VA Virtual Care Consortium of Research (VC CORE)
State of the Art (SOTA) Conference

Pre-Conference Readings: Outcomes Workgroup

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Evidence and Findings on Outcomes of Virtual Care

Your pre-conference assignment is to review this evidence brief and the assigned readings focused on outcomes of Virtual Care (VC). As you read the brief, we ask that you record your thoughts on the Key Questions below to help facilitate and enrich our in-person group discussions. We also encourage you to compose additional discussion questions for the SOTA Conference.

During the SOTA, your workgroup facilitator(s) will lead the group through discussions towards the goal of reaching consensus on what is known (current evidence base) and what needs to be known (knowledge gaps) in key domains, thus allowing us to make and prioritize recommendations for future research related to virtual care. Following our discussions, workgroup leads will create a Powerpoint summarizing the discussion, agreed upon priorities and recommendations, which will be presented to all SOTA participants on Day Two of the conference.

Key Questions for the Outcomes Workgroup:

1. **What process measures specific to VC are needed to assess/improve quality of VC?** *Examples of process measures may include the amount of time it takes to connect to TH visits or the proportion of visits in which recommended care is provided (e.g., HbA1c measured at appropriate intervals for diabetic patients).*
    a) What VC structure/process-focused measures are associated with better outcomes?
    b) Assuming existing structure/process measures for traditional healthcare are maintained, what additional measures unique to VC should be measured?
2. **What VC outcomes (or categories of outcomes) are most important to track?**
    a) How do we or should we measure these outcomes?
3. **Based on the existing evidence about the processes and outcomes identified in Questions 1 and 2**
    a) When is VC better/equivalent/worse than in-person care?
    b) When should VC be a complement versus a substitute for in-person care?
    c) What evidence is available and what are the gaps in the literature?

Questions 3a, b, and/or c may be considered in relation to the following categories:

- Outcomes of video telehealth for specific diseases/settings
    - Acute care needs, such as acute mental health (e.g. for suicidal ideation), urgent care, emergency department or inpatient settings
    - Mental health
    - Primary/Specialty care
- Evidence for self-management in specialty care
- Evidence for incorporating Patient Generated Health Data (PGHD) into routine care effectively
- Outcomes for specific patient subgroups in video vs. telephone vs. in person
- Costs and cost-effectiveness of VC

To inform discussions at the Virtual Care (VC) SOTA, leaders for the Outcomes workgroup conducted a limited literature review of VC Outcomes across domains, modalities and contexts of care. We examined studies both within and outside of the VA health care system. The articles and ideas included in this document are not meant to be exhaustive, but aim to provide a foundation for discussion. Below, we summarize some of the key themes and findings of this literature search, including a framework for VC measurement, thoughts on potential intended and unintended consequences of VC and a synthesis of existing outcomes literature.

Background/Context

Virtual Care, such as telehealth, has been available for many decades. Yet prior to the COVID-19 pandemic, telehealth use was more limited, often to address specific clinical issues (i.e., lack of specialist availability). Telehealth use significantly increased in 2020, spurred by the COVID-19 pandemic, which resulted in temporary changes in healthcare delivery, regulations and reimbursement. While the shift to telehealth offers potential benefits, such as greater access to care for patients and potentially reduced costs, measuring the quality and outcomes of care provided via telehealth is critical.

Until recently, virtual care has largely supplemented traditional office or urgent care visits. The COVID-19 pandemic has catalyzed a new form of VC that instead may supplant traditional care, such as via entirely remote mental health services, as well as virtual-first primary care that is complemented by office or home visits when needed. There is therefore a need to understand the impact and outcomes of VC, both as a supplement and as a replacement to traditional care across outcome domains.

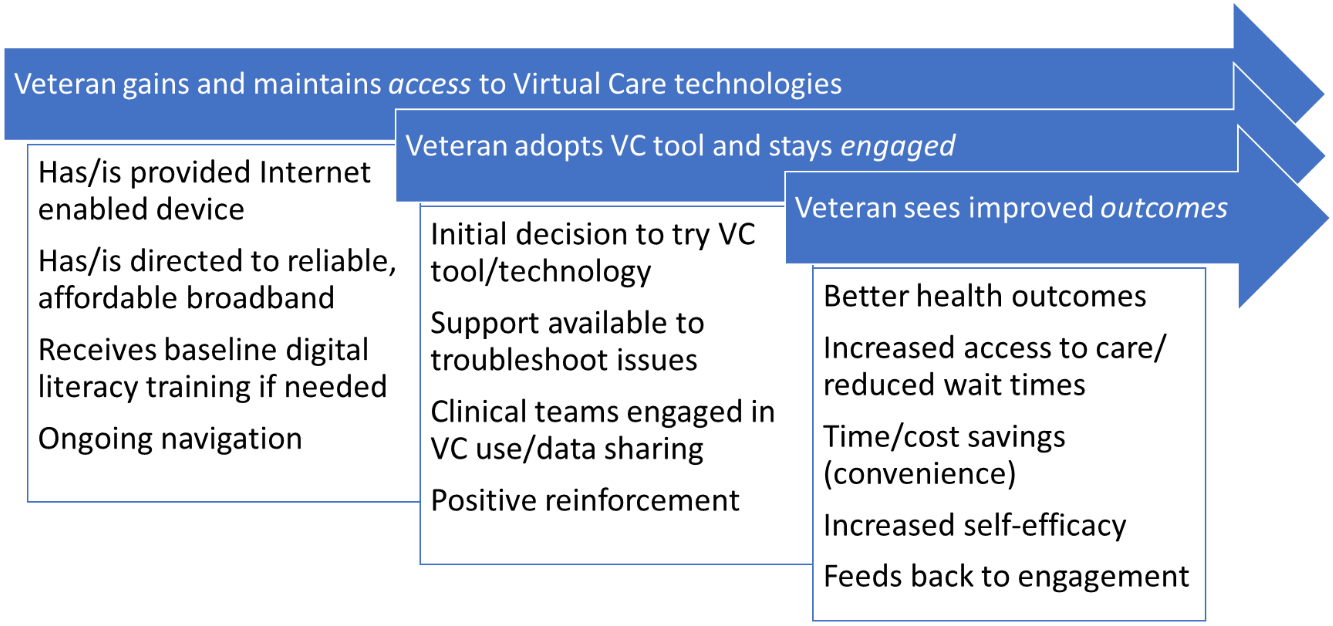
Efforts within VHA

For VHA's Office of Connected Care (OCC), the VC CORE's primary operational partner, it is increasingly important to demonstrate how its portfolio of virtual tools impacts "outcomes." OCC also recognizes, however, that many discussions of outcomes in the existing virtual care literature are narrowly focused on clinical outcomes and as such, risk overlooking other potentially important outcomes for Veterans, VHA clinical teams and the healthcare system. Working from this premise, OCC is collaborating with members of the HSR&D and QUERI communities through the eHealth Partnered Evaluation Initiative to develop a framework that can help the Office more fully account for the universe of potential outcomes associated with their technologies. This framework development effort is currently underway and has involved a combination of participatory approaches involving key stakeholder input and a review of studies within VHA's HSR&D portfolio focused on virtual care technologies. These activities have yielded a preliminary set of eight overarching outcome categories:

- Digital Access and Support
- Self-Management Processes
- Service Delivery Processes
- Veteran and Caregiver Experiences
- Healthcare Team Member Experiences
- Quality and Clinical Outcomes
- VA's Reputation
- Cost

This outcomes framework will be completed later this year and is envisioned as a communications tool that OCC leadership will be able to reference in discussions with the research community, other operational and clinical offices and VHA leadership. Stay tuned for more information in the months ahead.

Our temporal model of Virtual Care *access, engagement and outcomes* below includes a few examples of outcomes in these categories and aims to display our three workgroups in relation to each other, in order to disambiguate where themes of these groups may appear to overlap.



Section 1. Existing Frameworks for Measuring Virtual Care

Quality measurement for Virtual Care is in its infancy. In 2017 the National Quality Forum (NQF) published a Framework to Support Measure Development for Telehealth that includes four domains[1]. Each domain is further delineated into subdomains (see right). This framework can serve as a helpful guide to orient our discussion around important categories of telehealth outcomes.

The report includes definitions for each of the domains and subdomains, measure concepts and specific measures of structures, processes and outcomes of VC, as well as case studies demonstrating the use of some of these concepts. We have included the report in its entirety as *optional reading* (in a separate attachment), with highlighted examples and case studies of measure concepts (pages 10-19 in the report). The appendices with tables describing measure concepts and selected measures for each domain (pages 39-46 in the report) will also be helpful foundation for the discussion of this workgroup.

Domain	Subdomain(s)
Access to Care	• Access for patient, family and/or caregiver • Access for care team • Access to information
Financial Impact/ Cost	• Financial impact to patient, family and/or caregiver • Financial impact to care team • Financial impact to health system • Financial impact to society
Experience	• Patient, family and/or caregiver experience • Care team member experience • Community experience
Effectiveness	• System effectiveness • Clinical effectiveness • Operational effectiveness • Technical effectiveness

Section 2. Potential Impacts of Virtual Care on Quality

In 2001, the Institute of Medicine defined high-quality care as being safe, effective, efficient, timely, patient-centered and equitable. Article 1 (Herzer and Provonost) of our assigned reading uses this framework to assess virtual care challenges and opportunities. We outline some key take-aways from Article 1[2] below.

1. **Safety and effectiveness**
   a. There is a potential for **decreased** health measurements during telehealth visits. For example, an analysis of 125.8 million primary care visits found that assessment of blood pressure declined by 37% (from 74.4% of all primary care visits in April-June 2018/2019 to 47.2% in April-June 2020) and measurement of cholesterol levels declined by 20% (from 23.2% to 18.5%), in part because of the significant increase in virtual visits during which such assessment was less likely. Yet, we don't know if this will impact health outcomes. Article 2 (Khoong et al) below will expand on safety concerns.

2. **Timeliness and efficiency**
   a. Visits that do not require in-person assessment require less time commitment from patients, avoiding the costs of transit and lost productivity. Office visits could then be prioritized for more complex patients or situations. VC visits could also be scheduled between office appointments for follow up or addressing additional issues in complex patients. VC could also reduce delays through "on-demand" virtual appointments and more flexible hours and clinical staffing.
   b. However, the convenience of VC could lead to more unnecessary visits, supplementary office or home visits or more tests to compensate for the absence of a physical exam.

3. **Patient-centeredness and equity**
   a. The choice to use VC should be respectful of patient preferences and values; just like in-person care, VC should incorporate shared decision-making and facilitate rapport and trust between patients and physicians.
   b. VC could increase access to care for individuals who have mobility limitations, work multiple jobs or irregular hours, have complex childcare needs or cannot find specialists where they live.
   c. Accessing VC requires internet access with adequate broadband capabilities, a smartphone or computer, digital literacy and some form of health insurance, which may disadvantage some US residents who are older, have lower incomes or live in rural places (note: these issues are being discussed in the Access Workgroup).

4. **Potential Guiding Principles**
   a. Comparative effectiveness research across disciplines is needed to gauge the performance of VC on process and outcome measures of quality.
   b. More research is needed to determine when VC should be substitutive versus additive.
   c. Retrospective analyses of claims data estimating the share of visits that could be "virtualized" do not substitute for rigorous randomized trials and prospective studies.
   d. VC services should exist as part of a comprehensive population health strategy.

The rapid shift to telehealth experienced across healthcare systems requires attention to unintended consequences. Chief among these are the implications for patient safety. By identifying factors that heighten safety risks in telemedicine, we can mitigate them.

Article 2 (Khoong et al) uses a framework created by the Agency for Healthcare Research and Quality (AHRQ) and highlights two domains of ambulatory safety that could be negatively impacted by VC and three strategies used to address these vulnerabilities[3]. (*We note that it is possible to imagine ways in which VC may positively impact these domains as well*).

1. **Diagnostic errors**
    a. Inadequate or lower quality history or physical exam (especially with audio-only encounters or other factors that reduce communication quality).
    b. Reliance on patients to collect key data (vital signs, description of physical findings).
    c. Increased cognitive load on clinician from potential reduction in team-based care.
    d. Changes in diagnostic work-up procedures.

2. **Medication safety**
    a. Patient-provider communication challenges may impede high-quality medication reconciliation, which is an evidence-based approach to prevent adverse drug events.
    b. Potential lack of access to other team members to conduct more in-depth medication reconciliation (e.g., pharmacist).
    c. Increased reliance on patients' literacy, language skills or technology skills to conduct medication reconciliation.
    d. Change in availability of tools that can be used to ensure shared understanding of medication regimens (e.g., after visit summaries).

The authors go on to make three recommendations to move from an anecdotal understanding of safety in VC to a robust evidence-based practice, broken down by stakeholder.

