Technical Brief
Number 26

Telehealth: Mapping the Evidence for Patient Outcomes From Systematic Reviews

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Telehealth: Mapping the Evidence for Patient Outcomes From Systematic Reviews

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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 health care decisionmakers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of health care 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 health care in the United States. The reports and assessments provide organizations with comprehensive, science-based information on common, costly medical conditions and new health care technologies and strategies. 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.

The goals of this Technical Brief are to provide an objective description of the state of the science in an evidence map of systematic reviews, that identifies key areas important for practice and policy decisionmaking in relation to the available evidence, creates a potential framework for assessing the applications and implications of telehealth interventions, generates a summary of ongoing research, and provides information on what future research is needed. In particular, through the Technical Brief, AHRQ hopes to gain insight on the appropriate conceptual framework and critical issues that will inform future research.

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

If you have comments on this Technical Brief, 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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Key Informants

In designing the study questions, the EPC consulted several Key Informants with diverse experiences and perspectives in implementing and evaluating telehealth. The EPC sought the Key Informant input to identify areas where telehealth is being used but has not been studied, issues raised by telehealth, the important questions about telehealth that different stakeholders want research evidence to answer, and to help identify the next steps in research that would be most likely to move the field forward. Key Informants were not involved in the analysis of the evidence or the writing of the report. Therefore, study questions, design, methodological approaches, and/or conclusions do not necessarily represent the views of individual Key Informants.

Key Informants must disclose any financial conflicts of interest greater than $10,000 and any other relevant business or professional conflicts of interest. Because of their role as end-users, individuals with potential conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any conflicts of interest.

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*Thank you to these Key Informants for their review of the draft technical brief.

Peer Reviewers

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

Peer Reviewers must disclose any financial conflicts of interest greater than $10,000 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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Telehealth: Mapping the Evidence for Patient Outcomes from Systematic Reviews

Structured Abstract

Background. Telehealth includes a wide range of technologies used to fulfill many functions in in health care for patients with a variety of clinical conditions. For this evidence map, telehealth is defined as the use of information and telecommunications technology in health care delivery for a specific patient involving a provider across distance or time. Various types of telehealth interventions have been evaluated in thousands of research studies and hundreds of systematic reviews. The vast size of the literature and the variations in how the literature has been collected, evaluated, and synthesized make it challenging to determine what is known about the effectiveness of telehealth for specific purposes and what questions remain unanswered.

Purpose. The purpose of this brief is to provide an overview of the large and disparate body of evidence about telehealth for use by decisionmakers. The approach used was to create an evidence map of systematic reviews published to date that assess the impact of telehealth on clinical outcomes. This evidence map describes a limited number of key characteristics of the systematic reviews currently available in order to evaluate the bodies of evidence available to inform practice, policy, and research decisions about telehealth.

Methods. An evidence map is a specific type of rapid or abbreviated review. While the creation of the evidence map is based on systematic review methodology, its goal is to describe rather than synthesize available research and to use graphics when possible to represent selected characteristics of the evidence. We included systematic reviews that synthesized the impact of telehealth interventions on clinical outcomes, utilization, or cost. We created bubble plots to separately examine the distribution of the evidence from systematic reviews in terms of volume (number of reviews, number of patients in the included studies), conclusions about benefit by clinical focus area, and telehealth function. We also determined how much evidence is available about combinations of clinical areas and telehealth functions reported in existing systematic reviews. We supplemented this by summarizing the topics covered in excluded reviews and the results of exploratory searches for primary studies on selected topics in order to assess the need for future systematic reviews or primary studies in key telehealth domains.

Findings. We identified 1,494 citations about telehealth, from which 58 systematic reviews met our inclusion criteria. A large volume of research reported that telehealth interventions produce positive outcomes when used for remote patient monitoring, broadly defined, for several chronic conditions and for psychotherapy as part of behavioral health. The most consistent benefit has been reported when telehealth is used for communication and counseling or remote monitoring in chronic conditions such as cardiovascular and respiratory disease, with improvements in outcomes such as mortality, quality of life, and reductions in hospital admissions. Given sufficient evidence of effectiveness for these topics, the focus of future research should shift to implementation and practice-based research. Topics with an evidence base that could be the focus of future systematic reviews include telehealth for consultation, uses in intensive care units, and applications in maternal and child health. We also identified topics with a limited

evidence base such as telehealth for triage in urgent/primary care, management of serious pediatric conditions, patient outcomes for teledermatology, and the integration of behavioral and physical health that may be best addressed by additional primary research. Finally, telehealth research should be integrated into evaluation of new models of care and payment so that the potential of telehealth can be assessed across the continuum of care in organizations that are implementing these reforms.

Box 1 below summarizes the key messages of this report.

Box 1. Key messages

- The research literature on telehealth is vast and varied, consisting of hundreds of systematic reviews and thousands of studies of use across various clinical conditions and health care functions.
- There is sufficient evidence to support the effectiveness of telehealth for specific uses with some types of patients, including—
    - Remote patient monitoring for patients with chronic conditions;
    - Communication and counseling for patients with chronic conditions;
    - Psychotherapy as part of behavioral health.

For these telehealth applications, the research focus should shift to how to promote broader implementation and address barriers.

- Additional systematic reviews may be helpful for some topics, such as consultation and maternal and child health, where primary studies are available but these have not been synthesized.
- For other uses, such as triage for urgent care, telehealth is cited as offering value but limited primary evidence was identified, suggesting more studies are needed.
- Future research also should assess the use and impact of telehealth in new health care organizational and payment models.

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Introduction

The purpose of this technical brief is to identify and describe the body of research evidence currently available in the form of systematic reviews to inform decisions related to contemporary practice and policy issues about telehealth. Beyond describing what is available, the brief also aims to identify key areas in which systematic reviews are insufficient for these purposes and suggest what future research (systematic reviews or primary studies) is needed.

The existence of research studies about a topic does not guarantee that the evidence is in a form that can be used to support practice and policy decisions. Ideally for research to support decisionmaking, studies need to be identified, evaluated, and synthesized into a body of evidence. Furthermore, each of these steps needs to be planned, operationalized, executed, and presented so that the evidence addresses the questions relevant to the important decisions. Decisionmakers and other stakeholders may be able to do this ad hoc if the volume of literature is small and the issues are straightforward. However, if the topic is broad and the body of literature is expansive, the task quickly becomes daunting.

This is precisely the case with telehealth. Telehealth includes several different technologies that are not treatments or inventions in and of themselves, rather the technologies are used to expand access, exchange information, and deliver care in alternate formats. Technologies such as remote patient monitoring and videoconferencing can be used to expand specialty care to seriously ill patients in intensive care units (ICUs), to patients in critical assess hospitals, or to patients and providers in areas with shortages of health care providers. Similarly, technology can be used to extend primary care to remote areas and increase the frequency of patient and primary care provider interactions. Internet applications can be used to facilitate psychiatric treatment and other counseling. Devices can be used to evaluate status in patients with chronic conditions who need close monitoring.

Many combinations of technologies, functions, and conditions have been studied to date. The National Library of Medicine added the Medical Subject Headings (MeSH) term "Telemedicine," as a synonym for Telehealth to its list of indexing terms in 1993. As of January 2016 there were over 15,000 articles and over 400 systematic reviews that have been assigned Telemedicine as a major subject heading, indicating that telehealth is the focus of the publication.

Our task was to characterize the systematic reviews available about the effectiveness of telehealth. In this brief we present the results in the form of an evidence map. An evidence map is a combination of a systematic approach to identifying the existing literature on a topic and a description of key characteristics of the existing evidence. This description includes graphic presentation of these key characteristics. It is called a "map" because of the use of graphics and because, like a map, it is a representation that emphasizes and presents some, but not all features, just as we use topographic, economic, road, and climate maps of the same area for different purposes. An evidence map should help clarify the current state of research and possible future directions. Evidence mapping is "emerging as a less exhaustive yet systematic and replicable methodology that allows an understanding of the extent and distribution of evidence in a broad clinical area, highlighting both what is known and where gaps in evidence exist."[1] As a form of rapid review, evidence maps have been used by several organizations and are likely to become more common as the evidence base across health topics grows in size and complexity.[2-11]

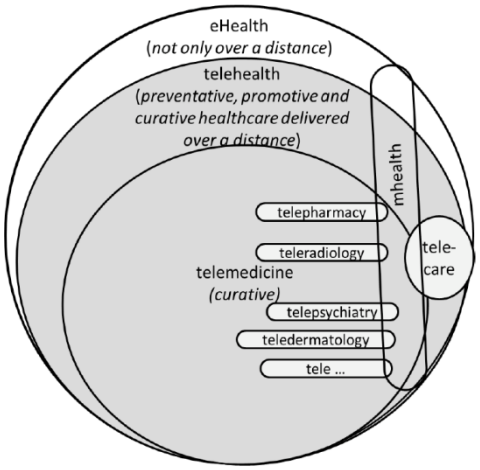
Background

The State of Telehealth

Telehealth encompasses multiple technologies that have been applied to health services for a wide range of conditions, populations, and settings. In fact, telehealth is one of the oldest uses of technology in health care. Telehealth interventions in place today interact with many different specialties across the continuum of care, and affect patients of all ages.[12] Additionally, telehealth mirrors the rapidly changing technology environment, and the corresponding evidence base is expanding in both volume and scope. Many different definitions of telehealth are used in the scientific literature, among policy leaders, and by industry and other stakeholders. The Health Resources and Services Administration (HRSA) provides the following well-accepted definition of telehealth: "the use of telecommunications and information technologies to share information, and provide clinical care, education, public health, and administrative services at a distance."[13] There are also several related terms such as telemedicine, eHealth, and mHealth, which have been defined by the Office of the National Coordinator for Health Information Technology (ONC).[14]

The relationships among the many varied terms related to telehealth has been illustrated by van Dyk (Figure 1).[15] The different forms of telehealth can be used in a variety of clinical areas and the technologies evaluated in the literature range from videoconferencing, image exchange, and streaming media to wireless communications and monitoring.[14] These telecommunications technologies can provide long-distance health care, educate patients and providers, and support management of chronic conditions in patients' homes. The wide-ranging capabilities and applications also create one of the major challenges when systematically reviewing the literature on telehealth—the heterogeneity among existing studies. Studies of telehealth vary by setting (e.g., rural or urban; home, community, clinic, nursing home, or hospital; radiology department; pharmacy)[16] by clinical indication, by health care delivery function, by type of technology, and by expected impact.

Figure 1. Scope of telehealth terminology[a]



[a] Figure reprinted from *A Review of Telehealth Service Implementation Frameworks* by van Dyk[15] under the terms and conditions of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/3.0/

Current Practice and Policy Issues

The motivation for this technical brief originates from a request by United States Senators Bill Nelson and John Thune for a literature review on the value of telehealth and remote patient monitoring, particularly for the chronically ill, with a focus on expanding access to care and reducing costs.[17] A multi-stakeholder letter to Senators Bill Nelson and Susan Collins from several medical, patient advocacy, and industry groups supported the request for such a review.[18] Initial searches in response to this request confirmed that there is a large volume of literature consisting of both primary studies and systematic reviews about applications of telehealth. This literature covers a broad range of topics and is of varying quality. Given both the volume and variability of the literature, it was not feasible to provide a full, comprehensive report on the evidence for effectiveness of all aspects of telehealth in a single technical brief. As such, this evidence map is the first step toward identifying domains or topics where systematic reviews have already synthesized evidence of effectiveness and topics which remain to be synthesized as well as areas where there is little primary research. As an evidence map, this technical brief was not designed to be a comprehensive review of primary research.

The request for a systematic review of "the growing body of evidence demonstrating the value of telehealth technologies"[17] is rooted in a belief that telehealth has the potential to produce positive benefits, a desire to promote the effective use of telehealth, and motivation to remove barriers to its use. Telehealth has been described as having great promise in the sense that it could leverage the $30 billion investment in electronic health records that ONC has made in the last half-decade through the Health Information Technology for Economic and Clinical Health (HITECH) Act.[19] While the potential benefits and possible uses have been extensively enumerated and described (e.g., improving quality, promoting safety, and expanding access),[20-22] there is also a body of literature that outlines barriers and challenges to implementation and widespread adoption of telehealth.[23-25] The goal of this evidence map is to increase our understanding of what uses of telehealth are supported by existing bodies of evidence in the form of systematic reviews so that resources can be used judiciously to support both systematic reviews and primary studies in areas where either research has not been conducted or the evidence is not in a usable form.

In order to inform the methodology and the structure for this evidence map we started by identifying the key issues that stakeholders hoped the research evidence would help address. We based our assessment on the letter mentioned above, our discussions with Key Informants (see Methods below for details), background materials such as reports and testimony, and our expertise derived from both an earlier review and our team's collective experience in this field.[21,22,26,27]

Key issues involve identifying situations where telehealth use is supported by the evidence, obtaining sustainable funding for its use, and encouraging health care providers to apply it. Although telehealth has great potential to improve health care delivery,[16,28,29] challenges include problems in reimbursement, scalability, and licensure.[23,24]

A technical brief differs from a systematic review both in terms of scope and methodology. Because the letter from the Senators emphasized a focus on the use of telehealth within the health care system, we narrowed the scope of our analysis to interventions that included some aspect of a patient interacting with the health care system or a health care providers interacting about a specific patient for the purposes of treatment, management, or prevention of disease. These interactions could occur over distance or time, which is in real time or asynchronous and in different or the same locations. This excluded applications such as informational Web sites,

mobile applications that did not facilitate interaction, and any purely educational activities. Also, because issues related to implementation are addressed after effectiveness is established, we focused on describing the available evidence related to effectiveness and did not include evaluations of telehealth implementation or spread. How these decisions were operationalized is described in the next sections on objectives and methods.

Objectives and Guiding Questions

The purpose of this technical brief is to provide a survey of the large amount of currently available research about the impact of telehealth on health outcomes and health care utilization that can be used to inform policy and practice decisions and guide future research. This differs from a common use of technical briefs to explore topics with scant evidence. This technical brief uses an evidence map format as a means of both presenting and analyzing the information. The map first focuses on describing the currently available systematic reviews that could potentially be used to guide decisions. This approach acknowledges that evidence-based decisions should be guided by a body of literature, and not usually by an individual study. The map format also provides an opportunity for two additional activities: 1) to identify areas not addressed or inadequately addressed in these reviews, for which primary literature may be robust enough for further systematic reviews, and 2) to allow enumeration of areas with gaps in evidence that will require additional primary research.

The questions below guided our work mapping the available research on telehealth interventions.

1. What is the current research on the effectiveness of telehealth interventions?
    a. What telehealth interventions have been studied for effectiveness or harms?
        i. For which interventions are there systematic reviews available?
    b. What patient populations and conditions have been studied with telehealth interventions?
    c. What settings and situations have been studied with telehealth interventions?
    d. What primary outcomes have been studied with telehealth interventions?
    e. What study designs have been used in studies of the effectiveness of telehealth interventions?
2. What gaps exist in the current research?
    a. Which telehealth interventions identified by experts as currently relevant have no research evidence, or inadequate evidence?
    b. For which telehealth interventions are additional primary research studies needed to answer questions important to policy and practice, e.g., additional patient populations or outcome measures?
    c. For which telehealth interventions are there sufficient primary research studies that a new systematic review would add to current knowledge?

The organizing principal for this specific evidence map, given the goals of the stakeholders, is that the evidence must be structured in terms of both format and content so that it can be used to inform current policy and practice decisions. For this reason, we include general consideration of the quality and the findings of systematic reviews in our map. Quality and results are not addressed as comprehensively as they would be in a full systematic review, and it should be noted that these topics are often not included in technical briefs. We used and adapted

approaches that have been used in other literature maps to include selected elements of quality and results.[5-8] We describe these approaches in the methods section of this report.

Methods

An evidence map combines a systematic approach to identifying the existing literature on a topic with a description of key characteristics of the evidence identified. While evidence maps use some elements of systematic review methodology, they are a type of rapid review, and by definition are not comprehensive and do not purport to provide a definitive synthesis of results across a body of evidence. Methodology and guidance for the creation of literature maps exist;[30-32] however, there are currently no accepted standards for this type of abbreviated, descriptive review and a systematic review of evidence mapping confirmed that the exact content and approach vary based on the goals of the project.[33]

In order to achieve the objectives listed above and create an evidence map of systematic reviews about telehealth, we developed a protocol based on adaptations of widely accepted systematic review methods[34-36] and after consulting with Key Informants (KIs) and the funding agency, AHRQ. The KIs and AHRQ provided valuable perspectives, but they are not responsible for the resulting protocol or report. The protocol was posted on the AHRQ Web site on August 11, 2015 (http://www.effectivehealthcare.ahrq.gov/search-for-guides-reviews-and-reports/?pageaction=displayproduct&productid=2110).

Discussions with Key Informants

A group of six KIs representing diverse perspectives, including policy, research, telehealth use, and practice, supplemented with representation from U.S. Senate staff, participated in interviews during the initial phase of the project. KIs are recruited to provide insight and offer opinions, but they are not authors of the report, they are not responsible for the content, and the report does not necessarily reflect their views. In addition to the initial consultation, KIs are offered the opportunity to comment on the draft report as part of the peer review process. The purpose of KI interviews varies depending on the project requirements. In technical briefs about topics with limited research evidence they may offer expert opinion. It this case the KI role was to identify the current major practice and policy issues surrounding telehealth. This information informed our searches and development of the review inclusion and exclusion criteria, and also guided the collection and presentation of descriptive information in the evidence map. Recognizing these issues was crucial to understanding how research evidence about telehealth could best be organized in order to support stakeholder decisionmaking.

During the interviews, KIs raised the following major points:

KIs discussed the state of the field and the fact that the scope of a technical brief may not be sufficient to address all stakeholder needs.

KIs were concerned that there is already a vast body of literature available, but much of it may be of low quality and therefore not useful for decisionmakers. At the same time, they noted that, in their opinion, there are a number of well-executed studies. They stressed that combining results across studies without considering the quality of the research of the individual studies may be the reason many systematic reviews fail to come to clear conclusions about the effectiveness of telehealth.

KIs emphasized that enough detail about how telehealth is used, including for which type of patients and what situations telehealth is studied, needs to be included in the research evidence in order for it to inform decisions about payment, licensing, credentialing, and investment.

KIs underscored the need for cost effectiveness and other health care utilization outcomes in addition to clinical effectiveness outcomes. They emphasized the need for data on effectiveness

and cost as higher priority than data on more process-related outcomes such as acceptability of telehealth by providers, patient satisfaction, or implementation facilitators and barriers.

Search Strategies

We searched Ovid MEDLINE®, the Cochrane Database of Systematic Reviews, and PROSPERO, looking for completed systematic reviews and for systematic reviews in process. We also identified reviews of reviews (sometimes referred to as umbrella reviews) and checked their reference lists against our list of identified reviews. Searches were limited to systematic reviews published in or after 2006 through the end of January 2016 with search date ranges ending in 2005 or later. This date (2006) was selected because it was deemed early enough to capture all relevant published systematic reviews and primary studies of current telehealth approaches and technologies, and it coincided with the publication date of a previous systematic review of telemedicine that our Evidence-based Practice Center performed.[26] These dates were discussed with the KIs, who agreed that older evidence would have limited relevance for pending decisions.

After screening, assessing, and categorizing the reviews, we conducted additional searches in Ovid MEDLINE for primary studies using the same relevant inclusion criteria on topics not covered by included systematic reviews. Similarly, to identify grey literature reports that were essentially systematic reviews, we searched the New York Academy of Medicine Grey Literature database. We also searched the Websites of telehealth-related organizations and U.S. government agencies with involvement in telehealth. When reviewing reports by U.S. government agencies and telehealth organizations we searched for both reports that were similar in methodology and purpose to published systematic reviews as well as for products with objectives similar to this brief (i.e., describing the state of the evidence available to support decisions about telehealth). Our search strategies including a list of Web sites searched are included in **Appendix A**.

Study Selection

We developed criteria for inclusion and exclusion of studies (first systematic reviews and then primary studies) based on the Guiding Questions and consideration of the current issues and questions raised by stakeholders. The ability of the research evidence to inform decisionmaking guided study eligibility criteria, influenced what information we collected, and shaped how we presented our findings. We adapted a standard framework used in systematic reviews referred to as PICOTS (population, intervention, comparators, outcomes, timing, and setting) to outline our eligibility criteria. Inclusion and exclusion criteria are detailed in **Appendix B** and are described in this section. A list of the included systematic reviews can be found in **Appendix C**; excluded reviews are listed in **Appendix D**.

Definition of telehealth interventions for this brief. As described in the introduction, telehealth can refer to the use of several different technologies for many purposes related to health care. In order to define a scope that corresponded to pressing policy questions and to be sure that we were summarizing evidence on comparable interventions (i.e., not comparing apples and oranges), we established a core definition for this brief that includes the use of interactive technology to provide health care for specific patients. For our purposes, for an intervention to be considered telehealth it had to include the use of technology to facilitate an interaction between a patient and the health care system or interaction between two or more providers when the interaction was directly related to an individual patient's care. The interaction could occur over

distance and/or over time (asynchronous as opposed to in real time). Using this definition, telehealth includes using video or mobile devices to offer counseling (over distance and in real time), remote patient monitoring which uses a variety of technology to transmit patient physiologic data to providers who monitor the patient condition and adjust treatment when needed (over distance and asynchronous), or using technology to obtain a consultation from another provider (either in real time or asynchronous). Following a precedent set in previous studies, telephone-only voice conversations were not considered telehealth. E-mail and Short Message Service (SMS) text were considered to be telehealth if they were interactive and replaced an in-person interaction (i.e., automated text messaging was not included), but they were not included if they were only in one direction (e.g., notifications) or if they were not personalized (e.g., generic messages sent to a group of patients). This definition was applied to both systematic reviews and our later consideration of individual studies.

