Comparative Effectiveness Review
Number 254

Improving Rural Health Through Telehealth-Guided Provider-to-Provider Communication

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None of the investigators have any affiliations or financial involvement that conflicts with the material presented in this report.

The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of healthcare in the United States.

The National Institutes of Health (NIH) Office of Disease Prevention requested this report from the EPC Program at AHRQ. AHRQ assigned this report to the following EPC: Pacific Northwest Evidence-based Practice Center (Contract Number: 75Q80120D00006).

The report was presented at the NIH Office of Disease Prevention public meeting Improving Rural Health Through Telehealth-Guided Provider-to-Provider Communication on October 12–13, 2021.

The reports and assessments provide organizations with comprehensive, evidence-based information on common medical conditions and new healthcare technologies and strategies. They also identify research gaps in the selected scientific area, identify methodological and scientific weaknesses, suggest research needs, and move the field forward through an unbiased, evidence-based assessment of the available literature. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

To bring the broadest range of experts into the development of evidence reports and health technology assessments, AHRQ encourages the EPCs to form partnerships and enter into collaborations with other medical and research organizations. The EPCs work with these partner organizations to ensure that the evidence reports and technology assessments they produce will become building blocks for healthcare quality improvement projects throughout the Nation. The reports undergo peer review and public comment prior to their release as a final report.

AHRQ expects that the EPC evidence reports and technology assessments, when appropriate, will inform individual health plans, providers, and purchasers as well as the healthcare system as a whole by providing important information to help improve healthcare quality.

If you have comments on this evidence report, they may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 5600 Fishers Lane, Rockville, MD 20857, or by email to epc@ahrq.hhs.gov.

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Technical Expert Panel

In designing the study questions and methodology at the outset of this report, the EPC consulted several technical and content experts. Broad expertise and perspectives were sought. Divergent and conflicted opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Therefore, in the end, study questions, design, methodological approaches, and/or conclusions do not necessarily represent the views of individual technical and content experts.

Technical Experts must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals with potential conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any potential conflicts of interest identified.

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Prior to publication of the final evidence report, the EPC sought input from independent Peer Reviewers without financial conflicts of interest. However, the conclusions and synthesis of the scientific literature presented in this report do not necessarily represent the views of individual reviewers.

Peer Reviewers must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals with potential nonfinancial conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

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Improving Rural Health Through Telehealth-Guided Provider-to-Provider Communication

Structured Abstract

Objectives. To assess the use, effectiveness, and implementation of telehealth-supported provider-to-provider communication and collaboration for the provision of healthcare services to rural populations and to inform a scientific workshop convened by the National Institutes of Health Office of Disease Prevention on October 12–14, 2021.

Data sources. We conducted a comprehensive literature search of Ovid MEDLINE®, CINAHL®, Embase®, and Cochrane CENTRAL. We searched for articles published from January 1, 2015, to October 12, 2021, to identify data on use of rural provider-to-provider telehealth (Key Question 1) and the same databases for articles published January 1, 2010, to October 12, 2021, for studies of effectiveness and implementation (Key Questions 2 and 3) and to identify methodological weaknesses in the research (Key Question 4). Additional sources were identified through reference lists, stakeholder suggestions, and responses to a Federal Register notice.

Review methods. Our methods followed the Agency for Healthcare Research and Quality *Methods Guide* (available at https://effectivehealthcare.ahrq.gov/topics/cer-methods-guide/overview) and the PRISMA reporting guidelines. We used predefined criteria and dual review of abstracts and full-text articles to identify research results on (1) regional or national use, (2) effectiveness, (3) barriers and facilitators to implementation, and (4) methodological weakness in studies of provider-to-provider telehealth for rural populations. We assessed the risk of bias of the effectiveness studies using criteria specific to the different study designs and evaluated strength of evidence (SOE) for studies of similar telehealth interventions with similar outcomes. We categorized barriers and facilitators to implementation using the Consolidated Framework for Implementation Research (CFIR) and summarized methodological weaknesses of studies.

Results. We included 166 studies reported in 179 publications. Studies on the degree of uptake of provider-to-provider telehealth were limited to specific clinical uses (pharmacy, psychiatry, emergency care, and stroke management) in seven studies using national or regional surveys and claims data. They reported variability across States and regions, but increasing uptake over time.

Ninety-seven studies (20 trials and 77 observational studies) evaluated the effectiveness of provider-to-provider telehealth in rural settings, finding that there may be similar rates of transfers and lengths of stay with telehealth for inpatient consultations; similar mortality rates for remote intensive care unit care; similar clinical outcomes and transfer rates for neonates; improvements in medication adherence and treatment response in outpatient care for depression; improvements in some clinical monitoring measures for diabetes with endocrinology or pharmacy outpatient consultations; similar mortality or time to treatment when used to support emergency assessment and management of stroke, heart attack, or chest pain at rural hospitals; and similar rates of appropriate versus inappropriate transfers of critical care and trauma patients with specialist telehealth consultations for rural emergency departments (SOE: low). Studies of telehealth for education and mentoring of rural healthcare providers may result in intended

changes in provider behavior and increases in provider knowledge, confidence, and self-efficacy (SOE: low). Patient outcomes were not frequently reported for telehealth provider education, but two studies reported improvement (SOE: low). Evidence for telehealth interventions for other clinical uses and outcomes was insufficient.

We identified 67 program evaluations and qualitative studies that identified barriers and facilitators to rural provider-to-provider telehealth. Success was linked to well-functioning technology; sufficient resources, including time, staff, leadership, and equipment; and adequate payment or reimbursement. Some considerations may be unique to implementation of provider-to-provider telehealth in rural areas. These include the need for consultants to better understand the rural context; regional initiatives that pool resources among rural organizations that may not be able to support telehealth individually; and programs that can support care for infrequent as well as frequent clinical situations in rural practices.

An assessment of methodological weaknesses found that studies were limited by less rigorous study designs, small sample sizes, and lack of analyses that address risks for bias. A key weakness was that studies did not assess or attempt to adjust for the risk that temporal changes may impact the results in studies that compared outcomes before and after telehealth implementation.

Conclusions. While the evidence base is limited, what is available suggests that telehealth supporting provider-to-provider communications and collaboration may be beneficial. Telehealth studies report better patient outcomes in some clinical scenarios (e.g., outpatient care for depression or diabetes, education/mentoring) where telehealth interventions increase access to expertise and high-quality care. In other applications (e.g., inpatient care, emergency care), telehealth results in patient outcomes that are similar to usual care, which may be interpreted as a benefit when the purpose of telehealth is to make equivalent services available locally to rural residents. Most barriers to implementation are common to practice change efforts. Methodological weaknesses stem from weaker study designs, such as before-after studies, and small numbers of participants. The rapid increase in the use of telehealth in response to the Coronavirus disease 2019 (COVID-19) pandemic is likely to produce more data and offer opportunities for more rigorous studies.

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Executive Summary

Main Points

- **Use of Provider-to-Provider Telehealth for Rural Populations:** Limited research from regional and national surveys and claims data suggest that telehealth for provider-to-provider communication is used to different extents across location for specific clinical care uses such as psychiatry, emergency, and stroke care. Use was increasing even before the COVID-19 pandemic and this seems likely to continue, though research evaluating new and increased use has yet to be published.
- **Effectiveness of Provider-to-Provider Telehealth for Rural Populations:**
    - Telehealth to support direct patient care may provide benefits for inpatient care, for neonates in rural hospitals, outpatient management of depression and diabetes, and emergency care of stroke/heart attack/chest pain and trauma.
        - Evidence on other uses, outcomes, or populations was insufficient to support conclusions. No studies reported harms or unexpected negative outcomes for provider-to-provider telehealth.
    - Use of telehealth for provider education and mentoring, including programs like Extension for Community Healthcare Outcomes (ECHO) that use video for instruction and collaboration, may improve patient outcomes, change provider behavior, and increase provider knowledge and confidence in treating specific conditions.
- **Barriers and Facilitators to Implementation of Provider-to-Provider Telehealth for Rural Populations:** Inadequate provider time, technology, and other resources, as well as limited understanding of the rural context and lack of long-term commitments to telehealth are barriers to broader implementation of provider-to-provider telehealth in rural settings. Telehealth implementation was facilitated when there were sufficient resources, access to knowledge, engagement of leadership and the program addressed patient needs.
- **Methodological Weakness of Studies:** Effectiveness and implementation studies frequently employed less rigorous designs, had small sample sizes, and often did not minimize bias through design or analyses.

Background and Purpose

Numerous studies have documented health disparities for people living in rural areas.[1] Rural populations experience higher mortality[2-5] and morbidity from a wide range of conditions including substance/opioid abuse,[6, 7] chronic illnesses,[8-11] and HIV/human papillomavirus and other infectious diseases.[12, 13] The purpose of this review is to identify, summarize, and evaluate the research available on whether telehealth supporting provider-to-provider communication and collaboration can contribute to addressing these disparities and improving the health and well-being of rural communities. The review was commissioned by the National Institutes of Health (NIH) Office of Disease Prevention to inform a Pathways to Prevention workshop, *Improving Rural Health Through Telehealth-Guided Provider-to-Provider Communication*, that was held on October 12-14, 2021 (https://prevention.nih.gov/research-priorities/research-needs-and-gaps/pathways-prevention/improving-rural-health-through-telehealth-guided-provider-provider-communication).

Methods

The Key Questions guiding the systematic evidence review were developed by an NIH working group and revised through a topic refinement process. We employed methods consistent with those outlined in the Agency for Healthcare Research and Quality Evidence-based Practice Center Program methods guidance (https://effectivehealthcare.ahrq.gov/topics/cer-methods-guide/overview). Our search included articles published from January 1, 2010, through October 12, 2021. Detailed methods, including the search strategies, are included in the full report and appendixes.

Results

We identified 166 studies reported in 179 publications that addressed the use, effectiveness, implementation of telehealth designed to support provider-to-provider interactions. The extent to which these studies are able to answer each of the questions posed is summarized below.

Key Question 1. What is the uptake of different types of provider-to-provider telehealth in rural areas?

- We did not identify any surveys or national datasets that provided overall counts or estimates of provider-to-provider telehealth usage in the United States.
- Seven published reports provide data from surveys and claims data about rural use of telehealth for specific clinial uses. Examples are: reported rates of use of telepsychiatry (29.2% by U.S. mental health providers), telehealth in emergency care (54% of emergency departments in the United States), and telestroke (8.6 per 1,000 stroke cases for rural residents). Reported use of telehealth in the United States is variable across states and regions, but has been increasing over time.

Key Question 2. What is the effectiveness of provider-to-provider telehealth for rural patients?

a. How does provider-to-provider telehealth affect outcomes for patients and populations?

b. How does provider-to-provider telehealth affect outcomes for healthcare providers?

c. How does provider-to-provider telehealth affect outcomes for private and public payers?

We assessed the research on effectiveness first by healthcare setting (i.e., inpatient, outpatient emergency care, education and mentoring), then by clinical topic within settings as telehealth interventions and outcomes differed across settings based on data from 97 studies.

Inpatient Care

- Telehealth consultations in rural hospitals may result in no difference in length of hospital stay (6 studies) or transfers (3 studies; low strength of evidence [SOE]) compared to usual care, including in-person or phone consultations.

- Telehealth supported care for neonates at rural hospitals may result in no difference in clinical outcomes when compared to transfer and care at a hospital with a Level 4 neonatal intensive care unit (3 studies; low SOE). When telehealth is available, neonate transfers may be more appropriate (2 studies; low SOE).
- Evidence suggests remote intensive care units (ICUs) in rural areas result in no difference in mortality rates compared to transferring patients to more distant locations for ICU care (2 studies; low SOE).

Outpatient Care

- Outpatient telehealth consultations with specialists may result in improvements in clinical outcomes compared to care without specialist involvement:
    - For patients with diabetes:
        - Some improvement in medication adherence and treatment response for patients with depression (3 studies; low SOE).
        - Improvements in A1c and self-management but no effect on blood pressure or cholesterol levels in patients with diabetes (4 studies; low SOE).
        - Improvements in A1c, fasting glucose, and blood pressure in patients with both hypertension and diabetes with pharmacy teleconsultations (2 studies; low SOE).
    - For patients with depression:
        - Higher utilization of telehealth and corresponding costs for outpatient consultations for depression are associated with increased access and cost-effectiveness analyses reported overall benefit (2 studies; low SOE).

Emergency Care

- Telehealth consultations supporting emergency assessment and care of stroke, heart attack. or chest pain at rural hospitals:
    - May result in similar rates of mortality when patients are treated locally as opposed to transferred (5 studies; low SOE).
    - May result in similar time to treatment when patients are treated locally as opposed to transferred (8 studies; low SOE).
- Telehealth consultations by specialists for critical care and trauma patients in rural emergency departments may result in no difference in appropriate or inappropriate transfers (5 studies; low SOE).

Education and Mentoring

- Clinical outcomes: ECHO programs (a specific model that uses video for instruction and case reviews) are associated with better or equivalent patient outcomes (2 studies; low SOE):
    - Reduction in A1c in patients of trainees after ECHO compared to before participation (1 study).
    - Hepatitis C viral response and serious adverse events rates at “spoke” site with ECHO participation were similar to those at an academic medical center (1 study).
- ECHO and non-ECHO video training programs:

- May result in desired changes in provider behavior (e.g., increased appropriate prescribing practices, screening, and patient counseling) (8 studies; low SOE).
- May be associated with increased provider confidence, efficacy, and scores on knowledge tests (13 studies; low SOE).

Key Question 3. What strategies are effective and what are the barriers and facilitators to implementation and sustainability of provider-to-provider telehealth in rural areas??

Sixty-seven program evaluation and qualitative studies using a wide range of methodologies provide information on implementation of provider-to-provider telehealth.

- Barriers and facilitators are similar across provider-to-provider telehealth programs implemented in different settings and for different purposes. The majority are related to available resources, and access to knowledge and information.
- Barriers to rural provider-to-provider telehealth may be addressed by the implementation of specific evidence-based strategies. The following were identified and suggested by the authors of included studies:
  - Consulting providers need to understand the characteristics of rural areas and populations and what resources are available. *Strategy:* rural rotations or periodic in person collaboration.
  - Successful implementation and sustainment require a long-term commitment and resources on a scale that may not be feasible for individual rural organizations. *Strategy:* statewide or regional initiatives with government or philanthropic support.
  - Provider-to-provider telehealth systems may be used for frequent events or serve as a resource for rare events in rural healthcare and the technology and support need to be tailored to frequency of use. *Strategy:* customize system to accommodate frequency of use, such as schedule periodic testing of systems used for rare events.

Key Question 4. What are the methodological weaknesses of the included studies of provider-to-provider telehealth for rural patients and what improvements in study design (e.g., focus on relevant comparisons and outcomes) might increase the impact of future research?

When reviewing studies for Key Questions 2 and 3 we abstracted the limitations cited by the authors and combined these with our risk of bias and applicability assessments in order to identify and categorize the methodological weaknesses.

- Studies of provider-to-provider telehealth for rural areas could be improved by addressing methodological weakness.
- Key weakness: it is often difficult to attribute impact to telehealth because--
  - Weaker study designs are common: randomized controlled trials and cohort studies were identified and accounted for 3/5 of the included studies, but more than 40 percent of the studies were repeated measures (pre/post or before/after) with no other comparison group.

    - Lack of control for confounders related to patients, providers, facilities, and differences in telehealth implementation across study sites
- The most frequently identified weakness after overall study design is small sample sizes that result in lack of power to detect differences.
- Studies are also hampered by data limitations related to use of retrospective data, and data produced for care delivery and billing purposes, that can be incomplete or coded differently across organizations.

Strengths and Limitations

The research on provider-to-provider telehealth for communication and collaboration in the delivery of rural healthcare includes studies that directly address the questions asked by this review, but they are spread across settings, many different clinical uses, and evaluated different telehealth outcomes. For these reasons, the existing evidence base is unable to support strong conclusions. Overall, research on telehealth in general is often not based on a clear model of how telehealth is expected to affect outcomes; an outcome-oriented model for telehealth could inform better research. While telehealth should increase patient and provider satisfaction and other outcomes, there is no agreement on how to prioritize across clinical outcomes, resource use, costs, access to care and potential harms. It is also often unclear if the goal of telehealth is to provide care that is as good as care provided without telehealth or if the investment in telehealth requires that outcomes be better.

Implications and Conclusions

The limited available evidence suggests that telehealth supporting provider-to-provider communications and collaboration may produce similar or better results for patients, providers, and payers compared with care without telehealth. Barriers to implementation are known and common to practice change efforts. Methodological weaknesses are due to the use of less rigorous study designs that do not sufficiently address differences in the groups compared and include small numbers of participants. The rapid increase in the use of telehealth in response to the COVID-19 pandemic is likely to produce more data and may offer opportunities for more rigorous studies.

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Introduction

Background

Almost one-fifth of the population of the United States lives in rural areas. Health disparities for people living in rural areas are well studied[1] and include higher mortality[2-5] and morbidity from a wide range of conditions such as substance/opioid abuse,[6, 7] chronic illnesses,[8-11] and HIV/AIDS, human papillomavirus, and other infectious diseases.[12, 13] Rural-urban health inequities have been extensively documented and the subject of research for several decades.[2, 14, 15] Despite this recognition, inequities persist today and may be amplified by the COVID-19 pandemic[16] which has increased the risk of morbidity and mortality[17, 18] and continues to impact access to health services.[19-21] Underlying causes are complex and varied as they are related to macro and micro sociologic-demographic forces[22] and economic trends.[23, 24] Research on health disparities continues to evolve from early work describing the extent of disparities, to attempts to understand the underlying reasons disparities exist, and finally to the current focus on identifying and implementing interventions to reduce these disparities.[25-27] The need for interventions to reduce disparities has garnered additional attention due to impacts of the COVID-19 pandemic,[28, 29] race,[30] and structural racism[31] on access to care[32] and health outcomes.[33]

Telehealth is the use of information and telecommunications technology to provide healthcare across time and/or distance.[34] This broad definition includes many modes of delivery (e.g., asynchronous, real-time video, and many others) and is the starting point for this review. Telehealth is a tool with the potential to increase access, improve the quality of care, increase patient satisfaction, positively impact patient outcomes, and reduce the cost of care. Telehealth includes using technology to directly deliver care but it can encompass broader applications of technologies to healthcare functions such as consultation, distance education, and mentoring, monitoring and data collection, and consumer outreach.[35] Provider-to-provider telehealth is a more specific, but still broad, telehealth application and is the focus of this review. We have defined provider-to-provider telehealth as any form of interactive support using telecommunications technology provided to healthcare professionals while they are caring for rural patients and populations. This includes using technology to support clinicians through mechanisms including consultations, mentoring, and education with the goal of improving the care they provide to individual patients or patient populations. More detailed definitions and descriptions that are specific to healthcare settings and clinical indications were used to group similar interventions in our synthesis, and are provided in **Appendix A, Appendix Table A-1**.

Application of telehealth had been steadily increasing in many areas of healthcare before the COVID-19 pandemic[36] began in 2020. The potential benefits of telehealth are frequently cited,[37, 38] and there is a sizable body of research on telehealth, including systematic reviews and reviews of reviews.[39-44] Yet implementation and spread have been slow.[45-47] Nevertheless, telehealth adoption appeared to be accelerating with improvement in technologies[48] and expansion of coverage by both public and private payers prior to the pandemic. The increase in use has been accompanied by an increase in the research and published literature on telehealth. Use of provider-to-provider telehealth for consultations has been studied across a range of clinical indications[49] including specialty care,[50] acute/emergency care,[51] and intensive care.[52] Additionally, other forms of provider-to-provider telehealth such as distance learning[53] and

Project Extension for Community Healthcare Outcomes [54, 55] that combines provider education with review of specific cases are increasingly the subject of study.

The COVID-19 pandemic continues to create an environment that requires balancing the need to provide care while minimizing exposure and maximizing resources. Growth in the use of telehealth has been exponential, spurred by this need and supported by temporary changes in payment and regulation,[56] some of which may become permanent. Documentation of implementation and research on the effectiveness of this recent expansion of telehealth is now becoming available, though with the time lags necessary for data collection and for the measurement of patient-centered outcomes in addition to intermediate, process measures (e.g., numbers of telehealth encounters).

Identifying and synthesizing the available evidence about the use of provider-to-provider telehealth as a means of addressing rural health disparities can support ongoing spread, conversion of telehealth friendly pandemic policies to permanent support, and the identification of potential new areas and approaches for the expansion of telehealth in rural America.[57]

Purpose and Scope of This Systematic Review

The scope of this review is provider-to-provider telehealth interventions designed to address the needs of rural patients and populations. This systematic review is intended to address a number of decisional dilemmas, including areas of uncertainty and lack of accessible evidence to support clinical, organizational and policy decision-making. The review first identified and synthesized the literature regarding the use of telehealth technologies to support provider-to-provider consultation in rural areas. In addition, the report identified known facilitators, barriers and strategies that are effective in promoting the adoption, implementation and sustainability of provider-to-provider telehealth for rural patients and populations. Finally, the project systematically categorized and summarized gaps in the evidence and the strengths and weaknesses of study designs to inform the design and conduct of future research. Narrow definitions of rural and provider-to-provider telehealth were avoided. We accepted study authors' designation of rural. The provider-to-provider telehealth scope is also broadly defined and includes interventions across a range of healthcare settings (inpatient, outpatient, emergency and educational setting) and clinical indications (e.g., stroke, diabetes, mental health).

This review is intended for a broad audience of stakeholders including but not limited to healthcare administrators, clinical leaders and policy makers interested in telehealth as an approach to address rural health disparities and improve the health and wellbeing of rural populations. It was specifically commissioned to inform the Pathways to Prevention workshop: *Improving Rural Health Through Telehealth-Guided Provider-to-Provider Communication,* developed by the National Institutes of Health (NIH) Office of Disease Prevention (ODP) in collaboration with the National Center for Advancing Translational Sciences; National Heart, Lung, and Blood Institute; Federal Office of Rural Health Policy at the Health Resources and Services Administration; and the Office of the Associate Director for Policy and Strategy, Centers for Disease Control and Prevention (hereafter referred to as the NIH/ODP Working Group). The workshop was convened by the NIH on October 12-14, 2021 (https://prevention.nih.gov/research-priorities/research-needs-and-gaps/pathways-prevention/improving-rural-health-through-telehealth-guided-provider-provider-communication).

Methods

Review Approach

This systematic review follows the methods suggested in the Agency for Healthcare Research and Quality (AHRQ) *Methods Guide for Effectiveness and Comparative Effectiveness Reviews* (hereafter "AHRQ Methods Guide").[58] All methods were determined *a priori*, and a protocol was published on the AHRQ website (https://effectivehealthcare.ahrq.gov/products/rural-telehealth/protocol) and included in the PROSPERO systematic reviews registry (registration no. CRD42021233545). Below is a summary of the specific methods used in this review. A detailed description of the methods is provided in **Appendix A**.

Key Questions

The Key Questions for this systematic review are based on questions provided in the statement of work that accompanied the Request for Task Order. The questions were initially developed by the National Institutes of Health/Office of Disease Prevention (NIH/ODP) Working Group, and reviewed, reorganized, and refined by the systematic review project team; they were further revised after additional input from the AHRQ Task Order Officer (TOO) and the NIH/ODP Working Group.

Key Question 1. What is the uptake of different types of provider-to-provider telehealth in rural areas?

Key Question 2. What is the effectiveness of provider-to-provider telehealth for rural patients?

a. How does provider-to-provider telehealth affect outcomes for patients and populations?
b. How does provider-to-provider telehealth affect outcomes for healthcare providers?
c. How does provider-to-provider telehealth affect outcomes for private and public payers?

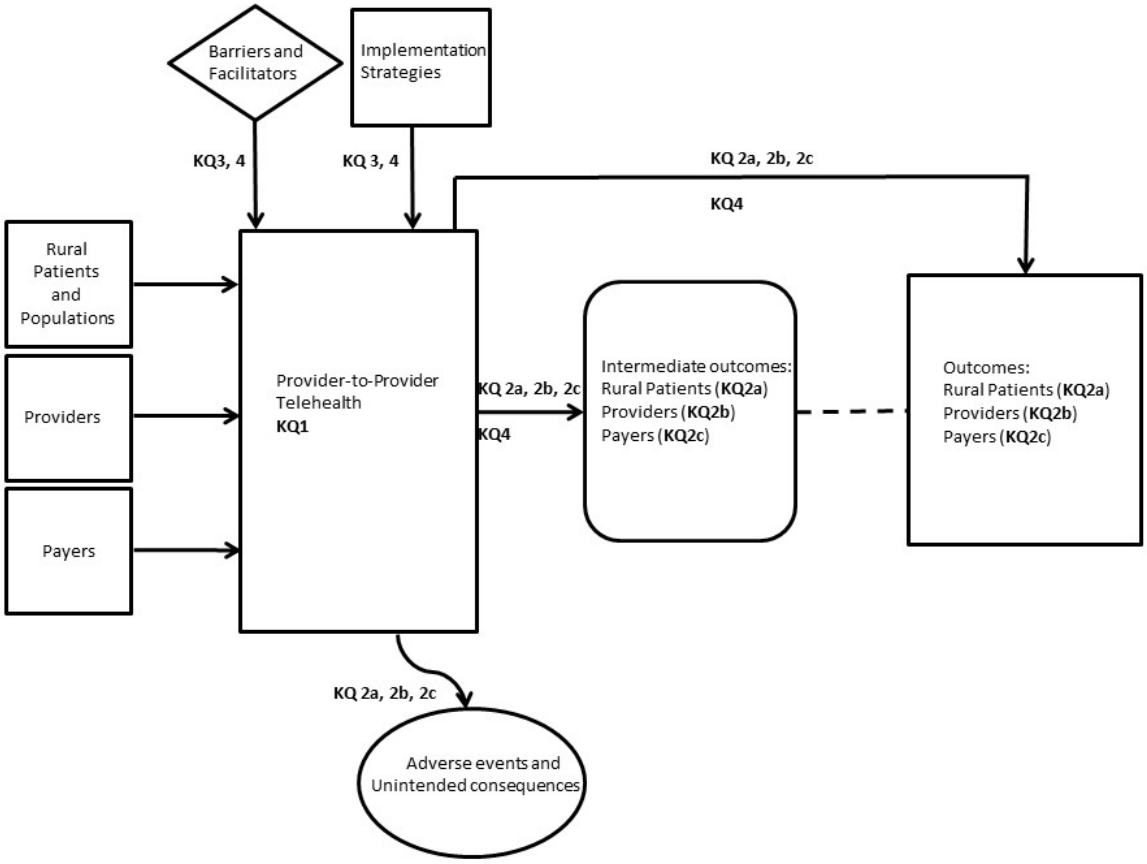
Key Question 3. What strategies are effective and what are the barriers and facilitators to implementation and sustainability of provider-to-provider telehealth in rural areas?

Key Question 4. What are the methodological weaknesses of the included studies of provider-to-provider telehealth for rural patients and what improvements in study design (e.g., focus on relevant comparisons and outcomes) might increase the impact of future research?

Analytic Framework

The analytic framework **(Figure 1)** shows the target populations, interventions, and outcomes examined; the Key Questions are numbered and indicated in the framework.

Figure 1. Analytic framework



Abbreviation: KQ = Key Question.

Study Selection

We established criteria *a priori* to determine eligibility for inclusion and exclusion of abstracts in accordance with the AHRQ Methods Guide,[58] based on the Key Questions and population, intervention, comparisons, outcomes, settings, and study designs of interest (PICOS) framework. PICOS elements operationalized in terms of detailed inclusion and exclusion criteria are included in **Appendix Table A-1**.

Data Extraction and Risk of Bias Assessment

After studies were deemed to meet inclusion criteria, data were abstracted, including: study design, year, setting, country, sample size, patient and providers types and characteristics (e.g., age, sex, race, reason for presentation, diagnosis, provider training/background/scope of practice and primary care or specialty type), intervention characteristics (e.g., mode of delivery, duration or frequency, function) and results relevant to each Key Question as outlined in the PICOS

section in **Appendix A**. As Key Question 2 asks about outcomes for three groups: patients and populations, healthcare providers, and payers, outcomes were sorted by these groups. Data abstraction forms were developed after full text review and the data to be included in evidence tables was discussed with the AHRQ TOO and the NIH/ODP Working Group. Information relevant for assessing applicability included the number and diversity of settings or locations as well characteristics of the population, telehealth intervention or implementation strategy, and administrating personnel. Sources of funding for all studies were also recorded. All study data was initially abstracted by one team member, then verified for accuracy and completeness by a second team member.

Predefined criteria were used to assess the risk of bias (also referred to as quality or internal validity) for each individual included effectiveness study, using criteria appropriate for the study designs. Controlled trials and observational studies were assessed using *a priori* established criteria consistent with the approach recommended in the chapter "Assessing the Risk of Bias of Individual Studies When Comparing Medical Interventions" in the AHRQ Methods Guide.[59] Studies were rated as "low risk of bias," "medium risk of bias," or "high risk of bias." We did not exclude studies rated high risk of bias *a priori*, but high risk of bias studies are considered less reliable than low or medium risk of bias studies. For full details about the methods for data extraction and risk of bias assessment, see **Appendix A**.

Data Synthesis and Analysis

We constructed evidence tables identifying the study characteristics (as discussed above), results of interest, and risk of bias ratings for all included studies, and summary tables to highlight the main findings. As the Key Questions varied in nature and scope, our approach to synthesis differed.

For Key Question 2, the question about comparative effectiveness, we applied standard systematic review methods and reviewed and highlighted studies using a hierarchy-of-evidence approach, where the studies with better risk of bias ratings were given more weight in our synthesis for each clinical indication and outcome. Descriptive analysis and interpretation of the results were provided based on the direction and magnitude of effect. Meta-analyses were not performed as they would not producing meaningful results due to limited numbers of studies reporting similar outcomes, and heterogeneity among studies in design, patient population, and interventions.

Our response to Key Question 3 involved identifying and summarizing barriers and facilitators to implementation of provider-to-provider telehealth for rural healthcare. When studies directly compared different strategies, we provide a narrative summary of the studies and their results. When studies only reported on implementation for an individual intervention (not comparative), we abstracted what study authors described as barriers, facilitators, and indicators of implementation success. We applied an existing framework, the Consolidated Framework for Implementation Research (CFIR), to classify barriers and facilitators,[60] then summarized how frequently they were reported, both across all identified studies and then by setting.

For Key Question 1 (use of telehealth) and Key Question 4 (strengths and weaknesses of included studies) synthesis consists of descriptive narratives and tables, corresponding to the nature of the questions and data.

Grading the Strength of the Body of Evidence

The strength of evidence (SOE) for Key Questions 2a-2c (effectiveness) was determined for each clinical indication and major outcome category. SOE was initially assessed by one researcher and confirmed by a second using the approach described in the AHRQ Methods Guide.[59] The body of evidence was assessed using the following criteria as they are defined in the AHRQ Methods Guide:

- Study limitations (low, medium, or high level of study limitations)
- Consistency (consistent, inconsistent, or unknown/not applicable)
- Directness (direct or indirect)
- Precision (precise or imprecise)

For definitions of the ratings used to categorize the strength of evidence, see **Appendix Table A-2**.

SOE and the corresponding conclusions are expressed in terms of whether the outcome measured and analyzed in the studies is better, worse, or similar with telehealth compared to typical provider-to-provider interactions without telehealth, often referred to in studies as usual care. However, usual care could have different meanings including in-person interactions or no interactions. For this reason, we have provided detailed descriptions of usual care when they were provided by the study authors.

In studies of telehealth, interpreting results requires consideration of the context and the intended function of telehealth. When outcomes are better or worse, the interpretation is relatively clear. If telehealth consultations are used to provide access to specialized knowledge and patient outcomes are found to be better, telehealth is providing a benefit. If the opposite is true, and a study finds patient outcomes are worse, then telehealth is having a negative impact or causing harm. Drawing a conclusion is less straightforward when patient outcomes are found to be similar with and without telehealth. Telehealth is often used to allow healthcare to be delivered in rural locations rather than transferring the patient or requiring travel. If patient outcomes are similar in rural locations, telehealth may be beneficial, if it reduced travel burdens and this was the intention. However, determining if similar outcomes equals a benefit depends on considering multiple factors, such as resources needed and how perspectives may differ (e.g., what is most important to a patient may not be what is most important to a health system). For this reason, we report when outcomes are similar in results, and then discuss the context to help facilitate conclusions about whether similar outcomes with telehealth can be interpreted as a benefit.