3. **Recommendations**
    a. **Recommendation 1:** *Systematically measure patient safety outcomes and increase reporting of safety incidents, with a focus on those most likely increased by telehealth.*
        i. **Researchers**
            1. Explicitly include safety outcomes, particularly those identified in existing ambulatory patient safety literature.
            2. Include easily measured outcomes extracted from the electronic health record.
        ii. **Healthcare systems**
            1. Improve infrastructure to ease clinician use and access to incident reporting systems.
            2. Increase patient engagement in safety evaluations by increasing opportunities for patients to report safety incidents and including patients in quality and safety committees.

    b. **Recommendation 2:** *Identify the patients and clinical scenarios with the greatest risk of unsafe telemedicine care.*
        i. **Researchers**
            1. Identify patient characteristics that may increase risk for safety incidents.

        2. Evaluate clinical scenarios when telemedicine can facilitate safer care, including variations in chief complaints, visit purpose, clinician specialty or type of telemedicine.
        3. Focus on comparative effectiveness evaluations.
    ii. **Healthcare systems**
        1. Disseminate and describe telemedicine implementation strategies to facilitate research that explores the issues above.
        2. Partner with evaluators to ensure rigorous, real-world evaluations.

c. **Recommendation 3:** *Identify and support best practices to ensure equal access to safe telemedicine care.*
    i. **Research funders**
        1. Fund evidence generation to identify best practices.
    ii. **Healthcare systems**
        1. Proactively support video encounters for as many patients as possible (as opposed to audio-only visits).
        2. Develop strategies to support patients that may have challenges accessing video telemedicine encounters, such as older patients and patients with language barriers or limited digital literacy.
    iii. **Policymakers**
        1. Increase funding for programs that improve digital infrastructure (broadband) and digital access (low-cost broadband and devices).
    iv. **Healthcare payors**
        1. Provide reimbursement to support all patients in accessing telemedicine care.
        2. Recognize additional resources are needed by clinicians that serve patients with challenges accessing telemedicine.
        3. Reimburse for remote monitoring tools and home diagnostic procedures.

Section 3. Outcomes of Virtual Care in the Literature

Below we summarize key VC outcome findings, as reported in recently published review articles.

1. **Synchronous Telehealth**
    a. **Video Teleconferencing (VTC)**
        i. **Article 3** (Albritton et al) is a rapid literature review that examines the clinical effectiveness and harms of **VTC** for disease prevention, diagnosis and treatment compared with usual care[4].
            1. The review included findings from 38 randomized controlled trials, all of which had at least 50 participants. Studies compared patients who received care via VTC to a comparator group. Eligible comparators included 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.
            2. Studies that used VTC to **replace** usual care, as well as studies that used VTC to **augment** usual care, were included.

a. Of note, mental health, maternal health and obesity studies were excluded from this review.

3. For the specific disease conditions reviewed (e.g. diabetes; certain respiratory, neurologic, and cardiovascular conditions; and pain management), VTC produced similar outcomes compared with usual care.

   a. *Note: this finding is* consistent with another recent study within VA, where despite a shift to virtual visits and a decrease in A1c measurement during the pandemic, Aubert et al observed no associated changes in subsequent A1c levels or short-term T2D-related outcomes[5].

4. There were no notable differences in clinical outcomes between studies that used VTC to replace usual care versus studies that used VTC to augment usual care, although no study directly compared these two approaches.
5. None of the studies reported statistically significant differences in harms between the intervention and comparison groups; however, many studies did not include any data regarding harms.
6. No more than 4 studies (of adequate quality) addressed any single disease category, and no adequate-quality studies addressed key conditions such as cancer, postoperative follow-up, HIV, rheumatoid arthritis, or comorbid conditions.

ii. **Article 4** is an excerpt from the California Health Benefits Review Program (**CHBRP**), which sought to review the existing telehealth literature to inform telehealth coverage and reimbursement policies for the state of California[6].

1. The CHBRP assessed the medical effectiveness of **video and phone (audio-only)** telehealth by conducting a literature review of recent, high-quality research. They were specifically interested in health outcomes, processes of care, access and utilization. They use the following terminology to classify their results:
   a. **Preponderance of evidence** indicates that the majority of the studies reviewed are consistent in their findings that treatment is either effective or not effective.
   b. **Clear and convincing evidence** indicates that there are multiple studies of a treatment and that the large majority of studies are of high quality and consistently find that the treatment is either effective or not effective.
   c. **Inconclusive evidence** indicates that although some studies included in the medical effectiveness review find that a treatment is effective, a similar number of studies of equal quality suggest the treatment is not effective.
2. Findings for video care included a **preponderance of evidence** that care delivered by live video is at least as effective as in-person care for health outcomes for several conditions and health care settings, including infectious disease, obesity, diabetes and abortion.
3. There is **clear and convincing evidence** that mental health services for attention deficit/hyperactivity disorder (ADHD), depression and posttraumatic stress disorder (PTSD) delivered by live video are at least as effective as in-person care for **processes of care and health outcomes**.

a. In less common mental health conditions and physical conditions requiring psychological support, a systematic review found **insufficient evidence of a difference** between psychotherapy delivered via telehealth and the same therapy delivered face-to-face. However, there was **no includable evidence** in this review for some serious mental health conditions, such as schizophrenia and bipolar disorders, and further high-quality research was considered needed to determine whether telehealth is a viable, equivalent treatment option for these conditions.

4. There is **clear and convincing evidence** that dermatology diagnoses made via live video are as accurate as diagnoses made during in-person visits.
5. There is a **preponderance of evidence** that scores on neurocognitive tests administered via live video are similar to scores obtained when tests are administered in person.
6. Studies have also found diagnostic concordance between live video and in-person examination for shoulder disorders, otolaryngology and fetal alcohol syndrome.
7. There is **limited evidence** that care delivered by live video is at least as effective as in-person care for **access to care and utilization.**

b. Audio-only (phone) Care:

i. The CHBRP found that for the diseases and conditions studied (e.g., multiple sclerosis, cystic fibrosis, head and neck surgery postoperative visits), there is a ***preponderance of evidence*** that telephone consultations were at least as effective as in-person consultations on **health outcomes.**

ii. For the diseases and conditions studied, findings from studies of the effect of telephone consultations on **processes of care** (e.g., antibiotic prescribing) and **access to care and utilization** are inconsistent.

c. Findings comparing video to phone care:

i. There is ***preponderance of evidence*** that behavioral health services delivered by live video are comparable to services delivered by telephone consultation on **health outcomes**.

1. The review does state, however, that a meta-analysis found video care to be slightly more beneficial than phone for treatment of trauma and depression.

ii. CHBRP found no studies that compared live video to telephone consultation on outcomes for **processes of care** and **access to care and utilization**.

2. Remote Patient Monitoring

Remote monitoring is of particular interest as it makes new or significantly different forms of information and treatment available that can supplement and extend office-based care rather than replace face-to-face interactions. AHRQ's 2016 evidence map of patient telehealth outcomes noted that the research literature on remote patient monitoring is vast and varied, consisting of hundreds of systematic reviews and thousands of studies of use across various clinical conditions and health care functions[7]. The evidence map included figures showing the intersection between clinical focus and telehealth function. For remote patient monitoring, specifically, the report concludes that:

a. There is sufficient evidence to support the effectiveness of remote patient monitoring for patients with chronic conditions, such as diabetes.
b. Systematic reviews that reported no benefits explored very different applications of remote monitoring, (e.g., use of home uterine monitors to prevent preterm births, use of video monitoring to observe babies in neonatal intensive care units).

For high level summaries of studies related to Remote Patient Monitoring, see **Figures 9 &10** from *Telehealth: Mapping the Evidence for Patient Outcomes From Systematic Reviews,* p. 48-50.

3. Automated Entry Patient-Generated Health Data (PGHD)[8]

AHRQ recently completed a technical brief to summarize the research related to consumer devices that collect and transmit PGHD (e.g., home blood pressure monitors, blood glucose monitors, fitness trackers, wireless scales) for the prevention or management of 11 chronic diseases[8]. The majority of studies on PGHD technologies were focused on non-health-related outcomes, and PGHD technologies are often provided as part of a multicomponent intervention. Lack of reporting of health outcomes and insufficient statistical power to assess these outcomes were the main reasons for “unclear” ratings below. Authors felt that future studies should attempt to determine the specific impact of PGHD, place a greater emphasis on the measurement of health outcomes and study long-term effects.

a. For **coronary artery disease, heart failure and asthma**, there was a **possible positive effect** of PGHD technologies on health outcomes.
b. For obesity, health outcome data was **unclear**, and there was consistent evidence of a **lack of effect** of PGHD interventions on the surrogate outcome of body mass index/weight.
c. For hypertension, health outcome data was **unclear**, and there was evidence of a **possible positive effect** of PGHD interventions on the surrogate outcome of blood pressure.
d. For cardiac arrhythmias, health outcome data was unclear but there was consistent evidence of a **beneficial effect** of PGHD interventions on the surrogate outcome of time to arrhythmia detection.
e. The evidence on both health outcomes and surrogate outcomes was **unclear** for COPD, diabetes prevention, sleep apnea, stroke and Parkinson’s disease.

4. Short Message Service (SMS) and Mobile Applications

Limited evidence exists on text messaging interventions and mobile applications in most care contexts, but evidence is generally positive where these interventions have been studied, particularly in the areas of self-care management and mental health.

a. Findings from a 2019 meta-analysis indicated that mHealth interventions are significantly more effective than comparison conditions at improving health outcomes across five measured topics: mental health, nutrition and weight status, physical activity, health-related quality of life and well-being, and chronic disease management (diabetes), with effect sizes impacted by key moderators, namely[9]:
    i. *Theoretical paradigm*: mHealth interventions based on cognitive and behavioral theories were more effective than those applying no theory.
    ii. *Types of engagement*: interventions with the function of changing one’s personal environment (e.g., with soothing sounds) and reinforcement tracking (e.g., with personalized messages based on users’ progress on health outcomes) were significantly more effective.

    iii. *Mobile use type*: interventions combining text messaging and mobile apps were significantly more effective than either modality by itself.
    iv. *Intervention channel*: interventions combining mobile phone with another type of media (e.g., video) were more effective than interventions using mobile phone only or combining mobile phone with face-to-face communication.

b. An earlier systematic review from 2017 found that mobile apps and text messaging were effective in promoting weight management/physical activity, smoking cessation and medication adherence, as well as in the treatment of anxiety, depression and stress[10].
c. Finally, while evidence in specialty care was limited, one 2018 systematic review of 10 RCTs and one quasi-experimental study conducted among heart failure (HF) patients reported that mobile technologies can improve HF-related outcomes, with significantly reduced HF-related hospital days and reduction trends in total mortality and HF-related admissions, mortality and cost[11]. However, the study also reported increased *total* costs related to more clinic visits and implementation of technologies.
d. In a systematic review of text messaging protocols for patients with psychosis, most studies demonstrated positive effects on dimensions of engagement, including medication adherence, clinic attendance and therapeutic alliance. Cost-effectiveness and safety considerations were not adequately examined in the studies included.

5. Patient Portals

Patient portals have been widely implemented to engage patients in healthcare for over a decade, as incentivized by the Meaningful Use provision of the Health Information Technology for Economic and Clinical Health (HITECH) Act. Our workgroup reviewed three systematic reviews of the impacts of patient portal use[12-14]. A common finding across these reviews was conflicting study results.

a. Generally, the systematic reviews did not find clinically relevant health-related effects for patients with chronic diseases or mental health conditions.
    i. A potential reason posited for this was that the patient portal was often not used consistently. For example, in one study, the number of logins declined over time. In another, less than 25% of patients used the portal consistently. In one RCT, 16% of patients never logged in over the three-month study period[12].
    ii. Sub-group analysis of the intervention groups revealed that, in these groups, portal users show better outcome than portal nonusers. However, users of the patient portal were more often male, white, commercially insured and college-educated, all of which are patient characteristics associated with better health outcomes. Therefore, the identified difference may be an overestimation of the true effect[12].

b. A significant association was found between patients' preventive health behaviors and portal use[13].
    i. Concerning diabetes, portal users were significantly more likely to control their HbA1c levels successfully compared to nonusers.
    ii. Concerning mental health, portal use had a positive impact related to clinical conditions in health behavior domains, such as the reduction of drinking days.
        1. However, no marked short-term impact on health status was described.

c. Evidence on cost and utilization was conflicting[13].

i. In one study, active portal users showed more outpatient and inpatient visits, but fewer ER visits per month, compared with patients without an account.
ii. In others, a reduction in hospitalizations was described for asthma and mental health conditions.
iii. Different findings were observed in patients with acute myocardial infarction, congestive heart failure or pneumonia. In these cases, the odds of 30-day readmission for active users was 66% higher than that for nonusers, while no significant difference was described between nonusers and light users. (*This may be inherently biased as a patient experiencing symptoms is more likely/motivated to log-in in the portal to seek care, therefore readmissions might be more common because they are sicker or more symptomatic.*)
iv. Portal use by patients reduced missed appointments and showed an improvement in appointment adherence after portal adoption.
v. Portal use was associated with fewer missed workdays due to asthma issues.
vi. Lastly, portal use may decrease administrative workload among clinic staff, as it led to a reduced number of information requests.