Study design and quality. Our core search was for systematic reviews that focused on telehealth and synthesized clinical or utilization/cost outcomes across primary research studies. The rationale for basing the map on systematic reviews is that systematic reviews are the pinnacle of the evidence hierarchy for informing decisions. In most cases changes in policy and practice are not based on a single study; rather they are based on a body of evidence consisting of several studies. Systematic reviews are by definition a means of assembling a body of evidence and making it more accessible to users than the individual studies on their own. A systematic review should identify, evaluate, and synthesize evidence, including drawing conclusions across studies about the effectiveness of interventions or explaining why such a conclusion could not be made. This corresponds to the main objective of the report, which is to identify telehealth topics for which sufficient evidence exists and topics for which either additional systematic reviews or additional primary studies are needed.

It is also important that included reviews be of high quality. We incorporated key elements of the AMSTAR checklist,[37] one of several tools that can be used to assess the methodological quality of systematic reviews, into our inclusion criteria and analysis. Specifically, for a review to be considered "systematic" and included in our map it had to have 1) included a comprehensive literature search of one or more citation databases, 2) based study selection on prespecified inclusion and exclusion criteria, and 3) assessed the quality (or risk of bias) of individual studies included in the review. These correspond to three of the eleven AMSTAR criteria. Reviews that did not meet these criteria were excluded. Two additional AMSTAR criteria are included in our descriptions and analyses. We documented whether each review included a strength of evidence (SOE) assessment, which entails incorporating the quality of the individual studies and other explicitly stated criteria into a rating of the body of evidence. We also documented if meta-analysis were used to combine quantitative results. Incorporating these five criteria in this way allowed us to give significant weight to these criteria that were essential to our purpose and to use them in different ways in our descriptions and analyses that would not be possible if they were combined into a single AMSTAR score for each review. This does not mean the other criteria are not important nor that the score is not useful, rather in our design of an evidence map we decided to focus on these critical criteria and create a flexible approach that allowed us to use different criteria at different points in the process.

Outcomes. Included systematic reviews had to report clinical, resource utilization, or cost outcomes, corresponding to our interest in research on the effectiveness of telehealth in terms of patient-level outcomes. We did not include other outcomes such as patient or provider satisfaction with or attitudes toward telehealth or assessments of diagnostic accuracy or

agreement when telehealth was used. We also excluded studies where the outcome was the extent or success of implementation

Population. We included reviews that included studies involving adults and/or children for whose care telehealth was used for prevention, diagnosis, or treatment for any health condition.

Timing. We did not restrict inclusion according to timing, length of the intervention, or length of followup. We included systematic reviews published in 2006 or later and that included a search with an end date in 2005 or later.

Setting. We did not restrict the location of either the provider or patient.

To identify potential studies, abstracts were reviewed by two investigators and full-text articles for all citations deemed appropriate for inclusion by at least one of the reviewers were retrieved. Full-text articles were reviewed for inclusion or exclusion by one investigator and confirmed by a second investigator. Discrepancies were resolved by discussion and consensus.

Included systematic reviews were grouped by clinical focus and telehealth function. These groupings were developed by the investigators based on the identified and included reviews. For this reason, they are listed and defined in the Results section of this brief.

We used these groupings to describe the literature and generate the tables and bubble plots that constitute our primary analysis. As a secondary analysis we then compared the topics covered by the included reviews to major topic areas in which telehealth interventions have been observed. For the topics not covered by our included systematic reviews, we first examined the topics covered by excluded reviews as a means of verifying the existence of studies that could be analyzed, and supplemented this with searches for primary research on the topics that were still not represented. We applied the same inclusion criteria related to the population, intervention, definition of telehealth, outcomes, time, and setting, but not study design, to identify potentially relevant primary research.

Data Extraction and Data Management

After identifying the subset of systematic reviews that met our inclusion criteria, we extracted data from the reviews into tables. This included basic information (dates of search, number of included studies, number of included randomized controlled trials [RCTs]), information on the clinical focus area, study purpose, populations included, the function telehealth played in care, telehealth modality/technology, and two indicators of the rigor and type of analysis used in the review (i.e., was there a strength of evidence assessment and was a meta-analysis attempted?). To develop these tables, we started with a list of information of interest and tested it on selected included studies, and then refined and finalized the list to include what is reported in the identified systematic reviews on telehealth. See **Appendixes E and F** for data extraction tables. Additionally, we generated a list of the included studies and their sample sizes for each review **(Appendix G)**. We used these lists to eliminate duplicate studies and avoid double counting when reporting the number of studies and patients in the included reviews within a clinical or functional area as indicators of the size of the evidence base.

Data Synthesis: Generating an Evidence Map

An evidence map combines graphics, tables, and accompanying text. While the methodology for evidence maps is not standardized, by nature they involve a reductive approach to summarizing and presenting information. Evidence maps are not designed to be comprehensive,

rather they present selected characteristics and they rely on categorization and grouping of information.

For our evidence map, the core graphics are two bubble plots and a figure. One bubble plot is organized by clinical focus of the telehealth interventions, while the other is organized by health care function. We selected these two categorizations because decisions about telehealth are usually made about its use with particular types of patients (clinical focus, e.g., patients with diabetes or heart failure) or to deliver a type of health care service (e.g., health care functions such as remote patient monitoring or psychotherapy). Each of the two bubble plots then convey four additional dimensions about the clinical focus or health care function categories: 1) number of studies included in reviews, 2) total sample sizes (e.g., the number of patients), 3) the general direction and strength of any reported effect, and 4) the percentage of the reviews that include strength of evidence assessment. A third figure presents how the clinical focus and function categories intersect. This creates groupings of the evidence that are more specific, for example it shows what evidence is available about telehealth for remote patient monitoring (function) for people with chronic conditions (clinical area). This figure reports for each grouping: 1) the number of included systematic reviews, 2) the number of studies in the reviews, and 3) the overall conclusion of each review.

To develop the clinical and function categories, team members first individually extracted the information from all the included reviews. Then team members met, reviewed the topics of the included reviews, and developed the categories for clinical focus and function through discussion and consensus. It is important to note that the categories for this descriptive analysis were derived from the literature and do not constitute a list of all possibilities for telehealth. For clinical focus the reviews included those with specific indications (e.g., diabetes) or more general clinical areas (e.g., behavioral health). For function we grouped the reviews by the service the telehealth intervention provided (e.g., monitoring and counseling). Each included systematic review was assigned to the one clinical focus and the one function category that best matched its content. The categories and their definitions are included in the Results below.

While both of these bubble plots represent the same group of systematic reviews we chose these two different approaches to organization and representation of the information as these correspond to the key types of decisionmaking identified by the Guiding Questions and the KIs. Policy and clinical decisions can be made based on the functional category (e.g., decisions about programs for monitoring chronic disease in the rural elderly), by a clinical area (e.g., support for specific interventions for patients with diabetes), or by combinations. The organization of the evidence in these plots and the figure are designed to assist users in determining if evidence exists about specific telehealth interventions and if this evidence can be used to inform decisions about telehealth for specific clinical focus areas and/or functions in health care delivery.

The individual bubbles in these plots represent the specific clinical area or function for which we found systematic review evidence that met our criteria. The other dimensions are the number of individual studies (indicated by the size of the bubble), the number of patients studied (represented on the y-axis), and a weighted estimate of the reported effect (represented on the x-axis). The first two characteristics required looking across reviews and determining which studies were in multiple reviews. The lists of studies included in each review were used to create a list of primary studies without duplicates. The number of patients in these studies and the number of unique studies were then aggregated by both clinical focus and function. In the figure that combines clinical focus and function, the number of studies reported is the total number in each review and therefore there are duplicates within the cells.

Creating a weighted way to summarize the conclusions about the effectiveness of telehealth reported in the systematic reviews involved more interpretation and decision rules. First we reviewed the conclusion of each review. Many reviews include multiple outcomes (details are provided in **Appendix E)**; however, the conclusions needed to be summarized. The systematic review results were coded as 0=no effect, 1=unclear, 2=possible positive effect, 3=positive effect based on an assessment of the primary outcomes, as well as all outcomes. If the results had a consistent direction of effect for the primary outcomes, the codes of 0=no effect, or 3=positive effect were used. If the primary results were mixed, any secondary results were also considered. If the results had an inconsistent direction of effect and the review authors stated that a conclusion was not possible it was coded as 1=unclear in order to indicate that it was unclear what the conclusion about telehealth should be, not that the evidence was unclear. If either some primary outcomes or the majority of all outcomes showed a positive effect, the conclusion was coded as 2=possible positive effect. These codes were assigned by one team member and were checked by another team member. Any differences were discussed by the entire team and a code was assigned based on that discussion.

The weighted estimate of reported effect used in the bubble plots was created by multiplying the overall conclusion code (0 to 3) by the number of studies in the review, and then averaging the scores for all reviews in given clinical area or function. While this did not create a value with absolute meaning, it allowed us to compare the relative strength of the conclusions by clinical area or function. Based on this, the farther to the right the position of the bubble is on the plot, the more the conclusions of the reviews are consistently positive, where farther to the left indicates no effect or unclear findings.

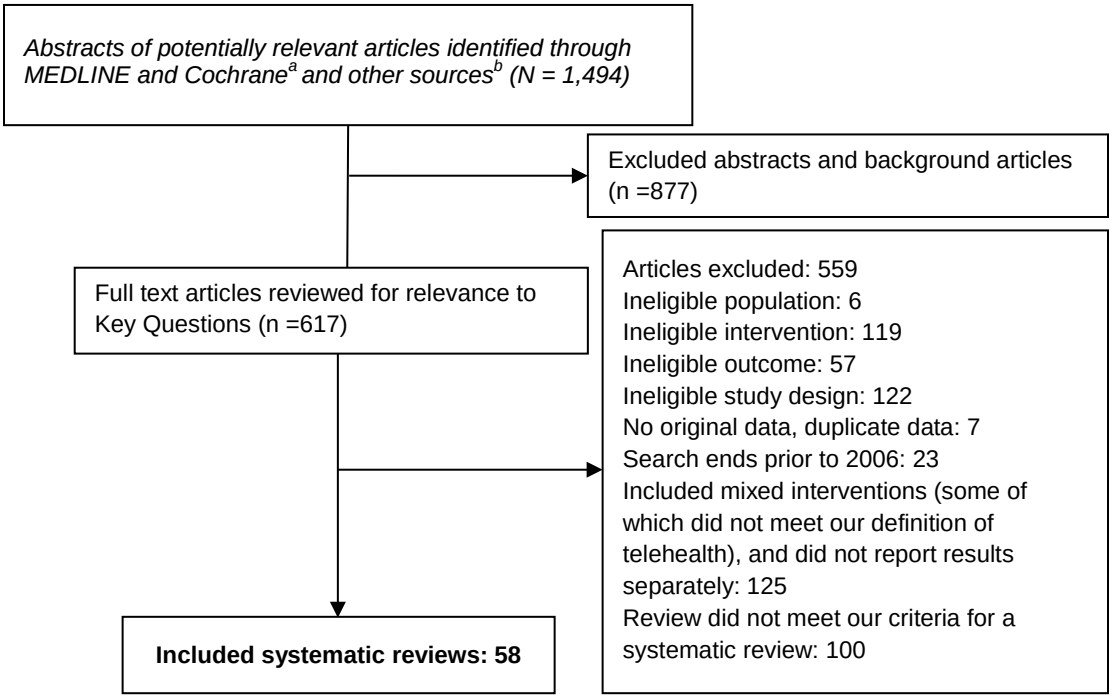
While bubble plots and the intersection figure provide an overall picture of the literature, they can only represent limited numbers of variables and estimates that are not extremely precise (more detail is provided in the Discussion section of this brief). For this reason, we have included other tables, charts, and narratives. We used Chi-square tests to explore relationships between the conclusions of the systematic reviews and the patient setting, type of outcome, whether the reviews used quantitative analysis, and whether the reviews incorporated as assessment of the strength of evidence in their conclusions. We consider the evidence map to consist of the sum of the information in this report.

Findings

Results of Literature Searches

The search and selection of systematic reviews are summarized in the literature flow diagram **(Figure 2)**. Database searches of published literature resulted in 1,311 potentially relevant articles. We identified an additional 183 potentially relevant articles through the grey literature search and searches of Web sites for telehealth organizations and government agencies. After dual review of abstracts and titles, 617 articles and grey literature reports were selected for full-text dual review. Of these, we determined that 58 systematic reviews met the inclusion criteria and we included these in the literature map. A list of included reviews is in **Appendix C.** We did not identify additional eligible reviews or relevant reports via the search of government or organization Web sites. The two reasons we excluded reviews that were about telehealth were: 1) because they included mixed interventions, some of which did not meet our definition of telehealth, and they did not report results separately for the interventions and outcomes we included or 2) they did not meet our criteria for a systematic review (i.e., they did not state questions, search citation databases, and assess the quality of identified studies; see Methods above). The reviews excluded for these two reasons are listed in **Appendix D**.

Figure 2. Literature flow diagram: search results to included studies



[a] Cochrane Database of Systematic Reviews.
[b] Grey literature search included the New York Academy of Medicine Grey Literature Collection, Web sites for the American Telemedicine Association, U.S. Department of Health & Human Services, Healthcare Information and Management Systems Society, U.S. Office of the Assistant Secretary for Planning and Evaluation, Personal Connected Health Alliance, Centers for Medicare & Medicaid Services, The Office of the National Coordinator for Health Information Technology, Wireless-Life Sciences Alliance, U.S. Health Resources and Services Administration, National Institute of Standards and Technology, U.S. Department of Veterans Affairs, and U.S. Agency for Healthcare Research and Quality. Other sources include reference lists of relevant articles, systematic reviews, etc.

Description of Included Systematic Reviews

The 58 included reviews met the strict criteria we established to distinguish systematic reviews that provided content organized, analyzed, and presented in a way that could support contemporary policy and practice decisions about telehealth.[38-95] Information abstracted from each included systematic review is provided in **Appendixes E and F**. **Figure 3** presents the publication year of the included reviews. Almost 80 percent (46 of 58) were published since 2011, indicating a high level of interest in this topic and enough studies to support numerous reviews.

Figure 3. Included systematic reviews by year of publication

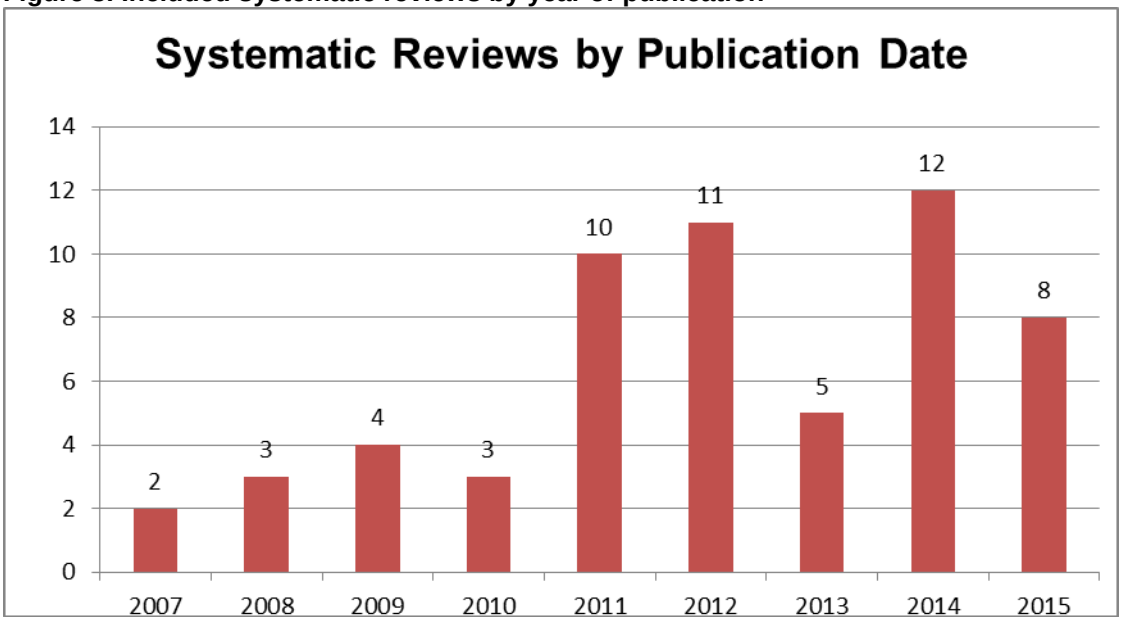


Table 1 includes descriptive information on basic characteristics of the included reviews, such as the final year of the searches performed in the review, which we used as a means of checking how current the information was that formed the basis for the reviews. Table 1 also reports the setting (i.e., where the patients were located). In the majority of reviews, the patients were in their home (60%), while a small number of reviews addressed telehealth when the patient was hospitalized (5%), and some included a mixture of settings including home, hospital and clinic (35%). In terms of the types of outcomes reported, 55 percent reported clinical outcomes, 12 percent reported cost outcomes, and 33 percent reported both clinical and cost outcomes.

Table 1 also includes three characteristics of the reviews that can be used to consider the rigor and utility of the reviews. The current standards for systematic reviews require more than simply listing and describing individual studies – they require that the evidence for a topic be synthesized across studies and that the body of evidence is evaluated. This evaluation is often referred to as strength of evidence (SOE) assessment.[34-36] We defined SOE as an evaluation of a group of studies that incorporated prespecified criteria. Quality assessment of individual studies is always considered in determining strength of evidence but other criteria are often added. For example, the SOE used in AHRQ reviews frequently includes the following criteria in addition to the quality of studies: consistency (i.e., whether the results are consistent across studies), directness (i.e., whether the studies provide direct or indirect evidence given the questions asked

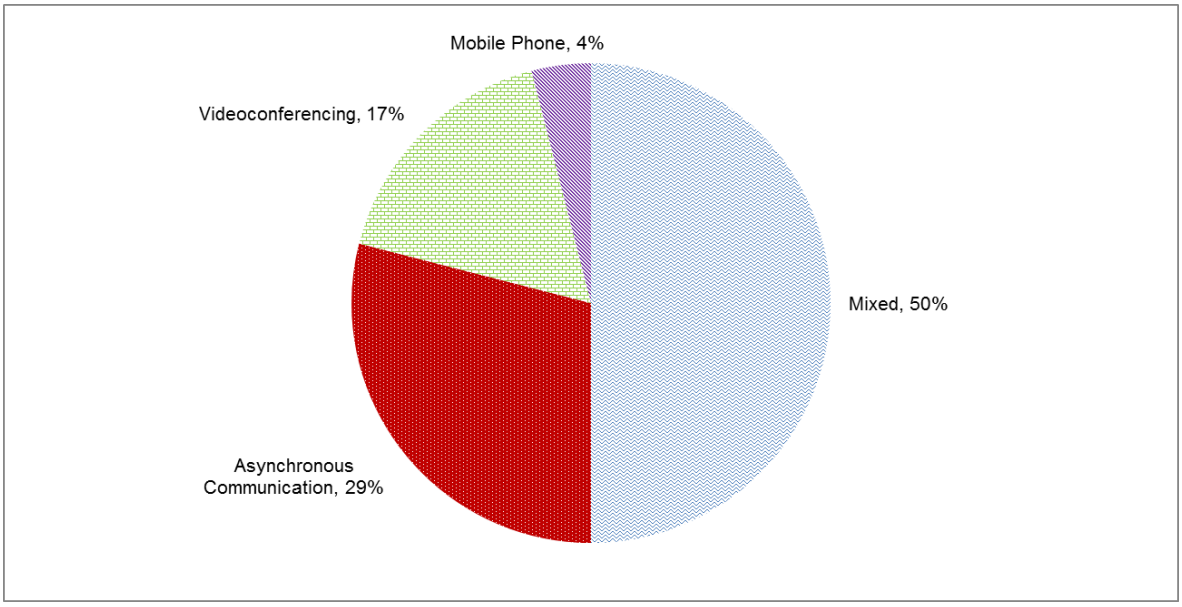
in the review) and precision (i.e., how precise the effect estimates are). SOE may also consider other factors such as evidence of publication bias. Less than half (41%) of the included reviews reported some form of SOE assessment. We also reported on whether the reviews included a meta-analysis. While quantitative synthesis is not appropriate in all cases, it was used in 26 (45%) reviews. The final characteristic of the included reviews reported in Table 1 is whether the review did or did not present a conclusion about the effectiveness of telehealth. Just over one-fifth (22%) reported that the evidence was inconsistent or contradictory (we used the term unclear to include both) and did not draw a conclusion after reviewing the literature.

