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REVIEW

Video Teleconferencing for Disease Prevention, Diagnosis, and Treatment

A Rapid Review

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Background: Video teleconferencing (VTC) as a substitute for in-person health care or as an adjunct to usual care has increased in recent years.

Purpose: To assess the benefits and harms of VTC visits for disease prevention, diagnosis, and treatment and to develop an evidence map describing gaps in the evidence.

Data Sources: Systematically searched PubMed, EMBASE, Web of Science, and the Cochrane Library from 1 January 2013 to 3 March 2021.

Study Selection: Two investigators independently screened the literature and identified 38 randomized controlled trials (RCTs) meeting inclusion criteria.

Data Extraction: Data abstraction by a single investigator was confirmed by a second investigator; 2 investigators independently rated risk of bias.

Data Synthesis: Results from 20 RCTs rated low risk of bias or some concerns of bias show that the use of VTC for the treatment and management of specific diseases produces largely similar outcomes when used to replace or augment usual care. Nine of 12 studies where VTC was intended to replace usual care and 5 of 8 studies where VTC was intended to augment usual care found similar effects between the intervention and control groups. The remaining 6 included studies (3 intended to replace usual care and 3 intended to augment usual care) found 1 or more primary outcomes that favored the VTC group over the usual care group. Studies comparing VTC with usual care that did not involve in-person care were more likely to favor the VTC group. No studies evaluated the use of VTC for diagnosis or prevention of disease. Studies that reported harms found no differences between the intervention and control groups; however, many studies did not report harms. No studies evaluated the effect of VTC on health equity or disparities.

Limitations: Studies that focused on mental health, substance use disorders, maternal care, and weight management were excluded. Included studies were limited to RCTs with sample sizes of 50 patients or greater. Component analyses were not conducted in the studies.

Conclusion: Replacing or augmenting aspects of usual care with VTC generally results in similar clinical effectiveness, health care use, patient satisfaction, and quality of life as usual care for areas studied. However, included trials were limited to a handful of disease categories, with patients seeking care for a limited set of purposes.

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When in-person care is not possible, video-based telehealth may offer patients, caregivers, and clinicians advantages over audio-only communication, including being able to directly observe patients and their home environment (1). The COVID-19 pandemic has led to a dramatic increase in use of video teleconferencing (VTC) in health care (2, 3). A 2020 survey found that 22% of patients and 80% of physicians reported having participated in a video visit, 3 times the rate from the prior year (4). Several policy changes enacted to support telehealth strategies in the United States during the pandemic are expected to remain in place (5), and although patients have begun to return to in-person care for some services, the virtual visit market is expected to continue growing over the coming years (6). Many have raised concerns about the safety and appropriateness of VTC in health care, and evidence from systematic reviews is unclear or missing (7, 8). In addition, there is little evidence on whether VTC is more effective when used alone or combined with other telemedicine methods and whether these interventions have been studied in vulnerable and underserved populations who may be less likely to use telehealth (9). This review systematically assesses recent evidence of the benefits and harms associated with 2-way, real-time, audio–visual communication between 1 or more patients and 1 or more providers (that is, synchronous VTC visits) for disease prevention, diagnosis, and treatment. The aim is to inform clinicians and policymakers of opportunities for safe and effective deployment of VTC, summarize existing research gaps, and inform future research funding priorities.

Methods

A rapid review format was necessary to expedite and inform the Patient-Centered Outcomes Research Institute's (PCORI) research investments. We followed guidance from

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the Cochrane Rapid Reviews Methods Group, which defines a rapid review as "a form of knowledge synthesis that accelerates the process of conducting a traditional systematic review through streamlining or omitting various methods to produce evidence for stakeholders in a resource-efficient manner" (10). We also followed international PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) reporting guidelines (11), and we registered our rapid review protocol in the Open Science Framework (https://osf.io/twn97) on 22 March 2021. Compared with the methods of a standard systematic review, we applied the following methodological adjustments: a 6-month timeline for completing the review, drafting the full report, and submitting the manuscript to a journal. Other adjustments included a narrow scope, omission of gray literature searches, dual screening only of excluded abstracts and full texts, exclusion of studies with a sample size of fewer than 50 patients, and focused data extraction only of studies rated as low risk of bias or as having some concerns of bias. Data abstraction for studies rated as high risk of bias were limited to characteristics of the studies. Supplement Figure 1 (available at Annals.org) shows the analytic framework and key questions (KQs) that guided the review. There are currently no plans to update the review as a living, rapid review. Our review addressed the following 5 KQs:

1. What are the clinical effectiveness and harms of using synchronous VTC for disease prevention, diagnosis, and treatment compared with usual care?
2. Do the results vary by subgroup?
3. What evidence is there regarding the effects of synchronous VTC on health disparities?
4. What is the context in which synchronous VTC is implemented, and how do contextual factors impact effectiveness?
5. What gaps exist in the current research?

Detailed methods and findings for all KQs are available in the full rapid review report (www.pcori.org/impact/evidence-synthesis/rapid-reviews). Here, we focus on key findings of particular interest to clinicians, researchers, and policymakers involved in implementing VTC.

Data Sources and Searches

A trained librarian searched PubMed, EMBASE, Web of Science, and the Cochrane Library from 1 January 2013 to 3 March 2021 using various terms, MeSH (Medical Subject Headings), and major headings limited to English-language randomized controlled trials (RCTs) and including human-only studies (Supplement Table 1, available at Annals.org). We also manually searched the reference list of recent landmark studies and reviews to identify additional relevant citations.

Study Selection

We used Covidence (Veritas Health Innovation), an online systematic review software, to aid in the literature screening process. Supplement Table 2 (available at Annals.org) shows the prespecified inclusion and exclusion criteria. A single reviewer screened abstracts and full texts for eligibility. A second reviewer screened all excluded abstracts and full-text records. We resolved discrepancies by consensus or by involving a third reviewer. We included RCTs of VTC interventions with and without added intervention components. All intervention participants were required to have access to VTC but were not required to turn on their video during the intervention. Eligible comparators were described as "usual care," including in-person care (where patients received the same care as the VTC patients but via a different modality, such as at a clinic), asynchronous telemedicine, audio-only telemedicine, other author-defined usual care comparators, and unspecified care. Only RCTs with a sample size of 50 patients or more and from countries with a very high Human Development Index were eligible for this review.

Data Extraction and Quality Assessment

We designed, pilot tested, and used a structured data abstraction form in Microsoft Excel to ensure consistency of data abstraction. A single reviewer abstracted data from each study. A second team member verified abstracted study data for accuracy and completeness. Two reviewers independently assessed the risk of bias of included studies using the Cochrane Revised Risk of Bias Tool (12). Disagreements between the 2 reviewers were resolved by discussion and consensus or by consulting a third reviewer.

Data Synthesis and Analysis

We summarized the evidence narratively and in tables that displayed important features of the study populations, design, intervention, outcomes, setting, country, and results. We developed an evidence map to identify and depict gaps. Because of substantial heterogeneity, we did not consider a meta-analysis.