6. Evidence on Cost and Utilization

The AHRQ Evidence Map found that information on costs is limited; additional research examining costs and utilization is needed[7].

a. Very few studies considered the overall cost-impact or cost-effectiveness of an intervention; rather they documented individual costs or resource use measures considered in isolation.
b. Comprehensive cost analyses are needed to understand the full implications of telehealth in various situations.
c. Several of the above-mentioned reviews further underscored that cost information was incomplete or inconsistently reported.

For findings from studies related to Cost and Utilization of care, see **Table 7** from *Telehealth: Mapping the Evidence for Patient Outcomes From Systematic Reviews,* p. 51.

7. Evidence on Patient and Clinical Team Satisfaction

Many factors identified in the literature as associated with satisfaction are the same that are discussed in literature relating to *engagement* with VC. As such, our planning committee examined some reviews in this domain that provide an overview of the evidence, but included them as optional reading. Our full workgroup may choose to focus on other outcome domains, as the engagement workgroup will be discussing satisfaction in more depth.

a. Nguyen et al conducted a review of both patient and provider satisfaction that investigates key dimensions including the technology's perceived usefulness, its ease of use and reliability, who the stakeholders are (providers, patients, and administrators), the type of care (medical specialty and asynchronous, synchronous, or mobile health), type of system used (e.g., ongoing care, consultation, triage) and the context in which the care is delivered)[15].
    i. The most common satisfaction/effectiveness factors reported by studies in the review were:

1. Improved patient reported outcomes
2. Preferred modality of care
3. Ease of use
4. Improved communication
5. Access and quality of care
6. Self-management
7. Self-efficacy
8. Medication adherence

ii. In the studies shown, patients reported high satisfaction with telemedicine when compared to in-person appointments. Frequently mentioned benefits of virtual care included decreased travel times and cost, smaller time commitments and decreased wait times.

1. Patients reported similar satisfaction with reduced wait times resulting from asynchronous testing via telemedicine. Most found the technology easy to use and the same or better than traditional testing.
2. In Dermatology, Marchell et al (2017) found that in-person examinations were preferred both by patients and providers[16]. However, both patients and providers had no preference between asynchronous or synchronous telemedicine, and Mounessa et al (2018) found that 96% of patients and 82% of providers were satisfied with asynchronous teledermatology[17].

iii. Patients were more likely to be satisfied with telemedicine if they were already comfortable with technology in general, and patients and providers reported that they were more likely to use telemedicine successfully if they were more experienced (or coached by someone more experienced), flexible, tolerant and creative and had strong problem-solving skills.

iv. Provider satisfaction was higher when telemedicine was supported by opinion leaders, the format was well-matched to patient context and had adequate resources.

v. Providers who were satisfied with telehealth were more likely to mention positive working relationships with staff.

vi. For providers, disincentives to use VC included perceived difficulty to use, lack of accessibility and reduced incentives. However, involving providers in the design of VC programs and personal tendencies towards innovation and self-sufficiency may overcome disincentives.

vii. Based on their review the authors provided recommendations for improved patient and provider satisfaction, summarized in the table below.

Improved provider satisfaction	**Improved patient satisfaction**
Involve providers in the design of the VC program	Promote realistic expectations before the visit takes place
Administrative support for use of VC	Use satisfaction surveys formatively to improve the experience of telemedicine
Easy to use, reliable technology	Easy to use, reliable technology
Involve appropriate providers who are flexible, enjoy innovation	Involve appropriate patients who are adaptable and who welcome the convenience of the new technology
Adequate reimbursement for VC	

b. In another systematic review (Kruse, et al 2017) of patient satisfaction with VC, authors only included articles that also had discussed VC effectiveness or efficiency from the patient's perspective[18]. Effective was defined as achieving patients' desired results / outcomes. Efficient was defined as performing or functioning in the best possible manner with the least waste of time and effort.
   i. Multiple telehealth interventions and modalities were examined, including videoconferencing, telephone, remote patient monitoring, text messaging, smartphone applications and others.
   ii. Of the 44 articles reviewed, most studies reported high and very high patient satisfaction and preference for telehealth modality, with very few exceptions:
      1. Polinski et al, 2016 reported that only 33% of the patients preferred telehealth visit vs in-person[19].
      2. Another study reported concerns about public perceptions of wearable devices.
   iii. In addition, several studies reported higher satisfaction with efficiency measures including low cost, decreased wait and travel times and decreased missed appointments and in-person visits.

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VIEWPOINT

Ensuring Quality in the Era of Virtual Care

Kurt R. Herzer, MD, PhD, MSc
Johns Hopkins School of Medicine, Baltimore, Maryland.

Peter J. Pronovost, MD, PhD
University Hospitals, Case Western Reserve University School of Medicine, Cleveland, Ohio.

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Multimedia

Corresponding Author: Peter J. Pronovost, MD, PhD, Case Western Reserve University, University Hospitals Health System, Cleveland, OH 44106-1716 (peter.pronovost@uhhospitals.org).

The coronavirus disease 2019 (COVID-19) pandemic, aided by a relaxation in federal telemedicine regulations, has ushered in a new era of virtual care. Physicians and patients have substantially increased their adoption and use of virtual care. According to one report, an estimated 1.6 million telemedicine visits were conducted early in the pandemic, between January and March 2020, representing approximately 50% more telemedicine visits than occurred in the same period in 2019.[1] Based on aggregated payer data covering 150 million privately insured individuals in the US, by April 2020 telemedicine visits accounted for 13% of all medical claims compared with 0.15% in April 2019, an 86-fold increase.[2]

Virtual care refers to patient-physician interactions related to diagnosis, evaluation, and management conducted remotely using some combination of text, audio, and video either synchronously or asynchronously. Until recently, virtual care has largely supplemented traditional office or urgent care visits. The COVID-19 pandemic has catalyzed a new form of virtual care that instead seeks to supplant traditional care, such as with virtual-first primary care complemented by office or home visits when needed. For some disciplines, like mental health, virtual care could become the dominant form of encounters. Despite the growing enthusiasm and use of virtual care, there has been limited discussion of its quality and the principles that should inform its development and assimilation into the US health care system.

> Health systems, health plans, and health technology companies should ultimately demonstrate that virtual care represents an effective, efficient, and equitable contribution to the US health care system.

In 2001, the Institute of Medicine described high-quality care as being safe, effective, efficient, timely, patient centered, and equitable.[3] This Viewpoint uses this framework to assess the current state and challenges of virtual care and suggests 3 principles to guide the development of virtual care going forward.

Safe and Effective

The highest priorities of medicine are to avoid patient harm and deliver evidence-based care.[3] Current virtual encounters, such as for refilling prescriptions, treating low-severity symptoms, and counseling for mental health, are broadly accepted. In the future, virtual care may enable joint visits among patients, primary care physicians, and specialists, potentially improving care coordination and effective treatment.

However, there is limited high-quality evidence that virtual primary care does not harm patients, such as through misdiagnosis, and achieves the same or better clinical outcomes as traditional care.[4] Clinical practice guidelines, which presuppose a conventional in-office visit—supported by a physical examination, objective measurement of clinical data, equipment, and teamwork common to the office setting, may not generalize to the virtual setting. Early evidence from the COVID-19 pandemic based on an analysis of 125.8 million primary care visits suggests that assessment of blood pressure declined by 37% (from 74.4% of all primary care visits in April-June 2018/2019 to 47.2% in April-June 2020) and cholesterol levels by 20% (from 23.2% to 18.5%), in part because of the significant increase in virtual visits during which such assessment was less likely.[5] For example, in the second quarter of 2020, 69.7% of primary care office-based visits had recorded blood pressure assessment compared with 9.6% of telemedicine visits.[5] Given the failure of the US health care system to detect, diagnosis, and treat patients with hypertension, these data are concerning.[6]

Efficient and Timely

High-quality care avoids wasted effort and harmful delays.[3] How virtual care affects efficiency may be mixed. Visits that do not require in-person assessment could be completed more quickly, avoiding the costs of transit and lost productivity for patients. Office visits could then be prioritized for more complex patients. Virtual care could also reduce delays through "on-demand" virtual appointments and more flexible hours or clinical staffing.

However, the convenience of virtual care could lead to more unnecessary visits. Separately, the need to frequently supplement a virtual visit with an office or home visit to investigate a patient's concerns or clinical issues would have an additive effect on utilization and require extra effort by patients. Physicians could also order incrementally more tests than they otherwise would to compensate for the absence of a physical examination or to mitigate liability concerns around misdiagnosis given the lack of established practice norms and standards of care in the virtual setting. Taken together, these sources of inefficiency could needlessly add to the total cost of care within a population, particularly if telemedicine continues to be reimbursed at similar rates as in-person care.

Patient Centered and Equitable

All forms of care should be respectful of patient preferences and values and not vary in quality because of personal characteristics, such as sex/gender, race, and socioeconomic status.[3] Shared decision-making that incorporates patients' preferences relies on a foundation of rapport and trust with physicians. Whether the virtual setting facilitates this rapport and engages patients as active participants in longitudinal care remains to be seen. As virtual care subsumes primary care, effectively counseling patients through new diagnoses, difficult treatment decisions, or sensitive topics will be increasingly necessary.

Health care disparities exist when receipt of care varies on the basis of personal characteristics, such as sex/gender, race, and socioeconomic status, and is not explained by differences in individual preferences or health needs.[3] Virtual care could increase access to care for individuals who have mobility limitations, work multiple jobs or irregular hours, have complex child care needs, or cannot find specialists where they live. But accessing virtual care requires internet access, a smartphone or computer, digital literacy, and some form of health insurance, which may disadvantage some US residents who are older, have lower income, or live in rural places.[7]

Potential Guiding Principles

As health systems, health plans, and health technology companies expand their virtual care offerings, several principles could be helpful to guide this pursuit.

First, virtual care should achieve comparable safety and effectiveness as traditional care. Comparative effectiveness research across clinical disciplines is needed to gauge the performance of virtual care on process and outcome measures of quality. Retrospective analyses of claims data estimating the share of visits that could be "virtualized" do not substitute for high-quality randomized trials and prospective studies. To reduce unwarranted variation in practice, medical professional societies could adapt clinical practice guidelines to the virtual setting, with a focus on addressing the absence of objective clinical data and enumerating when diversion from virtual to traditional care is warranted. Regulators could likewise adapt quality reporting systems to assess virtual care, hold myriad organizations delivering virtual care accountable, and share relevant data with the public.

Second, virtual care should achieve a net increase in efficiency within the health care system and not add to the total cost of care. Integrated health systems that have the full spectrum of care delivery assets, such as acute care hospitals, skilled nursing facilities, and outpatient practices, may be best positioned to deploy virtual care services as part of a comprehensive population health strategy. In contrast, venture capital–backed virtual primary care companies could further fragment patient care and silo the data gathered in virtual visits from other clinicians and health care organizations. Given the multitude of these emerging virtual care offerings, it is unclear how patients and physicians will incorporate them into a coherent longitudinal care experience. To mitigate the risk that an inefficient mix of virtual care and in-person care increases total costs of care, payers could promote efficiency through alternative payment models like global payments or bundling that encourage clinicians to identify the highest-value applications of virtual care for their patients. Payers also could selectively cover virtual care for certain patient populations, types of clinicians, or conditions in which the clinical rationale is sound and costs are likely substitutive rather than additive. With their comprehensive data on utilization, payers are well suited to generate evidence about how patients use virtual care and influence the effects of virtual care on cost and quality.

Third, virtual care should be respectful of patient preferences and values and not exacerbate health care disparities within a population. Lower-income and minority populations, who already experience significant disparities in health care quality,[8] could be induced into using virtual care products or systems with unclear effectiveness. For example, some health insurers are selling plans in 2021 offering lower premiums and minimal or no cost sharing for virtual primary care compared with traditional care. Early adopters to these plans have no opportunity to evaluate quality of care and may opt in solely on the basis of low out-of-pocket cost. Alternatively, if virtual primary care proves effective, it may disproportionately cater to younger populations at the expense of older, less educated, and minority populations who are less likely to possess the necessary digital literacy and technology.[7] Scrutiny of such disparities is needed as virtual care evolves.

Conclusions

Proponents of virtual care imagine a future in which a substantial proportion of patient care may be delivered and received virtually, abetted by an increasing number and variety of wearables, remote medical devices, and mobile apps that integrate with electronic health records. In the near term, virtual care more accurately presents trade-offs among the domains of quality (increasing timeliness at the expense of effectiveness). Still, physicians' fundamental duty to patients remains unchanged. Health systems, health plans, and health technology companies should ultimately demonstrate that virtual care represents an effective, efficient, and equitable contribution to the US health care system.

