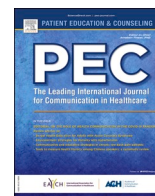




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Review article

Characterising consumer engagement in virtual models of care: A systematic review and narrative synthesis

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ABSTRACT

Background: Widespread adoption of digital tools and technologies now support the delivery of virtual healthcare. Although, consumer engagement is central to care processes in virtual care models, there is paucity of evidence regarding the nature and outcomes of consumer engagement. This study aimed to determine the nature of consumer engagement used in virtual models of care, and its impact on quality and safety of care.

Methods: A systematic review was undertaken with a narrative synthesis, with a search strategy applied to five electronic databases (CINAHL, EMBASE, MEDLINE, PsycINFO and Web of Science)

Results: Fifty-eight studies were included in the review that utilised a variety of virtual models of care across care services. Consumer engagement, such as patients' active involvement in monitoring, capturing and reporting their health data, was a common feature of the identified virtual models.

Conclusion: Increasing use of virtual models of care requires consideration of the role of patients and their support persons in the use of technology and in wider care processes that occur at a distance from health professionals. Ensuring consumers are equipped with necessary support to effectively engage in virtual care is important to ensure equity in access to, and outcomes of, virtual care models.

1. Introduction

Widespread adoption of digital tools and technologies now support the delivery of healthcare services virtually and/or remotely [1]. Virtual models include the use of remote monitoring, wearables, video- and tele-health conferencing, often supported by electronic systems for storing and sharing health information [2]. A central feature of virtual care models is the more substantial contribution of patients and carers in the care process than may be required in face-to-face processes. Examples include, but are not limited to, patients and/or carers inputting health information to digital systems, supporting physical examination processes over videoconference, and managing technology used to capture and assess health in the home [3,4]. Less is known about whether the extent or quality of consumer engagement in virtual care is associated with the safety and quality of care outcomes.

Contemporary health systems utilise a range of strategies to optimise safety and quality in care delivery through service design, policy, training and education and, in recent years, through increasing consumer engagement in their care [5]. Consumer engagement has been

conceptualised on a continuum from information provision through to partnership and can apply to consumer involvement in decision making about their care, service and organisational design and governance, and policy development [6]. This definition of consumer engagement is applied in the present study. Evidence over the past two decades demonstrates that consumer engagement can improve healthcare safety by; enabling consumers to raise concerns or flag inconsistencies and inaccuracies during healthcare interactions [7], activating patients to take charge of their health through involvement, providing education which improves consumers' confidence and skills in managing their health conditions [8–10], and more broadly by contributing to improve health care processes and experiences [11,12]. In direct care, consumer engagement also has been linked to reduction in errors: related to prescription of investigations like X-rays [13], confirming surgical sites [14] and inconsistencies in medications [15].

Whilst consumer engagement is connected with improved safety and quality outcomes, there are notable barriers to engaging in healthcare interactions and service for many health care consumers. For example, consumers have described feeling uncomfortable to ask questions about

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their care, to challenge health professionals about their practice or to voice concerns that a mistake has been made [16]. A number of consumer engagement interventions have been developed and used in face to face health care provision that seek to overcome these barriers [17]. Emerging evidence from the growth of virtual models of care provision indicates that several factors may influence consumer experiences of engaging in health care interactions when using virtual modalities, such as levels of digital and health literacy [4]. Yet little is known about the nature of consumer engagement that occurs in virtual models of care, and whether effective consumer engagement leads to better safety and quality of care outcomes. This knowledge is important towards understanding how interventions designed to promote consumer engagement might support virtual care interactions and lead to better care outcomes. This systematic review aimed to address the following objectives: To characterise the nature of consumer engagement used in virtual models of care; and To determine the impact of consumer engagement on quality and safety outcomes when using virtual care.

2. Methods

A systematic review was undertaken and reported in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement. The review was also registered with Prospero (registration number: CRD42021284530).

2.1. Data sources and study strategy

The search strategy was developed in liaison with a medical information specialist (SM) (a librarian who specialises in health and medical literature). This strategy was applied to the following five databases: CINAHL, EMBASE, MEDLINE, PsycINFO and Web of Science. The detailed search strategy for the databases is attached as supplementary file 1.

2.1.1. Inclusion criteria

Studies published between 1st January 2011 and 1st December 2022 in English were included to capture contemporary literature relevant to current and recent virtual care models. All research designs were eligible, including qualitative, quantitative, multi- and mixed-method studies. Studies were eligible if they reported evaluative data about the use of consumer engagement in a virtual model of care and focused on safety and quality of care outcomes. All study designs were eligible if the sample included participants who were health care consumers that were patients, families and/or carers. Consumer engagement was defined based on the Carmen at al model as 'patients, families, their representatives, and health professionals working in active partnership at various levels across the health care system' [6]. In accordance with this conceptualisation of consumer engagement, the nature of engagement could take any form, 'from consultation to partnership and what we call shared leadership, which includes decision-making authority.' Virtual models of care were defined as remote interaction between patients and/or members of the health care team via the use of technology [18]. Relevant outcomes included clinical, health and service delivery outcomes that indicate care quality and/or safety, including but not limited to healthcare associated complications/harms, longer length of stay, hospital readmissions, healthcare associated infections and missed/delayed diagnosis or treatments.

2.1.2. Exclusion criteria

All studies outside the date range or published in a language other than English were excluded. Literature reviews, including systematic reviews were not included, but their reference lists were searched. Commentaries, opinion pieces, editorials, study protocols and non-peer reviewed papers were also excluded.

2.2. Study selection and data extraction

Search results were exported to Endnote (X9) and duplicates were removed. Articles were then extracted to Covidence systematic review management software (Veritas 150 Health Innovation). Three reviewers (MPI, BN and LAE) completed the initial title and abstract review, followed by an independent screening by a fourth reviewer (RH). The inclusion criteria were then independently applied to full-text articles by two reviewers (MPI and RH), with disagreements or uncertainty resolved through discussion. The following data were extracted: author, year, country, setting, design, sample, type of virtual care, type of patient engagement and key findings. Data extraction table of included studies, see Table 1.

2.3. Assessment of study quality

All the included studies involving diverse study designs were assessed using the Quality Assessment for Diverse Studies (QuADS) [19] which is a validated quality appraisal tool used for heterogeneous study types. Two reviewers (MPI and BN) independently applied the criteria to the included studies.

3. Results

The initial search yielded a total of 9310 articles, with 4946 duplicates removed, and 4364 studies subject to title and abstract screening. A further 4116 studies were identified as ineligible and 248 full-text studies were assessed for eligibility. In the full text review, 190 studies were excluded (150 reported ineligible outcomes and 40 ineligible intervention types). The screening process resulted in 58 studies eligible for the review (Fig. 1).

3.1. Characteristics of the included studies

Studies originated from USA (n = 31), Spain (n = 4), Sweden (n = 3), Canada (n = 2), Norway (n = 2), Netherland (n = 2), China (n = 2), Italy (n = 2), Denmark (n = 2), Turkey (n = 1), Mexico (n = 1), Austria (n = 1), Korea (n = 1), France (n = 1), Brazil (n = 1) Australia (n = 1) and New Zealand (n = 1). The study design of included studies was randomised control trials (n = 25), quasi experimental studies (n = 17); out of these nine studies were pre and post study design. Other studies were interventional cohort studies (n = 7), longitudinal studies (n = 4), cross-sectional non-randomised (n = 3), observational studies (n = 3), action research (n = 1) and case study (n = 1). The studies were conducted using a range of virtual models of care including mHealth application (n = 26) [20–45], telemonitoring via wearable device (n = 3) [46–48], telehealth communication using various modalities such as video conferencing (n = 9) [49–57], web-based (n = 9) [38,55,56,58–64], telephone (n = 9) [47,56,62,65–70], email (n = 3) [15,71,72] and via gaming (n = 1) [73]. Fifteen studies had incorporated more than one virtual modality such as: a remote monitoring device, online app and web program [37,74,75], a web/online app and telephone based [23,24,62,70], an email and telephone [66,72], video conference and web-based [55,56], a remote monitoring device and web-based program [46,76] and an online app and a web-based program [38,43]. Studies with consumer engagement were for chronic clinical conditions (including hypertension, diabetes mellitus, heart failure, cancers, epilepsy and usage of long term medications) (n = 44) [15,20–22,24,27,29,30,33–39,41–50,52,56,58–71,73–75], or acute conditions (pre or post-operative care, obstetrics care, burn management, allergies and asthma management) (n = 14) [23,25,26,28,31,32,40,51,53–55,57,72,76].

Healthcare consumers in all included studies were adults (> 18 years of age) with the exception of three studies in which the direct consumers were paediatric patients [28,73] and one study focused on the adolescents (12–18 year old) [32]. Basic demographic information, in relation to consumer's ethnic background was included in 25 studies [20,22,23,

Table 1
Summary of included studies.

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
Aberger	2014	USA	Hospital	Study 1 Pre and post-test study Study 2 Case study	A convenience sample of 66 post renal transplant patients. Patient demographics indicate that they mostly white (72%), 15% African Americans, 8% Latino, and the remaining 5% Asian or mixed race/ethnicity. Average age was 54.0 years, and 52% were female.	Wearable device- Home based electronic blood pressure (BP) monitor and a web program	Automated feedback messages sent to patients via mail and texts. Tailored prompts sent to patients not providing sufficient readings. A phone service also assists patients	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery <ol style="list-style-type: none"> Statistically significant reductions in average systolic and diastolic BP at 30 days and at 180 days after enrolment. The narrative in the case studies outlines improvement in medication adherence and improved patient knowledge on BP management in terms of nonpharmacologic methods for preventing high BP such as exercise and a healthy diet.
Agarwal	2019	Canada	Primary care	Randomized controlled trial (RCT) (duration 4 months) Quantitative and Qualitative study (Patient interviews and focus group discussions)	Random Sample of 50/425 patients (11.8%) signed consent and 35 completed the program (15 intervention, 20 control)	Online App	Engagement via an online Healthy Lifestyle App Regular, weekly communication with patients	<ol style="list-style-type: none"> Improvement in intervention group scores for patient-reported outcome measures (PROMs) (diabetes self-efficacy, chronic disease self-efficacy, readiness for change) and patient-reported experience measures (PREMs) (patient empowerment, patient-centeredness, and patient assessment of chronic illness care) were better in the intervention- small effect size ($\eta^2 = 0.09$) The qualitative narrative reported an improved physical activity in the intervention group
Aikens	2014	USA	Hospital	Observational Study	Patients (n = 303) participated	Telehealth: interactive voice response (IVR) service	Weekly IVR call was scheduled in which patients responded to questions about diabetes and hypertension.	<ol style="list-style-type: none"> Clinician notifications were found to become significantly less likely over time (AOR = 0.95, p b 0.001). Patient attrition was low Calculated the Physical Composite Summary (PCS; higher scores reflect better physical functioning) and Mental Composite Summary (MCS; higher scores reflect better adjustment)- scores suggested that most patients were not impaired by psychological distress (50.0 ± 11.7) 10-item version of the Center for Epidemiological Studies Depression Scale (CES-D)-