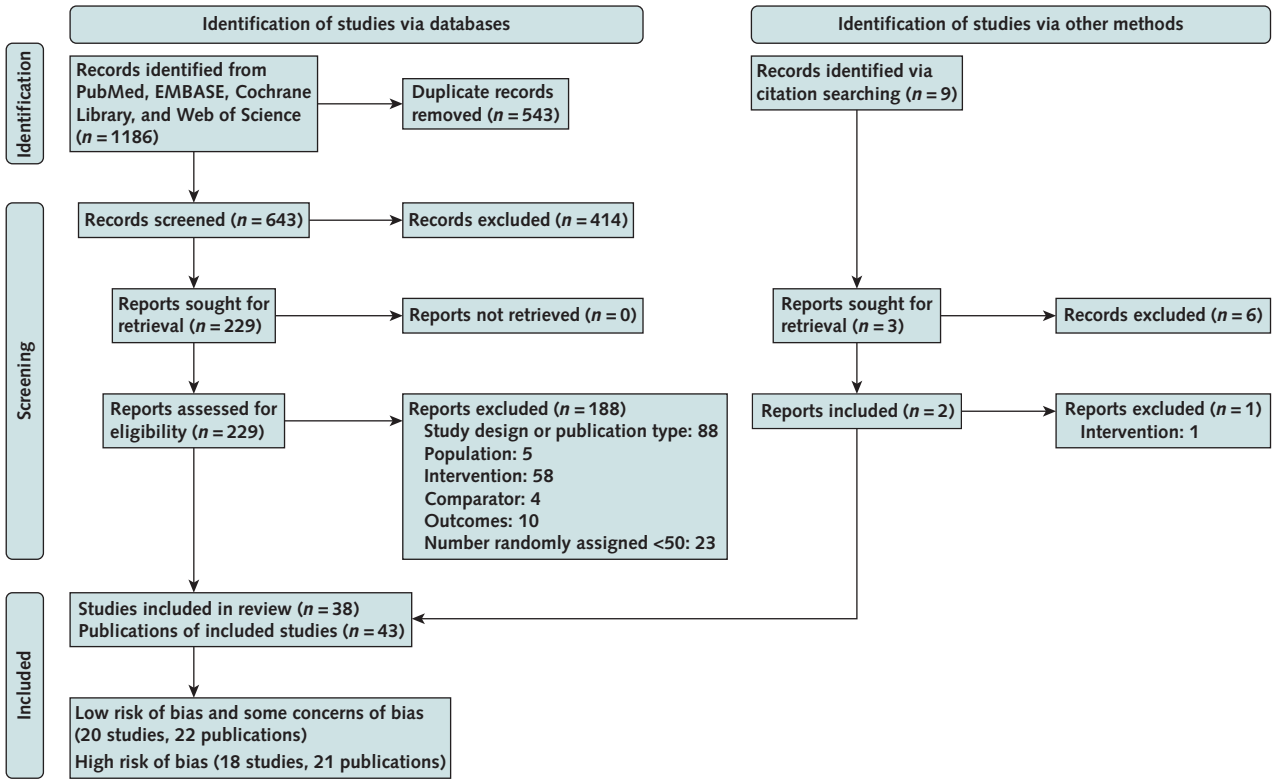
Role of the Funding Source

The review was funded by PCORI and guided by a technical expert panel. The technical expert panel and PCORI helped develop KQs, study inclusion criteria, and outcome measures of interest but were not involved in data collection, analysis, or manuscript preparation.

RESULTS

Of 652 unique records, we included 43 publications representing 38 RCTs (13–55). Figure 1 shows the PRISMA diagram outlining the selection and screening process. We rated 6 studies as low risk of bias (13, 21, 40, 43, 45, 53), 14 as some concerns of bias (15, 18, 20, 25, 29, 32, 34, 35, 44, 46–49, 51), and 18 as high risk of bias (16, 19, 22, 23, 26, 28, 30, 31, 33, 36–39, 41, 42, 50, 54, 55). Sample sizes ranged from 57 to 601 patients, and mean age ranged from 5 to 87 years across studies. We abstracted study characteristics from all 38 studies and abstracted outcomes from the 20 studies rated as low risk of bias or some concerns of bias. Supplement Tables 3 and 4 (available at Annals.org) present detailed study characteristics and findings. Supplement Figure 2 (available at Annals.org) shows the risk of bias ratings for each study.

Figure 1. Evidence search and selection.



PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) diagram. (Adapted from Page and colleagues [11].).

The Context in Which VTC Is Implemented and the Effect of Contextual Factors on Effectiveness

Across the body of literature, we found substantial heterogeneity in the contexts in which VTC is implemented. The 20 studies rated as low risk of bias or some concerns of bias varied widely in terms of the diseases studied, reasons for care, intervention components, comparison groups, sample size, and outcomes. The Table shows key characteristics and findings of these studies. Although most studies (16 of 20) compared the VTC intervention with usual care that included in-person care (13, 15, 18, 20, 24, 25, 32, 34, 35, 40, 44–49), 4 studies did not include in-person care—1 study included an audio-visit control group (29), the control group in another study only received online educational materials (53), and 2 studies instructed patients in the control group to follow up with their providers outside of the study without specifying in-person care (21, 43). In addition, 16 of 20 studies involved VTC interventions with additional added intervention components, such as automated, electronic remote patient monitoring (RPM); access to an electronic platform for reporting history and vitals or sending messages; or educational support (see the Appendix Table, available at Annals.org, for a detailed description of added components for select studies). Some studies included control groups that also received additional components.

As described in the Table, studies can be divided into those where the VTC intervention was intended to replace usual care and studies where the intervention was intended to augment usual care; and of note, the intervention and comparator components were generally guided by this intention. In 12 studies, VTC was investigated as an alternative intended to replace usual care. Of these, 4 studies compared VTC alone with in-person care that included no other usual care components (24, 25, 46, 49) and involved either a noninferiority design (24, 25) or noninferiority goals (46, 49). Seven studies compared VTC plus additional intervention components with in-person care (with or without additional usual care components) (13, 18, 20, 35, 44, 45, 47), and 1 study compared VTC plus additional intervention components with an audio-only comparator (29). In the 8 other studies, the VTC intervention was intended to augment usual care. Of these, the intervention groups in 2 studies received VTC plus the same in-person care received by the usual care control group, with no other added components in either group (15, 40). In 1 study, the VTC and control groups received the same educational materials, with no other differences between the groups other than the VTC component (53). Three studies involved intervention groups that received VTC, the same in-person care as the control group, and other components not received by the control group (such as RPM, data reporting system, or education) (32, 48). In the remaining 2 studies where the VTC intervention was

Table. Key Characteristics and Findings of VTC Studies

Study, Year (Reference)	Reason for Care	Condition	Study Design Features			Additional Intervention Components						Patients, *n*	Primary/Key Effect of VTC‖
			Intervention Approach*	Noninferiority Methodology	Similar Effectiveness Aims	Study Group	In-Person Care	RPM	Reporting System‡	Education	Other§		
Herbert et al, 2017 (25)	Chronic disease management	Chronic pain	Replace UC	X	X	VTC UC	 X					129	Noninferior for change in pain severity at 8 wk
Hwang et al, 2017 (18)	Rehabilitation	Heart failure	Replace UC	X	X	VTC UC	 X			X	X	53	Noninferior for change in 6-min walking distance test
Isetta et al, 2015 (44)	Chronic disease management	Obstructive sleep apnea	Replace UC	X	X	VTC UC	 X		X	X		139	Noninferior for CPAP use and adherence
Müller et al, 2016 (24)	Treatment	Nonacute headaches	Replace UC	X	X	VTC UC	 X					409	Similar change in Headache Impact Test at 12 mo
Fatehi et al, 2015 (46)	Chronic disease management	Type 1 and 2 diabetes	Replace UC		X	VTC UC	 X					75	Similar agreement in prescribing decisions
Gandolfi et al, 2017 (13)	Rehabilitation	Parkinson disease¶	Replace UC		X	VTC UC	 X				X	76	Balance at 7 wk favors VTC ($P = 0.02$)**
Gunasekeran et al, 2020 (29)	ED follow-up	Abdominal pain	Replace UC††		X	VTC UC			X		X	70	Similar representation to ED
Silva et al, 2019 (49)	Treatment	Pediatric fractures	Replace UC		X	VTC UC	 X					52	Similar fracture displacement rate and angulation
Comín-Colet et al, 2016 (45)	Chronic disease management	Heart failure	Replace UC			VTC UC	 X	X	X		X	188	Nonfatal heart failure (hazard ratio, 0.35; $P < 0.001$)**
Jeong et al, 2018 (20)	Chronic disease management	Type 2 diabetes	Replace UC			VTC UC	 X	X‡‡		X	X	338	Similar change in hemoglobin A_{1c} level
Nouryan et al, 2019 (35)	Chronic disease management	Heart failure	Replace UC			VTC UC	 X	X			X	89	Reduction in all-cause ED visits over 6 mo ($P = 0.04$)**
Ringbæk et al, 2015 (47)	Chronic disease management	COPD	Replace UC			VTC UC	 X	X			X	281	Similar rate of COPD hospital admissions over 6 mo
Halterman et al, 2018 (21)	Chronic disease management	Pediatric asthma	Augment††			VTC UC			X	X	X X	400	Greater increase in symptom free days ($P = 0.01$)**
Ishani et al, 2016 (43)	Chronic disease management	Chronic kidney disease	Augment††			VTC UC		X		X		601	Similar hospitalization and death over 12 mo
von Sengbusch et al, 2020 (34)	Chronic disease management	Type 1 diabetes	Augment			VTC UC	X X		X			240	Similar change in hemoglobin A_{1c} level
Beck et al, 2017 (15)	Chronic disease management	Parkinson disease	Augment			VTC UC	X X					195	Similar change in functioning and quality of life at 12 mo
Bennell et al, 2017 (53)	Treatment	Knee pain	Augment††			VTC UC				X X		148	Reduced walking knee pain at 9 mo ($P = 0.003$)**