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The Abrupt Expansion of Ambulatory Telemedicine: Implications for Patient Safety

Elaine C Khoong, MD, MS[1,2], *Anjana E Sharma, MD, MAS*[2,3], *Kiran Gupta, MD, MPH*[4], *Julia Adler-Milstein, PhD*[5,6], *and Urmimala Sarkar, MD, MPH*[1,2]

[1]Division of General Internal Medicine at Zuckerberg San Francisco General Hospital, Department of Medicine, University of California San Francisco, San Francisco, CA, USA; [2]UCSF Center for Vulnerable Populations at Zuckerberg San Francisco General Hospital, San Francisco, USA; [3]Department of Family and Community Medicine, University of California San Francisco, San Francisco, USA; [4]Division of Hospital Medicine, Department of Medicine, University of California San Francisco, San Francisco, USA; [5]Center for Clinical Informatics and Improvement Research (CLIIR) at University of California San Francisco, San Francisco, USA; [6]Department of Medicine, University of California San Francisco, San Francisco, USA.

The exponential growth of telemedicine in ambulatory care triggered by the COVID-19 public health emergency has undoubtedly impacted the quality of care and patient safety. In particular, the increased adoption of remote care has impacted communication, care teams, and patient engagement, which are key factors that impact patient safety in ambulatory care. In this perspective, we draw on a scoping review of the literature, our own clinical experiences, and conversations with patient safety experts to describe how changes in communication, care teams, and patient engagement have impacted two high priority areas in ambulatory safety: diagnostic errors and medication safety. We then provide recommendations for research funders, researchers, healthcare systems, policy makers, and healthcare payors for how to improve patient safety in telemedicine based on what is currently known as well as next steps for how to advance understanding of the safety implications of telemedicine utilization.

KEY WORDS: Ambulatory care; Patient safety; Telemedicine; Diagnostic errors; Medication errors.

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COVID-19 spurred significant growth in telemedicine use in American ambulatory healthcare. Previously, telemedicine (which we define as synchronous, scheduled video or telephone visits between clinicians and patients) had been limited primarily to specific clinical scenarios (e.g., specialty consultations in rural areas, low acuity concerns) or large health systems. The pandemic expanded telemedicine to additional contexts and populations. Moving forward, telemedicine use will remain more prevalent compared to pre-pandemic. This rapid shift requires attention to unintended consequences. Chief among these is the implications for patient safety, particularly in low-income populations and communities of color who are disproportionately cared for by under-resourced systems that may have adopted telemedicine rapidly but incompletely thereby increasing the potential for safety vulnerabilities. By identifying factors that heighten safety risk in telemedicine care, we can mitigate them. In this paper, we focus on the safety risks of telemedicine only and do not include consideration of other telehealth modalities (e.g., remote patient monitoring, secure messaging).

Ambulatory patient safety incidents are frequent, with an estimated 2–3 adverse events in every 100 primary care visits.[1]In an AHRQ (Agency for Healthcare Research and Quality)-commissioned technical brief on ambulatory safety, key informants identified six *domains of ambulatory safety* (medication management, diagnostic errors, care transitions, referrals, culture, and testing) and six *strategies used to address these vulnerabilities* (communication, health technology, teams, patient engagement, organizational approaches, and measurement).[2] We use this framework to identify the strategies most altered by telemedicine and how those changes impact specific ambulatory safety domains.

HOW TELEMEDICINE IMPACTS AMBULATORY PATIENT SAFETY: CHANGES IN COMMUNICATION, CARE TEAMS, AND PATIENT ENGAGEMENT

To some extent, telemedicine impacts all six strategies, but in comparison to in-person care, telemedicine care delivery most dramatically alters communication, care teams, and patient engagement. Communication is the cornerstone of safe care.[3] Telemedicine amplifies communication challenges between patients and providers due to loss of nonverbal cues from patients and clinicians as well as discomfort raising sensitive topics. These issues are even further exacerbated in audio-only encounters, which account for >90% of telemedicine encounters in safety-net systems.[4]

When healthcare teams are not co-located, clinical teams must rely on less rich communication modalities, such as

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written communication, which is more likely to result in miscommunication in comparison to verbal handoffs.[5] The reduction in team-based care also increases the cognitive load on clinicians as they take on more work during the same amount of encounter time.[6] Even if clinical teams return to work in-person, these issues could persist if clinicians deliver telemedicine care “from the office.” Unfortunately, there is limited experience with how to optimally design care teams around models that feature high use of telemedicine.[7]

Care delivered through telemedicine is more reliant on patient engagement. At a basic level, patients need to use digital tools to attend the telemedicine visit. In addition, telemedicine relies more heavily on patients monitoring their health through home devices, such as blood pressure monitors. Due to a limited physical exam, clinical decision-making in telemedicine visits often relies on patient self-monitoring and patient ability to accurately identify and describe changes in symptoms. Since the patient is not on-site, clinicians also rely on patients to follow through with diagnostic tests, such as blood draws or imaging, in a timely fashion.

While these three areas, and the changes described within them, impact all patient safety domains, two domains are disproportionately impacted—diagnostic errors and medication safety, and these domains have high preexisting levels of ambulatory safety concerns.[8, 9] Below we describe how the changes outlined above may increase concerns in these two domains, drawing on our clinical experiences, conversations with patient safety experts, and a review of the telemedicine and patient safety literature (Table 1).

Table 1 Domains of Potential Ambulatory Safety Concerns from Telemedicine

Dimensions of patient safety	Mechanisms through which telemedicine could worsen patient safety
Diagnostic errors	- Inadequate or lower quality history or physical exam (especially with audio-only encounters or other factors that reduce communication quality) - Reliance on patients to collect key data (vital signs, description of physical findings) - Increased cognitive load on clinician from reduction in team-based care - Changes in behaviors for diagnostic work-up
Medication safety	- Patient-provider communication challenges may impede high-quality medication reconciliation, which is an evidence-based approach to prevent adverse drug events - Lack of access to other team members to conduct more in-depth medication reconciliation (e.g., pharmacist) - Increased reliance on patients' literacy, language skills, or technology skills to conduct medication reconciliation - Change in availability of tools that can be used to ensure shared understanding of medication regimens (e.g., after visit summaries)

POTENTIAL IMPACT ON DIAGNOSTIC ERRORS

Achieving a timely, accurate diagnosis in ambulatory care is a significant safety challenge.[10] In a recent study, clinicians expressed concern about diagnostic safety in telemedicine encounters.[11] This largely results from a reduced ability to collect information to formulate an accurate diagnosis.

Specifically, most telemedicine encounters have limited objective information including vital signs and physical exam findings. Although a patient may have remote medical devices (e.g., blood pressure monitor) and the clinician can visualize some physical exam concerns, the clinician is not able to conduct a full physical exam. Clinicians also do not have access to other diagnostic tools (e.g., stethoscopes, reflex hammers) and may be unable to perform specific diagnostic maneuvers. Contextual information such as the patient's gait, the effort involved rising from a chair, or the ability to see a patient's entire body is lost without explicitly instructing a patient to perform these tasks. These challenges are exacerbated in audio-only encounters that lack all visual diagnostic clues. Importantly, few clinicians have received training on how to perform clinical assessments during telemedicine encounters, and best practices are still under development. As best practices are developed, clinicians may express fewer concerns about being unable to conduct a traditional physical exam.

Another concern is whether telemedicine impacts a clinician's likelihood of ordering a diagnostic test. It is unclear if telemedicine results in clinicians being less likely to order a diagnostic test (since a patient is not physically present) or more likely to order a diagnostic test (since the clinician has less clarity on the diagnosis). Moreover, if clinicians are experiencing increased cognitive load from having less support from their clinical team, clinicians may be more prone to over-testing and its resulting negative impacts on patient care and outcomes.

It is therefore surprising that early literature suggests that overall diagnostic accuracy is not impacted during telemedicine encounters.[12] However, the importance of missing vital signs or physical exams likely depends on the clinical concern. Abdominal pain is difficult to assess remotely because it requires a physical exam to appropriately triage the concern, but an elevated blood pressure can often be triaged with an accurate blood pressure measurement. Further, it is concerning that diagnostic errors comprise most telemedicine-related malpractice lawsuits.[13]

POTENTIAL IMPACT ON MEDICATION SAFETY

Ambulatory medication safety concerns include high levels of adverse drug events (ADEs) with one study estimating that ~25% of new prescriptions in primary care encounters resulted in an ADE.[8] While ADEs can include serious outcomes, such as life-threatening drug reactions, many are preventable or easily ameliorable if clinicians responded to medication-related symptoms.[8]

A high-quality medication reconciliation reduces the risks of ADEs and facilitates safe medication management.[14] However, conducting a quality medication reconciliation is challenging, and telemedicine poses unique challenges. Studies have shown that non-physician team members conduct higher quality medication reconciliation;[15] if pharmacists or other team members are not incorporated into telemedicine encounters, clinician understanding of how patients are taking their medications is likely reduced. Moreover, remote medication reconciliation (particularly in audio-only encounters) relies on a patient's ability to read a medication name. This is particularly challenging for patients with limited health literacy or limited English proficiency, who already experience greater medication misunderstandings during in-person medication reconciliation processes.[16]

Clinician communication of recommended medication changes is also impacted by telemedicine. Visual cues and written education are often used to improve understanding, particularly for complex medication regimens. These tools are more limited in telemedicine interactions, especially during audio-only encounters. While screen sharing or provision of educational materials through patient portals may address some challenges, these tools are not accessible to all patients. Early literature in a young population with simple medication regimens suggests that medication changes in telemedicine encounters are equally safe to in-person care, but this finding may not be applicable to the broader population.[17]

ADVANCING AMBULATORY PATIENT SAFETY IN TELEMEDICINE

Given potential risks related to diagnostic and medication safety, it is critical to move from our anecdotal understanding of safety to a robust evidence base. We advise the following steps (Table 2).

1. Systematically measure patient safety outcomes and increase reporting of safety incidents, with a focus on those most likely increased by telemedicine

Table 2 Steps to Advance Understanding of Telemedicine Impact on Patient Safety

Key recommendations	Recommendations for each stakeholder
Systematically measure patient safety outcomes and increase reporting of safety incidents, with a focus on those most likely increased by telemedicine	**Researchers** - Explicitly include safety outcomes, particularly those identified in existing ambulatory patient safety literature - Include easily measured outcomes extracted from the electronic health record **Healthcare systems** - Improve infrastructure to ease clinician use and access to incident reporting systems - Increase patient engagement in safety evaluations by: - Increasing opportunities for patients to report safety incidents - Including patients in quality and safety committees
Identify the patients and clinical scenarios with the greatest risk of unsafe telemedicine care	**Researchers** - Identify patient characteristics that may increase risk for safety incidents - Evaluate clinical scenarios when telemedicine can facilitate safer care, including variations in chief complaints, visit purpose, clinician specialty, or type of telemedicine - Focus on comparative effectiveness evaluations (e.g., is in-person care an appropriate comparison?) **Healthcare systems** - Disseminate and describe telemedicine implementation strategies to facilitate research that explores the issues above - Partner with evaluators to ensure rigorous, real-world evaluations
Identify and support best practices* to ensure equal access to safe telemedicine care	**Research funders** (identify best practices) - Fund evidence generation to identify best practices **Healthcare systems** (support best practices) - Proactively support audio-visual encounters for as many patients as possible - Develop strategies to support patients that may have challenges accessing video telemedicine encounters, such as older patients or patients with language barriers or limited digital literacy[21] **Policy makers** (support best practices) - Increase funding for programs that improve digital infrastructure (broadband) and digital access (low-cost broadband and devices) **Healthcare payors** (support best practices) - Provide reimbursement to support all patients in accessing telemedicine care - Recognize additional resources are needed by clinicians that serve patients with challenges accessing telemedicine - Reimburse for remote monitoring tools and home diagnostic procedures

These recommendations are focused on video-based telemedicine and access to remote clinical data as best practices and meant to illustrate how best practices should be supported by multiple stakeholders

Researchers must explicitly include safety outcomes drawn from the safety literature[18] in telemedicine evaluations. Focusing on measures easily captured in electronic health records (EHR) rather than on chart reviews may facilitate earlier understanding of the breadth and depth of patient safety concerns. EHR measures for diagnostic safety include emergency department presentations or hospital admissions shortly after a telemedicine encounter.[18] Medication safety can be measured by assessing inappropriate concurrent use of medications with similar risks, such as warfarin and non-steroidal anti-inflammatory drugs, or hospital admissions for adverse drug events.

To increase clinician utilization of incident reporting systems, healthcare systems should incentivize clinicians to report incidents related to telemedicine encounters and consider integrating reporting systems into EHRs, such as by linking to an external reporting system within the EHR or automating completion of basic clinical information in the incident report.[19] Any integration effort should carefully consider the tradeoffs between reducing barriers to incident reporting and potential inclusion of unverified assertions in the legal medical record. Given the importance of patient self-assessment in telemedicine and prior literature showing that patients identify different safety incidents than healthcare teams,[20] healthcare systems should expand opportunities for patients to report safety incidents and include patients in quality and safety committees.