(continued on next page)

Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
								<p>patients reported mild depressive symptoms at baseline (CESD: 2.50 ± 2.37; 30% elevated)</p> <p>5. Defined diabetes distress using the Problem Areas in Diabetes (PAID) measuring diabetes specific psychological distress- indicated little evidence of diabetes-specific distress (13.2 ± 13.1; 4% elevated)</p> <p>6. Morisky Medication Adherence Scale (MMAS) was used to identify patients at baseline with significant medication nonadherence- Antihyperglycemic non-adherence was somewhat prevalent (MMAS mean 1.2 ± 1.0; 36% elevated)</p> <p>7. Measured health literacy (the capacity to obtain, process, and understand basic health information and services to make appropriate health decisions)- inadequate health literacy (52%).</p>
Bakogiannis	2021	USA	Hospital	Cross-sectional study and pre and post-test study	Sampling inclusion criteria: 30 patients recruited	Online App- supported virtual patient visits	An evidence-based, patient-oriented mHealth app (The Hellenic Educational Self-care and Support Heart Failure app [ThessHF app]) in cooperation with patients and their caregivers from our department's Heart Failure Outpatient clinic.	<ol style="list-style-type: none"> Quality of life as measured by questionnaires Kansas City Cardiomyopathy Questionnaire-KCCQ and 5-level EQ-5D version-EQ-5D-5 L, showed a nonsignificant trend toward improvement during the study duration. <ul style="list-style-type: none"> The mean baseline KCCQ-TTS score was 73.4 (SD 13.6), whereas the mean increase after 3 months of app usage was 5.8 (SD 15) (95% CI $-0.1-11.6$, $P = .054$). The mean baseline EQ-5D-5 L VAS was 59.5% (SD 14.9%), whereas the mean increase after 3 months of app usage was 5.6% (SD 15.6%) (95% CI $-0.4-11.5$, $P = .06$). The mean quality of self-care significantly increased during <p>(continued on next page)</p>

Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Batsis	2019	USA	Hospital	Cross-sectional, non-randomised	Sampling inclusion criteria: 27 patients completed the study	Telehealth: Live, two-way video-conferencing, lifestyle intervention to promote health-behaviour change	Patients participating in a lifestyle intervention to promote health behaviour change	<p>the study duration, as the baseline European Heart Failure Self-care Behavior Scale-EHFScBs score of 64.2% (SD 10.2%) increased by an average of 4.4% (SD 7.2%) (95% CI 1.7–7.1, $P = .002$).</p> <p>3. N = 1 patient was hospitalized for heart failure decompensation during the follow-up period.</p> <p>1. Preliminary effectiveness outcomes over the 16-week study period. Patients who completed the study lost 2.22 ± 3.18 kg, representing a 2.1% change ($P < .001$) from baseline to follow-up. Of the completers, 19% lost more than 5% of their weight and waist circumference dropped 3.4% (-4.1 ± 5.9 cm; $P = .001$).</p> <p>2. Body composition measures were all significantly different at follow-up ($P < .05$), with reductions in fat mass (2.9%), visceral fat (12.5%), and marginal improvements in appendicular skeletal muscle mass (1.7%).</p> <p>3. There were improvements ($P = .005$) in the 30-second sit-to-stand test (39% with an improvement of 2) but no significant changes in 6-minute walk test ($P = .23$).</p>
Bradway	2018	Norway	Hospital	Randomised Control Trial	n = 151 patients randomized into two interventions groups: n = 51 used the mHealth intervention (referred to as FTA); n = 50 used the mHealth intervention together with health counselling (referred to as FTA+HC); and a control group (n = 50)	Online App and glucose meter which is self-management intervention called the Few Touch Application (FTA)	This promotes behaviour change when patients registered and reviewed their blood glucose, diet and physical activity, goals as well as accessed general disease information stored within the application	<p>1. The interaction between time and intervention and control groups did not significantly impact change in HbA1c, $F(4148) = 1.26$, $P = .288$, $\eta^2 = 0.033$</p> <p>2. Patients used the FTA mostly for diet / exercise (D/E) registration and navigations</p> <p>3. Overall, patients used the functionalities the most in the first month (461.2 ± 63) with a significant drop by 212.25</p> <p>(continued on next page)</p>

Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
Bruce	2020	USA	Hospital	Retrospective Observational Cohort Study	Comparison between (n = 2059 patients) of participating using mHealth technology with all patients of nonparticipating (n = 2554 patients).	Online app and Telehealth via email which provides two-way communication providing: (1) education, (2) monitor health and recovery, (3) key reminders to needed actions or taking of medication, and (4) ensure resolution of patients' action items	Messages sent were unidirectional or bidirectional. The bidirectional messages were sent to solicit patient responses using close-ended questions	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery <p>interactions ($t = 5.022$, $P < .001$, effect size = 0.643) during the second month</p> <ol style="list-style-type: none"> The inpatient readmission rates for the nonparticipating group when compared with the participating group were higher and demonstrated higher odds ratios (ORs) for 30-day inpatient readmissions (nonparticipating group 106/2636, 4.02% and participating group 54/2048, 2.64%; OR 1.48, 95% CI 1.03–2.13; $P = .04$), Patients treated by participating surgeons received and read text messages using mHealth 83% of the time and read emails 84% of the time. Patients responded to 60% of the text messages and 53% of the email surveys. Patients were least responsive to digital monitoring questions when the hospital asked them to do something, and they were most engaged with emails that did not require action, including informational content. A total of 96% (558/580) of patients indicated high satisfaction with using mHealth technology to support their care. The average length of stay for inpatient hospitalization for the nonparticipating group was 1.87 days as compared with 1.50 days for the participating group ($P < .001$). Only 0.40% (75/2059) patients opted-out of the mHealth technology program after enrolment
Catalan-Matamoros	2021	Spain	Hospital	Nonrandomised Clinical trial	Convenience sample. N = 55 patients	Telehealth program: comparing telemonitoring (TM) versus conventional	Patients monitored and submitted data at different times. Patient and practitioner	<ol style="list-style-type: none"> Generic Short Patient Experiences Questionnaire (GS-PEQ): TM users received adequate information about

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
						monitoring (CM) of patients with pacemakers.	communication via the telephone	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Cichosz	2020	Denmark	Hospital	Randomized controlled trial. Pre and post test	N = 299 (145 interventions, 154 controls) patients were enrolled.	Telehealth: Online app and telephone contact	Telehealth care solution (Telekit) as the intervention (with a focus on self-empowerment achieved by engaging patients in their own illness through self-monitoring)	<p>their diagnosis or afflictions ($p = .035$) and the treatment was better adapted to their situation ($p = .009$).</p> <p>2. Adapted version of the HCCQ (Health Care Communication Questionnaire) was used and the TM group experienced poorer consultation management by the healthcare provider ($p = .041$). Patients reported positive overall communication experiences.</p> <p>1. Primary outcome was a change in HRQoL as measured by the Short Form-36 (SF-36) questionnaire Physical Component Summary (PCS) score: PCS -0.81 (95% CI -2.7 to 1.1)</p> <p>2. Secondary outcomes were changes in HRQoL as measured by the SF-36 questionnaire Mental Component Summary (MCS) score: MCS 4.66 (95% CI $1.8-7.5$) and the HF disease-specific questionnaire Kansas City Cardiomyopathy Questionnaire 12 (KCCQ12) score: 3.67 (95% CI -0.7 to 8.1).</p> <p>3. Only the change in MCS was statistically significant.</p>
Cingi	2015	Turkey	Hospital	Randomised control trial: pre and post test	Total N = 327 patients	Online App: ("physician on call patient engagement trial" [POPET]). Intervention Groups: POPET-AR and POPET-Asthma	mobile patient engagement application on health outcomes and quality of life in allergic rhinitis (AR) and asthma patients.	<p>1. The POPET-AR group showed better clinical improvement than the control group in terms of the overall Rhinitis Quality of Life Questionnaire RQLQ score as well in measures of general problems, activity, symptoms other than nose/eye, and emotion domains ($p < .05$).</p> <p>2. In the POPET-Asthma group, more patients, (49%) achieved a well-controlled asthma score on Asthma Control Test (ACT > 19) compared with the control group (27%); this was statistically significant ($p < .05$).</p> <p>3. Follow up visits: The difference between visit numbers in the</p> <p>(continued on next page)</p>

Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Costa	2022	USA	Hospital	Interventional cohort study	N = 7785 patients (across three clusters)	Online App offering a digital care program: delivery of a multimodal program involving educational content, tailored exercise plan, and patient monitoring	Two directional patient and physical therapist communication	<p>groups was not statistically significant ($p = .081$). Meanwhile, in the control group, 12% of the subjects had unplanned visits, compared with 5% in the POPET-AR group.</p> <ul style="list-style-type: none"> PHQ-9: 9-item Patient Health Questionnaire and GAD-7: 7-item Generalized Anxiety Disorder questionnaire: Significant improvements in depression and anxiety scores were observed dWPAl: Work Productivity and Activity Impairment questionnaire: significant improvements in productivity impairment scores (mean changes from -16.82, 95% CI -20.32 to -13.42 in cluster 1 to -20.10, 95% CI -32.64 to -7.57 in cluster 3)
Cook	2013	USA	Hospital	Cross-sectional Study design- Qualitative	N = 149 patients selected based on an inclusion and exclusion criteria	Online App: delivered via an iPad involving modules on self-assessment, early screen for discharge planning (ESDP) and the visual-analog pain scale, and a modification of the I-MOVE mobility assessment tool.	Patient engagement with the platform to support the delivery and acquisition of patient reported outcomes (PROs) during hospitalization after cardiac surgery.	<ol style="list-style-type: none"> The app collected patient reported data and this was analysed in terms of its impact on the patient's resource use (length of stay) or outcomes (i. e. discharge disposition) Higher patient-reported mobility on early recovery days was associated with shorter hospital length of stay (LOS) (day 1, $p = .004$ and day 2, $p = .0001$). The mobility score on recovery day 2 also had a significant relationship with LOS as short, intermediate, or long ($p = .0006$). Patient self-reported mobility on recovery days 1 and 2 were also predictive of discharge disposition ($p = .007$ and $p < .0001$, respectively). A higher ESDP score was significantly associated with longer hospital LOS ($p = .004$) associated with discharge disposition ($p < .001$). Higher