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Table–Continued

Study, Year (Reference)	Reason for Care	Condition	Study Design Features			Additional Intervention Components						Patients, *n*	Primary/Key Effect of VTC‖
			Intervention Approach*	Noninferiority Methodology	Similar Effectiveness Aims	Study Group	In-Person Care	RPM	Reporting System‡	Education	Other§		
Hansen et al, 2017 (32)	Chronic disease management	Type 2 diabetes	Augment			VTC UC	X X		X			165	Similar change in hemoglobin A_{1c} level ($P = 0.055$)
Orlandoni et al, 2016 (40)	Chronic disease management	Home enteral nutrition	Augment			VTC UC	X X					188	Reduction in complications over 1 y ($P < 0.001$)**
Sorknaes et al, 2013 (48)	Chronic disease management	COPD	Augment			VTC UC	X X	X		X		266	Similar rate of hospital readmission through 26 wk

COPD = chronic obstructive pulmonary disease; CPAP = continuous positive airway pressure; ED = emergency department; RPM = remote patient monitoring; UC = usual care; VTC = video teleconferencing.
* Intervention approach refers to whether the intervention was designed as an add-on to augment UC or to replace ≥1 components of UC.
†Some studies implemented a true noninferiority approach. However, several more studies implied or stated noninferiority aims or hypotheses.
‡ Reporting system may include cloud-based systems or direct access to the patient record. The system may also include the ability to send or receive messages.
§ Other interventions components: Hwang and colleagues (18) provided the VTC group self-monitoring tools and rehabilitation training equipment; Gandolfi and colleagues (13) provided the VTC group with a Nintendo Wii fit system; Gunasekeran and colleagues (29) used audio-only follow-up visits for the control group; Comín-Colet and colleagues (45) provided the control group with audio support; Jeong and colleagues (20) provided the control group with a glucometer for self-monitoring; Nouryan and colleagues' (35) control group was contacted by a nurse weekly by telephone; Ringbæk and colleagues (47) provided the VTC group with audio support and self-monitoring tools; and Halterman and colleagues (21) used directly observed therapy with the VTC group and also provided recommendations to the control group.
‖ Studies typically reported multiple outcomes. We note a positive effect for VTC if ≥1 primary outcomes favored VTC and was statistically significant.
¶ Parkinson disease is a chronic disease, but the purpose of the intervention was specifically for rehabilitation.
** Study favored the VTC group for at least 1 key outcome.
†† Studies where patients in the control group did not receive any notable in-person care with a provider as part of the study. The control group in Gunasekeran and colleagues (29) only received audio follow-up. Halterman and colleagues (21) provided enhanced UC to the control group but in-person care was not described as part of that care. Ishani and colleagues (43) did not define UC but rather instructed participants to follow up with their provider. Bennell and colleagues (53) provided only educational materials to the control group.
‡‡ Jeong and colleagues (20) used a multigroup study, comparing UC with VTC with and without RPM. The non-RPM VTC group did self-monitoring with a glucometer.

intended to augment usual care, the intervention group received VTC plus additional components and were compared with a usual care group that did not specify in-person care (13, 18, 20, 21, 29, 34, 35, 43–45, 47).

Nine of 12 studies where VTC was intended to replace usual care found similar effects between the intervention and control groups (18, 20, 24, 25, 29, 44, 46, 47, 49). Five of 8 studies intended to augment usual care found similar effects between the intervention and control groups (15, 32, 34, 43, 48). The remaining 6 included studies found 1 or more primary outcomes that favored the VTC group over the usual care comparison group (13, 21, 35, 40, 45, 53). Three of these studies involved VTC interventions intended to replace usual care (13, 35, 45), and 3 involved VTC interventions intended to augment usual care (21, 40, 53). All 6 studies favoring VTC included 1 or more additional components to VTC. Two of the studies that favored VTC were compared with usual care comparators that did not receive an in-person visit as part of the study (43, 53).

The following describes the clinical effectiveness and harms outcomes, health care use patterns, patient satisfaction, and quality-of-life (QoL) findings by disease category for the 20 studies rated as low risk of bias or some concerns of bias.

Diabetes

Four RCTs, all rated as some concerns of bias, with data on 818 participants, suggested similar effects for the use of VTC versus usual care for the management of diabetes-related outcomes (**Supplement Table 5**, available at Annals.org) (20, 32, 34, 46). One RCT ($n = 75$) replaced an in-person endocrinologist visit with a VTC visit and found similar effects for level of agreement in prescribing decisions for diabetes medication (46). Three RCTs ($n = 743$) investigating the use of VTC interventions with additional components versus usual care found similar effects for change in hemoglobin A_{1c} level from baseline to the end of the intervention at 6 months (20, 34) and 8 months (32). One of these studies evaluated the use of VTC to replace in-person care (20); the other 2 studies were intended to augment usual care (32, 34).

In addition to similar effects for hemoglobin A_{1c} control, 1 study ($n = 240$) that compared VTC plus an online data reporting platform with a waitlisted control group that received in-person care also found similar effects for patient satisfaction, participant health-related QoL, and caregiver psychological well-being at 6 months (34). However, the VTC intervention group reported greater caregiver satisfaction

at 6 months (adjusted mean difference on the Diabetes Treatment Satisfaction Questionnaire at 6 months, 4.0 [95% CI, 2.1 to 5.8]) (34). Two RCTs reported no difference between the VTC and usual care groups for incidence of hypoglycemia at 8 months (32) and 6 months (34), respectively. In addition, 3 RCTs reported no differences in adverse events between the VTC and usual care groups (20, 32, 34). No study reported a service use outcome.

Respiratory Conditions

Four RCTs, 1 rated as low risk of bias (21) and 3 rated as some concerns of bias (44, 47, 48), with data on 1086 participants, evaluated the use of VTC with other components for participants with respiratory conditions. Two studies evaluated the use of VTC to replace in-person care (44), and 2 studies involved VTC interventions intended to augment usual care (21, 48). Three RCTs (n = 686) suggest similar effects for care delivered by VTC versus usual care for the treatment of adults with chronic obstructive pulmonary disease (COPD) (47, 48) or obstructive sleep apnea (44). One RCT (n = 400) found improved outcomes (clinical effectiveness and health care use) in children receiving school-based VTC plus added components versus usual care for the management of asthma and reported no adverse events (21) (**Supplement Table 6**, available at Annals.org). Two RCTs investigating VTC plus RPM to manage COPD found similar effects between the VTC and usual care groups for COPD-related hospital admissions, all-cause hospital admissions, emergency department (ED) visits, and nonrespiratory outpatient clinic visits over 6 months (47) and total hospital days per patient and readmissions over 26 weeks (48). One of the COPD studies reported fewer outpatient clinic visits during the 6-month study period compared with usual care (0.26 vs. 0.99, P = 0.001) (47). For obstructive sleep apnea, the use of VTC plus an online messaging system met noninferiority criteria (compared with in-person follow-up) for adequate continuous positive airway pressure use and adherence during a 6-month study period (n = 139) (44). The study also reported similar effects between the VTC group and the in-person group for QoL at 6 months and reported similar effects between groups for length of follow-up visits, number of general practitioner visits, and use of emergency services (44).