2. Identify the patients and clinical scenarios with the greatest risk of unsafe telemedicine care

Communication and safety challenges are likely exacerbated in certain populations (e.g., older adults, visual/hearing impaired) and clinical scenarios (e.g., follow-up of chronic disease vs acute concern). Similarly, the potential benefits of telemedicine relative to in-person care may be greater for populations with barriers accessing in-person care (e.g., transportation challenges). To create actionable evidence, researchers need to assess the impact of telemedicine on safety outcomes in these specific populations. Evaluations should therefore not simply compare telemedicine versus in-person care. Instead, evaluators should acknowledge the variations in how and when telemedicine is used rather than making broad conclusions about telemedicine safety regardless of chief complaint, type of patient, purpose of use, or mode of telemedicine delivery. In turn, this understanding can guide health systems and clinicians in designing processes that determine when a telemedicine option should be offered.

To help facilitate evaluations, healthcare systems should delineate how and when they use telemedicine care. With more widespread use, telemedicine operations and workflows will change. Health systems should document changes they make and the rationale behind these changes, so that a real-world understanding emerges of how to employ telemedicine safely and optimally. Importantly, they should partner with researchers to conduct health system embedded research to accelerate understanding of these issues.

3. Identify and support best practices to ensure equal access to safe telemedicine care

Given the limited literature on telemedicine ambulatory safety, the most important steps are those listed above: measuring safety outcomes and understanding for which patients in which situations safety may be compromised. These efforts will facilitate identification of best practices, but this evidence generation is not possible without support from funding agencies. When best practices are identified, healthcare systems and payors should support clinicians in adopting best practices. Although there is limited knowledge about best practices, we believe it is reasonable to start advocating for broader access to video-based telemedicine encounters and remotely collected clinical data. We will use these two examples to illustrate how multi-level stakeholders can support clinicians to engage in best practices.

We know that communication is central to safety, and communication is better with access to the nonverbal, visual cues available in video-based telemedicine. Although there is no definitive evidence on the safety of audio-only versus audio-visual telemedicine encounters, we believe it is crucial to improve access to video-based telemedicine to foster safer communication. Policymakers and payors need to address patient- and healthcare system-related barriers[21] to audio-visual encounters. This includes expanding programs, such as the Lifeline program, that reduce the cost of acquiring devices for low-income populations; incentivizing development of broadband access in rural and low-income urban areas; and providing reimbursement for time spent supporting patients in accessing telemedicine care. Similarly, while health systems should not eliminate audio-only encounters for those patients who cannot access video-based services, health systems should support patients in accessing video-based care, recognizing that some patients (e.g., older, limited digital literacy, language barriers) may require substantial support.

Similarly, access to key objective data (such as vital signs) will address some concerns about the safety of telemedicine encounters. Healthcare payors should support acquisition of remote monitoring tools by providing reimbursement for devices that collect vital signs, including weight, blood pressure, or pulse. This is crucial for patients with financial challenges to securing their own devices. For patients who have challenges leaving the home, reimbursement for home diagnostic procedures (e.g., phlebotomy, electrocardiograms) will ensure safer (and more accessible) care.

CONCLUSION

As telemedicine adoption grows, it is imperative that researchers expand evaluation of patient outcomes beyond feasibility and satisfaction to quality and safety. Studies should build on our growing understanding of the diversity in how, when, and to whom telemedicine is delivered as well as our increasing sophistication in measuring ambulatory safety. We specifically advise that safety advocates and researchers focus on measuring safety implications in diagnosis and medication management, where telemedicine has had the biggest impact. Health systems can help facilitate evaluation by improving the infrastructure for and use of incident reporting mechanisms and leveraging EHR data. We can turn the current crisis into an opportunity to identify best practices to ensure that health systems deliver telemedicine that is safe, equitable, and of high quality.

***Corresponding Author:** Urmimala Sarkar, MD, MPH; Division of General Internal Medicine at Zuckerberg San Francisco General Hospital, Department of Medicine, University of California San Francisco, San Francisco, CA, USA (e-mail: urmimala.sarkar@ucsf.edu).*

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Video Teleconferencing for Disease Prevention, Diagnosis, and Treatment

A Rapid Review

Jordan Albritton, PhD, MPH; Alexa Ortiz, MSN, RN; Roberta Wines, MPH; Graham Booth, BS; Michael DiBello, MPH; Stephen Brown, MS; Gerald Gartlehner, MD, MPH; and Karen Crotty, PhD, MPH

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

See also:

Web-Only
Supplement

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.

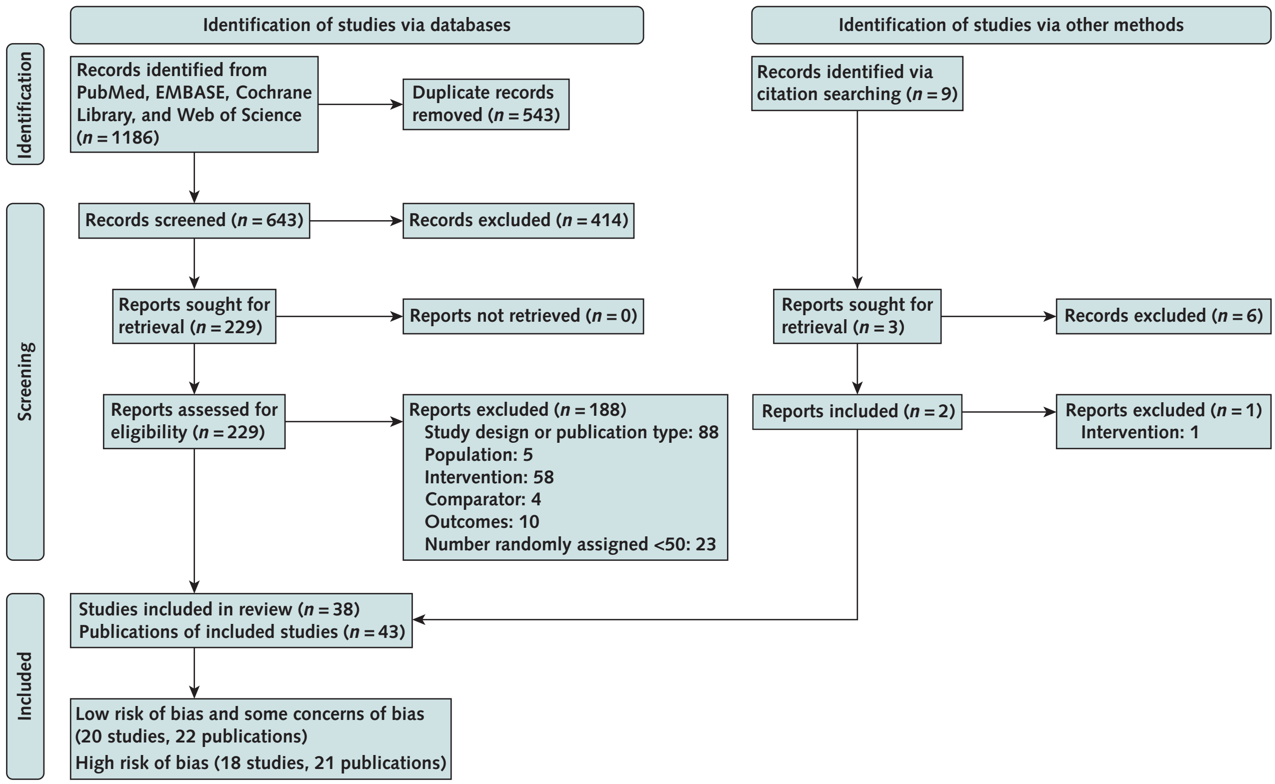
Role of the Funding Source

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 ($P = 0.003$)**

Continued on following page

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.

From RTI International, Research Triangle Park, North Carolina (J.A., A.O., R.W., G.B., S.B., K.C.); Insight Policy Research, Hyde Park, Massachusetts (M.D.); and Danube University Krems, Krems an der Donau, Austria (G.G.).

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Corresponding Author: Jordan Albritton, PhD, MPH, RTI International, 3040 East Cornwallis Road, PO Box 12194, Research Triangle Park, NC 27709; e-mail, jalbritton@rti.org.

Author contributions are available at Annals.org.

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Author Contributions: Conception and design: J. Albritton, G. Gartlehner, K. Crotty.
Analysis and interpretation of the data: J. Albritton, A. Ortiz, G. Booth, M. DiBello, S. Brown, G. Gartlehner, K. Crotty.
Drafting of the article: J. Albritton, G. Booth, M. DiBello, K. Crotty.
Critical revision of the article for important intellectual content: G. Gartlehner, K. Crotty.
Final approval of the article: J. Albritton, A. Ortiz, R. Wines, G. Booth, M. DiBello, S. Brown, G. Gartlehner, K. Crotty.
Obtaining of funding: J. Albritton, K. Crotty.
Administrative, technical, or logistic support: J. Albritton, R. Wines, G. Booth, M. DiBello, K. Crotty.
Collection and assembly of data: J. Albritton, A. Ortiz, G. Booth, M. DiBello, K. Crotty.

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."

Continued on following page

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.

California Health Benefits Review Program

Analysis of California Assembly Bill 32 Telehealth

A Report to the 2021–2022 California State Legislature

April 16, 2021

MEDICAL EFFECTIVENESS

As discussed in the *Policy Context* section, AB 32 would require state-regulated health insurance to cover and reimburse telehealth services at parity with services delivered in-person; AB 32 explicitly requires coverage of telehealth services provided via live video and telephone by physicians or billable non-physician providers. This review encompasses studies of patients with a wide range of diseases and conditions because AB 32 would require coverage and reimbursement for telehealth modalities for all enrollees.

Research Approach and Methods

The literature review encompassed the telehealth modalities for which AB 32 would affect coverage: live video and telephone.

Studies were identified through searches of PubMed, the Cochrane Library, Web of Science, EconLit, and Business Source Complete, the Cumulative Index of Nursing and Allied Health Literature, and PsycINFO. Websites maintained by the following organizations that produce and/or index meta-analyses and systematic reviews were also searched: the Agency for Healthcare Research and Quality (AHRQ), the International Network of Agencies for Health Technology Assessment (INAHTA), the National Health Service (NHS) Centre for Reviews and Dissemination, the National Institute for Health and Clinical Excellence (NICE), and the Scottish Intercollegiate Guideline Network.

The search was limited to abstracts of studies published in English. The search was limited to studies published from 2020 to present. For studies published prior to 2019, CHBRP relied on literature searches conducted in 2014, 2015, 2016, and 2019 for reports on previous bills regarding coverage for telehealth services.

Of the 1,100 articles found in the current literature review, 77 were reviewed for potential inclusion in this report. In total, 54 studies were included in the medical effectiveness review for AB 32, based on the quality of the studies and their relevance to this bill. Studies were eliminated because they did not report findings from clinical research studies, were of poor quality, or did not focus on the telehealth modalities relevant to AB 32. The 107 studies previously included in the medical effectiveness review for AB 744 (2019), AB 2507 (2016), and SB 289 (2015) were also reconsidered based on the quality of the studies and their relevance to AB 32. Additionally, CHBRP had previously conducted thorough literature searches on these topics in 2020 for the Telehealth Brief and included any relevant studies. For the multiple systematic reviews included in the report that had inclusion criteria broader than the mandate of this bill, CHBRP only summarized findings from the relevant studies.

The conclusions below are based on the best available evidence from peer-reviewed and grey literature.[37] Unpublished studies are not reviewed because the results of such studies, if they exist, cannot be obtained within the 60-day timeframe for CHBRP reports.

Key Questions

1. Does the evidence indicate whether services delivered via telehealth (and specifically telephone) are equivalent to in-person services?

2. Does the evidence indicate whether the use of telehealth services (and specifically telephone services) increase, decrease, or supplement the use of other services?

[37] Grey literature consists of material that is not published commercially or indexed systematically in bibliographic databases. For more information on CHBRP's use of grey literature, visit http://chbrp.com/analysis_methodology/medical_effectiveness_analysis.php.

Methodological Considerations

Most studies pertinent to this report examine the use of telehealth modalities as a substitute for in-person care. In these cases, the relevant studies evaluated whether care provided via these technologies resulted in equal or better outcomes and processes of care than care delivered in person and whether use of these technologies improved access to care. Some studies assessed the effects of telehealth as a supplement to in-person care; these studies evaluate whether adding these technologies improves processes of care and health outcomes relative to receiving in-person care alone.

A major methodological limitation of the literature is that the pace at which studies of telehealth are published does not keep pace with the rate of change in telehealth technology. Another important limitation of some studies is the inability to disaggregate the telehealth services from other interventions, such as an integrated web portal that includes e-mails as well as information about self-care, access to test results, and ability to refill prescriptions.

The literature search for this report used general terms for telehealth services, which may have missed peer-reviewed literature that was indexed using terms associated with particular diseases or conditions.

Outcomes Assessed

To examine whether services delivered via telehealth are of the same quality as in-person services, CHBRP examined three sets of outcomes: (1) health outcomes, including both physiological measures and patient-reported outcomes; (2) process of care outcomes, including treatment adherence and accuracy of diagnoses and treatment plans; and (3) access to care and utilization outcomes, such as wait time for specialty care, or number of outpatient visits, emergency department visits and hospitalizations.