Results

Description of Included Evidence

A total of 6,329 references were reviewed, including 5,973 from electronic database searches and 356 from reference lists and other systematic reviews. After dual review of titles and abstracts, 1,024 articles were selected for full-text review, of which 166 studies in 179 publications were included in this review. Search results and selection of studies are summarized in the literature flow diagram (**Appendix B, Appendix Figure B-1**). Results are arranged by Key Question and then by clinical indication in tables and summarized in accompanying text.

Characteristics of included studies are detailed in **Tables B-1, B-2, and B-3.** A list of included studies can be found in **Appendix C.** Data abstraction of study characteristics and results, quality assessment for all included studies, and details for grading strength of evidence (SOE) are available in **Appendixes D, E, and F**, respectively. A list of excluded studies with reasons for exclusion are included in **Appendix G.** A list of references appearing in the appendix is available in **Appendix H.**

Key Question 1. What is the uptake of different types of provider-to-provider telehealth in rural areas?

Key Points

- We did not identify any surveys or national datasets that provided a comprehensive assessment of the use of provider-to-provider telehealth for rural populations in the United States.
- Seven published reports provide data about regional or national use for specific clinical applications. These include telepsychiatry, telehealth in emergency care, and telehealth use by hospitals for intensive care unit (ICU), stroke and heart attack care.
- While use varies across states and regions, telehealth use remains low, with a minority of rural hospitals reporting telehealth use in the included studies and less use compared to urban areas, though telehealth use has increased over time.

Summary of Findings

To address this Key Question we searched for and included any studies published since 2015 that reported the use of provider-to-provider telehealth in rural areas. We also searched gray literature and asked experts and stakeholders for any known studies or reports (details on the search are included in **Appendix A**). The identified evidence to address Key Question 1 was limited. No national surveys or datasets that provided a comprehensive description or global estimate of provider-to-provider telehealth in rural areas generally were identified through our literature search. Additionally, no supplemental evidence for Key Question 1 was identified following the search process outlined in **Appendix B**.

We did however identify seven studies reporting the uptake of different types of provider-to-provider telehealth for a specific use in rural areas.[61-67] All studies were regional or national in focus, and all were conducted in the United States. Six studies report the results of surveys,[61-66] while one study performed a secondary analysis on healthcare claims data.[67] Telehealth modalities represented across the seven studies include telepsychiatry, emergency telehealth,

remote ICU, telestroke and telecardiology. Risk of bias ratings and grading the SOE were not appropriate for the descriptive nature of this Key Question. The studies that reported on national surveys and trends are summarized in **Table 1** and additional details can be found in **Appendix Tables B-1 and D-1.**

These studies reported relatively low rates of telehealth adoption and most reported lower rates in rural than urban area. All that examined change over time reported increases in rural as well as urban hospital and the results from these surveys underscore variation in use across specialties and regions. Surveys documented that telepsychiatry use increased over time from 15.2 percent of mental health facilities in 2010 to 29.2 percent in 2017. There was wide variability across states, and telehealth was more commonly used by facilities in medically underserved and rural areas.[64] Rural location, Critical Access Hospital designation, and higher annual total visit volumes were associated with higher likelihood of telepsychiatry use.[63]

Forty-six percent of rural emergency departments (EDs) responding to a survey reported they were not using telehealth, with the Southern Region of the United States significantly less likely to use telehealth than other regions.[65] When telehealth was used it was more often in EDs that are rural, that do not have 24-hour per day neurologist availability, and that had an annual volume greater than 20,000 visits.[66]

A study of the use of multiple types of telehealth by hospitals in 2018 found that urban hospitals were twice as likely as rural hospitals to use telehealth for ICU and stroke care.[62] Similarly, a study of use of telehealth for heart attack and stroke reported that use by rural hospitals increased from 6 percent in 2012 to 16 percent in 2017, though these rates are still lower than those for urban hospitals.[61] In both of these studies, smaller hospitals (fewer beds) were less likely to have adopted telehealth.

The only included study that used claims data, reported that between 2008 and 2015, the proportion of ischemic stroke patients receiving telestroke services increased from 0.4 to 3.8 per 1,000 among fee-for-service Medicare beneficiaries and use of telestroke services increased most rapidly among rural residents. Patients dually eligible for Medicare and Medicaid had a lower proportion of telestroke care use than Medicare-only patients residing in rural and super rural counties as defined by the study authors, but its use was similar among both groups of patients living in urban counties.[67]

Table 1. Key Question 1: summary of provider-to-provider telehealth use in rural areas

Clinical Topic	Modality	Number of Studies	Data Source Sample	Key Findings
Pharmacy	Telepharmacy	1	**Data Source** Researcher initiated survey and interviews **Sample** 50 state offices of rural health Followup interviews: 10 states	Use of telepharmacy in rural hospitals varied across states but was not widely adopted[68] Telepharmacy models differed according to area, state regulations, hospital ownership, and hospital size and medication order volume[68]
Mental health	Telepsychiatry	2	**Data Sources** 2016 National Survey of U.S. Emergency Departments[63] 2010-2017 waves of the National Mental Health Services Survey[64] **Sample** 4,507 of 5,375 (84% response)	20% of all U.S. Emergency Departments reported utilizing telepsychiatry services. The most common applications: admission or discharge decisions (80%) transfer coordination (76%).[63] Use increased over time 2010: 15.2% of mental health facilities (n=1,580) 2017: 29.2% (n=3,385) OR=2.30, 95% CI 1.96 to 2.69, with wide variability among states.[64]
Emergency Care	Emergency Telehealth	2	**Data Sources** 2014 National Emergency Department Inventory-New England[66] 2016 National Emergency Department Inventory Survey[65] **Sample** 169 of 195 (87% response)[66] 977 rural emergency departments[65]	49% of New England Emergency Departments (12% Rural, 7% Urban) report using telehealth, most commonly for neurology/stroke, pediatrics, psychiatry, and trauma.[66] 46% of rural emergency departments in the U.S. did not report using telehealth, with the Southern Region of the U.S. significantly less likely to use telehealth than other regions.[65] Telehealth was more often used in emergency departments that are rural, that do not have 24 hour 7 days per week neurologist availability, and with an annual volume of ≥ 20,000 visits.[66]
Stroke	Telestroke	1	**Data Sources** 2008-2015 Medicare fee-for-service administrative claims data[67] **Sample** 1,002,2245 ischemic stroke hospitalizations	2008 to 2015 for fee-for-service Medicare beneficiaries: Increases in ischemic stroke cases receiving telestroke services Overall: 0.4 to 3.8 per 1,000 Rural residents: 0.6 to 8.6 per 1,000 Super rural: 1.0 to 6.1 per 1,000 Urban: 0.3 to 2.3 per 1,000.[67]

Clinical Topic	Modality	Number of Studies	Data Source Sample	Key Findings
Stroke and ICU	Telestroke and remote ICU	1	**Data Source** 2018 American Hospital Association Survey[62] **Sample** 781 rural hospitals 2,756 metropolitan and micropolitan*	Metropolitan areas* are more than twice as likely to adopt telehealth for ICU and stroke. eICU 0.48 vs. 0.13 Stroke 0.43 vs. 0.21 Small numbers of beds and lack of health information change capacity explained some of this difference.[62]
Stroke and Heart Attack	Telestroke or Telecardiology	1	**Data Sources** 2012-2017 Health Information Management and System Society Dorenfest Database and Healthcare Cost Report Information System **Sample** 2,012 rural hospitals 2,096 not rural	Percentage of hospitals with telemedicine, change 2012 to 2017 Rural: 6.31% to 16.45% Urban: 7.30% to 19.42% In rural hospitals government vs. private hospitals, larger hospitals (more beds) and less Medicare patients, and a higher number of ED visits were associated with higher likelihood of telehealth adoption.[61]

Abbreviations: CI = confidence interval; ED = emergency department; ICU = intensive care unit; OR = odds ratio
*Metropolitan areas have at least 1 core urbanized area of at 50,000 people; micropoltitan at least 10,000 people but less than 50,000.

Key Question 2. What is the effectiveness of provider-to-provider telehealth for rural patients?

a. How does provider-to-provider telehealth affect outcomes for patients and populations?

b. How does provider-to-provider telehealth affect outcomes for healthcare providers?

c. How does provider-to-provider telehealth affect outcomes for private and public payers?

Key Question 2 presents the available evidence about the effectiveness of provider-to-provider telehealth for rural populations. The following sections summarize the results of the 97 comparative studies in 106 publications we identified using the search and selection process described in the methods section above. Full details of the search and selection process are provided in **Appendix Figure B-1**. We included research that evaluated the effect of telehealth on outcomes for patients, providers, and payers. As these studies include diverse uses of telehealth in different settings for different clinical indications, we have organized results first by setting (i.e., in-patient, out-patient, emergency care and education) and then by clinical indication within settings. This facilitates summarizing evidence that is likely to be comparable. Consideration of findings across settings and broader interpretations are provided in the Discussion section of this report.

Inpatient

Key Points

- Telehealth consultations as part of inpatient care at a rural hospital may result in similar lengths of hospital stay (6 studies; Low SOE) and rates of transfers (3 studies; Low SOE) compared to usual care that involves in person or phone consultations.
- Telehealth supporting care for neonates at rural hospitals may result in similar clinical outcomes when compared to transfer and care at a hospital with a Level 4 neonatal intensive care unit (NICU) (2 studies; Low SOE) and may result in more appropriate transfers (2 studies; Low SOE).
- Remote ICU care in rural hospitals result in no difference in mortality rates compared to transferring patients to more distant locations for ICU care (2 studies; Low SOE) while evidence is insufficient to support conclusions about the impact of remote ICUs in rural area on transfers. (1 study, insufficient evidence).

Summary of Findings

We identified 17 studies reported in 18 articles that evaluated provider-to-provider telehealth for inpatient care of rural populations. Five studies reported in six articles evaluated teleconsultations for care of neonates,[69-74] three for infectious disease,[75-77] one for spinal fractures,[78] one for stroke,[79] one for mental and behavioral disorders,[80] and two studied remote ICU.[81, 82] Additionally, five studies evaluated telehealth facilitated rounds and remote consultations for multiple conditions[83-86], include one that focused on pediatric patients.[84] The majority (13) were studies that compared outcomes before and after the implementation of telehealth,[69, 72, 75-81, 84-86] two studies reported in three articles were prospective cohort studies,[70, 71, 74] and three were retrospective cohort studies.[73, 82, 83] Eleven were conducted in the United States,[69, 70, 72-74, 76, 77, 82-85] five in Australia[75, 78, 80, 81, 86] and one in Scotland.[79] Risk of bias was rated as high for six studies[69, 72, 75, 77, 78, 85] and medium for eleven studies (**Appendix E**).[70, 73, 74, 76, 79-84, 86] Additional descriptive information about these studies and key results are included in **Appendix Tables D-2 and D-3.**

The key results are organized by clinical indication in **Table 2** below. Given the small number of studies, we assessed the body of evidence for the same outcome across similar interventions to determine the strength of possible conclusions (SOE details in **Appendix F**).

We considered studies of teleconsultations for infectious disease, stroke, mental and behavioral disorders, spinal fracture and multiple conditions addressed via teleconsultation rounds together as these connected specialists with the inpatient care team to assist in the management of specific patient issues. The evidence was insufficient to support a conclusion about the impact on mortality based on three studies with imprecise and inconsistent results, with one study reporting a decline in mortality after infectious disease teleconsultations were available (odds ratio [OR] 0.3; 95% confidence interval [CI], 0.2 to 0.7)[76] and two studies reporting no significant differences in mortality after instituting teleconsultation rounds of various types (1.7% vs. 2.3%; 4% vs. 1%).[83, 85]

Six studies of inpatient consultations provide low SOE that telehealth resulted in similar patient length of stay. The SOE is low as their results were inconsistent with one study reporting an increase in hospitals days with infectious disease teleconsultation versus pre-telehealth phone consultations (OR 1.3; 95% CI, 1.2 to 1.5);[76] one finding a decrease with remote consultations for spinal fractures versus in-person consultations requiring patient transfer to specialist and back

to local hospital (9.25 vs. 4.2, p<0.01);[78] and four reported finding no significant difference in length of stay between telehealth and pre-telehealth (mean number of days 2.55 vs. 3.74, p>0.05; median days: 17 [interquartile range [IQR] 9.5 to 31] vs. 29 [IQR 18.75 to 41]; mean (standard deviation [SD]) days: 2.82 (2.49) vs. 2.55 (3.059); p=0.136; mean days: 1.92 vs.1.94; p=0.896).[75, 79, 83, 85] Three studies[76, 80, 85] reported and supported a conclusion that telehealth resulted in similar or fewer patient transfers (Low SOE).

We summarized the results of studies of telehealth consultation and collaborative care of neonates separately as these programs often include mechanisms to transfer imaging and monitoring data as well as video for examination and discussion. One study (n=384 hospitals) reported that mortality declined with telehealth in the hospitals using telehealth and that infant mortality declined state wide.[72] Two smaller studies (n=143 and 155)[73, 74] provided consistent but imprecise results that clinical outcomes at the regional center with telehealth were similar to (not different from) those achieved when neonates were transferred to a hospital with level 4 NICU. This was consistent with the findings of a study of neonate care in 9 hospitals in Arkansas before and after telehealth (3 studies; Low SOE). Two studies also reported that with telehealth, transfers were more appropriate. In one study this meant low birth weight babies were not delivered in hospitals without NICUs,[72] while in the other it meant that few transfers were needed and transferred patients were more stable.[70] The evidence is insufficient to support a conclusion about the impact of neonatal teleconsultations on length of stay as this outcome was only reported in one study.

Two included studies evaluated remote ICUs. A case control study of U.S. hospitals based on Medicare claims data reported no significant difference in mortality in rural hospitals that had adopted telehealth for ICU compared to control hospitals (OR 1.06 [95% CI 0.99 to 1.13]).[82] One included study evaluated a remote ICU program in Australia and reported no difference in mortality but a significant reduction in transfers (31.8% to 22.9%, relative risk [RR] 0.88, 95% CI 0.80 to 0.98).[81] As the two studies that consistently reported no difference in mortality with remote ICU were conducted in different countries and used observational designs susceptible bias, we rated the SOE as low (Low SOE). Only one of these studies reported on transfers and we consider this evidence insufficient to support a conclusion.

None of these studies of inpatient provider-to-provider telehealth reported payer outcomes or costs and only one study of teleconsultation for spinal fracture[78] reported an improvement in provider's knowledge, skills and confidence.

Table 2. Key Question 2: summary of inpatient findings

Clinical Topic N Studies	Provider Specialty	Consultant Specialty	Patient Outcomes: Mortality*	Patient Outcomes: Hospital Use*	Patient Outcomes: Other Clinical*	Provider Outcomes/ Payer Outcomes*
Multiple conditions 4	Physicians, nurse practitioners, nurses	Hospitalist, pharmacist	~ Mortality in hospital[83, 85]	~ Transfers[85] ~ Length of stay[83, 85] ~ Readmission[83]	Not reported	+ Communication ratings[85] + Hospital Revenue[84] + Professional Billing Revenue [84] ~ Drug prescribing outcomes[86]
Infectious Disease 3	Multidisciplinary	Infectious disease specialist physicians and pharmacists	+ Mortality[76]	~ Transfers[76] − Length of stay[76†] ~ Length of stay[75] ~ 30-day Readmission[76]	Not reported	+ Provider satisfaction[76] + Improved antimicrobial use and infection rate[75, 77] ~ Antibiotic use[75] + Appropriate prescribing and adherence to guidelines[75]
Stroke 1	Stroke-unit multidisciplinary team	Stroke physician	Not reported	~ Length of stay[79]	None reported	+ Cost[79]
Mental and behavioral disorders 1	Community-based mental health providers	Psychiatrist or senior mental health provider	Not reported	+ Transfers[80]	Not reported	Not reported
Spinal fracture 1	ED medical officer	Physiotherapist, clinical nurse consultant	Not reported	+ Length of stay[78]	None reported	+ Knowledge, skills, confidence[78]

Clinical Topic N Studies	Provider Specialty	Consultant Specialty	Patient Outcomes: Mortality*	Patient Outcomes: Hospital Use*	Patient Outcomes: Other Clinical*	Provider Outcomes/ Payer Outcomes*
Neonates 5	Pediatricians, Nurse practitioners, family medicine, neonatology	Intensivists, Neonatologists	+ Statewide infant mortality to 1 year and telehealth hospital death before discharge[72]	+ Transfers[70, 72] ~ Length of stay[73, 74]	~ Enteral feeding[73, 74] ~ Ventilation-oxygen [73, 74] ~ Proportion of deliveries at community hospitals[69] ~ Morbidity[72]	None reported
ICU 2	General practitioners and nurses	ICU team	~ Mortality in high dependency unit[81] ~ Mortality in hospital[81] ~ Mortality total[81] + Mortality 90-day [82]	+ Transfers[81]	None reported	None reported

*Symbol meaning: + = Improved Outcome with telehealth; ~ = Similar outcome with telehealth; — = Worse outcome with telehealth

†Length of stay was longer with telehealth, and longer stays are usually considered a negative outcome. However mortality decreased which may indicate that more care was appropriate. The authors note that the consultations tended to occur later in the hospital stay in this study and a study in which the consultation happened sooner would provide clearer evidence about the impact on length of stay.

Abbreviations: ICU = intensive care unit; NICU = newborn intensive care unit.

Outpatient Care and Services

Key Points

- Outpatient telehealth consultations with specialists may result in improvements in clinical outcomes compared to care without specialist involvement:
    - For patients with diabetes:
        - Some improvement in medication adherence and treatment response for patients with depression. (3 studies; Low SOE)
        - Improvements in A1c and self-management but no effect on blood pressure or cholesterol levels in patients with diabetes (3 studies; Low SOE)
        - Improvements in A1c, fasting glucose, and blood pressure in patients with hypertension and diabetes with pharmacy teleconsultations. (2 studies; Low SOE)
    - For patients with depression:
        - Higher utilization and corresponding costs for outpatient consultations for depression are associated with increased access from telehealth, but cost-effectiveness analyses report overall benefit. (2 studies; Low SOE)
- Telehealth pharmacy consultations improved guideline adherence and patient outcomes in subgroups of patients with both diabetes and hypertension. (2 studies; Low SOE)

Summary of Findings

Thirty-two studies (in 35 publications) evaluated the use of provider-to-provider telehealth interventions to support outpatient care for rural populations.[87-121] Four studies assessed diabetes care;[90, 101, 103, 106] three studies assessed telehealth for depression (in 7 publications);[93, 95, 97, 109-111, 122] and three studies addressed remote consultations;[94, 100, 102] two studies each assessed telepharmacy,[87, 89] rheumatology,[116, 120] dermatology[92, 119] and oncology;[114, 117] and one study each assessed telehealth for echocardiography,[88] endoscopy,[118] hemodialysis,[113] blood pressure control,[121] fracture,[105] dementia,[99] hepatitis C,[112] attention-deficit/hyperactivity disorder,[107] post-traumatic stress disorder (in two publications),[96, 108] diabetic retinopathy screening,[91] palliative care,[98] wound care, and ultrasound in pregnancy.[104, 115] Sixteen studies (reported in 17 publications) were randomized controlled trials (RCTs),[88-90, 92, 93, 95-97, 102, 103, 107-110, 116, 119, 121] six were prospective cohort studies,[91, 94, 98, 99, 111, 120] six were retrospective cohort studies,[101, 105, 112, 114, 117, 118] four were pre-post study designs (same group measured before and after implementation),[87, 100, 106, 113] and two were before-after studies (different groups/systems measured before and after implementation).[104, 115] Eleven of the studies were conducted in the United States;[87, 89, 92, 93, 95-97, 104, 106, 107, 112, 119, 120] the remainder were conducted in Canada,[102, 113, 116] Australia,[91, 98, 105, 117] Korea,[90, 99, 100] China,[121] Denmark,[101] New Zealand,[114] Spain,[94] United Kingdom,[115, 118] Chile,[111] Taiwan,[103] and Sweden.[88] Risk of bias was rated as high for eight studies,[88, 100, 101, 104-106, 115, 118] medium for 21 studies,[87, 89-92, 94, 96-99, 103, 107, 111-114, 116, 117, 119, 120, 123] and low for two studies (**Appendix E**).[102, 121] Additional details can be found in **Table 3,** and **Appendix Tables D-4 and D-5**.

Depression

Three studies (2 trials[97, 122] [n=364 and n=395] and 1 prospective cohort[111] [n=250]) evaluated telehealth-based care for depression in rural settings.[93, 95, 97, 109-111, 122] The providers in these studies were primary care clinicians, including physicians, psychologists, social workers, midwives, and pharmacists; remote consultations added depression care manager nurses, psychologists, and psychiatrists. All studies compared telehealth-based care with usual practice-based, in-person care without the specialist. One trial reported mixed results with better, but not statistically significantly different, medication adherence at 6 months and 12 months, improved response to treatment at 6 months (but not at 12 months), remission at 12 months (but not at 6 months), 36 item short form survey (SF-36) Mental Component Score at 12 months (but not 6 months), and Quality of Well-Being scores at 6 months (but not at 12 months); treatment satisfaction was superior in the telehealth group at 6 and 12 months.[96, 122] A subanalysis[93] of this trial reported racial differences in response, and found minority group status remaining a significant moderator of the intervention's effect even after adjusting for other factors associated with minority status (adjusted odds ratio [aOR] 6.02; 95% CI 1.48-24.30). Minority participants were more likely to have symptoms improve (i.e., response to treatment) with telehealth but white participants were not. Another subanalysis did not find a difference in depression-free days for either white or nonwhite participants.[110] One longer trial reported improved response to treatment (OR 3.26; 95% CI, 1.95 to 5.47) and remission at 18 months (OR 3.15; 95% CI, 1.62 to 6.09),[97] as well as improvements in SF-36 Mental Component Score (difference 4.75, p=0.002) and Hopkins Symptoms Checklist (difference -0.36, p<0.001), but did not report differences in satisfaction or Quality of Well-Being (difference 0.02, p=0.22). Telehealth-based collaborative care for depression was significantly more expensive than office-based team care when total outpatient costs (difference 391.20, p=0.012),[95, 109, 110] or depression-related costs were considered in one study (difference 97.42, p=0.013).[95] However, appropriate utilization increased, especially for depression-related care (difference 1.97, p=0.001),[109] and the incremental cost effectiveness for depression-free days ($10.78/day) was considered low.

Attention Deficit/Hyperactivity Disorder (ADHD)

One trial compared treatment of ADHD in two telehealth models used to augment primary care.[107] The more intensive intervention included six sessions of pharmacotherapy and caregiver behavior training provided by community therapists with remote supervision by a psychiatrist, while the standard telehealth consultation care group received treatment by their primary care clinicians augmented with a telepsychiatry consultation. Children in both models improved, and although the improvement was greater with the more intensive intervention, the difference was not statistically significant (OR 1.34; 95% CI, 0.55 to 3.24).

Post-Traumatic Stress Disorder (PTSD)

One trial (n=225; reported in two publications) evaluated telehealth-based care for PTSD compared to practice-based care.[96, 108] Primary care physicians, psychiatric advanced practice nurses, and master's degree-level social workers in the intervention group consulted with remote telephone nurse care managers, clinical pharmacists, psychologists, and psychiatrists. Patients in the telehealth group were more likely to be prescribed a medication for PTSD in the first 6 months (93% vs. 86%) and to be prescribed prazosin hydrochloride at 6 months (27% vs. 15%) and 12 months (32% vs. 11%). Telehealth did not result in differences in adherence (adherent at least 80% of the time; OR 0.91; 95% CI, 0.47 to 1.78) or the proportion of patients with a

psychiatric encounter at 12 months (33% vs. 41%). At 12 months, patients in the telehealth group were more likely to have cognitive processing therapy (OR 18.08; 95% CI, 7.96 to 41.06), and to have received more sessions (OR 7.86; 95% CI, 3.15 to 19.61). They also had greater improvement in Posttraumatic Diagnostic Scale scores (-4.17 [SD=9.82] vs. -1.32 [SD=8.79]; p=0.04), Hopkins Symptom Checklist (−0.43 [SD=0.72] vs. −0.23 [SD=0.62]; p=0.01), and SF-36 Physical Component Score (−1.02 [SD=8.30] vs. −1.56 [SD=8.30]; p=0.35) but did not result in difference in the SF-36 Mental Component Score (2.72 [SD=11.92] vs. 4.05 [SD=10.07]; p=0.36). The telehealth group had higher outpatient mental health specialty costs ($2,964.63 vs. $2,159.26; p=0.01), total outpatient costs ($8,150.20 vs. $6,944.13; p=0.02), and telephone and non-telephone outpatient PTSD-specific care costs ($799.61 vs. $6.94; p=0.01 and $238.00 vs. $174.96; p=0.03). Treatment effectiveness differences were very small (0.008 for Quality of Well-Being and 0.001 for 12 item short form [SF-12] for Veterans), with rather large cost differences ($2,495/patient) resulting in very high incremental cost-effectiveness ratios ($185,565 for Quality of Well-Being and $138,108 for SF-12 for Veterans).

Diabetes

Four studies (two trials[90, 103] [n=71 and n=95], one retrospective cohort study[101][n=78 telehealth patients compared to national data] and one pre-post study[106] [n=59]) assessed telehealth for diabetes care in rural settings.[90, 101, 103, 106] Providers in these studies were primary care clinicians,[103, 106] including nurses.[90, 101] Consultants involved in the telehealth-based care were nurses, dieticians, and diabetes specialists. Three studies compared telehealth to in-person care; the trials compared telehealth to in-person diabetes education, and the pre-post study compared the time before implementation of the telehealth program, when patents were referred to an endocrinologist in a distant secondary/tertiary hospital, to the period after telehealth implementation.[90, 103, 106] The three studies all found telehealth was associated with improved management of glycated hemoglobin (A1c; p=0.002; -0.5%, p<0.01; 0.7 vs. 0.1 , p=0.03; Effect size -0.49 [95% CI -0.87 to -0.09], p=0.002).[90, 103,106] Additionally, a pre-post study reported improvements in self-monitoring of blood glucose and in Diabetes Self-Management Education scores with telehealth compared to care provided prior to telehealth implementation (1.65 [95% CI 0.94-2.30]; p<0.001).[106] One trial did not report a difference in systolic blood pressure (Change from baseline -1.0 [SD=14.9] vs. -6.7 [SD=17.3]; p=0.057),[103] and the pre-post study did not report a difference in systolic blood pressure (Effect size -0.31 [95% CI -0.74 to 0.11]; p=0.08).[106] One study compared telehealth findings to a national diabetes registry (n=78), and reported greater improvements in A1c levels for telehealth participants with Type 1 and Type 2 diabetes.[101]

An Australian prospective cohort study (n=1,024) also evaluated remote diabetic retinopathy screening compared to usual in-person screening.[91] The use of a remote ophthalmologist to perform diabetic retinopathy screening in cooperation with in-person primary care clinicians was associated with increased rate of referral or reminder for screening, as well as an improved screening rate (100% vs. 41%; RR 2.44; 95% CI, 2.14 to 2.79).

Hepatitis C

One retrospective cohort study (n=80) compared telehealth-based hepatitis C virus treatment at rural sites with treatment at a hepatology clinic.[112] Primary care clinicians at the rural sites consulted with remote specialists via videoconference. The study did not report differences in sustained virologic response (55% vs. 43%; p=0.36) or in mean weeks of therapy, but did report

a higher proportion of patients completing therapy (78% vs. 53%; p=0.03), higher mean number of face-to-face patient visits and face-to-face visits per week, and lower rates of anemia and patient withdrawal due to adverse events (RR 0.42; 95% CI, 0.21 to 0.85).

Rheumatology

Two studies (one trial[116] [n=85] and one prospective cohort[120] [n=85]) evaluated telehealth-based rheumatology in rural settings. Both compared telehealth consultations with in-person rheumatology consultations. The in-person providers in the trial were physical therapists, while those in the cohort study were rheumatology graduate medical education trainees; both studies used rheumatologists to provide the remote consultations. The trial did not report differences in the Rheumatoid Arthritis Disease Activity Index (difference 0.9, 95% CI -2.4 to 0.5), the EQ-5D Questionnaire (difference -0.1, 95% CI -0.1 to 0.4), the modified Health Assessment Questionnaire (difference 0.2, 95% CI -0.5 to 0.1), the Disease Activity in 28 Joints with c-reactive protein (CRP) Measure Score (difference 0.9, 95% CI -3.1 to 1.2), or the 9-item Visit-specific Satisfaction Score (data not reported).[116] The prospective cohort study reported benefits of telerheumatology in reducing distances traveled to visit (difference, -384.8 miles/visit; p<0.01) and cost of visits (difference, -$113.80/visit; p<0.01).[120]

Oncology

Two retrospective cohort studies (n=110 and n=147) evaluated telehealth-based oncology in rural settings.[114, 117] One study focused on lung cancer,[114] while the other included any cancer diagnosis.[117] Both compared telehealth to in-person/usual care. The lung cancer study compared video conference thoracic radiology multidisciplinary meetings with co-located meetings, and did not report any differences in proportion of patients receiving radiotherapy (71% vs. 71%) or in any other management measure (including clinic visits, offering of radiotherapy, receipt of radiotherapy, and completion of radiotherapy).[114] The other study of multiple cancers combined reported lower total costs with telehealth compared to hypothetical travel costs ($442,276 vs. $762,394; net savings, $320,118).[117]

Echocardiology

One small (n=38) trial[88] compared robot-assisted videoconference echocardiography and teleconsultation to in-person echocardiography and consultation at a secondary/tertiary hospital in patients with symptoms of heart failure in a rural setting. The study compared remote echocardiography performed by a trained sonographer and subsequent teleconsultation among the patient, general practitioner, sonographer, and remote cardiologist with usual care referral to a secondary/tertiary hospital cardiologist. The study reported beneficial reductions in total process time (median 27 vs. 114 days; p<0.001) and time from randomization to attaining a specialist consultation (median 12 vs. 86 days; p<0.001).

Hemodialysis

One small (n=19) pre-post study compared telehemodialysis to usual care in a rural Canadian First Nation setting.[113] The study compared healthcare utilization before and after introduction of the telehemodialysis program, which provided hospital-based hemodialysis care in the community (by nurses, nutritionists, and general practitioners) with remote supervision by nephrologists in a university dialysis center. The study reported increased amounts of urea

removed (effect size 5.3, p=0.03), but did not report differences in other clinical measures, indicating compliance with dialysis best practices.

Fracture

One small (n=12) retrospective cohort study compared a telehealth fracture clinic with in-person care in a rural setting.[105] The consultation was a video conference with remote orthopedic specialists in real time. The study reported lower costs compared to transferring patients (savings of $5941/patient) or sending a specialist to rural locations (savings of $1779/patient).

Dementia

One prospective cohort study (n=188) compared remote dementia care to in-person care in a dementia clinic.[99] Primary care clinicians and their patients at a rural public health center used a videoconference system to consult with a dementia specialist. The study did not find differences in mean change in Mini-Mental Status Exam (MMSE) scores per year in the study overall (-0.60 vs. -1.03; p=0.29); however, patients with higher baseline MMSE (15-30) showed significantly less deterioration with telehealth consultations (-0.62 vs. -1.59; p=0.049).

Wound Care

One study (n=54) compared wound care outcomes before and after introduction of a telehealth consultation system.[115] Primary care clinicians used the store-and-forward telehealth system to receive consultation from wound specialists in secondary care centers. The study reported decreased waiting times from referral to appointment (median 18 vs. 47 days, p-value not reported), as well as improvements in leg ulcer healing time (median 70 vs. 105 days, p-value not reported), but did not result in differences in cost of care per patient (£665 vs. £651).

