context.¹³ In this review, we specifically sought to explore mechanisms related to patient self-efficacy and self-management. The impact of these tools on access to healthcare more broadly is the topic of a future manuscript.

Research question

The objective of this review was to assess the benefit of using electronic, mobile and telehealth tools for vulnerable patients with chronic disease and to explore the mechanisms by which these tools impact patient self-efficacy and self-management.

Our population of interest included adults with one or more diagnosed chronic health conditions. We used the definition of chronic disease provided by the National Public Health Partnership¹⁴ framework, a seminal Australian resource setting out a strategic framework for the prevention and control of chronic non-communicable diseases in Australia. This framework identified 12 chronic conditions.

The definition of vulnerability was based on the IMPACT study definition: Indigenous/first nation people, culturally and linguistically diverse groups including recently arrived refugee groups, those experiencing socioeconomic hardship and disadvantage (unemployed, low income, those in public housing and homeless) and geographic disadvantage (living in a rural and remote area). For these population groups, these demographic, geographic, economic and/or cultural characteristics impede or compromise access to community-based primary healthcare.

There are many and varied definitions of eHealth, mHealth and telehealth used across the health sector.¹ For the purpose of this review, we defined these in the following ways:

- ▶ eHealth, is the general transfer of health resources and healthcare by electronic means through the internet and telecommunications.¹⁵

- ▶ Mobile health (mHealth) is the delivery of healthcare services via mobile/wireless communication devices such as smartphones and tablets.
- ▶ Telehealth describes the use of telecommunication techniques (voice, data and images) for providing telemedicine (remote clinical service delivery), medical education and health education over a distance.¹⁶ Telehealth encompasses long-distance clinical healthcare, patient and professional health-related education, public health and health administration.

METHODS

Our processes were based on standard systematic review methodology.¹⁷ Realist synthesis similarly follows the stages of a traditional systematic review except the appraisal of evidence is theoretically driven and intent on explaining why the intervention works or does not work.¹⁸ Reporting was guided by the Rameses publication standards for reporting realist synthesis¹⁹ and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.²⁰

We searched MEDLINE, all evidence-based medicine, CINAHL, Embase and PsychINFO covering the period 1 January 2009–12 February 2018. Our basic search strategy (box 1) was modified for use in each database.

The criteria for study selection are described in detail in table 1. We did not exclude studies based on design as we wanted to collect a richer understanding of the interventions.

Included studies required a description of the e/m/telehealth intervention and/or its components. Interventions that did not offer broader patient involvement through coaching/skill improvement components and ongoing skill development were excluded, including those programmes used solely for simple self-monitoring of symptoms. Inpatient hospital-based services were excluded, as were those not presenting evaluative data and those involving primarily children or adolescent populations.

We also selected only studies originating in Organisation for Economic Cooperation and Development (OECD) countries.

Study selection process

Title and abstract screen were undertaken by at least two authors (SP, AP and LT). For citations requiring full-text review, SP, AP and LT reviewed a subset of papers, with final inclusion determined through joint discussion and review.

Data extraction and study variables

Data were collected using a five-page data collection form within an Access database incorporating the Reach, Efficacy, Adoption, Implementation, Maintenance (REAIM) framework,²¹ the Template for Intervention Description and Replication (TIDieR) framework,²² the Place, Race, Occupation, Gender, Religion, Education, Socioeconomic status, social capital

Box 1 Search strategy conducted 12 February 2018 and modified for each database

Search terms

1. telemedicine/
2. ehealth.mp.
3. E health.mp.
4. electronic health.mp.
5. internet health.mp.
6. mhealth.mp.
7. m health.mp.
8. mobile health.mp.
9. mobile health devices.mp.
10. social media/
11. telephone/
12. telehealth.mp.
13. tele health.mp.
14. telehomecare.mp.
15. text messaging/
16. exp therapy, computer-assisted/
17. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
18. exp medical records systems, computerized/
19. 17 not 18
20. primary health care/
21. exp family practice/
22. exp general practice/
23. exp physicians, family/
24. practice nurse.mp.
25. pharmacists/
26. nutritionists/or physical therapists/
27. aboriginal health worker.mp.
28. audiologist.mp.
29. diabetes educator.mp.
30. exercise physiologist.mp.
31. occupational therapist.mp.
32. osteopathic physicians/
33. podiatrist.mp.
34. home care services/
35. 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34
36. chronic disease/
37. long term illness.mp.
38. long term condition.mp.
39. multimorbidity.mp.
40. multi morbidity.mp.
41. myocardial ischemia/
42. stroke/
43. lung neoplasms/
44. colorectal neoplasms/
45. exp depression/
46. diabetes mellitus, type 2/
47. arthritis/
48. pulmonary disease, chronic obstructive/
49. osteoporosis/
50. asthma/
51. renal insufficiency, chronic/
52. dental caries/
53. 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52
54. 19 and 35 and 53

Continued

Box 1 Continued

55. exp child/or adolescent/
56. 54 not 55
57. editorial.pt.
58. case reports.pt.
59. letter.pt.
60. 57 or 58 or 59
61. 56 not 60
62. limit 61 to (English language and yr='2009 -Current')

(PROGRESS) framework²³ and several predefined variables including study type, country of origin, the procedures, activities and/or processes used in the interventions, supportive activities, recipients and the personnel involved in delivery of the intervention and reported study outcomes. All data extraction was conducted by two authors.

Quality appraisal

Within realist synthesis, there is no accepted process for assessing quality. Pawson *et al*¹² argues that quality should not determine inclusion, but a realist synthesis should provide a 'quality filter',²⁴ which assesses the contribution of data to *rigour* (whether the method used to generate the data is credible and trustworthy) and *relevance* (whether it contributes to theory building and/or testing).¹⁹

We used a method described by O'Campo *et al*²⁵ due to recognition that the most useful study information may not be within the reports of studies with the highest quality. Studies were classified against the criteria (table 2) by one author (SP) and confirmed by a second author (AP). Rigour was assessed as 'high', 'moderate' or 'weak' and plotted on a continuum from 0 to 7. One point was allocated for each positive response and studies graded as high (7 points), moderate (4–6 points) and low (0–3 points). Relevance was assessed based on 'thick' or 'thin' descriptions of the intervention components and their mechanisms. One point was allocated for each 'yes' answer and studies considered thick (3–4 points) or thin (0–2 points).

Realist synthesis

At the core of realist synthesis is to make explicit the underlying assumptions as to how an intervention is supposed to work and to then map the evidence in a systematic way to test and refine this theory.²⁶ We developed a linear logic model to explain the engagement of primary care providers and patients in the use of mobile, telehealth and eHealth tools (figure 1). We explored known theories associated with patient self-efficacy and self-management and extracted data against a realist matrix using those included studies that had been assessed as providing a 'thick' description of the intervention. The matrix comprised documented results from each study plus relevant author discussion that attempted to place their results into context. Realist matrices are a complementary approach to