Study Findings

This following section summarizes CHBRP's findings regarding the strength of evidence for the effectiveness of telehealth services addressed by AB 32. Each section is accompanied by a corresponding figure. The title of the figure indicates the test, treatment, or service for which evidence is summarized. The statement in the box above the figure presents CHBRP's conclusion regarding the strength of evidence about the effect of a particular test, treatment, or service based on a specific relevant outcome and the number of studies on which CHBRP's conclusion is based. Definitions of CHBRP's grading scale terms is included in the box below, and more information is included in Appendix B.

The following terms are used to characterize the body of evidence regarding an outcome:

Clear and convincing evidence indicates that there are multiple studies of a treatment and that the large majority of studies are of high quality and consistently find that the treatment is either effective or not effective.

Preponderance of evidence indicates that the majority of the studies reviewed are consistent in their findings that treatment is either effective or not effective.

Limited evidence indicates that the studies have limited generalizability to the population of interest and/or the studies have a fatal flaw in research design or implementation.

Inconclusive evidence indicates that although some studies included in the medical effectiveness review find that a treatment is effective, a similar number of studies of equal quality suggest the treatment is not effective.

Insufficient evidence indicates that there is not enough evidence available to know whether or not a treatment is effective, either because there are too few studies of the treatment or because the available studies are not of high quality. It does not indicate that a treatment is not effective.

More information is available in Appendix B.

Diseases and Conditions Studied

CHBRP found that evidence regarding whether telehealth modalities and services result in equal or better outcomes than care delivered in person is mixed depending on the disease and condition, telehealth modality and type of outcome studied: health outcomes, process of care, or use of other services. Because telehealth studies have only focused on a limited number of diseases and conditions, the findings may not be generalizable outside of the specific diseases and conditions studied.

There are multiple studies with evidence for live video, which include multiple RCTs and meta-analyses and systematic reviews across specialties, on multiple conditions and diseases, including cardiology, dermatology, infectious disease consultations, neurocognitive assessments and psychiatry, orthopedics, primary care, respiratory infections, rheumatology, abortion, stroke, and urology.

There have also been multiple systematic reviews examining the impact of telephone as a form of telehealth. Most studies for telephone consultations are on cardiology, gastroenterology, telepsychiatry, and on multiple sclerosis. Systematic reviews on telephone consultations have been conducted across specialties. For the diseases and conditions studied, the preponderance of evidence suggests that telephone consultations were at least as effective as in-person consultations on health outcomes. There is insufficient evidence to determine whether processes of care outcomes are equivalent for services provided by telephone and in person. Findings from studies of the effect of telephone consultations on access to care and utilization are inconsistent.

Behavioral health services are the only services for which studies that compare telehealth modalities have been published and these comparisons are limited to live video visits and telephone visits. These studies found that health outcomes were similar across the two modalities.

Findings for Live Video [38]

Health outcomes

Literature reviews that CHBRP conducted for its previous reports on SB 289, AB 2507, and AB 744 identified a large number of studies that compared the effects of live video and in-person care on health outcomes (Ferrer-Roca et al., 2010; Fortney et al., 2015; Garcia-Lizana and Munoz-Mayorga, 2010; Harrison et al., 1999; Kairy et al., 2009; Morland et al., 2010, 2014; Myers et al., 2015; Shukla et al., 2017; Wallace et al., 2004). These studies report that quality of life, clinical outcomes, and functional status, such as severity of depression symptoms, are similar between people who participate in live video and people who receive in-person care.

Two systematic reviews and one meta-analysis found that telepsychiatry delivered via live video is similar to in-person care for the management of mental health care in terms of quality of care and quality of doctor-patient relationship (Coustasse et al., 2020; Sunjaya et al., 2020). A systematic review reported that patients with post-traumatic stress disorder in programs that included live video were associated with shorter total therapeutic hours than patients receiving face-to-face therapy (Sunjaya et al., 2020). One recent meta-analysis (McClellan et al., 2021) (18 RCT studies:2,648 subjects) found that telepsychiatry delivered through live video has a moderate-to-strong effect on mental health outcomes and has similar

[38] Two-way, real-time interactive video to connect users. Occurs provider-to-provider or between a patient and a provider.

effects to in-person care for the management of symptoms of PTSD, specifically trauma and depression, in veterans. Arnedt et al. (2021) (65 subjects) reported significant and similar improvements in insomnia severity, measured with the Insomnia Severity Index, and Daytime functioning measures for subjects who received cognitive behavioral treatment via live video versus in-person treatment immediately post treatment and at 3-months follow-up. Daytime functioning measures included reductions in fatigue, depression and anxiety symptoms, sleep-related cognitions, and improvement in quality of life (all $p<0.05$).

Legha et al. (2020) studied telepsychiatric care provided via live video within a rural Alaska native psychiatric program and reported that, compared to patients who received usual care, patients in the telepsychiatry group remained engaged in treatment longer and were more likely to complete treatment. The odds of treatment completion was 99% greater in the telepsychiatry group than in the usual care group.

Lu et al. (2021) (9,010 subjects) reported similar health outcomes for veterans who received live video primary care visits in addition to usual care for diabetes. The researchers reported that while there was a significant improvement in blood pressure control and hemoglobin A1C (HbA1C) levels for both groups, there was no significant difference between groups for these outcomes. However, the video visit group showed significant increases in the proportion of patients meeting diabetes quality indicators: statin use and angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers (ACEi/ARB) relative to patients in the group that received usual care.

Additionally, CHBRP found a recent large systematic review (Burnham et al., 2019) (18 studies) on the clinical effectiveness of live video for infectious diseases consultations, which reported that people who received consultations via live video had shorter hospital length of stay, similar rates of readmission as people who received in-person care and similar rates adherence to treatment as people who receive in-person care. This systematic review reported mixed findings for mortality, with higher mortality in the group receiving care through live video in two studies reporting on this outcome and lower in two studies reporting this outcome (range, 0%–22%).

Another systematic review (Shah and Badawy, 2021) (5/11 studies;1,129 subjects) of multiple health conditions reported that in all included studies live video consultations resulted in outcomes that were similar to or better than the outcomes of a standard in person visit. Two studies reported the effects of live video on health outcomes. One study (Fleischman et al., 2016) (33 subjects) found that, compared to usual care (regular primary care visits), patients who attended primary care physician in-person visits plus specialist video visits had significantly greater decreases in BMI after 3 months than patients who only attended primary care physician visits ($P=.049$).

A 2019 retrospective cohort study (5,952 patients: 738 telemedicine visits, 5,214 standard visits) comparing medication abortion with a live video to a standard in person visit for medication abortion (Kohn et al., 2019) reported that health outcomes for medication abortion provided via live video are similar to standard in person visits. The study reported that ongoing pregnancy was less common among telemedicine patients (0.5%) than standard patients (1.8%) (OR=.23) and that follow up aspiration procedures were less common among telemedicine patients 1.4%) than standard patients (4.5%) (OR 0.28). In both groups, fewer than 1% of patients reported clinically significant adverse events.

Process of care

CHBRP's previous reports on telehealth found no difference in processes of care between patients who received care via live video and patients who received in-person care. These studies include three systematic reviews and one randomized controlled trial (RCT): Brearly et al. (2017) 12 studies, 497 participants; Fortney et al. (2015) 265 subjects; Simpson and Reid (2014) 23 studies; Warshaw et al. (2011) 10 studies, 1,290 subjects.

Bradley et al. (2020) found no significant difference (62 patients; P = 0.98) in the overall diagnostic reliability of a live video clinical examination compared to a traditional in-person shoulder clinical examination (with an MRI as reference) for patients with shoulder rotator cuff tears. The study found that the diagnostic effectiveness of both tests without an MRI was poor regardless of the group. A study of 47 patients (Rabin et al., 2021) with shoulder disorders at a shoulder surgery clinic were assessed sequentially by live video examination and through an in-person examination. Researchers found that there was substantial to almost perfect agreement between the video examination and in person examination for the diagnosis of patients with various shoulder disorders. Agreement between the live video examination and in person examination for the treatment plan and the need for additional diagnostic studies was moderate.

Another systematic review (Moentmann et al., 2021)(35 studies:2700 subjects) reported that the studies consistently found that synchronous live video between otolaryngologists and patients is similar to an in-person visit in terms of diagnostic concordance (5 studies). One study (Yulzari et al.,2018) (48 subjects) found diagnostic concordance in 79.2% of the consultations between patients who had a remote otolaryngology visit at a general physician's office and patients who had an in-person otolaryngology clinic visit.

A retrospective cohort study (Yao et al., 2020) (260 subjects) found no statistically significant difference in the rates at which patients seen via live video and patients seen in an emergency department were prescribed antibiotics for acute respiratory infections (29% of telemedicine visits and 28% of in-person visits (OR 1.038; P = 0.846)).

However, a large retrospective cohort study using claims data (528,213 total pediatric visits), Ray et al. (2019), that compared the quality of antibiotic prescribing for acute respiratory infections among children in three different health care settings -- live video telehealth consultations, urgent care, and primary care provider offices – reached the opposite conclusion. The study reported that clinicians who cared for children via live video were less likely to prescribe antibiotics in a manner that was consistent with clinical practice guidelines (59% of telemedicine visits versus 67% urgent care and 78% primary care provider visits). For visits with a diagnosis of streptococcal pharyngitis (strep throat), live video providers were less likely to order a streptococcal test to confirm the diagnosis (4% of telemedicine visits versus 75% urgent care and 68% primary care provider visits), which could have led live video providers to prescribe antibiotics unnecessarily because some children who they suspected had strep throat may not have had it and, thus, did not need antibiotics. It is important to note that in this study the live video consultations were provided by physicians who were not the children's usual primary care providers. They did not have access to the children's medical records or prior relationships with the children or their parents. Thus, one cannot determine whether the differences in antibiotic prescribing were due to the use of live video versus consultation with providers who were not children's usual source of primary care.

Del Campo et al. (2021) (61 subjects) compared in-person dysmorphology examinations for children with fetal alcohol syndrome to two different types of remotely guided live video technology: a smartphone using Zoom and a tablet Transportable Examination Station (TES) system using a precision camera and laptop. The study reported "almost perfect" percentages of agreement and Cohen's K coefficient between interviews when comparing both technologies with in-person interviews for most examinations, and a few "substantial" agreements for measurements of the head circumference (HC) and the evaluation of the 3 key facial features, including palpebral fissure length (PF), smooth philtrum, and thin and smooth vermilion of the upper lip, common traits of children born with fetal alcohol syndrome.

One retrospective chart review study of patients referred for evaluation in an outpatient neuropsychology clinic compared validity of in-home teleneuropsychology assessments using live video to in person assessments. Parks et al. (2021) (131 subjects) compared test scores for teleneuropsychology tests consisting of tests measuring attention/processing speed, verbal memory, naming, verbal fluency, and visuoconstruction to in person test scores. Teleneuropsychology test scores did not significantly differ from in-person testing across all tests except the Hopkins Verbal Learning Test-Revised Discrimination Index.

Lu et al. (2021) (9,010 subjects) reported similar health outcomes for veterans who received live video primary care visits in addition to usual care for diabetes. The researchers reported the live video visit group showed significant increases in the proportion of patients meeting diabetes quality indicators for annual microalbuminuria testing, statistically more than in the virtual care group.

Access to care and utilization

Studies have found that live video increases access to care and decreases follow up visits (Andino et al., 2020; Wood and Caplan, 2019).

Wood and Caplan (2019) (85 subjects) reported that substituting live video for in-person visits with a specialist was associated with a substantial and statistically significant reduction in the distance that rural veterans with inflammatory arthritis traveled to obtain care ($p < 0.01$).

In a retrospective study of 600 live video visits among established patients completed by 13 urology providers, Andino et al. (2020) found that for new or persistent medical concerns, the 30-day revisit rates — defined as an in-person evaluation within 30 days of the patient's initial visit by any urologist or urology advanced practice provider in the clinic, emergency room, or inpatient hospital — were similar across both groups (0.5% vs. 0.67%; $p = 0.60$).

A 2019 retrospective cohort study (5,952 patients: 738 telemedicine visits; 5,214 standard visits) comparing medication abortion with a live video to a standard in-person visit for medication abortion (Kohn et al., 2019) reported that medication abortion provided via live video significantly improves access to earlier abortion and abortion care services. The study reported that ongoing pregnancy was less common among telemedicine patients (2/445, 0.5%) than standard patients (71/4,011, 1.8%) (adjusted OR 0.23) and that aspiration procedures were less common among telemedicine patients (6/445, 1.4%) than standard patients (182/4,011, 4.5%) (adjusted OR 0.28).

Summary of findings regarding the effectiveness of health services delivered by live video: There is a *preponderance of evidence* that care delivered by live video is at least as effective as in-person care for *health outcomes* for several conditions and health care settings, including infectious disease, obesity, diabetes, and abortion.

There is *clear and convincing evidence* that mental health services for ADHD depression, and PTSD delivered by live video are at least as effective as in-person care for *processes of care and health outcomes*.

There is *clear and convincing evidence* that dermatology diagnoses made via live video are as accurate as *diagnoses* made during in-person visits. There is a *preponderance of evidence* that scores on *neurocognitive tests* administered via live video are similar to scores obtained when tests are administered in person. Studies have also found diagnostic concordance between live video and in-person examination for shoulder disorders, otolaryngology, and fetal alcohol syndrome.