Pharmacy

Two studies (one trial[89] [n=302] and one pre-post study[87] [n=577]) assessed telepharmacy in rural settings. The providers were pharmacy technicians[89] or in-person clinic staff,[87] and the remote consultants were pharmacists. The trial evaluated pharmacy for a broad range of conditions common to a family medicine clinic, and reported improved guideline adherence with telehealth compared to usual care, though this was not statistically significant (5.0% [SD 2.4%]; 95% CI, -0.5 to 10.4%; p=0.07).[89] The pre-post study evaluated pharmacy for management of diabetes and hypertension[87] and reported improvements after telepharmacy was implemented in A1c (-0.2 [SD 1.1]; p=0.008), fasting blood glucose (-10.6 [SD 39.4]; p<0.0001), and systolic blood pressure (-0.37 [SD 19.4]; p=0.009) only in patients with both diabetes and hypertension; telehealth did not result in differences in these outcomes for patients with either diabetes or hypertension alone.[87]

Remote Consultation

Three studies (one trial[102] [n=113], one prospective cohort study,[94] [n=76] and one pre-post study[100] [n=113]) assessed remote consultations for multiple health conditions. One trial randomly assigned primary care providers to an electronic consultation program or to usual care in which patients traveled to a specialist for an in-person consultation. The eConsult system allowed primary care clinicians to ask patient-specific clinical questions to remote specialists, who are asked to review patient data and respond within 7 days. The study, which aimed to reduce referrals for in person consultations, found that such referrals declined from baseline in

both arms and there was no significant difference in referrals for in person visits for the specialties covered by eConsult (adjusted RR 0.93; 95% CI, 0.85 to 1.03) or overall referrals (adjusted RR 0.94; 95% CI, 0.85 to 1.04) during the followup period.[102] One study of patients with hypertension, hyperlipidemia, or diabetes found improved medication adherence (OR 1.76, 95% CI 1.34 to 2.31) but no difference in healthcare quality of life (OR 1.07, 95% CI 0.90 to 1.27) after implementation of telehealth remote consultations.[100] Another study investigated remote consultations in an integrated care model for older patients (≥55 years) recovering from a respiratory or cardiovascular event.[94] Patients receiving integrated care experienced fewer hospital visits (mean 1.0 [SD=1.1] vs. 2.3 [SD=3.1], p-value not reported), but there were no differences in between the groups in physical function.

Dermatology

One RCT (n=261)[119]) compared clinical course after store-and-forward teledermatology consultation or conventional consultation. The study did not find significant differences in the proportion of patients with favorable clinical courses (telehealth 36% vs. in-person 38%, p=0.78 at first clinic visit; 82% vs. 83%, p=0.88 at 9 months). A second RCT (n=391)[92] compared costs between teledermatology referral and the conventional referral process for patients with ambulatory skin conditions. The study did not find significant differences in cost per participant from a U.S. Department of Veteran's Affairs perspective ($30, 95% CI -$79 to $20), and identified very small differences in cost per participant from a societal perspective (-$82, 95% CI -$12 to -$152).

Endoscopy

One study (n=90) compared costs of tele-endoscopy on an island in United Kingdom versus in-person endoscopy on the mainland.[118] The study found that when 27 or more patients per year attended tele-endoscopy, the cost was lower with telehealth (£353) than for the mainland clinic (£381). They also estimated that it would take 9.5 years for these savings to pay back the set up costs. The study did not assess the impact of locally available tele-endoscopy on waiting time or missed appointments.

Blood Pressure Control

A cluster-randomized trial (n=1299) compared an integrated mobile health program with usual rural community provider care to control blood pressure in adults with history of stroke in China.[121] Patients in the integrated mobile health program had significantly greater reductions in systolic blood pressure (adjusted mean difference -2.8 mmHg (95% CI -4.8 to -0.9), diastolic blood pressure (adjusted mean difference -2.2 mmHg (95% CI -3.2 to -1.3), and stroke recurrence (RR 0.46 [95% CI 0.32 to 0.66]q).

Palliative Care

One small prospective cohort study (n=21) compared telehealth videoconference assisted palliative care with traditional nurse visit palliative care.[98] The study did not find significant differences in symptoms or function, but did report that 30 days prior to death, participants receiving telehealth had fewer per capita nursing visits (5.46 vs. 9.32, effect size=0.7), general practitioner visits (0.13 per capita vs. 3.88, effect size=1.34), and hospital admissions (0.02 per capita vs. 0.2, effect size=0.65).

Ultrasound During Pregnancy

One evaluation of a statewide teleprogram (Arkansas, United States) to improve care for patients with high-risk pregnancies tracked whether patients received ultrasounds in the 3 years prior to the program (2001-2003) and the 3 years after its inception (2004-2007). The total number and the percentage of patients receiving comprehensive ultrasounds increased for all patients (9.6% to 11.3%, $p<0.0001$) and for high-risk patients (16.9% vs. 19.9%, $p<0.0001$)[104]

Table 3. Key Question 2: summary of outpatient findings*

Clinical Topic Number of Studies	Provider Specialty	Consultant Specialty	Patient Outcomes*	Provider Outcomes*	Payer Outcomes*
Telehealth-based collaborative care for depression Studies 3	Primary care clinicians; (physicians, psychologists, social workers, midwives, and nurses; nurse and pharmacist	Depression care managers (nurse, pharmacist, psychologists, psychiatrists); psychiatrists	**Patient outcomes** **M** Response (varies by timepoint 6, 12, 18 months)[93, 95, 97, 109-111, 122] **M** Remission (varies by timepoint 6, 12, 18 months)[93, 95, 97, 109-111, 122] **~** Depression-free days[93, 95, 97, 109-111, 122] **~** Treatment adherence at 3 months, **+** at 6 months[93, 95, 97, 109-111, 122] **+** Medication adherence 6 &12 months[93, 95, 97, 109-111, 122] **~** Depression symptom score (BDI) at 3 and 6 months[93, 95, 97, 109-111, 122] **M** Quality of Life (varies by timepoint 6, 12, 18 months and scale, Quality of Well-being Scale and SF-36 Mental)[93, 95, 97, 109-111, 122]	None reported	**~** Utilization: overall, **+** outpatient only[95,93, 110, 111] **~** Total costs[95, 110] **−** Adjusted total cost[109] **+** Incremental cost/ depression-free d[109] **−** Depression-related primary and mental health costs[95, 110]
Telehealth-based collaborative care for PTSD Studies 1	Primary care physicians, psychiatric advanced practice nurses, social workers	Nurse care manager, clinical pharmacist, psychologist, psychiatrist	**+** Prescribed any medication for PTSD[96] **~** Adherence to medication regimen >80%[96] **~** Any psychiatric encounter at 12 months[96] **+** Mean number of CPT sessions at 12 months[96] **M** Quality of Life (varies by scale, Quality of Well-being Scale and SF-36 Mental and Physical scales)[96]	None reported	**−** Total outpatient costs[96, 108]
Tele-mental health treatment for AD/HD Studies 1	Primary care physicians and caregivers	Child psychiatrists	**~** Teacher ratings (VADRS)[107] **~** Caregiver ratings (VADRS-Role Performance and CIS-P Scale)[107]	None reported	None reported
Telehealth-based diabetes care Studies 4	Primary care clinicians, nurses	Nurse, dietician, and a diabetes specialist, diabetes specialist	**+** A1c[90, 101, 103, 106] and self-monitoring of blood glucose[106] **+** Diabetes Self-Management Education score[90, 106] **~** Total cholesterol[90, 106] and systolic blood pressure[103]	None reported	None reported

Clinical Topic Number of Studies	Provider Specialty	Consultant Specialty	Patient Outcomes*	Provider Outcomes*	Payer Outcomes*
Remote diabetic neuropathy screening Studies 1	Primary care clinicians	Ophthalmologist	+ Screening rate[91]	+Screening referral or reminder[91]	None reported
Telehealth hepatitis C virus consultation Studies 1	Primary care physicians	Hepatologist	~ Sustained virologic response[112] + Completion of therapy[112] ~ Mean weeks of therapy[112] + Mean face-to-face visits[112] + Anemia and withdrawal due to adverse events[112]	None reported	None reported
Tele-rheumatology Studies 2	Rheumatology graduate medical education trainee; physical therapists	Rheumatologist	+ Distance to visit[120] ~ Quality of life, disease-related function and visit satisfaction scores[116]	None reported	+ Cost of visit[120]
Teleoncology Studies 2	Local healthcare professionals; Local oncology care team	Oncologists; respiratory physicians, thoracic surgeons, radiation oncologists, medical oncologists and a diagnostic radiologist	~ Receipt of radiotherapy[114]	None reported	+ Total costs[117]
Tele-echocardiography Studies 1	General practitioners	Cardiologists	+ Total process time[88] + Time to specialist consultation[88]	None reported	None reported
Tele-hemodialysis Studies 1	Nurse, nutritionist, and general practitioners	Nephrologist	+ Amount of urea removed[113] ~ Other clinical measures[113]	None reported	None reported
Telehealth fracture clinic Studies 1	Registrar (details NR)	Orthopedic surgeon	None reported	None reported	+ Cost compared to transfer or sending a specialist[105]
Telehealth dementia care Studies 1	Local medical staff	Dementia specialists	~ Yearly change in MMSE score among all patients[99] + Yearly change in MMSE score among patients with baseline MMSE 15-30[99]	None reported	None reported

Clinical Topic Number of Studies	Provider Specialty	Consultant Specialty	Patient Outcomes*	Provider Outcomes*	Payer Outcomes*
Telehealth-based ulcer care Studies 1	Primary care	Secondary care	+ Time from referral to appointment[115] + Leg ulcer healing time[115]	None reported	~ Cost per patient[115]
Telepharmacy Studies 2	Pharmacy technicians	Pharmacists	~ A1c and systolic blood pressure in patients with either diabetes or hypertension[87] + A1c and systolic blood pressure in patients with both diabetes and hypertension[87]	+ Guideline adherence[89]	None reported
Remote consultation 3	Family physicians, nurses	Specialists (type NR), multidisciplinary team	+ hospital visits[94] + patient function + medication adherence[100] + health-related quality of life[100]	~ Overall referrals or to eConsult specialties[102]	None reported
Dermatology 2	Primary care	Dermatology	~ clinical course[119]	None reported	**M** cost per participant[92]
Endoscopy 1	Surgeon on anesthetist	ENT	None reported	None reported	~ costs[118]
Blood pressure 1	Primary care provider	Physician, specialty not reported	+ blood pressure[121] + stroke recurrence[121]	None reported	None reported
Palliative care 1	Nurse, general practitioner	Palliative care specialist	~ patient symptoms and function + nurse or general practitioner visits, hospital admissions	None reported	None reported
Ultrasound for pregnancy 1	Community obstetrics providers	Maternal-fetal medicine and radiology	+ increase in comprehensive ultrasound for all and high-risk pregnancies[104]	None reported	None reported

*Symbol meaning: + = Improved Outcome with telehealth; ~ = Similar outcome with telehealth; - = Worse outcome with telehealth, M = Outcomes were not consistent across studies

Abbreviations: CIS-P = Columbia impairment scale-parent version; CRP = c-reactive protein; ENT = ear, nose, throat specialist; ICER = incremental cost-effectiveness ratio; MMSE = mini-mental state examination; NR = not reported; PTSD = post-traumatic stress disorder; QALY = quality adjusted life-years; RN = registered nurse; SF-12 = 12-item short form survey; SF-36 = 36-item short form survey; VADRS = Vanderbilt Attention-Deficit/Hyperactivity Disorder Rating Scale.

Emergency Department/Emergency Medical Services

Key Points

- Telehealth consultations supporting emergency assessment and care of stroke/ST-elevation myocardial infarction (STEMI) and chest pain at a rural hospital:
    - Result in similar rates of mortality when patients are treated locally as opposed to transferred (5 studies; Low SOE)
    - May result in similar time to treatment when patients are treated locally as opposed to transferred (8 studies; Low SOE)
- Telehealth consultations by specialists for rural ED critical care and trauma patients may result in similar appropriate or inappropriate transfers (5 studies; Low SOE)

Summary of Findings

We identified and included 28 studies of provider-to-provider telehealth use in rural areas for the provision of emergency care, either by emergency medical services (EMS) or EDs.[67, 124-150] Fifteen of these studies evaluated telehealth for the assessment and management of conditions that are time sensitive and require decision about the course and best location for treatment. These include ten studies of stroke,[67, 127, 136, 139, 140, 142, 143, 145, 148, 149] three studies of STEMI,[124-126] and two studies of chest pain/potential myocardial infarction.[133, 136] Five of the included studies were of the use of teleconsultations for a range of conditions seen in EDs[132, 138, 140, 144, 150] and five additional studies were of video consultations for critical care,[128, 129, 131] trauma,[135] or hand trauma.[146] The three remaining studies also employed video consultations for sepsis or septic shock,[137] suicidal ideation or attempt[130] and the evaluation of sexual abuse.[134]

Two of these studies were RCTs[127, 149], ten were prospective cohort studies,[124-126, 132, 133, 136, 137, 142, 143, 145] eight were retrospective cohort studies[67, 128, 129, 131, 134, 135, 147, 150], and eight were studies that compared outcomes before and after telehealth initiation.[130, 138-141, 144, 146, 148] Eighteen of these studies were conducted in the United States[67, 127-131, 133-138, 141, 144-147, 150] two were conducted in Italy,[125, 126] two in Australia[139, 148] and one each in Canada,[132] Spain,[142] Finland,[143] Turkey,[124] Japan,[140] and Germany.[149] Risk of bias was rated as high for one study,[136] medium for 26 studies,[67, 124-126, 128-135, 137-150] and low for one trial[127] (**Appendix E**).

Key results are presented in **Table 4,** and additional study details and results can be found in **Appendix Tables D-6 and D-7**. We grouped studies by similar clinical issues for our qualitative synthesis and SOE assessment.

In studies of telehealth for stroke, STEMI and chest pain combined, five studies reported no significant differences in mortality.[67, 127, 139, 143, 148] One study of telestroke versus usual care reported no differences in in-hospital mortality for rural or super-rural (areas in the bottom quartile of rural areas as defined by the Centers for Medicare & Medicaid Services Zip code file) patients, (adjusted differences: -0.6, 95% CI, -2.5 to 1.4; 0.4, 95% CI, -2.7 to 3.4), or 30-day all-cause mortality in rural patients (adjusted difference 0.0, 95% CI, -2.6 to 2.7). The study reported a small difference in 30-day all-cause mortality in super-rural patients (adjusted difference -4.5, 95% CI, -8.0 to -1.0).[67] Similarly, two other studies of telestroke reported small non-significant differences in mortality rates: 13% vs. 10%, p=0.6[139] and 10% vs. 7%, p=0.58).[148] One study of telehealth consultations between hub and spoke sites versus telephone consultation for stroke patients did not find a difference in 90-day mortality (OR 0.74; 95% CI, 0.35 to 1.55).[127] The final study compared telestroke with neurologic emergency room care, and did not report a

difference in 3-month mortality (11.5% vs. 10.2%, p=0.662).[143] When combined, these five studies provide a low SOE supporting no difference in mortality with telehealth.

In eight studies time to treatment was either the same or better, with no study reporting that telehealth resulted in treatment delays.[125-127, 133, 136, 139, 142, 148] No studies reported an increase in harms, such as increases in intracranial bleeds. Only one study reported a payer outcome, finding that mean total expenditures for telestroke patients were higher than with usual care in both rural ($13,868 vs. $9,721, p<0.001) and super-rural areas ($14,596 vs. $10,020, p<0.001), likely due to the increase in use of tissue plasminogen activator (tPA).[67] One study also assessed a provider behavioral outcome, finding that correct thrombolysis decisions were more frequent with telestroke consults than when advice was provided by phone (96% vs. 83%).[127] While there a number of studies, time to treatment is measured differently and with varying degrees of validity and reliability and as a group these studies provide low SOE that there is either no difference or some improvement in time to treatment with telehealth. telehealth

Three studies of telehealth emergency care consultations for the other clinical indications reported that telehealth reduces unnecessary transfers and increases appropriate transfers,[131, 132, 141] though two studies did not find differences.[135, 144] Another key outcome for the use of telehealth was length of stay in the ED, as consultations should help speed disposition decisions. For this outcome even though there are four studies, the evidence is insufficient to support a conclusion as the findings were contradictory with one study reporting shorter length of stay,[135] one longer length of stay,[130] and two finding no difference or mixed results.[138, 147]

Table 4. Key Question 2: summary of emergency care findings

Clinical Topic Number of Studies	Modality	Provider Specialty Consultant Specialty	Patient Outcomes*	Provider Outcomes*	Payer Outcomes*
Stroke 10	TeleED Video-conference	**Providers** ED clinicians **Consultants** Neurologist, Stroke expert, ED Physicians, ED Nurses	~ In-hospital, 30-day and 90-day mortality[67, 127, 139, 143, 148] + 30-day all-cause mortality, super rural patients[67] + **Discharge to home or rehab[148]** ~ Symptom onset to tPA time[67, 127, 136, 139, 140, 142, 143, 145, 148] + tPA within 3 h of symptom onset[67, 127, 136, 139, 140, 142, 143, 145] ~ 90-day modified Rankin Scale[127, 143] ~ post-tPA intracranial hemorrhage[127, 143, 148] **M** tPA use[67, 127, 136, 139, 140, 142, 143, 145] ~ Length of stay, overall and rural patients[67, 127, 136, 139, 140, 142, 143, 145] + Length of stay, super rural patients[67] + Appropriate transfer to high-volume center or higher level of care[140, 149]	+ Correctness of decision-making/accurate triage[127, 149]	– Total medical expenditures per event[67]
Heart attack/ STEMI 2	TeleECG	**Providers** Paramedics, EMS **Consultants** Cardiologists	+ On-time and time-to treatment[125, 126]	None reported	None reported
Heart attack/ STEMI 1	Text triage	**Providers** ED clinicians **Consultants** Cardiologists	+Time to hospital arrival[124] **M** Arrival -to-balloon time[124] ~ False-positive STEMI[124]	None reported	None reported
Chest pain/ MI 2	TeleED video-conference	**Providers** ED clinicians **Consultants:** ED Physicians ED Nurses	**M** Time from ED arrival to ECG[133, 136] ~ Time from ED arrival to fibrinolytic[133, 136] + Likelihood of receiving fibrinolytic when eligible[133]	None reported	None reported

Clinical Topic Number of Studies	Modality	Provider Specialty Consultant Specialty	Patient Outcomes*	Provider Outcomes*	Payer Outcomes*
Multiple 1	TeleED robot	**Providers** Nurses, Nurse Practitioners **Consultants** Pediatric intensivist	+ Transfer[132] + Length of stay (robot/transfer vs. no robot/no transfer)[132]	None reported	None reported
Multiple 4	TeleED video-conference	**Providers** Nurse Practitioners, ED clinicians **Consultants** ED physicians, ED nurses	~ Patient deaths in ER[144] **M** Transfer to another facility[141,144] + Admit to provider time[138] – ED length of stay, nontransferred patients[138] + ED length of stay, transferred patients[138] – Likelihood of discharge from ED[144] – Rural hospital admission[144] – Discharged against medical advice from ED[144]	None reported	~ Total ED patient volume[144] +Lower ED costs and operating expenses [150]
Critical care 3	TeleED video-conference	**Providers** ED clinicians **Consultants** Pediatric critical care physician	+ Transfer avoided[131] + Transfer to lower level of care[131] + Parent/guardian satisfaction[129] + Accuracy of clinical picture prior to arrival[131]	+ Physician-related ED medication errors[128] + Quality of care scores[129] + Referring physician satisfaction[129]	None reported
Trauma 1	TeleED video-conference	**Providers** ED clinicians **Consultants** ED Physicians, ED nurses	~ Mortality + Chest tube, intubation[135] + ED length of stay[135] **M** Increased diagnostic imaging[135] + Time to arrival at final hospital[135] ~ Transfer[135]	None reported	None reported
Hand trauma 1	TeleED video-conference	**Providers** ED clinicians **Consultants** Hand surgeon	~ Length of stay at first hospital[146] ~ Type of transfer, air or ground[146] + Admitted from ED [146]	None reported	~ Transport cost

Clinical Topic Number of Studies	Modality	Provider Specialty Consultant Specialty	Patient Outcomes*	Provider Outcomes*	Payer Outcomes*
Sepsis/ septic shock 1	TeleED video-conference	**Providers** ED clinicians **Consultants** Physician (specialty varied)	None reported	+ Adherence to sepsis treatment bundle[137]	None reported
Behavioral health; suicidal ideation or attempt 2	TeleED video-conference	**Providers** ED clinicians **Consultants** Psychiatric providers, mental health providers	+ ED wait time[130] − ED length of stay[130]† + Hospital admission[147] + Involuntary hold placement[147] ~ 30-day readmission[147]	None reported	None reported
Sexual abuse 1	TeleED video-conference	**Providers** Rural examiners **Consultants** Advance practice nurse practitioners	None reported	+ Quality, completeness, accuracy of abuse examination forms[134]	None reported

*Symbol meaning: + = Improved Outcome with telehealth; ~ = Similar outcome with telehealth; - = Worse outcome with telehealth, M = Outcomes were not consistent across studies

†Difference in ED length of stay exceeds the time for the consult and was not associated with reductions in admissions.

Abbreviations: ECG = electrocardiogram; ED = emergency department; EMS = emergency medical services; MI = myocardial infarction; STEMI = ST-elevated myocardial infarction; TeleED = telehealth emergency department; tPA = tissue plasminogen activator.

Education and Mentoring

Key Points

- Clinical outcomes: Extension for Community Healthcare Outcomes (ECHO) programs are associated with better or similar patient outcomes. (2 studies; Low SOE)
    - Reduction of A1c in patients of trainees after ECHO compared to before participation (1 study)
    - Hepatitis C viral response and serious adverse events rates at "spoke" site with ECHO participation were similar to those at an academic medical center (1 study)
- Provider behavior: ECHO and non-ECHO video training programs result in desired changes in provider behavior (e.g., increased appropriate prescribing practices, screening, and patient counseling). (8 studies; Low SOE)
- Provider knowledge, efficacy, perceptions: ECHO and non-ECHO video training are associated with increased confidence, efficacy, and scores on knowledge tests. (13 studies; Low SOE)

Summary of Findings

Provider-to-provider telehealth for education and mentoring uses communications technology to transmit knowledge, develop capacity and share expertise. Education and mentoring programs usually contain didactic elements and may or may not also include case reviews or supervised or mentored patient care. Telehealth for this purpose may use different technologies, including video, online learning platforms, or simulation devices and complex monitoring. While most uses of telehealth for training are in real time, some asynchronous applications exist. Multiple terms are used to describe use of telehealth technologies for purposes of education and mentoring, including tele-mentoring, distance education, virtual grand rounds, etc.

Twenty-three studies evaluated the use of telehealth for provider-to-provider education and mentoring,[151-173] including three RCTs[153, 157, 169] and 20 observational studies. Observational study designs included pre-post,[152, 154, 158-163, 166, 167, 168, 170, 171, 173] before-after,[155, 165] prospective cohort studies,[151, 164] and retrospective cohort studies.[156, 172] All studies were conducted across multiple clinical sites or healthcare organizations. Sixteen studies were performed in the United States,[151, 152, 154, 156, 158, 159, 161, 162, 164, 165, 167-169, 171-173] four in Australia,[153, 155, 160, 163] two in Canada,[166, 170] and one in Vietnam.[157] The duration of the education or mentoring intervention made available to rural care providers ranged from 3 months to 4.5 years, with one study that did not specify the length.[169] All studies evaluated patient clinical or provider outcomes. One study was rated low risk of bias,[166] 11 were rated medium risk of bias,[151, 153, 156, 157, 164, 165, 168-172] and 11 were rated high risk of bias[152, 154, 155, 158-163, 167, 173] (**Appendix E**).

Clinical topics addressed through distance education and mentoring included antibiotic therapy,[168] childhood obesity,[165] dermatology,[159] diabetes,[167] liver disease,[151, 161, 172] mental health,[152, 153, 155, 156, 158, 162, 163, 166, 169] multiple conditions in primary care,[157] pediatric burns,[160] perioperative care,[164] low vision,[171] dementia,[173] and COVID-19 in long term care.[170] Telehealth modalities used in the studies of remote education and mentoring that we identified include:

- ECHO Videoconference: ECHO is a technology-enabled collaborative learning and capacity building model launched in 2003 by the University of New Mexico Health Sciences Center (https://hsc.unm.edu/echo/). ECHO is designed to amplify the capacity

to provide best practice care for people in rural and underserved communities. ECHO programs consist of a "hub" site, which is typically housed within an academic medical center, and "spokes" consisting of smaller medical offices, community health centers, nursing homes or other health-related facilities or organizations in rural or underserved areas. ECHO sessions are facilitated by specialist providers and others with clinical subject matter expertise from the "hub" site, and attended by a wide variety of clinicians at "spoke" sites. ECHO sessions are typically comprised of a combination of didactic education sessions and review of clinical cases. The ECHO model, originally designed for improving the care of patients with hepatitis C, had expanded to include many more conditions, and has spread across the United States and the globe through the University of New Mexico ECHO replication program.

- Non-ECHO Videoconference: Videoconference-based education and mentoring that is not reported to be affiliated with or organized by an ECHO replication site and may use a different educational model.
- Online Education Courses: Online education and mentoring includes asynchronous online education courses, or a mix of asynchronous online courses and synchronous interaction with remote mentors via videoconferencing or telephone.
- Short Messaging Service (SMS): Education and mentoring provided through text messaging on a mobile communication device.

Table 5 includes a summary of the clinical and intermediate results from included studies of remote education and mentoring (additional details available in **Appendix Tables D-8 and D-9**). The table is organized by training modality and then by clinical topic. It summarizes the number of articles associated with each by clinical topic, provides information on the type(s) of providers who received remote education and mentoring, and summarizes key clinical and provider outcomes.

Two studies reported only patient outcomes. A prospective cohort study compared sustained viral response and adverse events between patients seen at an ECHO spoke site and those seen at an academic medical center hub site after implementation of a hepatitis C ECHO program. This study did not report differences across the hub and spoke sites (0.70; 95% CI, -9.2 to 10).[151] One study reported on patient care, specifically the impact of ECHO programs on the use of direct-viral treatment for hepatitis C, and found that the program was not associated with the odds of treatment among rural vs. urban patients (adjusted OR 1.01; 95% CI 0.99 to 1.02, p=0.49)[172]

Three studies reported both patient and provider outcomes, all evaluated videoconference-based delivery of remote education and mentoring, but reported mixed results.[165, 167, 168] Studies found improved provider self-efficacy and knowledge and improved A1c in diabetic patients (10.2 [SD = 1.4] vs. 8.3 [SD = 0.97], $p < 0.001$),[167] improved prescribing practices but no reduction in mean length of stay or in-hospital mortality in antibiotic therapy,[168] and improved documentation (1; 95% CI 0.9 to 1.2, $p<0.001$) and counseling behaviors (0.8; 95% CI 0.2 to 1.4, p=0.01) but no change in child nutrition or physical activity levels (0.3; 95% CI −0.2 to 0.8) in childhood obesity.[165]

Eighteen studies reported a range of provider only outcomes including provider knowledge, efficacy, perception and satisfaction. Education and mentoring modalities utilized in studies reporting only intermediate outcomes include ECHO video-conference (9), Non-ECHO Videoconference (4), online education (4), and SMS (1).[152-164, 166, 169, 170, 171, 173] Eleven studies reported improvement in provider knowledge, self-efficacy and perception across a range of

clinical topics.[153-155, 158, 160, 161, 163, 166, 170, 171, 173] A single study of SMS-provided education reported no change in provider knowledge.[157] A single study did not report differences in scores of perioperative skill evaluations among video-conference and in-person participants.[164] Four studies reported improved provider behaviors related to patient screening rates[152, 161] and prescribing.[156, 158] A single study of provider capacity to perform dermatology procedures found an increase in the number of providers of biopsies, excisions, shave biopsies, electrocautery, and no change in capacity to provide liquid nitrogen at the spoke site.[159] Four studies reported increased provider satisfaction with remote education and mentoring.[155, 157, 166, 169] One study[169] reported negative perception of balance between instruction and practice in video-conference-based education and monitoring.

Table 5. Key Question 2: Summary of remote education and mentoring findings

Modality	Clinical Topic Number of Studies	Provider Specialty Consultant/Mentor Specialty	Provider Outcomes*	Patient Outcomes*
ECHO video-conference	Antibiotic therapy 1	**Providers** Multidisciplinary **Consultants** Infection disease	+ Antibiotic prescribing[168]	~ In-hospital mortality[168] ~ Mean length of stay[168]
ECHO video-conference	COVID-19 in long-term care 1	**Providers** Multidisciplinary **Consultants/instructors** Long-term care experts	+ Self-efficacy and satisfaction[170]	None
ECHO video-conference	Dementia 1	**Providers** Multidisciplinary **Consultants/instructors** Neurology and dementia experts	+ Comfort with assessment and treatment[173]	None
ECHO video-conference	Diabetes 2	**Providers** PCPs Community health workers **Consultants** Multidisciplinary diabetes team; diabetes specialist	+ Self-efficacy in patient coaching/education, and identification of psychosocial treatment barriers[154]	+ A1c[167]
ECHO video-conference	Liver disease 3	**Providers** Multidisciplinary physicians **Consultants** Multidisciplinary	+ Hepatitis C Virus awareness, knowledge, abilities and intention to recommend screening for at-risk patients[161]	~ Sustained viral response[151] ~ Serious adverse events[151] ~ Access to direct acting antiviral treatment in rural areas [171]

Modality	Clinical Topic Number of Studies	Provider Specialty Consultant/Mentor Specialty	Provider Outcomes*	Patient Outcomes*
ECHO video-conference	Mental health 5	**Providers** Multidisciplinary **Consultants** Multidisciplinary teams, including addiction and psychiatry specialists	+ Opioid use disorder diagnosis/ prescribing[156] + Reduction in patients prescribed ≥3 psychotropic medications[158] + Provider knowledge and self-efficacy[166] + General development and Autism-specific screening[152] + Pediatric behavioral health knowledge and patient management[158] + Satisfaction with sessions[158, 166, 169]	None Reported
Non-ECHO video-conference	Childhood obesity 1	**Providers** Clinician champions, nurses, medical assistants **Consultants/Mentors** Healthy Eating Active Living Telehealth Community of Practicefaculty and staff	+ Documentation and counseling[165] ~ Family centered car[165]	~ Child nutrition and physical activity[165]
Non-ECHO video-conference	Dermatology 1	**Providers** PCPs, imaging technicians **Consultants/mentors** Dermatologist	+ Knowledge of dermatology procedures, ability to provide punch or shave biopsies, excisions, electrocautery [159] ~ Ability to provide liquid nitrogen[159]	None reported
Non-ECHO video-conference	Mental health 1	**Providers** Dementia behavior management advisory service **Consultants/mentors** Mental health services for older people, old age psychiatrist	+ Confidence in managing behavioral and psychological symptoms of dementia[155] + Satisfaction with educational program[155]	None reported
Non-ECHO video-conference	Pediatric burns 1	**Providers** Multidisciplinary **Consultants/mentors** Burn consultants and nurse	+ Knowledge of burn prevention, first aid, airway and inhalation injury, and circulation and fluid resuscitation[160] **M** Chemical and electrical burns, burn wound, pain and itch management[160]	None reported
Non-ECHO video-conference	Perioperative care 1	**Providers** Registered nurses **Consultants/mentors** Trained preceptor nurses	~ Perioperative training scores[164] ~ Rating program as a success[164]	None reported

Modality	Clinical Topic Number of Studies	Provider Specialty Consultant/Mentor Specialty	Provider Outcomes*	Patient Outcomes*
Online education course	Mental health 3	**Providers** Multidisciplinary **Consultants/mentors** Clinical psychologist; mental health clinicians	+ Role adequacy, legitimacy and support[162] **M** Role motivation, work satisfaction, and task-specific self-esteem[162] + Education completion[153] + Knowledge, skills, confidence, and utilization of CBT[153] + Computer and internet-related skills[163] + Knowledge about the roles of mental health service, confidence in responding to mental health problems[163]	None reported
Online education course	Low vision screening 1	**Providers** Occupational therapists **Consultants/mentors** Low vision specialists	+ Knowledge of low vision screening and treatment[171]	None reported
Short messaging service	Multiple conditions common in primary care 1	**Providers** Physician Assistants **Consultants/mentors** Automated text messages created by specialists	~ Medical knowledge[157] + Satisfaction with intervention[157]	None reported

*Symbol meaning: + = Improved Outcome with telehealth; ~ = Similar outcome with telehealth; - = Worse outcome with telehealth; **M** = Outcomes were not consistent across studies

Abbreviations: A1c = glycated hemoglobin; CBT = cognitive behavioral therapy; ECHO = Extension for Community Healthcare Outcomes; PCP = primary care provider.

Key Question 3. What strategies are effective and what are the barriers and facilitators to implementation and sustainability of provider-to-provider telehealth in rural areas?