Table 1 Study selection criteria

Selection criteria	Inclusion	Exclusion
Population – consumer	<p>1. General adult (18+ years) population with one or more diagnosed chronic health conditions as classified by the National Public Health Partnership¹⁴: ischaemic heart disease (also known as coronary heart disease), stroke, lung cancer, colorectal cancer, depression, type 2 diabetes, arthritis, osteoporosis, asthma, chronic obstructive pulmonary disease, chronic kidney disease and oral disease. Patients described as having multimorbidity (ie, two or more chronic conditions).</p> <p>2. Participants classified as vulnerable based on IMPACT definition and of specific relevance to South West Sydney including: Indigenous/first nation people, culturally and linguistically diverse groups including recently arrived refugee groups, those experiencing socioeconomic hardship and disadvantage (unemployed, low income, those in public housing and homeless); and geographic disadvantage (living in a rural and remote area).</p> <p>Any health professional providing primary care to a community-based population including general practitioner/family physician, practice nurse or community/clinic nurse, pharmacist, allied health professionals (Aboriginal health workers or Aboriginal and Torres Strait Islander health practitioners, audiologists, chiropractors, diabetes educators, dietitians, exercise, physiologists, mental health workers, occupational therapists, osteopaths, physiotherapists, podiatrists, psychologists and speech pathologists).</p>	<p>Mixed populations of adult and children unless these groups have been separated as part of the analysis.</p> <p>Patients with mental health conditions that may impair cognition or understanding, such as dementia and psychosis.</p>
Population – practitioner	<p>Comprehensive (multicomponent) or simple (one component) patient directed or patient-focused tools available via a personal computer, telephone or mobile device (mobile phone or tablet). This includes the provision of instant feedback or SMS reminders that encourage patients to achieve their health goals and interactive programmes that provide ongoing monitoring with self-assessment activities.</p> <p>Access to the tools should involve an initial direct interaction between a primary healthcare provider (defined above) and the patient (defined above) during which instruction or training is provided to the patient to aid understanding, promote knowledge or increase skills, including coaching and education tools provided over the phone.</p> <p>The intervention/tool should provide patients with a short to medium term or ongoing interactive method of education, training or skill development that supports self-management and empowerment related to their management of chronic disease and its risk factors.</p>	<p>e/m/Telehealth intervention/s implied but not described.</p> <p>Devices or programmes used for simple self-monitoring of symptoms related to chronic condition such as sugar or blood pressure except where these are a component of a broader interactive intervention.</p> <p>Readings recorded via the internet or through devices that allow the download of readings. These may be included if they are one component of a more comprehensive self-management programme.</p> <p>Telephone triage services where a patient is advised as to what level of care to seek (General Practitioner (GP) or hospital).</p> <p>Single contact for the provision of simple educational material only without added coaching/skill improvement and ongoing skill development.</p> <p>Telemedicine for routine consultations with no health education component/intention.</p> <p>Establishing, utilising or reviewing electronic health record systems within Community Based Primary Health Care (CBPHC).</p>
Comparator	Usual care, enhanced usual care (eg, added counselling or education) or a second intervention arm.	

Continued

Table 1 Continued

Selection criteria	Inclusion	Exclusion
Outcomes	<p>Primary outcomes:</p> <ol style="list-style-type: none"> 1. <i>Health service use</i>: <ul style="list-style-type: none"> ▲ Increased attendance at primary care service. ▲ Number of General Practitioner visits per year. ▲ Use of the e/m/telehealth intervention by patients and practitioners including practitioner adoption/inclusion in day-to-day practice or negative implications from use reported by patients or providers. ▲ Satisfaction with service/practitioner care. ▲ Decreased Emergency Department (ED) presentations. ▲ Reduction in cost of providing primary care ▲ Reduction in medication errors. ▲ Reduction in adverse events including drug-related events. 2. <i>Behavioural outcomes</i> <ol style="list-style-type: none"> a) Patient behaviour <ul style="list-style-type: none"> ▲ Number of patients with regular monitoring of their clinical parameters. ▲ Number of people who self-report improvements in their management of chronic disease or risk factors. ▲ Self-reported or measured change in level or risk/engagement in risk behaviour. ▲ Levels of motivation. ▲ Levels of knowledge and/or understanding. ▲ Level of health literacy — self-reported or validated instruments. ▲ Level of e-health literacy — self reported or validated instrument. ▲ Self-efficacy. ▲ Level of confidence with self-management of their condition and associated risk factors. ▲ Self-reported or measured changes in communication/interaction with their PC provider. ▲ Quality of life. b) Practitioner behaviour <ul style="list-style-type: none"> ▲ Enhanced use of tools/satisfaction with tools. ▲ Self-reported or measured increased patient communication. 2. <i>Secondary outcomes</i> <ol style="list-style-type: none"> <i>Health-related outcomes</i> <ul style="list-style-type: none"> ▲ Compliance with treatment/medication. ▲ Decreased exacerbation of symptoms. ▲ Decreased mortality and morbidity. ▲ Negative outcomes from the use of the intervention/side effects. 	

Continued

Table 1 Continued

Selection criteria	Inclusion	Exclusion
Setting	A community-based primary healthcare setting such as general practice primary healthcare clinics, Aboriginal healthcare centres; community healthcare clinics and after-hours GP clinics within a hospital or any combination of these settings. This includes primary health care (PHC) services provided in a person's home. Outpatient clinics such as cardiac rehabilitation and diabetes clinics (may be on or adjacent to a hospital site) if they cater for people residing in the community and provide valuable services for the management of chronic conditions.	Solely inpatient hospital-based services. Non-health-based settings, that is, gyms, private insurance companies and so on.

GP, general practitioner; IMPACT, Innovative Models Promoting Access-to-Care Transformation.

Table 2 Quality appraisal

Assessment of rigour	<ol style="list-style-type: none"> 1. Is there a clear statement of the aims of the research? 2. Did the study include an appropriate comparison group? 3. Did the study use appropriate eligibility criteria to obtain its target group? 4. Did the study use standardised methods for selecting/putting people into the study and state how they did this? 5. Did the study provide details about sample size? 6. Did the study have a comparatively long study period (≥ 6 months)? 7. Is the methodology appropriate for what they were trying to achieve?
Assessment of relevance	<ol style="list-style-type: none"> 1. Is the intervention programme description detailed? 2. Did the study describe factors that affected programme implementation? 3. Did the study consider reasons for the results that they achieved? 4. Did the study discuss reasons for programme success or failure?

Based on: O'Campo *et al.*²⁵

outcome chains and other programme logic models. A realist matrix focuses on the causal mechanisms at work in a programme or project,²⁷ and it helps to map the factors from a programme that may be contributing to outcomes by reflecting on:

- ▶ Agency: whose actions exactly are causing the change to occur?
- ▶ Context: what are the external variables or 'moderators' that affect outcomes? Including the impact of the social and political situation, broad social or geographic features and different population profiles.
- ▶ Resources: what resources have been provided or are available?
- ▶ Mechanism: how are the resources and the thing/person being changed interact?
- ▶ Outcome: what is the anticipated change relating to self-efficacy and self-management under the specified conditions?

Patient and public involvement

Our research question was formulated through a collaborative process with the South-Western Sydney Local Innovative Partnership comprising policy makers, healthcare providers and field experts involved in service provision to key vulnerable communities. We did not involve patients directly in this process.

RESULTS

From 1540 records initially identified, 1111 duplicates were removed, and a further 869 were excluded after title and

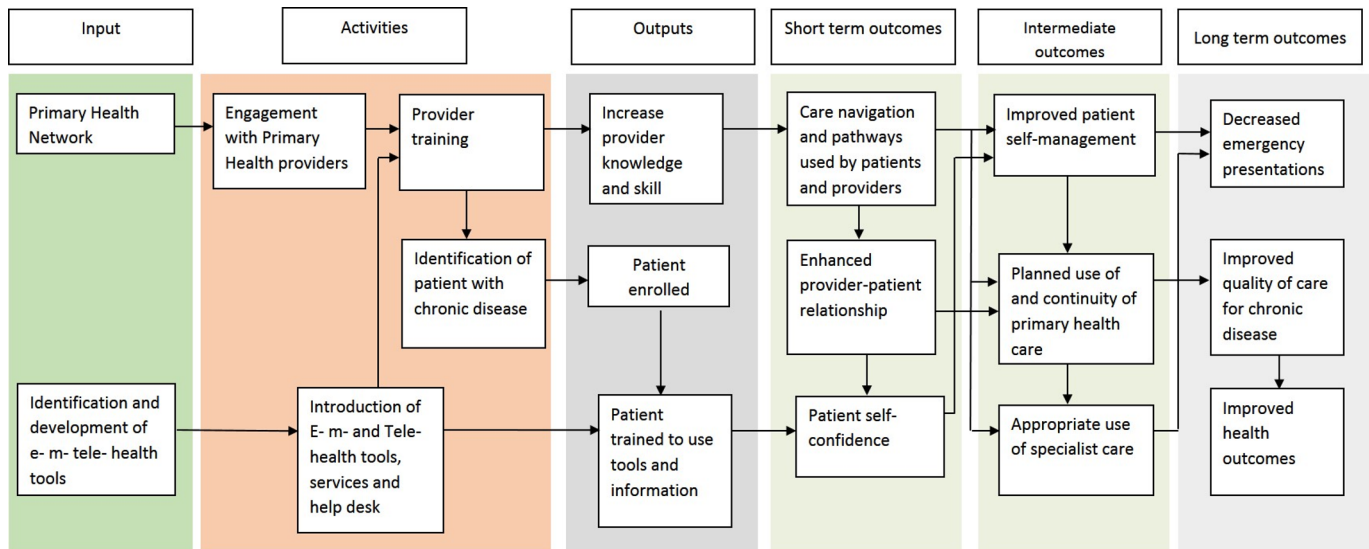


Figure 1 Logic model.