One study (n = 400) also found that children with asthma who received school-based VTC telemedicine had a statistically significantly greater number of symptom-free days versus those who received enhanced usual care (mean difference, 0.69 [CI, 0.15 to 1.22]; P = 0.01) (21). The study also reported fewer ED visits or hospitalizations among children receiving VTC telemedicine (odds ratio, 0.52 [CI, 0.32 to 0.84]) and greater caregiver satisfaction in the VTC program group (99% vs. 92%, P = 0.003) (21).

Pain-Related Disorders

Four RCTs, 1 rated as low risk of bias (53) and 3 rated as some concerns of bias (24, 25, 27, 29, 51, 52), represented in 7 publications with data on 756 participants evaluated knee pain (53), abdominal pain (29), chronic pain (25), and nonacute headaches (24, 27, 51, 52) (**Supplement Table 7**, available at Annals.org). Two were noninferiority studies investigating the use of VTC alone as an intended replacement for in-person visits (24, 25). Another study aimed to show that the use of VTC for patient-led follow-up for abdominal pain was equally effective as a replacement for provider-led audio follow-up (29). The fourth study investigated the use of VTC to augment usual care for knee pain (53).

Overall, these studies found similar effects for the use of VTC as a replacement for usual care for the treatment of chronic pain (25), nonacute headaches (24), and abdominal pain (29). One study unsurprisingly found that educational materials plus VTC physiotherapy versus educational materials only resulted in improved pain during walking in 148 patients (difference in change between groups, 1.1 [CI, 0.4 to 1.8]; P = 0.003) and improved physical function (measured using the Western Ontario and McMaster Universities Osteoarthritis Index) (difference in change between groups, 7.0 [CI, 3.4 to 10.5]; P < 0.001) from baseline to 9 months (53). This study also found significantly greater improvement in QoL at 9 months with VTC compared with educational materials alone (measured using version 2 of the Assessment of Quality of Life instrument) (difference in change between groups, −0.1 [CI, −0.1 to 0.0]; P = 0.018) (53). The study reported an increase in adverse events in the VTC group versus the usual care group (22 vs. 3, P = not reported [NR]), noting that adverse events were generally minor instances of knee pain or cramping (53).

Among 129 participants with chronic, nonterminal pain, acceptance and commitment therapy via VTC was noninferior to in-person care for change in pain severity, as measured by the Brief Pain Inventory at 8 weeks (25). This study also found that VTC was noninferior to in-person care in terms of patient satisfaction at 8 weeks and QoL at 6 months (25). Compared with in-person care, VTC consultations with a neurologist to manage nonacute headaches (n = 409) resulted in similar effects for reduced headache pain, as measured on the Headache Impact Test at 12 months, and VTC was found to be noninferior to in-person care at 3 and 12 months in terms of patient satisfaction (51, 52). The same study found that VTC resulted in less time in consultation (4.9 minutes, P < 0.001) (24, 51) and less frequent, unplanned general practitioner visits because of headaches over 3 months (data NR, P = 0.041) (51). Across several other health care use outcomes, this study found similar effects for VTC consultations with a neurologist versus in-person care (24) (**Supplement Table 7**). Compared with provider-initiated telephone review after ED discharge for abdominal pain (n = 70), VTC follow-up plus an online platform for patients to manage scheduling and cancelling appointments resulted in similar effects for adherence to a disposition plan and representation to the ED over a 2-week follow-up period (29).

Cardiovascular Conditions

Three RCTs, 1 rated as low risk of bias (45) and 2 rated as some concerns of bias (18, 35), with data on 330 participants, focused on the use of VTC for patients with chronic heart failure (**Supplement Table 8**, available at Annals.org)

(18, 35, 45). All 3 studies involved VTC interventions intended to replace in-person care. Two studies evaluated the use of VTC plus RPM and found outcomes that favored the VTC intervention (35, 45). A noninferiority study found that VTC-based rehabilitation was generally noninferior compared with in-person rehabilitation (18).

Both studies of VTC plus RPM (n = 377) reported greater improvements in heart failure–related QoL at 6 months for the VTC group compared with in-person care (P = 0.02 for each) (35, 45). One of these studies found that compared with in-person follow-up, VTC with RPM resulted in a reduction in nonfatal heart failure events through 6-month follow-up (hazard ratio, 0.35 [CI, 0.20 to 0.59]; P < 0.001) (45). In the telerehabilitation study (n = 53), VTC-based group telerehabilitation compared with in-person rehabilitation met noninferiority criteria on the basis of change in the 6-minute walk test at 12 weeks (18). At 24 weeks (12 weeks postintervention), the 6-minute walk test continued to favor the VTC-based group telerehabilitation but no longer met the noninferiority criteria (18). This same study reported similar effects for patient satisfaction at 12 weeks and mixed results for QoL outcomes (18).

In terms of health care use, the 2 studies (n = 277) of VTC plus telemonitoring for patients with chronic heart failure found that the VTC intervention resulted in a greater reduction in the number of heart failure hospitalizations (hazard ratio, 0.39 [CI, 0.19 to 0.77]; P = 0.007) and all-cause hospitalizations (hazard ratio, 0.50 [CI, 0.30 to 0.86]; P = 0.011) over 6 months compared with in-person care (45) and was associated with a greater reduction in the number of patients with an all-cause ED visit over 6 months (relative risk, 1.56 [CI, 1.00 to 2.56]; P = 0.04) (35). This latter RCT reported similar between-group effects in the total number of patients with all-cause hospitalizations (35). Only the noninferiority study of telerehabilitation reported adverse events, finding similar rates of serious and minor adverse events between VTC-based group telerehabilitation for chronic heart failure versus in-person rehabilitation over 12 weeks (18).

Neurologic Conditions

Two RCTs, 1 rated as low risk of bias (13) and 1 rated as some concerns of bias (15), with data on 271 participants, investigated the use of VTC to treat Parkinson disease (**Supplement Table 9**, available at Annals.org). One study (n = 76) compared VTC-based group training sessions using the Nintendo Wii Fit system as an alternative to in-person training sessions and favored the VTC intervention for static and dynamic balance at 7 weeks (mean between-group difference, 2.54 [CI, 0.41 to 4.67]; P = 0.02), with similar outcomes at 1-month follow-up (P = NR) (13). This study also reported similar effects on patient satisfaction at 7 weeks (13). The other study (n = 195) evaluated 4 home-based VTC visits with a neurologist plus usual care compared with usual care only and found similar effects for the number of ED visits and the number of overnight hospital admissions over 12 months (15). Both studies reported similar effects for QoL outcomes (13, 15). One study reported similar incidence of falls among patients with Parkinson disease in VTC versus usual care at 7 weeks and at the postintervention 1-month follow-up (13). The other study reported no deaths, harms, or safety issues during the study (15).

Orthopedic Conditions

One RCT (n = 52), categorized as orthopedic and rated as having some concerns of bias, investigated the use of VTC to replace in-person follow-up on children with elbow fractures (**Supplement Table 10**, available at Annals.org) (49). This study found similar effects between patients followed up by VTC versus usual in-person care for fracture displacement and angulation (P = NR) (49). Groups reported similar patient satisfaction scores, and the VTC group reported significantly shorter total encounter time at the 4-week follow-up (mean difference between groups, 29.6 minutes; P < 0.001) (49).