Key Points

- The majority of barriers and facilitators are similar across provider-to-provider telehealth programs implemented in different settings and for different purposes. These are related to available resources and access to knowledge & information.
- While most barriers and facilitators are likely not unique to rural provider-to-provider telehealth, some may be specific and study authors suggested specific strategies:
    - Consulting providers who are often located in urban areas need to understand the rural context and what resources are available. Strategy: rural rotations or periodic in person collaboration may support success.
    - Successful implementation and sustainment require a long-term commitment and resources on a scale that may not be feasible for individual rural organizations. Strategy: statewide or regional initiatives with government or philanthropic start up support.
    - Provider-to-provider telehealth systems may be used for frequent events or serve as a resource for rare events in rural healthcare and the technology and support need to be tailored to frequency of use. Strategy: schedule periodic testing of systems used for rare events.

Summary of Findings

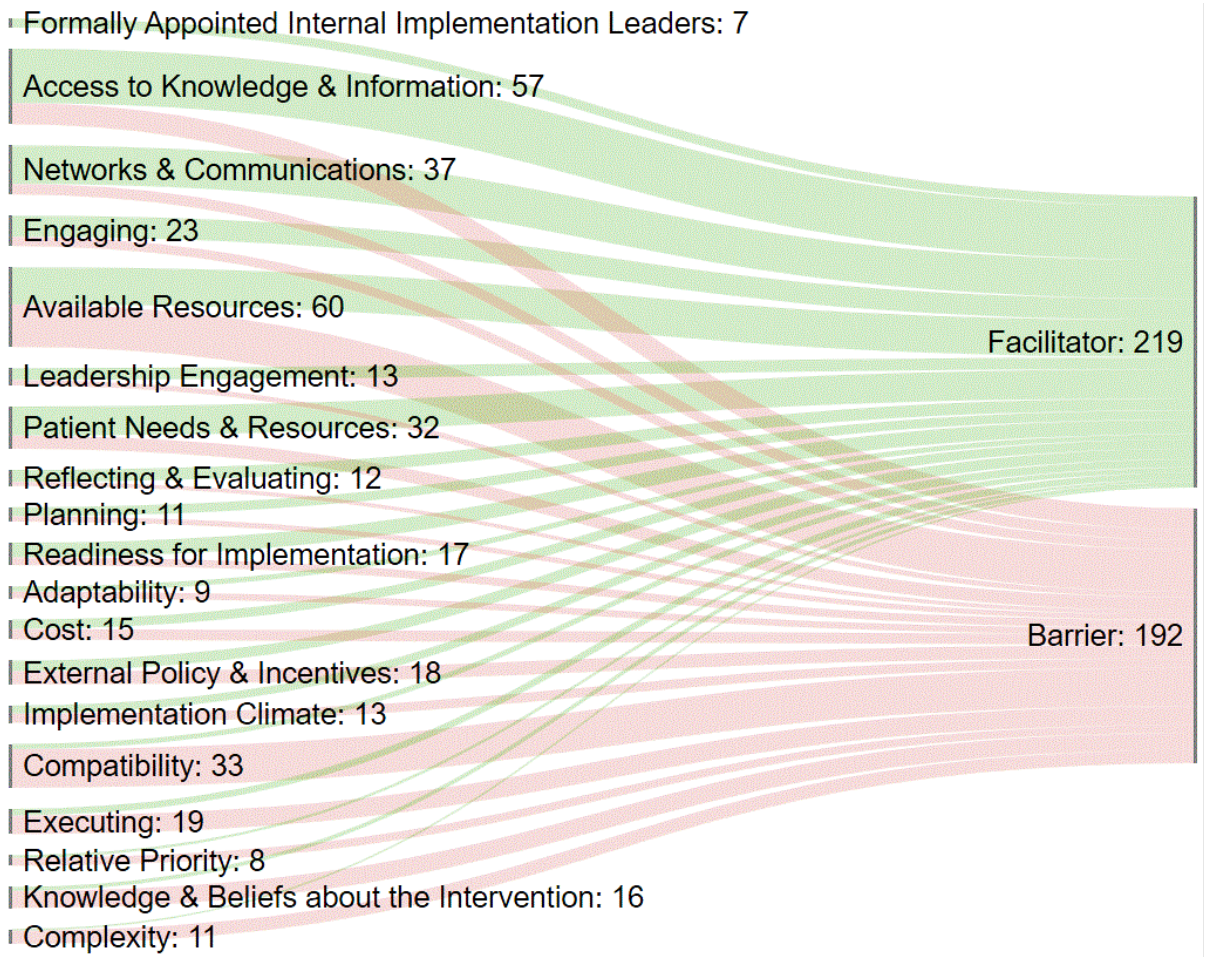
We identified 67 studies (in 71 publications)[52, 62, 65, 79, 144, 174-239] that addressed implementation of provider-to-provider telehealth in rural areas. We used these studies to collectively assess the barriers and facilitators that have been encountered in implementing provider-to-provider telehealth for rural populations. As the inclusion criteria for this Key Question were broad, the studies include not only a wide range of topics, but also diverse methods. Many of these studies included for this Key Question are program evaluations that combine data from several sources, such as site visits, observations, surveys and interviews. These evaluations often describe the telehealth program components or experience in more detail than is often included in effectiveness studies. Others were qualitative research studies that analyze interviews, focus groups, or documents and then categorize or catalog specific barriers and facilitators to initial implementation, ongoing operations, longer term sustainment, or spread of the use of telehealth. In some cases, an effectiveness study (included in Key Question 2) collected data and reported on implementation, in which case these studies are included in both Key Questions. Few studies actually compared programs, models or implementation approaches; instead they report on a single experience. Additional details about the included studies can be found in **Appendix Table B-3** and **Appendix Table D-10**.

As outlined in the Methods Section above and described in more detail in **Appendix A**, Methods, we used constructs from a framework called CFIR (Consolidated Framework for Implementation Research) to standardize our description of the facilitators and barriers to implementation and sustainability cited in the included studies. Studies often use different terms

and narratives to describe their experience and using a framework with defined constructs allowed us to group similar concepts and describe patterns.

Figure 2 illustrates how the 219 facilitators and 192 barriers we identified in the included studies map to 19 of 39 possible CFIR constructs. The number next to each construct is the number of times it occurred in our data and the width of the line represents the relative frequency. Short definitions of each construct are included as notes to this figure and the tables in this section. More comprehensive descriptions are available in CFIR articles and tools.[60, 240] This diagram allows us to represent the important fact that most constructs can be either barriers or facilitators, depending on context and their presence or absence. In our synthesis this is the case for both of the most frequently cited constructs. ***Available Resources*** is a broad concept including the wide range of investments an organization dedicates to implementing or sustaining an innovation or program. This was cited sixty times, but as represented in the figure, almost equally split between mention as a facilitator and as a barrier. ***Access to Knowledge & Information***, was cited 57 times, but most frequently as a facilitator. Additional details regarding facilitators and barriers presented by setting (inpatient, outpatient, EMS/ED, education/mentoring) are found in **Appendix B**.

Figure 2. CFIR constructs as facilitators and barriers*



*Construct definitions: **Access to Knowledge & Information**: Access to digestible information and knowledge about the innovation and how to incorporate it into work tasks; **Formally Appointed Internal Implementation Leaders**: Individuals from within the organization who have been formally appointed with responsibility for implementing an innovation as coordinator, project manager, team leader, or other similar role; **Planning**: Degree to which a scheme or method of behavior and tasks for

implementing an innovation are developed in advance, and the quality of those schemes or methods; **Leadership Engagement**: Commitment, involvement, and accountability of leaders and managers with the implementation of the innovation; **Engaging**: Attracting and involving appropriate individuals in the implementation and use of the innovation through a combined strategy of social marketing, education, role modeling, training, and other similar activities; **Available Resources**: Level of resources organizational dedicated for implementation and on-going operations including physical space and time; **Networks & Communications**: Nature and quality of webs of social networks, and the nature and quality of formal and informal communications within an organization; **Reflecting & Evaluating**: Quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience; **Cost**: Costs of the innovation and costs associated with implementing the innovation including investment, supply, and opportunity costs; **External Policy & Incentives**: External strategies to spread innovations including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting; **Relative Priority**: Individuals' shared perception of the importance of the implementation within the organization; **Implementation Climate**: Absorptive capacity for change, shared receptivity of involved individuals to an innovation, and the extent to which use of that innovation will be rewarded, supported, and expected within their organization; **Readiness for Implementation**: Tangible and immediate indicators of organizational commitment to its decision to implement an innovation; **Adaptability**: Degree to which an innovation can be adapted, tailored, refined, or reinvented to meet local needs; Patient **Needs & Resources**: Extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organization; **Compatibility**: Degree of tangible fit between meaning and values attached to the innovation by involved individuals, how those align with individuals' own norms, values, and perceived risks and needs, and how the innovation fits with existing workflows and systems; **Knowledge & Beliefs about the Innovation**: Individuals' attitudes toward and value placed on the innovation, as well as familiarity with facts, truths, and principles related to the innovation; **Complexity**: Perceived difficulty of the innovation, reflected by duration, scope, radicalness, disruptiveness, centrality, and intricacy and number of steps required to implement; **Executing**: Carrying out or accomplishing the implementation according to plan

Abbreviations: CFIR = Consolidated Framework for Implementation Research[60, 240]

We identified and distilled evaluations and qualitative research studies to help assess the potential of provider-to-provider telehealth to improve the health and well-being of rural populations. These implementation studies and reports on programs provide insight into what is needed to translate what we know about the effectiveness of provider-to-provider telehealth (Key Question 2) to improving actual practice. Reviewing studies and reports of rural provider-to-provider telehealth reveals that there are many facilitators, barriers, and the impacts are likely not specific to rural settings. Telehealth needs to alleviate burden on providers, the technology needs to work, staff resources and reimbursement need to be allocated to provide both start-up infrastructure and ongoing support, and training is needed. Stakeholder engagement and commitment, from patients through to health system leadership and governments seems essential.

There are, however, some issues that do seem to be more specific to implementing provider-to-provider telehealth to serve rural populations. In the United States, lack of broadband internet in rural areas and the need to have offline options remains a barrier to diffusion. Disconnects or lack of understanding of the rural context and environment can reduce the utility of teleconsultations and remote training programs. Solutions that involve periodic in person visits or rotations by the specialists or trainers have been proposed as a way to both assure relevance and develop relationships. While many rural areas face similar changes, most programs are local or in a single health system and networking appears to be minimal. Successful statewide programs have been implemented and sustained, but in some cases uptake or use has been lower than anticipated. Few of the evaluations or studies identified for this review used an implementation framework or reported developing an implementation manual. Use of frameworks could standardize evaluations making comparisons across program evaluations easier and could provide a structure for documenting and disseminating implementation plans that could speed replication and uptake in more sites.

Key Question 4. What are the methodological weaknesses of the included studies of provider-to-provider telehealth for rural patients and what improvements in study design (e.g., focus on relevant comparisons and outcomes) might increase the impact of future research?

Key Points

- Studies of provider-to-provider telehealth for rural areas could be improved by addressing methodological weaknesses.
- A key weakness is that it is often difficult to attribute impact to telehealth because
    - Weaker study designs are common: RCTs and cohort studies were identified, but more than 40 percent of the studies were studies using repeated measures (pre/post or before/after) with no other comparison group.
    - Lack of control for confounders related to patients, providers, facilities, and differences in telehealth implementation across study sites
- The most frequently identified weakness after study design is small sample size and the resulting lack of power to detect differences.
- Studies are also hampered by data limitations related to use of retrospective data, and data produced for care delivery and billing purposes, rather than for research.

Summary of Findings

Conducting effectiveness and implementation research in order to develop an evidence base for telehealth is challenging for many reasons. However, two characteristics are at the root of many of these challenges: First, telehealth includes diverse interventions designed to address different healthcare functions. Even when the scope is narrowed to provider-to-provider telehealth for rural populations the interventions range from remote ICU, which requires significant hardware and other resources, to text message-based remote education using participants' cell phones. Second, telehealth is a means to facilitate communication and deliver health services, but it is not necessarily designed to impact patient health outcomes, provider experience or behavior, or payers independently of the service provided. If the service is inappropriate or care is of low quality, simply using telehealth to deliver it without addressing these issues cannot be expected to improve outcomes. Studies are not always designed to consider if services provided via telehealth vary in quality for some other reason independent of telehealth being the mode of delivery.

The methodological weaknesses of studies of telehealth have been reviewed, citied by other systematic reviews on telehealth,[44, 49] and study design and methods limitations are often listed by the authors when studies are published, as is the case for many of the studies included in this review. Most of these weaknesses fall into two large categories, 1) the study design employed and 2) how the chosen design was executed. We attempted to identify and describe these two categories of weaknesses in the evidence base for provider-to-provider telehealth for rural populations.

It is generally accepted that an important contributor to methodological weaknesses in the literature evaluating telehealth is choice of study design. While specific designs do not correlate perfectly with weaknesses, and all study designs have some potential to produce high quality results, it is harder to product unambiguous results with less rigorous designs that are more

susceptible to bias. In order to help consider the impact of design on the evidence base for provider-to-provider telehealth, the study designs of the effectiveness studies in Key Question 2 in each setting are listed in **Table 6**. Note that in this analysis the unit is number of publications, rather than studies, as the study design can differ across publications (e.g., one publication may report the main results of an RCT and another publication from the same study may be a pre-post analysis of effects in a subgroup of patients or providers). The table is ordered in the generally accepted hierarchy for lower risk of bias or better internal validity associated with study design. In this review an almost equal number (about 20% or 1/5 each) of the publications were RCTs, prospective cohorts and retrospective cohort studies. The remaining over 2/5s (43%) of the studies used a pre-post or before-after design. These two designs are open to all the biases that are risks with observational designs, but they are also more susceptible to secular trends. This is particularly concerning in a field like telehealth with rapidly evolving technology and in which the environment and organizational context play an important role.

Table 6. Publication study designs by Key Question 2 topic

Study Design	Inpatient	Outpatient	EMS/ED	Education/ Mentoring	Total
RCT	0	15	2	3	20
Prospective Cohort	2	6	10	2	20
Retrospective Cohort	3	6	8	2	19
Pre/Post*	0	4	0	14	18
Before/After†	13	3	8	2	26
Total	18	34	28	23	103

* Same patients or providers evaluated pre and post intervention

† May not have the same patients or providers in both time points

Abbreviations: ED = emergency department; EMS = emergency medical services; RCT = randomized controlled trial.

Other weaknesses are related to how the study is conducted. One important choice in designing a study is what organization or organizations will be involved. While the number of sites and subjects in a study need to be feasible, studying an intervention in only one setting increases the likelihood that the results could be due to some characteristic or other event at that particular site. When similar results are found across multiple organizations, particularly when the study includes a range of organizations that represent important differences, we are more confident that the result can be attributed to telehealth. **Table 7** shows the distribution of studies in Key Question 2 that were conducted at single sites versus multiple sites, with 17% (18 of 103 studies) reflecting experience at only a single center. The fact that the majority of telehealth studies are including multiple sites is encouraging. Studying a complex intervention at multiple sites enhances the applicability of the findings to other locations.

Table 7. Publication site types by Key Question 2 topic

Number of Sites	Inpatient	Outpatient	EMS/ED	Education/ Mentoring	Total
Multisite	13	27	22	23	85
Single Center	5	7	6	0	18
Total	18	34	28	23	103

Abbreviations: ED = emergency department; EMS = emergency medical services.

The list of potential other weaknesses resulting from how a study in conducted is long. Weaknesses or limitations cited more than once by the authors of included studies are presented in **Table 8** (data abstractions included in **Appendix D**). These are arranged by healthcare setting as a means to potentially identify differences across settings. The table includes the weaknesses cited by the study authors and is not meant to include all possible weaknesses. For example while the inability to blind patients and clinicians in telehealth studies may introduce bias in any setting, it is only included in the row for the setting in **Table 8** if it was explicitly mentioned in included studies.

The most frequently cited weakness across all settings are small sample sizes that result in lack of power to detect statistically significant differences. Other weaknesses include lack of a clearly stated research question and hypothesis, and absence of theory or paradigmatic logic model linking telehealth to outcomes of interest. Additional challenges include historically low utilization of telehealth services, inability to randomize patients to telehealth interventions in many instances, and practical issues that rule out using approaches such as blinding to minimize bias because telehealth use cannot be concealed. Another challenge is that a wide variety of direct and indirect outcomes are utilized in telehealth studies and often measures are not clearly defined or measured. For example, different studies define time-to-treatment outcomes in different ways, and many education and mentoring studies utilized non-validated survey instruments to collect information from participating providers.

One weakness not acknowledged by the publication authors but identified by the review team is the very limited use of evaluation and implementation frameworks or logic models to structure the studies. Frameworks such as CFIR[60] and Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM)[241] use theory-based domains associated with the adoption, implementation and maintenance of clinical and technological interventions to standardize terminology and facilitate comparisons across studies. Analytic frameworks and logic models make explicit how the intervention is expected to impact outcomes and how variables are related. These models usually require acknowledging the potential for harms or unintended consequences, something that was rarely done in the included studies. The fact that few studies in this report have used these frameworks made comparing both implementation and effectiveness across studies difficult and raises concerns that important elements, such as harms, may be missing in the research.

Table 8. Methodological weaknesses reported in included studies

Clinical Topic	Number of Publications	Summary of Identified Weaknesses
Inpatient Effectiveness	18	Limited applicability - Single center studies, small sample sizes Selection bias –may be vulnerable to secular trends; allocation to groups potentially biased, differences in severity of comparison groups Performance bias – e.g., single researcher performed, documented, and analyzed activities (lack of blinding), changes in clinical providers over time (limits consistency of the intervention and therefore internal validity) Detection bias – underpowered to detect outcomes with precision; unblinded assessment of outcomes, outcomes not clearly or inconsistently defined measured, or reported across studies, outcomes not always conceptually linked to telehealth, lag times in outcome measurement or followup not long enough Attrition bias - Incomplete data (electronic or human data capture) Analysis bias – lack of controlling for confounding
Outpatient Effectiveness	34	Limited applicability - Single center studies, small sample sizes Selection bias; randomized by site without appropriate design and analysis for cluster randomization, comparison groups received enhanced usual care, or were a hypothetical reference Attrition bias - High attrition, high refusal to participate in all parts of studies, missing data, between-group differences in followup Performance bias - not all costs identified; unclear if costs (current and future) and outcomes valued appropriately, lack of methods to ensure accurate and reliable data capture from administrative databases Detection bias - Complex intervention without assessment of individual components, followup time inadequate for some outcomes Analysis bias – lack of controlling for confounding by patient characteristics (e.g., race/ethnicity) Other - Unclear methods for enrollment (randomization and allocation concealment), outcome ascertainment, handling of missing data, concerns about fidelity of the intervention to the protocol
Emergency Management Services/ Emergency Department Effectiveness	28	Limited applicability - Single service/center studies, small sample sizes Selection bias –may be vulnerable to secular trends; allocation to groups potentially biased (controls selected based on available data –sites not missing data may not be representative, patient or clinician factors may alter group selection) Performance bias – clinicians knew who received telehealth Retrospective design – analysis was limited to available data; Attrition bias - Missing data, response rate for surveys not reported Analysis bias - lack of control for confounders (e.g., change in practice during study period, severity of illness which may have influenced selection for teleED); comparator not well described

Clinical Topic	Number of Publications	Summary of Identified Weaknesses
Education and Mentoring	23	Limited applicability - Single center studies, small sample sizes Selection bias – analysis may be vulnerable to secular trends (e.g., pre-post designs); allocation to groups potentially biased Detection bias - point-in-time assessment of provider knowledge only (does not assess retention), lack of data on specific provider behavior and comprehensive, consistent and validated outcome measures Analysis bias – does not account for program implementation differences across "spoke" sites, impact of provider technological difficulties with the education and mentoring modality. Other – unclear 'dosage' of the intervention; people did not have to attend all sessions.
Barriers & Facilitators	71	Analysis bias – Frequent use of pre post design w/o control for other factors or descriptive studies Selection bias - Few patients or providers willing to be interviewed; differences between groups due to difficulties identifying similar controls across systems; may be vulnerable to secular trends, including perceptions that are likely to change over time Performance bias -Measures of frequency of use maybe misleading if the purpose of the telehealth intervention is to provide capacity to respond to a rare event. Detection bias - Programs are evaluated before long-term results are available; no systematic assessment of the relative impact of different barriers and facilitators; lack of direct measures of patient outcomes; lack of specificity in concepts measured; evaluation is based on impressions of what patients need rather than patient experience, and assessments based in part on a hypothetical scenario Attrition bias - Unknown barriers of provider non-respondents, Analysis bias – does not account for implementation differences across "spoke" sites, few studies use established implementation assessment frameworks that would help facilitate comparisons across sites or across studies

Abbreviation: TeleED = telehealth emergency department.

Discussion

Findings in Relation to the Decisional Dilemmas

While telehealth has the potential to increase access to timely, appropriate, and high quality healthcare for rural populations its promise has yet to be realized. Use of telehealth had been steadily increasing, though many people would say too slowly, over the past three decades. In healthcare, telecommunications technology can be used in a wide variety of ways to expand options for interactions both between patients and clinicians as well as among healthcare providers.

One of the most significant impacts of the COVID-19 pandemic has been the rapid acceleration of telehealth in many forms.[55, 242, 243] Data on use for direct patient care indicate that the crisis has been a catalyst for changes in technology, regulations, payment/reimbursement, and workflows. While virtual patient visits spiked, then declined somewhat as science and routines adapted to the pandemic, the use of telehealth remains high and is unlikely to return to low, pre pandemic levels.[244-246] Telehealth use has likely increased as well for different uses among providers, such as remote consultations for inpatient, outpatient and emergency care, virtual care conferences, remote diagnosis and supervision of treatment, and use of technology for education and mentoring of healthcare providers. This review of telehealth for provider-to-provider communications and collaborations was initiated prior to the pandemic. Nevertheless, assembling the available evidence about use (Key Question 1), effectiveness (Key Question 2), implementation (Key Question 3), and methodological weaknesses of research studies (Key Question 4) provides a foundation that, combined with current pandemic experience, can serve as a foundation for future use of telehealth by informing policy and practice initiatives. Which temporary policies should become permanent and where telehealth investments are most likely to help address rural disparities that may have worsened during the pandemic are questions healthcare organizations and policy makers will be grappling with for the coming months and years.

This review underscores that evidence specific to rural telehealth is limited. The number of studies included in the results section of this report is deceptive. If these studieswere similar, this would represent a sizable body of evidence; however, the included studies are spread across different settings, clinical indications, and roles in healthcare delivery. Our findings are organized by setting and then by specific clinical indications. We did this because most decisions are made about targeted telehealth programs for a specific use and these distinctions are important for policy and practice. The discussion below strives to provide a high-level overview of the results and an assessment of the context to complement the detail provided earlier in this report.

Key Question 1: Uptake of Provider-to-Provider Telehealth in Rural Areas

How telehealth has been used for provider collaboration in the diagnosis and management of rural patients has not been well documented in the published research literature. Despite requests and searches for unpublished data, we are unable to provide a comprehensive, empirical response to this question. Data on national overall provider-to-provider telehealth use for rural populations was not identified. We did identify studies that included data on specific uses, including six surveys and one analysis of claims data that report on national or regional trends and included

rural location in the analysis or surveyed rural providers. These document that telehealth use is different across specialties, and does appear to be increasing (see **Table 1** for details).

The data sources and designs in the few studies that were identified suggest future approaches to answering this question. Studies were based on national surveys of provider organizations, three survey of emergency departments[63, 65, 66] one and of mental health services.[64] These surveys included items about telehealth use and contain information about the responding organizations, including location, which can be used to identify rural providers. One study used claims data to track the extent to which telestroke was used in over 1 million stroke hospitalizations and how this changed over time in rural as well as urban areas.[67]

While these studies provide a very incomplete picture of provider-to-provider telehealth in rural areas, they allow two important conclusions. Telehealth use is increasing and data exists in national surveys and claims that could be used to generate a deeper understanding of recent treads and current use and this understanding could help target future policy initiatives and telehealth program development.

Key Question 2: Effectiveness of Provider-to-Provider Telehealth in Improving Health Outcomes for Rural Populations and Providers and Payers

Appendix Table B-2 provides a description of the characteristics of included studies including geographic distribution, study design, sample size, and mode of telehealth. More details about individual studies are available in the results section above and the evidence tables **in Appendix D**. The assessment of the strength of evidence (SOE) criteria, the overall assessment of the evidence by outcome is in **Appendix F**.

Assessing effectiveness of telehealth is challenging as the modes, functions and outcomes studied and how they are measured are varied. For conclusions and the assessment of the SOE supporting each of these, we attempted to group studies of similar topics that assess similar outcomes. Despite this effort, there are several instances where only one study was located that was not large or rigorous enough to support a conclusion and the overall assessment is "unclear effect" and "insufficient evidence." Other instances where we have noted "unclear effect" and "insufficient evidence" involve two or more studies that reported conflicting results and are based on small samples (resulting in imprecise estimates). One way SOE is operationalized is the level of confidence that the next study would not change the overall conclusions. Given the lack of multiple, rigorous studies on these topics, for those that we were able to propose a conclusion the SOE is low as even one large, rigorous study could support a different conclusion.

Provider-to-Provider Telehealth for Inpatient Care

Evidence on the impact of inpatient consultations on mortality in studies that involved specialist advice on management for multiple specialties (2 studies) and infection disease (1 study) was insufficient as the results were not consistent across studies. Included studies support a conclusion that telehealth resulted in similar length of hospital stay and the rate of transfers. Two studies of remote intensive care unit (ICU) specifically in rural areas were identified, providing some limited evidence that there is no difference in mortality when patients are treated in rural hospitals using remote ICU rather than being transferred to other hospitals for ICU care (2 studies; Low SOE). Remote monitoring and consultations that allowed neonates to be cared for in rural hospitals results in clinical outcomes similar to those achieved by patients in more

specialized hospitals (Low SOE) and more appropriate transfers (2 studies; Low SOE); however, there were not consistent findings to support conclusions about the impact of teleconsultations on mortality or length of stay (Low SOE, **Table 9 and Appendix F**).

Table 9. Strength of evidence for inpatient effectiveness studies

Topic	Outcome	Number of Studies (Combined N)	Conclusion	Strength of Evidence (Insufficient, Low, Moderate, High)
Teleconsultation	Mortality	3 (N=1841)[76, 83, 85]	Unclear effect	Insufficient
	Length of Stay	6 (N=2867)[75, 76, 78, 79, 83, 85]	Similar length of stay with telehealth consultations	Low
	Transfers	3 (N=2032)[76, 80, 85]	Similar transfers with telehealth consultations	Low
Remote ICU	Mortality	2(N=525)[81] (N=83 rural hospitals)[82]	Similar mortality rates	Low
	Transfers	1 (N=525)[81]	Unclear effect	Insufficient
Management of Neontates (specialty care)	Mortality	1 (N=317)[70]	Unclear effect	Insufficient
	Length of Stay	2 (N=298)[73, 74]	Unclear effect	Insufficient
	Transfers	2(N=317)[70] 1 (N=384 hospitals)[72]	Unclear effect	Insufficient
	Clinical Outcomes	2 (N=298)[73, 74]	Similar clinical measures with telehealth supported care and a higher level NICU	Low

Abbreviations: ICU = intensive care unit; NICU = neonatal intensive care unit.

Provider-to-Provider Telehealth for Outpatient Care

Studies of outpatient consultants as part of rural care included many different clinical topics**.** However, we only identified more that one study for depression, diabetes, pharmacy consultations, and remote consultations for multiple conditions. For depression the identified research supports the conclusion that telehealth consultations result in improvement in clinical and patient-centered outcomes including medication adherence, treatment response, and well-being (three studies; Low SOE). These studies of outpatient telehealth also documented that costs increased, though this was expected as telehealth consultations resulted in increased access to ongoing care (e.g., residential treatment, inpatient placement). Specialist support was also shown to produce better outcomes for rural diabetic patients in both laboratory tests (e.g., A1c) and patient behaviors (e.g., glucose monitoring) (4 studies; Low SOE). Similarly, studies in which pharmacists provided consultations resulted in more patients being treated according to established guidelines and improvements in physiologic measures in the more complex patients with both diabetes and hypertension. Two studies of remote consultants for multiple conditions reported mixed effects on outcomes with some better with telehealth (e.g., medication adherence), but not significantly different on others (e.g., function and quality of life) (Insufficient SOE). These are summarized in **Table 10.** For the remaining outpatient topic and outcome combinations only one study was identified and each was small, with most studies including fewer than 200 subjects and the majority less than 100. Details on these studies are included in the Results and Appendixes.

Table 10. Strength of evidence for outpatient effectiveness studies

Topic	Outcome Type	Number of Studies (Combined N)	Conclusion	Strength of Evidence (Insufficient, Low, Moderate, High)
Depression	Clinical	3 (N=974)[97, 111, 122]	Improvement in medication adherence, treatment response, satisfaction, and quality of well-being	Low
Depression	Payer	2 (N=724)[97, 122]	Higher costs associated with intended higher utilization, acceptable incremental cost effectiveness	Low
Diabetes	Clinical	4 (N=303)[90, 101, 103, 106]	Improved A1c, self-monitoring of blood glucose, and Diabetes Self-Management Education score	Low
Pharmacy	Clinical	2 (N=879)[87, 89]	Improved guideline adherence; improved A1c, fasting blood glucose, and systolic blood pressure in patients with both diabetes and hypertension (similar improvement in patients with only one of the conditions)	Low
Remote consultations	Clinical	2 (N=189)[94, 100]	Unclear effect	Insufficient

Provider-to-Provider Telehealth for Emergency Care

We combined our assessment of programs designed to assess ST-elevated myocardial infarction (STEMI) and chest pain with telestroke as all of these focus on facilitating remote expert review of patients and available data (e.g., imaging, electrocardiogram) with the goal of assuring timely assessment and supporting decisions on how or where patients should be treated. The available evidence supports the safety of these programs, finding that mortality rates were the same for patients treated locally with telehealth compared to those treated at more distant specialized hospitals (5 studies; Low SOE, **Table 11**), though these studies used different mortality metrics (in hospital, 30-day and 90-day). Eight studies included measures of time to treatment for these conditions in which rapid assessment and intervention are key. These studies all found that telehealth and local treatment results in either faster treatment or no difference in the time to treatment, again suggesting that patients can be effectively treated at local hospitals with telehealth support (8 studies; Low SOE).

The other studies of telehealth in emergency care involve providing access to expert advice on whether patients can be treated locally or should be transferred to a higher level hospital. Assessing this type of consultation is challenging because the goal is to both avoid unnecessary transfers and increase transfers when appropriate for the patient. Across these studies there were either improvements in or similar rates of transfer with and without telehealth. (Low SOE). Another metric used in these studies is length of stay in the emergency department (ED), the assumption being it is better to quickly either discharge or admit a patient. Despite identifying multiple studies that reported this outcome, we were unable come to a conclusion and the body of evidence was rated insufficient as the results of each study differed, with studies reporting increases, decreases, or similar length of stay for different subgroups of patients.

Table 11. Strength of evidence for emergency care effectiveness studies

Topic	Outcome Type	Number of Studies (Combined N)	Conclusion	Strength of Evidence (Insufficient, Low, Moderate, High)
EMS/ED: Telestroke/ STEMI/Chest Pain	Mortality	5 (N=2,312)[67, 127, 139, 143, 148]	Similar mortality with telehealth supported care	Low
	Time to treatment	8 (N=3,725)[125-127, 133, 136, 139, 142, 148]	Similar time to treatment. No evidence of increased time to treatment	Low
EMS/ED: Consultation	Transfers	5 (N= 147,910)[131, 132, 135, 141, 144]	Similar appropriate patient transfers. No evidence of increased inappropriate patient transfers	Low
	ED length of stay	4 (N=9,094)[130, 135, 138, 147]	Unclear effect	Insufficient

Abbreviations: EMS = emergency medical services; ED = emergency department; STEMI = ST-elevation myocardial infarction

Provider-to-Provider Telehealth for Education/Mentoring

Provider-to-provider telehealth for education and mentoring of rural healthcare providers includes Extension for Community Healthcare Outcomes (ECHO) programs as well as training conducted via video or SMS (text messages). In **Table 12** the results are summarized by outcome. When patient outcomes are included in research on education programs, the results either show improvement or that similar results can be achieved in the rural locations as at the more distance hubs with onsite expertise (2 studies; Low SOE, **Table 12**). More frequently studied are provider outcomes. While the studies measured different behaviors specific to particular conditions and programs (e.g., appropriate antibiotic, opioid, and psychotropic prescribing, increasing screening, or initiation of counseling), all studies documented improvement in the desired behavior (8 studies; Low SOE). Additionally, most studies of education and mentoring evaluated provider knowledge, confidence, self-efficacy and satisfaction and report that these measures improved or were positive after participation in the programs (13 studies; Low SOE). All the reports are positive, and while this may be the reality, it is also possible that programs are unlikely to publish negative assessments by participants.