abstract screening. Eligibility was frequently difficult to assess from the title and abstract, so 243 citations underwent a brief full-text review, resulting in 192 exclusions. We identified nine additional related publications that were also eligible. Fifty-nine citations underwent data extraction. Thirty were excluded on the basis that they described simple telemonitoring only, did not provide data related to the intervention, were of an incorrect publication type or contained a population not meeting our definition of vulnerable. Twenty-nine citations relating to 18 separate studies were ultimately included (figure 2).²⁰

Randomised controlled trials (RCTs) and cluster RCTs were the predominant study types. Two studies compared alternative interventions.^{28 29}

Appraisal of studies for rigour and relevance

Generally, studies were of moderate to high rigour (15/18 studies), and 12/18 studies provided additional valuable contextual information (tables 3–6).

Assessment of self-efficacy and self-management from study reported outcomes

Studies predominantly assessed a range of clinical and functional outcomes. Several proxy outcomes (that might reasonably be used to make assumptions about the effect on self-efficacy and self-management) were included such as feasibility, satisfaction and acceptability (tables 3–6). Several studies reported positive changes in health behaviour (improved lifestyle indicators), increased compliance and adherence to lifestyle goals and satisfaction with services.

From our logic model, we anticipated that access to reliable electronic tools, supported through a healthcare environment, would enhance patients' ability to obtain, process and understand relevant health information (health literacy), thereby improving efficacy and their capacity to self-manage their chronic condition. The information provided by the studies was inconclusive as to whether this was achieved. Only one study²⁹ actively assessed health

literacy and tailored their intervention accordingly. No studies assessed e-health literacy.

Overall satisfaction with the use of eHealth and telehealth tools by patients was generally positive. Satisfaction was directly related to the participant's perceived relevance of the tools and the level of positivity in the relationship with the intervention provider. In two studies,^{30 31} patients expressed high levels of satisfaction from their interaction with nurses, which promoted better understanding of their condition. Others showed high levels of willingness among patients to use telemonitoring equipment (95%) and recommend it to others (90%) or pay for telehealth services³² and a sense that equipment helped them to monitor and improve their health.³³

Theoretical basis for the interventions

For most studies, the choice of intervention had no documented theoretical basis. Interventions developed from either a supporting rationale or belief in the benefit of the intervention. These broad principles or frameworks surrounded equitable access, evidence-based medicine, quality improvement, cost effectiveness, better disease management (chronic care and transitional models) and the improvement of health literacy. Only two associated studies specifically commented on the theoretical basis underpinning their intervention.^{34 35} This incorporated motivational interviewing 'grounded in social cognitive theory constructs of self-efficacy, social support and outcome expectancies, which emphasized the building of participant skills in behaviour change strategies'.

Theory mapping

We used theory to explore how electronic, mobile and telehealth interventions might influence an individual's response (through learning and behaviour change) towards self-efficacy and self-management. Self-efficacy and self-management are interwoven concepts. Self-efficacy is the sense of patient confidence in their ability to exert

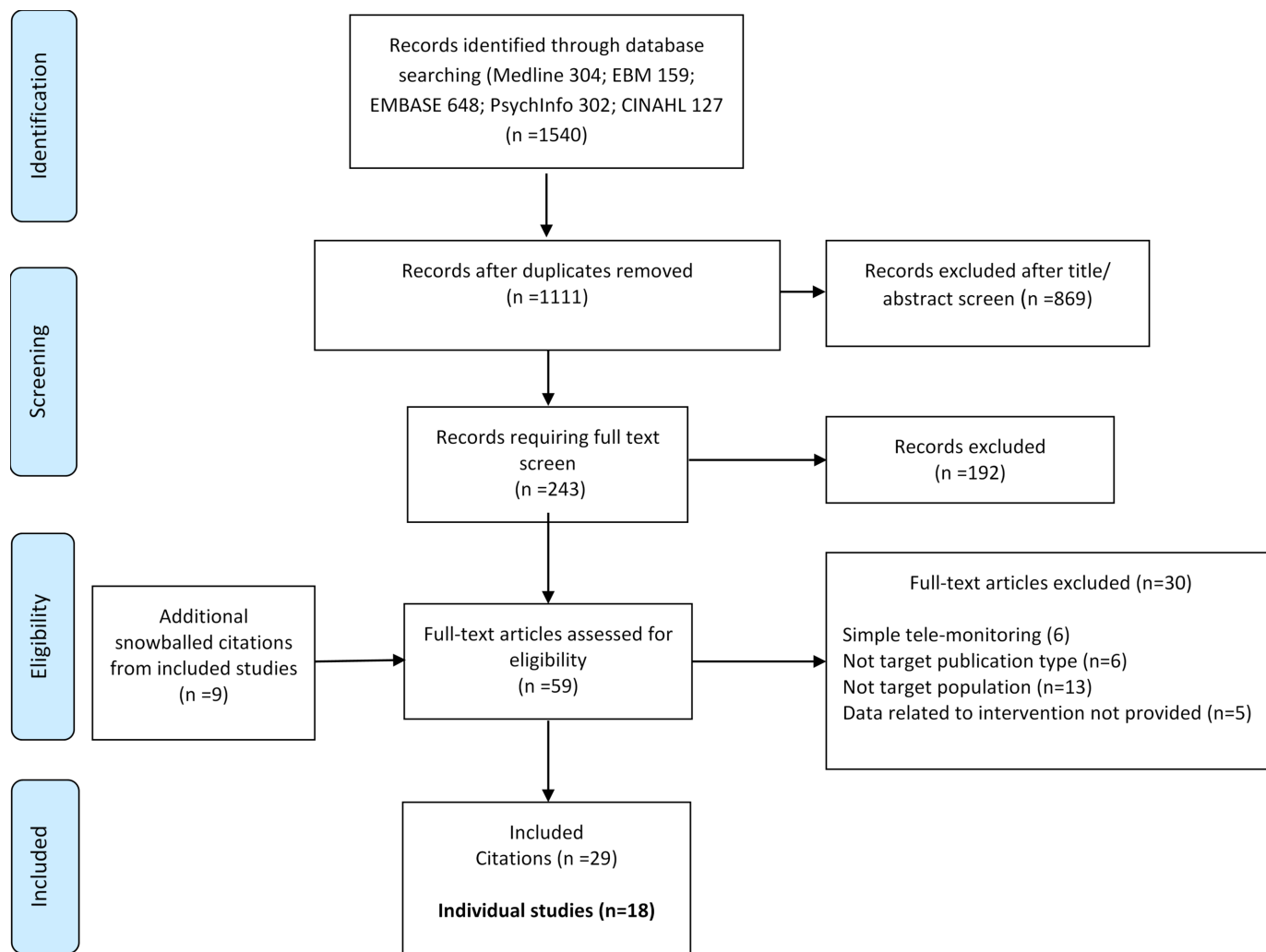


Figure 2 PRISMA flow chart. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

control over their own motivation, behaviour and social environment, and self-management is active participation by the patient in their own healthcare.