Table 1. Characteristics of included systematic reviews

Study Characteristic		Systematic Reviews (N)	Percent of Systematic Reviews
Final year of search in systematic review	2005	1	2
	2006	1	2
	2007	5	8
	2008	2	3
	2009	12	21
	2010	7	12
	2011	11	19
	2012	3	5
	2013	11	19
	2014	4	7
	2015	1	2
Setting – Location of patient	Home only	35	60
	Hospital only	3	5
	Other or Mixed Locations	20	35
Outcome type	Clinical only	26	45
	Cost or Resource Utilization only	7	12
	Both	25	43
Strength of evidence reported in systematic review	No	34	59
	Yes	24	41
Meta-analysis conducted in systematic review	No	32	55
	Yes	26	45
Conclusion reported in systematic review	Conclusion drawn	48	83
	Unable to draw conclusion	10	17
Telehealth Modality	Asynchronous communication	17	29
	Mobile phone	2	4
	Videoconferencing	10	17
	More than one technology	29	50

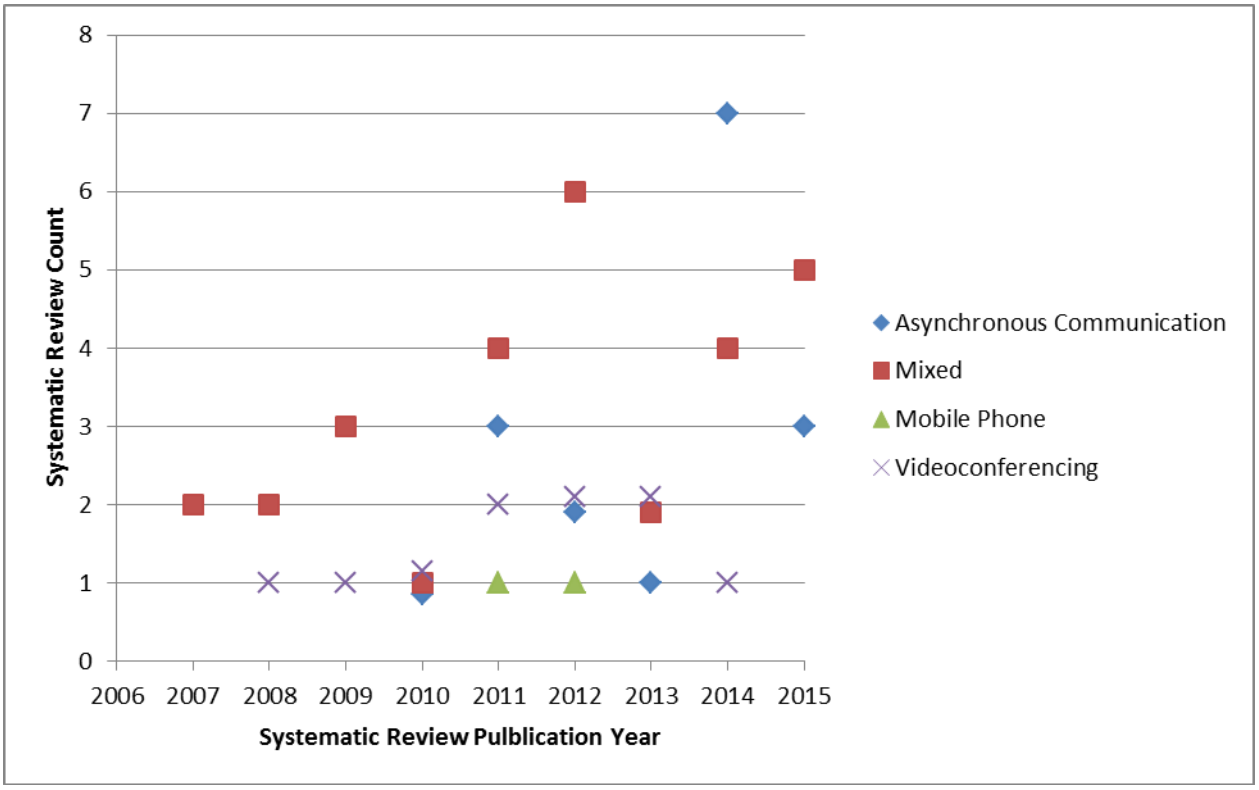
The modality or type of technology used for telehealth is also included in Table 1 and represented in **Figure 4**. Half of the reviews (50%) included mix modalities, meaning either they included primary studies that used multiple technologies or they included primary studies of several different technologies.[41-45,47,50,51,54-56,58,65,70,71,73,76,79-82,85-87,90,91,94,95] Other reviews limited their inclusion to studies of asynchronous communication, employing various technologies, including special monitors or internet-based applications on standard computers(29%) to facilitate communication.[38,46,49,59,60,64,66,67,69,72,77,83,84,88,89,92,93] Another common modality was videoconferencing, which was the focus of 17 percent of included reviews.[39,40,48,57,61,62,68,74,75,78] A smaller number of reviews included only studies that used mobile phones for telehealth (4%).[53,63]

Figure 4. Distribution of telehealth modality across included systematic reviews



Because technology has changed over time, we also looked at the distribution of the modalities covered by the included reviews by publication date **(Figure 5)**. The number of reviews published that reviewed several technologies (mixed) peaked in 2012 at six but was also high in 2014 and 2015. One or two reviews of studies of video have been published every year from 2008 to 2014. More recently, since 2010, reviews have been published that evaluate the use of asynchronous communication and mobile phones.

Figure 5. Systematic reviews by telehealth modalities and publication year



We classified the included systematic reviews according to the clinical focus and telehealth function. As explained in Methods, these were developed based on our review of the included studies. "Clinical focus" is the clinical condition, indication, or situation telehealth was used to address. Function is the role telehealth played in health care. These categories are defined below and the number of reviews in each category is provided in **Table 2.**

The categories identified and used to describe the clinical focus of each systematic review are:

Cardiovascular disease: These reviews included studies of the use of telehealth for the management of heart failure, acute care and followup for myocardial infarction, management of patients with implantable defibrillators, and primary and secondary prevention of coronary disease.

Diabetes: Reviews in this group included management of type 1, type 2, and gestational diabetes and a target range of activities from regulating glucose levels to promoting physical activity.

Respiratory disease: This category included reviews of telehealth interventions for managing chronic obstructive pulmonary disease (COPD), cystic fibrosis, asthma, and lung transplantation.

Mixed chronic conditions: These reviews considered that the uses of telehealth are similar across chronic conditions and included studies conditions such as asthma, hypertension, diabetes, COPD, and kidney failure in their reviews.

Physical rehabilitation: These reviews included telehealth uses for rehabilitation for stroke, traumatic brain injury, or multiple reasons in children or adults.

Behavioral health: Telehealth was evaluated in these reviews for mental health treatment for unspecified conditions, treatment of depression and anxiety, and addiction treatment, including substance abuse, smoking cessation, alcohol abuse, and pathological gambling.
ICU or Surgery: This is a comparatively diverse category, including use of telehealth to allow physicians to advise on ICU patient management or surgery remotely and to facilitate communication between NICUs and parents of preterm babies.
Dermatological conditions: This category included a review of studies that focused on treating several skin conditions.
Preterm birth: This refers to telehealth interventions designed to monitor maternal and fetal health and prevent preterm birth.
Mixed: When a review included uses for a wide range of conditions it was assigned to this category.
Burn care: This refers to telehealth interventions designed to address the clinical needs of patients recovering from burns.

In creating the function categories we looked at the activities telehealth was used for and, when appropriate, what activities telehealth supplemented or replaced. We grouped the reviews in to the following categories:
Remote patient monitoring: This category included interventions that are often called by other names such as home telehealth, or home telemonitoring, but it is broadly defined to also include remote monitoring and management of patients in other settings such as patients in critical care units or patients during transport to the hospital. Home telehealth may require special devices or may use computer applications and networks while in hospital monitoring may include video as well as transmission of data from monitoring devices. The key characteristic is that it involves the collection of data about a patient, usually physiological data such as blood glucose, weight, and blood pressure over time, and this data is transmitted to a health care provider or care team which reviews the data and adjusts care (often medications) based on this data.
Communication and counseling: This category included the use of technology to facilitate the exchange of information between a patient and health care provider as well as the provision of advice. This could be synchronous, as is the case with videoconferencing and chat or asynchronous such as via Web sites or email. These interventions are often designed to increase access and can be used to replace or supplement face-to-face interactions with health care professionals.
Psychotherapy: This differs from general or limited counseling and includes the use of technology to provide a course of treatment for a mental health condition.
Consultation: This category was applied to interventions designed to facilitate involvement of another provider, often a specialist, across time and/or distance. While the patient may or may not be involved in the consultation, the consultation was required to be about a specific patient in order to differentiate this from training (which would not meet our definition of telehealth).
Telementoring: This category was similar to consultation but refers specifically to the use of technology to allow a remote provider to view and advise on a procedure being conducted in another location in real time.
Telerehabilitation: This included any type of rehabilitation services delivered via technology so the patient can be in a different location or can be engaged in rehabilitation activities at different times.

Multiple Functions: In some cases, the intervention included more than one function and in these cases we classified it as mixed.

The second largest group in the clinical focus classification is "mixed chronic conditions." These nine systematic reviews all defined their inclusion criteria such that the reviews either combined studies of several individual conditions, included primary studies with patients with more than one condition, or both. For example, the review by de Jong that evaluated internet communication between health providers and patients with chronic conditions included studies in which all patients had the same condition (e.g., diabetes), studies in which patients had related conditions (e.g., chronic neurological conditions), and studies in which included patients had different conditions (e.g., chronically ill women with a variety of clinical conditions).[46] The similarity in all these reviews was that their scopes were limited to chronic conditions.

Mixed conditions was the label given to reviews that included a wide range of conditions, all of which may not have typically been considered chronic. In many cases these reviews focused on a particular technology or health care function and included studies from varied patient populations. For example, a review of electronic patient portals included studies with populations undergoing in vitro fertilization, diabetes, and congestive heart failure, and patients without specific conditions.[38] Another review of electronic symptom reporting included studies of patients with several conditions including cancer and diabetes.[56]

Telehealth function included a similar category: multiple functions. Ten reviews were coded this way when the included studies stated telehealth was used for more than one function. For example, several reviews had a focus on a specific technology: video conferencing[74,78] or the internet,[49] and the technology was used to communicate with, monitor, and treat patients.

Data from Table 2 as well as the conclusions of the included systematic reviews were used to generate the bubble plots presented later in this report.

Table 2. Characteristics of systematic review evidence by clinical focus and telehealth function

Study Characteristic		Systematic Reviews (N)	Percent of Systematic Reviews by Category	Individual Studies included in Systematic Reviews[a] (N)	Patients[a] (N)
Clinical Focus	Cardiovascular Disease	12	21	121	57,811
	Mixed Chronic Condition	9	15	210	56,276
	Diabetes	8	14	103	16,823
	Behavioral Health	7	12	137	32,770
	Mixed Conditions	6	10	200	61,696
	Physical Rehabilitation	5	9	81	6,715
	Respiratory Disease	5	8	50	3,214
	ICU or Surgery Support	3	5	19	193
	Burn Care	1	2	16	6,782
	Preterm Birth	1	2	15	6,588
	Dermatological Conditions	1	2	24	11,942
	TOTAL for Systematic Reviews by Clinical Focus	**58**		**976[b]**	**260,054**
Telehealth Function	Remote Patient Monitoring	17	29	202	48,321
	Communication and Counseling	14	24	267	95,879
	Multiple Functions	10	17	247	51,684
	Psychotherapy	7	12	114	24,455
	Telerehabilitation	5	9	72	6,281
	Consultation	4	7	53	25,457
	Telementoring	1	2	10	118
	TOTAL for Systematic Reviews by telehealth function	**58**		**965[b]**	**252,195**

ICU=intensive care unit

[a] These are deduplicated numbers within each category, meaning for example that if one study was included in two different systematic reviews on the use of telehealth for diabetes, the study and its participating patients are only counted once in the data reported for diabetes.

[b] The total number of studies and patients differ for clinical focus and telehealth function because the deduplicating was done by category. So a study on telehealth for remote patient monitoring for CHF and COPD included in two different systematic reviews would be counted only once (deduplicated) in the function "remote patient monitoring" but would be included in both the cardiovascular disease and the respiratory disease clinical focus categories.

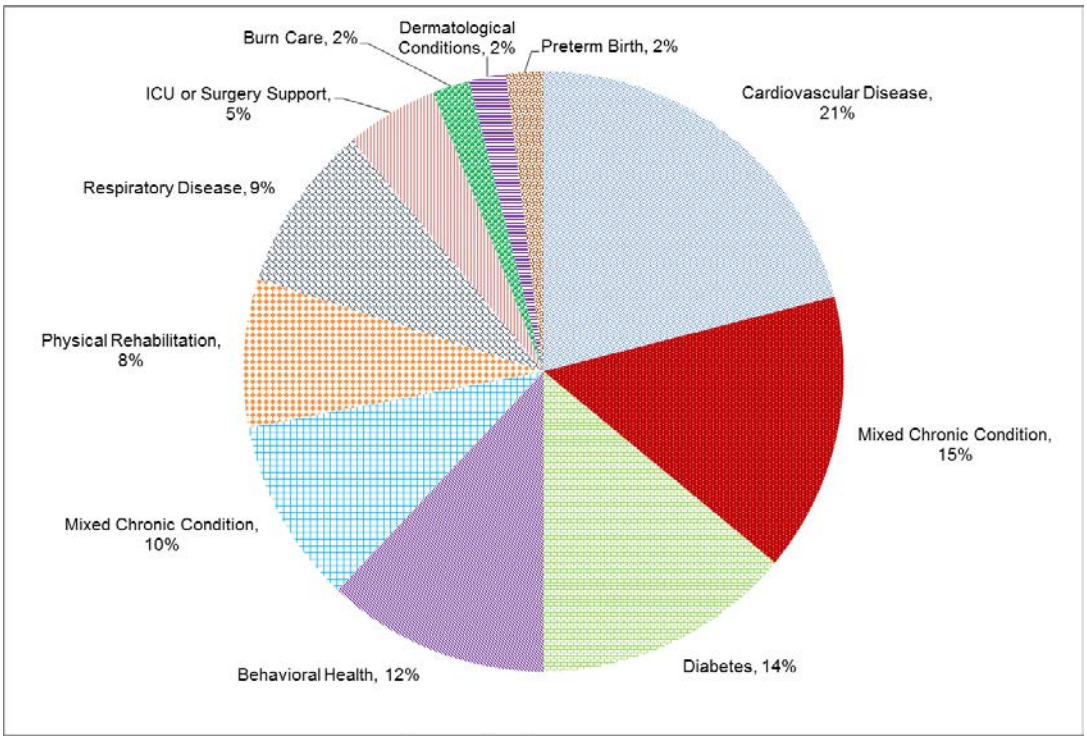
Figures 6 and 7 graphically present the distribution of included systematic reviews across the three major characteristics of the reviews (clinical focus, telehealth function, and telehealth modality).

Figure 6 depicts the distribution across clinical focus areas for the included reviews. Taking into account the number of reviews, primary studies, and patients, the most common clinical focus areas studied were cardiovascular disease (12 reviews). [41,42,45,47,67,73,81,82,84,87,89,95] The next largest group was mixed chronic conditions (9 reviews),[46,48-50,54,60,68,74,76] followed by diabetes (8),[43,53,63,69,80,88,91,92] behavioral health (7),[39,51,65,70,72,90,93] and mixed conditions (6).[38,56,59,64,78,86] Focus areas with five or fewer included systematic reviews were physical rehabilitation (5),[54,57,62,71,85] respiratory disease (5),[44,55,58,66,83] ICU or surgery support (3),[40,61,75] burn care (1),[79] dermatology conditions (1),[94] and preterm birth (1).[77] Over one-quarter of included systematic reviews (26%) focused on mixed chronic or mixed but not exclusively chronic conditions.

Figure 7 depicts the distribution of the function the telehealth interventions perform in health care delivery. The included reviews examined telehealth used to provide treatment, monitor patients' signs and symptoms, or facilitate communication between provider and patient. These

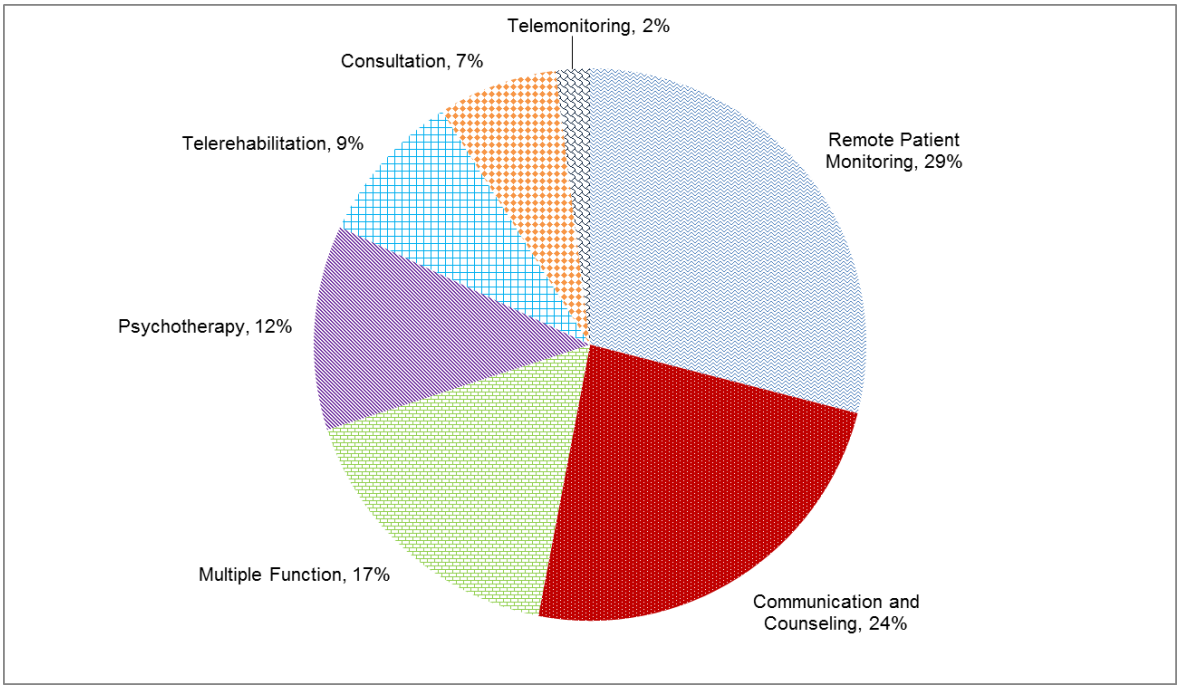
functions could replace or supplement in person service delivery. Telehealth was most frequently used for remote patient monitoring (17 reviews)[41,42,45,54,55,58,66,68,73,76,77,81,83,87-89,91] and communication and counseling (14 reviews).[38,43,46,56,59,60,63,64,67,71,72,75,92,95] Ten reviews combined research on multiple functions,[44,49,50,53,69,74,78,80,84,86] seven summarized studies in which telehealth was used for deliver psychotherapy,[39,48,51,65,70,90,93] and five reviews focused on telerehabilition.[54,57,62,82,85] Four reviews examined studies in which telehealth was used to provide consultations about patient care[47,61,79,94] and one review focused on telementoring.[40]

Figure 6. Distribution of clinical focus across included systematic reviews



ICU = intensive care unit

Figure 7. Distribution of telehealth function across included systematic reviews



Indicators of Rigor of the Reviews

In **Table 1** we reported selected characteristics of the included reviews that can be interpreted as indicators of the rigor or utility of the review. Specifically assessing the results across studies using either a "strength of evidence approach" or quantitative synthesis (i.e., a meta-analysis) are of interest, as reviews that incorporate these approaches may be more in accordance with contemporary standards for high-quality systematic reviews. While meta-analyses can be done poorly it may produce results and conclusions that are more definitive and easier to interpret.

In **Tables 3 and 4** we report the percentage of included systematic reviews that used these approaches (strength of evidence and meta-analysis) as well as the number of studies in the reviews that were RCTs, according to clinical focus and telehealth function. While it is possible for RCTs to be of poor quality, randomized studies are generally considered to be higher in the hierarchy of evidence than observational studies and a preponderance of RCTs is often an indication, albeit imperfect, both of interest in the topic and the quality of the evidence.

Table 3 reports these systematic review characteristics by clinical focus. From this table it is possible to see that some clinical areas, such as burn care and ICU/surgery support, had been the focus of at least one systematic review, but that these reviews contained no or few RCTs and have not included meta-analyses. However, of the three reviews about ICU/surgery support, two included a strength of evidence assessment. Reviews of other topic areas also had a large proportion of RCTs among the included studies such as cardiovascular disease (85%) and diabetes (82%), and about half of the systematic reviews for these clinical focus areas reported strength of evidence (58% and 50%, respectively).

Table 3. Data synthesis methods used in systematic reviews by clinical focus

Telehealth Clinical Focus	Number of Systematic Reviews (N=58)	Individual Studies Within Systematic Reviews That Were RCTs n/N (%)	Systematic Reviews That Conducted Meta-Analysis n/N (%)	Systematic Reviews That Report Strength of Evidence n/N (%)
Cardiovascular Disease	12	103/121 (85)	8/12 (67)	7/12 (58)
Mixed Chronic Condition	9	139/210 (66)	3/9 (33)	3/9 (33)
Diabetes	8	85/103 (82)	5/8 (63)	4/8 (50)
Behavioral Health	7	83/137 (61)	3/7 (43)	1/7 (14)
Mixed	6	169/200 (85)	2/6 (33)	2/6 (33)
Physical Rehabilitation	5	48/81 (59)	1/5 (20)	2/5 (40)
Respiratory Disease	5	28/50 (56)	3/5 (60)	2/5 (40)
ICU or Surgery Support	3	1/19 (5)	0/3 (0)	2/3 (67)
Burn Care	1	0/16 (0)	0/1 (0)	0/1 (0)
Dermatological Conditions	1	8/24 (33)	0/1 (0)	0/1 (0)
Preterm Birth	1	14/15 (93)	1/1 (100)	1/1 (100)

ICU=intensive care unit, RCT=randomized controlled trial

Table 4 includes the same information by telehealth functions. Reviews of telehealth for consultation and telementoring had fewer RCTs. Reviews of communication and counseling studies contained 88 percent RCTs.

Table 4. Data synthesis methods used in systematic reviews by telehealth function

Telehealth Function	Number of Systematic Reviews (N=58)	Studies in Systematic Reviews That Are RCTs n/N (%)	Systematic Reviews That Conducted Meta-Analysis n/N (%)	Systematic Reviews That Report Strength of Evidence n/N (%)
Remote Patient Monitoring	17	146/202 (72)	11/17 (65)	10/17 (59)
Communication and Counseling	14	234/267 (88)	7/14 (50)	3/14 (21)
Multiple Functions	10	177/247 (72)	3/10 (30)	6/10 (60)
Psychotherapy	7	58/114 (51)	3/7 (43)	1/7 (14)
Telerehabilitation	5	43/72 (60)	1/5 (20)	2/5 (40)
Consultation	4	9/53 (17)	1/4 (25)	1/4 (25)
Telementoring	1	0/10 (0)	0/1 (33)	1/1 (100)

RCT=randomized controlled trial

We also evaluated the included reviews (n=58) for relationships between the conclusion (i.e., whether the telehealth provided benefit) and several independent variables; use of quantitative analysis (meta-analysis vs. not); use of strength of evidence (or not reported); and type of outcome (clinical, cost or utilization, or combined). Conclusions (dependent variables) were defined with two approaches: 1) benefit vs. no benefit and 2) reported positive or negative conclusion vs. no clear conclusion. All included studies were code for these independent and dependent variables. Chi square tests were used to explore differences between the observed counts and the expected counts using SPSS® (IBM SPSS® Statistics for Windows, Version 23). We found no statistically significant relationships ($p>0.05$) across all the chi-square analyses; however, the cell sizes for some comparisons were less than 10, suggesting that this quantitative approach was not appropriate for the analysis of this number of reviews and variables. To better understand the relationships between clinical condition, telehealth function, and effectiveness, we used qualitative approaches and the graphical presentations included in the next section.