Table 12. Strength of evidence for education and mentoring effectiveness studies

Topic	Outcome Type	Number of Studies	Conclusion	Strength of Evidence (Insufficient, Low, Moderate, High)
Education/ Mentoring	Clinical response	2[151, 167]	Patient outcomes improve or are equivalent across spoke and hub sites	Low
	Provider behavior	8[152-154, 156, 158, 159, 165, 168]	Provider behaviors improve	Low
	Provider knowledge, efficacy, perception	13[153, 155, 157-161, 163, 164, 166, 170, 172, 173]	Provider knowledge, self-efficacy and perception improve	Low

Key Question 3: Barriers and Facilitators to Implementation and Implementation Strategies of Provider-to-Provider Telehealth

The original intention of this review was to focus on studies that compared implementation strategies. However, only a very few comparative studies were identified, and these compared models of telehealth for a specific use (remote ICU) and the experiences of different networks implementing telestroke rather than explicit implementations strategies. In order to summarize experience, we expanded the scope to include program evaluations that reported barriers and/or facilitators or the impact of the program and studies that used qualitative research methodology to identify and categorize factors that affected implementation. We continued to restrict our focus to provider-to-provider telehealth for rural populations and excluded publications that simply described telehealth programs without assessing barriers or facilitators to implementation in some way.

This expansion led to identifying and including 67 studies in 71 publications. The barriers, facilitators, and impacts are reported separately for each setting (i.e., inpatient, outpatient, emergency, and education) in detail in the appendix to this report.

Looking across settings, most of the barriers and facilitators are similar to what would be expected for any practice change initiative or new program. These studies confirm that the change needs to fit with the organizational mission, address a specific problem or need, have backing from organizational leadership, a local champion and support from key stakeholders at all levels. Financing and costs are important and all new programs, not just telehealth, struggle with identifying the resources needed for initial investments (e.g., hardware, software, space). Another group of factors highlighted frequently is the 'fit' of the intervention on many levels, including the overall mission of the organization, the needs of specific patients and providers, and telehealth's ability to be integrated easily into the workflows and processes of specific hospitals, practices, or individual providers. Though only occasionally mentioned directly, factors cited as supporting implementation included the need for an understanding of implementation, knowledge of implementation science, explicit planning for implementation, and creating an implementation toolkit or guide that could be used to sustain the program or support its replication.

Telecommunications technology is essential to telehealth, so its role in implementation is specific to telehealth. Aspects of technology were cited as both barriers and facilitators for provider-to-provider telehealth. Technology that does not work reliably, is too expensive, or requires infrastructure that is not available, such as broadband internet, cell phone coverage, or 24/7 tech support not surprisingly slowed or prevented successful implementation. On the other hand, the ability to use existing technology, technology that functioned well, and technology familiar to users all contributed to the success of telehealth programs.

While less frequent, the studies did identify barriers and facilitators and suggest some strategies that are more specific to provider-to-provider telehealth in rural environments. Rural environments differ from the urban environments where consultants or hubs are usually located. Understanding the local culture and policy context, what healthcare and social resources are available and values and preference of patients and providers helps assure telehealth consultations and training are appropriate and relevant. This is likely the motivation for programs to suggest or include some in-person interactions including in-person visits or rotations of the consultants to the rural sites and periods in which rural providers shadow consultants or observe practice at the hub sites.

Another challenge for rural programs is identifying the inputs needed to start-up and then sustain new telehealth programs given the lack of volume, scale, and economic resources in many rural areas. Several of the rural health programs had state government or philanthropic support to start up and depended on changes in reimbursement policy to make programs financially sustainable. Creating regional or statewide networks also allowed programs to share experiences and resources and to develop approaches for rare events or infrequent needs that would not be feasible if attempted individually.

Key Question 4: Methodological Weaknesses of Studies of Provider-to-Provider Telehealth for Rural Populations

This review included an assessment of methodological weaknesses as a Key Question. For this reason, we abstracted the limitations noted by the researchers/authors and looked for trends across studies. The specific weaknesses cited in each study are included in the evidence tables in **Appendix D**. Then these are summarized in the Results chapter and by setting in **Appendix Table B-4** and are grouped by the approximate type of bias or limitation they are likely to cause.

While the majority of studies included more than one site, which supports both applicability and helps assure that site-specific environment is not the sole cause of any impact, many were still small to medium sized studies in a single location. Also, this continues to be a field with few randomized trials. Some elements of classic randomized controlled trials (RCTs), such as blinding participant and providers, are not possible. However, other designs that take advantage of the possibility or need for phased starts across sites (often referred to as step-wedge, delayed start, or wait list designs) could be used to increase the rigor of the evidence base. As pragmatic trial methods evolve and gain acceptance, trials may become more feasible. One of the major sources of methodological weaknesses is the dependence on pre-post (same subjects) or before-after (same organization, different subjects) designs. These rarely include a comparison group or documentation of historical changes in policy or practice, making it difficult to attribute changes in outcomes to telehealth and rule out other explanations.

In addition to the overarching study design, most studies did not provide information on important characteristics of their samples or control for any differences in analyses. Studies were presented with the underlying assumption that telehealth would affect outcomes, but particularly the program evaluations and qualitative studies of implementation rarely make their assumptions or underlying theory or model explicit or use a framework that would facilitate comparing implementation across studies. This is linked to the ongoing challenge of determining what the most appropriate outcomes are for telehealth interventions. In some cases, increasing access is the primary goal and process measure may be most important; in others concerns about safety of objectives related to health disparities require including patient clinical outcomes.

Limitations of the Review Process

There are limitations to this review that are the product of our process and the decisions, tools, and methods available for systematic reviews. Searching for rural provider-to-provider telehealth studies poses several challenges that required assessing whether and how to use specific indexing and key word terms. While telehealth is increasingly indexed, it is a broad term that overlaps with others. Additionally, while the Mesh term “Remote Consultation” exists in Medline this does not capture all possible models of provider-to-provider telehealth. Furthermore, studies do not always include ‘rural’ in titles or abstracts or are not always indexed

as including either rural or underserved populations. Given these challenges we worked with an expert reference librarian with extensive experience with systematic reviews and tested combinations of index terms and key words. Our search strategies are included in **Appendix A**. Despite this approach and our supplemental efforts which included checking references of included studies and other systematic reviews, suggestions from stakeholders, and responses to requests for data, it is possible that relevant studies were missed.

Given the variety of study designs, interventions, outcomes and the lack of detail on comparators in many studies, we were unable to use quantitative synthesis (i.e., meta-analyses). This diversity makes even qualitative synthesis of the effectiveness studies (Key Question 2) challenging. We made decisions to combine studies with similar, but not exactly the same outcome, and to combine some studies that were used for different clinical indications in our SOE assessment. By expanding our scope for the implementation studies to include studies that were not comparative and by including evaluation studies as well as qualitative studies, we were able to provide a broader picture of the state of the science but at the cost of not being able to apply standard risk of bias or strength of evidence assessments. Summarizing and synthesizing in this way requires significant subjective judgements and it is possible that others could interpret the same evidence differently.

Limitations of the Evidence Base

We were able to identify 97 studies (in 106 articles) published in the last 10 years that evaluated the effectiveness or implementation of provider-to-provider telehealth for rural populations. For decades, telehealth has been advanced as an important means of addressing disparities in healthcare access and health outcomes in rural areas. The existence of studies that directly answer the Key Questions is a strength. However, important limitations to this evidence base need to be considered as they impact the utility of this research for practice and policy decisions. Most of the apparent limitations are related to the relative weakness of study designs used in this field, the rigor with which the studies were executed, and the completeness of documentation.

Methodological weaknesses are the focus of a separate Key Question in this review (see Key Question 4 in Results and above) so they are summarized here briefly. Most of the included studies were smaller and are not randomized trials, though the majority involved more than one site. Many studies of telehealth compared outcomes before and after the implementation of telehealth or compare cohorts of patients, clinicians, or organizations with and without telehealth and do not include comparison groups or efforts to isolate the effect of telehealth from historical trends or changes over time. We assessed the risk of bias of all the included effectiveness studies (Key Question 2); very few studies were rated as low risk of bias, with most rated as medium, and several as high risk of bias (**Appendix E**). The criteria that are not met in these studies are those related to selection bias (e.g., whether inclusion based on a random sample or all that meet inclusion criteria and whether analyses account for important potential confounding).

Other weaknesses include the lack of a clear conceptual model and agreement on what outcomes are most important. There have been efforts to develop frameworks for telehealth research and quality measures.[247, 248] These measures have not consistently been used in the literature published to date. Additionally, the lack of a clear conceptual model and related explicit statements about the intention of telehealth in most studies make interpreting the impact on outcomes challenging. In many studies is it implied, but not explicitly stated that the goal is to achieve patient outcomes that are similar, not necessarily better, than those achieved without

telehealth. But the studies do no provide the context needed to determine if similar outcomes are truly an overall benefit. Additionally most studies, do not acknowledge potential harms or that telehealth could be inferior to face-to-face care in some situations or for some people. Negative outcomes are not defined and measured, making it difficult to determine when in person care may be superior or required. The COVID-19 pandemic resulted in changes in existing telehealth quality measures, in consideration of approaches to measure the quality of telehealth,[249] and more explicit statements about telehealth intentions (e.g., provide equivalent care while reducing infection risk). However, these newer measures and frameworks have not yet been integrated into studies that have been completed.

In addition to weaknesses in study design and execution, the lack of key information in published research reports is also a weakness of this evidence base. Both the telehealth interventions and the comparison group or time period are often not well described. This is true in both effectiveness and implementation studies although implementation studies tend to provide more detail. Within each use of telehealth there are a wide range of models. For example, a remote ICU system could use hard wired monitoring in ICU patient rooms or a portable cart or 'robot;' consults for emergency care could be available at the push of a call button or may require paging the appropriate services; and outpatient consultations may or may not involve the patient and providers in real time. These details are often not provided. While more details were often provided in implementation studies (Key Question 3), even these did not always describe the specific telehealth intervention. Combined with the lack of consistent, clearly defined outcomes, lack of information about the specifics of telehealth interventions make it difficult to synthesize results across studies, even qualitatively. Furthermore, identification of facilitators and barriers to implementation was often not the primary purpose of the studies included in Key Question 3. Many studies mentioned facilitators and barriers in the context of pragmatic lessons learned during telehealth deployment. The result is a collection of findings that may not provide a clear, definitive path for decision makers.

Applicability

The scope of this review was defined to include a subset of telehealth (i.e., provider-to-provider communication and collaboration) used to benefit a specific population (i.e., patients in rural areas). As other uses of telehealth and studies that did not explicitly focus on rural populations were excluded, the identified evidence does not differ significantly from the populations, interventions, comparators, outcomes, and settings (PICOS) reflected in the Key Questions. However, there are finer grained applicability issues that should be considered when interpreting and applying this evidence.

One consideration that is rarely acknowledged in summarizing studies related to rural health is that there is diversity across rural settings. The barriers to healthcare access and underlying causes of health disparities as well as the resources that can be marshalled may differ from one rural area to another. Geography, weather, history, natural resources, national policies, and U.S. state and local policies all create an environmental context that could affect whether a telehealth intervention that was successful in one rural area can be translated to another. It may not be reasonable to expect a program that worked for remote island communities to work for dispersed populations in the mountain west of the United States or the expansive Navajo lands.

Additionally, it may be difficult to translate some models that could use different technology or require different infrastructure across or even within clinical applications or care settings, and be confident of obtaining similar results. For example, remote ICUs can be set up using very

different hardware and organizational structures. Another example is that provider-to-provider telehealth for wound care or oral health in long-term care may be more difficult to implement as it requires specialized cameras that may be too expensive or require technical support and infrastructure that are not available.

Perhaps the biggest concern related to applicability is when the included studies were conducted. The time period covered by this review includes 2020 which was characterized by a sudden acceleration in the adoption of telehealth services, concurrent with rapid policy changes regarding reimbursement for healthcare services in response to the COVID-19 pandemic. However, although we included studies published in 2020 they are based on data collected under different policies, before provider and patient familiarity with telehealth services changed significantly. Studies of telehealth in this new context are ongoing, but were not published at the time of this review.

Implications for Clinical and Policy Decision Making

The COVID-19 pandemic has put a spotlight on healthcare systems, revealing numerous cracks in access to and quality of care and subgroups of the population who continue to fall through these cracks. Many observed deficiencies in the U.S. system affect rural populations and healthcare providers and organizations that serve rural areas. While the causes of worse healthcare outcomes in rural America are multi-factorial, telehealth has been and is now even more likely to be viewed as at least part of the solution.

The results of this systematic review do not contradict the idea that provider-to-provider telehealth can contribute to better health outcomes for rural populations. It is reassuring that we did not find any evidence that provider-to-provider telehealth resulted in harms or worse outcomes. However, this must be tempered by the fact that many studies do not explicitly define and then measure potential harms or unintended negative consequences of telehealth. Many of the results that found no significant difference between care that is facilitated by telehealth consultations or remote education can be interpreted that outcomes are “as good as” those resulting from in-person collaboration (although most of these studies were not designed to test equivalence). Other studies were evaluations of programs aiming for better outcomes. This was often the case for before/after or pre/post studies of telehealth programs that were designed to augment existing services, provide services that were not available without telehealth, or provide costly services in a less costly way. The studies may report better outcomes, but the evaluations are not methodologically rigorous, and provide imprecise estimates of effect, which contributed to rating as low SOE.

At the same time, the identified evidence does not provide a clear road map that can be easily followed. Telehealth can be used to address a wide range of problems, from lack of access or expertise to travel burden and the cost implications of patient transfers. Given this breadth, interventions can include all possible settings and a large number of clinical indications and applications. There is not yet enough evidence to conclude where, across all the available problems and options, investments in provider-to-provider telehealth are likely to make the biggest difference. For example, comparing remote ICU care to ECHO programs to decide which should be implemented is difficult.

Within a clinical use there are examples of targeted needs assessments for telehealth. For example, some of the programs that establish statewide telestroke programs have combined information on health status and resources by geographic region in order to identify where hubs and spokes could be placed to best serve the state.[174] Regional assessments of need like this

could extend beyond a single clinical indication or a single form of telehealth to provide more comprehensive guidance and ultimately more efficient targeting of telehealth.

Future Research Needs

A common, but very unsatisfying and impractical response to reviewing a body of evidence dominated by non-randomized studies is to conclude that more RCTs are needed. Identifying where resources should be invested in trials is an important task in any field. Additionally, randomized studies present both ethical and logistical challenges, particularly when underserved or disadvantaged populations are studied. However, addressing the methodological issues identified in the response to Key Question 4 and considering different types of research could also advance the field and promote the health and well-being of rural communities and the people and organizations that serve them, without having to fund expensive RCTs. Major improvements would include:

- Outcome measurement at multiple time points, as effects may become evident initially or over longer periods of time, and because short-term outcomes may differ from longer-term outcomes (e.g., provider retention of knowledge acquired through remote education and mentoring)
- Agreement on common outcomes and goals for similar provider-to provider telehealth interventions. For example, agreeing on: whether remotes ICUs should reduce ICU or all inpatient mortality and length of stay; if ED consultations should reduce the overall rate of transfers or specific types of transfers; what measures of patient access (e.g., time to appointment, care or diagnosis) or patient burden (e.g., travel cost, lost work time, anxiety) can be measured consistently across interventions; and what harms should be measured.
- Use of contemporary comparison groups and the inclusion of multiple sites so that the impact of telehealth could be separated from historical change or the potentially unique characteristics of specific sites or providers/consultants.
- More complete descriptions of both the content of telehealth and comparator interventions and the intention of the research articles would help inform assessments of fit and help clarify when telehealth replaced in-person services or added additional services.

In addition to these specific changes to trials or observational studies, different types of studies or studies of different topics may be useful. Given the need to understand both effectiveness and implementation, hybrid studies seem warranted. Hybrid designs fall on the continuum between purely effectiveness studies to purely implementation studies and include differing degrees of focus on the context and needs for implementation in addition to assessing effectiveness.[250, 251] Hybrid designs are one way to include more explicit consideration of the impact of the internal environment and local policies. Additionally, studies are needed that consider not just healthcare delivery, but the larger policy context in which care was delivered, including payment, licensing, regulations, and competition across providers.

Perhaps the most pressing future research need is to take advantage of the natural experiment resulting from the COVID-19 pandemic. Rapid telehealth adoption for patient-provider interactions has likely spilled over into provider-to-provider communications and collaborations. Larger studies should now be possible, involving more sites, and changes in reimbursement could lead to better coding or use of currently underused codes for activities like remote

consultations and in turn to more informative claims data that will allow tracking of telehealth consultations and associated patient outcomes. Other changes related to the pandemic have likely also created opportunities for robust studies of provider-to-provider telehealth.

Summary and Conclusion

This review identified and included 166 studies of provider-to-provider telehealth in rural areas. Evidence on where and how provider-to-provider telehealth is being used in the rural United States is sparse and generally limited to a small number of analyses of specific specialties. While these studies all report increasing use of telehealth, they do not provide a complete picture. Studies of effectiveness of provider-to-provider telehealth are dominated by findings of similar or improved outcomes when telehealth is implemented. However, it is not possible to make a universal conclusion across all the different clinical uses, various settings, and outcomes considered in the included research we examined.

Limiting the scope to provider-to-provider collaboration and use in rural areas makes the studies we identified directly applicable; nevertheless, there were too few studies to support clear conclusions with high SOE. We did find sufficient evidence to suggest that telehealth is likely to produce outcomes that are as good as or better in the following situations: inpatient consultations, the care of neonates, outpatient depression and diabetes care, emergency care for stroke/heart attack/chest pain, and emergency consultations for multiple conditions. Also, education and mentoring programs produce improvements in patient clinical outcomes, provider behavior, and provider knowledge and self-efficacy. The strength of evidence for all of these conclusions is low due to inconsistencies in results and the lack of precise estimates of effect given the small number of studies and small sample sizes.

When we searched for and analyzed studies of implementation, we found few comparative studies and our assessment across studies identified barriers and facilitators that are commonly linked to practice change efforts and are not unique to telehealth or rural implementation. Exceptions were the need to understand the rural context and the possible challenges presented by lack of scale. Similarly, assessing methodological weaknesses of the identified and included studies identified the need for larger, more rigorous observational studies, quasi-experimental studies and more trials (including adaptive trials), but also suggested that more studies should combine effectiveness and implementation research, or at minimum provide more detail on the telehealth interventions, comparators, and the context.

The existing evidence base for provider-to-provider telehealth is insufficient to support conclusions in which we can have confidence. However, it is reassuring that the studies we were able to identify do not report harms or negative consequences and do suggest that it is likely that application of telehealth can improve patient outcomes such as access to and quality of care, provider outcomes such as knowledge and self-efficacy, and payer outcomes such as reduced costs or maintenance of payments to rural providers.

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Abbreviations and Acronyms

Abbreviation	Definition
ADHD	Attention deficit hyperactivity disorder
AHRQ	Agency for Healthcare Research and Quality
CDC	Centers for Disease Control and Prevention
CFIR	Consolidated Framework for Implementation Research
CI	Confidence interval
CM	Centralized monitoring
COVID-19	Coronavirus disease 2019
CRP	c-reactive protein
ECG	electrocardiogram
ECHO	Extension for Community Healthcare Outcomes
ED	Emergency departments
EMS	Emergency medical services
FORHP	Federal Office of Rural Health Policy
ICU	Intensive care unit
MI	Myocardial infarction
MMSE	Mini-Mental Status Exam
NCATS	National Center for Advancing Translational Sciences
NHLBI	National Heart, Lung and Blood Institute
NICU	Neonatal intensive care unit
NIH	National Institutes of Health
ODP	Office of Disease Prevention
PICOS	Population, intervention, comparison, outcomes, settings and study designs of interest
PTSD	Post-traumatic stress disorder
RCT	Randomized controlled trial
RE-AIM	Reach, Effectiveness, Adoption, Implementation, and Maintenance
RR	Relative risk
SF-12	12-item short form survey
SF-36	36-item short form survey
SMS	Short messaging service
SOE	Strength of evidence
STEMI	ST-elevated myocardial infarction
TOO	Task Order Officer
tPA	Tissue plasminogen activator
VC	Virtual consult

Appendixes

Contents

Appendix A. Methods

Details of Study Selection

Search Strategy

Literature Databases: Ovid MEDLINE®, CINAHL®, EMBASE, and Cochrane CENTRAL were searched to capture both published and gray literature. The search strategies were developed by a librarian with expertise in conducting searches for systematic reviews. Searches were peer reviewed by a second librarian.

Search Strategy: Search strategies are included below. In order to focus the search on rural applications of telehealth, we used three specific indexing terms (Rural Health Services, Rural Population, and Medically Underserved Area) as well as key word searches of titles and abstracts for "rural," "remote," and "resource limited." Search and triage results were reviewed with the Technical Expert Panel (TEP) and NIH/ODP Working Group.

Publication Date Range: Searches identified studies published January 1, 2010 to October 12, 2021 for Key Questions 2, 3, and 4 and January 1, 2015 to October 12, 2021 for Key Question 1. This captured studies of systems that rely on more current technology. We included information on the dates the studies were conducted and the technologies used, as well the dates of publication.

Initial searches were conducted through September 2020. These searches were updated during the public comment period of the draft report to capture any new publications. Literature identified during the update search was assessed by following the same process of dual review as all other studies considered for inclusion in the report. New literature was identified for inclusion in the report, and was incorporated into the final submission of the report.

Supplemental Evidence and Data for Systematic review (SEADS): The AHRQ Evidence-based Practice Center (EPC) Scientific Resource Center notified stakeholders about the opportunity to submit information via the SEADS portal. There was also an announcement published in the Federal Register.

Gray Literature: Sources for gray (unpublished) literature included reports produced by government agencies, health care provider organizations, or others. With the help of AHRQ, we contacted the federal government community of practice on telehealth, and other appropriate organizations including, but not limited to the American Telemedicine Association, The Society for Education and the Advancement of Research in Connected Health (SEARCH) and AcademyHealth to make initial inquires, and we also followed up on any suggestions made by TEP members.

Hand Searching: Reference lists of included articles, selected excluded articles (e.g., narrative reviews), and systematic reviews were reviewed for includable literature.

Contacting Authors: In the event that information regarding methods or results appeared to be omitted from the published results of a study, or if were aware of unpublished data, we attempted to contact the authors to obtain additional information.

Search Strategies

Database: Ovid MEDLINE(R) ALL
1 Rural Health Services/
2 Rural Population/
3 (rural or “resource limited” or (remote adj5 (population* or community or communities or area*))).ti,ab,kf.
4 Medically Underserved Area/
5 exp Community Health Services/ or Community Health Centers/ or United States Indian Health Service/
6 "Referral and Consultation"/
7 exp Health Services Accessibility/
8 "Delivery of Health Care"/
9 2 or 3
10 or/4-8
11 9 and 10
12 1 or 11
13 exp Telemedicine/
14 Mobile Applications/
15 exp Telecommunications/
16 (telemedicine or telemedical or telehealth or teleconsult* or "e-consult*" or "econsult*" or ((remote or virtual) adj3 (consult* or education or round* or mentor*))).ti,ab,kf.
17 or/13-16
18 9 and 17
19 12 and 17
20 "provider to provider".ti,ab,kf.
21 ("Project ECHO" or "Extension for Community Healthcare Outcomes").ti,ab,kf.
22 or/18-21
23 "journal of telemedicine & telecare".jn.
24 "telemedicine journal & e-health".jn.
25 9 and (23 or 24)
26 "journal of rural health".jn.
27 17 and 26
28 22 or 25 or 27
29 limit 28 to english language
30 limit 29 to yr="2010 - 2021"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials
1 Rural Health Services/
2 Rural Population/
3 (rural or "resource limited" or (remote adj5 (population* or community or communities or area*))).ti,ab.
4 Medically Underserved Area/
5 exp Community Health Services/
6 "Referral and Consultation"/
7 exp Health Services Accessibility/
8 "Delivery of Health Care"/
9 2 or 3
10 or/4-8
11 9 and 10

12 1 or 11
13 exp Telemedicine/
14 Mobile Applications/
15 exp Telecommunications/
16 (telemedicine or telemedical or telehealth or teleconsult* or "e-consult*" or "econsult*" or ((remote or virtual) adj3 (consult* or education or round* or mentor*))).ti,ab.
17 or/13-16
18 9 and 17
19 12 and 17
20 "provider to provider".ti,ab.
21 ("Project ECHO" or "Extension for Community Healthcare Outcomes").ti,ab.
22 or/18-21
23 conference abstract.pt.
24 "journal: conference abstract".pt.
25 "journal: conference review".pt.
26 "http://.www.who.int/trialsearch*".so.
27 "https://clinicaltrials.gov*".so.
28 23 or 24 or 25 or 26 or 27
29 22 not 28

Database: EBM Reviews - Cochrane Database of Systematic Reviews
1 (telemedicine or telemedical or telehealth or teleconsult* or "e-consult*" or "econsult*" or ((remote or virtual) adj3 (consult* or education or round* or mentor*))).ti,ab.

Database: EBSCOhost CINAHL Plus
S1 (MH "Rural Health Personnel") OR (MH "Rural Health Centers") OR (MH "Hospitals, Rural") OR (MH "Rural Population") OR (MH "Rural Health Services") OR (MH "Rural Health Nursing") OR (MH "Rural Areas") OR (MH "Rural Health") OR (MH "Frontier Nursing Service")
S2 (MH "Telecommunications+")
S3 S1 and S2
S4 Limiters - Published Date: 20100101-20201231; English Language; Exclude MEDLINE records

Database: Elsevier Embase
('rural population'/exp OR 'rural population' OR 'rural area'/exp OR 'rural area' OR 'medically underserved'/exp OR 'medically underserved') AND ('telehealth'/exp OR telehealth OR 'telemedicine'/exp OR telemedicine OR 'teleconsultation'/exp OR teleconsultation) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND [2010-2020]/py

Inclusion and Exclusion Criteria

The criteria for inclusion and exclusion of individual studies are based on the Key Questions and PICOS described above. Additional details on the scope of this project are provided below and the inclusion and exclusion criteria are outlined in **Table A-1**.

Study Designs: We included comparative studies of any design including comparative trials and observational studies. We included observational cohort studies, including pre-post designs (i.e., the same participants compared across time points) as well as before-after designs (i.e., one group of participants before an intervention/system change compared to a different group after the change). We excluded descriptive studies with no outcomes data or studies that included only data from one point in time (post only). We also excluded modeling studies or studies that used synthetic data. We accessed existing systematic reviews, and reviewed reference lists to identify studies. We also excluded commentaries, letters, and articles that described telehealth systems or implementations but did not assess impact.

Outcomes: The protocol specified that we would include outcomes only for the following conditions: substance abuse/alcohol, HIV/HPV/other infectious diseases, suicide, heart disease, cancer, unintentional injury, chronic lower respiratory disease, and stroke. However, due to a limited body of evidence in some of these conditions, and additional evidence in other conditions, it was decided to include outcomes of interest for any health condition.

Non-English-Language Studies: We restricted to English-language articles, but reviewed English-language abstracts of non-English language articles to identify studies that would otherwise meet inclusion criteria, to assess for the likelihood of language bias.

Table A-1. PICOS and corresponding inclusion and exclusion criteria

PICOS	Include	Exclude
Population	Individual patients and partners of any age and populations with health care needs in geographically rural areas regardless of where the providers are located Rural is broadly defined; any commonly used or endorsed definition is acceptable Providers (clinicians broadly defined or health care organizations) of health care to patients and populations in rural areas Payers (public or private; insurers or self-pay) for health care provided to patients and populations in rural areas	Urban patients or populations Mixed patients and populations that are not separated and predominately urban Interactions between a formal provider and informal/family care partners/givers
Interventions	Provider-to-provider telehealth broadly defined as any form of interactive support using telecommunications technology provided to health care professionals while they are caring for rural patients and populations. This includes: Remote consultations across space (e.g., video) and time (e.g., store and forward) that support diagnosis, treatment, or management of patients Video, audio, or digital only consultations Remote mentoring Remote rounds or group education and case review (e.g., Project ECHOs) Remote continuing education	Use of telehealth for patient encounters involving one clinician (virtual visits) Remote patient monitoring (transmitting data from patient to a single provider) Referrals for services that involve no interaction among providers
Comparators	No service or support Care provided without telehealth In-person activities Time period prior to provider-to-provider telehealth implementation Excluded types of telehealth	KQ2, KQ4: No comparators (e.g., descriptive and cross-sectional studies) KQ1: None

PICOS	Include	Exclude
Outcomes	KQ2, KQ4: Clinical outcomes such as patient-reported outcomes, mortality, morbidity, function, illness recovery, infection rates, or viral load for the identified conditions* Economic outcomes such as return on investment, cost, volume of visits, and resource use Intermediate outcomes such as: Patient satisfaction, behavior, and decisions such as completion of treatment, or satisfaction with less travel to access healthcare Provider satisfaction, behavior, and decisions such as choice of treatment or antibiotic stewardship Time to diagnosis, time to treatment, length of stay (if applicable), 30 days hospitalization Appropriate utilization of health care services and avoided, preventable hospitalizations/readmissions/ED visits/test, treatments, procedures, etc. KQ1: Indicators and measures of uptake of telehealth (e.g., rates of use, timing to implementation) and characteristics of users KQ3: categories and descriptors of barriers and facilitators of telehealth; categories and descriptors of strategies of use of telehealth	KQ2, KQ4: Results of models, simulations, or projections without actual outcomes data Results of cross-sectional studies and surveys that include no comparison (e.g., descriptive statistics) Results from surveys of attitudes or opinions about hypothetical scenarios (i.e., not actual experience) Diagnostic concordance or accuracy or other measures of agreement between in-person and telehealth consultations
Settings	Outpatient (primary care and specialty care) Inpatient (e.g., remote ICU, consultations for hospitalized patients) Prehospital and emergency care (e.g., Telestroke, EMS, ED, urgent care) Post-acute and long-term care (e.g., home care and nursing homes) Studies of health care services delivered outside of health care settings (e.g., social services, churches, schools, prisons) Civilian, Veterans Health Administration, or Military (except battlefield) United States and other countries with similar or more advanced health care systems and resources	Mass casualty and war/battlefield events Countries with significantly different healthcare systems and fewer resources (e.g., low-income countries)
Study types and designs	KQ2, KQ4: Comparative studies including trial and observational studies, including prospective and retrospective cohort studies and before-after studies (i.e., natural experiments) KQ1, KQ3: Comparative or descriptive studies	All: Nonsystematic reviews, commentaries, or letters KQ2, KQ4: Descriptive studies, feasibility assessments
Study years	Published in 2010 or later. Included systematic reviews may include studies prior to 2010 if such studies are relevant to current technology For KQ1: published in 2015 or later	Published prior to 2010 For KQ1: Published prior to 2015

Abbreviations: ED = emergency department; EMS = emergency medical services; ICU = intensive care unit; KQ = Key Question; PICOS = population, intervention, comparator, outcomes, study designs; Project ECHO = Extension for Community Healthcare Outcomes

*Originally noted that only studies which examined outcomes for the following conditions would be included: substance abuse/alcohol, HIV/HPV/other infectious diseases, suicide, heart disease, cancer, unintentional injury, chronic lower respiratory disease, and stroke. However, after review of available body of literature we included any health condition.

Process for Selecting Studies: Pre-established criteria as presented in Table A-1 was used to determine eligibility for inclusion and exclusion of abstracts in accordance with the AHRQ *Methods Guide for Effectiveness and Comparative Effectiveness Reviews*.[1] After de-duplication,

we imported all references to DistillerSR for managing abstract and full-text review. To ensure accuracy, all excluded abstracts were dual reviewed. Full text was retrieved for all citations deemed appropriate for inclusion by at least one of the reviewers. All potentially relevant full-text articles were independently reviewed for eligibility by two team members. Any disagreements were resolved by consensus. A flow diagram of study screening and inclusion is below in Appendix B, and a record of studies included in the review and those excluded at the full-text level with reasons for exclusion can be found in Appendix C and G, respectively.