The theory of self-efficacy stems from social cognitive theory and describes the interaction between behavioural, personal and environmental factors in relation to health and chronic disease.³⁶ Confidence in the ability to perform specific health behaviours will subsequently influence which behaviours patients will engage in^{36–38} and is an important driver of sustained behaviour change.⁸

The components of self-efficacy theory that influences actions are performance accomplishments, vicarious experience, social persuasion and physiological and emotional states.³⁹ From our matrix (table 7), the study interventions used a range of resources designed to increase patient skill mastery such as assessment and feedback,³⁴ goal setting,^{28 29 34 35 40 41} workbooks,^{29 34 35} websites and training to use tools.^{33 41 42} Additional resource materials that encouraged participation or guided participants through the intervention process were frequently provided and translated.^{32 43}

Mastery with the ‘technology divide’ was inbuilt in some interventions but not all. Self-efficacy can be enhanced by

observing and interacting with those who have had similar experiences (ie, via vicarious experience). When we observe others succeed through sustained effort (eg, lose weight), this raises our beliefs that we too possess the capabilities to master the activities needed for success in that area.

Within the included studies vicarious experience was not overtly targeted with the exception of the study by Cherrington *et al*,⁴⁰ which used peer community health workers (with diabetes or caring for someone with diabetes) to link patients with diabetes to primary care via a web application and telephone coaching.

The largest concentration of effort within the interventions related to social persuasion or those activities where people are led, through suggestion, into believing that they can achieve a task. This was provided through motivational interviewing to manage expectations,^{35 40} behavioural activation approaches^{28 33 40 41 44} and counselling.^{29 44} Activities were purposefully designed to provide encouragement (eg, goal setting), were easily attainable and focused on achievements and rewards.³⁵ Physical and/or psychological morbidities were common among the populations, and due to the negative judgements and emotional reactions that go hand in hand with these conditions, significant effort

Table 3 Telehealth studies

Study, country	Vulnerability/ chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Dwight-Johnson <i>et al</i> ⁴⁷ , 2011, USA	Hispanic primary care patients with depression in rural Washington, USA.	Telephone-based CBT versus enhanced usual care.	Eight sessions of CBT by telephone. Patient given a workbook translated to Spanish. Sessions conducted by five-part time Spanish-speaking therapists with a master's in social work.	Satisfaction, symptom severity, use of medication and uptake/implementation.	Moderate/thin
Eakin <i>et al</i> ⁴⁸ , Australia*	Primary care patients within a socioeconomically disadvantaged region of Queensland, Australia, with multiple comorbid chronic conditions.	Telephone counselling intervention (weight and physical activity) versus usual care.	Mailed workbook with information on healthy eating and PA and a pedometer. 18 phone calls over 12 months from study counsellors. Calls went from biweekly to monthly and used the 4As approach (assessment and feedback, advice on PA and diet, assistance with goal setting and developing a personalised plan for modifying PA and diet according to guideline recommendations and arranging follow-up support in the form of subsequent calls).	PA levels and diet, no meeting guideline recommendations, uptake/implementation.	High/thick
Eakin <i>et al</i> , Australia ^{49 50*}	Adult patients with type 2 diabetes from a socioeconomically disadvantaged area of Queensland, Australia.	Telephone delivered weight loss intervention (living well with diabetes) versus usual care.	Workbook and up to 27 telephone calls over 18 months. The telephone counsellor works with participants to encourage reduced energy intake by 2000 kJ per day and 30 min a day of moderate-intensity, planned activity. Multimodal behaviour therapies are used to promote self-monitoring, goal setting, problem solving, social support, stimulus control, positive self-talk and self-reward.	No meeting programme targets for diet, physical activity, weight loss, weight circumference, levels of PA and uptake.	High/thick
Gabrielian <i>et al</i> ³⁰ 2013, USA	Previously homeless veterans with chronic disease who have been rehoused through US Dept. of Housing and Urban Development Supportive Housing Program.	Care Coordination Home Telehealth (CCHT) plus peer support for 'technology divide' versus usual care.	CCHT – protocol driven inhome messaging and recording of daily monitoring transmitted via the phone and stratified according to three risk categories (colour coded) prompting a telephone call by RN where indicated. Biweekly veteran support by peers.	Feasibility, satisfaction.	Weak/thin

Continued

Table 3 Continued

Study, country	Vulnerability/ chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Gellis <i>et al</i> ³¹ 2014, USA	Medically frail older homebound individuals with COPD or CHF and comorbid depression. Patients were recruited from a hospital-affiliated home care agency, which services low-income people.	Integrated Telehealth Education and Activation Model versus usual care with inhome nursing plus psychoeducation.	Telemonitoring for chronic illness and depression care management, and Problem-Solving Therapy (PST) for comorbid depression. Patients were given an inhome device to log symptoms and measurements daily. Nurses contacted for follow-up where required. Nurses provided brief PST over the phone for 8 weeks.	Symptom severity, number of ED visits/days hospitalised, problem solving skills and satisfaction.	Moderate/thin
Kahn <i>et al</i> ⁵¹ 2009, USA	Disadvantaged – Members of Gold Choice, a partially capitated Medicaid managed care programme for individuals with diabetes and a behavioural health diagnosis.	Telephonic nurse case management (TNCM). No comparison group.	The TNCM monitors members with diabetes between office visits, provides diabetes counselling and facilitates self-care by reminding the patients about appointments, lab work and speciality referrals.	Issues relating to implementation.	Weak/thin
Pickett <i>et al</i> ⁵² 2014, USA	Recently hospitalised older adults (>55 years) in an urban acute care hospital with depression.	Telephone facilitated depression care versus usual care.	Those in the facilitated group were reassessed by telephone at 2, 4, 6, 8 and 12 weeks, receiving techniques for problem solving, behavioural activation, self-management, monitoring response to treatment and countering premature discontinuation of medication.	Initiation of medication/prescribing.	Moderate/thin
Sheldon <i>et al</i> ⁴⁴ 2014, USA	Low-income culturally diverse patients with depression attending any of eight primary care clinics.	Telephone Assessment Support and Counselling Program. No comparison group.	Six telephone calls (one assessment and up to five therapy calls) covering behavioural activation for depression (form of CBT) and motivational interviewing strategies into medication adherence and depression counselling.	Recruitment, engagement/retention and fidelity.	Moderate/thick

Continued

Table 3 Continued

Study, country	Vulnerability/ chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Wolf <i>et al</i> ²⁹ 2014, USA	Patients with type 2 diabetes attending federally qualified health centres designed to cater for underserved US communities.	Two intervention arms: 1. Carve in (clinic based). 2. Carve out (outsourced telephone-based support).	Carve in: patient diabetes guide, brief counselling and action plan with primary care provider with telephone follow-up at 2 weeks and 2 months and via phone or in person at 3, 6 and 9 months. Carve out: diabetes guide distributed by primary care provider and referral to telephone diabetes educator who facilitates action plan and follow-up. Counselling provided by a research assistant. Patient followed up at same intervals as carve in by diabetes educator.	Knowledge/literacy, HbA1c, Moderate/thick systolic BP and LDL cholesterol, uptake and satisfaction with service.	

*Associated citations.

BP, blood pressure; CBT, cognitive-behavioural therapy; COPD, chronic obstructive pulmonary disease; LDL, low-density lipoprotein; PA, physical activity; RN, Registered Nurse; CHF, congestive heart failure; ED, emergency department

within the interventions targeted cognitive behavioural pursuits, reframing and increasing positive experiences and pleasurable activities.