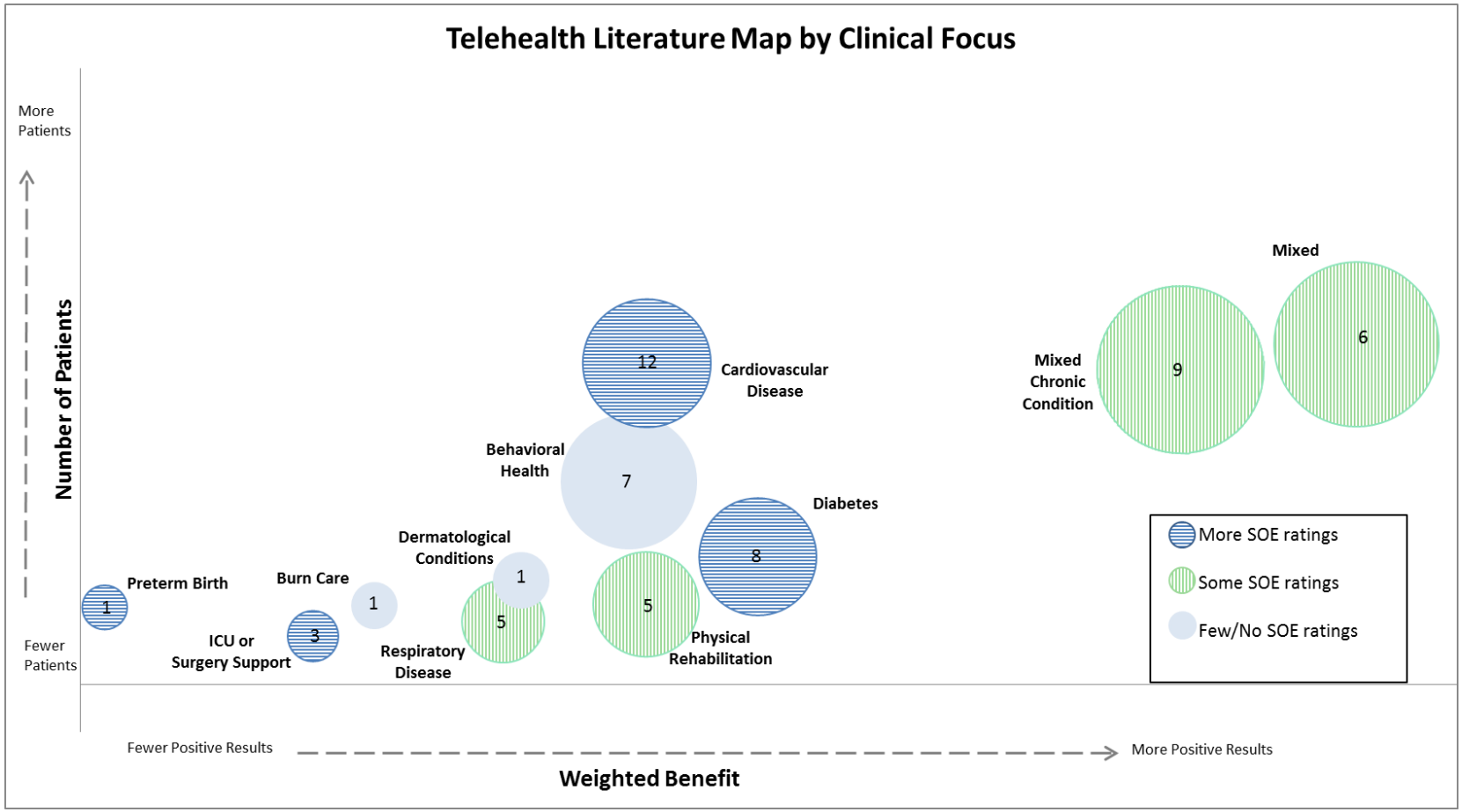
Evidence Map Core

The bubble and intersection plots in the sections below constitute the core of our evidence map and help to clarify the type of evidence that exists on telehealth and how useful it is for policymaking and clinical decisionmaking. We constructed the bubble plots for clinical focus and for telehealth function. After examining the results, we also created an intersection plot in order to examine how clinical focus and function overlap. Combined, we believe these provided the insights that most closely matched our stated objectives and questions and provided the best way to summarize and assess the state of the evidence about telehealth. In this section we presented a more detailed analysis after an overview of the three plots.

Clinical Focus

Figure 8 is the bubble plot by clinical focus. In this plot each bubble is a clinical focus area. The y-axis is the number of patients in studies in the systematic reviews, so the higher up the bubble is on the grid, the more patients were studied. The lists of studies were deduplicated, so that each patient is counted only once within a bubble. The size of the bubble is the number of studies included in the reviews, again with each study counted only once when determining the size of the bubble. The color of the bubble represents the percent of the reviews that included strength of evidence assessment. The horizontal placement along the x-axis is determined by weighting the overall conclusion of each review (coded as 0=no benefit, 1=unclear, 2=potential benefit, and 3=positive benefit) by the number of studies in the review. As stated above in the Methods section, this weighted estimate of reported effect was created by multiplying the overall conclusion code by the number of studies in the review and then averaging across the reviews for the clinical area or function. Bubbles more to the right indicate more positive findings while bubbles to the left represent findings that include more unclear conclusions or more reviews reporting no benefit. While the weighting does not create a value with absolute meaning, it allows comparisons of the consistency and direction of the conclusions across clinical areas.

Figure 8. Telehealth literature map of systematic reviews by clinical focus



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

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

ICU = intensive care unit; SOE = strength of evidence

As noted above (Table 2), the research volume, as measured by both the number of studies and the number of patients, is largest for mixed and mixed chronic conditions, followed by cardiovascular disease and behavioral health. This finding is represented on the plot by the fact that the bubbles are large and higher up on the y-axis. The mixed and mixed chronic condition bubbles are also farther to the right, indicating the conclusions of the reviews were that telehealth consistently provides benefit. The bubble representing diabetes shows that it is the single condition with fewer studies (the bubble is smaller) than mixed chronic conditions but about the same number as cardiovascular disease. However, diabetes studies included with fewer patients (the bubble is lower) than the cardiovascular disease studies but the findings were more positive findings (the bubble is farther to the right).

Telehealth Function

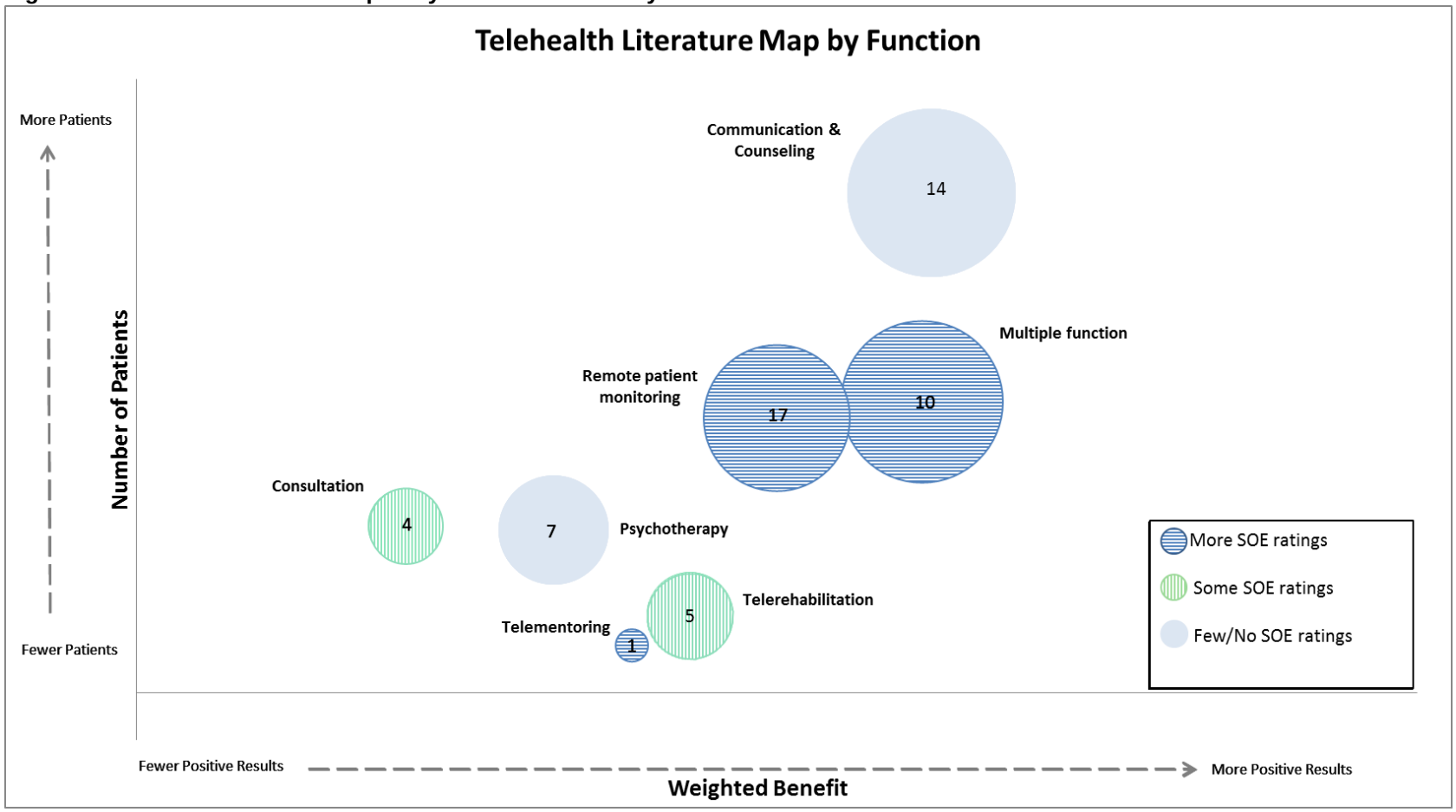
In addition to the evidence map by clinical focus, we also looked at the evidence by telehealth function. **Figure 9** represents the same included systematic reviews as shown in Figure 8 except the reviews are summarized by the function telehealth played instead of clinical focus.

Each bubble is a function of telehealth. The other variables are the same as in Figure 8. The y-axis is the number of patients in a deduplicated list of studies in the systematic reviews for that function; the size of the bubble is the number of unique studies included in the reviews about that function; and the color of the bubble is the percentage of reviews that include strength of evidence assessment. The horizontal placement along the x-axis is determined by weighting the overall conclusion of each review by the number of studies in the review (bubbles more to the right indicate more positive findings while bubbles to the left represent finding that that are unclear or found no benefit).

In this bubble chart, communication and counseling is the function bubble highest and farthest to right, indicating the most reports of positive benefits of telehealth when used for these purpose and that the studies in these reviews contained the highest number of patients among the function categories. Remote patient monitoring is lower than communication, as these studies included fewer patients, but it is higher than other functions. Remote patient monitoring is also toward the right, indicating that most reviews about remote patient monitoring conclude that telehealth provides benefits in quality of care or in utilization.

Reviewing the bubble plot provides a means of both comparing the characteristics of available evidence across topics and identifying areas where systematic reviews are not available to support decisions. The next steps in our analyses and mapping were designed to explore where clinical focus and function overlap.

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



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

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

SOE=strength of evidence

The Intersection of Clinical Areas and Telehealth Intervention Function

Much can be learned and several conclusions drawn from examining the literature on telehealth by clinical area/population of patients or by the health care function telehealth serves. However, examining the intersection of clinical areas and functions provides additional, more finely grained and potentially more useful insight for determining which telehealth intervention(s) could or should be used in specific patient populations. **Figure 10** displays how the evidence clusters by telehealth clinical area and function. Each of the systematic reviews that provide evidence for the intersection of the clinical area and function are represented in the corresponding cell by a circle that is shaded to represent the overall conclusion of the review. The number of studies in each review is included to the right of the circles. This intersection plot demonstrates how the research evidence about telehealth clusters into a few clinical area/telehealth function pairs, the extent to which the conclusions are consistent within and across these pairs, and the volume of research for each pair.

For example, the pair with the most reviews is cardiovascular disease and remote patient monitoring. There are seven circles in this cell representing seven systematic reviews. The shading indicates that the conclusions included five reviews finding telehealth provided benefit, one citing potential benefit, and one reporting no benefit. The reviews range in size from 4 to 30 studies.

Identifying subgroups of reviews allows more details to be examined in order to better understand patterns and diversity within the pairs. Empty cells include some potentially important topics for which we did not identify any reviews, and therefore could be topics for future reviews if primary literature is available. Some empty cells are intersections that are likely not applicable (e.g., psychotherapy and physical rehabilitation).

The diabetes and communication pair provides an example of the diversity of reviews even within a cell, the range of information available, and the challenges researchers conducting reviews and users of the reviews face. Three reviews concluded that telehealth resulted in benefit or potential benefit. One review summarized studies of social networking services in diabetes care and concluded that their use was feasible and effective.[92] Another review focused on how mobile phones were used in several ways to provide support and encouragement for patient self-management activities such as monitoring glucose, exercise, and maintaining diets, and found strong evidence of improvement in glycemic control in all patients, but the strongest for type 2 diabetic patients.[63] A third review reported potential benefits based on included studies that evaluated the use of a range of technologies to promote physical activity as part of type 2 diabetes management and concluded that telehealth is effective but that additional interventions were needed to sustain adherence, noting that the high dropout rate also raised concerns about potential bias in the results.[43]

Reviews of telehealth for diabetes that included multiple functions varied in that the conclusions were less strong, with two concluding the evidence was unclear and one reporting potential benefits from telehealth. One study in this clinical focus-function pair included studies of different technologies (e.g., electronic messaging, Web sites, and video conferencing) used to support glycemic control in patients with type 2 diabetes, but concluded that the evidence in their review was “unconvincing” due to concerns about publication bias and a small effects.[80] Another review related to diabetes was in the multiple function group as it included studies of mobile phone use both for communication as well as remote patient monitoring. This review concluded

that telehealth shows promise in this area but the evidence lacked rigorous study designs. Specifically, studies had insufficient sample sizes and short interventions and followup periods.[53] A third review of Web-based interventions for type 2 diabetes concluded that the Web could be used for behavioral interventions and to support self-management, however, the favorable results were enhanced if these were supplemented by other interventions such as case managers or mobile phone support and followup.[69]

Examining this plot shows where synthesized bodies of evidence (i.e., systematic reviews) about telehealth are available and allows more in-depth examination of details such as those included above about telehealth for diabetes and communication. Considering the empty cells or those with few or limited reviews allows consideration of the importance of these areas and whether they are gaps that should be addressed in future reviews and/or primary research. In the next sections of the results we identify gaps and delve more into selected topics. Then in the Discussion section we use this information to create categories related to the sufficiency and need for research in selected areas.

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

	Communication and Counseling	Remote Patient Monitoring	Multiple Functions	Psychotherapy	Consultation	Telerehabilitation	Telementoring
Mixed Chronic Condition	15 studies[46] 23 studies[60]	24 studies[52] 78 studies[76] 9 studies[68]	12 studies[49] 21 studies[50] 35 studies[74]	15 studies[48]	None	None	None
Cardiovascular Disease	29 studies[95] 13 studies[67]	9 studies[89] 10 studies[73] 11 studies[81] 30 studies[87] 9 studies[45] 13 studies[42] 4 studies[41]	11 studies[84]	--	5 studies[47]	12 studies[82]	None
Diabetes	34 studies[92] 21 studies[63] 15 studies[43]	6 studies[91] 2 studies[88]	13 studies[69] 21 studies[53] 35 studies[80]	--	None	None	None
Behavioral Health	34 studies[72]	None	None	10 studies[70] 9 studies[51] 23 studies[93] 12 studies[65] 7 studies[90] 45 studies[39]	None	--	None
Mixed Conditions	15 studies[59] 39 studies[64] 4 studies[38] 29 studies[56]	None	93 studies[86] 36 studies[78]	None	None	None	None
Physical Rehabilitation	16 studies[71]	None	None	--	None	9 studies[85] 27 studies[54] 28 studies[57] 10 studies[62]	None

	Communication and Counseling	Remote Patient Monitoring	Multiple Functions	Psychotherapy	Consultation	Telerehabilitation	Telementoring
Respiratory Disease	None	10 studies[66] 7 studies[58] 23 studies[55] 9 studies[83]	7 studies[44]	None	None	None	None
ICU/Surgery Support	1 study[75]	None	None	–	8 studies[61]	None	10 studies[40]
Burn Care	None	None	None	None	16 studies[79]	None	None
Preterm Birth	None	15 studies[77]	None	None	None	None	None
Dermatological Care	–	None	None	–	24 studies[94]	–	None

Legend: Positive Benefit Potential Benefit Unclear No Benefit

ICU=intensive care unit

Gaps and Priority Topics

Evidence Gaps

In order to identify which clinical and functional focus areas were not covered in the included systematic reviews, we assembled lists of telehealth practice domains generated by selected organizations and in reports on uses of telehealth, reviewed the notes from our KI interviews, and drew on our team's experience and expertise. Examples are included in **Table 5.** Certain domains on these lists may not be relevant if they do meet the definition of telehealth used for this report. For example, remote health care data management and some ancillary telemedicine services may not involve or augment an interaction between a provider and patient or interactions among providers about a specific patient, and would not be included here. It is also important to note that there is no definitive or authoritative list of domains, that these lists do not exactly correlate with our clinical focus areas and our definition of telehealth, and that the domains across these lists may overlap. This could be problematic if mutually exclusive categories were needed. However, for our purpose, which is to identify areas where systematic reviews that could support decisions are not available, these are useful. An initial review of these lists led us to identify certain areas that were not represented in our included reviews. For example, one such area is urgent/primary care.

Table 5. Examples of telehealth practice domains from four sources

American Telemedicine Association Workgroups[96]	Institute of Medicine[22]	Telehealth Round Table Testimony[21]	Center for Connected Health Policy Report[97]
• Wounds and Burns • Tele-ICU • Internet-based Telemental Health • Telepathology • Urgent/Primary Care • Remote Prescribing • Remote Healthcare Data Management	• Home and Community-based Care • Office-based Telemedicine • Ancillary Telemedicine Services • Hospital-based Telemedicine • Rural Health	• Patient Portals • eConsults • Video Visits and Consults • E-ICU • Telestroke	• Office/Outpatient Visits • Pediatrics and Pediatric Subspecialties • Psychotherapy and Assessment • Case Management • Specialty Consults • Chronic Disease Management (Diabetes, COPD, CHF, End Stage Renal Disease) • Cardiac Monitoring (included implanted device) • Medical Nutrition • Obstetric Monitoring • Speech Therapy

CHF=congestive heart failure, COPD=chronic obstructive pulmonary disease, E-ICU=electronic intensive care unit, ICU=intensive care unit

In order to determine if systematic reviews were underway on additional topics, we searched PROSPERO, the international prospective register of systematic reviews maintained by the University of York, Centre for Reviews and Dissemination.[98] We searched from August 1, 2013 through February 2016 for any ongoing reviews with the following words in any field: "telehealth" OR "telecare" OR "telemedicine" OR "eHealth" OR "mHealth." We reviewed the titles and identified 82 registered reviews that were listed as ongoing and appeared to be relevant. A list of the topics covered and the number of reviews on each topic is included in **Appendix H**. The most frequent specific topics of these reviews in process that were not well-represented in our included completed reviews are weight loss, cancer, and maternal/child health. Other topics such as diabetes (6 reviews in progress) and mixed chronic conditions (3 reviews in progress) are

represented in our included reviews, however, the PROSPERO entries means additional evidence syntheses will be available in the near future.

We also looked at the reviews we excluded (see **Appendix D** for a list and **Appendix I** for a table with the clinical focus area and the number of reviews). While these reviews did not meet our inclusion criteria, knowing there are substantial numbers of these reviews and which clinical areas they cover is useful because it could indicate that a more formal, rigorous, or differently structured systematic review could be conducted using the primary studies in these reviews. An assessment of the clinical focus areas covered in these excluded reviews revealed that they included additional areas not well-covered in our included reviews such as cancer, chronic pain, autism, and pregnancy (our map is limited to one review on uterine monitoring to prevent preterm birth). At the same time, this list also includes many of the areas that were covered in our included reviews, suggesting it is possible additional research exists that could be added to the body of evidence for these areas. It may also suggest that the utility of the evidence in these reviews could be increased if the included studies were summarized and analyzed in a different way. Specifically, reviews could 1) include quality assessments of the studies they include and examine whether their conclusions would differ if only high-quality studies were included and 2) include subgroup analysis by clinical focus or telehealth function or modality for reviews that have a wide range of telehealth interventions.

We identified one example of this type of supplemental analysis in our literature search. The original review[99] was excluded by us because structured telephone calls were included interventions in the review along with videophone and telemonitoring and the results were not summarized by type of intervention. In the subgroup analysis completed and published later, Conway and colleagues[81] reanalyzed the data by type of technology used in remote monitoring for heart failure. This allowed us to include the review for the telehealth interventions, and exclude the studies of telephone calls. It is likely that this analysis would also be more informative for practice and policy decisionmaking.

After reviewing the topics covered in the included systematic reviews, reviews in progress, and the reviews that were excluded, we identified three areas in which telehealth had been proposed as appropriate or studied that were not well-represented: 1) triage for urgent care/primary care, 2) maternal health, and 3) pediatric cancer and chronic pediatric health conditions, and one area, 4) dermatology, where telehealth has been widely used, but the focus of the research included in reviews had been on diagnostic accuracy/agreement, not patient outcomes. We conducted a targeted search for primary studies on each of these topics (from 2006) and reviewed the abstracts for clinical focus, telehealth function, and modality. (Search strategies appear in **Appendix A**.)