There is a *limited evidence* that care delivered by live video is at least as effective as in-person care for *access to care and utilization*.

Findings for Telephone[39]

Health outcomes

The 2016 report for AB 2507 found telephone consultations result in equal or better health outcomes as in-person consultations based on three studies (Akobeng et al., 2015; Fann et al., 2015; Kotb et al., 2015). The CHBRP report for AB 744 reported that a meta-analysis (11 RCTs; 1,104 subjects), found moderately better scores on a measure of depression for patients with multiple sclerosis who received telephone psychotherapy interventions and small to moderately better short-term scores on measures of fatigue, quality of life, multiple sclerosis symptoms, physical activity, and medication adherence compared with patients in control groups and patients who received other interventions (Proctor et al., 2018).

CHBRP found one recent study (Shah et al., 2021) (25 subject) that evaluated the impact of telephone follow up and virtual wound checks on readmissions after head and neck surgery. Patients who received telephone follow-up calls post-discharge to review symptoms and wound photos (30% of patients sent photos) showed lower emergency department visits ($P < 0.05$) and readmission rates (no statistically significant difference) compared to patients the previous year, before the telephone follow up program was implemented. In this study there was no comparison group, the authors used a pre-post design that did not control for trends over time, which may have affected the results.

Another recent study (Smith el al., 2021) (77 subjects) assessed telephone consultations for follow up visits in children who had been treated for enuresis. A statistically equivalent number of subjects in the telephone consultation group (61.9%) responded to treatment compared with 48.1% patients responding to treatment ($p = 0.22$).

In a systemic review of multiple telehealth modalities and multiple health conditions (Shah and Badawy, 2021) (11 studies), one study reported health outcomes for telephone consultations. This RCT (Powers et al., 2015) (78 subjects) compared patients with cystic fibrosis and pancreatitis who received regular in person visits to patients who received individual counseling by telephone in addition to regular care. The authors reported that patients in the regular care group had significantly lower energy intake levels ($P < 0.001$) and greater decreases in height ($P = 0.049$) at 18 months follow-up. There were no significant differences in weight ($P = 0.25$) between the two groups after treatment and at 18 months' follow-up.

Process of care

A systematic review comparing telehealth to in-person care in primary care settings (Han et al., 2020) included three retrospective cohort studies that compared antibiotic prescribing in telephone consultations and in-person consultations (Ewen et al., 2015; Murray et al., 2020; Penza et al., 2020). These studies reported mixed results. Ewen et al. (2015) and Penza et al. (2020) reported lower rates of antibiotic prescriptions during telephone consultations compared to in-person visits. In contrast, Murray et al. (2020) reported no significant differences in antibiotic prescribing rates between telephone and in-person visits for urinary tract infections (81% vs. 83%; $P = 0.76$).

One study (Malik et al., 2020) (400 subjects) examined the sensitivity of telephone-based questionnaire to detect symptoms of cancer recurrence. The questionnaire was administered to patients by telephone two weeks before a follow up appointment. Researchers compared the diagnostic accuracy of the telephone questionnaire against findings from a blinded in-person exam by an otorhinolaryngologist. The telephone consultations showed acceptable sensitivity and negative predictive value for detecting cancer recurrences in patients after treatment.

A study (Crossland et al., 2021) (150 subjects) evaluated the repeatability of visual acuity measured using an at-home visual acuity test (Home Acuity Test) administered by telephone and the agreement between

[39] Uses two-way, interactive audio to connect users via landline or cell-phone. Occurs provider-to-provider at a distant site or between a patient and a provider.

findings from the telephone-based test and the last in-clinic test of visual acuity. The at home test was developed for patients unable to attend hospital ophthalmology appointments because of the COVID-19 outbreak. The eye chart was printed and mailed to the patient before the telephone consultation. There was good repeatability and a high level of agreement between the Home Acuity Test and a conventional test used during in-person visits regarding the level of visual impairment.

Access to care and utilization

The 2015 CHBRP report for SB 289 found inconclusive evidence from RCTs and time-series studies of the effect of telephone consultation services on access to care and utilization, with studies showing different effects for use of the same type of service (e.g., emergency department, hospitalization, or primary care) (Bunn et al., 2004; Flores-Mateo et al., 2012).

A more recent study (Smith et al., 2021) (77 subjects) of follow up care for patients seen for nocturnal enuresis, a common childhood condition, found that patients who received telephone consultation follow-up missed fewer appointments (0.14) than patients with in person follow-up visits (0.5) (P = 0.016).

The data analyzed for all these studies were collected prior to the COVID-19 pandemic. As data about use of telephone during the pandemic becomes more widely available, researchers may find that telephone visits increased access to care and utilization, especially during the early months of the pandemic when people were discouraged from seeking in-person care unless necessary. Additionally, compensation for telephone visits also changed during COVID-19, which may have affected access to care because providers were more willing to use telephone as a modality.

Summary of findings regarding the effectiveness of health services delivered by telephone:

CHBRP concludes that, for the diseases and conditions studied, the *preponderance of evidence* from studies of the effect of telephone consultations suggests that telephone consultations were at least as effective as in-person consultations on *health outcomes*.

CHBRP concludes that, for the diseases and conditions studied, findings from studies of the effect of telephone consultations on *processes of care* and *access to care and utilization* are inconsistent; therefore, the evidence that medical care provided by telephone compared to medical care provided in person is *inconclusive*.

Findings That Compare Live Video to Telephone Visits

One recent meta-analysis (McClellan et al., 2021) (18 RCT studies, 2,648 subjects) found that telepsychiatry delivered through both telephone and live videoconference have a moderate-to-strong beneficial effect on mental health outcomes and is similar to in-person care for the management of symptoms of PTSD, specifically trauma and depression, in veterans. Additionally, the review found telepsychiatry delivered through videoconference was slightly more beneficial than telepsychiatry delivered through telephone for treatment of trauma and depression.

Another systematic review (Shah and Badawy, 2021) (5/11 studies;1,129 subjects) Included one cluster RCT study with physicians delivering behavioral group interventions to families through telephone or video (Davis et al., 2016) (103 subjects). The study reported no significant differences in changes in patients' or parents BMIs (pretreatment to posttreatment) between the video and telephone groups (P > 0.05).

Summary of findings regarding the effectiveness of health services delivered by live video compared to telephone consultation: There is *preponderance of evidence* based on one meta-analysis (18 RCTs) and one RCT study that behavioral health services delivered by live video are comparable to services delivered by telephone consultation on *health outcomes*.

CHBRP found no studies that compared live video to telephone consultation on outcomes for *processes of care* and *access to care and utilization* of health services. CHBRP notes that absence of evidence is not evidence of no effect.

Findings for Telehealth Services that Encompass Multiple Modalities

CHBRP has found evidence for other telehealth systems that encompass a variety of modalities for certain health conditions, specifically telestroke and telerehabilitation.

Studies that examine telestroke compared telestroke, typically at a rural hospital, to acute stroke care at a comprehensive stroke center with access to thrombolysis and physicians with specialized expertise in caring for patients with strokes. Telestroke modalities can include remote patient monitoring, telephone calls and video visits. Studies on telerehabilitation examine the effectiveness of multiple modalities of telerehabilitation on patients compared to standard rehabilitation or home-based exercise programs. Telerehabilitation modalities can include video-based therapy programs, remote patient monitoring, telephone calls and video with providers including physiotherapists, physical therapists, occupational therapists, neurologists, or physicians.

There is a preponderance of evidence based on two meta analyses that health services delivered by telestroke systems are at least as effective as in-person care at a comprehensive stroke center for processes of care and health outcomes, including onset to door duration (OTD), hospital length of stay, functional independence, and mortality (Baratloo et al., 2018; Kepplinger et al., 2016). There is limited evidence that telestroke can improve access to care and utilization of health services (Al Kasab et al., 2017; Jewett et al., 2017).

There is a preponderance of evidence that telerehabilitation is effective in improving health outcomes such as activities of daily living, motor function, and physical activity based on two meta-analyses of 21 studies (Shukla et al., 2017; Tchero et al., 2018).There is insufficient evidence to determine whether services provided by telerehabilitation are as effective as medical care provided in person with regard to processes of care (Richardson et al., 2017). CHBRP notes that the absence of evidence does not mean there is no effect; it means the effect is unknown. CHBRP concludes that there is inconclusive evidence to determine whether services provided by telerehabilitation are as effective as medical care provided in person for access to care (Kairy et al., 2009).

Summary of findings regarding the effectiveness of health services delivered by multiple modalities: CHBRP concludes that there is a *preponderance of evidence* that telestroke and telerehabilitation are as effective as in person care on *health outcomes*.

There is a *preponderance of evidence* based on 2 large systematic reviews and meta analyses of 33 studies that *processes of care* for health services delivered by telestroke systems are at least as effective as they are for in-person care at a comprehensive stroke center. There is *limited evidence* that telestroke can improve *access to care and utilization* of health services

There is a *preponderance of evidence* that telerehabilitation is effective in improving *health outcomes* such as activities of daily living, motor function, and physical activity. There is *insufficient evidence* to determine whether services provided by telerehabilitation are as effective as medical care provided in person for processes of care. CHBRP notes that the absence of evidence does not mean there is no effect; it means the effect is unknown. There is *inconclusive evidence* to determine whether services provided by telerehabilitation are as effective as medical care provided in person with regard to *access to care and utilization* of health services.

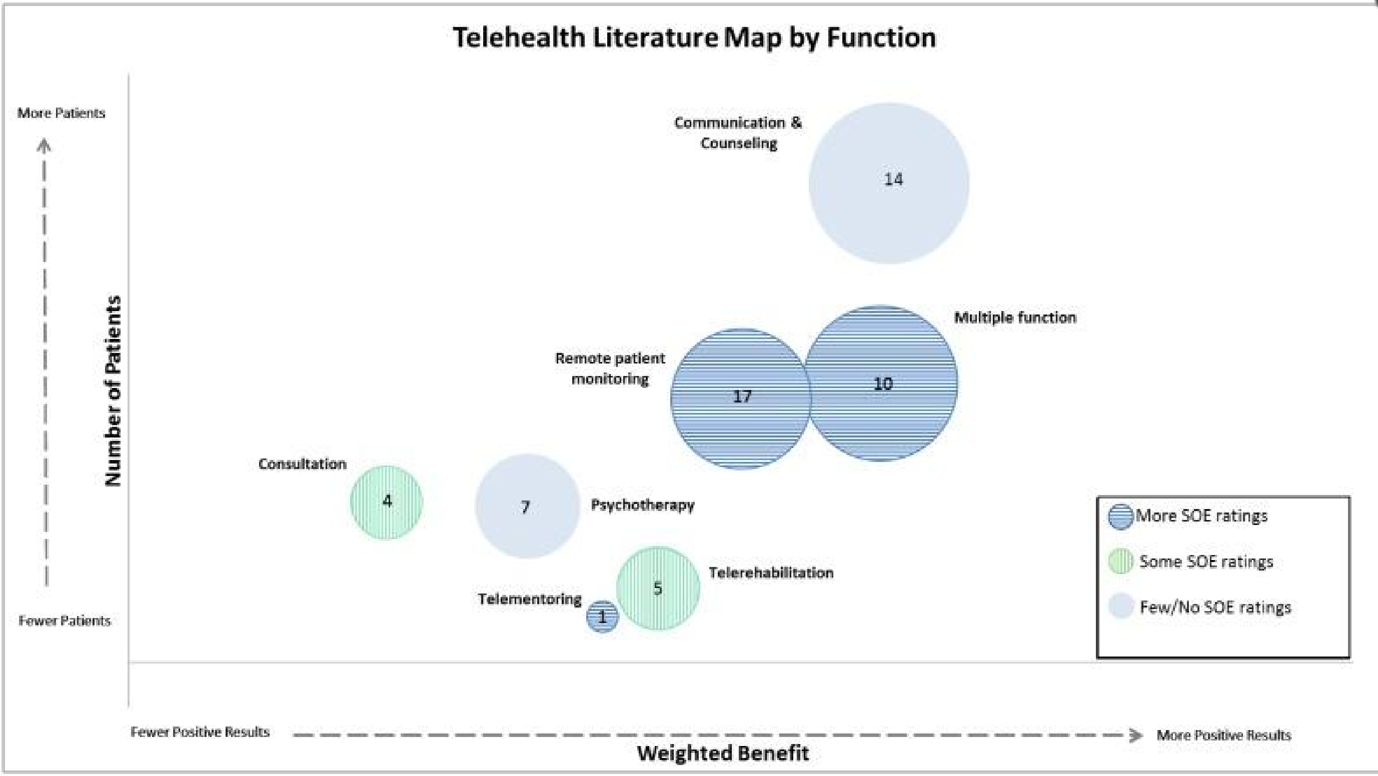


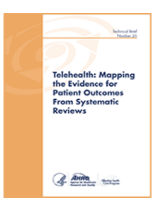
Figure 9 Telehealth literature map of systematic reviews by function of telehealth

a. Bubble size reflects the unduplicated number of individual studies included in the systematic reviews about that clinical focus. The number label on each bubble is the number of systematic reveiws. Smaller bubbles indicate fewer studies, larger bubbles indicate more studies. The color of the bubble represents how many of systematic reviews included strength of evidence assessment.

b. Weighted relative benefit is calculated by weighting the overall conclusion of each review by the number of studies in the review. Bubbles to the right indicate more positive findings while bubbles to the left represent findings that are unclear or found no benefit.