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
DavinsRiu	2018	USA	Hospital	Randomised Control trial	N = 150 patients, 75 in control and 75 in intervention group	Telehealth program: Control Telehealth Claudication Intermittent (CONTECI) for patients with peripheral arterial disease (PAD).	This program guides and educate patients on a free platform—issues questions and, based on their responses, helps patients perform self-checks	<p>5. The ESDP was also associated with discharge disposition ($p < .001$). Higher scoring patients were more likely to discharge to Skilled Nursing Facility or require Home Health Care.</p> <p>1. Complications were diagnosed more quickly in the intervention group (7.85 days standard deviation (SD) 9.95 vs. 53.89 days SD 41.56; $p = .016$) compared with the control group.</p> <p>2. Rest pain decreased (1.4% vs. 8.4%; $p = .05$) in the intervention group, as did the number of scheduled visits—decreased by 95.95%—and the number of emergency visits ($p = .017$).</p> <p>3. Quality of Life (QoL) scores in Intervention group patients improved from baseline (67.87 vs. 72.25; $p = .047$), as did patient satisfaction (67.36 vs. 76.78; $p = .03$).</p>
deBatlle	2021	Spain	Hospital	Randomized Control trial	N = 76 patients; N = 48 in the intervention group and N = 28 in the control group	Online App	Integrated care model and self-management app. The app includes a virtual coach with customizable automated feedback, and full communication with the care team.	<p>1. Quality of life (QoL) as measured by the 12-Item Short-Form Survey (SF-12) with physical and mental domains—Patients in the integrated care arm showed a significant increase in the SF-12 physical domain and total SF-12 scores. The differences in QoL between integrated care and control patients favoured the integrated care patients but did not achieve statistical significance.</p> <p>1. Integrated care patients had 57% less unplanned visits, representing a significant difference.</p> <p>2. Integrated care patients also experienced a 50% reduction in hospital admissions related to their main chronic diseases, although this difference was not statistically significant.</p>

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> • Findings about patient safety and engagement • Findings about how engagement improved quality of overall health care delivery
deJong	2016	Netherland	Hospital	Quasi-experimental study	N = 152 patients included in the trial	Telehealth via an online website: An electronic medication administration record-patient communication tool eMAR (eMAR-PCT)	Patients can asynchronously communicate with the pharmacist about their medication dispensed through the electronic medication administration record (eMAR)	<p>3. The integrated care program generated savings from US \$584 to \$1434 per patient, depending on the scenarios</p> <ol style="list-style-type: none"> 1. The patient communication was about the following concerns in relation to errors: Accuracy of eMAR-PCT (n = 21), corrections and additions and Questions about medication (n = 3). 2. Quality of life was measured digitally at week 0 and at week 26 using the 12-Item Short Form Health Survey (SF-12). The patients did not perceive a significant change in their health (quality of life) during the six-month study period. 3. Self-efficacy (confidence in one's own abilities) in relation to therapy adherence was measured with an adapted version of the Diabetes Management Self-efficacy Scale: Two of the three variables pertaining to self-care showed significant changes in the user group: self-efficacy in relation to medication use (p = .006) increased. 4. The collaborative relationship with the pharmacist was measured using a self-developed questionnaire consisting of six 5-point scale items: collaborative relationship with the pharmacist significantly improved (p = .021).
Diehl	2022	USA	Hospital	Pre and post study design	N = 50 patients	Online App: MobiMD designed for period between hospital discharge and routine postoperative clinic visits.	MobiMD's functions are 3-fold: (1) to provide procedure-specific information to the patient (eg, videos and text describing the patient's surgery, expected recovery, and frequently asked questions), (2) to send push notification reminders for important	<ol style="list-style-type: none"> 1. mean level of engagement, measured by notification response rate, over the 30-day postoperative period: Engagement with individual app features ranged from 48% to 81%, with highest engagement for symptom reports and lowest

(continued on next page)

Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
							discharge instructions, and (3) to collect clinical information for daily physician review	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery <p>engagement for wound care instructions</p> <ol style="list-style-type: none"> Descriptive statistics were recorded for prior experience downloading apps, number of surgery-related telephone encounters, clinic visits, emergency department (ED) visits, postoperative complications, and app-related contacts (by phone or message): only 5 patients using the app had at least one emergency department (ED) visit within 30 days of surgery. 5 patients had potentially avoidable ED visits. Only 7 patients develop post-operative complications compared with 10 who did not use the app.
Fiks	2018	USA	Hospital	Quasi experimental study	N = 198, single group study	Online App: Pediatric Tele dermatology Mobile Health Application	Users photographed the skin conditions of their children, answered questions, and submitted their case for review. One pediatric dermatologist viewed cases, diagnosed conditions, and provided instructions and prescriptions.	<ol style="list-style-type: none"> Quicker turnaround time to access dermatology consult: Median time for a dermatologist to open and accept a case (from time of submission) was 2.2 h (IQR 0.9–5.4) Median total case turnaround time (time for the dermatologist to accept the case plus time to send diagnosis to patient) was 2.8 h (IQR 1.1–6.4).
Frail	2016	USA	Hospital	Quasi experimental and pre and post-test study	N = 18 patients	Telehealth via a tablet device	Patients consulted with the pharmacist by videoconference using a computer tablet device and also received telephone follow-up shortly before medication supply was to run out and/or as needed on an individual basis.	<ol style="list-style-type: none"> Self-reported readmissions-Readmission data at 30 days 3 of whom had been readmitted and 1 was a planned readmission. Readmission data at 180 days 2 of whom had been readmitted, 1 was a trauma-related admission. Patient satisfaction data was collected using a tool modified from the previously validated National Quality Forum 15-item Care Transitions Measure (CTM-15), at 30 and 180 days and was positive overall.
Fruhauf	2012	Austria	Hospital	Quasi experimental	N = 10 patients	Telehealth via a mobile device	A mobile patient-support system	<ol style="list-style-type: none"> Patients completed a 20-item patient acceptance

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
							developed via a mobile for remote and patient-driven home monitoring	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Gillespie	2016	USA	Hospital	Prospective cohort study: randomised control trial	N = 1219 patients (479 intervention subjects and 740 control subjects)	Telehealth for older adult senior living community (SLC) residents with acute illnesses.	Patient images, video, clinical auscultation, and electrocardiogram information was relayed to the provider in real time. When patient or caregiver contacted staff of the geriatrics practice about an acute illness, the responsible clinic provider had the option to manage the concerns through traditional means or through telemedicine.	<p>questionnaire at weeks 6 and 12: Patients assigned the mobile service reported a high mean overall acceptance of 81.0% (SD: 6.53) at week 6 and 82.9% (SD: 9.15) at week 12. Acceptance in all subscales was comparably high with slightly higher values at week 12 than at week 6</p> <p>2. Patients also completed a daily life quality index (DLQI): The DLQI scores noticeably decreased over the 12-week period, indicating better patient quality of life at the end of the study.</p> <ul style="list-style-type: none"> At week 0, patients assigned to their disease a very large effect on their life with a median score of 15.5 (range 4–28) At week 6, they perceived a moderate effect with a median score of 8.5 (range: 0–17) At week 12, they noticed only a small effect, with a median score of 5.0 (range: 0–30). <p>1. The annual rate of change in ED was compared between patients who resided in SLC units that were more engaged in telemedicine services with patients who resided in SLC units that were less engaged in telemedicine and control patients who lived at facilities without access to telemedicine services. For patients residing in more engaged SLCs, ED use decreased at an annualized rate of 28% (rate ratio [RR] = 0.72; 95% confidence interval [CI], 0.58–0.89), whereas in the less engaged (RR = 0.962; 95% CI, 0.776–1.19) and control (RR = 0.909, 95% CI, 0.822–1.07) groups there was no significant</p> <p>(continued on next page)</p>

Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Gilljam	2020	Norway	Hospital	Quasi-experimental study: quantitative and qualitative data analysis	N = 14 patients	Telehealth: a digital communication tool: Sisom	Sisom is a telehealth service helping children to communicate in health care by engaging them in a playful virtual world	<p>change in ED use ($p = .036$ for group X time interaction)</p> <ol style="list-style-type: none"> Patient engagement: 45.8% of patients were involved in requesting the telemedicine visit in more engaged facilities, compared with 8.9% in less engaged facilities. Better engagement with pediatric patient: Paediatricians directed a greater proportion of their discussion toward the child in the intervention group (731 occasions) compared to the control group (624 occasions) Higher score for the children's participation, based on Shier's participation levels in the intervention group compared with the control group. The higher scores are particularly noticeable for the following 3 levels: children were listened to, children were supported in expressing their views, and children's views were taken into account. In the qualitative data analysis, a new category, which was not included in Shier's model, named "children received information" emerged No difference between the appointment time children for the intervention and control groups (mean 17.0 min vs 17.6 min)
Gimbel	2020	USA	Hospital	Randomized control trial	N = 240 patients In the intervention (n = 123, received mHealth technology and behavioural messages) and the control group (n = 117, received equipment but not messaging)	Online App: a mobile health care environment (MCHE) offered in a patient medical home	The MHCE was accessed by mobile phones and tablets patients received tailored behavioral messages	<ol style="list-style-type: none"> Patient Activation Measure [PAM] level was measured at baseline and based on the result targeted behavioural messages were sent. At month 12, the control group showed significantly greater improvements compared with the intervention group in PAM scores (control mean 7.49, intervention mean 1.77; $P = .007$), HbA1c (control mean

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Guo	2017	China	Hospital	Randomized control trial	N = 209 Patient; 113 randomized to the intervention group and N = 96 in the control group	Online App: Mobile Atrial Fibrillation App (mAF app)	The mAF App keeps a personal record of patient medical history and test results. Patients receive an educational program on their mobile device to improve their knowledge of atrial fibrillation and learn how to manage themselves at home	<p>–0.53, intervention mean –0.11; P = .006), and low-density lipoprotein cholesterol (control mean –7.14, intervention mean 4.38; P = .01). Both groups showed significant improvement in Summary of Diabetes Self-Care Activities (SDSCA), BMI, waist size, and diastolic blood pressure; between-group differences were not statistically significant.</p> <ol style="list-style-type: none"> Comparative analysis of Anti-Coagulation Satisfaction and Quality of Life questionnaire scores (EuroQol, EQ-5D-Y) between patients with usual care and the mAF App was performed- Quality of life scores were significantly increased in the mAF App arm compared with usual care at baseline and 1 and 3 months (all P < .05)
Hart	2022	USA	Primary care	Retrospective chart review	N = 40 patients in 2019 and N = 50 patients in 2020	Mobile app program for managing Diabetes Mellitus	Telehealth communication with a pharmacist especially designed non-English speaking patients	<ol style="list-style-type: none"> Telehealth visits, no shows to a scheduled visit, medication types (oral, insulin, or injectables) Baseline A1c (A1c documented at referral or in the 3 months preceding our study time frame), and follow-up A1c (at least 3 months after the baseline A1c): The mean change in A1c from baseline to follow-up was found to decrease by 1.0% in 2019 and 0.95% in 2020.
Heslin	2019	Mexico	Hospital	Randomized control trial	N = 28 Patients included (equally distributed that is n = 14 in control and study group)	Telehealth consultation via email communication	Regular, weekly email exchanges with surgeons to discuss preoperative medication management	<ol style="list-style-type: none"> Pre-operative medication (i.e. alpha blockade therapy) resulted in significantly fewer preoperative visits (mean 1.52 vs. 3.20 visits; P = .02) significantly shorter time from initiation of blockade to resection (33 vs. 82 days; P = .03).
Hesseldal	2022	Denmark	Primary care	Randomised control trial	N = 340; intervention (n = 200) or a control (n = 140) group	Telehealth program: digital coaching intervention	An initial 1-hour face-to-face motivational interview followed by digital	<ol style="list-style-type: none"> After 12 months, mean body weight and BMI were significantly reduced in both