Other Conditions

Two RCTs were categorized as other (**Supplement Table 11**, available at Annals.org) (40, 43). One study rated as low risk of bias (n = 601) evaluated care from an interprofessional team delivered via VTC in conjunction with RPM and education to manage chronic kidney disease in adults (43). In this study, participants in the control group were offered educational support and instructed to follow up with their usual care providers (43). The study reported similar effects between the VTC and usual care groups for the composite end point of death, hospitalization, ED visits, and admission to a skilled-nursing facility at 12 months (43). A study rated as having some concerns of bias (n = 188) evaluated the use of VTC plus usual care compared with usual care only for frail, elderly patients who were receiving home enteral nutrition and found a lower incidence of home enteral nutrition complications among the VTC participants over the 12-month period and reported similar effects in the frequency of all-cause hospitalizations, outpatient visits, and hospitalizations related to complications (40).

Differences in the Effectiveness of VTC Across Subgroups

We found that few studies focused on subgroups or on underserved and vulnerable populations, with no head-to-head studies identified. In addition, no studies examined the use of VTC versus usual care among patients with co-occurring conditions, and no studies evaluated VTC's effect on health equity or disparities. Only 1 study included a population that predominantly comprised participants from a minority population group (21). In the study that examined a VTC program for the management of pediatric asthma, 89.3% of the participants were African American or Hispanic children from urban schools (21). The study found that outcomes favored VTC for clinical effectiveness, health care use, and patient satisfaction (21).

Gaps in the Current Research

Figure 2 presents an evidence map summarizing outcomes studied and other key features of included RCTs. Of the 38 primary RCTs identified, we rated 18

Figure 2. Evidence map—number and risk of bias of randomized controlled trials for disease management and treatment.

Disease Category		Diabetes	Respiratory Conditions	Neurologic Conditions	Pain-Related Disorders	Postoperative Follow-up	Cardiovascular Conditions	Orthopedic Conditions	Cancer	Other Unclassified Conditions*
All interventions		●●●●○○○	●●●●○○○	●●○○	●●●●	○○○○	●●●	●○	○	●●○○○○
Total sample size, *n*		1280	1946	419	756	995	330	459	66	1340
Studies replacing usual care		●●○○	●●○	●○	●●●	○○○○	●●●	●○	○	○○
Studies augmenting usual care		●●○	●●○	●○	●	–	–	–	–	●●○○
Studies with noninferiority designs		–	●○	–	●●	○	●	○	–	–
Studies addressing process of care outcomes	Adherence to recommended care	●○○○	●●○○	–	●●●●	–	●●●	–	–	○
	Differences in travel requirements	–	●	●○	●	○○○	–	●○	○	○
	No shows or cancellations	●	○	–	–	○○	–	–	○	○
	Time to appointment or diagnosis	–	–	○	●	○	–	●○○	–	●
	Diagnostic ability or accuracy	●	–	–	●	○	–	●○	○	–
	Guideline-concordant care	–	–	–	–	–	–	–	–	–
Studies addressing patient outcomes	Patient-reported measures of health	●●●○○○	●○○○	●●○	●●●●	○	●●●	○	–	●○○
	Downstream costs and use	●●	●●●●	●○○	●●	○○○	●●	○	–	●●○
	Clinical outcomes	●●●○○○	●●○	○	●	○	●●	●	–	●●○
	Functional outcomes	●	●	●○○	●●	○	●	○	–	–
	Long-term outcomes (≥12 mo)	●	–	●	●	–	–	–	–	●●○
Studies addressing experience outcomes	Patient attitudes and satisfaction	●○	●●○	●●○	●●●	○○○	●●	●○	○	○○○○
	Staff attitudes and satisfaction	○	–	●	–	○	–	○	–	–

The review excluded mental health, maternal health, and obesity. No studies were found on prevention or diagnosis. The closed circle refers to studies rated as low risk of bias or having some concerns of bias, the open circle refers to high risk of bias studies, and the dash indicates no studies reported for the specified outcome.

* Unclassified conditions include chronic kidney disease, multiple chronic conditions, home enteral nutrition, HIV, rheumatoid arthritis, and genetic counseling. No studies evaluated the effect of video teleconferencing on health disparities and equity. Of 20 low risk/some concerns of bias studies, 6 did limited subgroup analyses, 2 compared video teleconferencing with audio interventions, and 5 included mental health outcomes. None of the 20 studies specifically included collaborative care models.

studies as high risk of bias (16, 19, 22, 23, 26, 28, 30, 31, 33, 36–39, 41, 42, 50, 54, 55). These were not abstracted or synthesized as part of the evidence base (that is, not included in KQ1 to KQ4) but are represented in the evidence map as open circles denoting a gap due to low-quality evidence. Of note, cancer and those diseases grouped under "other unclassified conditions" were each addressed in a single study and suggest a lack of overall evidence for these conditions (22, 28, 33, 39, 40, 42, 43). The evidence map also identifies postoperative follow-up and orthopedic conditions as disease categories that lack good-quality evidence. Other notable gaps not represented in the evidence map include studies assessing VTC use to prevent or diagnose a condition and studies addressing other key conditions, such as HIV and rheumatoid arthritis, and comorbid conditions. No study evaluated VTC's effect on guideline-concordant care, and provider and staff satisfaction were rarely reported. Similarly, little is known about the effectiveness of group VTC versus one-on-one VTC, the effectiveness of VTC visits to improve outcomes for patients with multiple chronic conditions, or the use of VTC as part of an integrated model of care. In addition, process outcomes were found to be poorly studied across all disease categories.

DISCUSSION

We sought to update the state of the evidence on the use of synchronous VTC to prevent, diagnose, and treat disease. We identified 38 RCTs associated with 43 published articles. We rated 18 studies as high risk of bias; these were excluded from data abstraction and synthesis (KQ1 to KQ4). Among the 20 studies rated as low risk of bias or some concerns of bias, few did subgroup analyses (KQ2) and none evaluated VTC's potential effect on health equity or disparities (KQ3). Many studies provided details of the contextual factors surrounding VTC use (KQ4) but few evaluated how these factors affected VTC. No studies evaluated the effect of training, intervention combinations, or staffing models on VTC effectiveness, and no studies assessed VTC use specifically to prevent or diagnose a condition. The reader should be mindful that the conclusions outlined here apply only to the studies identified through the narrow focus of this rapid review. Limitations to the work are outlined below, and there is a possibility that publication bias may have been present in that investigators were likely to focus VTC trials on interventions and disease conditions that were expected to produce desired outcomes compared with usual care comparators.

Overall, this article presents evidence showing that, for the specific disease conditions reviewed (for example, diabetes; certain respiratory, neurologic, and cardiovascular conditions; and pain management), using VTC to treat and manage the studied diseases produces similar outcomes compared with usual care. None of the studies reported statistically significant differences in harms between the intervention and control groups; however, many studies did not report harms. In addition,

the body of evidence is limited. We identified no more than 4 studies (of adequate quality) that addressed any 1 disease category, and no adequate-quality studies addressed other key conditions, such as cancer, postoperative follow-up, HIV, rheumatoid arthritis, and comorbid conditions.

Most studies evaluated VTC when implemented with additional intervention components (16 of 20 studies), including all 6 studies that favored VTC over usual care (when looking at primary outcomes). Although this is noteworthy because most multicomponent interventions found similar effects for VTC compared with usual care, the circumstances under which multicomponent interventions may favor VTC need further investigation. It is also notable that among the studies that did not include in-person care as part of usual care, outcomes were more likely to favor the VTC intervention group. No head-to-head study directly compared VTC as an add-on with usual care with VTC as a replacement for usual care. Indirect evidence from across the included studies suggests that the study approach—involving VTC as a replacement for usual care (12 studies) or as an add-on (8 studies)—did not have an obvious effect on outcomes. As noted, many of the included VTC studies aimed to show noninferiority or similar effects rather than superiority over usual care. All 8 studies that used noninferiority designs or implied that the objective was to show similar effectiveness generally found that VTC produced outcomes that were similar to usual care. However, as stated earlier, these findings are only true for the studies that met inclusion criteria for this review and caution must be taken not to generalize these results to conditions, contexts, and populations beyond those described.