Contextual factors identified

There was extensive contextual heterogeneity among the interventions (table 8). Patients were enrolled from a range of primary care settings (general practice, community health, supported veteran programmes, outpatient programmes, community home care and US federally funded health centres/Medicaid). The interventions were overwhelmingly home based and some unsupervised. Interventions targeted populations with a range of chronic conditions and vulnerabilities (older age >55years, low socioeconomic status, difficulties with accommodation (previously homeless persons in supported accommodation, and rural communities with a mixture of lower socioeconomic and underserved populations). Studies largely were artificial environments where intervention providers were put in place specifically for the period of the research. In some studies, it was not possible to know the degree to which routine clinical/service staff were incorporated into the delivery of the intervention. Some services ‘tagged’ interventions onto existing service structure, and in many cases extra services and staff were temporarily employed to conduct interventions. Only one study³² had a system of ‘organisational readiness’ where significant time had been spent developing a mental health service that could provide depression treatment to patients.

Interactions involved a range of primary care providers (nurses, counsellors, diabetes educators, pharmacists and lay/peer workers). Although providers were predominantly nurses operating in a variety of roles, there was no evidence that this was associated with a different outcome to that of other providers. Surprisingly, general practitioners (GPs) (or their equivalents) did not deliver any of the interventions so no conclusions could be drawn about their role in delivering or negotiating these interventions with patients. Interventions were additional to the care of the GP or compared with the usual care provided by the GP. In some cases, enhanced usual care was used and in others the GP was peripheral to the main intervention activity in that they prescribed medications or reviewed guidelines with the patient or participated in dialogue with the intervention staff over management.

Nine studies were subcategorised as providing a purely telehealth intervention, seven combined eHealth elements with telehealth, one was a mix of mHealth and eHealth and one was predominantly mHealth (tables 4–7). All but one study provided a telephone-based service. Interventions were all multicomponent and designed to address one or more health disparity for underserved populations. In addition to telephone or video support, interventions provided a varied range of additional components including but not limited to: in home devices with prompts (6 studies), self-management education (15 studies), brief counselling (7 studies), ancillary patient devices (eg, pedometers, BP cuffs and blood glucose monitors) (6 studies), paper or

Table 4 eHealth and telehealth studies

Study, country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Cardoza and Steinberg ⁵³ 2010, USA	Elderly patients following discharge from an inpatient setting with a diagnosis of HF, COPD, DM or HTN.	Case managed telemedicine. No comparison group.	Condition-based instruments including a scale, digital BP, heart rate monitor, pulse oximeter, glucometer and 'healthy buddy' – a telephone modem for information transmission monitored daily by a nurse. Failure to transmit data instigated an FU PC or home visit. Home visits averaging 1–3 a week for 60 days including review of condition, compliance, patient education. Disease management software programme tracked patients over time, and symptom assessment was performed through patient care management system that recorded nine quality of care indicators (pain, dyspnoea, urinary incontinence, dressing, bathing, toileting, transferring, ambulation and medication management).	Rehospitalisation and emergency department visits, compliance, quality of health perception, quality of care, mortality and satisfaction.	Moderate/thin
Cherrington <i>et al</i> ⁴⁰ 2015, USA ^{54 55}	Low-income African-American patients from safety net neighbourhoods with poorly controlled type 2 diabetes plus peer support Community Health Workers (CHW) who either also had type 2 diabetes or cared for someone with diabetes.	Diabetes Connect web application and telephone coaching and goal setting provided by peer support CHW.	Diabetes Connect web application that allowed for communication between the CHW, the patient and the diabetes team. The web application consisted of three core features: 1. Contact tracking and call reminder system. 2. Secure communication system. 3. Progress reports. CHWs were allocated to patients and provided telephone coaching and goal setting to patients via telephone (weekly for 3 months and monthly for another 3 months). They also held a monthly support/education group and tracked patient progress over time and linked them with the Diabetes Health Team and acted as a mediator between the patient and primary care. Self-management education was provided by the CHW through group/telephone and face-to-face interactions. CHWs were trained in communication, problem solving, goal setting, motivational interviewing (24 hours) and via online modules on group facilitation, basic research and confidentiality.	Process outcomes from web-based application (number of contacts and number of goals set). Qualitative feedback regarding CHW roles, goals and challenges and feedback about messaging system and tracking of patients. Barriers to patient self-management.	Moderate/thick
Chong and Moreno ³² 2012, USA	Hispanic low-income patients of a community health centre with major depression.	Telepsychiatry services through the internet using a webcam versus usual care.	Monthly telepsychiatry sessions at the community health centre for 6 months provided by one of two Hispanic psychiatrists using an online virtual meeting programme.	Symptom severity/incidence, acceptability of telepsychiatry, feasibility of implementing a telepsychiatry programme and satisfaction with care.	Moderate/thick

Continued

Table 4 Continued

Study, country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Davis <i>et al</i> ⁵⁶ 2011, USA† ^{57 58}	Veterans from minority groups with depression.	Telemedicine Enhanced Antidepressant Management study versus usual care.	Stepped care model of depression treatment for up to 12 months. The off-site intervention team focused on optimising pharmacotherapy. The RN used a scripted uniform protocol during telephone calls to patients to address treatment barriers and reasons for non-adherence and strategies for managing side effects. A pharmacist called patients who had not responded to treatment to provide management. Psychiatrists supervised the off-site team and provided consultations via interactive video/Skype.	Depression-related PC encounters and unintended increase in non-depression-related specialty PH encounters. Response rate, cost.	Moderate/thick
Fortney <i>et al</i> ²⁸ 2013, USA	Medically underserved patients with depression attending five federally qualified rural health centres.	Two intervention arms: 1. Practice-based collaborative care. 2. Telemedicine-based collaborative care.	1. Practice-based collaborative care: upskilled staff at clinic education/activation, self-management goal setting. 2. Telemedicine-based collaborative care: Full-time depression care manager – stepped depression care based on protocols with medication management by pharmacist. Psychiatric consultation via video conferencing. CBT was provided by videoconferencing.	No of primary care and mental health visits, levels of prescribing, response, remission, satisfaction and fidelity/uptake.	Moderate/thick
Shea <i>et al</i> ⁴³ USA† ^{59 60}	Older, ethnically diverse, Medicare beneficiaries with diabetes living in federally designated underserved areas of New York state.	Telemedicine (IDEATel) versus usual care.	Home telemedicine unit to videoconference with a diabetes educator every 4–6 weeks for self-management education, review of transmitted home blood glucose and blood pressure measurements and individualised goal setting. Access to special educational web page created for the project in both English and Spanish.	Physical impairment, and physical activity and self-reported pedometer use. BP, HbA1c and cholesterol.	Moderate/thick
Sheeran <i>et al</i> ⁴² 2011, USA	Patients over 65 years with depression (English and Spanish speaking) who were enrolled in homecare with one of three homecare agencies (Vermont, New York and Florida).	Telemonitor-based Depression Care Management (DCM) – Depression Tele-care Protocol. No comparison group.	The DCM (nurse or social worker) coordinates care between the patient, physician and mental health specialist. Telemonitors measure daily weight, blood sugar and heart rate through chime (synthetic voice through speakers) or touch screen, which prompts patients to enter measurements. They also ask simple questions about health and provide basic education. Protocol elements available in both Spanish and English. Nurses followed up patients by telephone as needed on care, education and to reassure patients and encourage pleasurable activities and assess depression status.	Symptom severity, feasibility, acceptability and satisfaction.	Moderate/thick

BP, blood pressure; CBT, cognitive-behavioural therapy; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; FU, follow-up; HF, heart failure; HTN, hypertension; PC, Primary Care; RN, Registered Nurse; HbA1C, glycated haemoglobin.

†Indicates there are associated publications.