Triage for urgent care has historically been provided most often in the form of advice from a nurse by phone; however, recent studies suggest telehealth is playing an increasing role, particularly related to heart health. Telehealth interventions are being used help decide the level of care needed in different situations. These have been used to address the following indications: chronic heart failure, arrhythmias causing dizziness/presyncope, flu, and a variety of primary care indications. Telehealth interventions are being used for the following functions: communication, monitoring, and diagnosis of heart arrhythmia conditions. Several modalities are described in the literature: mobile phone images, patient portals, single-lead electrocardiogram, mobile applications, and continuous mobile cardiac outpatient telemetry. We reviewed 353 abstracts of primary studies but identified only five potentially relevant studies, two of which were about cardiac care and may overlap with our included reviews on cardiovascular disease.

Much of this literature on triage was about telephone-only advice or nurse lines, which is not telehealth as defined for our evidence map. Another subtopic identified that did not fit our definition is use of telehealth by first responders forwarding data to the emergency room about myocardial function or other cardiovascular problems so the emergency department can be prepared when the patient arrives.

For maternal health, we reviewed 129 abstracts and identified 33 articles that evaluated several telehealth functions (remote fetal monitoring, antepartum cardiotocography monitoring, triage, consultation, counseling and health promotion, communication, screening, and diagnosis) in managing the following: gestational diabetes, perinatal depression, high-risk pregnancy, fetal and pediatric cardiology, pre-eclampsia, pregnancy termination, and fetal alcohol spectrum disorder. The studies used several modalities, including robotic ultrasound, videoconferencing, patient portals, text messaging/SMS, customized Web sites, mobile applications, and electronic logbooks.

We reviewed 61 abstracts from our search on telehealth for pediatric cancer and other chronic pediatric conditions. We found 12 potentially relevant studies—articles that performed the following telehealth functions: counseling in the form of support to families, remote case management, monitoring, psychotherapy, and consultation. These studies addressed the following indications: five were about pediatric cancer and the others covered several conditions including asthma, tic disorders, and other complex illnesses.

For dermatology, we identified and included one systematic review[94] and reviewed references from one narrative review[100] which included studies of clinical outcomes in addition to diagnostic concordance. As this suggests that research in the field may be expanding, we searched for studies of teledermatology that included clinical outcomes. We identified 315 abstracts on telehealth and dermatology of which only 15 included indexing terms for clinical outcomes. Our review of both the subset and the larger set of results failed to identify a discrete group of primary studies of teledermatology with clinical outcomes. The results included the studies in the reviews mentioned above, as well as abstracts of descriptive articles, articles not in English, feasibility studies, studies of diagnostic concordance, and studies with outcomes that were mixed or not clearly stated in the abstract. While further analysis of the literature would be needed to definitively confirm this, it appeared there were still few studies of teledermatology that include clinical outcomes.

Priority Topics

In creating the plots and tables, we sorted the included reviews into 11 different clinical categories and 7 different functions. While it is not unusual for bubble plots in literature maps to have 30 to 50 categories,[5,8] we also wanted to look across categories and summarize the results related to selected key policy and practice questions. In this section we describe in more detail the findings related to two subsets of the reviews that cut across categories and overlap, but that represent important approaches to considering telehealth.

Chronic Disease/Older Patients

A frequently cited target population for telehealth is patients with chronic disease, most of whom are older. The logic is straightforward, if over simplified here: patients with chronic disease are likely to require frequent visits for monitoring and management as well as support to self-manage their conditions. However, they may have barriers to access, or office visits may not be the best type of support and these challenges can be ameliorated by telehealth. Furthermore,

by avoiding acute episodes (e.g., hospitalization for COPD) or adverse effects (e.g., amputations in diabetics), telehealth can reduce costs while increasing function and quality of life.

Thirty-one of the systematic reviews we identified for this report examined telehealth in either multiple chronic conditions or specific chronic conditions. This included the 9 reviews we classified as mixed chronic conditions,[46,48-50,52,60,68,74,76] all 8 of the reviews that focused specifically on diabetes,[43,53,63,69,80,88,91,92] 10[41,42,45,73,81,82,84,87,89,95] of the 12 reviews on cardiovascular disease (those not considered chronic included 1 about acute myocardial infarction[47] and 1 about primary prevention),[67] and 4 of 5 about respiratory illness (1 included telehealth use in transplant),[55] including 3 about COPD[58,66,83] and 1 about cystic fibrosis.[44]

Only two of these reviews, one about diabetes[53] and one about cystic fibrosis,[44] included studies with children as well as adults, and one other review included pregnant women with pre-existing diabetes.[88] While most of the reviews did not specify elderly, the patients in these studies were adults with chronic conditions and most were older. The majority of the systematic reviews (16 of 31) included telehealth interventions used for remote patient monitoring : six reviews focused on telehealth used to provide counseling or facilitate other communication and seven reviews included multiple functions, while one review examined the use of telehealth for psychological therapies and one considered rehabilitation.

As a group, the conclusions of the systematic reviews of research on the effectiveness of telehealth for chronic conditions were generally positive. Of the 31 studies, 13 (42%) reported benefits in primary or most outcomes, 11 reported potential benefits, 4 found no benefit, and 3 stated that the impact was unclear. Details on the findings from the thirteen reviews reporting benefits are included in **Table 6** below. These reviews have characteristics associated with rigorous systematic review methods: 8 of 13 included some approach to assessing the strength of evidence across studies and 10 included a quantitative meta-analysis.

Table 6. Selected results: Systematic reviews of telehealth for chronic conditions

Clinical Focus of SR	Author, Year Number of RCTs/Total Number of Included Studies Telehealth Function	Selected Results: Clinical Outcomes	Selected Results: Cost and/or Utilization
COPD	Kamei, 2013[58] 7/9 Remote Patient Monitoring	Mortality: No significant difference (5 trials) Fewer disease exacerbations Risk ratio from meta-analysis (2 trials)	Fewer hospitalizations Meta-analysis of 6 trials Fewer emergency department visits Meta-analysis of 4 trials
	McLean, 2011[a,66] 10/10 Remote Patient Monitoring	Higher quality of life (2 trials) Mortality: No significant difference 3 trials	Fewer hospitalizations Meta-analysis of 6 trials Fewer emergency department visits Meta-analysis of 3 trials
Heart Failure	Conway, 2014[81] 11/11 Remote Patient Monitoring	Lower reduced all-cause mortality (RR 0.62; 95% CI 0.50-0.077; p<0.0001)	Fewer HR-related hospitalizations (RR 0.75; 95% CI 0.63-0.91; p=0.003)
	Dang, 2008[45] 9/9 Remote Patient Monitoring	Lower mortality in 3 studies (not significant in 4; not reported in 2)	Fewer heart failure-related hospital admissions: 6 of 9 studies (1 trend toward increase; 2 not reported)
	Kotb, 2015[87] 30/30 Remote Patient Monitoring	Lower mortality (OR 0.53; 95% CI 0.36 - 0.080)	Fewer HR-related hospitalizations (OR 0.64; 95% CI 0.39-0.95)
	Seto, 2008[73] 4/10 Remote Patient Monitoring	None reported	Lower direct costs Reduced compared to usual care in all 9 studies that analyzed this (range 1.6% to 68.3%). Attributable to reductions in hospitalizations. Lower patient costs: 1 study reported reductions in travel costs
Secondary Prevention: Cardiovascular Disease	Widmer, 2015[95] 28/29 Communication and Counseling	Reduction in CVD outcomes, weight, body mass index and Framingham risk score. No improvement in blood pressure.	None reported
Implanted Cardioverter-Defibrillators	Parthiban, 2015[89] 9/9 Remote Patient Monitoring	Not significantly different from office followup overall Reduction in all-cause mortality in 3 studies with daily transmission verification (OR: 0.65; p=0.021) Reduction in inappropriate shock OR 0.55; p=0.002	Similar hospitalization to office followup

Clinical Focus of SR	Author, Year Number of RCTs/Total Number of Included Studies Telehealth Function	Selected Results: Clinical Outcomes	Selected Results: Cost and/or Utilization
Diabetes	Liang, 2010[63] 11/22 Communication and Counseling	Improvement in clinical outcomes, meta-analysis of 22 studies (diabetes)	None reported
	Saffari, 2014[91] 6/6 Remote Patient Monitoring	Improvement in HgA1c	None reported
	Toma, 2014 [92] 34/34 Communication and Counseling	Improvement in clinical outcomes (HgA1c, BP, triglycerides and total cholesterol)	None reported
Mixed Chronic Conditions	Tran, 2008[76] 18/34 Remote Patient Monitoring	Improvement in clinical outcomes for diabetes and heart failure, meta-analysis of 12 and 5 trials (not seen in COPD—1 study reported higher mortality)	Fewer hospitalization and emergency visits More primary care and specialty visits
	de Jong, 2014[46] 15/15 Communication and Counseling	Improvement in clinical outcomes (5 trials) Improvement in symptoms (5 trials) Positive psychosocial outcomes (5 trials)	Physician visits: difference not significant 2 trials

BP=blood pressure, CI=confidence interval, COPD=chronic obstructive pulmonary disease, HgA1c=hemoglobin A1c, HR=hazard ratio, OR=odds ratio, RCTs=randomized controlled trials, RR=relative risk
[a] Two individual studies are repeated in these reviews

Remote Patient Monitoring

Remote patient monitoring is a frequently studied telehealth function. Seventeen of the included reviews assessed telehealth use for monitoring and managing illnesses[41,42,45,52,55,58,66,68,73,76,77,81,83,87-89,91] and five assessed multiple functions that included remote patient monitoring.[49,50,78,84,86] Remote monitoring is of particular interest in considering telehealth because it makes new or significantly different forms of information and treatment available that can supplement and extend office-based care rather than replace face-to-face interactions. Specifically, many remote monitoring applications of telehealth allow patients to provide more data to providers, in a timelier way than could be obtained in outpatient visits, or allow patients to be monitored in their homes rather than in hospitals. With this information, providers can then tailor their recommendations and treatment. In this usage, telehealth changes not just the mode of care delivery (from face-to-face and in real time to something distant and/or asynchronous); rather it transforms the form of care.

In some studies, remote monitoring uses specialized devices to record and transmit data, but some types of remote monitoring may be done using more standard devices with specialized applications (e.g., mobile phones and computers with internet connections). Most, but not all of the reviews we identified used remote patient monitoring in the context of single or multiple common chronic conditions (e.g., diabetes, COPD, and congestive heart failure). The exceptions were a review of uterine monitoring of pregnant women to prevent preterm births[77] and

monitoring that allowed parents to monitor babies in neonatal ICU and communicate with providers.[75]

Of the 22 reviews that synthesized studies of monitoring, 10 concluded telehealth lead to positive benefits, 6 concluded benefits were possible, 2 were inconclusive, and 4 reported no benefit from telehealth. The 10 that reported benefits overlapped with those discussed in relation to chronic disease and are in Table 6 and the 6 that concluded potential benefit for remote patient monitoring also addressed chronic conditions.

Three of the four that reported no benefits explored very different applications of remote monitoring: a review of the use of home uterine monitors to prevent preterm birth that found no impact on maternal and perinatal outcomes,[77] a review of the addition of real time video as part of home care,[68] and a review that identified only one study of the use of monitoring for parents with babies in neonatal intensive care unit that did not find a significant difference in the primary outcome (i.e., length of hospital stay).[75]

While the overlap of telehealth for chronic conditions and monitoring is not unexpected, it reinforces the potential of telehealth as a positive, transformative force in the care of chronic illnesses; one that may require more attention, development, or more adaptation for other uses.

Impact on Costs and Utilization

Fewer of the systematic reviews included in the map focused on costs or economic impact of telehealth exclusively. Out of 58 included reviews, 32 contained some cost/utilization outcomes and of these 7[41,57,59,61,68,73,75] focused on these outcomes exclusively. In the remaining 25 reviews, clinical outcomes and cost or utilization were included. [38,42,44-46,49,50,52,54-56,58,65,66,77-81,83,84,86,87,89,94]

In general, the results reported for clinical outcomes were more extensive and the syntheses more sophisticated than those reported for costs or utilization. For example, there were fewer meta-analyses of utilization than of clinical outcomes, and there were very few true cost-effectiveness or cost-benefit analyses identified in the included reviews. It is also important to note that costs are perhaps more affected by the organization of health services, coverage policies, and health policy in general than clinical outcomes. For this reason, it is necessary to underscore that the studies included in currently available reviews were not conducted under new models of care. In addition, not all of these studies were conducted in the United States and costs may be very different in different health care systems (e.g., 2 studies of telehealth for gastrointestinal care were conducted in Sweden, and one study that focused on travel costs was conducted in Newfoundland).

Figure 11 is a variation of Figure 10. For this version we re-reviewed the 32 systematic reviews that included any information on cost, cost-effectiveness, or health services utilization. Each review is represented by a bubble placed in the grid consisting of rows for telehealth functions and columns for clinical focus areas. The shading of the bubble represents the overall conclusion: whether for these outcomes the research suggests that telehealth provides a benefit, a potential benefit, is inconclusive, or provides no benefit. For this figure, benefit is defined as cost savings or reduction in health services utilization. For reviews that included both clinical outcomes and cost/utilization, only the cost/utilizations outcomes are included here.

Telehealth functions and clinical areas represented in the literature overall (including clinical as well as cost outcomes) are not all represented when we limit our focus to costs and utilization. None of the reviews contained cost or utilization outcomes for telementoring, and behavioral health is less well represented (1 review included costs/utilization out of 6 reviews included). In

general, the cost/utilization results were less positive, in that they reported less benefit. Four reviews (13%) concluded telehealth provides benefit in terms of reduced costs or utilization, 11 (34%) potential benefit, 10 (31%) were inconclusive, and 7 (22%) found no benefit or increases in cost or utilization.

Table 7 contains a row for each included systematic review that included reports on cost or utilization outcomes and provides the key findings cited in the reviews. Most of these finding are not the result of complex, sophisticated, or even comprehensive analyses. A few meta-analyses on utilization such as hospital admissions and emergency department visits were available. Furthermore, very few studies considered the overall cost-impact or cost-effectiveness of an intervention; rather they documented individual costs or resource use measures taken in isolation. Comprehensive cost-analyses are needed to understand the full implications of telehealth in various situations. Several of the authors of the reviews underscored that cost information was incomplete or inconsistently reported.

We re-examined our search of PROSPERO, a database of systematic review protocols for reviews in progress. From this we identified four pending reviews. Two planned to review the evidence for specific uses; costs of telehealth in home care and cost effectiveness of teleconsultations for patients in rural areas. The other two reviews were more general, examining the impact of mHealth and cost-effectiveness of health information technologies; this will only be useful for telehealth policy decisions if the reviews create subsets of health information technologies or include costs in their assessment of impact.

This initial review of information complied to create an evidence map suggests that information on costs is limited and costs and utilization may be an appropriate topic for additional research. While there may be primary studies that could be synthesized in a new review, there will be applicability challenges because current pending policy decisions are likely concerned with newer, integrated models of care, and existing research is likely to be based predominately on experiences in fee-for-service and nonintegrated-care organizations. More primary research is needed about how telehealth impacts costs and utilization of health services, although restrictions on funding cost-effective research may be a barrier to research that could address these current policy and practice questions.

Figure 11. Evidence on cost and utilization from systematic reviews: the intersection between clinical focus and telehealth function

	Communication and Counseling	Remote Patient Monitoring	Multiple Functions	Psychotherapy	Consultation	Telerehabilitation	Telementoring
Mixed Chronic Condition	15 studies[46]	24 studies[52] 9 studies[68]	10 studies[49] 21 studies[50]	None	None	None	None
Cardiovascular Disease	None	12 studies[73] 9 studies[45] 11 studies[42] 4 studies[41]	None	--	None	None	None
Diabetes	35 studies[80]	None	None	--	None	None	None
Behavioral Health	None	None	None	12 studies [65]	None	--	None
Mixed	15 studies[59] 5 studies[38] 31 studies[56]	None	36 studies[78]	None	None	None	None
Physical Rehabilitation	None	None	None	--	None	28 studies[57] 27 studies[54]	None
Respiratory Disease	None	7 studies[58] 23 studies[55] 10 studies[66]	7 studies[44]	None	None	None	None
ICU/Surgery Support	None	1 study[75]	None	--	8 studies[61]	None	None
Burn Care	None	None	None	None	24 studies[79]	None	None
Preterm Birth	None	15 studies[77]	None	None	None	None	None

ICU=intensive care unit

Note: Study counts given reflect the total number of studies included in the review, including studies that did not analyze cost.

Legend: Benefit Potential Benefit Unclear No Benefit

Table 7. Telehealth cost and utilization: Findings from systematic reviews

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
Positive Benefit= Cost Saving Or Utilization Reduction	Conway, 2014[81] Remote Patient Monitoring Cardiovascular Disease	• Reduction in heart failure hospitalizations RR 0.75; 95% CI 0.63 to 0.91; p=0.003 (3 studies)
	Kotb, 2015[87] Remote Patient Monitoring Cardiovascular Disease	• Reduction in health failure hospitalization o for telemonitoring: OR 0.64; 95% CI 0.39 to 0.95 (3 studies) o for telemonitoring that included transmission of ECG data OR 0.71; 95% CI 0.52 to 0.98 (3 studies)
	Seto, 2008[73] Remote Patient Monitoring Cardiovascular Disease	• Savings ranging from 1.6% to 68% to the health care system (9 studies) • 3.5% saving on patient travel (1 study)
	Kamei, 2013[58] Remote Patient Monitoring Respiratory Diseases	• Hospitalization risk lower with telehome monitoring; RR 0.81; 95% CI 0.69 to 0.95 for severe and very severe COPD (5 studies) o difference not significant for moderate disease (2 studies) • ED visits lower; RR 0.52; 95% CI 0.41 to 0.65 (4 studies)
Potential Benefit= Likely Savings Or Utilization Reduction (mixed results, but tending toward benefit)	Dang, 2009[45] Remote Patient Monitoring Cardiovascular Disease	• 20% to 63% reduction in health care utilization costs (3 studies) • 53% to 62% reduction in overall admissions (6 studies) o No difference in admissions (3 studies) • Significant reductions in ED visits (2 studies) o No difference (4 studies)
	Clarke, 2011[42] Remote Patient Monitoring Cardiovascular Disease	• Mixed finding about cost; 4 studies concluded costs were reduced; 2 found no significant difference • No cost-effectiveness or cost benefit • Significant reduction CHF admissions Meta-analysis RR 0.73; 95% CI 0.62 to 0.87 (6 studies) • No difference: All cause hospital admission (6 studies) • No difference: All cause ER (4 studies)
	Chaudhry, 2007[41] Remote Patient Monitoring Cardiovascular Disease	• Reduction in all cause hospitalizations (15%) (1 study) • Reduction in heart failure hospitalizations (40%) (1 study) • No difference in comparative studies of video and phone support (2 studies)
	Cruz, 2014 Remote Patient Monitoring/ Respiratory Diseases	• Reduction in hospitalizations (8 studies) • No difference in other utilization outcomes (number of hospitalizations, length of stay, emergency department visits • Trend toward reduced costs
	Jaana, 2009[55] Remote Patient Monitoring Respiratory Diseases	• Utilization-no consistent evidence (13 studies) • Mixed results from cost estimates or analysis (8 studies) o 2 showed ability to produce savings

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
	Garcia-Lizana, 2007[52] Remote Patient Monitoring Mixed Chronic Conditions	• Asthma: significant reduction in hospitalization (1 study) • Reduction in ER mixed: significant (2 studies); not significant (2 studies) • Hypertension: Early study (1996) reported cost-effectiveness (1 study) • Heart failure: Reduction in readmissions-mixed (1 study significant, 1 not significant); ER (2 studies significant; Hospitalizations (1 study significant, 3 not significant) • Diabetes: cost reduction (1 study significant, 1 not significant)
	Knowles, 2013[59] Communication & Counseling Other-GI	• 87% of intervention group had lower medical costs and estimated savings at $39,821 per person (1 study in Sweden) • 36% of IBS patients that reported reduced clinical symptoms resulted in savings of $16,806 per person (1 study in Sweden) • No difference in utilization (5 studies) • Reduced costs for mileage and patient travel time (1 study)
	Kairy, 2009[57] Telerehabilitation Physical rehabilitation	• 17% lower cost ($100) for telePT vs. in-home PT (1 study) • 58% lower cost ($ NR) for telecardiac rehab vs. inpatient rehab (1 study) • 850 sessions per year as break-even point for videoconferencing (1 study) • Resource utilization: mixed findings (3 studies)
	Hailey, 2010[54] Telerehabilitation Physical rehabilitation	• Spinal cord injury: fewer hospital days (1 study) • Arthritis: no difference in health care utilization (1 study) • Knee pain in elderly: lower hospital costs and shorter length of stay (1 study) • Elderly at risk of readmission: lower ER admissions and GP visits (1 study)
	Martin, 2011[65] Psychotherapy Behavioral Health	• Telepsychiatry for 3 months was less expensive than usual care due to lower travel costs of $419 vs. $428 per patient (1 study conducted in Newfoundland)
	Eland de Kok, 2011[49] Multiple Functions Mixed Chronic Conditions	• No significant difference in number of visits (2 studies) • Return on investment of 2.13 and net cost savings of $948 per person (1 study) • Visit costs were $48 for actual; $22 for virtual and $33 for virtual visits and monitoring (1 study)
Inconclusive	Cox, 2012[44] Remote Patient Monitoring Respiratory Disease	• Only cost estimate was from a single patient case study (1 study)
	Gaikwad, 2009[50] Multiple Functions Mixed Chronic Conditions	• Reductions in utilization or cost (6 of 13 studies, details not provided)

Conclusion Category	Author, year Function/Clinical Area	Selected Findings
	McLean, 2011[66] Remote Patient Monitoring Respiratory Disease	• Fewer hospitalizations RR 0.46; 95% CI 0.28 to 0.68 (4 studies: 2 telehealth, 2 complex interventions) • Fewer ER visits driven by one study of complex interventions; 2 studies of telehealth not significant (RR 0.19; 95% CI 0.03 to 1.27) • Estimate reducing hospital days (1 out of 2.8 per patient) would pay for the system in one year (1 study-modeling not actual data) • Reduced costs of nursing visits due to time saved by nurse travel • Savings for telehealth but estimate very imprecise (1 study with a wide SD)
	Ammenwerth, 2012[38] Communication & Counseling Mixed Conditions	• Larger decrease in office visits in the patient portal group compared to control (1 study) • Increase in ER visits and no difference in hospitalization or heart failure clinic visits (1 study)
	Devi, 2015[84] Multiple Functions Cardiovascular Disease	• No difference in health care utilization (2 studies) • Likely cost-effective in increasing activity (1 study) • Projected 213% return on investment based on health care costs for cardiovascular events (1 study)
	Flodgren, 2015[86] Multiple Functions Mixed Conditions	• Admission to hospital (11 studies). Inconsistent results (RRs range from 0.36 to 1.60; high level of heterogeneity precluded meta-analysis) • One study reported no difference in total health services costs; 1 small study (n=25) reported lower costs for hospital readmission costs
	Wade, 2010[78] Multiple Functions Mixed Conditions	• 35 studies looked at costs for health services. 49% reported higher costs; 46% lower; 3% costs went from higher to lower over time, and 3% costs were the same. • When costs are viewed from a societal perspective, more studies (61%) report lower costs due to reductions in patient travel in rural areas
	Warshaw, 2011[94] Consultation Dermatological Conditions	• Cost studies were limited. Finding support cost effectiveness if critical assumptions are made but studies vary widely in terms of factors included in cost assessments and the perspective used. (10 studies) • Patient required fewer visits (14 studies) o Clinic visits avoided. In 3 of 4 comparative studies, fewer "preventable" visits.
	Wallace, 2012[79] Consultation Burn Care	Cost • Cost outlay range $1300 - $115,000; cost avoided (e.g., transport costs) $2000 per month and $14,000/ 2 patients treated (2 studies) • Patient costs reduced by a few hundred dollars for followup care (7 studies) • Break-even point was 774 telehealth consultations (1 study)
	Kumar, 2013[61] Consultation ICU	• Implementation $50,000-$100,000 per bed over first year. Cost change after first year range from -$3,000 to + $5000 per patient (6 studies)
No Benefit= No Difference or Increase in Costs/Utilization	Parthiban, 2015[89] Remote Patient Monitoring Cardiovascular Disease	• No difference in hospitalizations (OR 0.83; 95% CI 0.63 to 1.10; p=0.196) (7 studies) • Nonsignificant increase in unscheduled visits (OR 1.29; 95% CI 0.99 to 1.67; p=0.061) (5 studies)

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

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

Telehealth and New Models of Payment and Service Delivery

A key policy consideration is how telehealth might figure into new service delivery and payment models. Initiatives such as value-based purchasing and Accountable Care Organizations have been designed to create incentives for care that is high quality, accessible, and lower cost.[101] Indeed, the US Centers for Medicare and Medicaid Services has a stated goal of increasing Medicare and Medicaid reimbursement to value-based models that share risk with provider organizations and give incentives for more coordinated and efficient care.[102] The incentives are to improve or meet targets for performance on multiple measures. For example in the Medicare hospital value-based purchasing program, payments are adjusted based how a hospital scores on several measures in four domains (clinical processes, patient experiences, outcomes, and efficiency).[103]

Many of the evaluations of telehealth we identified considered a variety of outcomes, including clinical outcomes and health services utilization (e.g., hospitalizations and urgent visits) and costs. While most studies did include more than a single outcome, none purposefully examined the impact of telehealth on all the domains or the groups of measures used in these new models. This is understandable, as the widespread use of these models of reimbursement is relatively new to health care in the United States, and studies of telehealth have not yet been able to assess the contribution of telehealth to value-based models.