Data Extraction

After studies were deemed to meet inclusion criteria, we abstracted study design, year, setting, country, sample size, patient and providers types and characteristics (e.g., age, sex, race, reason for presentation, diagnosis, and provider specialty), intervention characteristics (e.g., mode of delivery, duration or frequency, function) and results relevant to each Key Question as outlined in the PICOS section in **Table A-1**. As Key Question 2 asks about outcomes for three groups: patients and providers, healthcare providers, and payers, outcomes were sorted by who was impacted. Information relevant for assessing applicability included the number of patients randomized/eligible for inclusion in an observational study relative to the number of patients enrolled or the number and diversity of settings or locations as well characteristics of the population, telehealth intervention or implementation strategy, and administrating personnel. Sources of funding for all studies were also recorded. All study data was extracted into Excel and verified for accuracy and completeness by a second team member.

Risk of Bias Assessment of Individual Studies

Predefined criteria were used to assess the risk of bias (also referred to as quality or internal validity) for each individual included study, using criteria appropriate for the study designs. Risk of bias assessment was managed using DistillerSR. Controlled trials and observational studies were assessed using a priori established criteria consistent with the approach recommended in the chapter, Assessing the Risk of Bias of Individual Studies When Comparing Medical Interventions in the *Methods Guide for Effectiveness and Comparative Effectiveness Reviews*.[1] For controlled trials we assessed adequacy of randomization and allocation concealment, eligibility criteria, baseline differences between groups, intention-to-treat analyses, attrition and adherence levels, blinding methods, reliable and consistently implemented outcome measures, and prespecified and reported outcomes. For observational cohort studies, we assessed eligibility criteria, participant selection, baseline differences between groups, reliable and consistently implemented outcome measures, blinding of outcome assessors or data analysts, amount and handling of missing data, loss-to-follow up and attrition, and prespecified and reported outcomes We adapted criteria and details for evaluating cost effectiveness studies from Consensus Health Economic Criteria-CHEC List.[2] We assessed whether competing alternatives were clearly described, appropriateness of study design, whether important and relevant costs for each alternative were identified, appropriateness of costs measured and valued, identified relevant outcomes for each alternative, outcomes measured and valued appropriately, whether an incremental analysis of costs and outcomes of alternatives was performed, whether all future costs and outcomes were discounted, and all important variables whose values are uncertain were subjected to sensitivity anlysis. Individual studies were rated as “low risk of bias,” “medium risk of bias,” or “high risk of bias.” Risk of bias ratings can be seen in **Appendix E**.

Studies rated "low risk of bias" are considered to have the least risk of bias, and their results are generally considered valid. "Low risk of bias" studies include clear descriptions of the population, setting, interventions, and comparison groups; a valid method for allocation of patients to treatment; low dropout rates and clear reporting of dropouts; appropriate means for preventing bias; and appropriate measurement of outcomes.

Studies rated "medium risk of bias" are susceptible to some bias, though not enough to invalidate the results. These studies may not meet all the criteria for a rating of low risk of bias, but no flaw is likely to cause major bias. The study may be missing information, making it difficult to assess limitations and potential problems. The "medium risk of bias" category is broad, and studies with this rating will vary in their strengths and weaknesses. The results of some medium risk of bias studies are likely to be valid, while others may be only possibly valid.

Studies rated "high risk of bias" have significant flaws that imply biases of various types that may invalidate the results. They have a serious or "fatal" flaw in design, analysis, or reporting; large amounts of missing information; discrepancies in reporting; or serious problems in the delivery of the intervention. In general, observational studies that do not perform adjustment for potential confounders will be assessed as "high risk of bias." This is because it is likely the results of these studies are at least as likely to reflect flaws in the study design as the true difference between the compared interventions. We did not exclude studies rated high risk of bias a priori, but high risk of bias studies were considered to be less reliable than low or medium risk of bias studies when synthesizing the evidence, particularly if discrepancies between studies were present.

Two team members independently reviewed included studies, and resolved disagreements by consensus.

Data Synthesis and Analysis

We constructed evidence tables identifying the study characteristics (as discussed above), results of interest, and risk of bias ratings for all included studies, and summary tables to highlight the main findings. As the key questions varied in nature and scope, our approach to synthesis differed.

For the comparative effectiveness question (KQ2), we applied standard systematic review methods. We reviewed and highlighted studies using a hierarchy-of-evidence approach, where the studies with better risk of bias ratings were given more weight in our synthesis for each clinical indication and outcome. Qualitative data were summarized in tables and ranges. Descriptive analysis and interpretation of the results were provided based on the direction and magnitude of effect. Meta-analyses would not produce meaningful results and were not performed due to limited numbers of studies reporting similar outcomes, and heterogeneity among studies in design, patient population, and interventions.

Our response to KQ3 involved identifying and summarizing barriers and facilitators to implementation of provider-to-provider telehealth for rural healthcare. When studies directly compared different strategies, we provide a narrative summary of the studies and their results. When studies only reported on implementation for an individual study (not comparative) we abstracted what was study authors described as barriers, faciliators, and indicators of implementation success. Facilitators and barriers were consistently described in narratives reporting results or discussing implications. These lacked common vocabulary and definitions. To address this and facilitate synthesis, we first abstracted what was reported in each study Noting conceptual similarities, but different nomenclature across articles, we sought to group

facilitators and barriers into meaningful and informative categories. We selected and used the Consolidated Framework for Implementation Research (CFIR)[3] to organize this information. CFIR is composed of 5 categories and 39 defined constructs, designed to aggregate facilitators and barriers into common groupings. Two members of the study team independently matched abstracted descriptions to a CFIR construct using the CFIR code book template available at https://cfirguide.org/. Independent coding was followed by collaborative review and arrival at consensus among three members of the study team. Descriptive analysis of study findings and CFIR themes were presented in figure and tables.

For KQ1 (use of telehealth) and KQ4 (strengths and weaknesses of included studies), synthesis consists of descriptive narrative and tables, corresponding to the nature of the questions and data.

Grading the Strength of the Body of Evidence

Key Question 1 (the uptake of telehealth in rural areas) is descriptive and a formal strength of evidence (SOE) assessment was not conducted. We prioritized reports of U.S. national or regional studies over local reports or data from other countries. We summarized the strengths and limitations of the data collection and analyses of the included reports for Key Question 1, with a focus on elements such as the extent the sample represents the population of interest and the completeness and reliability of the data.

The strength of evidence (SOE) for Key Question 2 was assessed using the approach described in the *Methods Guide for Effectiveness and Comparative Effectiveness Reviews*.[1] Outcomes were prioritized for SOE assessment based on input from the ODP working group. SOE was initially assessed by one researcher for each outcome. To ensure reliability and validity of the evaluation, the body of evidence was assessed for the following criteria as they are defined in the Methods Guide:

- Study limitations (low, medium, or high level of study limitations)
    - Rated as the degree to which studies for a given outcome are likely to reduce bias with study design and study conduct, based on risk of bias assessments.
- Consistency (consistent, inconsistent, or unknown/not applicable)
    - Rated by degree to which studies find similar magnitude of effect (i.e., range sizes are similar) or same direction (i.e., effect sizes have the same sign) or where there was only one study of a given design, we assessed consistency as "unknown" and downgraded the SOE.
- Directness (direct or indirect)
    - Rated by degree to which evidence assesses a) comparison of interest, b) in the population of interest, and measures the specific outcome of interest.
- Precision (precise or imprecise)
    - Degree of certainty surrounding an effect estimate as it relates to a specific outcome. This may be based on sufficiency of sample size and number of events, and if these are adequate, the interpretation of the confidence interval.
- Publication bias (suspected or undetected)
    - Whether selective publishing of research findings based on favorable direction or magnitude of effects was identified using funnel plots or statistical methods, however, we did not have enough studies to conduct this assessment, so the majority of SOE assessments rated this domain as "unknown."

The bodies of evidence were assigned an overall SOE grade of high, moderate, low, or insufficient according to a four-level scale by evaluating and weighing the combined results of the above domains **(Table A-2)**. Because studies were anticipated to be heterogeneous in the interventions, clinical targets, and outcomes, we did not anticipate that meta-analysis would be possible. As such, the conclusion of findings being similar were based on individual studies not finding statistically significant differences, with consistency across multiple studies in this finding, and that the point estimates were not subjectively viewed as being large.

Table A-2. Definitions of the grades of overall strength of evidence[4]

Grade	Definition
High	We are very confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has few or no deficiencies. We believe that the findings are stable (i.e., another study would not change the conclusions).
Moderate	We are moderately confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has some deficiencies. We believe that the findings are likely to be stable, but some doubt remains.
Low	We have limited confidence that the estimate of effect lies close to the true effect for this outcome. The body of evidence has major or numerous deficiencies (or both). We believe that additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect.
Insufficient	We have no evidence, we are unable to estimate an effect, or we have no confidence in the estimate of effect for this outcome. No evidence is available, or the body of evidence has unacceptable deficiencies, precluding reaching a conclusion.

Following the Agency for Healthcare and Quality (AHRQ) Methods Guidance for bodies of evidence consisting of observational studies, the strength rating starts at moderate for harms outcomes, and low for benefit outcomes. Although this allows this evidence to be upgraded under specific circumstances, including if all or most of the studies are low risk of bias and they report consistent, precise estimates. However, this was not the case in this review so no upgrades were made. In cases where there were both RCTs and observational studies were included for a given intervention-outcome pair, we followed the additional guidance on how to weight RCTs over observational studies, how to assess consistency across the two bodies of evidence, and how to come to a final rating.

Given our broad inclusion criteria, the evidence for Key Question 3 consists of studies that used qualitative methods (e.g., interviews, case studies, focus groups) as well as program evaluations that combined qualitative and quantitative information. Very few of the studies were comparative and they are heterogeneous in terms of topics and methods. We considered the GRADE-CERQual[5] approach to grading qualitative research synthesis to rate our finding for Key Question 3, but the studies included mixed methods, and evaluation studies that were often descriptive or did not adhere to standard qualitative methods. As a result, we were not able to apply this relatively new approach rigourously and reliably.

Assessing Applicability

Applicability was considered according to the approach described in the *Methods Guide for Effectiveness and Comparative Effectiveness Reviews*.[1] We used the PICOS framework to consider the applicability of the evidence base for each Key Question, for example, examining the characteristics of the patient populations (e.g., clinical condition) and study setting (e.g., inpatient or outpatient). Variability in the studies may limit the ability to generalize the results to other populations and settings.

Peer Review and Public Commentary

Peer reviewers were invited to provide written comments on the draft report based on their clinical, content, or methodological expertise. The EPC considers all peer review comments on the draft report in preparation of the final report. Peer reviewers do not participate in writing or editing of the final report or other products. The final report does not necessarily represent the views of individual reviewers.

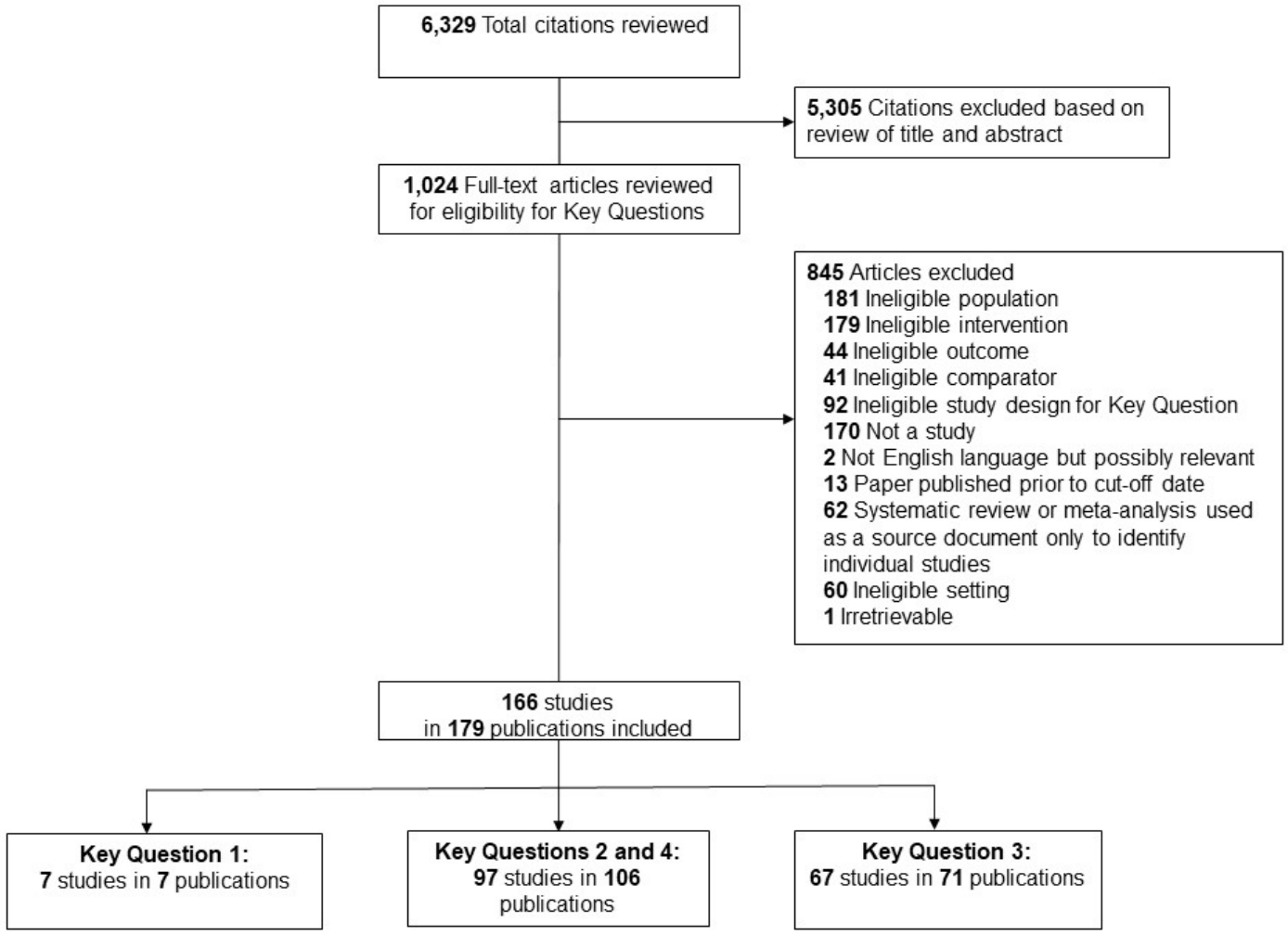
Potential Peer Reviewers must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Invited Peer Reviewers may not have any financial conflict of interest greater than $5,000. Peer reviewers who disclose potential business or professional conflicts of interest may submit comments on draft reports through the public comment mechanism.

A draft report revised to address comments from peer reviewers was posted for four weeks for public comment. The EPC completed a disposition of comments document containing a summary of peer reviewer comments and author responses to the original draft report as well as point-by-point responses to all public comments on the revised draft report.

Appendix B. Results

Results of Literature Searches

Figure B-1. Literature flow diagram



Note: Five papers are included for more than one Key Question

A total of 6,329 references were identified from electronic database searches. After dual review of abstracts, 1,024 articles were evaluated for inclusion. Search results and selection of studies are summarized in the literature flow diagram above **(Figure B-1)**. A total of 166 studies (in 179 publications) were included for at least one key question.[6-184]Seven studies were included for Key Question 1, 97 studies in 106 publications were included for Key Question 2, and 67 studies in 71 publications were included for Key Question 3. A list of included studies appears in **Appendix C** and excluded studies with reason for exclusion in **Appendix G.**

Description of Included Studies

Key Question 1

The systematic review protocol and a request for unpublished information was posted by AHRQ on the Federal Register Supplemental Evidence and Data (SEADs) webpage. Additionally, we sent emails requesting information to individual federal agencies as well as non governmental organizations involved in telehealth and experts familiar with telehealth practices and policy. Specific program offices contacted included FedTel, the U.S. Federal government working group on Teleheath, the Telehealth Focused Rural Health Research Center Program of the Health Resources and Services Administration (HRSA), and the COVID-19 Telehealth Impact Study organized by the COVID-19 Healthcare Coalition Telehealth Impact Study Work Group with leadership from Mayo Clinic and the MITRE Corporation.

We also explored the possibility of identifying trends through claims data. Although the Centers for Medicare & Medicaid Services has approved Common Procedure Terminology (CPT) codes 99446-99449, 99451 and 99452 for interprofessional electronic assessment and management and referral services provided by a consultative physician, or other qualified health care professional (QHP) and by a patient's treating/requesting physician/QHP (in the case of 99452), there is anecdotal evidence that use of these billing codes is very low (personal communications).[185] It is very likely that informal interprofessional consultations are occurring in a non-compensated manner, but such interactions would not be included in billing records, and literature describing the frequency of informal interprofessional consultations is not currently available.

We did not receive any additional unpublished evidence on provider-to-provider telehealth in the rural U.S. usable for this report. While use of telehealth for patient and provider interactions has been documented, particularly the increase as part of the response to the COVID-19 pandemic,[186, 187] trends in provider-to-provider telehealth have not yet been documented to the same extent. Details can be found in **Appendix Table D-1.**

Table B-1. Characteristics of included studies for Key Question 1

Characteristic	Categories	Number of Articles - 6	Percentage of Articles	References
Location	Nationwide	6	86%	8, 30, 50, 149, 180, 182
	Regional- New England	1	14%	181
Adoption Category	Use	7	100%	8, 30, 50, 149, 180-182
	Spread	2	29%	149, 182
	Mental Health	2	29%	50, 149
	Emergency Care	2	29%	180, 181
	Stroke	3	43%	8, 30, 182

Key Questions 2 and 4

Study details can be found in **Appendix Tables D-2, D-3, D-4, D-5, D-6, D-7, D-8, D-9, E-1, E-2, E-3, and E-4.**

Table B-2. Characteristics of included studies for Key Question 2

Characteristic	Categories	Number of Articles - 106	Percentage of Articles	References
Geographic Location	United States	63	59%	10, 11, 18, 21, 23, 29, 36, 38-41, 44-49, 51, 55, 58-60, 66, 72, 75, 78, 84, 92, 93, 96, 98, 100, 101, 103-107, 110, 114, 117, 120, 130-132, 139, 142, 143, 150, 153, 154, 158, 159, 164, 167, 173, 175, 176, 178, 182, 184,35, 172
	Australia	15	14%	13, 19, 20, 27, 34, 42, 52, 70, 97, 99, 111, 122, 128, 136, 156
	Canada	5	5%	65, 82, 85, 145, 148, 155
	United Kingdom	3	3%	81, 152, 165
	Korea	3	3%	31, 76, 79
	Italy	2	2%	25, 26
	Countries with a single study*	14	13%	12, 16, 22, 37, 53, 61, 81, 86, 112, 124, 138, 141, 151, 179
Study Design	RCT	23	22%	19, 22, 29, 31, 35, 36, 38, 45, 47-49, 53, 61, 82, 86, 110, 131, 132, 155, 172, 179, 184
	Observational-before/after	25	24%	13, 16, 20, 27, 41, 42, 44, 52, 55, 75, 78, 87, 105, 111, 112, 114, 120, 122, 128, 143, 150, 152, 154, 159, 178
	Observational-pre/post	18	17%	10, 18, 23, 66, 79, 84, 85, 96, 98, 99, 107, 117, 130, 136, 145, 148, 167, 175
	Observational-prospective cohort	21	20%	11, 12, 25, 26, 34, 37, 59, 60, 65, 70, 76, 93, 100, 103, 106, 124, 138, 141, 142, 153, 176
	Observational-retrospective cohort	19	18%	21, 39, 40, 51, 58, 72, 81, 92, 97, 101, 104, 139, 151, 156, 158, 164, 165, 173, 182
Risk of Bias	Low	5	5%	38, 82, 120, 132, 148
	Medium	75	71%	10-12, 16, 19-21, 25-27, 29, 31, 34-37, 39-41, 44-49, 51, 53, 58-61, 65, 70, 72, 76, 85, 86, 92, 93, 100, 101, 103-105, 110-112, 114, 117, 122, 124, 128, 131, 138, 139, 141-143, 145, 150, 151, 153-156, 158, 159, 164, 172, 173, 175, 176, 179, 182, 184
	High	26	25%	13, 18, 22, 23, 42, 52, 55, 66, 75, 78, 79, 81, 84, 87, 96-99, 106, 107, 130, 136, 152, 165, 167, 178
Sample Size	Under 100	30	28%	18, 19, 22, 23, 25, 31, 37, 52, 66, 70, 81, 84, 86, 96-99, 111, 112, 117, 136, 139, 142, 145, 152, 155, 165, 167, 176, 184
	100-500	48	45%	11, 12, 16, 20, 26, 29, 35, 36, 38-40, 42, 44-49, 58, 59, 61, 65, 72, 76, 78, 79, 82, 85, 92, 93, 101, 110, 120, 124, 130-132, 138, 143, 148, 151, 154, 156, 159, 164, 172, 173, 178
	501-1000	6	6%	10, 53, 75, 103, 122, 153
	1001-10,000	11	10%	21, 27, 34, 51, 100, 104-107, 141, 179
	10,000+	7	7%	41, 53, 55, 87, 114, 150, 158
	Not reported/unclear	2	2%	13, 175, 182
Mode of Telehealth	Video	79	75%	11, 13, 16, 18, 20-23, 27, 31, 34-36, 38-42, 44, 47, 51, 52, 55, 58-61, 65, 66, 70, 72, 75, 76, 78, 79, 81, 84-87, 92, 93, 96-101, 103-107, 111, 114, 120, 122, 124, 128, 132, 139, 141-143, 148, 150, 153, 155, 156, 158, 159, 165, 167, 175, 176, 178, 182, 184
	Data store and forward	4	4%	37, 82, 172, 179
	Electronic chart/record review	3	3%	29, 45, 152
	Mixed modalities	10	12%	19, 46, 48, 49, 110, 112, 131, 138, 145, 154

Characteristic	Categories	Number of Articles - 106	Percentage of Articles	References
	Data streaming	1	1%	25
	Telephone	2	2%	10, 25
	Whats App	1	1%	12
	SMS Based	1	1%	53
	Online Module	3	3%	117, 130, 136
	NR/Unclear	2	2%	164, 173
Clinical category	Inpatient	18	17%	13, 21, 27, 41, 52, 55, 59, 60, 72, 75, 78, 92, 93, 111, 122, 128, 154, 178
	Outpatient	37	35%	10, 22, 29, 31, 34-37, 45-49, 70, 76, 79, 81, 82, 86, 87, 97, 98, 110, 120, 131, 132, 138, 139, 145, 151, 152, 155, 156, 165, 172, 176, 179
	EMS/ED	28	26%	12, 20, 25, 26, 38-40, 44, 58, 61, 65, 100, 101, 103-106, 111, 112, 114, 124, 141, 150, 153, 159, 164, 173, 182
	Education/mentoring	23	22%	11, 19, 23, 42, 51, 53, 66, 84, 85, 96, 99, 107, 117, 128, 130, 136, 142, 143, 148, 158, 167, 175, 184
Outcome categories	Patient	71	67%	10-13, 16, 20-22, 25-27, 29, 31, 34, 36-38, 40, 44, 46, 47, 49, 52, 55, 58-61, 65, 70, 72, 75, 76, 78, 79, 81, 82, 86, 87, 92, 93, 98, 100, 104-106, 110-112, 114, 122, 124, 128, 139, 141, 143, 145, 151-155, 159, 164, 167, 172, 175, 176, 178, 179, 182
	Provider	32	30%	18, 19, 23, 38-42, 51-53, 58, 66, 78, 84, 85, 96, 99, 101, 103, 107, 117, 130, 136, 142, 143, 148, 150, 158, 165, 175, 184
	Payer	13	12%	35, 37, 45, 70, 97, 120, 131, 132, 152, 156, 173, 182,16

* China, Denmark, Scotland, Finland, New Zealand, Spain, Germany, Chile, Turkey, Japan, Sweden, Taiwan, Vietnam

Key Question 3

Additional study details can be found in **Appendix Table D-10.**

Table B-3. Characteristics of included studies for Key Question 3

Characteristic	Categories	Number of Articles (71 total)	Percentage of Articles	References
Geographic Location	United States	35	49%	6, 7, 9, 17, 24, 30, 33, 56, 57, 63, 64, 67, 73, 77, 80, 90, 91, 108, 115, 126, 127, 129, 134, 135, 144, 146, 147, 150, 157, 166, 169, 170, 174, 180, 183, 185
	Sweden	1	1%	71
	Norway	2	3%	160, 161
	Germany	2	3%	95, 119
	Australia	18	25%	14, 15, 28, 43, 69, 74, 83, 89, 102, 113, 116, 121, 123, 125, 140, 162, 163, 168
	Canada	5	7%	32, 54, 62, 68, 177
	New Zealand	1	1%	88
	Scotland	3	4%	16, 94, 171
	South Africa	1	1%	118
	Multiple	2	2%	133, 137
	Countries with a single study*	1	7%	109
Method	Program statistics	1	1%	91

Characteristic	Categories	Number of Articles (71 total)	Percentage of Articles	References
	Program records	6	8%	54, 63, 74, 126, 162, 163
	Program review	3	4%	113, 116, 123
	Program reporting	1	1%	125
	Program manager observations	1	1%	9
	Patient records	3	4%	54, 68, 140
	Registries	3	4%	6, 7, 146
	Hospital records	1	1%	150
	Administrative data	4	6%	6, 7, 146, 174
	Financial data	1	1%	90
	EHR data	1	1%	125
	EMR data	1	1%	166
	Pre-questionnaire	1	1%	9
	Survey	20	28%	17, 30, 32, 43, 56, 73, 80, 91, 108, 109, 115, 118, 125, 127, 134, 135, 137, 150, 174, 180
	Pilot tests	1	1%	64
	Comparison of two models	2	3%	169, 170
	Interview/Focus groups	28	39%	14-16, 24, 28, 67, 69, 71, 73, 80, 83, 88-90, 94, 95, 102, 119, 121, 129, 135, 144, 160-163, 166, 168, 171, 177, 183
	Exit interviews focused on case presentation	1	1%	9
	Chart review	5	7%	32, 62, 91, 162, 163
	Case study	4	6%	14, 28, 33, 147
	Case reports	2	3%	14, 28
	Case review	3	4%	24, 115, 157
	Site visits	4	6%	57, 90, 135, 166
	Patient and staff evaluations	1	1%	32
	Review of state statutes and regulations	1	1%	77
	Document analysis	2	3%	133, 135
Clinical category	Inpatient	8	11%	16, 118, 133
	Outpatient	30	42%	24, 32, 43, 54, 62-64, 69, 71, 74, 80, 91, 102, 113, 116, 119, 125, 126, 135, 140, 162, 163, 168, 171
	Telestroke and Emergency Care	20	28%	6, 7, 14, 28, 33, 77, 88, 90, 94, 134, 146, 147, 150, 160, 161, 166, 169, 170, 180
	Education/mentoring	13	18%	9, 56, 68, 73, 115, 121, 127, 144, 157, 174, 183
Outcome categories	Facilitators	55	77%	6, 7, 9, 16, 24, 32, 33, 43, 54, 56, 62-64, 68, 69, 71, 73, 74, 77, 80, 88, 90, 91, 94, 102, 113, 115, 116, 118, 119, 121, 125-127, 133-135, 140, 144, 146, 147, 150, 157, 160-163, 166, 168-171, 174, 180, 183
	Barriers	51	72%	6, 7, 9, 16, 24, 32, 33, 54, 56, 62-64, 68, 69, 71, 73, 74, 77, 80, 88, 90, 91, 94, 102, 113, 115, 116, 118, 119, 121, 125-127, 133-135, 140, 144, 146, 147, 150, 157, 162, 163, 166, 168, 170, 171, 174, 180, 183

Table B-4 repeats the number of times a construct was mentioned and adds the number of publications and the number of settings out of the four possible settings (inpatient, outpatient,

EMS/ED, or Education/Mentoring) in which these studies were conducted. This examination demonstrates that the constructs are relevant in all or most of the settings.

We also summarized facilitators and barriers by health care setting (inpatient, outpatient, emergency, and education/mentoring) in two ways. First, **Table B-5** reports the number of barriers and facilitators by setting. Included studies of provider-to-provider telehealth for EMS/ED and education/mentoring reported more faciliators the barriers. This was reversed infor inpatient studies and the number of reports were about equal for outpatient care.
Next, we created tables by setting and clinical indication similar to how the results are organized for Key Question 2. These tables provide the number of studies we identified for each clinical indication with a brief description of the telehealth interventions; basic information about the studies for each topic, including the method, size and location; implementation facilitators and barriers identified in the study as well as the impact cited as an indicator of successful implementation or motivation for sustainment. Not all studies sought to identify all three so the number of facilitators, barriers, and indicators of impact varies by topic. Finally, the studies we identified that compared strategies or interventions we described these in the narrative text for each setting.

Table B-4. Distribution of CFIR constructs

Barrier or Facilitator	CFIR Contructs	# Settings	# Mentions	# Publications
Facilitators	Leadership Engagement	4	13	10
	Implementation Climate	4	13	11
	Patient Needs & Resources	4	32	25
	Planning	4	11	9
	Compatibility	4	33	23
	External Policy & Incentives	4	18	12
	Adaptability	4	9	9
	Knowledge & Beliefs about the Intervention	4	16	11
	Available Resources	4	60	40
	Reflecting & Evaluating	4	12	11
	Access to Knowledge & Information	4	57	36
	Networks & Communications	4	37	30
	Engaging	4	23	18
Barriers	Cost	3	15	13
	Readiness for Implementation	3	17	12
	Formally Appointed Internal Implementation Leaders	3	7	7
	Executing	3	19	12
	Relative Priority	3	8	8
	Complexity	2	11	8

Table B-5. Facilitators and barriers by topic area

Topic	Facilitator or Barrier	# Mentions	# Publications
Inpatient	Barrier	45	9
	Facilitator	24	8
Outpatient	Barrier	95	26
	Facilitator	90	25
ED/EMS	Barrier	28	7
	Facilitator	65	19
Education/Mentoring	Barrier	24	7
	Facilitator	40	13

Inpatient

We identified eight assessments of implementation of provider-to-provider telehealth in rural areas that addressed inpatient care including intensive care, use of anesthesia, stroke rehabilitation, teletrauma, multidisciplinary specialty consultation, and telerobotics (**Table B-6, Appendix Table D-10)**. One study compared facilitators and barriers in ICU programs using centralized monitoring (CM) versus virtual consult (VC) models,[133] one study used surveys to evaluate phone support consultation in South Africa,[118] and one study used focus groups in Scotland to describe user experiences with video team consultations.[16]

One study of remote ICUs directly compared the facilitators and barriers for CM, which uses a hub with intensivists and hardwired data transfer and VC that uses portable equipment to connect local providers to relevant specialists This study analyzed documents collected as part of a systematic review of effectiveness of remote ICU programs that use CM or VC.[133] The structural differences in the models drove the differences in barriers and facilitators such as lower cost and faster start-up for VC compared to the CM, but VC required more effort to integrate into workflows (**Table B-6**). Based on surveys of rural physicians who were trained in person and then offered telephone support when they needed to use anesthesia, Ngala et al. identified that an important barrier was remote consultants lacked understanding of the rural environment (**Table B-6**).[118] The study of stroke rehabilitation video team consultations reported that lack of technological issues supported implementation and that the consultation increased the patient representative's confidence in the care provided locally (**Table B-6**).[16]

Table B-6. Findings of inpatient implementation studies

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Remote ICU 1 CM compared to VC	Document analysis N=91 documents Varied[133]	• Lower cost, faster start-up (VC) • Evidence supporting efficacy (CM) • No legal issues (both models) • Provided clinical information support (CM)	• Higher fixed costs (CM) • Longer start up time (CM) • More reactive, requiring initiation or scheduling (VC) • Lack of evidence of clinical efficacy (VC)	Not reported
Anesthesia 1 Phone support following in person training	Survey N=17 rural physicians South Africa[118]	• In person training prior to implementation • Perception that good advice was available	• Inadequate training • Lack of consultant understanding of environment • No occasion to provide service/no need	Not reported
Stroke rehabilitation 1 Specialist participation via video in remote team meeting	Focus Group N=12 people; different roles in program Scotland[16]	• No staff resistance; clear rational for use • Technology training and IT involvement • Reliable equipment	• Delay of not having specialist immediately accessible	• Improved decision making • Increased confidence in care (patient representative)
Teletrauma 1	Interview N=14 stakeholders Canada[177]	• Flexibility of the technology to receive clinical input • Interprofessional relationships • Seamless integration of technology	• Complicated nature of use • Familiarity with the technology • Workflow changes	• Increased personal and professional support for rural clinicians

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Robotic Telemedicine 1	Survey N=38 health care institutions United States, Canada, Ireland[137]	Not reported	• Equipment Cost • Executive administration and leadership hesitancy regarding adoption of robotic telemedicine • Lack of effective leadership • Lack of exposure to robotic telemedicine • Lack of understanding of robotic telemedicine • Patients, Physicians and Nurse hesitancy regarding adoption of robotic telemedicine • Physician lack of incentives to use robotic telemedicine • Potential impact on quality of care • Regulatory barriers (out-of-state licensing, malpractice liability, credentialing, government and nongovernment reimbursement, DEA licensing) • Robotic telemedicine seen as a local threat • Technology issues (usability, reliability, internet connectivity, remote data access, technical support, documentation and billing)	Not reported
Multidisciplinary Specialty Consultation 3	Interview N=63 hospitals Australia[15] Secondary analysis national survey data N= 4,608 hospitals U.S. 50 States[30] Method= N=8 hospitals U.S. Montana, Nevada, North Dakota[57]	• Benefits of telehealth well communicated • Investment in services to support telehealth delivery • Specific service agreements • Practitioner Champion • Technical assistance • Training on work flow and infrastructure	• Billing system • Clinician resistance • Confusion regarding policy for out-of-catchment • Cost of using existing computers to provide telehealth • Credentialing process and agreeing to be credentialed • Fragmentation of information technology between tertiary and primary care • Software difficulties • Health Information Exchange capabilities • Cost • Practitioner reluctance • Securing properly credentialed practitioners	Not reported

*N is used here to represent the unit of analysis, which may be number of individual participants or may be number of health care sites or systems.