Table 5 mHealth studies

Study, country	Vulnerability/ chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/ relevance
Wayne, 2015, ⁴¹ Canada ⁶¹	Low SES community (multiracial) with type 2 diabetes.	Cloud-based platform for mobile phone/ software- based health management plus smartphone- based health coaching technology.	Participants received a Samsung Galaxy Ace II mobile phone running on Google Android Ice Cream Sandwich (Android 4.0.2) with a data-only carrier plan. Patients received a user account with the Connected Wellness Platform (CWP) provided by NexJ Systems, which supported participants in health-related goal setting and progress monitoring. This allowed individual tracking of key metrics, (blood glucose levels, exercise frequency/ duration/intensity, food intake (via photo journaling) and mood). HC primarily focused on planning to reach health targets, exercise (frequency, duration and intensity) and modifying diet to reduce carbohydrate intake. Communication with the HC 24/7 via secure messaging, scheduled phone contact, and/or during inperson meetings. Health data from the CWP were immediately visible to HCs through a secure, web-accessible portal. Participant data and software- enabled communication required two-way certificate-based authentication and passwords that were stored in encrypted columns. Based on patient's goals, HCs used the 24 hours/day logging function to guide healthy lifestyle choices, while providing support when clients diverged from intended health goals and routines. Concurrent exercise education programme with trainers and blood glucose testing before and after exercise sessions.	HbA1c levels, weight, BMI, waist circumference, psychometric assessment (satisfaction, QoL and mood).	High/thick

BMI, body mass index; QoL, quality of life; SES, socioeconomic status; HF, heart failure, HbA1c, glycated haemoglobin.

electronic patient information resources (9 studies), medication management (7 studies), stepped care (2 studies) and bilingual providers (4 studies).

Mechanisms

Within realist synthesis, a mechanism is a response that is triggered by changes in context.¹³ Given the contextual heterogeneity, it was not possible to clearly identify these reactions.

The level of an individual's 'motivation' or 'activation' was one possible mechanism prompting patients to respond either positively or negatively to the situations

in which the intervention was employed.^{35 44} Feelings of 'being supported',^{32 40 44} having 'a sense of purpose',⁴⁴ experiencing 'a sense of achievement'⁴⁴ and the sharing of experiences³³ are interwoven reactions that may serve to motivate people. It was difficult to know how the level of rapport/interaction between patient and provider contributed in these instances, although it was highlighted as an important contributor in some studies^{28 33 42 44} and is a well-recognised enabling factor in self-efficacy and self-management programmes generally.

One study suggested that patients with limited motivation should be excluded from these types of

Table 6 mHealth and eHealth studies

Study, country	Vulnerability/ chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/ relevance
Davis <i>et al</i> , 2015 USA	Underserved, low SES, English and Spanish speaking patients with a primary diagnosis of COPD or HF.	Remote monitoring device (RMD), which could use either landline or wireless technology. The RMD allowed patients to enter symptom-related data such as pulse oximetry, heart rate and weight. The RMD was also preprogrammed with a set of questions that verbally transmitted in English and Spanish targeted to symptomatology.	Integrated mobile health technology and home visits. The RMD operated on landline or wireless systems. The RMD was customised based on disease severity and allowed patients to enter symptom-related data such as pulse oximetry, heart rate and weight. It consisted of a preprogrammed set of questions that were verbally transmitted in English or Spanish and targeted to COPD or HF symptomatology, which were answered yes or no by pushing specific buttons on the device. The RMD also included an interactive educational component in which information was verbally transmitted to the patient with tips on symptom management. Acute changes in symptomatology triggered an acute alert that was directly communicated to the RMD monitoring staff for immediate response. The intervention included a phone call made to the patients by RMD staff or primary care based on patient answers. During this call, symptoms were discussed, management was reviewed, education was provided and the physician was contacted if required. Phone calls were prompted if the patient had made no contact in 3 days. Home visits were made to set up the device within 1 week of discharge. Patients were also trained to use the device. Medication and functional status was assessed, and a personal health plan was developed, including follow-up by the physician. Additional home visits were triggered to perform symptom review and as required up until 90 days from enrolment.	Emergency department use within 30 days of discharge. Readmission rates. Functional status. Satisfaction.	Moderate/thick

COPD, chronic obstructive pulmonary disease; SES, socioeconomic status.; HF, heart failure

Table 7 Realist matrix

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
Telehealth studies Eakin <i>et al</i> , 2009 ³⁴	Unclear – based on the interaction between the counsellor delivering the intervention and the patient.	Ethnically diverse patients with type 2 diabetes from a region on the outskirts of a state capital city in Australia. Comparatively elevated indicators of social disadvantage including a greater percentage of single-parent families, unemployment and foreign-born residents. Participants usually supported through a fee for service primary healthcare practice although intervention is home based and unsupervised. Counsellors (master's-level graduates with a background in nutrition) trained in physical activity promotion and motivational interviewing techniques.	Detailed workbook to promote education on physical activity and healthy eating; pedometer. Telephone support providing assessment (and feedback); advice on physical activity and diet; and assistance with goal setting and a personalised plan for modifying physical activity and diet. Follow-up support in the form of subsequent telephone contacts.	Unknown	Behaviour change – increased physical activity and improved diet (decreased calories from fat and increased intake of fruit, vegetables and fibre).
Eakin <i>et al</i> , 2014 ³⁵	Unclear – based on the interaction between the counsellor delivering the intervention and the patient.	Ethnically diverse patients with type 2 diabetes from a region on the outskirts of a state capital city in Australia. Comparatively elevated indicators of social disadvantage including a greater percentage of single-parent families, unemployment and foreign-born residents. Participants usually supported through a fee for service primary healthcare practice although intervention is home based and unsupervised.	Detailed patient workbook. Accelerometer was worn by patients to collect physical activity (PA) data and record use of device. Motivational interviewing providing support and managing expectations; identifying health benefits of weight loss; setting goals for diet and PA; self-monitoring progress; focusing on achievements and rewards.	Unknown. Authors propose that engagement and motivation of participants was low and only motivated patients should be included in such programmes.	Behaviour change – loss of weight, increase in moderate/vigorous physical activity, and diet quality. Improved clinical biomarkers: HbA1c, lipids and BP.
Sheldon <i>et al</i> , 2014 ⁴⁴	Unclear – based on the interaction between the therapist delivering the intervention and the patient.	Low-income, culturally diverse, medically underserved patients with depression in US (Medicaid). Self-nomination offered to patients through clinics and direct referral options by PCP. Multidisciplinary contact and therapists trained.	Behavioural activation delivered as brief intervention to reduce self-punishment and increase positive reinforcement by teaching mood monitoring and social engagement (form of CBT). Protocol-driven incorporating language skills to foster collaboration and motivation. Motivational interviewing to enhance medication adherence. Flexible timeframes for patients who were more difficult to re-direct – up to 75mins. Pleasant activities list.	Motivation: I want to talk about my problems and seek advice. Doing things when I don't really feel like it will still help me achieve my goals. Rapport with a 'warm and objective' therapist (this person understands my issues and is there to help me). 'The self-help resources give me a sense of purpose'. These skills will be useful in the future (skill mastery).	Improved engagement with depression management and increased self-management especially in relation to medication management leading to improved adherence.