Our review has limitations. We excluded mental health and substance use disorders and studies focused on maternal health (pre- or postnatal care) or obesity (unless another disease condition was also present). These exclusions limit the review's generalizability to these populations. In addition, included studies were limited to RCTs. Observational studies may have provided important data in areas where we found serious gaps in the evidence, including harms; a broader array of disease conditions; patient and provider attitudes toward VTC; VTC in the context of collaborative or integrative care models; process outcomes, such as guideline-concordant care; and no-shows and cancellations. Although including interventions with added components enabled us to assess VTC's effectiveness in the context in which it is most commonly implemented, studies did not conduct component analysis; therefore, we could not determine the VTC component's effect on the reported findings of these multicomponent studies. Participants in both the intervention and control groups were also typically free to pursue additional care on their own.

The findings from this review provide some evidence for how physicians and policymakers can safely implement the use of VTC as a replacement for or to augment usual care. However, the body of evidence remains limited to the disease conditions studied, and little is known about whether these benefits vary by subgroups, sociodemographic characteristics, or social determinants of health. Additional evidence is needed to identify the combinations of disease condition, intervention characteristics, and contextual factors that will result in improved care and outcomes. Critical needs for future research include studies investigating the effectiveness and harms of VTC in underserved and vulnerable populations; studies assessing health disparities and equity, including subgroup analyses focused on demographic characteristics and social determinants of health; multicomponent VTC interventions with component-level analysis; interventions focusing on collaborative care models or patients with multiple chronic conditions; and pragmatic clinical trials investigating real-world hybrid interventions.

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References

1. **Lindsay JA, Hogan JB, Ecker AH, et al.** The importance of video visits in the time of COVID-19. J Rural Health. 2021;37:242-245. [PMID: 32506751] doi:10.1111/jrh.12480

2. **Robinson J, Borgo L, Fennell K, et al.** The Covid-19 pandemic accelerates the transition to virtual care. NEJM Catal Innov Care Deliv. 2020. doi:10.1056/CAT.20.0399

3. **Mann DM, Chen J, Chunara R, et al.** COVID-19 transforms health care through telemedicine: evidence from the field. J Am Med Inform Assoc. 2020;27:1132-1135. [PMID: 32324855] doi:10.1093/jamia/ocaa072

4. **Amwell.** From virtual care to hybrid care: COVID-19 and the future of telehealth. Insights from the 2020 Amwell Physician and Consumer Survey. Accessed at https://static.americanwell.com/

app/uploads/2020/09/Amwell-2020-Physician-and-Consumer-Survey.pdf on 25 August 2021.
5. **Koonin LM, Hoots B, Tsang CA, et al.** Trends in the use of telehealth during the emergence of the COVID-19 pandemic–United States, January-March 2020. MMWR Morb Mortal Wkly Rep. 2020;69:1595-1599. [PMID: 33119561] doi:10.15585/mmwr.mm6943a3
6. **Grand View Research.** U.S. virtual visits market size, share & trends analysis report by service type, by commercial plan type (small group, self-funded/ASO group plans, Medicaid, Medicare), by age group, by gender, and segment forecasts, 2020–2027. September 2020. Accessed at www.grandviewresearch.com/industry-analysis/us-virtual-visits-market on 25 August 2021.
7. **Ray KN, Shi Z, Gidengil CA, et al.** Antibiotic prescribing during pediatric direct-to-consumer telemedicine visits. Pediatrics. 2019;143. [PMID: 30962253] doi:10.1542/peds.2018-2491
8. **McLean S, Sheikh A, Cresswell K, et al.** The impact of telehealthcare on the quality and safety of care: a systematic overview. PLoS One. 2013;8:e71238. [PMID: 23977001] doi:10.1371/journal.pone.0071238
9. **Rodriguez JA, Betancourt JR, Sequist TD, et al.** Differences in the use of telephone and video telemedicine visits during the COVID-19 pandemic. Am J Manag Care. 2021;27:21-26. [PMID: 33471458] doi:10.37765/ajmc.2021.88573
10. **Garritty C, Gartlehner G, Nussbaumer-Streit B, et al.** Cochrane Rapid Reviews Methods Group offers evidence-informed guidance to conduct rapid reviews. J Clin Epidemiol. 2021;130:13-22. [PMID: 33068715] doi:10.1016/j.jclinepi.2020.10.007
11. **Page MJ, McKenzie JE, Bossuyt PM, et al.** The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. [PMID: 33782057] doi:10.1136/bmj.n71
12. **Sterne JAC, Savovic J, Page MJ, et al.** RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019;366:l4898. [PMID: 31462531] doi:10.1136/bmj.l4898
13. **Gandolfi M, Geroin C, Dimitrova E, et al.** Virtual reality telerehabilitation for postural instability in Parkinson's disease: a multicenter, single-blind, randomized, controlled trial. Biomed Res Int. 2017;2017:7962826. [PMID: 29333454] doi:10.1155/2017/7962826
14. **Buvik A, Bergmo TS, Bugge E, et al.** Cost-effectiveness of telemedicine in remote orthopedic consultations: randomized controlled trial. J Med Internet Res. 2019;21:e11330. [PMID: 30777845] doi:10.2196/11330
15. **Beck CA, Beran DB, Biglan KM, et al; Connect Parkinson Investigators.** National randomized controlled trial of virtual house calls for Parkinson disease. Neurology. 2017;89:1152-1161. [PMID: 28814455] doi:10.1212/WNL.0000000000004357
16. **Sood A, Watts SA, Johnson JK, et al.** Telemedicine consultation for patients with diabetes mellitus: a cluster randomised controlled trial. J Telemed Telecare. 2018;24:385-391. [PMID: 28406066] doi:10.1177/1357633X17704346
17. **Buvik A, Bugge E, Knutsen G, et al.** Patient reported outcomes with remote orthopaedic consultations by telemedicine: a randomised controlled trial. J Telemed Telecare. 2019;25:451-459. [PMID: 29973130] doi:10.1177/1357633X18783921
18. **Hwang R, Bruning J, Morris NR, et al.** Home-based telerehabilitation is not inferior to a centre-based program in patients with chronic heart failure: a randomised trial. J Physiother. 2017;63:101-107. [PMID: 28336297] doi:10.1016/j.jphys.2017.02.017
19. **Buvik A, Bugge E, Knutsen G, et al.** Quality of care for remote orthopaedic consultations using telemedicine: a randomised controlled trial. BMC Health Serv Res. 2016;16:483. [PMID: 27608768] doi:10.1186/s12913-016-1717-7
20. **Jeong JY, Jeon JH, Bae KH, et al.** Smart care based on telemonitoring and telemedicine for type 2 diabetes care: multi-center randomized controlled trial. Telemed J E Health. 2018;24:604-613. [PMID: 29341843] doi:10.1089/tmj.2017.0203
21. **Halterman JS, Fagnano M, Tajon RS, et al.** Effect of the school-based telemedicine enhanced asthma management (SB-TEAM) program on asthma morbidity: a randomized clinical trial. JAMA Pediatr. 2018;172:e174938. [PMID: 29309483] doi:10.1001/jamapediatrics.2017.4938
22. **Buchanan AH, Datta SK, Skinner CS, et al.** Randomized trial of telegenetics vs. in-person cancer genetic counseling: cost, patient satisfaction and attendance. J Genet Couns. 2015;24:961-70. [PMID: 25833335] doi:10.1007/s10897-015-9836-6
23. **Tupper OD, Gregersen TL, Ringbaek T, et al.** Effect of tele-health care on quality of life in patients with severe COPD: a randomized clinical trial. Int J Chron Obstruct Pulmon Dis. 2018;13:2657-2662. [PMID: 30214183] doi:10.2147/COPD.S164121
24. **Müller KI, Alstadhaug KB, Bekkelund SI.** Acceptability, feasibility, and cost of telemedicine for nonacute headaches: a randomized study comparing video and traditional consultations. J Med Internet Res. 2016;18:e140. [PMID: 27241876] doi:10.2196/jmir.5221
25. **Herbert MS, Afari N, Liu L, et al.** Telehealth versus in-person acceptance and commitment therapy for chronic pain: a randomized noninferiority trial. J Pain. 2017;18:200-211. [PMID: 27838498] doi:10.1016/j.jpain.2016.10.014
26. **Øra HP, Kirmess M, Brady MC, et al..** The effect of augmented speech-language therapy delivered by telerehabilitation on poststroke aphasia–a pilot randomized controlled trial. Clin Rehabil. 2020;34:369-381. [PMID: 31903800] doi:10.1177/0269215519896616
27. **Müller KI, Alstadhaug KB, Bekkelund SI.** A randomized trial of telemedicine efficacy and safety for nonacute headaches. Neurology. 2017;89:153-162. [PMID: 28615434] doi:10.1212/WNL.0000000000004085
28. **Noel K, Messina C, Hou W, et al.** Tele-transitions of care (TTOC): a 12-month, randomized controlled trial evaluating the use of telehealth to achieve triple aim objectives. BMC Fam Pract. 2020;21:27. [PMID: 32033535] doi:10.1186/s12875-020-1094-5
29. **Gunasekeran DV, Liu Z, Tan WJ, et al.** Evaluating safety and efficacy of follow-up for patients with abdominal pain using video consultation (SAVED study): randomized controlled trial. J Med Internet Res. 2020;22:e17417. [PMID: 32459637] doi:10.2196/17417
30. **Goedeke J, Ertl A, Zöller D, et al.** Telemedicine for pediatric surgical outpatient follow-up: a prospective, randomized single-center trial. J Pediatr Surg. 2019;54:200-207. [PMID: 30343977] doi:10.1016/j.jpedsurg.2018.10.014
31. **Augestad KM, Sneve AM, Lindsetmo RO.** Telemedicine in postoperative follow-up of STOMa PAtients: a randomized clinical trial (the STOMPA trial). Br J Surg. 2020;107:509-518. [PMID: 32100297] doi:10.1002/bjs.11491
32. **Hansen CR, Perrild H, Koefoed BG, et al.** Video consultations as add-on to standard care among patients with type 2 diabetes not responding to standard regimens: a randomized controlled trial. Eur J Endocrinol. 2017;176:727-736. [PMID: 28325823] doi:10.1530/EJE-16-0811
33. **Walle T, Erdal E, Mühlsteffen L, et al.** Completion rate and impact on physician-patient relationship of video consultations in medical oncology: a randomised controlled open-label trial. ESMO Open. 2020;5:e000912. [PMID: 33203685] doi:10.1136/esmoopen-2020-000912
34. **von Sengbusch S, Eisemann N, Mueller-Godeffroy E, et al..** Outcomes of monthly video consultations as an add-on to regular care for children with type 1 diabetes: a 6-month quasi-randomized clinical trial followed by an extension phase. Pediatr Diabetes. 2020;21:1502-1515. [PMID: 33009690] doi:10.1111/pedi.13133
35. **Nouryan CN, Morahan S, Pecinka K, et al.** Home telemonitoring of community-dwelling heart failure patients after home care discharge. Telemed J E Health. 2019;25:447-454. [PMID: 30036166] doi:10.1089/tmj.2018.0099
36. **Duke DC, Wagner DV, Ulrich J, et al.** Videoconferencing for teens with diabetes: family matters. J Diabetes Sci Technol. 2016;10:816-23. [PMID: 27075708] doi:10.1177/1932296816642577
37. **Harris MA, Freeman KA, Duke DC.** Seeing is believing: using Skype to improve diabetes outcomes in youth. Diabetes Care. 2015;38:1427-34. [PMID: 26033508] doi:10.2337/dc14-2469