Abbreviations: CM = centralized monitoring; ICU = intensive care unit; VC = virtual consult.

Table B-7 provides the barriers and facilitators from studies of provider-to-provider telehealth for inpatient studies standardized by CFIR constructs. While there are fewer studies of inpatient care, the barriers and facilitators are not repeated in multiple studies. The most frequently repeated are *complexity* cited seven times as a barrier and *available resources* cited as a facilitator six times.

Table B-7. Inpatient: barriers and facilitators by CFIR constructs

Type	Facilitator or Barrier Name	Facilitator or Barrier Number of Mentions	Reference Number(s)
Barrier	Access to Knowledge & Information*	2	15, 118
	Adaptability†	1	118
	Available Resources‡	1	118
	Compatibility	3	15, 57, 177
	Complexity§	7	15, 30, 133, 177
	Cost‖	4	15, 57, 133, 137
	Engaging	2	57, 137
	Executing	2	137, 177
	External Policy & Incentives	1	137
	Knowledge & Beliefs about the Innovation¶	3	118, 133, 137
	Implementation Climate	2	137
	Leadership Engagement	2	137
	Patient Needs & Resources #	3	16, 129, 137
	Networks & Communications**	1	118
	Planning	2	15
	Reflecting & Evaluating††	1	118
Facilitator	Access to Knowledge & Information*	2	16, 118
	Adaptability	1	177
	Available Resources‡	6	15, 16, 57, 133
	Cost‖	1	133
	Executing	1	177
	External Policy & Incentives	1	15
	Formally Appointed Internal Implementation Leaders	1	57
	Knowledge & Beliefs about the Innovation¶	1	16
	Patient Needs & Resources#	1	118
	Networks & Communications**	3	15, 118, 177
	Planning	1	57
	Readiness for Implementation‡‡	1	133

* Access to digestible information and knowledge about the innovation and how to incorporate it into work tasks.
† Degree to which an innovation can be adapted, tailored, refined, or reinvented to meet local needs.
‡ Level of resources organizational dedicated for implementation and on-going operations including physical space and time.
§ Perceived difficulty of the innovation, reflected by duration, scope, radicalness, disruptiveness, centrality, and intricacy and number of steps required to implement.
‖ Costs of the innovation and costs associated with implementing the innovation including investment, supply, and opportunity costs.

¶ Individuals' attitudes toward and value placed on the innovation, as well as familiarity with facts, truths, and principles related to the innovation.
# Extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organization.
** Nature and quality of webs of social networks, and the nature and quality of formal and informal communications within an organization.
†† Quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience.
‡‡Tangible and immediate indicators of organizational commitment to its decision to implement an innovation.

Outpatient

We identified 30 studies of implementation of provider-to-provider telehealth for rural outpatient care. These studies all assessed consultations in which one provider, often a specialist, contributed to the diagnosis or management of a patient by another provider, often a primary care physician, nurse or someone lacking specialist certification or extensive experience with the condition or treatment. The barriers and facilitators are grouped and organized by clinical indication in **Table B-8,** and additional details can be found in **Appendix Table D-10**.

Five studies of multi-specialty programs included two statewide programs[80, 135] and three programs serving a small group of clinics or a single health system.[71, 102, 119] Psychiatric consultations were the subject of five studies of services that provided expert advice on a range of mental health issues including: medication therapy for opioid use disorder in a group of community clinics that are part of the Veteran Health Administration;[24] advice on medications and treatment for children in a state Medicaid program,[63] and programs to help diagnose adults and identify and arrange appropriate services.[32, 62, 91] Five studies were of programs that provided consultations for different aspects of care related to long term services and supports including assessment of whether nursing home residents should be transferred to hospitals,[64] oral health screening and teledentistry,[162, 163] wound care,[74] outpatient geriatric assessment and management,[126] and pediatric hospice care.[168] The remaining studies each evaluated consultations related to evaluating or managing patients with chronic conditions including cancer,[69, 140] gastroenterology,[54] dermatology,[125] cardiology,[116] nephrology,[113] occupational screening of miners,[43] and support for midwifes managing pre-eclampsia.[171]

Studies of multispecialty programs included assessments of how one program evolved from a pilot test to a statewide program over years with a mixture of sources of funding.[80] An evaluation of a 10-year, multi-site initiative to increase access to care in rural areas in California through telehealth reported that organizational barriers contributed to a lack of networking across programs and lower uptake than expected of telehealth services.[135] Both of these studies demonstrate how implementation and spread requires sustained efforts and commitments from multiple stakeholders and suggests that statewide or regional efforts can be effective. Questions among rural clinicians about whether telehealth was truly patient-centered were a barrier for teleconsultations in rural Sweden as some providers felt it may be easier to send patients to the hospital directly rather than delay hospitalization for a consult.[71] Concerns cited in United States studies were echoed in studies in other countries. A program in Germany cited concerns about time, financing and changes to established workflows as barriers that could be addressed if systems were more usable and training provided.[119] A program in Australia illustrated time concerns by documenting that teledermatology consultations take twice as long as in-person assessments and payment does not include this extra time. This program addressed this and other barriers by adding a telehealth coordinator who reduced the need for clinician time and by assuring technical support was available.[102]

Telehealth is often proposed as one solution to the shortage of mental and behavioral health providers and programs in rural areas. Some of the telehealth programs address specific treatments, such as the use of Buprenorphine for opioid use disorder in VA clinics in one state,[24] while others are more general. The evaluation telehealth supported Buprenorphine was one of the few that used an implementation science framework to assess their experience and then translate this experience into an implementation tool kit that could be used by others to replicate the program. Another telehealth consult program provided medication review and treatment recommendations for children in a state Medicaid program.[63] These programs had to overcome specific barriers including legal concerns related to prescribing and the need for consultants to understand resource availability in other locations. Another program used a continuous quality improvement approach to identify and make workflow adjustments to assure success.[91] Psychiatric teleconsultation services in Ontario, Canada, one for adults[62] and one focused on geriatric psychiatry[32] identified fundamental gaps in organization and culture as barriers, such a lack of integration of the telehealth consultation with telephone and in person visits with the patient[62] and a concern among providers that telehealth would allow the government to justify the lack of support for increasing local, in-person services for patients.[32]

The two articles on provider-to-provider telehealth for cancer care were both reports about the same program in Queensland, Australia. This program allowed chemotherapy to be administered in rural hospitals by local physicians and nurses supported by remote oncologists and chemotherapy nurses.[69, 140] Starting with a pilot to demonstrate safety, the program expanded to six sites after addressing barriers including lack of role clarity and technology restrictions. Changes included assuring the iCamera could zoom sufficiently to allow checks on chemotherapy bags and provide good visuals during physical exams; structuring the program to provide professional development opportunities for rural nurses; and financial incentives for physicians to participate.

Long term care residents often have limited access to health care services for many reasons including resident's/patient's difficulties traveling and the fact that specialty services are rarely available onsite in nursing homes and other residential care and home-based long-term care. In this context, telehealth consultations and programs may offer services that would not otherwise be available. For example, a multisite program was established by a health system to provide acute assessment and care planning support in order to reduce patient transfers to hospitals.[64] The program grew from 5 to 34 sites in 4 years by building on the health system's experience with telehealth for other uses and working to change the culture from one that had defaulted to hospitalization to one that accepted treating residents in place. An oral health program provides another example in which a new service was made available. Residents who were not receiving dentistry services were screened by a technician who used a live intra oral camera to transmit images to a remote dentist who could assess what could be done on site and what required travel to a dentist.[162, 163] This program was able to increase compliance with guidelines and regulations while increasing staff confidence in their ability to manage oral health. Other applications included a geriatric consult service in the Veterans Health Administration that was able to increase assessments by setting up both synchronous and asynchronous consultations.[126] Implementation of a teleconsult program to support wound care by home and community providers revealed structural barriers to implementation including the need for staff computer literacy and the lack of use of standardized terminology by the home care nurses and consultants.[74] Adding telehealth consultations to a pediatric hospice program underscored trade-offs and challenges. The program demonstrated the ability to provide multidisciplinary, timely

help to supplement in person care, but found that video consults were limited in their ability to assess family distress and that the consults risk prioritizing expert views over family needs.[168]

The remaining outpatient studies included one report each about telehealth consultations for different chronic, or not immediately acute conditions, including a regional cardiology program,[116] chronic kidney disease consultations for an Indian Health Service clinic,[113] a local gastroenterology program focused on a single condition,[54] and a large dermatology program with 15 hubs in the VA.[125] All these programs were designed to increase access and timeliness of care and all faced hurdles related to lack of staff support, space, and connectivity/bandwidth. Two less common approaches included adding telehealth to a mobile clinic that provides screening for coal miners[43] and creating a phone app to supplement support to midwives managing pre-eclampsia in a rural area.[171] Both of these programs had to overcome unique technical challenges, but faced common barriers related to limited connectivity.

Table B-8. Findings of outpatient implementation studies

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Multi-specialty 5 Programs that make consultations from a range of specialists available over video, phone or electronic records	Stakeholder (patients and provider) surveys and interviews N=Not reported Statewide hub/spoke program in South Carolina[80] Evaluation with surveys, site visits, documentation review, interviews N=10 organizations in 22 counties California[135] Focus groups N=5 primary health-care centers; 19 health care personnel Sweden[71] Interviews N=18; Physicians, administrators, medical students Germany[119] Interviews N=10 expert providers of telehealth Australia[102]	• Private foundation support for start up • Ongoing support from state funds and billing • Purposeful stages of implementation including training and evaluation • Rural providers perceived benefits were worth their investment • Usability of system/ training • Financing plan Coordinator and tech support	• Limits to pro bono consults specialists can provide, need for financial support for specialist time or other concerns about financing • Low networking across programs • Organization barriers and lower utilization than expected • Some specialties and exams not a good fit • Aversion among staff to new ways of working including technology • Time demands Perception it could be easier to transport patient	• Grew from 11 in 2012 to over 1300 consults in 2017 • Travel/cost savings for patients

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Psych/Mental Health 7 Managing opioid use disorder, mental health care planning, for adults and medications and treatment for recommendations for children	Interviews and case review N=3 Clinics; 19 interviews VA in Maine[24] Continuous Quality Improvement Surveys, Chart reviews and program statistics N=1 health system Illinois[91] Program records N=1 state Medicaid program Washington provision to Wyoming state Medicaid[63] Chart reviews Interviews N=10 Ontario, Canada[62] Chart review, patient and staff evaluations, survey to referring MDs, focus groups with community agencies GeroPsych service N=6 communities Ontario, Canada[32] Focus group N=10 Psychiatrists and 4 psychologists across 3 states U.S. Washington, Michigan, Arkansas[67] Questionnaire N=8 primary care providers, 4 psychologists Chile[109]	• Mission to address issue • Prior teleprescribing experience • Maintenance of local control over patient • Development of tool kit • Ongoing evaluation and adjustment • Peer relationships among clinicians • Detailed recommendations and education • Teamwork • Communication • Provider willingness to collaborate • Punctuality • Staff openness	• Legal concerns • Conflicting interests • Coordination with other programs • Need for team integration • E consults limited to quick or simple inquiries • Need for understanding of local resources • Limited awareness of consults • Discomfort managing mental health in primary care • Perception that telehealth provides justification for not increasing in person access • Ability to track clinical outcomes and cost (2234) • Clinic investment • Communication • Credentialing • Electronic record process • Mobilizing resources • Scheduling support • Staff Turnover • Training • Access to computer and suitable room • Incomplete information on patient • Technical difficulties	• Positive evaluations of ability to see and hear and usefulness by patients • Physician intension to continue to use • Increased ability to include family or an interpreter • Reduction in outlier pediatric psychiatric medications
Cancer 2 Chemotherapy administration at remote sites	Interviews N=19[69] Patient records N=62[140] Australia	• Opportunity for professional development for rural nurses • Good communication • Implementation management team that developed plan and documentation • Funding support and financial incentives for physicians to participate	• IT did not have capacity to zoom in to check chemotherapy bags and physical exam • Lack of good electronic documentation (fixed after pilot) • Lack of role clarity • Turnover in management and nurses	• Better continuity of care • Spread from pilot to 6 sites • Similar safety to in person care • Project transitioned from special funding to normal financing

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Long-Term Care 3 Acute illness; hospital transfer decisions	Pilot Tests N=1 health system, up to 14 sites Avera Health, Several States[64] Interview N=21 administrators and clinicians across 16 facilities U.S. Nationwide[129] Interview N=8 Clinicians Germany[95]	• Meetings with leadership • Creation of an implementation plan with stakeholder review • Establishing billing procedures • Leveraging decision support tools • Health system experience with telehealth • Communication • Creating one time slot for visits creates focus, information getting lost • Transmitting patient information 1 day ahead	• Need for bandwidth • Space constraints requiring mobile equipment • Culture change to accept treating in place • Building relationships • Cannot see or hear as well • Clinician reluctance • Difficulty working with cognitively impaired patients • Increased burden on staff • Lack of training • Technology challenges, including internet and connectivity • Workflow changes	• Increase from 5 to 34 sites in 4 years
Oral Health in Long-Term Care residencies 2	Chart review and program records, interviews and focus group N=250 charts, 9 facilities Australian[162, 163]	• Feedback on compliance • Documentation of cost savings	• Not enough staff time for program management • Oral health staff lack of experience with dementia	• Minimized disruption to residents • Increase compliance • Increased staff confidence in managing oral health
Geriatrics 1	Program records N=12 hubs U.S. Veterans Health Administration[126]	• Prior relationships between hubs and rural clinics	• Multiple contacts needed to establish new relationships • Need to develop case finding approaches to identify patients who could benefit from consultation.	• Increase from 4 to 12 hubs in 4 years
Wound Care 1	Program records N=4 home and community health providers Australia[74]	• Train the trainer model • Staff commitment	• Need for computers and staff computer training/literacy • Need for web access • Need for standardized terminology	Not reported

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Pediatrics 2	Interview N=15 hospice nurses 1 Midwestern U.S. state[168] Interview N=1 hub, 7 community health centers Australia[89]	• Ability to involve multiple disciplines and family members • Timely goals of care discussions • Networking and collaboration	• Difficult to assess and address distress • Family perceptions could be usurped by experts • Enough rooms • Funding • Technical issues, being able to tell who was speaking and being able to hear	Not reported
Chronic Conditions 1 Gastroenterology, care for inflammatory bowel disease	Patient and program records N=99 patients Ontario, Canada[54]	• Multidisciplinary team	• Limited availability of remote telehealth sites • Lack of awareness of program	• Travel cost savings • Reduction in wait times
Dermatology 2 Remote assessment and diagnosis	EHR data, program reporting, online survey N=15 hubs U.S. Veterans Administration[125] Survey N=34 Primary care providers U.S. Mississippi[108]	• Strong stakeholder support • Use of residents to reduce burden on dermatologists • Communications with primary care	• Understaffing at rural spokes • Lack of space and equipment • Restrictions on funding • Bureaucracy • Concern regarding possibility of misdiagnosis due to poor image quality • Concerns regarding possible loss of patient confidentiality • Insurance coverage • Investment in time needed to master technology • Misconceptions about teledermatology • Time required to submit consult and response time	Not reported
Cardiology 1 Case review and remote exam	Program review N=5 sites Minnesota, Wisconsin[116]	• Using local nurses to prepare patient and chart	• Difference in reimbursement rules for locations • Need for patient and scheduler education	• Able to expand from 1 to 5 sites, one site dropped out

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Nephrology 1 Care review and remote patient/provider appointment	Program review N=1 site Zuni Pueblo, Indian Health Services[113]	• Nurse care manager and ancillary staff are key • EHR access • Access to specialist between scheduled clinics • Periodic in-person visits to build rapport and trust	• Does not address need patients with acute needs • Technical issues • Communication components (eye contact, emotional support)	Not reported
Screening 1 Mobile clinic: mining related exposure and general health	Surveys N=278 (62%) of 4511 mobile clinic with telehealth for miners New Mexico[43]	• Understanding of occupation risks • Specialist mentor non-specialists • Financially sustainable; most patients have insurance	• Not reported	• Expansion from New Mexico to Wyoming • High percentage return to clinic
Midwifery 1 Using phone app to managing pre-eclampsia	Focus groups, N=18 midwives Scotland[171]	• Access to up to data information on a relative rare event	• Concerns about using technology • Need for system that works without an internet connection	Not reported

*N is used here to represent the unit of analysis, which may be number of individual participants or may be number of health care sites or systems.

Abbreviations: EHR = electronic health record; IT = information technology; MD = medical doctor; U.S. = United States; VA = U.S. Department of Veteran's Affairs.

Table B-9 provides a summary of the barriers and facilitators identified in studies of outpatient provider-to-provider telehealth for rural populations by the standardized constructs. As almost half of the studies included for Key Question 3 involved outpatient care, the counts of facilitators and barrier are higher. However, unlike inpatient care some constructs were identified much more frequently than others. ***Available resources*** was the most frequent barrier, cited 23 times. But others also mapped to higher numbers of cited barriers including ***compatibility*** (14) and ***access to knowledge and information*** (9). ***Available resources (15)*** and ***access to knowledge and information*** (15) were also cited as common facilitators (11 times), but other important facilitators included ***networks & communications(16)*** and ***patient needs & resource(9)s.*** In the case of this last category, a facilitator for use of telehealth was often patients' needs for expertise and services that were not otherwise available without telehealth.

Table B-9. Outpatient: barriers and facilitators by CFIR constructs

Type	Facilitator or Barrier Name	Facilitator or Barrier Number of Mentions	Reference Number(s)
Barrier	Access to Knowledge & Information*	9	62, 67, 69, 74, 102, 129, 162
	Adaptability†	2	62, 67
	Available Resources‡	23	24, 32, 49, 64, 67, 69, 71, 74, 89, 91, 102, 109, 113, 125, 140, 162, 171

Type	Facilitator or Barrier Name	Facilitator or Barrier Number of Mentions	Reference Number(s)
	Compatibility§	14	64, 67, 69, 74, 80, 102, 108, 113, 119, 129, 135
	Complexity‖	3	67, 74, 171
	Cost¶	3	80, 116, 119
	Engaging#	5	24, 54, 71, 116, 135
	Executing**	10	32, 89, 108, 109, 119, 129, 140
	External Policy & Incentives††	5	89, 102, 108, 125, 135
	Implementation Climate‡‡	1	62
	Knowledge & Beliefs about the Innovation§§	4	32, 119, 135
	Leadership Engagement	1	108
	Networks & Communications¶¶	6	24, 67, 113, 125, 126, 129
	Patient Needs & Resources‖‖	8	54, 62, 71, 129, 168
	Planning##	1	135
	Readiness for Implementation***	3	24, 67, 119
	Reflecting & Evaluating†††	2	63, 135
	Relative Priority‡‡‡	3	24, 32, 102
Facilitator	Access to Knowledge & Information*	15	24, 32, 43, 62, 64, 69, 71, 74, 91, 125, 126, 135
	Adaptability†	1	125
	Available Resources‡	11	32, 62, 64, 113, 116, 119, 125, 140, 162
	Compatibility	1	109
	Complexity‖	1	119
	Cost¶	4	43, 91, 119, 163
	Engaging#	7	54, 62, 80, 119, 140, 168
	External Policy & Incentives††	3	80, 140
	Executing	2	95, 109
	Formally Appointed Internal Implementation Leaders§§§	3	54, 113, 135
	Knowledge & Beliefs about the Innovation§§	1	32
	Leadership Engagement‖‖‖	4	24, 125, 140
	Patient Needs & Resources ‖‖	9	32, 43, 108, 113, 119, 126, 168, 171
	Networks & Communications¶¶	16	32, 62, 67, 69, 80, 89, 95, 109, 113, 125, 126, 129, 135, 140, 162
	Planning##	4	64, 119, 135, 140
	Readiness for Implementation***	5	24, 64, 80
	Reflecting & Evaluating†††	4	64, 91, 140, 163
	Relative Priority‡‡‡	1	74

[*] Access to digestible information and knowledge about the innovation and how to incorporate it into work tasks.
[†] Degree to which an innovation can be adapted, tailored, refined, or reinvented to meet local needs.
[‡] Level of resources organizational dedicated for implementation and on-going operations including physical space and time.
[§] Degree of tangible fit between meaning and values attached to the innovation by involved individuals, how those align with individuals' own norms, values, and perceived risks and needs, and how the innovation fits with existing workflows and systems.
[‖] Perceived difficulty of the innovation, reflected by duration, scope, radicalness, disruptiveness, centrality, and intricacy and number of steps required to implement.
[¶] Costs of the innovation and costs associated with implementing the innovation including investment, supply, and opportunity costs.
[#] Attracting and involving appropriate individuals in the implementation and use of the innovation through a combined strategy of social marketing, education, role modeling, training, and other similar activities.
[**] Carrying out or accomplishing the implementation according to plan.
[††] External strategies to spread innovations including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting.
[‡‡] Absorptive capacity for change, shared receptivity of involved individuals to an innovation, and the extent to which use of that innovation will be rewarded, supported, and expected within their organization.
[§§] Individuals' attitudes toward and value placed on the innovation, as well as familiarity with facts, truths, and principles related to the innovation.
[‖‖] Extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organization.
[¶¶] Nature and quality of webs of social networks, and the nature and quality of formal and informal communications within an organization.
[##] Degree to which a scheme or method of behavior and tasks for implementing an innovation are developed in advance, and the quality of those schemes or methods.
[***] Tangible and immediate indicators of organizational commitment to its decision to implement an innovation.
[†††] Quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience.
[‡‡‡] Individuals' shared perception of the importance of the implementation within the organization.
[§§§] Individuals from within the organization who have been formally appointed with responsibility for implementing an innovation as coordinator, project manager, team leader, or other similar role.
[‖‖‖] Commitment, involvement, and accountability of leaders and managers with the implementation of the innovation.

Telestroke and Emergency Care

One of the most commonly studied applications of provider-to-provider telehealth in rural areas is the diagnosis and management of stroke due to the higher prevalence of stroke and stroke risk factors in rural areas and treatments that require accurate diagnosis and timely administration.[188, 189] The telestroke programs described in this section bridge ED and inpatient care as they include consultations as part of initial assessment and triage as well treatment decisions and care delivery. We did not identify studies of the implementation of EMS telestroke programs in which consultations focus on prehospital triage and decisions made in the field about where the patient should be transported.

Table B-10 provides an overview of seven studies (reported in eight articles)[6, 7, 14, 28, 33, 77, 146] of facilitators, barriers and impact related to the implementation of telestroke programs (Additional details in **Appendix Table D-10**). All of the projects studied were hub-spoke models in which one or more hubs where specialists were located were connected with rural hospitals. Evaluations of these programs included studies of statewide programs in West Virginia[6] and South Carolina,[7, 146] case studies of networks around a single hub,[33] a comparison of the early implementation of a network in South Carolina to one in Georgia[147] and an assessment of a regional program in Australia.[14, 28] One evaluation reviewed state laws and regulations in the United States.[77]

The telestroke implementation studies were of successful programs and the evaluations focused on the factors that supported this success. A case study comparing the early (1991) implementation in two networks reported that the networks had not integrated the technology into their care delivery processes and identified enablers which continue to be called out in other,

more recent studies including: resource needs, the key role of performance monitoring and continuous improvement; the importance of a champion and dedicated coordinator at spokes, stakeholder involvement, and tangible goals such as stroke center certification[147] A frequently cited approach included stepped or phased implementation that started with preliminary needs and workflow assessments to inform pilot tests; diversity of engagement and funding, including private and government support; the need for staff to support the program, and training; and the importance of ongoing evaluation and program improvement. Barriers were less frequently cited but included lack of sufficient IT support, lack of integration of records and patient data, and the prohibition on fees or additional reimbursement for telehealth infrastructure in some states. Reports on telestroke implementation also focused on the impact on care and organizational outcomes, citing fewer transfers and certification as a stroke center as motivation to continue to sustain and improve the programs.

We identified studies of implementation of provider-to-provider consultations for general emergency care, pediatric emergencies and psychiatric emergencies in addition to telestroke. Five studies were of models in which a remote specialist or emergency physician advises a generalist physician, nurse practitioner or nurse who staff a rural emergency room.[88, 90, 150, 166, 180] Follow-up with rural EDs that did and did not use telehealth based on a United States national survey, found that 67% of nonusers had considered implementing telehealth but reported that the single most important reason the ED is not using telehealth was cost (37% of respondents), followed by technologic concerns and the assessment that telehealth is not needed to meet patient's needs (11% each). Despite these barriers, six percent reported they had started to use telehealth since the original survey.[180] Costs cited in this and other studies included the cost of technology but also the cost of the subscription services that provide access to the consultants. Additional barriers included rural providers lack of understanding of telehealth, lack of perception that telehealth will address a clear problem and perceptions that the motivation is to save money, particularly on personnel. For this particular use the identified facilitators were general satisfaction and having a telehealth coordinator who could handle scheduling and technology.

Two studies assessed implementation of telehealth specifically for pediatric emergencies.[134, 170] One is an example of the few studies that compared different models; one model that provided only pediatric specialty consultations and one in which pediatrics was one of several specialties provided as part of a system wide consult service.[170] This study found that both models were considered successful, but produced very different results as they served different populations. The specialist only model was used for more critical cases while in the other, pediatric consults were used less, but used for both high and low risk cases. As a result, perceptions and measures of the systems differed. These studies identified specific factors that were not emphasized in other studies, such as the need to test technology that is not in frequent use and the importance of building rapport and assuring telehealth fits in the culture of the practice.

Two studies in three articles assessed telehealth psychiatric consultations for patients presenting in EDs. One study evaluated two different network approaches to emergency psychiatric telehealth: a regional network, with assessments and consults available as part of a system that provides multispecialty consults for MI, stroke and other acute illnesses as well as behavior health, by pressing a button compared to a smaller, local system in which a behavioral health specialist was paged when needed.[169] The assessment focused on patient characteristics and confirmed that both models increase access to inpatient care, but the evaluation did not

explore detailed implementation differences in the systems. A study in northern Norway [160, 161] evaluated a system that made consultation available 24/7 by telephone and video; the study reported that using well established technology and having a safety net system supported the implementation and use of telehealth consults.

We identified one study that specifically addressed implementation of telehealth in prehospital care by EMS. A small study in Scotland[94] reported several major barriers to the use of remotely guided ultrasound in prehospital care. These included a lack of evidence and lack of documented need for remote guided ultrasound as well as different perceptions of EMS personnel and consulting physicians about skills and priorities.

Table B-10. Findings of telestroke and emergency care implementation studies

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Telestroke 7 Hub:Spoke	Registries and administrative Data N=2 statewide studies West Virginia[6] South Carolina[7, 146] Case study N=1 program South Carolina[33] Case studies N=2 networks in South Carolina/ Georgia[147] Case study including reports and interviews N=16 stakeholder reports, 13 funder reports, 10 protocols, 3 collaborative agreements, 93 meeting minutes Australia [14, 28] Review of state statutes and regulations N=50 states United States[77]	• Stepped implementation: pre, pilot, full, sustainability • Engagement • Diverse support and funding (governmental health and non-health, philanthropic) • Site champions • Pre-implementation clinician surveys • State legislation • Shadowing at hubs • Training for all roles with technology and guidelines • Sustainable technology • Local site coordinator to support start-up at spokes • Expansion locations based on data • Feedback on performance; ongoing evaluation and promotion of success • Focus on application of telehealth that is sustainable and improved care • Licensing and allowing practice across state lines • Same reimbursement for in-person or additional technology fee	• Video conferencing, imaging and clinical records not integrated • IT support not available 24/7 • Prohibition of fees or reimbursement in some states related to telehealth infrastructure	• Increase in consult use • Appropriate triage and treatment (tPA) • Fewer transfers • Certification of additional stroke centers • Diffusion of knowledge • Expansion from pilots to regional or multisite programs

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Emergency Care: Non specific 6 Remote consultation Rural: Primary care provider, Nurse practitioner, nurse or generalist Consultant: Specialists or ED physician or nurse.	Survey of rural EDs N=153/177 telehealth users;375/453 non users U.S.[180] Surveys and hospital records Pre/Post implementation N=9 hospitals Mississippi[150] EMR data, interviews, and site visits N=85 administrator at 26 rural hospitals South Dakota Avera Health[166] Financial data, interviews, site visits N=1 emergency system; 49 rural hospitals, same interviews as Ward above South Dakota Avera Health[90] Interviews N=12 New Zealand[88] Program evaluation N = 206 patient records Australia[123]	• Rural provider satisfaction • Having a telehealth coordinator • Communication • Executive Sponsorship	• Cost of technology or subscription • Lack of understanding of telehealth • No relationship or experience with distance provider • Perception it is about saving money, not improving care • Lack of a clear problem telehealth will solve • Technology issues include lack of bandwidth and power cuts	• Increase in rural hospital admissions (sterling) • -Increase in volume • -Decrease in inappropriate admissions • Low rate of utilization, but used when expert needed • Facilitates transfers, documentation, urgent critical care when physicians not in ED • Maybe profitable if hospital is able to increase revenue admissions and save on local physician back up for NP/PA staffing ED • High level of use (67% of NP used system every shift)
Emergency Care: Pediatrics 2 Pediatrics as part of multispecialty consults service; Dedicated pediatric service	Two models (University of California Davis-specialty/hub vs. Advera -general ED including pediatrics) N=30 hospitals; 15 each[170] Survey based on themes from interviews N=7 hospitals, 48 interviews, surveys 5 hospitals 104 (34%) of 306 clinicians invited University of Pittsburgh[134]	• Weekly test calls to preemptively solve connection issues • Hub providers build rapport by attending remote ED staff meetings and collaborating on quality initiatives • Perception that telehealth is useful	• Initially use not part of culture or care processes • Lack of provider comfort with telehealth • Technology issues • Lack of time; negative impact on workflows	• Unclear when use is appropriate and whether goal is to reduce transfers and/or discharges

Topic Number of Studies Intervention	Method N* Location	Facilitators	Barriers	Impact
Emergency Care: Psychiatrics 2 studies (3 articles)	Compare 2 ED Behavioral Health Models N=19 spoke hospitals; 2 networks) U.S. Midwest[169] Interviews N=29 Norway[160, 161]	• Well established technology • Ability to confirm initial assessment and collaborative solve problems • System provides safety net	• Not reported	• Increase in admissions to inpatient facilities (interpreted as an increase in access) • Immediacy of assessment • Engagement with patient • Access to specialist/MD that is not available locally • Reduced uncertainty
EMS: Ultrasound 1	Interviews N=12 Scotland[94]	• Willingness to collaborate in training and care	• Difference in EMS and MD perceptions of utility and skills needed • Unclear evidence of need and benefits • Perception it could result in delay in transport	Not reported

*N is used here to represent the unit of analysis, which may be number of individual participants or may be number of health care sites or systems.