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
							coaching using behavioral change techniques enabled by individual live monitoring.	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Higa	2021	USA	Primary care	Action research	N = 7 patients who were patients and each patient had a personal carer /family member	Telehealth consultations were part of the wider community-based Diabetes Self-Management (DSM) program	The first 6 months of the project focused on telehealth sessions and the last 3 months focused on text messaging and Support.	<p>groups but significantly more so in the intervention group than the control group.</p> <ol style="list-style-type: none"> Hemoglobin A1c was significantly reduced in both the intervention (-6.0 mmol/mol, 95% CI -7.7 to -4.3) and control (-4.9 mmol/mol, 95% CI -7.4 to -2.4) groups, without a significant group difference (all P > .46). At the 12-month follow-up, blood pressure, total cholesterol, and TG were reduced in both groups without any between-group differences <ol style="list-style-type: none"> Positive changes in diabetes knowledge based on results from the diabetes knowledge check scores before and after the DSM classes and before and after the text message support Changes in pre- and postintervention DSM behaviours among patients- Increased blood glucose monitoring frequency was the most consistent DSM behaviour change for patients. Four of 7 also reported increased exercise or increases in daily foot exams, 2 of 7 increased daily medication adherence and others maintained high adherence levels.
Indraratna	2021	Australia	Hospital	Randomised control trial	N = 164, intervention arm n = 83, control arm n = 81	Mobile App: TeleClinical Care – TCC for patients with acute coronary syndrome (ACS) and heart failure (HF)	Promote patients' self-management, and to provide clinicians with daily home-based readings blood pressure (BP), heart rate (HR) and weight. The data were measured using three Bluetooth-enabled digital devices: a sphygmomanometer, weighing scale and fitness wristband. The app also allowed the patient, general practitioner or cardiologist to review readings	<ol style="list-style-type: none"> There was a statistically significant reduction in total readmissions, driven by a reduction in cardiac readmissions. Higher patient completion rates with Cardiac Rehabilitation. Improved medication compliance- improvement as measured by self-reported questionnaire (Morisky-Green Levine [MGL] score)

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
Janela	2022 (1)	USA	Hospital	Single arm interventional study: Longitudinal cohort study	534 subjects started the program, and 396 completed the intervention (74.2% completion rate)	Digital Care Programs for Chronic Hip Pain: Provided exercise, education, and cognitive behavioral therapy (CBT), under the monitoring of a dedicated physical therapist (PT)	and provided educational push notifications for patient The program consists of (1) a motion capture system composed of wearable motion-tracking sensors, (2) a mobile App, which guides the patient in each exercise session, and (3) a Web-based portal that allows the physical therapist to define and edit the program (add/remove/edit exercises, difficulty levels, and goals) and gathers all the information from every session enabling remote monitoring (through analysis of patient performance, including correct and incorrect movements as well as the range of motion).	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery <ol style="list-style-type: none"> Outcomes were collected at baseline, 4-, 8-, and 12-weeks. Primary outcome was the Hip Disability and Osteoarthritis Outcome Score (HOOS). Secondary outcomes were pain, intent to undergo surgery, mental health, productivity, patient engagement (exercise sessions frequency), and satisfaction. <ol style="list-style-type: none"> Significant improvements were observed across all HOOS subscales (14.7–26.8%, $p < .05$), with 66.8% treatment responders considering pain. Marked improvements were observed in surgery intent (70.1%), mental health (54%), and productivity impairment (60.5%) (all $p < .001$).
Janela	2022 (2)	USA	Hospital	Longitudinal cohort study	N = 132 patients included and N = 112 completed the study	Multimodal digital care program (DCP) in patients with elbow musculoskeletal pain. The virtual care modal included an inertial motion trackers (IMU), a mobile app integrated on a dedicated tablet, and a cloud-based portal	The DCP incorporated exercise, education, and cognitive behavioral therapy (CBT). Exercise programs consisted of gradual progressive movement exposure prescribed by the assigned Physical Therapist who adjusted the program according to patient needs and progress. Patients were advised to complete at least 4 exercise sessions per week performed through an FDA-listed medical device.	<ol style="list-style-type: none"> The DCP consisted of exercise, education, and cognitive-behavioral therapy for 8 weeks. Primary outcome: disability change (through the Quick Disabilities of the Arm, Shoulder, and Hand questionnaire (QuickDASH)-significant improvements were observed in QuickDASH with an average reduction of 48.7% (11.9, 95% CI 9.8; 14.0), with 75.3% of patients reporting $\geq 30\%$ change and 47.7% reporting ≥ 12.0 points. Secondary outcomes: pain, analgesic intake, surgery intent, mental health, fear-avoidance beliefs, work productivity, and patient engagement: Disability change was accompanied by reductions in pain (53.1%), surgery intent (57.5%), anxiety

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Jeganathan	2020	USA	Hospital	Quasi experimental	N = 91 patients	Telehealth consult	telehealth for the delivery of high-risk obstetrical	<p>(59.8%), depression (68.9%), fear-avoidance beliefs (34.2%), and productivity impairment (72.3%).</p> <p>1. When comparing visits between 2019 and 2020, there was a significantly lower rate of no-show appointments (8.49% vs 4.61%, $P < .001$) patient-cancelled appointments (7.06% vs 4.96%, $P < .001$), and patient same-day cancellations (2.30% vs 1.35%, $P < .001$) with the implementation of telehealth.</p> <p>1. There was also a significantly lower rate of patient-cancelled appointments (3.82% vs 5.44%, $P = .021$) and patient same-day cancellations (0.60% vs 1.65%, $P = .002$) with those receiving telehealth visits than in-person visits in 2020.</p>
Jimenez-Reguera	2020	Spain	Hospital	Randomized control trial	N = 44 patients (control group n = 24 and HappyAir=intervention group n = 20)	Telehealth: Web-Based Platform (HappyAir) which includes an online app and a web based platform	HappyAir group completed an integrated care plan for 10 months, supervised by an mHealth system and therapeutic educator	<p>1. Adherence to the program was rated using a respiratory physiotherapy adherence self-report (CAP FISIO) questionnaire and this showed an improvement in adherence during follow-up period for the HappyAir group, which was statistically different compared with the control group at 12 months (56.1 [SD 4.0] vs 44.0 [SD 13.6]; $P = .004$) after pulmonary rehabilitation.</p> <p>2. Adherence to physical activity (Morisky-Green Test): In the intervention group 25% of patients were adherent at 12 months of follow-up versus 11% of patients in the control group. The difference was statistically significant in relation to adherence to physical activity at 12-month follow-up ($P = .049$).</p> <p>3. Quality of life (Chronic Obstructive Pulmonary Disease</p> <p>(continued on next page)</p>

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Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> • Findings about patient safety and engagement • Findings about how engagement improved quality of overall health care delivery
								<p>Assessment Test (CAT), St. George's Respiratory Questionnaire (SGRQ), and EuroQOL-5D), exercise capacity (6-Minute Walk Test), and lung function</p> <ul style="list-style-type: none"> o No statistically significant differences between the intervention or control groups were observed in the CAT at 6 months (P = .53; 95% CI -5.8-3.1) or at 12 months (P = .21; 95% CI -8.1-1.9) o No statistically significant differences between the two groups were observed in the SGRQ at 6 months (P = .77; 95% CI -10.2-13.9) or at 12 months (P = .79; 95% CI -13.2-17.0) o The EuroQOL-5D questionnaire showed no statistically significant differences between groups o In terms of the 6- minute walk test no statistically significant differences between the two groups were observed at 6 months (P = .38; 95% CI -34.8-88.3) or 12 months (P = .58; 95% CI -47.6-82.6)
Johnson	2020	USA	Hospital	Randomized control trial	N = 101	Telehealth via telephone: PACES-Program of Active Consumer Engagement in Self-Management	PACES is a group-based, eight-session, manualized psychoeducational intervention	<ol style="list-style-type: none"> 1. Outcomes included the Epilepsy Self-Management Scale (ESMS), Epilepsy Self-Efficacy Scale (ESES), Quality of Life in Epilepsy-31 (QOLIE-31), Patient Health Questionnaire-9 and Generalized Anxiety Disorder-7 2. At 8 weeks (immediately posttreatment), the treatment group had better improvement compared to the control group on ESMS total score, ESES total score, QOLIE-31 total score. The treatment effect on depression was not significant, <p>(continued on next page)</p>

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Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Kim	2016	USA	Hospital	Randomized control trial	N = 95 hypertensive patients (n = 52 monitoring program, n = 43 control)	A remote monitoring device, online app and web program	A blood pressure monitoring device connected with a mobile phone, reminders for self-monitoring, a Web-based disease management program, and an online app for monitoring and education	<p>both groups showed a reduction in PHQ-9 scores to below clinical threshold</p> <p>3. At 6 months posttreatment, the treatment group remained improved as compared to the control group on self-management, self-efficacy, and the overall composite, with all differences remaining significant</p> <p>4. At 12 months posttreatment the results were similar</p> <p>1. Improvements in patient activation, at 6 months among individuals participating, were associated with:</p> <ul style="list-style-type: none"> improvements in cigarette smoking (beta=-0.46, P < .001) Improvement in blood pressure control (beta=0.04, P = .02). reducing cigarettes (beta=-0.60, P < .001), reduced alcohol drinking (beta=-0.26, P = .01) reduced systolic (beta=-0.27, P = .02) reduced diastolic blood pressure (beta=-0.34, P = .007) <p>2. Baseline Morisky Medication Adherence Scale (MAS) scores also did not change over the study period (baseline: 6.5, end of study: 6.6; P = .46)</p> <p>3. According to Eighth Joint National Committee (JNC 8) guidelines, the frequency of achieved blood pressure control increased from 45% to 59%.</p>
Kneuertz	2020	USA	Hospital	Quasi experimental	N = 50 patients	Online App	SeamlessMD App customized to meet requirements of the thoracic enhanced recovery pathway. The App guided patients through preoperative preparation, in-hospital recovery, and postop discharge	<p>1. Almost all patients (95%) reported having received preparative instructions on wound care and preoperative antimicrobial wash and being compliant with some or all the</p>