While it may be possible to make some inferences with regards to value-based care across studies, doing so would require re-examining the literature and organizing a review around

groups of measures similar to those used in these new models. However, this approach is unlikely to identify studies where the suite of measures is used within an organization, making it difficult to determine how telehealth and performance measures interact across these domains. Understanding this would require additional primary research that evaluates telehealth on all the relevant domains, though reviews of existing evidence could be used to inform the development of a demonstration or evaluation by suggesting which combinations of telehealth technologies and functions combined with specific patient populations should be the focus of larger studies.

Carrying out telehealth research under models of value-based care presents an important opportunity for future work, as any intervention or innovation that delivers care in more coordinated and efficient ways could be of great benefit to organizations entering into shared-risk models. For example, the processes and outcomes related to managing chronic disease could potentially be enhanced by some of the beneficial aspects of telehealth identified in the systematic reviews described above. Research would need to go beyond clinical factors and focus on delivering benefits not only from an individual-patient perspective, but from a population health management perspective as well.

Discussion

Summary and Implications

This technical brief was designed to characterize the existing systematic reviews available to inform decisions about telehealth, using an evidence map approach. Various stakeholders, including federal and state policymakers, health care provider organizations, insurers and payers, are faced with making decisions related to supporting, implementing, and paying for telehealth. The literature, specifically in the form of systematic reviews is helpful and important to the extent that research can be used as evidence to support these decisions. When the evidence either does not exist or exists in a form that is not useful, additional work is required. An evidence map is a preliminary step in a multi-step process that can be used to identify relevant evidence and to initiate the process of developing a research agenda that can address remaining gaps.

This broad overview focuses on 58 systematic reviews that evaluate studies of telehealth, defined as the use of technology in interactions, over time or space, between providers and patients or between two providers. We grouped these results by clinical focus areas (a hybrid of conditions, body systems, and type of health care), and developed an approach to assessing the volume of the literature in terms of number of unique studies and the number of patients in these studies. We also weighted the conclusion (i.e., whether the systematic review concluded that telehealth provided a benefit) in order to provide a relative estimate of the benefit across clinical areas.

Creating bubble and intersection plots allowed us to identify areas where significant evidence exists supporting the benefits of telehealth (e.g., chronic conditions, diabetes, cardiovascular disease and behavioral health), where the evidence is more moderate (e.g., physical rehabilitation), and areas with a smaller evidence base and less positive conclusions (e.g., ICU, surgery support, and preterm birth).

We categorized abstracts of reviews in progress, reviews that mixed different interventions or did not consider the quality of the included studies, and conducted searches for primary studies in order to determine if more evidence was available for either the identified clinical focus areas with few included reviews or for areas that telehealth is likely being used or considered that were not covered by the included reviews. We identified protocols for 82 reviews in progress that would likely both increase the evidence for clinical areas we identified and add to additional topics such as maternal health and pediatrics. We also considered the reviews we excluded as indicators of the existence of primary studies that could be reanalyzed. Clinical areas not covered by our included reviews but included in reviews in process or excluded reviews were cancer, chronic pain, autism, and pregnancy.

Based on a combination of these assessments including the first bubble plot, we identified three areas where telehealth is likely being studied that were no covered by our included reviews and we conducted a search and scan of research primary literature. We identified primary studies in maternal health, in complex pediatrics, and in triage that evaluated the effectiveness of telehealth.

In a second plot, we replicated the bubble plot and organized the reviews by the health care function for which telehealth was used. In this analysis the largest number of studies and largest number of patient participants involved telehealth for communication and counseling followed by remote patient monitoring and multiple functions. A smaller evidence base of fewer studies and patients was available for the use of telehealth in psychotherapy and consultation.

Our third plot depicts the evidence at the intersection of clinical focus and function, creating smaller subgroups that we refer to as topics. This plot (Figure 10) showed that the systematic reviews that met the inclusion criteria were concentrated in communication/counseling and monitoring/management functions across all clinical categories. Cardiovascular disease/remote patient monitoring had the most evidence followed by psychotherapy and behavioral health.

We described the interventions and results in the reviews about telehealth for diabetes and communication in the results section as an example and we looked more broadly at applications for chronic diseases and telehealth use for remote patient monitoring. We also examined the impact of telehealth on service utilization and costs. Next we drew on our assessment of included and excluded reviews and our primary literature searches as well as the lack of results in some areas to develop recommendations related to the next steps in developing a research agenda and evidence base for telehealth.

Considering all the plots and additional analysis, we have created three categories for our overall assessment. These are defined as follows:

Category A: Topics that have a body of evidence in the form of several systematic reviews that according to our assessment can be used to inform decisions. For these topics there is a sizable quantity of evidence and some consistency in the conclusions. While there is always more to be learned and this research may not answer every specific question, for these topics it seems unlikely that in the near future new studies would overturn the conclusions supporting the effectiveness of telehealth.

Category B: Topics that would benefit from new or additional systematic reviews. For these topics, there appears to be enough primary studies to constitute a body of evidence, based on our assessment of excluded reviews, reviews in progress, and primary studies. However, these primary studies have not been a) synthesized in systematic reviews to date, but were identified in exploratory searches of primary literature; b) were included in reviews that did not meet the inclusion criteria (e.g. mixed interventions without separating results or did not consider the quality of the included studied); or c) were included in reviews that were unable to draw conclusions.

Category C: Topics with few primary studies completed to date and are less likely to constitute a body of evidence that could support policy decisions. Systematic reviews in these areas would risk being small and inconclusive until more primary research is done. Because this category is defined by a lack of identified evidence or evidence that is very disparate it is possible that the searches were not comprehensive or that research is constrained in these areas for good reasons. Topics in this category need to be assessed in term of importance to the field and potential reasons for the difficulty in locating or conducting primary studies (e.g., methodological or practical barriers to study).

In **Table 8** below we sorted several topics into the three categories described above and provided a brief rationale for the placement in the assigned category.

Table 8. Telehealth topics: Evidence categories

Category	Topic	Rationale
A	Remote patient monitoring for chronic conditions	Several systematic reviews available, consistent findings of benefit or potential benefit from most reviews
A	Communication and counseling for chronic conditions	Several systematic reviews available, consistent findings of benefit or potential benefit from most reviews.
A	Psychotherapy for behavioral health	Most systematic reviews report benefit or potential benefit; 1 review finds insufficient evidence for use in forensic and correctional psychiatry.
B	Consultation for various clinical reasons	Four reviews addressed telehealth for consultation; three of these did not come to a conclusion. The use of telehealth for consultation crosses clinical areas and may be a viable topic for future synthesis.
B	Applications of telehealth for acute/ICU care including remote patient monitoring and telementoring	The reviews identified for ICU/surgery and burn care combined with reviews in progress in critical care and postoperative care suggest a growing literature base on this important use of telehealth designed to expand access to high tech care in areas where access is limited.
B	Maternal and child health	Pregnancy and newborn routine health care monitoring is a frequent reason for health care visits and access can be limited in some areas. A preliminary search identified studies that cover multiple technologies and uses. A future systemative review may be able to organize the literature in a way that it would be useful for policy and decisionmaking.
C	Triage for urgent and primary care	While this has been proposed as a use for telehealth, most of the identified research was on telephone only interventions. It is unclear if telehealth is not used extensively for this purpose or if it has been used but has not been studied.
C	Applications in pediatrics (managing chronic serious conditions)	Healthcare for children with serious illnesses can be disruptive and impinge on normal life, activities and development. A small number of studies were identified across diverse conditions.
C	Applications relevant to the integration of mental and physical health	Although the integration of mental and physical health is an important goal in many health care reform efforts we did not identify overlap of these topics in telehealth research (e.g., telehealth to address depression in people with diabetes or to help patients struggling with addition to obtain preventive care).
C	Impact of teledermatology on patient outcomes	While there is substantial evidence related to diagnostic concordance, we were unable to identify more than a few studies that included clinical outcomes. While diagnostic concordance is important, research focused on outcomes appears to be needed to inform decisions about this use of the telehealth.
C	Impact on cost and utilization	The evidence on costs is limited and does not correspond to the importance of this issue. Additionally, studies are needed that evaluate telehealth under new payment models.

ICU=intensive care unit

Limitations of Evidence Maps

Evidence maps are exercises in abstraction and require a reductionist approach to information. Their purpose is to provide a view that combines a few selected variables in a way that increases understanding, but does not provide comprehensive review of the topic. Maps of a geographic area usually provide more information on a selected type of variable, such as natural features (e.g., rivers, mountains, or elevation) or manmade variables (e.g., roads, city, county, or

state boundaries). Similarly, evidence maps must focus on a limited number of characteristics. These characteristics then have to be standardized and simplified in a way that allows them to be presented simultaneously. By definition, detail is reduced. Ideally the ability to identify patterns and relationships is worth the amount of detail lost and helps focus attention on which details should be re-examined using a different methodology. However, which characteristics are chosen and how data are simplified can also potentially mislead or at least not respond to the questions the analyses are designed to answer. Other than clarifying the purpose, soliciting feedback, and refining the approach, there is no way to avoid this limitation. There is no such thing as a "correct" or "definitive" evidence map. The best that can be achieved is that a map serves a useful purpose.

Additionally, like a road map, these plots provide information on key variables that help plan a route, but they do not select the route for the user. Interpretations of where the evidence is adequate and where more is needed that can vary based on perspectives and priorities of the user. Stakeholders interested in different aspects of telehealth maybe more interested in some specific uses over others. While one map cannot address all possible goals and priorities, the plots and the data in this report and the appendixes are provided in order to facilitate other considerations and interpretations.

Limitations of the Literature

The key limitations of the literature are related to both the nature of telehealth and the current state of systematic reviews.

Telehealth is a term that has been broadly applied to a range of applications of technology in health and health care. Using one term to describe everything from generic reminders sent to a cell phone, to the use of video for psychotherapy, to a complex system that allows a physician in another location to participate in a robotic surgery remotely is problematic for many reasons. As we found, the inclusiveness of the term telehealth can make searching literature and identifying relevant studies challenging and time consuming. Perhaps more importantly, such broad application of the term increases the chance that a synthesis could make comparisons of or summaries across, very different interventions that perhaps should not be combined or compared.

Knowing the diversity that exists under the label "telehealth," when assessing evidence we want details that help create meaningful subgroups or identify trends. However, as is often the case with complex interventions, details about the actual intervention and its implementation are often under described in primary research and/or not selected for reporting in systematic reviews. In the literature on telehealth several variables were often not reported (e.g., the studies we identified did not discuss the frequencies or the intensity of telehealth use) reported inconsistently (e.g., the particulars of use in different settings such as rural verses urban health systems) or ambiguous (e.g., the lack of clarity and readers left to assume whether telehealth was replacing or augmenting in-person care).

Systematic reviews should identify, describe, and synthesize individual studies so that the collective results are accessible and more useful. Another limitation is that not all reviews achieve this. Many reviews we examined did not go beyond cataloging the research and providing varying levels of descriptions. Some did not examine the quality of the included studies or discuss how the quality of studies should affect the interpretation of the findings. Others included very different interventions and did not separate the findings by type of intervention. The result is often either the lack of a conclusion or a tentative conclusion that is not at the confidence level required to support current practice or policy decisions about the use

of specific telehealth interventions. While it is possible that these reviews were designed and executed for other reasons, there is a risk that not only will their use be limited, but that reviews become viewed by policymakers and decisionmakers as an academic exercise rather than useful tools.

Another challenge with systematic reviews in this literature is the uneven quality of studies within the reviews. Often, lower-quality studies are less likely to find an effect even where one exists such that the results of high-quality studies may be muted by lower-quality studies, especially when the latter are more numerous. This is particularly problematic when results cannot be analyzed by meta-analysis, where heterogeneity may be identified, when the stability of findings cannot be tested through sensitivity analysis, or when reviewers do not include strength of evidence assessments that include consideration of the quality of individual studies.

Other Summaries of Telehealth Research

As part of our searching and triage, we looked for other efforts to summarize, describe, or analyze the evidence base for telehealth. In reviewing both the published literature as well as grey literature and related Web sites (e.g., U.S. government agency sites) we did not identify any other efforts to map the literature on telehealth despite the fact that there have been numerous systematic reviews. We have found no other efforts to summarize what is available to support decisions and to identify areas lacking evidence that parallels our mapping.

We did identify several "reviews of reviews", that is syntheses of systematic reviews and meta-analyses. These are sometimes called umbrella reviews. We found seven of these umbrella reviews published since 2012.[104-110] Some of these asked research questions that differed from the focus of this literature map. One addressed factors that promote or inhibit the implementation of any e-health system and included 37 papers published between 1995 and 2009 that were not only systematic reviews, but also narrative reviews and meta-ethnographies.[108] Others defined telehealth differently than it has been defined in this literature map. A meta-review of the use of mobile phones and text messaging for self-management interventions for chronic conditions included 11 systematic reviews,[107] but many of the interventions were unidirectional or not personalized (e.g., appointment reminders, general encouragement). Four of the reviews did not assess the quality of the included studies. Based on the four highest-quality reviews, the authors concluded that these technologies show promise, but that "more high-quality studies are needed to judge the long-term benefits."

Other umbrella reviews focused on a particular technology or condition and can, in some cases, be compared to subsets of our map. A summary of 29 systematic reviews on digital self-management support for adults and children with asthma reported evidence of some beneficial effects on some outcomes but emphasized that the characteristics of the patient population and the interventions themselves were so poorly described, and so few studies included economic analysis, that understanding the potential reach and uptake was difficult.[110] Another targeted study summarized the findings of 10 systematic reviews of telepsychiatry.[104] While the emphasis for the review was on the feasibility of use in resource constrained environments (such as South Africa, the country of the authors), the studies in the reviews were conducted in United States, Canada, Europe, Australia, Japan, and Hong Kong. These researchers reported the reviews were of acceptable quality, but that common deficiencies were lack of grading the strength of evidence or linking the quality of the included studies to the conclusions. Nevertheless, this review of reviews concluded that telepsychiatry is as effective as face-to-face treatment and testing and does improve symptoms. Similarly, a meta-review of systematic reviews of remote monitoring

for heart failure included 17 systematic reviews that summarized studies of implanted devices as well as telemonitoring. The authors rated seven of these as high-quality reviews, combined the results across these reviews, and concluded "that remote monitoring improves mortality and quality of life as well as reduces hospitalizations and, as a consequence, health care costs."[105] However, the authors noted that the evidence bases did not provide enough detail about how to best target remote monitoring to those most likely to benefit.

Two large reviews of reviews overlapped with many of the objectives of this literature map; however, they differed in both content and conclusions. Elbert 2014[106] updated a 2010 review of reviews by Ekeland[111] by summarizing reviews published 2009−2012. Their definition of eHealth was narrower than the definition of telehealth used for this map (i.e., excluded interventions that are not home based like tele-ICU) and they excluded studies of mental health and behavior change. They included 31 reviews; 7 concluded that eHealth is effective and/or cost effective and 13 concluded the evidence was promising, while 11 reported limited or inconsistent proof. The authors of this review concluded that while larger more rigorous studies could provide more definite proof of effectiveness, the evidence has been and continues to be promising and efforts could be better focused on evaluating the implementation of eHealth interventions that have been shown to be effective. McLean 2013 identified 80 systematic reviews of telehealth (using a definition similar to ours, but including phone only support as well) published between 1997 and November 2011 and summarized these as part of an evaluation for the National Health Service in the United Kingdom.[109] They concluded "While reported improvements in surrogate clinical endpoints and hospitalizations are encouraging, the evidence overall remains equivocal."[109] The author attributed this to the failure of large trials to show benefit, the focus of research on evaluations of smaller projects that are not scaled in order to assess long term impact, failure to include patient and broader societal perspectives, and flawed economic analysis that did not consider downstream effects on the distribution of services.

While our literature map shares some objectives and conclusions with these reviews of reviews, by definition the scope, analysis and presentation are different. Our literature map scope is broader than many reviews of reviews, but the key difference is that the analysis is more descriptive and uses figures and tables to allow comparisons across subtopics within the literature on telehealth, in order to facilitate identification of topics for which the available evidence can support decisionmaking.

Future Research

We identified groups of studies in clinical focus areas that have been included in reviews, but in ways that have made them less useful for decisionmaking. Specifically in many cases reviews have identified and grouped existing research together in ways that do correspond to current policy or practice issues. This evidence could be reanalyzed in order to support decisions. Additionally, there are pending reviews and individual studies on several topics that can add to the evidence base. In a field with such a wealth of information, the key will be to help decisionmakers identify what important questions are truly still outstanding and develop a research agenda for both systematic reviews and primary studies that will answer these questions. This evidence map provides a foundation for that effort.

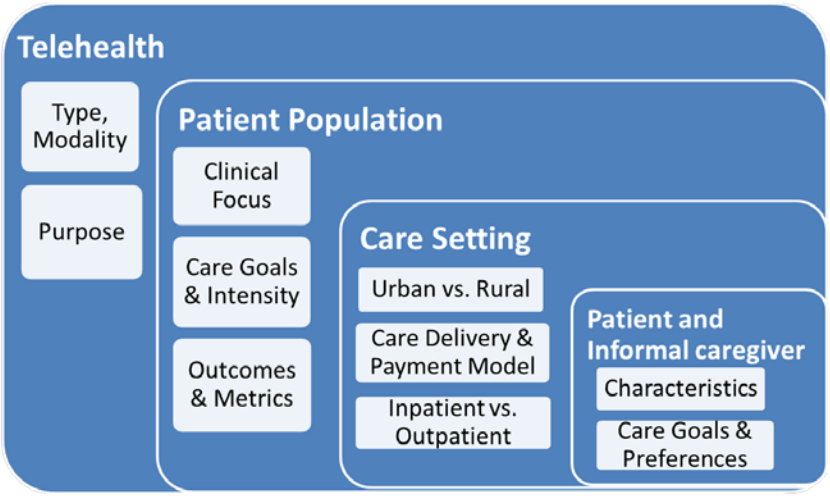
Another less traditional approach would involve a different kind of "mapping." It would involve outlining potential benefits of telehealth, mapping these to the goals and/or measures in health reform programs, such as value-based purchasing. Then, based on this, a research agenda

for both primary research and systematic reviews could be developed that explicitly addresses the questions about what role telehealth can and should play in future reforms in health care.

As evidenced in this literature map, telehealth is used for a variety of functions within multiple clinical focus areas. Use and evaluation of telehealth is also affected by characteristics of the care setting and circumstances surrounding individual patients, as depicted in **Figure 12**. The studies that make up the existing knowledge base for telehealth typically focus on a limited number of research questions within a single context. A narrowed research focus and tightly defined research population can reduce confounders, but it also necessitates that a large number of studies must be conducted to provide insight into the complex system of care that an individual patient, or a patient population experiences.