Continued

Table 7 Continued

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
Wolf <i>et al.</i> , 2014 ^{29*}	Unclear – based on the interaction between the primary care clinic staff and the patient.	Patients with type 2 diabetes attending federally qualified health centres (urban, suburban and rural) designed to cater for underserved US communities. Diabetes champion to deconstruct tasks and assign responsibilities to clinic staff. Clinic staff trained in counselling—teach back—positive encouragement, problem solving and coaching of patients to develop action plans. Semistructured script to encourage standardised interactions with patients. No financial support received to sustain staff roles.	Carve in: diabetes guide reviewed between patients and PC staff. Colourful 48-page diabetes guide tailored to low literacy levels (fifth-grade level) with descriptive photographs to depict self-care concepts. Patient engagement activities delivered by a nurse: brief counselling intervention and action plans and iterative counselling process to identify individual behavioural goals that are easily attainable and increase their confidence. Tracking system to follow-up patients.	<p>Patient desires to have care provided within the PC practice as opposed to care from an outsourced service (even if more specialised).</p> <p>Authors propose that the outsourced intervention worked better for patients who had not reached glycaemic control to reach it and those who were stable remained well managed (goal attainment).</p>	Improved knowledge self-management for people with low health literacy. Improved access/uptake of service. Improved clinical biomarkers: HbA1C, PB and cholesterol. Patient satisfaction.
eHealth plus telehealth	Unclear – based on the interaction between the patient and the peer CHW; the CHW and the diabetes team as an advocate for the patient; the CHW is influenced by their interaction with the primary care team.	Practice redesign to incorporate brief diabetes education and counselling. Referral to diabetes educator. Trained research staff delivered counselling. At the time of the intervention, there had been an injection of state funding that had resulted in more resources than had been previously available.	Carve out: diabetes guide reviewed between patients and diabetes educator. Colourful 48-page diabetes guide tailored to low literacy levels (fifth-grade level) with descriptive photographs to depict self-care concepts. Patient engagement activities delivered by diabetes educator: brief counselling intervention and action plans, iterative counselling process to identify individual behavioural goals that are easily attainable and increase their confidence.	Shared experience, emotional supportiveness and availability; family-focused dynamic.	Increased access to the primary care team via the CHW, better follow-up. Improved knowledge/understanding and adherence by patients around diet, physical activity, self-monitoring of blood glucose, medication/insulin adjustment.
Cherrington <i>et al.</i> , 2015 ⁴⁰	Unclear – based on the interaction between the patient and the peer CHW; the CHW and the diabetes team as an advocate for the patient; the CHW is influenced by their interaction with the primary care team.	African-American patients from underserved/safety net organisations in southern USA. Patients were part of a safety net neighbourhood/CHWs were also peers from the same location and either had diabetes or cared for someone with diabetes. Intervention free of cost but managed by peer support/CHWs. Male and female. 67.1% of participants and CHWs were female. High levels of mobile phone ownership but low use of text messaging or internet use.	Self-management group education and support with goal setting, motivational interviewing and coaching. Peers who also had life experience with diabetes and its management. Community-based diabetes self-management education session.	Shared experience, emotional supportiveness and availability; family-focused dynamic.	Increased access to the primary care team via the CHW, better follow-up. Improved knowledge/understanding and adherence by patients around diet, physical activity, self-monitoring of blood glucose, medication/insulin adjustment.

Continued

Table 7 Continued

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
Chong and Moreno, 2012 ²²	Unclear – based on the interaction between the psychiatrist and patient.	Hispanic, low-income, uninsured patients with depression in a rural setting. 88% were women, married or with a partner. Low rates of education and employment. Poorer representation of men due to restriction from low level employment. Patients oriented more to Mexican than to Anglo culture. No previous treatment for mental health. Telemedicine had been operating within the clinic for some time (organisational readiness), and for 5 years, the clinic had been trying to increase access to depression treatment for patients. No costs incurred by patients. Care provided in a clinic – patients taken to telemedicine room from the recruiter's office and not directly from the waiting room to reduce stigma.	Culturally compatible components – Hispanic-speaking psychiatrists (one male, one female). The clinic was housed in an agency located within the community with ease of transport so it was – easy to get there. Virtual meeting space.	Patients said the programme made them feel better and it helped me feel supported.	Increased access to depression management via culturally relevant service. Decrease in depression symptoms and improved medication adherence. Patient satisfaction.
Davis <i>et al</i> ⁵⁶ , 2011	Unclear – based on the interaction between the clinic nurse/clinical pharmacist and patient.	Veterans from minority groups in a rural setting with depression.	Stepped care depression module with care escalated for those not responding to lower levels of care by involving more professionals with additional expertise.	Unknown – authors propose these may relate to education and activation.	Increased adherence to medication and better response to treatment.
Fortney <i>et al</i> , 2013 ^{28*}	Unclear – based on the interaction between the PCP and on-site nurse depression care manager and the patient.	Medically underserved population in a remote setting (Arkansas' Mississippi Delta, Ozark Highlands) with depression and numerous comorbidities. High unemployment/lack of insurance. Half time-funded depression care manager (nurse) – no prior MH training but received study training. Decision support used to guide treatment – no clinical supervision. Patients could choose 'watchful waiting' or antidepressant treatment. Patients preference for face-to-face or telephone encounters.	Practice-based collaborative care. Up-skilled staff at clinic education/activation, self-management goal setting.	Unknown – authors propose that patients were more likely to engage in self-management activities because the depression care manager (despite being off-site) practiced a more intensive programme and provided more encouragement to undertake physical, rewarding and social activities.	Changes in depression severity, treatment response and remission. Self-management. Patient satisfaction.
	Unclear – based on the interaction between multiple PC providers, off-site depression care manager and patient.	Medically underserved population in a remote setting (Arkansas' Mississippi Delta, Ozark Highlands) with depression and numerous comorbidities. High unemployment/lack of insurance. Off-site team funded by study.	Telemedicine-based collaborative care. Full-time depression care manager. CBT delivered by videoconferencing.		

Continued

Table 7 Continued

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
Shea <i>et al</i> , 2009 ⁴²	Unclear – based on the interaction between the off-site nurse manager and the patient.	Older ethnically diverse medically underserved patients with type 2 diabetes receiving Medicare. ¼ spoke primarily Spanish. Nurses trained in computer-based case management tools and to facilitate interactions through videoconferencing. PCPs kept full responsibility of intervention patients – tried to avoid disruption of relationships.	Web-enabled computer and modem connection to existing telephone line – web cam and videoconferencing capacity. Home glucometer, BP cuff connected to the telemedicine unit. Direct upload of data to clinical database. Educational web page in English and Spanish and in regular or low literacy versions in each language.	Unknown	Improved clinical biomarkers: HbA1c, BP and LDL cholesterol.
Sheeran <i>et al</i> , 2011 ⁴²	Unclear – based on the interaction between the telehealth nurse and patient.	Ethnically diverse sample of older patients with depression – homebound. Three Medicare-certified home care agencies (urban, suburban and rural). Nurses trained on telehealth protocol.	Spanish and English versions of telemonitoring tools and materials. Touch screen and/or synthetic voice to prompt patients – online interactive screen can ‘ask’ patients questions. Basic education and behavioural activation/ goal setting.	I felt more connected to the agency. The frequent checks from the telemonitor were comforting, reassuring. I better understood my depression. I was able to be more honest about my feelings with a machine. I don't like using a machine to discuss my feelings. Telemonitoring reduces the sense of stigma.	Change in behaviour. Satisfaction. Reduction in depression severity.
mHealth					
Wayne <i>et al</i> , 2015 ⁴¹	Unclear – based on the interaction between patients, HCs, exercise groups and web-based programme.	Patients with type 2 diabetes. The population was from a lower SES neighbourhood (90% of participants) and a midlevel SES community (10% of participants). All patients under the age of 70 years. Patients included first nation, African, Caribbean, Caucasian, Hispanic, South Asian, South East Asian, West Indian. 36% unemployed. Clients determined their own health related goals. 24/7 monitoring allowed intervention based on desirable progress, relapse and resistance. Interactive system	Health coaching protocol highlighting behaviour change for individuals with type 2 diabetes mellitus. Concurrent exercise education programme with trainers and blood glucose testing before and after exercise sessions.	Meal photographing to enforce food portions and carbohydrate intake. Reminder messages. Self-awareness of habitual behaviours. ‘Feedback was motivating’, reduced feelings of isolation and being misunderstood. Emotional happiness. Therapeutic alliance. Activation through comonitoring.	Improved HbA1c, reduced weight and waist circumference. Satisfaction, improved mental health outcomes and QoL. Increased knowledge and self-management, control and confidence.
mHealth and eHealth					

Continued

Table 7 Continued

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
Davis <i>et al</i> , 2015 ³³	Unclear – based on the interaction between patients, web-based programmes, monitors and physicians.	Underserved, low SES, English and Spanish speaking patients. Predominantly older, retired, unemployed and with disability. Participants were all recruited in hospital as they were being discharged after experiencing acute exacerbations of illness. Patients were all uninsured in the US system of healthcare and hence part of medical insurance programmes.	Interactive educational component in which information was verbally transmitted to the patient with tips on symptom management via the RMD. Programme and information folder, contact information and preprinted education materials about symptom management provided free of charge. Support and information from monitoring staff.	Upright loading of information and attention by the PC at the home visits. Personalised consistent feedback reinforced through habitual process of symptom reporting.	Reduced hospital admission and emergency department use. Symptom management/self-management and confidence to manage their symptoms. Satisfaction and improved QoL.