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Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
							care with personalized reminders, task lists, education, progress tracking, and surveys.	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Kosse	2019	Netherland	Community pharmacy	Randomized control trial	N = 234 patients included (intervention group n = 87 patients and control group 147 patients)	Online App	ADAPT intervention consisted of an app for patients containing multiple functionalities like questionnaires to monitor symptoms and adherence, medication reminders, short movies, pharmacist chat, and peer chat	<p>preoperative exercise instructions</p> <ol style="list-style-type: none"> Postoperative health checks were successful in improving patient's confidence in 23/27 (85.2%) patients and decrease worries in 22/27 (81.5%) patients. 9/27 patients (40.9%) reported that the postoperative health checks through the App avoided at least one phone call to the care team 4/27 (18.2%) patients reported they avoided one or more visit to the hospital <ol style="list-style-type: none"> The total app use was not associated with a difference in self-reported adherence (P = .12). Logged activity in pharmacist chat positively affected self-reported adherence (Medication Adherence Report Scale (MARS) score increased with 0.1 points per message; (P = .03). Data showed that messages sent by pharmacists were not related to the outcome (P = .06), whereas activity of patients in the pharmacist chat did positively affect the outcome (P = .01), that is, if patients sent messages to their pharmacist, it positively affected adherence (MARS score increased with 0.3 points per chat message).
Kraepelien	2020	Sweden	Hospital	Randomized control trial	N = 77 patients (Intervention group n = 38 and control group n = 39)	Telehealth consult	Individually tailored internet-based cognitive behavioral therapy (ICBT)	<ol style="list-style-type: none"> Patients receiving ICBT reported significantly higher functioning after treatment (Work and Social Adjustment Scale (WSAS) group difference -4.56, controlled effect size g = 0.69, significant group by time interaction, $W\chi^2 = 26.23$, p = .001). One third of the patients in the ICBT-group (12/37, 32%) were treatment responders, <p>(continued on next page)</p>

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Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Kuo	2022	USA	Hospital	Quasi Experimental	N = 75 patients	Telehealth program involving Remote Patient Monitoring (RPM): cloud-based RPM platform (Vivify Health) and a nurse-monitoring service (Global Medical Response) to monitor COVID-19 patients who required oxygen supplementation after hospital discharge.	The telehealth program was designed to remotely monitor real-time alarms for patients' clinical symptoms, vital signs and oxygen saturation in patient's home. The RPM technology provided patients direct access to a member of the care team.	<p>compared to a tenth of patients in the control group (4/39, 10%).</p> <p>2. Significant improvement in the intervention group noted in depression (HADS-D), insomnia severity (ISI), Parkinson-specific functioning (PDQ-8) and quality of life (BBQ).</p> <p>1. RPM group was associated with shorter hospital LOS (median 4.8 vs 6.1 days; $P = .03$) without adversely impacting return to the ED or readmission.</p>
Lee	2021	Korea	Hospital	Randomized control trial	N = 72 patients. These were randomized into 2 groups based on user utility score (UUS) to measure patient engagement, for the first 3 months: UUS:0–4 (n = 38) and UUS:5–8 (n = 34)	Online App	Users of the mobile app could upload self-monitoring data such as blood glucose, blood pressure, and body weight, along with their lifestyle, including dietary records, physical activities, and medical information. Care managers sent messages to provide appropriate educational information to patients. Patients received regular mobile messages and were allowed to communicate with providers via the app	<p>1. There was a significant between-group difference in glycated haemoglobin test (HbA1c) levels for the 12-months study period ($P = .011$). The HbA1c decrement at 12 months in the UUS:5–8 group (i.e. Patient with a higher engagement) was greater than that of the UUS:0–4 group (i.e. patient with a low engagement) [-0.92 (SD 1.24%) vs -0.33 (SD 0.80%); $P = .049$]</p> <p>2. The high UUS group achieved greater improvement in HDL cholesterol at 3 months than the low UUS group but this difference was not statistically significant</p>
Lyth	2021	Sweden	Hospital	Quasi Experimental	Total N = 94 patients i.e., 58 patients with HF (heart failure) and 36 patients with COPD (chronic obstructive pulmonary disease) participated in the study	The eHealth Diary and a digital pen	The Health Diary system enables patients to report their daily health status, such as symptoms and measurement values, and intake of as-needed medication using a digital pen and a Health Diary in paper form, and it supports professional	<p>1. For the HF group, the average use of healthcare resources, during the study year was 18.6 contacts (visits and hospitalizations) and this was significantly lower than expected ($p < .001$) 66%</p> <p>2. For the COPD group, the average number of healthcare</p>

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
							caregivers in detecting early signs of patients' deterioration.	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
MonteSoldado	2020	Spain	Hospital	Quasi Experimental	Total N = 43 patients	Telehealth monitoring of remote patients	Teleburns project- a new medical software with) real time interactive video communication	<p>contacts without HBHC during the study year was 14.3 and this was significantly lower than expected ($p < .001$) 60%</p> <p>3. The number of hospitalizations was 0.94 for HF and 1.16 for COPD. This was significantly lower than expected, with 67% in the HF group ($p < .001$) and 61% in the COPD group ($p = .003$).</p> <p>1. Tele-encounters could avoid the immediate transfer of 35 patients and 23 patients (53.5%) did not need to be transferred to the Burn Center. 5 of them were followed via Teleburns without complications and 17 patients were discharged after the first telematic assistance. All patients discharged presented an uneventful evolution and did not undergo further specialized assessment or care from the Burn Unit</p>
Nahm	2019	USA	Hospital	Quasi Experimental- single group, pre and post study	N = 30 patients	Interactive electronic Cancer Survivorship Patient Engagement Toolkit (CaS-PET)	CaS-PET program provided supportive resources and continued communication between the patient and healthcare team. The program included Survivorship Care Plans, biweekly follow-up using patient portal e-messages, and online survivorship resources (Well Beyond Cancer [WBC])	<p>1. Health-related quality of life was assessed using the 12-item SF-12- significant improvement on the physical component only</p> <p>2. Symptom burden was assessed using the Memorial Symptom Assessment Scale- significant difference in the physical symptom and total symptom scale</p> <p>3. Impact of cancer on the lives of survivors was assessed by the 47-item Impact of Cancer scale- significant different for the employment concern scale</p> <p>4. Levels of dietary behaviors were assessed using the Combined Fat/Fruit-Vegetable Screener- no significant difference</p>
Nikolian	2018	USA	Hospital	Quasi experimental	Total N = 233 patients	Telehealth- e Clinic platform	eClinic- Post-op patients were evaluated by secure videoconference call utilizing a	<p>1. Frequencies of readmission, reoperation, and emergency department visits (2.7%, 0%,</p>

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Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
							cell-phone, iPad, or a laptop computer with video capabilities, on the Epic Virtual Visit platform	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
OgmundsdottirMichelsen	2022	Sweden	Hospital	Randomized control trial	N = 150 patients	Online App	Access to an application was provided for 25 weeks where information about lifestyle (eg, diet and physical activity), risk factors (eg, weight and blood pressure [BP]), and symptoms could be registered. The software provided feedback and lifestyle advice.	<p>and 4.2%, respectively) in the eClinic group were also similar to the tClinic group.</p> <ol style="list-style-type: none"> total visit time was significantly shorter in the eClinic group (14 vs 145 min, $P < .01$) There was a nonsignificant trend toward a larger change in exercise capacity in the intervention group ($n = 66$) compared with the usual care group ($n = 40$; $+14.4$, SD 19.0 W, vs $+10.3$, SD 16.1 W; $P = .22$) Patients in the intervention group achieved significantly larger BP reduction compared with usual care patients at 2 weeks (systolic -27.7 vs -16.4 mm Hg; $P = .006$) and at 6–10 weeks (systolic -25.3 vs -16.4 mm Hg; $P = .02$, and diastolic -13.4 vs -9.1 mm Hg; $P = .05$). A healthy diet index score improved significantly more between baseline and the 2-week follow-up in the intervention group ($+2.3$ vs $+1.4$ points; $P = .05$), mostly owing to an increase in the consumption of fish and fruit. At 6–10 weeks, 64% (14/22) versus 46% (5/11) of smokers in the intervention versus usual care groups had quit smoking
Paneroni	2015	Italy	Hospital	Randomized control trial	Total N = 36	Home based telerehabilitation (TRP)	The program included strength exercises, cycle ergometer training, and an educational intervention to promote an appropriate lifestyle and self-management	<ol style="list-style-type: none"> walking capacity was measured by the standardized 6-min walking test (6MWT)-there was a significant improvement ($p .0002$) in physical activity in terms of number of steps walked/day (3412 at T1 vs. 1863 at T0) in the TRP group Dyspnea measured by the Modified Research Council (MRC) scale- The dyspnea of

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Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Ross	2020	USA	Hospital	Retrospective study	Total N = 253 patients	Online App	Brigham and Women's Hospital Pain Management Center (BWH-PMC) developed an app for users with chronic pain to assess and monitor pain and communicate with their providers.	<p>patient improved in both groups.</p> <p>3. quality of life evaluated by the Italian version of the Saint George's Respiratory Questionnaire (SGRQ)- Quality of life improved in both groups</p> <p>1. Pain intensity and pain description were assessed using the Brief Pain Inventory (BPI)- Comparisons between baseline measures and repeat measures at 3 months showed an overall decrease in average pain intensity on the BPI (5.3, SD 1.8 vs 4.9, SD 2.3; $t_{185} = 4.0$; $P < .001$)</p> <p>2. Activity interference and disability was assessed with items from the BPI and the Pain Disability Inventory (PDI)- Comparisons between baseline and at 3 months showed a decrease in disability on the PDI (30.6, SD 17.7 vs 27.2, SD 18.2; $t_{156} = 3.9$; $P < .001$)</p> <p>3. Mood, negative affect, and emotional distress were assessed using the Hospital Anxiety and Depression Scale (HADS)- no differences in mood between baseline measurement and at 3 months was reported (mean HADS score 14.4, SD 8.1 vs 14.6, SD 8.3)</p>
Sabatier	2022	France	Hospital	Retrospective observational study	N = 659 patients	Telehealth program (Suivi Clinique A Domicile (SCAD) monitoring system) for heart failure: Educational home telemonitoring of patients with heart failure following hospitalization	Patient-oriented service of home-based interactive telemonitoring offered to heart failure patients during hospitalization who agree to participate in a therapeutic education programme. Personalized feedback is provided to the patient by the HF nurse through a telephone call or a text message.	<p>1. The 12 month mortality rate was 11.2%. Significant associations were observed between level of use of the telehealth programme and all-cause rehospitalization ($P = .0085$), rehospitalization for cardiovascular disease ($P = .0010$),</p> <p>1. Rates of unplanned hospitalizations for a cardiovascular diagnosis decreased from 79.4% in the year preceding enrolment to 41.1% in</p>

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Scalvini	2018	Italy	Hospital	Quasi experimental and longitudinal study between dec. 2015 till Jan.2000	Total N = 1635	Telehealth- Maugeri Centre for Telehealth and Telecare (MCTT)	Model of integrated care based on remote telemonitoring and telephone support, to enable home care for patients with chronic disease and multi-morbidity	<p>the following year, and rates of unplanned hospitalizations for HF decreased from 52.8% to 18.8%.</p> <p>1. The mean number of days alive outside hospital were 279 ± 111 in low users, 312 ± 90 in intermediate users, and 304 ± 100 in high users ($P = .0022$).</p> <p>1. For Chronic Obstructive Pulmonary Disease (COPD) and Chronic Renal Injury (CRI) patients, we have demonstrated the feasibility of MCTT, its efficacy in reducing re-hospitalizations (36%), acute exacerbations (71%) and urgent calls to GP (65%) and its cost-effectiveness (33%) versus a control group.</p> <p>2. For Congestive Heart Failure (CHF) patients, we demonstrated the feasibility of the program, its efficacy in reducing the rate of re-hospitalization (44%) and of instability (50%) and its cost-effectiveness (24%) compared with a control group.</p> <p>3. An improvement in the quality of life (QoL) score was also observed (pre-post intervention), measured with different appropriate scales for COPD and CRI, post-stroke and CHF patients.</p> <p>1. user engagement, measured using a modified user version of the Mobile Application Rating Scale (uMARS)- patients rated the gout app as more engaging, with a mean difference of -0.58 ($P = .003$; effect size=0.77),</p> <p>2. Adherence to gout self-management guidelines and self-care behaviors were assessed with a self-report questionnaire that covers behaviors adapted from the</p>
Serlachius	2019	New Zealand	Hospital	Randomized control trial	Total N = 72 patients. Patients were randomized to use either Gout Central (n = 36), a self-management app, or the Dietary Approaches to Stop Hypertension Diet Plan (n = 36).	Online App	Gout Central App to aid patients in monitoring symptoms and also communicating with physicians	<p>(continued on next page)</p>

Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
								<p>diabetes-specific Multidimensional Diabetes Questionnaire- There were no differences in any self-care behaviors between the two groups ($P > .05$) postintervention</p> <p>3. Illness perceptions were measured using a gout-specific Brief Illness Perceptions Questionnaire (B-IPQ)- The gout app group demonstrated stronger negative beliefs regarding the impact of gout (mean difference 2.43; $P = .04$; effect size=0.97), stronger beliefs regarding the severity of symptoms (mean difference of -1.97; $P = .001$; effect size=0.86), and a stronger emotional response to gout (mean difference of -2.38; $P = .002$; effect size=0.81) at follow-up.</p>
Stamenova	2020	Canada	Hospital	Randomized Control trial	A total of 122 patients participated in the study: 40 in the standard care, 41 in the self-monitoring, and 41 in the remote monitoring groups	Telehealth monitoring	Study designed to compare the effectiveness of implementing a technology-enabled self-monitoring program versus a technology-enabled remote monitoring program in patients with COPD compared with a standard care group	<ol style="list-style-type: none"> All 3 groups improved in Partners in Health (PIH) scores, Bristol COPD Knowledge Questionnaire (BCKQ) scores, and St George's Respiratory Questionnaire (SGRQ) impact scores No effects were observed on the SGRQ activity or symptom scores or on hospitalizations, ED visits, or clinic visits.
SteeleGray	2021	USA	Primary care	Randomised control trial	N = 142 patients	Electronic Patient-Reported Outcome (ePRO) mobile app and portal system, designed to enable goal-oriented care delivery in interprofessional primary care practices.	The objective of the intervention is to deliver person-centered primary care to older adults with multimorbidity and complex care needs. Patients set a variety of goals related to self-management, mental health, social health, and overall well-being.	<ol style="list-style-type: none"> Assessment of Quality of Life-4D (AQoL-4D). patients with ePRO combined with usual care(mean 15.28, SD 18.60) demonstrated a nonsignificant decrease in quality of life($t_{24} = -1.20$; $P = .24$) as compared with usual care only (mean21.76, SD 2.17). With regard to patient engagement, ePRO combined with usual care (mean 66.5, SD 17.3) demonstrated a nonsignificant decrease in patient activation, ($t_{27} = -1.41$; $P = .17$, as compared with usual care (mean 59.49, SD 9.60).

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
								<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery
Steinberg	2021	USA	Hospital	Quasi experimental	N = 22 patients	Online App	A novel mHealth smartphone application, "SweetMama," designed to improve diabetes care	<ol style="list-style-type: none"> eHEALS: eHealth Literacy Scale-Patients with Gestational Diabetes Mellitus (GDM) trended towards greater eHEALS scores (median 87.50 [IQR 82.50, 100.00] vs 82.50 [IQR 70.00 vs 100.00]), but were more likely to have a low diabetes self-efficacy score (54.6% vs 36.4%) than those with Type 2 Diabetes Mellitus (T2DM). Diabetes self-efficacy measured on the (DES-SF: Diabetes Empowerment Scale--Short Form)- greater proportion of patients with GDM having inadequate general health literacy (54.6% among GDM and 36.4% among T2DM with inadequate health literacy) Patient activation measured on the PAM: Patient Activation Measure)- Patient activation was similar by diabetes type (81.8% among GDM and 90.0% among T2DM with highest-level activation).
Summerfelt	2015	USA	Hospital	Quasi experimental	patients cared for in HaH (n = 50) were compared with patients receiving traditional acute care hospital (n = 52).	Telehealth	Hospital at Home (HaH) model where physician care was provided via 2-way biometrically enhanced tele-video	<ol style="list-style-type: none"> The ED observation unit provided 58% of admissions to HaH, while 85% of comparison patients were admitted to the hospital directly from the ED (P < .001). Time spent in the ED prior to admission was similar for the 2 groups and had a mean of 405 min. There were no statistically significant differences in functional outcomes with regard to Katz' activities of daily living (ADL) or Lawton-Brody's instrumental activities of daily living (IADL) status between study groups, but there was a statistically nonsignificant trend toward better ADL outcomes at 90 days in HaH (P = .064).

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
Tumeh	2022	Brazil	Hospital	quasi-experimental pre-post study	N = 125 patients	Mobile app: mHealth program to screen biopsychological symptoms among patients with advanced breast or gynaecological cancer.	Patients diagnosed with advanced breast of gynaecological cancer who were about to initiate chemotherapy treatment were invited to participate. Patients received training on using the app Comfort, a program developed to rate their physical and emotional symptoms during the 6-month of the proposed study.	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery <ol style="list-style-type: none"> 67.2% of patients engaged with the Comfort program, and few patients (4%) withdrew due to lack of engagement with the program or issues with internet connection <ol style="list-style-type: none"> patients who engaged with the program reported improvement in physical and emotional symptoms ($p < .01$), as well as in their overall quality of life (VAS; $p = .009$), compared with patients who did not engage with the program.
Visperas	2021	USA	Hospital	Randomized clinical trial and longitudinal study between May 2018-Mrch 2020	N = 399 patients undergoing elective total hip or knee arthroplasty were randomized to SOC arm (n = 204) or SOC IPSP arm (n = 195)	Telehealth	Web-based interactive patient-provider software platform (IPSP), JointCOACH, which enabled patient communication with their care team and preparatory/recovery guidance	<ol style="list-style-type: none"> No difference was found in length of stay between SOC and SOC-IPSP. No differences were found in 30-day or 90-day satisfaction or in healthcare resource utilization ($P > .05$) including number of office and emergency department visits, phone calls, and readmissions.
Yount	2014	USA	Hospital	Randomized clinical trial	Total N = 253 patients, randomized to monitoring and reporting (MR) or monitoring alone (MA)	Telehealth	Telephone-based interactive voice response (IVR) technology for Symptom Monitoring and Reporting System for Lung Cancer (SyMon-L)	<ol style="list-style-type: none"> No improved efficacy of symptom monitoring and reporting in reducing symptom burden compared with monitoring alone in lung cancer Health-related quality of life (HRQL)- HRQL declined over 12 weeks in both groups ($P < .006$ to $P < .025$); at week 12, treatment satisfaction was higher in MA than MR patients ($P < .012$, $P < .027$).
Zan	2015	USA	Hospital	Quasi Experimental	N = 21 patients	Telehealth	iGetBetter system, a secure Web- and telephone-based heart failure remote monitoring program	<ol style="list-style-type: none"> The heart failure-related quality of life improved from baseline, it was not statistically significant ($P = .55$) Hospital utilization did not differ in the intervention group compared to the control group (planned hospitalizations $P = .23$, and unplanned hospitalizations $P = .99$) Intervention patients recorded shorter average length of

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Table 1 (continued)

Author	Year	Country	Setting	Design	Sample and Condition	Type of virtual care	Type of patient engagement	Key Findings
Zeng	2020	China	Hospital	Randomized control trial	N = 150 patients	Telehealth	Run4Love intervention which provides an adapted cognitive-behavioral stress management (CBSM) course and physical activities promotion. This intervention was designed to reduce the depressive symptoms in HIV patients with elevated depressive symptoms	<ul style="list-style-type: none"> Findings about patient safety and engagement Findings about how engagement improved quality of overall health care delivery <p>hospital stay, but no significant differences were observed between intervention and control groups ($P = .30$)</p> <ol style="list-style-type: none"> The mean Patient Health Questionnaire (PHQ-9) scores were 10.2 (SD 4.5), 7.7 (SD 4.8), 6.5 (SD 4.7), and 6.7 (SD 4.1) at baseline, 1 month, 2 months, and 3 months, respectively. Latent growth curve models (LGCMs)- LGCMs showed good model fit and indicated that a higher completion rate (β at 3 months = -2.184, $P = .048$) and a greater frequency of items completed (β at 3 months = -0.018, $P = .04$) were associated with fewer depressive symptoms at 3 months. Although not significant, similar trends were found in the abovementioned relationships at 1 and 2 months. No significant relationship between time spent on the program and depressive symptoms.

26,28,34,36,37,40,41,43,46,49,51–53,57,60,62,63,65,67,68,72,76].

Only 12 studies provided sociocultural data that indicated if consumers were from culturally and linguistically diverse (CALD) backgrounds [20, 23,36,41,43,49,51,53,60,63,65,67]. Generally, included studies did not report variations in consumer engagement and its outcomes based on population characteristics, except for four studies, in which consumer engagement with the virtual modality was less because of inadequate health literacy of the patient cohort [65] or vice versa [28]. In addition to this, two studies were specifically designed for diverse, low income female patients [36] and non-English speaking patients [41]. Generally, studies did not demarcate between urban and rural settings, with the exception of two studies which specifically offered virtual care support for patients located in rural and remote context [50,54].

3.2. Study quality

A score of 0–3 was assigned to the 13 criteria used to assess the study quality. (See supplementary file: 2). Most studies achieved a high score in the statement of research aims and critical discussion of strengths and limitations. Only 12 studies mentioned the theoretical/conceptual underpinning to the research (criteria 1). All studies, except for one, reported on sampling to address the research aims (criteria 5) and all reported the rationale for choice of data collection (criteria 6). Eleven studies (n = 11) reported the evidence of research stakeholders have been considered in research design or conduct (criteria 12). Studies were not excluded based on the quality assessment; rather, the quality assessment data were used simply to indicate the strength of the available evidence. The main reason of study exclusion, reviewed at full text stage, were that studies did report on relevant outcomes of consumer engagement that involve clinical, health and service delivery outcomes indicating care quality and/or safety.

3.3. Review objective 1: Characterising consumer engagement in virtual models of care

Virtual care platforms enabled consumer contributions in four main ways: 1) virtual care platforms facilitated communication between patient/carer and health care professional [15,21,23–25,27–29,32–34, 38–45,47–55,57,58,60,64–67,69–76] (n = 43/58); 2) virtual care platforms were used to provide patient education for self- management [21–24,26,27,29–33,35–40,42–44,48,49,52,56,60–65,71,74,75] (n = 34/58); 3) virtual care platforms enabled self- monitoring, capture and reporting of health data (e.g. body weight, blood pressure, heart rate, glucose level, symptoms etc) [20,22,24–26,29,30,33–35,37,39,42, 44,46–48,51,59,62,64,68–70,74–76] (n = 27/58); and 4) virtual care platforms were used to engage consumers in therapeutic services [41,48, 54,57,58,63] (n = 6/58) (See Fig. 2).