The insights provided by narrowly defined research studies are analogous to looking at a landscape through a soda straw. The viewer can become overly confident, or miss key insights that would be more visible in a larger context. As the industry shifts toward value-based care and personalized care, the challenge will be for future telehealth research to evaluate the contributions of telehealth across care contexts. This includes within increasingly integrated care delivery models where telehealth may be but one of many modes of care that patient may simultaneously experience and where experience may vary across patients. A telehealth research network recently published a 12-point global research agenda for telehealth, in which they assert the need to "incorporate health care parameters across mediated and traditional modes of care for the benefit of providers, companies, policymakers, and the international research community."[25]

Figure 12. Levels of context influencing telehealth use and evaluation



The implementation of the triple aim, concurrent with move to value-based care, has elevated the cost of care and the patient experience to equal footing with clinical outcomes of care. This focus has implications for telehealth in that future research should help providers and health systems differentiate the value of telehealth services as an addition to traditional in-person care and the value of telehealth as a replacement for in-person care. Increasingly, decisionmakers will need evidence-based practices and guidelines to facilitate decisions regarding when to employ telehealth services. Guidelines will need to consider the context of care as well as the impact of telehealth services on the cost, quality and experience of care.

Future telehealth research will also need to look at multiple time horizons. Telehealth benefits may be seen at the time of the initial service, or over longer periods of time. As the

Center for Medicare and Medicaid Services tests new payment and service delivery models, it will be important to ensure that clinical and administrative records reflect which parts of bundled services were delivered in-person or via telehealth to support longitudinal studies of the value of telehealth services within new service delivery models.

Conclusion

Our searches confirmed that there is a large, broad evidence base about the effectiveness of telehealth, including over 200 systematic reviews and hundreds of primary studies published since 2006. Although we found that many reviews are not structured or conducted in a way that would support current decisions related to telehealth, we did identify a substantial amount of evidence—58 systematic reviews that covered several important clinical focus areas and met our inclusion criteria. The largest volume of research reported that telehealth interventions have produced positive results when used in the clinical areas of chronic conditions and behavioral health and when telehealth is used for providing communication/counseling and monitoring/management. Considering both clinical areas and the functions of telehealth allowed us to create more specific subgroups and look at the variation and consistency within these as well.

Based on our analysis, advancing the use telehealth maybe best served by two different research agendas. First, as this evidence map has demonstrated, there is substantial evidence supporting subsets of telehealth uses, such as remote patient monitoring for chronic conditions. In these cases, the focus should shift from effectiveness studies to broader implementation efforts and studies of barriers to spread. Two distinct approaches are needed to address gaps in the evidence with future research. One approach to future research is to continue to elaborate on our findings as well as develop additional research in a variety of clinical topics and for different health care functions for telehealth. In areas where we did not find sufficient synthesized research, such as telehealth for consultation, in ICU and surgery, and in maternal and child health new systematic reviews may be able to organize primary research (some of which is new and some of which has been included in reviews in the past) into better reviews designed to address practice and policy considerations related to these issues. Additionally, there are clinical areas and roles for telehealth that do not yet have a sufficient evidence base to support important decisions and in these cases, more primary research is needed rather than more systematic reviews. We identified triage in urgent/primary care, management of serious pediatric conditions and the integration of behavioral and physical health as three potential topics for more primary research.

The agenda is based on expanding the orientation of future work to include new organizational and payment models. Going forward, research should be conducted in emerging models of care, particularly value-based models where use of telehealth may improve the ability to share risk and attain quality and related outcomes. These studies of telehealth should consider combinations of applications of telehealth and outcomes that are important in these new models and that evaluate the specific contribution telehealth can make in these contexts.

A recent comment published in the journal Nature reported on the use of evidence maps in conservation and development. The authors point out that failure to evaluate the existing evidence can result in unnecessary harm, that relative costs and benefits may be overlooked, and people assume evidence exists that does not. They propose that a “atlas” of evidence maps that are maintained and updated could transform work in their field.[11] While this single map may not rise to the level of an atlas, our experience suggests that in a field with a large diffuse evidence

base, maps are useful. This map confirms that there are important areas within telehealth with substantial evidence that can support broader implementation and spread. The fact that there are other areas where evidence is still minimal should not delay building on what we do know.

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Telehealth: Mapping the Evidence for Patient Outcomes from Systematic Reviews

Appendixes

Appendix A. Search Strategies

Searches for systematic reviews

Ovid MEDLINE (2006 to February 2016)

1 exp Telemedicine/
2 exp Patient Care/
3 exp Therapeutics/
4 exp Health Services/
5 exp Diagnosis/
6 exp Professional-Patient Relations/
7 exp Health Services Accessibility/
8 exp Health Behavior/
9 2 or 3 or 4 or 5 or 6 or 7 or 8
10 exp *Telecommunications/
11 exp *Computer Communication Networks/
12 10 or 11
13 9 and 12
14 1 or 13
15 limit 14 to english language
16 limit 15 to systematic reviews
17 limit 16 to yr="2006 -Current"

Cochrane Database of Systematic Reviews (2005 to February 2016)

1 (telemedic$ or telehealth$ or teleradiol$ or teledermat$).mp.
2 (tele-medic$ or tele-heal$ or tele-radiol$ or tele-dermat$).mp.
4 (emedicine or ehealth or e-medicine or e-health).mp.

Searches for ongoing systematic reviews

PROSPERO database (August 1, 2013 to March 2016)

Protocols marked “Ongoing” with the following words in any of the fields: “telehealth” OR “telecare” OR “telemedicine” OR “eHealth” OR “mHealth.”

Searches for primary research

Ovid MEDLINE (2005 to August 2015)

1 exp telemedicine
2 telehealth.mp
3 1 or 2
4 exp cancer
5 exp chronic disease
6 4 or 5
7 3 and 6
8 limit 7 to english language
9 limit 8 to yr="2005 -Current"
10 limit 9 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)")

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1 exp telemedicine/
2 telehealth.mp.

3 1 or 2
4 exp Pregnancy/
5 exp Postpartum Period/
6 4 or 5
7 3 and 6
8 limit 7 to english language
9 limit 8 to yr="2005 - 2015"

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1 exp telemedicine/
2 telehealth.mp.
3 1 or 2
4 ambulatory care.mp. or *Ambulatory Care/
5 urgent care.mp.
6 exp Triage/ or triage.mp.
7 4 or 5 or 6
8 3 and 7
9 limit 8 to english language
10 limit 9 to yr="2005 -Current"

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1 exp telemedicine.mp or exp Telemedicine/
2 *Dermatology/
3 exp Remote Consultation/
4 1 or 3
5 exp Prognosis/
6 2 and 4
7 5 and 6
8 exp Treatment Outcome/
9 6 and 8

Search for grey literature

The New York Academy of Medicine Library Grey Literature Collection (searched on 9.28.2015)

1 Telehealth
2 Telemedicine

Searches of websites of organizations and federal agencies

Text word searches of the following websites were conducted on 9.28.2015 and 9.29.2015

Agency/Organization	URL
American Telemedicine Association	www.americantelemed.org
United States Department of Health & Human Services	www.hhs.gov
Healthcare Information and Management Systems Society (HIMSS)	www.himss.org
United States Office of the Assistant Secretary for Planning and Evaluation (ASPE)	www.aspe.hhs.gov
Personal Connected Health Alliance	www.pchalliance.org
Centers for Medicare & Medicaid Services	www.cms.gov/Medicare/Medicare-General-

Agency/Organization	URL
(CMS)	information/telehealth
The Office of the National Coordinator for Health Information Technology	www.healthit.gov
Wireless-Life Sciences Alliance	www.wirelesslifesciences.org
United States Health Resources and Services Administration	www.hrsa.gov/index.html
National Institute of Standards and Technology	www.nist.gov
United States Department of Veterans Affairs (VA)	www.telehealth.va.gov
Agency for Healthcare Research and Quality (AHRQ)	http://www.ahrq.gov/
Markle Foundation	www.markle.org/
National Center for Telehealth and Technology (T2)	www.t2health.dcoe.mil/programs-telehealth
New York Academy of Medicine Library of Grey Literature	www.greylit.org
California Healthcare Foundation	www.chcf.org

Appendix B. Inclusion Criteria for Systematic Reviews

Study Designs	**INCLUDE:** Systematic reviews: Must have conducted literature searches in at least one database AND reported quality for the included papers. **EXCLUDE:** Nonsystematic reviews, narrative reviews, opinions, letters, primary studies
Populations	**INCLUDE:** Patients (adult or pediatric) interacting with a provider (physician, nurse, therapist, etc.) over distance or time. Providers interacting without patient interaction when the interaction is directly related to care of a specific patient and not purely for education purposes. Acute and chronic conditions included.
Interventions	**INCLUDE:** Any telehealth intervention: The use of technology to facilitate an interaction between a patient and the health care system or interaction between two or more providers when the interaction was directly related to an individual patient's care. Interventions could: • Occur over distance and/or over time (asynchronous and/or real time) • Include video, mobile devices or a variety of technology **EXCLUDE:** Any intervention that does not include an interaction between a health professional and patient, or between two health professionals; training/education interventions that do not include a patient; telephone-only interactions
Comparators	Any of the included interventions, usual care
Outcomes	**INCLUDE:** **Clinical Outcomes:** • Mortality • Morbidity • Illness • Test parameters (e.g., HbA1c) **Health Care Utilization and Access:** • Hospitalizations (length of stay, readmission) • ER • Outpatient visits • Nursing home/rehab • Reduced travel time • Time to receipt of care **Cost Effectiveness** **EXCLUDE:** Patient or provider satisfaction, provider concordance, compliance, other nonclinical outcomes, or nonutilization outcomes.
Timing/Setting	**INCLUDE:** Any setting, including rural or urban, home or community-based care, clinic, radiology, pharmacy, nursing home, or hospital-based care Any duration of followup **EXCLUDE:** Systematic reviews with search date ranges ending prior to 2005

Appendix C. Included Studies

Ammenwerth E, Schnell-Inderst P, Hoerbst A. The impact of electronic patient portals on patient care: a systematic review of controlled trials. J Med Internet Res. 2012;14(6):e162. PMID: 23183044.

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Appendix D. Excluded Reviews

Review articles were excluded if they analyzed studies with various interventions together, if they did not meet our criteria for *systematic* reviews, or both.

Aalbers T, Baars MAE, Rikkert MGMO. Characteristics of effective Internet-mediated interventions to change lifestyle in people aged 50 and older: a systematic review. Ageing Res Rev. 2011;10(4):487-97. PMID: 21628005.

Aardoom JJ, Dingemans AE, Spinhoven P, et al. Treating eating disorders over the internet: a systematic review and future research directions. Int J Eat Disord. 2013;46(6):539-52. PMID: 23674367.

Agboola SO, Ju W, Elfiky A, et al. The effect of technology-based interventions on pain, depression, and quality of life in patients with cancer: a systematic review of randomized controlled trials. J Med Internet Res. 2015;17(3):e65. PMID: 25793945.

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Andersson G, Cuijpers P. Internet-based and other computerized psychological treatments for adult depression: a meta-analysis. Cognitive Behav Ther. 2009;38(4):196-205. PMID: 20183695.

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Appendix E. Systematic Review Characteristics, Modality, and Function

Author	Year	End Date of Search	Clinical Indication (Broad Category)	Clinical Indication (Narrow Category)	Telehealth Function
Ammenwerth	2012	2011	Mixed	Mixed	Communication and counseling
Antonacci	2008	2007	Behavioral health	Mixed behavioral health	Psychotherapy
Antoniou	2012	2011	ICU or surgery support	Surgical telementoring	Telementoring
Chaudhry	2007	2006	Cardiovascular disease	CHF	Remote patient monitoring
Clark	2015	2011	Cardiovascular disease	Cardiac rehabilitation	Telerehabilitation
Clarke	2011	2009	Cardiovascular disease	CHF	Remote patient monitoring
Connelley	2013	2013	Diabetes	Diabetes	Communication and counseling
Conway	2014	2008	Cardiovascular disease	CHF	Remote patient monitoring
Cox	2012	2011	Respiratory disease	Cystic fibrosis	Multiple functions
Cruz	2014	2013	Respiratory disease	COPD	Remote patient monitoring
Dang	2009	2009	Cardiovascular disease	CHF	Remote patient monitoring
de Jong	2014	2013	Mixed chronic condition	Mixed chronic condition	Communication and counseling
de Waure	2012	2010	Cardiovascular disease	Myocardial Infarction	Consultation
Devi	2015	2014	Cardiovascular disease	Cardiovascular disease prevention	Multiple functions
dos Santos	2014	2010	Physical rehabilitation	Pediatric physical rehabilitation	Telerehabilitation
Eccleston	2014	2013	Mixed chronic condition	Chronic pain	Psychotherapy
Eland de Kok	2011	2009	Mixed chronic condition	Mixed chronic condition	Multiple functions
Flodgren	2015	2013	Mixed	Mixed	Multiple functions
Gaikwad	2009	2007	Mixed chronic condition	Mixed chronic condition	Multiple functions
Gainsbury	2011	2009	Behavioral health	Addictive disorder	Psychotherapy
Garcia-Lizana	2007	2005	Mixed chronic condition	Mixed chronic condition	Remote patient monitoring
Hailey	2010	2009	Physical rehabilitation	Physical rehabilitation	Telerehabilitation
Holtz	2012	2010	Diabetes	Diabetes	Multiple functions
Jaana	2009	2007	Respiratory disease	Mixed respiratory	Remote patient monitoring
Johansen	2012	2011	Mixed	Mixed	Communication and counseling
Kairy	2009	2007	Physical rehabilitation	Physical rehabilitation	Telerehabilitation
Kamei	2013	2011	Respiratory disease	COPD	Remote patient monitoring
Knowles	2014	2013	Mixed	Mixed GI	Communication and counseling
Kodama	2012	2011	Mixed chronic condition	Obesity	Communication and counseling
Kotb	2015	2012	Cardiovascular disease	CHF	Remote patient monitoring
Kumar	2013	2011	ICU or surgery support	Tele-ICU	Consultation
Laver	2013	2012	Physical rehabilitation	Tele-stroke	Telerehabilitation
Liang	2011	2010	Diabetes	Diabetes	Communication and counseling
Lustria	2013	2009	Mixed	Mixed Health Behaviors	Communication and counseling
Martin	2011	2009	Behavioral health	Behavioral health	Psychotherapy
McLean	2011	2010	Respiratory disease	COPD	Remote patient monitoring
Merriel	2014	2013	Cardiovascular disease	Cardiovascular disease prevention	Communication and counseling
Moy	2014	2013	Diabetes	Diabetes	Remote patient monitoring

Author	Year	Telehealth Modality	Individual Studies (N)	Randomized Controlled Trials (N)	Randomized Controlled Trials (%)	Patients (N)
Ammenwerth	2012	Asynchronous communication	4	3	75.00%	6907
Antonacci	2008	Videoconferencing	45	5	11.11%	3835
Antoniou	2012	Videoconferencing	10	0	0.00%	118
Chaudhry	2007	Mixed	4	4	100.00%	959
Clark	2015	Mixed	12	5	41.67%	1165
Clarke	2011	Mixed	13	13	100.00%	3202
Connelley	2013	Mixed	15	15	100.00%	4567
Conway	2014	Mixed	11	11	100.00%	3031
Cox	2012	Mixed	7	2	28.57%	203
Cruz	2014	Asynchronous communication	9	7	77.78%	583
Dang	2009	Mixed	9	9	100.00%	2149
de Jong	2014	Asynchronous communication	15	15	100.00%	2657
de Waure	2012	Mixed	5	1	20.00%	6927
Devi	2015	Asynchronous communication	11	11	100.00%	1112
dos Santos	2014	Mixed	9	9	100.00%	933
Eccleston	2014	Videoconferencing	15	15	100.00%	2014
Eland de Kok	2011	Asynchronous communication	12	12	100.00%	2144
Flodgren	2015	Mixed	93	93	100.00%	22119
Gaikwad	2009	Mixed	21	8	38.10%	16962
Gainsbury	2011	Mixed	9	7	77.78%	12561
Garcia-Lizana	2007	Mixed	24	24	100.00%	3764
Hailey	2010	Mixed	27	21	77.78%	3234
Holtz	2012	Mobile phone	21	10	47.62%	1035
Jaana	2009	Mixed	23	8	34.78%	1464
Johansen	2012	Mixed	29	29	100.00%	6104
Kairy	2009	Videoconferencing	28	8	28.57%	1039
Kamei	2013	Mixed	7	5	71.43%	590
Knowles	2014	Asynchronous communication	15	9	60.00%	1371
Kodama	2012	Asynchronous communication	23	23	100.00%	9076
Kotb	2015	Mixed	30	30	100.00%	11690
Kumar	2013	Videoconferencing	8	0	0.00%	0
Laver	2013	Videoconferencing	10	10	100.00%	810
Liang	2011	Mobile phone	21	11	52.38%	1604
Lustria	2013	Asynchronous communication	39	33	84.62%	26030
Martin	2011	Mixed	12	2	16.67%	533
McLean	2011	Asynchronous communication	10	10	100.00%	907
Merriel	2014	Asynchronous communication	13	13	100.00%	9500
Moy	2014	Asynchronous communication	2	2	100.00%	52

Author	Year	End Date of Search	Clinical Indication (Broad Category)	Clinical Indication (Narrow Category)	Telehealth Function
Parthiban	2015	2014	Cardiovascular disease	Implantable cardioverter-defibrillators	Remote patient monitoring
Peeters	2011	2009	Mixed chronic condition	Mixed chronic condition	Remote patient monitoring
Ramadas	2011	2010	Diabetes	Diabetes	Multiple functions
Richards	2012	2011	Behavioral health	Depression	Psychotherapy
Rietdijk	2012	2011	Physical rehabilitation	Traumatic brain injury	Communication and counseling
Rooke	2010	2009	Behavioral health	Addictive disorder	Communication and counseling
Rooksby	2015	2013	Behavioral health	Anxiety	Psychotherapy
Saffari	2014	2013	Diabetes	Diabetes	Remote patient monitoring
Seto	2008	2007	Cardiovascular disease	CHF	Remote patient monitoring
Steel	2011	2009	Mixed chronic condition	Mixed chronic condition	Multiple functions
Tan	2012	2011	ICU or surgery support	NICU family support	Communication and counseling
Toma	2014	2013	Diabetes	Diabetes	Communication and counseling
Tran	2008	2008	Mixed chronic condition	Mixed chronic condition	Remote patient monitoring
Urquhart	2015	2014	Preterm birth	Preterm birth	Remote patient monitoring
van Beugen	2014	2012	Behavioral health	Mixed behavioral health	Psychotherapy
Wade	2010	2009	Mixed	Mixed	Multiple functions
Wallace	2012	2010	Burn care	Burn care	Consultation
Warshaw	2011	2009	Dermatological conditions	Mixed	Consultation
Widmer	2015	2015	Cardiovascular disease	Cardiovascular disease prevention	Communication and counseling
Zhai	2014	2014	Diabetes	Diabetes	Multiple functions

Author	Year	Telehealth Modality	Individual Studies (N)	Randomized Controlled Trials (N)	Randomized Controlled Trials (%)	Patients (N)
Parthiban	2015	Asynchronous communication	9	9	100.00%	6686
Peeters	2011	Videoconferencing	9	4	44.44%	2663
Ramadas	2011	Asynchronous communication	13	11	84.62%	1647
Richards	2012	Mixed	10	8	80.00%	937
Rietdijk	2012	Mixed	16	7	43.75%	1150
Rooke	2010	Asynchronous communication	34	34	100.00%	9951
Rooksby	2015	Mixed	7	4	57.14%	241
Saffari	2014	Mixed	6	6	100.00%	657
Seto	2008	Mixed	10	4	40.00%	1404
Steel	2011	Videoconferencing	35	10	28.57%	2659
Tan	2012	Videoconferencing	1	1	100.00%	75
Toma	2014	Asynchronous communication	34	34	100.00%	4977
Tran	2008	Mixed	78	48	61.54%	17217
Urquhart	2015	Asynchronous communication	15	14	93.33%	6026
van Beugen	2014	Asynchronous communication	23	23	100.00%	4712
Wade	2010	Videoconferencing	36	18	50.00%	581
Wallace	2012	Mixed	16	0	0.00%	6588
Warshaw	2011	Mixed	24	8	33.33%	11942
Widmer	2015	Mixed	29	28	96.55%	18500
Zhai	2014	Mixed	35	35	100.00%	8149

Please see Appendix C. Included Studies for full study references.

CHF=congestive heart failure, COPD=chronic obstructive pulmonary disease, GI=Gastrointestinal, ICU=intensive care unit, NICU=neonatal intensive care unit.