Abbreviations: ED = emergency department; EMS = emergency medical services; EMR = electronic medical record; IT = information technology; NP = nurse practitioner; PA = physician's assistant; tPA = tissue plasminogen activator; U.S. = United States.

These barriers and facilitators are presented according to the CFIR constructs in **Table B-11**. The barriers are distributed across constructs, with mosted cited one to three times. The most frequently identified category of barrier was ***knowledge & beliefs about the innovation*** with this cited five times. The facilitators were more concentrated in categories that were also frequent in in- and out-patient studies; ***access to knowledge and information*** (11), ***available resources (9),*** and ***patient needs & resources*** (7). One construct that was more frequent in emergency care was ***engaging*** (7) which represents including the right people in the implementation, which may respresent the need for emergency care to coordinate activities and processes across organizations such as EMS, multiple hospitals and outpatient care.

Table B-11. Emergency care: barriers and facilitators by CFIR constructs

Type	Facilitator or Barrier Name	Facilitator or Barrier Number of Mentions	Reference Number(s)
Barrier	Access to Knowledge & Information*	2	28, 88
	Adaptability†	1	170
	Available Resources‡	4	88, 134, 170
	Compatibility§	4	94, 134, 180
	Cost‖	1	180
	Executing¶	2	28

Type	Facilitator or Barrier Name	Facilitator or Barrier Number of Mentions	Reference Number(s)
	External Policy & Incentives[#]	1	77
	Implementation Climate[**]	1	88
	Knowledge & Beliefs about the Innovation[††]	5	94, 170, 180
	Networks & Communications[‡‡]	2	88, 123
	Readiness for Implementation[§§]	3	88, 180
	Relative Priority[lll]	3	28, 94, 180
Facilitators	Access to Knowledge & Information[*]	11	7, 14, 28, 33, 88, 134, 146, 147
	Available Resources[‡]	9	7, 14, 33, 88, 147, 166, 169, 170
	Cost[ll]	2	77, 90
	Engaging[¶¶]	7	14, 28, 33, 147
	Executing[¶]	1	33
	External Policy & Incentives[#]	4	14, 77
	Formally Appointed Internal Implementation Leaders[##]	3	14, 33, 147
	Implementation Climate[**]	3	28, 94, 147
	Knowledge & Beliefs about the Innovation[††]	1	170
	Leadership Engagement[***]	4	28, 123, 147
	Patient Needs & Resources[†††]	7	6, 7, 88, 150, 160, 161
	Networks & Communications[‡‡]	4	6, 94, 170
	Planning[‡‡‡]	2	28, 147
	Readiness for Implementation[§§]	5	7, 14, 33, 147
	Reflecting & Evaluating[§§§]	4	14, 146, 147

* Access to digestible information and knowledge about the innovation and how to incorporate it into work tasks.
† Degree to which an innovation can be adapted, tailored, refined, or reinvented to meet local needs.
‡ Level of resources organizational dedicated for implementation and on-going operations including physical space and time.
§ Degree of tangible fit between meaning and values attached to the innovation by involved individuals, how those align with individuals' own norms, values, and perceived risks and needs, and how the innovation fits with existing workflows and systems.
l Costs of the innovation and costs associated with implementing the innovation including investment, supply, and opportunity costs.
¶ Carrying out or accomplishing the implementation according to plan.
# External strategies to spread innovations including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting.
** Absorptive capacity for change, shared receptivity of involved individuals to an innovation, and the extent to which use of that innovation will be rewarded, supported, and expected within their organization.
†† Individuals' attitudes toward and value placed on the innovation, as well as familiarity with facts, truths, and principles related to the innovation.
‡‡ Nature and quality of webs of social networks, and the nature and quality of formal and informal communications within an organization.
§§ Tangible and immediate indicators of organizational commitment to its decision to implement an innovation.
ll Individuals' shared perception of the importance of the implementation within the organization.
¶¶ Attracting and involving appropriate individuals in the implementation and use of the innovation through a combined strategy of social marketing, education, role modeling, training, and other similar activities.
Individuals from within the organization who have been formally appointed with responsibility for implementing an innovation as coordinator, project manager, team leader, or other similar role.
*** Commitment, involvement, and accountability of leaders and managers with the implementation of the innovation.

††† Extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organization.
‡‡‡ Degree to which a scheme or method of behavior and tasks for implementing an innovation are developed in advance, and the quality of those schemes or methods.
§§§ Quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience.

Education/Mentoring

Table B-12 includes a summary of information from 13 studies or reports on the use of telehealth for training and mentoring health care providers in rural areas (Additional details in **Appendix D-10**).

Nine of these studies are assessments of ECHO programs. ECHO combines didactic training, case presentations, virtual clinics and peer support to increase capacity and quality of care.[9, 56, 73, 115, 127, 144, 157, 174] The ECHO programs evaluated in these articles address different topics with four focused on pain or opioids,[56, 73, 144, 157] one each about Hepatitis C,[127] Multiple Sclerosis,[9] and HIV in pregnancy,[115] and one program that implemented ECHO as part of a larger expansion of specialist care.[174] While the subject matter and scale of these programs differed, facilitators, challenges and impact were similar. A frequently cited barrier was lack of clinician time to attend sessions or issues with scheduling. The evaluations also acknowledged that while ECHO could increase provider knowledge and skills it could not address all policy and practice barriers to practice change. Most ECHO program evaluations report a high level of stakeholder support and that the programs address rural participants needs for peer interaction, current knowledge, and access to experts. Evaluations of the impact of ECHO programs have documented that participants have changed practice, managed patients they would have referred, engaged in consultations with the expert faculty outside of the ECHO program, and become resources for other providers in their communities.

The three additional evaluations all address the rural clinicians' need for training in emergency care. One evaluation documented how training could be incorporated into consultations, reporting how this assured training was useful and relevant.[183] An experimental study tested whether training medical students using simulations for relatively rare emergency procedures could be managed by a remote expert trainer and documented that this was feasible and produced similar educational outcomes.[68] An assessment of remote training for emergency care in Australia documented that training could reduce professional isolation, but that sometimes topics were not relevant to rural working conditions.[121]

Table B-12. Findings of education and mentoring implementation studies

Topic Number of studies Intervention	Method N Location	Facilitators	Barriers	Impact

ECHO
9
 	
Program with remote training, case reviews/ clinics and peer interaction
ECHO as part of a comprehensive program including e-consults
	Hepatitis C
	Survey to participants and non
	N=32 of 72 contacted; 15 facilities; Indian Health Service[127]
	
	Multiple Sclerosis
	Pre questionnaire, program manager observations, exit interviews focused on case presentations
	N=8 of 24 clinicians, 13 practice sites; Mississippi, Washington State, Alaska, Montana, Idaho[9]
	
	HIV in pregnancy
	Survey and review of cases
	N=41 of 53 surveys, 11 cases Perinatal HIV; Washington State, Alaska, Montana, Idaho, Oregon, Colorado[115]
	
	Chronic Pain
	Content analysis
	N=Random selection of 25 of 67 cases; 406 data units; U.S. Connecticut. Single federally qualified health center[157]
	
	Buprenorphine
	Interviews
	N=20; U.S. North Carolina[144]
	
	Pain and Opioid Management with 2-3 in person supplemental training
	Questionnaires and focus groups
	N=38 participants; 2 workshops; New Mexico Indian Health Service[73]
	
	Cancer Pain Survey of participants and non-participants
	N=24(46%) who attended education; 32 (34%) who attended case conferences; U.S. New Mexico[56]
	
	Multiple Topics
	Surveys of clinician leads, administrative data
	N=180 from 87 sites; U.S. VA[174]
	
	Melanoma
	Survey
	N = 10 Primary care providers; U.S. Missouri[17]
		• Preference or need for
		  ○ Collegial discussion with peers
		  ○ Being well-informed
		  ○ Access to experts
		• Willingness to present cases. conferences
		• High level of stakeholder support
		• Adaptability to local needs
		• Compatibility with existing workflows and systems
		• Feedback on progress
		• Quality of networks and communications
		• Leadership engagement
		• Access to Knowledge & Information
		• Networks & Communications
			• Lack of time to attend
			• Scheduling/time of day
			• Sessions seemed too long
			• Lack of local leadership support
			• Negative staff attitudes/stigma toward topic (Opioid use disorder)
			• ECHO cannot address policy issues (e.g., regulations and payment policy)
			• Assessment and screening skills require in-person add on
				• Increased ability to manage and treat, knowledge and confidence in existing treatment or changed care for case patient
				• Changed practice for other patients
				• Managed patients who would have been referred
				• Content consistent with guidelines
				• Participants engaged in additional consultations with faculty experts
				• Participants scored higher on competence than non-participants
				• Participants serve as resource for other providers

Topic Number of studies Intervention	Method N Location	Facilitators	Barriers	Impact
Telehealth Training **3** Training incorporated as part of the consultation[183] Simulation training lead by remote expert[68] Training needs assessment[121]	Emergency Care Interviews N=18 hospitals Kansas, Minnesota, Nebraska, North Dakota, South Dakota Avera tele-training during consultation[183] High-Acuity Low-Occurrence Procedures Assessments N=69 medical students Randomized to telehealth, in person and no training Newfoundland, Canada[68] Emergency Care Interviews N=20 rural physician Australia[121]	• Topics of formal training are useful • Real-time training can include exactly what is needed • Respect and supportive teaching from consultants • Interactive sessions preferred over didactic • Ability to reduce professional isolation • Broadcast live procedures • Technology that functions well.	• Timing of live sessions • Workload constraints • Limited relevance to current working conditions	• Asynchronous training courses included in program were valued • Training increased confidence and improved performance • Simulation training is feasible from a distance; results in similar education outcomes
Structured Dentist Network **1**	Dentistry Interview and focus group N= 2 Dental specialists and 8 General dentists Australia[83]	• Networks & Communications	• Access to Knowledge & Information • Planning • Available Resources	• Lower proportion of patients treated at the Special Needs Unit, reflecting increased treatment at local facilities

Abbreviations: ECHO = Extension for Community Healthcare Outcomes; HIV = human immunodeficiency virus; U.S. = United States.

While telehealth interventions for education and mentoring differ in format and outcomes from those that are targeted to care of a specific patient, barriers and facilitators were able to be mapped to CFIR constructs as the framework was designed to be applicable across different types of interventions. **Table B-13** summarizes these. The most frequently cited barrier was ***compatibility*** (8), being when education did not correspond to the need or environment of the trainees. Not surprisingly, the most common facilator was ***access to knowledge and information*** (11) as the telehealth education and mentoring programs were more likely to be implemented when they provided accessible information that could be directly incorporated into the trainees tasks and environment.

Table B-13. Education/mentoring: barriers and facilitators by CFIR constructs

Type	Facilitator or Barrier Name	Facilitator or Barrier Number of Mentions	Article Reference IDs
Barrier	Access to Knowledge & Information*	3	73, 83
	Adaptability*	1	121
	Available Resources‡	4	56, 73, 83, 127
	Compatibility§	8	121, 127, 144, 183
	External Policy & Incentives‖	2	144
	Implementation Climate¶	3	121, 127
	Knowledge & Beliefs about the Innovation#	1	144

Type	Facilitator or Barrier Name	Facilitator or Barrier Number of Mentions	Article Reference IDs
	Leadership Engagement**	1	144
	Planning	1	83
Facilitator	Access to Knowledge & Information*	12	17, 121, 127, 144, 174, 183
	Adaptability*	2	56, 174
	Available Resources‡	2	68, 121
	Compatibility§	2	121, 174
	Engaging††	3	157, 174
	Implementation Climate¶	3	73, 144, 174
	Leadership Engagement**	2	174
	Patient Needs & Resources‡‡	5	9, 115, 121, 127
	Networks & Communications§§	6	17, 83, 127, 157, 174, 183
	Reflecting & Evaluating‖‖	1	174
	Relative Priority¶¶	1	174

* Access to digestible information and knowledge about the innovation and how to incorporate it into work tasks.
† Degree to which an innovation can be adapted, tailored, refined, or reinvented to meet local needs.
‡ Level of resources organizational dedicated for implementation and on-going operations including physical space and time.
§ Degree of tangible fit between meaning and values attached to the innovation by involved individuals, how those align with individuals' own norms, values, and perceived risks and needs, and how the innovation fits with existing workflows and systems.
‖ External strategies to spread innovations including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting.
¶ Absorptive capacity for change, shared receptivity of involved individuals to an innovation, and the extent to which use of that innovation will be rewarded, supported, and expected within their organization.
# Individuals' attitudes toward and value placed on the innovation, as well as familiarity with facts, truths, and principles related to the innovation.
** Commitment, involvement, and accountability of leaders and managers with the implementation of the innovation.
†† Attracting and involving appropriate individuals in the implementation and use of the innovation through a combined strategy of social marketing, education, role modeling, training, and other similar activities.
‡‡ Extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organization.
§§ Nature and quality of webs of social networks, and the nature and quality of formal and informal communications within an organization.
‖‖ Quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience.
¶¶ Individuals' shared perception of the importance of the implementation within the organization.

Appendix C. Included Studies List

1. Adcock AK, Choi J, Alvi M, et al. Expanding acute stroke care in rural America: a model for statewide success. Telemed J E Health. 2020 Jul;26(7):865-71. doi: 10.1089/tmj.2019.0087. PMID: 31596679.
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3. Alishahi Tabriz A, Turner K, Williams D, et al. Association of financial factors and telemedicine adoption for heart attack and stroke care among rural and urban hospitals: a longitudinal study. Telemed J E Health. 2021 Sep 24;24:24. doi: 10.1089/tmj.2021.0341. PMID: 34559014.
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12. Becevic M, Smith E, Golzy M, et al. Melanoma extension for community healthcare outcomes: a feasibility study of melanoma screening implementation in primary care settings. Cureus. 2021 May 29;13(5):e15322. doi: 10.7759/cureus.15322. PMID: 34221770.
13. Bellesheim KR, Kizzee RL, Curran A, et al. ECHO autism: integrating maintenance of certification with extension for community healthcare outcomes improves developmental screening. J Dev Behav Pediatr. 2020 Aug;41(6):420-7. doi: 10.1097/DBP.0000000000000796. PMID: 32735419.
14. Bennett-Levy J, Hawkins R, Perry H, et al. Online cognitive behavioural therapy training for therapists: outcomes, acceptability, and impact of support. Aust Psychol. 2012;47(3):174-82. doi: 10.1111/j.1742-9544.2012.00089.x.

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Appendix D. Evidence Tables

See associated Excel file at https://effectivehealthcare.ahrq.gov/products/rural-telehealth/research.

Appendix E. Risk of Bias Assessment

See associated Excel file at https://effectivehealthcare.ahrq.gov/products/rural-telehealth/research.

Appendix F. Details on Strength of Evidence

Table F-1. Strength of evidence of selected outcomes (Key Question 2)

Topic	Outcome	Number of Studies (Combined N)	Study Limitations (Low, Medium, High)	Directness (Direct, Indirect)	Consistency Consistent, Inconsistent, Unknown	Precision (Precise, Imprecise)	Reporting Bias (Not Detected, Possible, Suspected)	Conclusion	Strength of Evidence Grade (Insufficient, Low, Moderate, High)
Inpatient: Teleconsultation	Mortality	3 (1841)[21, 78, 154]	Medium	Direct	Inconsistent	Imprecise	Not detected	Unclear effect	Insufficient
	Length of Stay	6 (2,113)[13, 16, 21, 52, 78, 154]	Medium	Direct	Inconsistent	Precise	Not detected	No difference in length of stay with telehealth consultations	Low
	Transfers	3 (2208)[27, 78, 154]	Medium	Direct	Consistent	Imprecise	Not detected	No difference or reduction in transfers with telehealth consultations	Low
Inpatient: Remote ICU	Mortality	1 (525 patients)[122] 1 (83 rural hospitals) [72]	Medium	Direct	Consistent	Imprecise	Not detected	No difference in mortality in for rural hospitals	Low
	Transfers	1 (525)[122]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Inpatient: Neonates (specialty care)	Mortality	1 (384 hospitals) [75]	High	Indirect	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
	Length of Stay	2 (298)[92, 93]	Medium	Direct	Consistent	Imprecise	Not detected	Unclear effect	Insufficient
	Transfers	1 (317 patients)[59] 1 (384 hospitals)[75]	Medium	Direct	Consistent	Imprecise	Not detected	More appropriate transfers	Low

Topic	Outcome	Number of Studies (Combined N)	Study Limitations (Low, Medium, High)	Directness (Direct, Indirect)	Consistency Consistent, Inconsistent, Unknown	Precision (Precise, Imprecise)	Reporting Bias (Not Detected, Possible, Suspected)	Conclusion	Strength of Evidence Grade (Insufficient, Low, Moderate, High)
	Clinical Outcomes	2 (298)[92, 93] 1 (384 hospitals)[75]	Medium	Direct	Consistent	Imprecise	Not detected	No difference in clinical measures between telehealth supported care and a higher level NICU	Low
Outpatient: Depression	Clinical outcomes	3 (974)[46, 49, 138]	Medium	Direct	Inconsistent	Imprecise	Not detected	Some improvement in medication adherence, treatment response, satisfaction, and quality of well-being	Low
Outpatient: Depression	Payer outcomes	2 (724)[46, 49]	Medium	Direct	Inconsistent	Imprecise	Not detected	Higher costs associated with intended higher utilization, acceptable incremental cost effectiveness	Low
Outpatient: Diabetes	Clinical outcomes	4 (303)[31, 81, 86, 98]	Medium	Direct	Inconsistent	Imprecise	Not detected	Improved A1c, self-monitoring of blood glucose, and Diabetes Self-Management Education score;	Low
Outpatient: Diabetes Outpatient: screening	Utilization outcomes	1 (1,024)[34]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Pharmacy	Clinical outcomes	2 (879)[10, 29]	Medium	Direct	Inconsistent	Imprecise	Not detected	Improved guideline adherence; improved A1c, fasting blood glucose, and systolic blood pressure in patients with both diabetes and hypertension (no difference in patients with only one of the conditions)	Low
Outpatient: Rheumatology	Clinical outcomes	1 (85)[155]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Rheumatology	Utilization outcomes	1 (85)[176]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Oncology	Utilization outcomes	1 (110)[151]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient

Topic	Outcome	Number of Studies (Combined N)	Study Limitations (Low, Medium, High)	Directness (Direct, Indirect)	Consistency Consistent, Inconsistent, Unknown	Precision (Precise, Imprecise)	Reporting Bias (Not Detected, Possible, Suspected)	Conclusion	Strength of Evidence Grade (Insufficient, Low, Moderate, High)
Outpatient: Oncology	Payer outcomes	1 (147)[156]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Remote Consults	Clinical outcomes	2 (189)[37, 79]	High	Direct	Inconsistent	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Remote Consults	Utilization outcomes	1 (113)[82]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Echocardiography	Utilization outcomes	1 (38)[22]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Hemodialysis	Clinical outcomes	1 (19)[145]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Fracture	Payer outcomes	1 (12)[97]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Dementia	Clinical outcomes	1 (188)[76]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Hepatitis C	Clinical outcomes	1 (80)[139]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: ADHD	Clinical outcomes	1 (223)[110]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: PTSD	Clinical outcomes	1 (225)[47]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: PTSD	Utilization outcomes	1 (225)[47]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: PTSD	Payer outcomes	1 (225)[120]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Wound care	Clinical outcomes	1 (54)[152]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Wound care	Utilization outcomes	1 (54)[152]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Wound care	Utilization outcomes	1 (54)[152]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Dermatology	Patient outcomes	1 (261)[172]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Dermatology	Payer outcomes	1 (392)[35]	Medium	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: endoscopy	Payer outcomes	1(90)[165]	High	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient

Topic	Outcome	Number of Studies (Combined N)	Study Limitations (Low, Medium, High)	Directness (Direct, Indirect)	Consistency Consistent, Inconsistent, Unknown	Precision (Precise, Imprecise)	Reporting Bias (Not Detected, Possible, Suspected)	Conclusion	Strength of Evidence Grade (Insufficient, Low, Moderate, High)
Outpatient: Blood Pressure Control	Patient outcomes	1 (1299)[179]	Low	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Palliative Care	Patient outcomes	1(n=21)[70]	High	Direct	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
Outpatient: Ultrasound during pregnancy	Patient outcomes	1 (statewide, over 100,000)[87]	High	Indirect	Unknown	Imprecise	Not detected	Unclear effect	Insufficient
EMS/ED: Telestroke/ STEMI/ Chest Pain	Mortality	5 (2,312)[20, 38, 111, 141, 182]	Medium	Direct	Consistent	Precise	Not detected	No difference in mortality with telethealth supported care	Low
	Time to treatment	8 (3,725)[20, 25, 26, 38, 100, 106, 111, 124]	Medium	Direct	Inconsistent	Imprecise	Not detected	No difference or improved time to treatment. No evidence of worsened time to treatment.	Low
EMS/ED: Consultation	Transfers	5 (147,910)[58, 65, 104, 114, 150]	Medium	Direct	Inconsistent	Precise	Not detected	No difference or improved appropriate patient transfers. No evidence of increased inappropriate patient transfers.	Low
	ED Length of Stay	4 (9,094)[44, 104, 105, 164]	Medium	Direct	Inconsistent	Imprecise	Not detected	Unclear effect	Insufficient
Education/ Mentoring	Clinical response	2 [11, 167]	Moderate	Direct	Consistent	Imprecise	Not detected	Patient outcomes (A1c) improve or are equivalent across spoke and hub sites (hepatitis C viral response) after their providers receive remote education and mentoring	Low
	Provider behavior	8 [18, 19, 23, 51, 66, 96, 143, 175]	High	Direct	Consistent	Imprecise	Possible	Provider behaviors improve (prescribing, documentation & counseling, screening) after participation in remote education and mentoring	Low

Topic	Outcome	Number of Studies (Combined N)	Study Limitations (Low, Medium, High)	Directness (Direct, Indirect)	Consistency Consistent, Inconsistent, Unknown	Precision (Precise, Imprecise)	Reporting Bias (Not Detected, Possible, Suspected)	Conclusion	Strength of Evidence Grade (Insufficient, Low, Moderate, High)
	Provider knowledge, efficacy, perception	13[19, 42, 53, 66, 84, 85, 96, 99, 107, 136, 142, 148, 158]	High	Direct	Consistent	Imprecise	Not detected	Provider knowledge, self-efficacy and perception improve after participation in remote education and mentoring (diabetes, liver disease, mental health, pediatric burn prevention)	Low

Abbreivations: AD/HD = attention deficit/ hyperactivity disorder; ED = emergency depatement; EMS = emergency medical services; A1c = glycated hemoglobin; ICU = intensive care unit; NICU = neonatal intensive care unit; PTSD = post-traumatic stress disorder; STEMI = ST-elevation acute myocardial infarction.

Appendix G. Excluded Studies List

1. Abadia de Barbara AH, Nicholas Iv TA, Del Real Colomo A, et al. Virtual simulation training using the Storz C-HUB to support distance airway training for the Spanish Medical Corps and NATO partners. Stud Health Technol Inform. 2012;182:1-9. PMID: 23138073. Exclusion: Ineligible population.

2. Abara E, Denton R. Collaborative care of urologic cancer patients through telemedicine in northeastern Ontario. Urology. 2013;82(3):S312. Exclusion: Ineligible study design.

3. Abd Allah M, Wahed S, Ammar I, et al. Utility of telemedicine in the treatment of patients with chronic HCV infection using DAAs in remote areas with limited resources. Liver International. 2021;41(8):1979-80. doi: 10.1111/liv.14982. PMID: 34153175. Exclusion: Ineligible study design.

4. Abshire DA, Graves JM, Amiri S, et al. Scaling-up telehealth during the COVID-19 pandemic: missed opportunities to leverage spatial data to ascertain the rural reach of services. J Adolesc Health. 2020;67(6):871-. doi: 10.1016/j.jadohealth.2020.07.017. PMID: 32839080. Exclusion: Not a study.

5. Adams SJ, Burbridge BE, Badea A, et al. Initial experience using a telerobotic ultrasound system for adult abdominal sonography. Can Assoc Radiol J. 2017;68(3):308-14. doi: 10.1016/j.carj.2016.08.002. PMID: 28159435. Exclusion: Ineligible population.

6. Adams SJ, Burbridge B, Chatterson L, et al. Telerobotic ultrasound to provide obstetrical ultrasound services remotely during the COVID-19 pandemic. J Telemed Telecare. 2020:1357633X20965422. doi: 10.1177/1357633X20965422. PMID: 33076753. Exclusion: Ineligible comparater.

7. Agley J, Adams ZW, Hulvershorn LA. Extension for Community Healthcare Outcomes (ECHO) as a tool for continuing medical education on opioid use disorder and comorbidities. Addiction. 2019;114(3):573-4. doi: 10.1111/add.14494. PMID: 30397977. Exclusion: Not a study.

8. Agley J, Delong J, Janota A, et al. Reflections on project ECHO: qualitative findings from five different ECHO programs. Med Educ Online. 2021;26(1):1936435. doi: 10.1080/10872981.2021.1936435. PMID: 34076567. Exclusion: Ineligible comparater.

9. Al Achkar M, Bennett IM, Chwastiak L, et al. Telepsychiatric consultation as a training and workforce development strategy for rural primary care. Ann Fam Med. 2020;18(5):438-45. doi: 10.1370/afm.2561. PMID: 32928760. Exclusion: Ineligible study design.

10. Al Kasab S, Harvey JB, Debenham E, et al. Door to needle time over telestroke-a comprehensive stroke center experience. Telemed J E Health. 2018;24(2):111-5. doi: 10.1089/tmj.2017.0067. PMID: 28753069. Exclusion: Ineligible comparater.

11. Al Quran HA, Khader YS, Ellauzi ZM, et al. Effect of real-time teledermatology on diagnosis, treatment and clinical improvement. J Telemed Telecare. 2015;21(2):93-9. doi: 10.1177/1357633X14566572. PMID: 25589469. Exclusion: Ineligible intervention.

12. AlAzab R, Khader Y. Telenephrology application in rural and remote areas of Jordan: benefits and impact on quality of life. Rural Remote Health. 2016;16(1):3646. PMID: 26745230. Exclusion: Ineligible intervention.

13. AlDossary S, Martin-Khan MG, Bradford NK, et al. The development of a telemedicine planning framework based on needs assessment. J Med Syst. 2017;41(5):74. doi: 10.1007/s10916-017-0709-4. PMID: 28321589. Exclusion: Not a study.

14. Aligeti M. Telemedicine wellness, intervention, triage, and referral project: a unique intervention strategy to prevent school violence. J Am Acad Child Adolesc Psychiatry. 2016;55(10):S12. doi: 10.1016/j.jaac.2016.07.480. Exclusion: Ineligible intervention.

15. Alschuler KN, von Geldern G, Ball D, et al. Rapid transfer of knowledge for multiple sclerosis clinical care during COVID-19: ECHO MS. Mult Scler Relat Disord. 2020;46:102600. doi: 10.1016/j.msard.2020.102600. PMID: 33296992. Exclusion: Ineligible outcome.

16. Amorim E, Shih MM, Koehler SA, et al. Impact of telemedicine implementation in thrombolytic use for acute ischemic stroke: the University of Pittsburgh Medical Center telestroke network experience. J Stroke Cerebrovasc Dis. 2013;22(4):527-31. doi: 10.1016/j.jstrokecerebrovasdis.2013.02.004. PMID: 23489955. Exclusion: Ineligible population.

17. Anders SH, Woods DD, Schweikhart S, et al. The effects of health information technology change over time: a study of tele-ICU functions. Appl Clin Inform. 2012;3(2):239-47. doi: 10.4338/ACI-2011-12-RA-0073. PMID: 23646073. Exclusion: Ineligible outcome.

18. Anderson D, Zlateva I, Davis B, et al. Improving pain care with Project ECHO in community health centers. Pain Med. 2017;18(10):1882-9. doi: 10.1093/pm/pnx187. PMID: 29044409. Exclusion: Ineligible population.

19. Anderson D, Villagra V, Coman EN, et al. A cost-effectiveness analysis of cardiology eConsults for Medicaid patients. Am J Manag Care. 2018;24(1):e9-e16. PMID: 29350511. Exclusion: Ineligible population.

20. Anderson ER, Smith B, Ido M, et al. Remote assessment of stroke using the iPhone 4. J Stroke Cerebrovasc Dis. 2013;22(4):340-4. doi: 10.1016/j.jstrokecerebrovasdis.2011.09.013. PMID: 22018507. Exclusion: Ineligible outcome.

21. Anderson J, Singh J. A case study of using telehealth in a rural healthcare facility to expand services and protect the health and safety of patients and staff. Healthcare (Basel). 2021;9(6):15. doi: 10.3390/healthcare9060736. PMID: 34203888. Exclusion: Ineligible intervention.

22. Anderson JB, Martin SA, Gadomski A, et al. Project ECHO and primary care buprenorphine treatment for opioid use disorder: implementation and clinical outcomes. Subst Abus. 2021:1-9. doi: 10.1080/08897077.2021.1931633. PMID: 34086529. Exclusion: Ineligible intervention.

23. Anderson LS. The development and implementation of eSchoolCare a novel health care support system for school nurses. ANS Adv Nurs Sci. 2013;36(4):289-303. doi: 10.1097/ANS.0000000000000003. PMID: 24169109. Exclusion: Not a study.

24. Anderson SL, Bianco J, DeRemer CE. Adapting ambulatory care learning environments in response to the COVID-19 pandemic. Am J Health-Syst Pharm. 2021;78(6):467-71. doi: 10.1093/ajhp/zxab016. PMID: 33483738. Exclusion: Not a study.

25. Anderson T, McClintock AS, McCarrick SS, et al. Working alliance, interpersonal problems, and depressive symptoms in tele-interpersonal psychotherapy for HIV-infected rural persons: evidence for indirect effects. J Clin Psychol. 2018;74(3):286-303. doi: 10.1002/jclp.22502. PMID: 28586534. Exclusion: Ineligible intervention.

26. Andrade MV, Maia AC, Cardoso CS, et al. Cost-benefit of the telecardiology service in the state of Minas Gerais: Minas Telecardio Project. Arq Bras Cardiol. 2011;97(4):307-16. PMID: 21808852. Exclusion: Ineligible comparater.

27. Andrees V, Klein TM, Augustin M, et al. Live interactive teledermatology compared to in-person care - a systematic review. J Eur Acad Dermatol Venereol. 2020;34(4):733-45. doi: 10.1111/jdv.16070. PMID: 31715035. Exclusion: Systematic review, secondary analysis, or meta-analysis used as a source document only to identify individual studies.

28. Anonymous. Telemedicine helps rural EDs access critical neurology expertise for stroke patients. ED Manag. 2012;24(3):30-3. PMID: 23687736. Exclusion: Not a study.

29. Anonymous. Technologies assisting in remote consultations for the diagnosis of stroke: a review of the clinical evidence. 2013. https://www.ncbi.nlm.nih.gov/books/NBK195829/ PMID: 24741717. Exclusion: Systematic review, secondary analysis, or meta-analysis used as a source document only to identify individual studies.

30. Anonymous. Connecting ruraL and remote services. Qld Nurse. 2016;35(1):10. PMID: 27356321. Exclusion: Not a study.

31. Anonymous. Project ECHO: a telementoring network model for continuing professional development: erratum. J Contin Educ Health Prof. 2018;38(1):78. doi: 10.1097/CEH.0000000000000192. PMID: 29517614. Exclusion: Not a study.

32. Antezana L, Scarpa A, Valdespino A, et al. Rural trends in diagnosis and services for autism spectrum disorder. Front Psychol. 2017;8:590. doi: 10.3389/fpsyg.2017.00590. PMID: 28473784. Exclusion: Systematic review, secondary analysis, or meta-analysis used as a source document only to identify individual studies.

33. Arba F, Piccardi B, Baldereschi M, et al. Telemedicine for acute ischaemic stroke. Cochrane Database Syst Rev. 2016 (2). Exclusion: Not a study.

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