38. **Harkey K, Kaiser N, Zhao J, et al.** Postdischarge virtual visits for low-risk surgeries: a randomized noninferiority clinical trial. JAMA Surg. 2021;156:221-228. [PMID: 33439221] doi:10.1001/jamasurg.2020.6265
39. **Taylor-Gjevre R, Nair B, Bath B, et al.** Addressing rural and remote access disparities for patients with inflammatory arthritis through video-conferencing and innovative inter-professional care models. Musculoskeletal Care. 2018;16:90-95. [PMID: 28967235] doi:10.1002/msc.1215
40. **Orlandoni P, Jukic Peladic N, Spazzafumo L, et al.** Utility of video consultation to improve the outcomes of home enteral nutrition in a population of frail older patients. Geriatr Gerontol Int. 2016;16:762-7. [PMID: 26171754] doi:10.1111/ggi.12551
41. **Wilkinson JR, Spindler M, Wood SM, et al.** High patient satisfaction with telehealth in Parkinson disease: a randomized controlled study. Neurol Clin Pract. 2016;6:241-251. [PMID: 27347441]
42. **Stephenson R, Todd K, Kahle E, et al.** Project Moxie: results of a feasibility study of a telehealth intervention to increase HIV testing among binary and nonbinary transgender youth. AIDS Behav. 2020;24:1517-1530. [PMID: 31760536] doi:10.1007/s10461-019-02741-z
43. **Ishani A, Christopher J, Palmer D, et al; Center for Innovative Kidney Care.** Telehealth by an interprofessional team in patients with CKD: a randomized controlled trial. Am J Kidney Dis. 2016;68:41-9. [PMID: 26947216] doi:10.1053/j.ajkd.2016.01.018
44. **Isetta V, Negrín MA, Monasterio C, et al; SPANISH SLEEP NETWORK.** A Bayesian cost-effectiveness analysis of a telemedicine-based strategy for the management of sleep apnoea: a multicentre randomised controlled trial. Thorax. 2015;70:1054-61. [PMID: 26310452] doi:10.1136/thoraxjnl-2015-207032
45. **Comín-Colet J, Enjuanes C, Verdú-Rotellar JM, et al.** Impact on clinical events and healthcare costs of adding telemedicine to multidisciplinary disease management programmes for heart failure: results of a randomized controlled trial. J Telemed Telecare. 2016;22:282-95. [PMID: 26350543] doi:10.1177/1357633X15600583
46. **Fatehi F, Gray LC, Russell AW, et al.** Validity study of video teleconsultation for the management of diabetes: a pilot randomized controlled trial. Diabetes Technol Ther. 2015;17:717-25. [PMID: 26181716] doi:10.1089/dia.2014.0416
47. **Ringbæk T, Green A, Laursen LC, et al.** Effect of tele health care on exacerbations and hospital admissions in patients with chronic obstructive pulmonary disease: a randomized clinical trial. Int J Chron Obstruct Pulmon Dis. 2015;10:1801-8. [PMID: 26366072] doi:10.2147/COPD.S85596
48. **Sorknaes AD, Bech M, Madsen H, et al.** The effect of real-time teleconsultations between hospital-based nurses and patients with severe COPD discharged after an exacerbation. J Telemed Telecare. 2013;19:466-74. [PMID: 24227799] doi:10.1177/1357633X13512067
49. **Silva M, Delfosse EM, Aceves-Martin B, et al.** Telehealth: a novel approach for the treatment of nondisplaced pediatric elbow fractures. J Pediatr Orthop B. 2019;28:542-548. [PMID: 31584922] doi:10.1097/BPB.0000000000000576
50. **Lugo VM, Garmendia O, Suarez-Girón M, et al.** Comprehensive management of obstructive sleep apnea by telemedicine: clinical improvement and cost-effectiveness of a virtual sleep unit. A randomized controlled trial. PLoS One. 2019;14:e0224069. [PMID: 31647838] doi:10.1371/journal.pone.0224069
51. **Müller KI, Alstadhaug KB, Bekkelund SI.** Telemedicine in the management of non-acute headaches: a prospective, open-labelled non-inferiority, randomised clinical trial. Cephalalgia. 2017;37:855-863. [PMID: 27301460] doi:10.1177/0333102416654885
52. **Müller KI, Alstadhaug KB, Bekkelund SI.** Headache patients' satisfaction with telemedicine: a 12-month follow-up randomized non-inferiority trial. Eur J Neurol. 2017;24:807-815. [PMID: 28432757] doi:10.1111/ene.13294
53. **Bennell KL, Nelligan R, Dobson F, et al.** Effectiveness of an internet-delivered exercise and pain-coping skills training intervention for persons with chronic knee pain: a randomized trial. Ann Intern Med. 2017;166:453-462. [PMID: 28241215] doi:10.7326/M16-1714
54. **Cremades M, Ferret G, Parés D, et al.** Telemedicine to follow patients in a general surgery department: a randomized controlled trial. Am J Surg. 2020;219:882-887. [PMID: 32252983] doi:10.1016/j.amjsurg.2020.03.023
55. **Perry TT, Halterman JS, Brown RH, et al.** Results of an asthma education program delivered via telemedicine in rural schools. Ann Allergy Asthma Immunol. 2018;120:401-408. [PMID: 29471032] doi:10.1016/j.anai.2018.02.013