The role and requirements of consumers within these virtual care environments varied between those using virtual care for chronic versus acute services. People with chronic conditions were more often engaged virtually as active partners in their care by undertaking monitoring and self-management, with patient education as a key enabler. For those with acute conditions, consumers were more often engaged to streamline and support service provision by connecting with service providers virtually.

3.3.1. Consumer engagement in virtual models of care for chronic clinical conditions

Forty-four studies reported virtual models of care for those with chronic, long term clinical conditions. This group of studies depicted the role of consumer engagement as central to the care model. Consumer engagement occurred in four ways: Information sharing for monitoring; Self-monitoring; Patient education for self-monitoring and Patient education for self-care.

Information sharing for health professional monitoring: A significant feature of (n = 33) virtual care interventions was to aid communication

and collaboration between interprofessional health care teams for optimal management and care provision [15,20,21,24,27,29,33,34, 36–39,41,42,44–48,50,52,60–62,64,65,67,69–71,73–75] through sharing of data for monitoring. For example, patient self-monitoring data was communicated to the relevant health care professionals who were then able to monitor patients and provide them with appropriate advice for self-management. Of these, eighteen studies explored the utility of a wearable device and an online application/ program for patients to upload regular measurements (such as blood pressure levels, weight, heart rate, glucose levels and symptoms assessment) for management of diabetes and blood sugar (n = 4) [20,22,29,33], heart conditions (n = 6) [24,30,42,62,69,70], pulmonary conditions like chronic obstructive pulmonary disease (n = 3) [47,48,59], blood pressure and hypertension (n = 2) [37,46], motion sensors to track movement (n = 2) [74,75], cancer (n = 2) [44,68] and gout (n = 1) [35]. All wearable devices had a feedback mechanism in which patients received automated responses via mail/texts; in some instances, tailored prompts were sent to encourage patient engagement with the telehealth/ application and to provide education. In these studies, communication was also established with health care professionals via the phone.

Self-monitoring: Nine studies focused on improving consumer self-care and disease management with promoting self- monitoring, via apps and/or telehealth programs especially for management of diabetes and heart conditions [20,22,29,33,36,42,44,52,65,75]. Some consisted of multiple components; for example, the Health TAPESTRY-HC-DM which involved integration of several components like a trained community volunteer “Health Connectors”; a telehealth program and self-management application and access to an interprofessional primary health care team along with community programs [20]. Similarly, another multifaceted online app CONNECARE, had several components, designed to provide integrated care involving monitoring of current status of clinical condition via measurements and questionnaires, FitBit activity tracker, a virtual coach and an interprofessional care team, all managed by a dedicated case manager for each patient [27]. The remaining studies evaluated an interactive voice response service in which patients responded to queries about their ability to self-manage (diabetes and hypertension) [65], online applications [22,29,33,36,42, 75] and telehealth programs [52]. The online applications and telehealth programs activated behaviour change and included features such as measurement of body weight, blood pressure and heart rate and provided an avenue of patient education, motivation and behavioural coaching.

Patient education for self-monitoring: While garnering patient measurements, online applications such as the ThessHF and telekit designed for heart failure patients, MAF app for atrial fibrillation, happyAir app for pulmonary conditions and application for musculoskeletal conditions promoted consumer self-empowerment through self-monitoring and encouraged healthy behaviours by including medication reminders and patient education reminders [21,24,30,38,39]. Three studies reported on a home- telerehabilitation program which involved life-style education to self-manage health condition and exercise training [49,56,64].

Patient education for self-care: Sixteen studies examined the utility of telehealth programs to establish a channel of communication with patients which promoted patient-education and self-directed treatment via provision of evidence based education and treatment for conditions like chronic pain [34,74,75], medication management [15,50], management of pulmonary conditions [38,48], cancer survivorship [60,68], intermittent claudication [71], skin conditions [66], epilepsy [67], pre and post-operative care for hip and knee arthroplasty [61], weight management [64], heart condition [42], musculoskeletal condition [39] and general wellbeing [43]. One study evaluated an online, gaming application- Sisom particularly designed for communicating with paediatric patients diagnosed with cancer [73]. Three studies focused on providing treatment by utilising an Internet-based cognitive behavioural therapy program to reduce depression and anxiety for people with

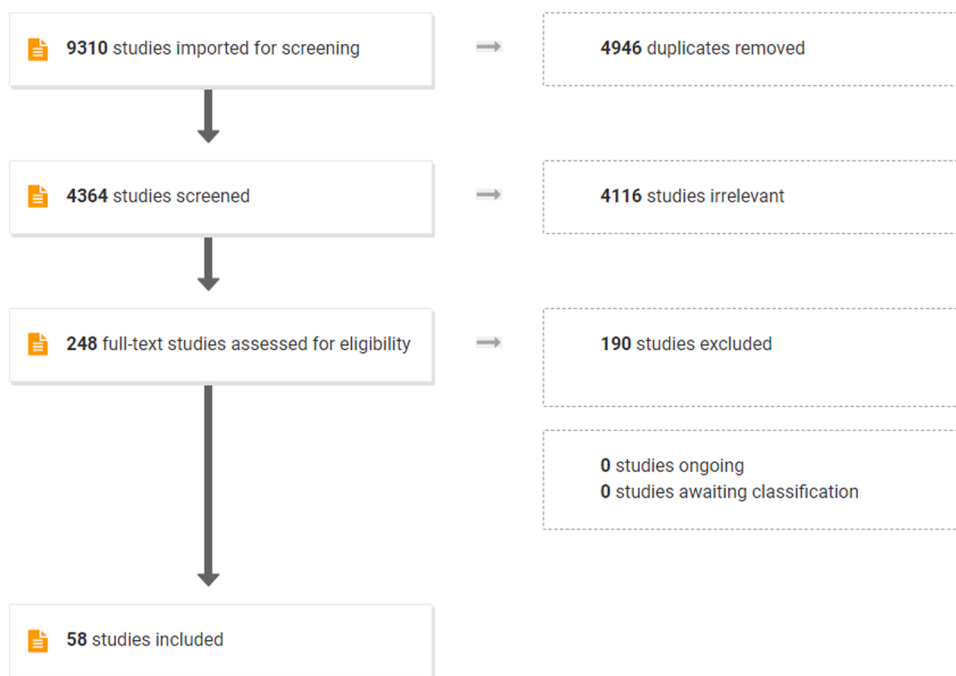


Fig. 1. PRISMA.

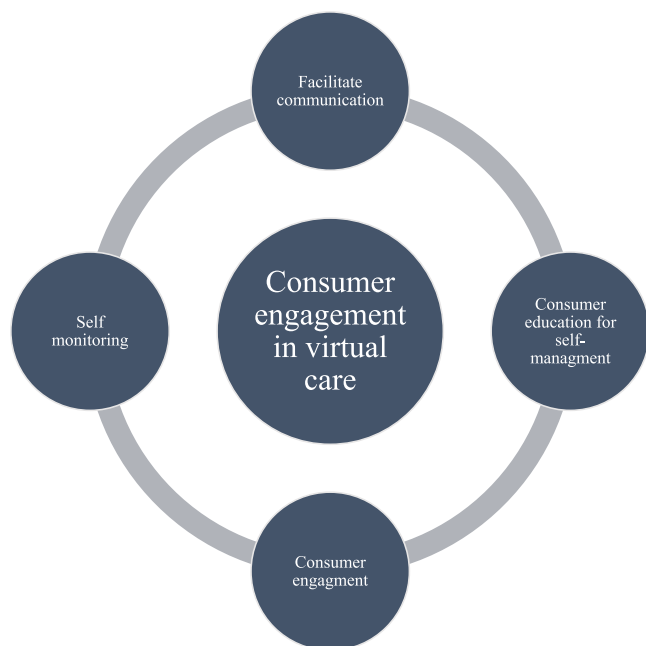


Fig. 2. Focus of Consumer engagement in virtual models of care.

musculoskeletal conditions [39,74,75], Parkinson’s Disease [58] and HIV [63].

3.3.2. Consumer engagement in virtual models of care for those with acute conditions

Fourteen studies reported consumer engagement to prepare for, prevent or for self-care for those with acute clinical conditions. Consumer engagement was in the form of: patient education for preventive, preparatory and after-care; providing information for health professionals to guide self-care and for facilitated service provision to increase efficiencies in high demand areas.

Patient education for preventive, preparatory and after-care: Seven

studies in this category were designed to track patients health condition via consumer self-monitoring, while providing motivational and education content to effectively manage acute clinical conditions such as post-operative care [26,31,40,55], asthma, allergic rhinitis, COVID signs and symptoms [25,32,76] and pre-operative consumer care [72]. The virtual care interventions designed to achieve self-monitoring and consumer education were in the format of mobile applications [25,26,31,32,40] and telehealth programs [55,72]. One application was designed to be used for post-operative patients monitoring of health conditions during the hospital stay which aided in organizing an appropriate discharge plan [26]. Consumer training to undertake accurate self-monitoring, prior to engagement with the virtual care model, was discussed in only one study [72]. All studies were designed for adult consumers, with the exception of one virtual care intervention for asthma management, which was designed for the adolescent age group (Age: 12–18 years) [32].

Providing information for health professionals to guide self-care: Two studies with a focus on acute conditions utilised consumer engagement for providing treatment [54,57]. A telehealth consultation was evaluated for remotely managing burn patients [54]. The second study was developed to provide physician care at home to substitute acute care provided in the hospital [57]. In both these studies, consumers uploaded pictures and submitted case for review and in return received advice and prescriptions. In these studies, the role of infrastructure planning to provide virtual care and data management of consumer information was discussed. In the hospital care at home model, a home monitoring station was managed by clinician assistants (nurse assistant and physician assistants) [57]. The virtual care delivery for burn patients was specifically designed for patients located in remote and rural locations who received care from a specialised burns unit located in a tertiary centre [54].

Facilitated service provision: Six studies discussed virtual health care delivery for acute conditions designed to streamline service provision to accommodate patient monitoring and effective care delivery at home. Telehealth strategies were designed to reduce demand on emergency department by providing virtual, physician consults for older people [23,51,57]. In these studies, dedicated telehealth assistants aided in collecting patient information and examination findings, and treatment

was offered onsite. To overcome the barrier of timely consultations, an online application was designed for a tele-dermatology consultation with a specialist practitioner [28]. Two studies discussed virtual health care delivery overcoming restrictions during the pandemic. One study reported the initiation of telehealth consultations for obstetric patients particularly designed for monitoring and care provision during the pandemic [53]. Another study was designed to monitor COVID patients' vital information like oxygen saturation at home [76].