*Assesses two intervention arms.

CBT, cognitive-behavioural therapy; CHWs, community health workers; LDL, low-density lipoprotein; QoL, quality of life; SES, socioeconomic status; PCP, primary care provider; HC's, health coaches; HbA1c, glycated haemoglobin; FB

interventions,³⁵ instead of providing efforts to 'kick start' motivation. Intuitively being motivated to seek assistance is a major driver in this process, but it is also a complex reaction in this type of population. Low levels of health literacy can affect the degree to which a person is motivated to act and equally low motivation can be construed as low health literacy. Only one study measured and/or categorised participants by their health literacy level.²⁹ It is therefore not possible to comment how the levels of health literacy (or eHealth literacy) influenced participant response.

Other contributing factors

Despite a strong underlying certitude around the value of the interventions to produce improvements in patient self-efficacy and self-management, we identified from the studies a tendency for the intervention provider to be the dominant player within the interaction, and the patient a more passive participant.

Studies reported several barriers to the use and uptake of tools by patients. These included a general unease or mistrust with the use of technology^{42 43} and a preference for face-to-face contact on the part of patients³² and pressures of added workloads,⁴⁴ reduced time and inadequate skills on the part of clinicians to take on additional roles.³⁴ We found less age-related barriers in this review with elderly populations equally satisfied if interventions were well designed, user friendly and supported. We anticipated that the most significant enabling factor would be patient training. However, overall, we found the information relating to patient education and training to be sparse.

DISCUSSION

We identified 18 studies testing a variety of electronic, mobile and eHealth interventions with vulnerable populations. The included studies provided limited insight into the relationships between context, mechanisms and self-management outcomes related to these interventions. We identified a wide range of contextual factors and variation in the outcomes reported. Predominantly, the interventions sought to persuade patients into believing they could self-manage their conditions by encouraging goal setting, providing rewards for achievement, enhancing the patient's responsibility for symptom monitoring and providing education and additional support. Within this review, patients were viewed by providers as relatively passive, and the level of patient response directly aligned to their intrinsic level of motivation. Health literacy, which can often be confounded with motivation, was only measured in one study, and eHealth literacy was not assessed.

The provision of these tools to patients with chronic disease assumes that they directly impact on a patient's level of health literacy and subsequently their capacity to self-manage their health conditions. The studies in this review however reported poorly on self-management and literacy outcomes, and we therefore do not know if the intensive

Table 8 Characteristics of included studies

Study characteristic	Number	Study characteristic	Number
Design		Setting	
RCT	9	General practice	6
Cluster RCT	2	Community health	2
Quality improvement	1	Supported veteran programme	1
Observational	2	Outpatient programme	1
Descriptive evaluation	1	Community home care	6
Qualitative	1	Federally funded health centres/Medicaid	2
Cohort	2		
Intervention		Geographical area	
Telehealth	9	USA	15
eHealth and telehealth	7	Australia	2
mHealth	1	Canada	1
mHealth and eHealth	1		
Chronic condition		Vulnerability	
Depression	7	Older age (>55 years)	3
Diabetes	6	Low SES	12
Multimorbidity	5	Homeless/supported accommodation	1
		Rural/low SES/underserved communities	2

RCT, randomised controlled trial; SES, socioeconomic status.

educational or behavioural activation components of the interventions identified were ultimately effective. Using tools to assess baseline health literacy and eHealth literacy levels may therefore be beneficial particularly if the intervention is tailored to individual needs and abilities. It would be highly valuable if future research could unpack this further since the mechanisms around this were largely unclear from this review, and the inter-relationship between these factors is highly complex. This is particularly true for those patients with competing physical and/or psychological morbidities.

These findings have implications for future implementation. Some studies have reported variable uptake and poor maintenance, leading some to suggest that these interventions be only offered to those with high levels of intrinsic motivation.³⁵ An alternative would be to concentrate efforts on identifying the specific needs of vulnerable groups, and highly tailoring interventions to these needs to be more effective. This would seem to be indicated since we found reasonable levels of satisfaction and acceptance when patients perceived the intervention to be relevant to their needs, and adequately supported. We found no evidence of negative patient consequences from any of the interventions. Acceptance of health technology may also be related to a participants' understanding of their condition and their overall interest in their own health or health literacy. There was also some evidence to suggest that the level of acceptance was not consistent for all participants who fall into the 'vulnerable' category. It is possible that this relates to the many and varied contextual factors providing influence at a given time, such as competing health, social and

cultural issues, although this could not be elaborated from this review.

Although these tools have been widely studied in the general population, we generally found a lack of studies involving vulnerable participants, particularly in groups speaking English as a second language. Most studies were conducted in the USA where social disadvantage was the major focus.

The strength of this review is a comprehensive search, the use of systematic processes to identify both quantitative and qualitative data and the use of Rameses publication standards as a basis for our reporting.¹⁹ We also incorporated a realist matrix and mapped our results according to self-efficacy theory to both determine and understand the mechanisms by which eHealth and telehealth influences self-efficacy and self-management for vulnerable patients with chronic disease. This notwithstanding, we found the realist component of this review challenging. The major drawback for this approach in our experience was the limited descriptions of context and mechanisms provided generally within published studies. The limited quantity of usable data inhibited our ability to effectively identify why these types of interventions worked (or did not work) differently across the varying primary healthcare contexts. Others have commented that the iterative and flexible methods required for realist reviews are at odds with the inflexible, structured processes inherent when conducting systematic reviews generally.¹³ Berg and Nanavati⁴⁵ in a review of published realist reviews found that limitations frequently cited include the scarcity of detail around the mechanisms by which an intervention was expected to work and the

diversity of contexts within studies that hamper generalisability. Developing the necessary skill set within the team, and sourcing appropriate guidance to perform a realist synthesis were also challenging. We chose to use a realist matrix and narrative summary because it provided a more structured process that we could follow. Others have also highlighted difficulties with incorporating realist methods, arguing that few studies incorporate it successfully while maintaining transparent and systematic methods because 'best practice' is under developed⁴⁶ and there is currently little uniformity in practice.⁴⁵

CONCLUSIONS

Although electronic, mobile and telehealth interventions have been widely assessed in several disease-specific groups covering the general population, specific research with vulnerable groups is much less comprehensive. Within the studies, the level of reported success was variable, but the reasons for this variation were not clear. Apart from intrinsic motivation, health literacy may be a factor influencing the reaction of vulnerable groups to technology. Symptom monitoring and management, goal setting, behavioural activation and motivational counselling were able to be successfully delivered by telephone or other modalities, but efforts to engage patients by healthcare providers were lower than expected.

Social persuasion and goal setting were the dominant components by which studies sought to achieve better self-management. Other theoretical aspects that underpin self-efficacy such as vicarious learning and interaction with similar people were less used but may warrant further research.

We would also encourage in future research some assessment of both health and eHealth literacy if including vulnerable populations, and further work to differentiate specific requirements for these groups that might differ to the general population when implementing health technologies.

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