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Appendix Table. Description of Other Components Included With Video Teleconferencing

Study, Year (Reference)	Component Type	Component Description
Comín-Colet et al, 2016 (45) (heart failure)	Remote patient monitoring	"The Home Tele-HealthCare (THC) Platform is a comprehensive solution for the care and monitoring of chronic patients, modelled and tested in patients with CHF that enables the provision of multichannel service and patient tracking through patient monitoring of biometric data (weight, heart rate, and blood pressure), symptoms reporting (7 questions to capture worsening symptoms of the cardiac condition, mainly worsening heart failure, and 1 question to capture general worsening), generation and management of warning alarms (biometrics out of range) and alerts (information related to the function of the household devices). . . All patients in the HFP + T group performed daily automated telemonitoring of biometrics and symptoms using the Home THC Platform."
Nouryan et al, 2019 (35) (heart failure)	Remote patient monitoring	"The technology utilized in this study was an FDA-approved computerized monitoring device, which connected the patient's residence, through wireless air card, broadband, or standard telephone line, to a nursing provider station. Electronic peripherals included a video monitor, blood pressure cuff, stethoscope, weight scale, and pulse oximetry monitor. Telehealth nursing staff monitored patient data on weekdays and conducted a weekly video visit, during which the nurse checked vital signs and listened for any abnormal lung sounds using stethoscope."
Gunasekeran et al, 2020 (29) (abdominal pain)	Platform for managing appointments and submitting history and symptoms before VTC appointment	"Patients in the intervention arm had access to DoctorBell, a novel telehealth platform accessible on smartphone or desktop by web browsers. This was designed using a design-thinking process based on the context and workflows of an emergency department. It allowed patient-led booking, rescheduling, or cancellation of 1 digital telereview appointment based on the patient's own individual availability, restricted to 48- to 72-hour window following discharge from the emergency department."
Hansen et al, 2017 (32) (diabetes)	VTC with an online platform to submit clinical patient data	"The intervention consisted of monthly video conferences with a health care center nurse via a tablet computer. Participants regularly uploaded measurements of blood sugar, blood pressure and weight directly from the meters via Bluetooth or USB jack to a tablet computer."
Halterman et al, 2018 (21) (pediatric asthma)	Mobile telemedicine unit with an online platform to submit patient history and symptoms before VTC appointment	"Briefly, a clinical telemedicine assistant who already worked in the school district brought a mobile telemedicine unit to the school and met with children, entered information regarding their symptoms and triggers, and uploaded physical examination data (i.e., images, height and weight data, and breath sounds). This information was securely stored in the telemedicine virtual waiting room until a clinician completed the visit from their office (within 3 days), or the visit was done in real-time using videoconferencing."
Isetta et al, 2015 (44) (OSA)	Virtual education or training for participants related to their disease/condition, questionnaire to monitor progress, and messaging tool built into website	"Patients randomised to the telemedicine group received their follow-up at home supported by a website developed for this study, where they could find information about OSA and CPAP therapy, and a biweekly 6-item questionnaire about their status, physical activity, sleep time, CPAP use, and treatment side effects. Each centre's staff monitored questionnaire answers and communicated with patients through the website messaging tool to solve treatment-related problems."
Ishani et al, 2016 (43) (chronic kidney disease)	Remote patient monitoring and virtual education or training for participants related to their disease/condition	"Participants in the intervention group received in-home training regarding how to use the device (LifeView; AmericanTeleCare) and all the peripherals (blood pressure cuff, scale, glucometer, pulse oximeter, stethoscope, and web camera) and how to contact the clinical team. . .A customized education program was developed based on each patient's comorbid conditions and was delivered over broadband to the device. Patients could interact with the educational modules at their own learning pace. Patients were also given a customized self-monitoring strategy based on their clinical condition. Vital signs were automatically measured by the device and transmitted to the study team."
Jeong et al, 2018 (20) (diabetes)	Remote patient monitoring and virtual education or training for participants related to their disease/condition	"All patients were instructed to perform SMBG and measure body composition and to transmit these data to the Smart Care Center by using the provided SCU. . .These patients also received general information about diabetes self-management once a week from the Smart Care Center."

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Appendix Table–Continued

Study, Year (Reference)	Component Type	Component Description
von Sengbusch et al, 2020 (34) (diabetes)	Platform for managing appointments and submitting continuous glucose monitoring data before appointment	"The study participants uploaded the diabetes treatment data into a cloud software of their choice 1 to 2 days before the appointment and sent a PDF file to the study diabetologists or allowed access to their private diabetes software account."
Ringbæk et al, 2015 (47) (chronic obstructive pulmonary disease)	Remote patient monitoring	"The TM equipment comprised a tablet computer with a web camera, a microphone, and measurement equipment (spirometer, pulse oximeter, and bathroom scale). Besides, patients reported changes in dyspnea, sputum color, volume, and purulence."
Bennell et al, 2017 (53) (chronic knee pain)	Virtual education or training for participants related to their disease/condition	"Participants received 3 Internet-delivered treatments. The first was educational material about exercise and physical activity, pain management, emotions, healthy eating, complementary therapies, and medications (www.arthritisaustralia.com.au). Participants were encouraged to access the material at their leisure. The second was an interactive automated PCST program (PainCOACH). Participants were asked to complete eight 35- to 45-minute modules (1 per week commencing in week 1) and practice pain-coping skills daily. These skills included progressive relaxation, activity–rest cycling, scheduling pleasant activities, changing negative thoughts, pleasant imagery and distraction techniques, and problem solving.
Gandolfi et al, 2017 (13) (Parkinson disease)	Video game–facilitated therapy	"TeleWii training included the following 10 exergames selected by the physiotherapist according to the patient's clinical condition and progressive improvement over time. The Skype video calls lasted the entire duration of each training session."

CHF = chronic heart failure; CPAP = continuous positive airway pressure; FDA = U.S. Food and Drug Administration; HFP + T = heart failure program plus telemedicine; OSA = obstructive sleep apnea; PCST = pain-coping skills training; SCU = smart care unit; SMBG = self-monitoring of blood glucose; TM = telemonitoring; VTC = video teleconferencing.