3.4. Review objective 2: associations between consumer engagement and outcomes of virtual care

Included studies provided evidence of the outcomes of the virtual care models in relation to patient health outcomes, quality and safety of care outcomes and consumer capability development. The role of in facilitating consumer engagement in virtual care models was also described, which can be considered an implementation outcome. It was often difficult to delineate the impact of consumer engagement within the care process on the virtual care outcomes due to the data captured and study designs, but the level of consumer engagement was explored in some studies. Generally, included studies indicated improved health outcomes as a result of the consumer engagement mechanisms used in virtual care. Broadly, outcomes of virtual care models that used consumer engagement were reported through patient reported measures (n = 35/58) and/or administrative data (n = 34/58).

Health outcomes: Patient-reported measures described positive impacts of virtual care interventions in terms of: improvements in managing health conditions in relation to improved scores in measures of self-efficacy to manage clinical condition and medication use [15,20,21,31,39,42,52,67], quality of life measures [21,24,25,27,30,36,38,43,44,47,56,60,62,66,71], improvements in the overall health of the consumers (e.g. reduced body weight, decreased waist circumference, reduction in fat mass, improvement in rates of sit to stand and changes in walking capacity, reduced pain) [29,41,44,49,52,56,63,64,71,74,75]. Other positive impacts of using virtual modalities to manage health conditions, included a high consumer satisfaction in using the virtual technology [23,39,50,52,66,69,73], an improved score on measures of consumer knowledge [24,69], improved productivity [74,75] and improved completion rates of attending rehabilitation [42].

Quality and safety of care: Impacts of patient engagement in virtual care was also obtained from administrative data in relation to care outcomes, with studies reporting a reduction in clinician input in managing health conditions because of reduction in related hospital readmission rates [23,27,42,47,51,55,59,70,72], a more active role of the patient [26,31,59,65], and reduced average length of hospital stay [23,26,76]. In addition to this, studies reported a reduction in the frequency of follow up visits [25,27,40,71], quicker diagnosis of a case or a complications [28,40,71] an increased adherence to medications and an increase in healthy behaviours which included increase exercise, more active self-monitoring and healthy diet [32,45,52]. One study had a significant cost reduction per patient after the implementation of the virtual care, aiding in better self-management of the health condition [27]. Improvements were directly related to enhanced consumer understanding on managing their health condition(s), while having an option of a feasible avenue, via a virtual application/telehealth program to communicate with a clinician. These outcomes were especially identified in virtual care interventions designed for acute health conditions like pre and post operative management [23,26,31,40,55,72], asthma and allergic rhinitis [25,32], geriatric care [51], dermatological conditions [28], or with symptom management for conditions like heart failure and chronic obstructive pulmonary disease [47,59].

Consumer capability development: Thirty-nine included studies (N = 39/58) involved consumer engagement in terms of patients' monitoring; capturing vital data and providing this information to a health care professional [20–29,33–37,39,40,42,44,46,47,51,52,54,55,57,59,62,63,65,66,68–70,72,74–76]. Out of these, thirteen studies [21,

29,44,46,47,51,57,62,66,69,72,74,76], measured consumer capability in using home monitors and collecting vital, patient measurements at home. Consumers were in some cases trained to use biomedical devices and were able to collect accurate, vital patient data, and to effectively communicate with a clinician [21,29,44,46,47,51,62,66,72]. For example, Aberger et al. (2014) reported a more accurate measure of patient vitals, such as blood pressure, via the home based electronic blood pressure monitor, that overcame 'whitecoat syndrome' (i.e. anxiety of being around doctors in white coats can cause a rise in blood pressure) [46].

Role of healthcare staff: Three studies highlighted the need for staff to support engagement of consumers by undertaking a range of activities. Here, technicians and staff members were directly involved in collecting the relevant patient data or assisting in collection [51,54,57]. For example, designated staff located in rural locations sent the relevant patient data to the main hospital [54] and specialised technical staff aided in collecting vital patient data (e.g. images, clinical auscultation and electrocardiogram) and reported it back to the relevant clinician [51,57]. Involvement of support staff in collecting patient data was critical because the consumer cohort were senior adults, residing in senior community homes [51] and were receiving substitutive hospital care at home instead [57]. Out of the studies which involved collection of vital data, one study used the virtual app to collect consumer data, in the hospital during the post-operative period to manage discharge planning [26]. Studies which especially involved the two-way communication, along with capturing vital patient data, reported an improvement in patients' ability to manage health condition [20,21,24–29,36,37,45–49,51,59,65,66]. Studies in which consumers were involved in collecting vital patient data reported a greater patient activation which was discussed in relation to reduction in smoking and drinking alcohol and significant improvement in blood pressure level and symptoms [33,34,36,37,45]. Consumer engagement in these studies involved their active involvement in monitoring and capturing data and communicating with the clinician [33,35].

Level of consumer engagement: Three studies measured the degree of consumer engagement in relation to care outcomes. In these studies, consumer engagement with the virtual modality was measured directly by quantitatively and qualitatively assessing the level and quality of engagement and participation with paediatric patients [73], and indirectly via consumer adherence to the virtual care program measured via questionnaire [38], or via the rate of missed appointments [41,53]. Higher levels of engagement, were noted with a game-based intervention which was used to communicate with paediatric patients designed via a participatory design approach [73]. Consumer engagement and adherence to the virtual care interventions was higher because patients were able to access personalised and tailored content of health care delivery [38,40,53,74,75]. Two studies reported a higher engagement and a higher level of consumer satisfaction, and this could be associated with consumer involvement in developing the virtual care intervention [38,52]. Two studies offered a personalised patient program that involved tracking patient motion for patients with chronic hip and chronic elbow pain; this program used a motion capture system with tailored feedback and promoted a healthy routine with tailoring patient goals, based on the collected consumer data [74].

4. Discussion

Healthcare models that utilise virtual modalities are increasingly common. Hybrid and entirely virtual models of care often include substantial requirements for consumer engagement; for consumers to contribute, review and interact with their care. This review identified 58 studies that utilised consumer engagement explicitly in the process of a virtual care model or intervention. Many of the studies identified were in the context of managing chronic health conditions including mental health, with consumer engagement occurring through self- and shared-monitoring, patient education and the provision of health data to care

teams. In such contexts, the provision of training and support to consumers to engage in these activities appeared to contribute to the positive health outcomes of these models of care and interventions. In the context of acute conditions, our findings suggest that consumer engagement may also occur as self- or shared monitoring, but predominantly is used to streamline and connect elements of the care process via the person at the centre.

Overall, our review indicates that consumer engagement is a critical part in virtual models of care and health interventions that are delivered virtually, but the nature of consumer engagement, how different types and depths of engagement impact care outcomes, and the experiences of different consumer cohorts e.g., by socio-economic, cultural and linguistic status in engaging in virtual care are under-studied. The opportunities for engagement identified in the review resonate with the wider literature from in-person service provision in which engagement with healthcare systems and services is often influenced by socio-cultural factors. Barriers to engaging meaningfully in healthcare encounters have been identified for a range of communities including for people from culturally and linguistically diverse backgrounds, those with disabilities and/or from refugee and asylum-seeking backgrounds. These barriers occur due to a range of factors such as access to services, facilities and technology, language proficiency, health, and digital literacy [77–80]. Given the elevated role of consumer contribution in some virtual care encounters, these well-established challenges associated with consumer engagement may be heightened in a virtual care environment. Such challenges may disproportionality impact certain patient cohorts who do not have access to technology or support persons to facilitate their engagement. These factors are also central to the ability to effectively engage in direct healthcare interactions using virtual modes but may also be facilitated by a virtual care environment in which opportunities language translation, use of imagery and the availability of support persons may be enhanced. Virtual health modalities have demonstrated potential to improve care delivery and disease management by increasing access to health information and health management skills [81,82]. mHealth and eHealth modalities of care offer people from diverse backgrounds and CALD patients efficient access, enabling effective communication with clinicians and subsequent care [83].

4.1. Implications

Consumer engagement is increasingly acknowledged as a critical element of health care to enhance quality and safety of care, but its importance may be elevated in virtual care models that are contingent on consumers providing information, monitoring, reporting and interacting in their care. As health systems start to integrate hybrid and fully virtual models of care, evaluation must consider diverse consumer groups and whether hybrid or virtual models have differential outcomes. In doing so, evidence of the type and depth of consumer engagement required for virtual care delivery to be successful is important to capture in order to ensure consumers are suitably prepared and supported to take this role.

Evidence of the capability development required for consumers to effectively engage in the range of ways required for self- and shared-monitoring, self-directed treatment or therapy and to benefit from distance patient-education would be valuable when developing models of care that include or rely on virtual mechanisms. Evidence of methods that successfully build consumer capability to engage in virtual models of care would also be of value to health systems internationally. The usefulness and importance of guidance and patient education materials which will help patients to select an appropriate modality (virtual versus face to face) for safe, satisfying, and efficient care is recognised [84]. In this review, only one study outlined patient education in accurate use of devices to self-monitor, share clinical data and self-directed treatment [72]. This training was conducted for patients by a clinical nurse during the initial clinic visit in which patients were educated on the use of a sphygmomanometer, vital measurements and the accurate detection of

orthostatic hypotension.

Supporting consumers to engage in virtual care often requires health professional involvement, with implications for the structure and funding of virtual care models. Consideration of administrative and technical support required, and the contributions required of health professionals to establish and sustain virtual care encounters and services more broadly is important in ensuring optimal virtual care engagement and outcomes for consumers.

4.2. Limitations

The findings of this review should be considered in light of the limitations of the review process and individual studies included. Whilst a medical information specialist was engaged to create and execute the search strategy, the diverse terms used to describe consumer engagement and virtual models of care mean that it is possible that all relevant material was not retrieved. The study aims were heterogenous, but often evaluating a model of care or intervention that incorporated consumer engagement rather than focusing on the nature and depth of engagement that occurred and its direct relationship to the study outcomes. As such, evidence of consumer engagement in many of the studies was limited such that we could not delineate the links between consumer engagement and outcomes of virtual care models. Evidence in the grey literature was not included in this review and, as a rapidly growing field, there may be very recent studies reporting virtual care evaluations relevant to the review that have also been omitted.

4.3. Conclusion

Consumer engagement is a common feature of virtual models and processes of care, often occurring as patients' active involvement in monitoring and capturing health data for those with chronic conditions and to streamline the provision of acute care. Ensuring consumers have the support required to effectively engage in their care is particularly important in a virtual care context given the increasing responsibility of consumers to provide health information, raise concerns and take greater responsibility for some aspects of their care when in a virtual environment.

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Consent for publication

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Mears Stephen: Data curation. **Ellis Louise:** Methodology, Investigation. **Harrison Reema:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Funding acquisition, Conceptualization. **Pervaz Iqbal Maha:** Writing – review & editing, Writing – original draft, Project administration, Investigation, Formal analysis, Data curation. **Newman Bronwyn:** Writing – review & editing, Validation, Formal analysis, Data curation. **Maha Pervaz Iqbal:** Methodology and investigation, writing, reviewing and editing

Declaration of Competing Interest

no COI.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.pec.2023.107922.

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