SOE=strength of evidence

From: Findings



Telehealth: Mapping the Evidence for Patient Outcomes From Systematic Reviews [Internet].
Technical Briefs, No. 26.
Totten AM, Womack DM, Eden KB, et al.
Rockville (MD): Agency for Healthcare Research and Quality (US); 2016 Jun.

Figure 10 Evidence from systematic reviews: the intersection of clinical focus and telehealth function

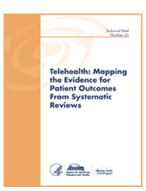
	Communication and Counseling	Remote Patient Monitoring	Multiple Functions	Psychotherapy	Consultation	Telerehabilitation	Telementoring
Mixed Chronic Condition	15 studies[46] 23 studies[60]	24 studies[52] 78 studies[76] 9 studies[68]	12 studies[49] 21 studies[50] 35 studies[74]	15 studies[48]	None	None	None
Cardiovascular Disease	29 studies[95] 13 studies[67]	9 studies[89] 10 studies[73] 11 studies[81] 30 studies[87] 9 studies[45] 13 studies[42] 4 studies[41]	11 studies[84]	--	5 studies[47]	12 studies[62]	None
Diabetes	34 studies[92] 21 studies[63] 15 studies[43]	6 studies[91] 2 studies[88]	13 studies[69] 21 studies[53] 35 studies[80]	--	None	None	None
Behavioral Health	34 studies[72]	None	None	10 studies[70] 9 studies[51] 23 studies[93] 12 studies[65] 7 studies[90] 45 studies[39]	None	--	None

Mixed Conditions	15 studies[59] 39 studies[64] 4 studies[38] 29 studies[56]	None	93 studies[86] 36 studies[78]	None	None	None	None
Physical Rehabilitation	16 studies[71]	None	None	--	None	9 studies[85] 27 studies[54] 28 studies[57] 10 studies[62]	None
Respiratory Disease	None	10 studies[68] 7 studies[58] 23 studies[55] 9 studies[83]	7 studies[44]	None	None	None	None
ICU/Surgery Support	1 study[75]	None	None	--	8 studies[61]	None	10 studies[40]
Bum Care	None	None	None	None	16 studies[79]	None	None
Preterm Birth	None	15 studies[77]	None	None	None	None	None
Dermatological Care	--	None	None	--	24 studies[94]	--	None

Legend: Positive Benefit Potential Benefit Unclear No Benefit

ICU=intensive care unit

From: Findings



Telehealth: Mapping the Evidence for Patient Outcomes From Systematic Reviews [Internet].
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Totten AM, Womack DM, Eden KB, et al.
Rockville (MD): Agency for Healthcare Research and Quality (US); 2016 Jun.

Table 7 Telehealth cost and utilization: Findings from systematic reviews

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
Positive Benefit= Cost Saving Or Utilization Reduction	Conway, 2014[81] Remote Patient Monitoring Cardiovascular Disease	• Reduction in heart failure hospitalizations RR 0.75; 95% CI 0.63 to 0.91; p=0.003 (3 studies)
	Kotb, 2015[87] Remote Patient Monitoring Cardiovascular Disease	• Reduction in health failure hospitalization ◦ for telemonitoring: OR 0.64; 95% CI 0.39 to 0.95 (3 studies) ◦ for telemonitoring that included transmission of ECG data OR 0.71; 95% CI 0.52 to 0.98 (3 studies)
	Seto, 2008[73] Remote Patient Monitoring Cardiovascular Disease	• Savings ranging from 1.6% to 68% to the health care system (9 studies) • 3.5% saving on patient travel (1 study)
	Kamei, 2013[58] Remote Patient Monitoring Respiratory Diseases	• Hospitalization risk lower with telehome monitoring; RR 0.81; 95% CI 0.69 to 0.95 for severe and very severe COPD (5 studies) ◦ difference not significant for moderate disease (2 studies) • ED visits lower; RR 0.52; 95% CI 0.41 to 0.65 (4 studies)
Potential Benefit= Likely Savings Or Utilization Reduction (mixed results, but tending toward benefit)	Dang, 2009[45] Remote Patient Monitoring Cardiovascular Disease	• 20% to 63% reduction in health care utilization costs (3 studies) • 53% to 62% reduction in overall admissions (6 studies) ◦ No difference in admissions (3 studies) • Significant reductions in ED visits (2 studies) ◦ No difference (4 studies)

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
	Clarke, 2011[42] Remote Patient Monitoring Cardiovascular Disease	• Mixed finding about cost; 4 studies concluded costs were reduced; 2 found no significant difference • No cost-effectiveness or cost benefit • Significant reduction CHF admissions Meta-analysis RR 0.73; 95% CI 0.62 to 0.87 (6 studies) • No difference: All cause hospital admission (6 studies) • No difference: All cause ER (4 studies)
	Chaudhry, 2007[41] Remote Patient Monitoring Cardiovascular Disease	• Reduction in all cause hospitalizations (15%) (1 study) • Reduction in heart failure hospitalizations (40%) (1 study) • No difference in comparative studies of video and phone support (2 studies)
	Cruz, 2014 Remote Patient Monitoring/ Respiratory Diseases	• Reduction in hospitalizations (8 studies) • No difference in other utilization outcomes (number of hospitalizations, length of stay, emergency department visits • Trend toward reduced costs
	Jaana, 2009[55] Remote Patient Monitoring Respiratory Diseases	• Utilization-no consistent evidence (13 studies) • Mixed results from cost estimates or analysis (8 studies) ○ 2 showed ability to produce savings
	Garcia-Lizana, 2007[52] Remote Patient Monitoring Mixed Chronic Conditions	• Asthma: significant reduction in hospitalization (1 study) • Reduction in ER mixed: significant (2 studies); not significant (2 studies) • Hypertension: Early study (1996) reported cost-effectiveness (1 study) • Heart failure: Reduction in readmissions-mixed (1 study significant, 1 not significant); ER (2 studies significant; Hospitalizations (1 study significant, 3 not significant) • Diabetes: cost reduction (1 study significant, 1 not significant)

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
	Knowles, 2013[59] Communication & Counseling Other-GI	• 87% of intervention group had lower medical costs and estimated savings at $39,821 per person (1 study in Sweden) • 36% of IBS patients that reported reduced clinical symptoms resulted in savings of $16,806 per person (1 study in Sweden) • No difference in utilization (5 studies) • Reduced costs for mileage and patient travel time (1 study)
	Kairy, 2009[57] Telerehabilitation Physical rehabilitation	• 17% lower cost ($100) for telePT vs. in-home PT (1 study) • 58% lower cost ($ NR) for telecardiac rehab vs. inpatient rehab (1 study) • 850 sessions per year as break-even point for videoconferencing (1 study) • Resource utilization: mixed findings (3 studies)
	Hailey, 2010[54] Telerehabilitation Physical rehabilitation	• Spinal cord injury: fewer hospital days (1 study) • Arthritis: no difference in health care utilization (1 study) • Knee pain in elderly: lower hospital costs and shorter length of stay (1 study) • Elderly at risk of readmission: lower ER admissions and GP visits (1 study)
	Martin, 2011[65] Psychotherapy Behavioral Health	• Telepsychiatry for 3 months was less expensive than usual care due to lower travel costs of $419 vs. $428 per patient (1 study conducted in Newfoundland)
	Eland de Kok, 2011[49] Multiple Functions Mixed Chronic Conditions	• No significant difference in number of visits (2 studies) • Return on investment of 2.13 and net cost savings of $948 per person (1 study) • Visit costs were $48 for actual; $22 for virtual and $33 for virtual visits and monitoring (1 study)

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
Inconclusive	Cox, 2012[44] Remote Patient Monitoring Respiratory Disease	• Only cost estimate was from a single patient case study (1 study)
	Gaikwad, 2009[50] Multiple Functions Mixed Chronic Conditions	• Reductions in utilization or cost (6 of 13 studies, details not provided)
	McLean, 2011[66] Remote Patient Monitoring Respiratory Disease	• Fewer hospitalizations RR 0.46; 95% CI 0.28 to 0.68 (4 studies: 2 telehealth, 2 complex interventions) • Fewer ER visits driven by one study of complex interventions; 2 studies of telehealth not significant (RR 0.19; 95% CI 0.03 to 1.27) • Estimate reducing hospital days (1 out of 2.8 per patient) would pay for the system in one year (1 study-modeling not actual data) • Reduced costs of nursing visits due to time saved by nurse travel • Savings for telehealth but estimate very imprecise (1 study with a wide SD)
	Ammenwerth, 2012[38] Communication & Counseling Mixed Conditions	• Larger decrease in office visits in the patient portal group compared to control (1 study) • Increase in ER visits and no difference in hospitalization or heart failure clinic visits (1 study)
	Devi, 2015[84] Multiple Functions Cardiovascular Disease	• No difference in health care utilization (2 studies) • Likely cost-effective in increasing activity (1 study) • Projected 213% return on investment based on health care costs for cardiovascular events (1 study)

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
	Flodgren, 2015[86] Multiple Functions Mixed Conditions	• Admission to hospital (11 studies). Inconsistent results (RRs range from 0.36 to 1.60; high level of heterogeneity precluded meta-analysis) • One study reported no difference in total health services costs; 1 small study (n=25) reported lower costs for hospital readmission costs
	Wade, 2010[78] Multiple Functions Mixed Conditions	• 35 studies looked at costs for health services. 49% reported higher costs; 46% lower; 3% costs went from higher to lower over time, and 3% costs were the same. • When costs are viewed from a societal perspective, more studies (61%) report lower costs due to reductions in patient travel in rural areas
	Warshaw, 2011[94] Consultation Dermatological Conditions	• Cost studies were limited. Finding support cost effectiveness if critical assumptions are made but studies vary widely in terms of factors included in cost assessments and the perspective used. (10 studies) • Patient required fewer visits (14 studies) ◦ Clinic visits avoided. In 3 of 4 comparative studies, fewer “preventable” visits.
	Wallace, 2012[79] Consultation Burn Care	Cost • Cost outlay range \$1300 - \$115,000; cost avoided (e.g., transport costs) \$2000 per month and \$14,000/ 2 patients treated (2 studies) • Patient costs reduced by a few hundred dollars for followup care (7 studies) • Break-even point was 774 telehealth consultations (1 study)
	Kumar, 2013[61] Consultation ICU	• Implementation \$50,000-\$100,000 per bed over first year. Cost change after first year range from -\$3,000 to + \$5000 per patient (6 studies)

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
No Benefit= No Difference or Increase in Costs/Utilization	Parthiban, 2015[89] Remote Patient Monitoring Cardiovascular Disease	• No difference in hospitalizations (OR 0.83; 95% CI 0.63 to 1.10; p=0.196) (7 studies) • Nonsignificant increase in unscheduled visits (OR 1.29; 95% CI 0.99 to 1.67; p=0.061) (5 studies)
	Peeters, 2011[68] Monitoring& Management/Mixed Chronic Conditions	• Costs were significantly higher (71% to 116%) with home video (1 high-quality study) • Benefits not greater than costs (8 low-quality studies)
	Urquhart, 2015[77] Monitoring& Management/Preterm Birth	• NICU admissions: significant reduction (RR 0.77; 95% CI 0.62 to 0.96) (5 articles) but when lower-quality studies were excluded, no significant difference • Unscheduled antenatal visits: higher in monitored group (4 studies) • Antenatal hospital admissions: no significant difference (3 studies)
	Tan, 2012[75] Monitoring& Management/ICU Surgery Support	• Length of stay 68.5 days telemedicine vs. 70.6 days control (1 study); no significant difference
	Zhai, 2014[80] Communication & Counseling Diabetes	• Incremental cost-effectiveness ration of $29,869 per capita for each unit reduction in HbA1c (1 study)
	de Jong, 20144[46] Communication & Counseling Mixed Chronic Conditions	• Number of visits did not decrease significantly for back pain or asthma patients (2 studies)
	Johansen, 2012[56] Communication & Counseling/Mixed Conditions	• No significant differences in hospitalizations (2 studies)

CHF=congestive heart failure, CI= confidence interval, COPD=chronic obstructive pulmonary disease, ECG=electrocardiogram, ED=emergency department, ER = emergency room, GI=gastrointestinal, GP=general practitioner, HbA1c=hemoglobin A1c, IBS=irritable bowel syndrome, NICU=neonatal intensive care unit, NR=not reported, OR=odds ratio, PT=physical therapy, RR=relative ratio, TelePT=Telehealth in physical therapy