Appendix F. Data Abstraction of Telehealth Systematic Reviews

Author	Publication Date	Date of Searches	Purpose of Systematic Review	Setting
Ammenwerth	2012	1990 - 2011	To systematically review the available evidence on the impact of electronic patient portals on patient care by analyzing controlled studies on the use of the use of patient portals.	Home
Antonacci	2008	1950 - June, 2007	Review empirical evidence on the use and effectiveness of videoconferencing in providing diagnostic and treatment services in the area of mental health.	Home
Antoniou	2012	1980-April, 2011	Evaluate efficiency and safety of telementoring in the field of general surgery.	Hospital
Chaudhry	2007	1966-August, 2006	Method, efficacy, and costs of telemonitoring for CHF.	Home
Clark	2015	1999-2011	Compare different modalities for cardiac rehabilitation (we're pulling some, but not all sub-analyses from this report).	Mixed
Clarke	2011	January 1969 - October 2009	Assess the effectiveness of telemonitoring on primary and secondary outcomes.	Home
Connelley	2013	January 2001-March 2013	Effectiveness of telehealth in promoting physical exercise in patients with Type 2 diabetes.	Home
Conway	2014	to November 2008	To examine the effect of specific technology used for noninvasive remote monitoring of people with heart failure.	Home
Cox	2012	1998-January 2011	Evaluate use of telehealth in people with cystic fibrosis.	Home
Cruz	2014	to July 2013	Assess effectiveness of home telemonitoring to reduce healthcare utilization and improve health-related outcomes of patients with COPD.	Home
Dang	2009	1966-2009	Review of literature to examine the evidence for home telehealth remote monitoring in CHF management.	Home

Author	Type of Outcomes Reported	Systematic Review Conclusions	Systematic Review Conclusions Reached (some conclusion or unclear)	Strength of Evidence Reported in Systematic Review	Meta Analysis
Ammenwerth	Clinical; Resources/Cost	Unclear	Unclear	No	No
Antonacci	Clinical	No Benefit	Some Conclusion	No	No
Antoniou	Clinical	Positive Benefit	Some Conclusion	Yes	No
Chaudhry	Resources/Cost	No Benefit	Some Conclusion	No	No
Clark	Clinical	Potential Benefit	Some Conclusion	Yes	No
Clarke	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	No	Yes
Connelley	Clinical	Potential Benefit	Some Conclusion	Yes	No
Conway	Clinical; Resources/Cost	Positive Benefit	Some Conclusion	No	Yes
Cox	Clinical; Resources/Cost	No Benefit	Some Conclusion	No	No
Cruz	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	No	Yes
Dang	Clinical; Resources/Cost	Positive Benefit	Some Conclusion	Yes	No

Author	Publication Date	Date of Searches	Purpose of Systematic Review	Setting
de Jong	2014	2001-2013	Do patients with chronic diseases use asynchronous communications and does it have an effect on health behavior, health outcomes, and patient satisfaction?	Home
de Waure	2012	to January 22, 2010	Does transmission of ECG from ambulance or home improve outcomes in acute MI?	Mixed
Devi	2015	to December 2014	Assess effectiveness of Internet-based intervention in mortality, lipid levels, health-related quality of life, cholesterol, BP, health care utilization, and medication compliance.	Mixed
dos Santos	2014	January 2002-February 2012	Objective: To systematically review the literature on the telehealth initiatives in telerehabilitation practices in children and adolescents from zero to 18 years old.	Home
Eccleston	2014	1950-mid/late 2013	Do Internet-delivered psychological therapies improve pain symptoms, reduce disability, and improve depression and anxiety in adults with chronic pain?	Home
Eland de Kok	2011	January 2000-July 2009	Is e-health in chronically ill patients as effective as usual care regarding health outcomes, cost effectiveness?	Mixed
Flodgren	2015	to June 2013	To assess the effectiveness, acceptability, and costs of interactive telemonitoring as an alternative to, or in addition to, usual care (i.e., face-to-face care or telephone consultation).	Mixed
Gaikwad	2009	June 2002- June 2007	To evaluate the feasibility and benefits of home-based information and communications technology enabled interventions for chronic disease management, with emphasis on their impact on health outcomes and costs.	Mixed
Gainsbury	2011	to September 2009	To evaluate and summarize existing evidence regarding the effectiveness of Internet-therapy for the general class of addictive disorders.	Mixed

Author	Type of Outcomes Reported	Systematic Review Conclusions	Systematic Review Conclusions Reached (some conclusion or unclear)	Strength of Evidence Reported in Systematic Review	Meta Analysis
de Jong	Clinical; Resources/Cost	Positive Benefit	Some Conclusion	No	No
de Waure	Clinical	Positive Benefit	Some Conclusion	Yes	Yes
Devi	Clinical; Resources/Cost	Unclear	Unclear	Yes	Yes
dos Santos	Clinical	Potential Benefit	Some Conclusion	No	No
Eccleston	Clinical	Potential Benefit	Some Conclusion	No	Yes
Eland de Kok	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	Yes	No
Flodgren	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	Yes	Yes
Gaikwad	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	No	No
Gainsbury	Clinical	Positive Benefit	Some Conclusion	No	No

Author	Publication Date	Date of Searches	Purpose of Systematic Review	Setting
Garcia-Lizana	2007	1995–January 2005	To review the clinical effectiveness of interventions using information and communication technologies for managing and controlling chronic diseases.	Mixed
Hailey	2010	to November 2009	To consider the evidence of benefit from use of telerehabilitation.	Home
Holtz	2012	2000 - May 2010	To understand the most common uses and functions of mobile phones in monitoring and managing diabetes, their potential role in a clinical setting, and the current state of research in this area.	Mixed
Jaana	2009	1966- December2007	To present evidence on effects of home telemonitoring for respiratory conditions in relation to data quality, patient medical condition, utilization of health services, feasibility and use, and economic viability.	Home
Johansen	2012	1990 -November 2011	To assess and summarize high-quality RCTs on electronic symptom or health information reporting.	Mixed
Kairy	2009	to February 2007	Identify clinical outcomes, clinical process, healthcare utilization, and costs associated with telerehabilitation for individuals with physical disabilities.	Mixed
Kamei	2013	to October 2011	To determine whether telehealth is better than conventional treatment or disease management for patients with COPD.	Home
Knowles	2014	Sep-13	Assess impact of eHealth interventions in GI treatment.	Home
Kodama	2012	1980 to April 2011	Determine effects of internet component in obesity treatment.	Home
Kotb	2015	to December 2012	Determine the comparative impact of different tele-medicine options for individuals with heart failure.	Mixed
Kumar	2013	January 1990 - July 2011	To summarize data on costs of tele-ICU.	Hospital

Author	Type of Outcomes Reported	Systematic Review Conclusions	Systematic Review Conclusions Reached (some conclusion or unclear)	Strength of Evidence Reported in Systematic Review	Meta Analysis
Garcia-Lizana	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	No	No
Hailey	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	No	No
Holtz	Clinical	Unclear	Some Conclusion	No	No
Jaana	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	No	No
Johansen	Clinical; Resources/Cost	Unclear	Unclear	No	No
Kairy	Resources/Cost	Potential Benefit	Some Conclusion	No	No
Kamei	Clinical; Resources/Cost	Positive Benefit	Some Conclusion	Yes	Yes
Knowles	Resources/Cost	Positive Benefit	Some Conclusion	No	No
Kodama	Clinical	Potential Benefit	Some Conclusion	No	Yes
Kotb	Clinical; Resources/Cost	Positive Benefit	Some Conclusion	Yes	Yes
Kumar	Resources/Cost	Unclear	Unclear	No	No

Author	Publication Date	Date of Searches	Purpose of Systematic Review	Setting
Laver	2013	1950 and 1980 to November 2012	To determine the impact of telerehabilitation for stroke.	Home
Liang	2011	January 1990 to February 2010	To assess the effect of mobile phone intervention on glycemic control in diabetes self-management.	Mixed
Lustria	2013	January 1999 to December 2009	To compare the effects of tailored versus nontailored web-based interventions on health behaviors and explores the influence of key moderators on treatment outcomes.	Home
Martin	2011	all through 2009	To evaluate the effectiveness, patient level impact, patient and clinician satisfaction of networked communication interventions associated with meeting healthcare needs of adolescents and young adults with diagnosed mental health disorders.	Home
McLean	2011	to January 2010	To review the effectiveness of telehealthcare for COPD compared with usual face-to-face care.	Home
Merriel	2014	to June 2013	To assess the effectiveness of telehealth interventions in the primary prevention of cardiovascular disease in adult patients in community settings.	Home
Moy	2014	to August 2013	Assess benefit of blood glucose reporting in pregnant women.	Mixed
Parthiban	2015	to August 2014	Compare remote vs. in-person monitoring of Implantable Cardioverter-Defibrillators.	Home
Peeters	2011	to December 2009.	Costs and financial benefits of video communication compared to usual care at home.	Home
Ramadas	2011	2000 and June 2010	Assess web-based behavioral interventions in management of type 2 diabetes mellitus.	Home
Richards	2012	March 2001-March 2011	Evaluate the overall effectiveness of computer-based treatments for depression and examine the impact of support on dropout rates and clinical outcomes.	Home

Author	Type of Outcomes Reported	Systematic Review Conclusions	Systematic Review Conclusions Reached (some conclusion or unclear)	Strength of Evidence Reported in Systematic Review	Meta Analysis
Laver	Clinical	Unclear	Unclear	Yes	Yes
Liang	Clinical	Positive Benefit	Some Conclusion	No	Yes
Lustria	Clinical	Positive Benefit	Some Conclusion	No	Yes
Martin	Clinical; Resources/Cost	Potential Benefit	Some Conclusion	No	No
McLean	Clinical; Resources/Cost	Positive Benefit	Some Conclusion	Yes	Yes
Merriel	Clinical	No Benefit	Some Conclusion	No	Yes
Moy	Clinical	No Benefit	Some Conclusion	Yes	Yes
Parthiban	Clinical; Resources/Cost	Positive Benefit	Some Conclusion	Yes	Yes
Peeters	Resources/Cost	No Benefit	Some Conclusion	No	No
Ramadas	Clinical	Potential Benefit	Some Conclusion	No	No
Richards	Clinical	Positive Benefit	Some Conclusion	Yes	No

Author	Publication Date	Date of Searches	Purpose of Systematic Review	Setting
Rietdijk	2012	to December 2011	To describe the effectiveness of using telehealth programs to provide training or support to family members of people with traumatic brain injury.	Home
Rooke	2010	to January 2009	To quantify the overall effectiveness of computer-delivered interventions for alcohol and tobacco use.	Mixed
Rooksby	2015	1950-2013	To assess efficacy of internet-delivered cognitive behavioral therapy for child anxiety disorder.	Home
Saffari	2014	January 2003 - November 2013	Assess glycemic control in patients with Type 2 diabetes.	Home
Seto	2008	to November 2007	Determine whether remote patient monitoring of patients with heart failure decreased costs.	Home
Steel	2011	to January 2009	We have therefore conducted a systematic review, specifically relating to the use of videoconferencing for chronic and/or long-term conditions.	Mixed
Tan	2012	to September 2011	How does telehealth support families of newborn infants receiving intensive care effect the length of hospital stay?	Hospital
Toma	2014	1946 - November 2013	Assess online social networking interventions for DM counseling and information exchange compared to usual care.	Home
Tran	2008	1998-2008	In-home management of chronic diseases issues include the improvement and maintenance of patients' QOL and health status, the avoidance of unnecessary trips to emergency departments, a reduction in hospital readmissions, and a reduction of costs.	Home
Urquhart	2015	1966-2014	To determine whether home uterine monitoring is effective in improving the outcomes for women and their infants considered to be at high risk of preterm birth when compared with conventional or other care packages which do not include home uterine monitoring.	Home

Author	Type of Outcomes Reported	Systematic Review Conclusions	Systematic Review Conclusions Reached (some conclusion or unclear)	Strength of Evidence Reported in Systematic Review	Meta Analysis
Rietdijk	Clinical	Unclear	Unclear	Yes	No
Rooke	Clinical	Potential Benefit	Some Conclusion	No	Yes
Rooksby	Clinical	Potential Benefit	Some Conclusion	No	Yes
Saffari	Clinical	Positive Benefit	Some Conclusion	Yes	Yes
Seto	Resources/Cost	Positive Benefit	Some Conclusion	Yes	No
Steel	Clinical	Potential Benefit	Some Conclusion	Yes	No
Tan	Resources/Cost	No Benefit	Some Conclusion	Yes	No
Toma	Clinical	Positive Benefit	Some Conclusion	No	Yes
Tran	Clinical	Positive Benefit	Some Conclusion	Yes	Yes
Urquhart	Clinical; Resources/Cost	No Benefit	Some Conclusion	Yes	Yes

Author	Publication Date	Date of Searches	Purpose of Systematic Review	Setting
van Beugen	2014	to February 2012	Determine how *guided* cognitive behavioral therapy compare with face-to-face cognitive behavioral therapy. Communication was largely via e-mail.	Home
Wade	2010	to June, 2009	What is the cost-benefit of real-time telehealth services?	Mixed
Wallace	2012	1966-2010	Assess evidence for the use of telemedicine in acute burn care and outpatient based management	Mixed
Warshaw	2011	1990-2009	KW 3 and 4 (excluding satisfaction) Determine: 3. How do clinical outcomes (clinical course, quality of life, visits avoided) of teledermatology compare with clinic dermatology for skin conditions? 4. How does the cost of teledermatology compare with clinic dermatology?	Mixed
Widmer	2015	January 1990 - January 2014	Assess benefit of digital health interventions on cardio dx outcomes and risk-factors, compared with non-digital-health interventions	Mixed
Zhai	2014	2000-February 2014.	Perform a meta-analysis of RCTs of telemedicine on HbA1c	Home

Author	Type of Outcomes Reported	Systematic Review Conclusions	Systematic Review Conclusions Reached (some conclusion or unclear)	Strength of Evidence Reported in Systematic Review	Meta Analysis
van Beugen	Clinical	Potential Benefit	Some Conclusion	No	Yes
Wade	Clinical; Resources/Cost	Unclear	Unclear	Yes	No
Wallace	Clinical; Resources/Cost	Unclear	Unclear	No	No
Warshaw	Clinical; Resources/Cost	Unclear	Unclear	No	No
Widmer	Clinical	Positive Benefit	Some Conclusion	No	Yes
Zhai	Clinical; Resources/Cost	Unclear	Unclear	Yes	Yes

Please see Appendix C. Included Studies for full study references.

BP=blood pressure, CHF=congestive heart failure, COPD=chronic obstructive pulmonary disorder, DM=diabetes mellitus, ECG=electrocardiogram, GI=gastrointestinal, ICU=intensive care unit, MI=myocardial infarction, RCT=randomized controlled trial, QOL=quality of life

Appendix G. Individual Studies Included in the Systematic Reviews

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Ades	2000	133	No
Alessi	2003	1	No
Armstrong	2007	451	No
Arsand	2008	9	No
Attwood (study 1)	2012	13	No
Attwood (study 2)	2012	12	No
Baer	1995	26	No
Barnett	2006	800	No
Barth	2001	32	No
Bella	2009	60	No
Benhamou	2007	60	No
Bergmo	1997	Undetermined	No
Bergmo	2000	375	No
Bishai	2003	Undetermined	No
Bishop	2002	24	No
Bohnenkamp	2004	Undetermined	No
Bondmass	1999	60	No
Bose	2001	13	No
Bouchard	2000	8	No
Bouchard	2004	21	No
Bradford	2004	126	No
Breslow	2004	Undetermined	No
Brodey	2000	43	No
Brown	1999	83	No
Bruderman and Abboud	1997	39	No
Bruschi	2005	8	No
Bujnowska-Fedak	2006	60	No
Burgiss	1997	87	No
Byrne	2000	34	No
Carroll	2007	10	No
Chan	2000	Undetermined	No
Chumber	2004	226	No
Chumbler	2005	537	No
Clark	2013	24	No
Cluver	2005	10	No
Cordisco	1999	81	No
Cowain	2000	1	No
Cross	2007	25	No
Crowther	1995	99	No
Cruz	2005	81	No
Cubano	1999	5	No
Cullum	2006	14	No
Curran	2010	6	No

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Dale	2003	55	No
Dalleck	2011	226	No
Dang	2006	59	No
Dang	2007	41	No
Deitsch	2000	4	No
DeMaio	2001	Undetermined	No
Deodhar	2002	Undetermined	No
Dickson	2008	12	No
Dimmick	2003	34	No
Dongier	1986	50	No
Dowie	2007	Undetermined	No
Duchesne	2008	Undetermined	No
Ehlers	2008	Undetermined	No
Elford	2000	23	No
Elford	2001	90	No
Elkjaer	2010	21	No
Elliot	2007	36	No
Eriksson	2009	22	No
Eron	2006	Undetermined	No
Farzanfar	2004	5	No
Ferrandiz	2007	226	No
Ferrer-Roca	2004	23	No
Finkelstein	1993	18	No
Finkelstein	1996	41	No
Finkelstein	1999	45	No
Finkelstein	2000	31	No
Franklin	2008	64	No
Franzini	2011	Undetermined	No
Frenn	2005	132	No
Frueh	2004	Undetermined	No
Frueh	2005	18	No
Gallar	2007	57	No
Gammon	2005	30	No
Giallauria	2006	45	No
Gilkey	2009	23	No
Granlund	2003	29	No
Grealish	2005	5	No
Greenwood	2004	31	No
Griffiths	2006	15	No
Guilfoyle	2003	12	No
Halpert	2010	156	No
Hassall	2003	12	No
Hauber	2002	9	No
Heidenreich	1999	154	No
Himle	2005	3	No
Himle	2006	3	No
Hoenig	2006	13	No
Hommel	2013	9	No

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Hotta	2007	101	No
Houtchens	1993	209	No
Hsiao	2008	149	No
Hui	2006	58	No
Hyler	2005	380	No
Jarad	2011	51	No
Johansen	2004	4	No
Johnston	2000	212	No
Jones	2001	30	No
Karagiannis	2006	21	No
Katz and Nordwall	2008	30	No
Kaye	1997	Undetermined	No
Keays	2006	344	No
Kennedy	2003	156	No
Kennedy and Yellowlees	2000	124	No
Kennedy and Yellowlees	2003	124	No
Kim	2005	45	No
Kim	2006	99	No
Kim	2006	33	No
Kim	2008	34	No
Knol	2006	306	No
Kobb	2003	281	No
Kobb	2003	1545	No
Kollmann	2007	10	No
Kople	2007	136	No
Kortke	2006	170	No
Korzeniowska-Kubacka	2011	92	No
Kwon	2004	185	No
Lai	2004	19	No
Lamminen	2000	25	No
Larizza	2006	68	No
Lee	2007	274	No
Lehmann	2006	20	No
Lemaire	2001	47	No
Leonard	2004	80	No
Lexcen	2006	72	No
Liesenfeld	2000	61	No
Limido	2006	368	No
Linassi	2005	15	No
Lindgren	1997	77	No
Loane	2000	96	No
Lohr	2007	3	No
Lum	2006	7	No
Magrabi	2005	5	No
Mahendran	2005	163	No
Mahmud	1995	12	No
Maiolo	2003	23	No
Mair	2008	20	No

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Marcin	2004	Undetermined	No
Marcin	2005	223	No
Massman	1999	40	No
Matsuura	2000	17	No
McCormick	2010	31	No
McManus	2004	60	No
McManus	2008	2394	No
Meheghini	1998	184	No
Mehra	2000	113	No
Miller	2006	1	No
Modai	2006	42	No
Modai	2006	81	No
Moreno-Ramirez	2005	219	No
Moreno-Ramirez	2007	2539	No
Moreno-Ramirez	2009	4018	No
Morgan	2008	372	No
Morland	2004	20	No
Morlion	2002	22	No
Morrison	1987	69	No
Morrison	2010	Undetermined	No
Myers	2004	369	No
Myers	2006	115	No
Myers	2006	166	No
Nakamura	1999	32	No
NEHI	2010	Undetermined	No
Nelson	2003	28	No
Nelson	2004	62	No
Neufield	2007	289	No
Nguyen	2004	294	No
Nikander	2010	19	No
Ortolani	2007	121	No
Pak	1999	100	No
Pak	2007	508	No
Palmer	2005	233	No
Pare	2006	29	No
Park	2012	97	No
Parker	2010	10	No
Pedersen	2012	92	No
Perini	2008	13	No
Persaud	2005	Undetermined	No
Phillips	1999	35	No
Piazza-Waggoner	2006	1	No
Piron	2002	5	No
Piron	2004	5	No
Pushparajah	2006	80	No
Quinn	2006	26	No
Rami	2006	72	No
Redlick	2002	14	No

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Rendina	1997	Undetermined	No
Riva	1999	1	No
Robertson	2006	104	No
Rosenfeld	2000	Undetermined	No
Rosser	1997	6	No
Rossi	2009	91	No
Rossi	2009	41	No
Roth	2004	118	No
Roth	2009	4598	No
Rotondi	2005	17	No
Roy	2008	1	No
Rumberger	2006	Undetermined	No
Russell	2004	31	No
Ryan	2005	91	No
Sable	1999	Undetermined	No
Saffle	2006	2	No
Saffle	2009	98	No
Sagraves	2007	311	No
Sander	2009	15	No
Savin	2006	21	No
Sawyer	2000	12	No
Scalvini	2005	230	No
Scalvini	2005	426	No
Scalvini	2006	230	No
Scalvini	2009	47	No
Scerri	1999	12	No
Schlachra	2009	26	No
Schlachta	2010	2	No
Schoenberg	2008	39	No
Schofield	2005	92	No
Segajang	2005	14	No
Shah	1998	27	No
Shepherd	2006	25	No
Shore	2004	50	No
Shore	2007	53	No
Sicotte	2003	6	No
Sicotte	2004	Undetermined	No
Sieibert	2008	23	No
Simpson	2001	10	No
Smart	2005	30	No
Smith	2002	5	No
Smith	2002	Undetermined	No
Smith	2002	1	No
Smith	2004	293	No
Smith	2007	1589	No
Soopramanien	2005	1	No
Sorknæs	2011	100	No
Spence	2008	2	No

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Spittaels	2007	434	No
Starling	2003	136	No
Steel	2002	33	No
Tam	2003	3	No
Taylor	2001	188	No
Thomas	2005	38	No
Tindall	2008	24	No
Tousignant	2006	4	No
Trappenburg	2008	115	No
Trappenburg	2008	165	No
Tsang	2001	20	No
Turner	2009	23	No
Urness	2006	48	No
Ushiyama	2003	1	No
Vaccaro	2001	690	No
Vahatalo	2004	203	No
Vahatalo	2004	103	No
Vesmarovich	1999	8	No
Vitacca	2006	45	No
Vontetsianos	2005	18	No
Voyles	2003	63	No
Wade	2004	6	No
Wade	2004	19	No
Wade	2009	9	No
Wade	2011	9	No
Wagner	1999	7	No
Wallace	2007	1165	No
Warrington	2003	40	No
Wasson	2006	13271	No
Weatherburn	2007	6	No
Wheeler	2006	41	No
Whitten	2004	546	No
Whitten	2007	322	No
Winett	1999	180	No
Winett	2007	1071	No
Wong	2005	20	No
Woods	2011	48	No
Woolf	2006	273	No
Wu	2006	17	No
Yager	2001	3	No
Yager	2003	3	No
Zanini	2005	340	No
Zarate	1997	45	No
Zawada	2009	Undetermined	No
Zaylor	2000	49	No
Zaylor	2001	45	No
Zbikowski	2008	11143	No
Zhou	2007	6402	No

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Abbot	2009	56	Yes
Abroms	2008	83	Yes
Adachi	2007	183	Yes
Ahring	1992	84	Yes
Al Khatib	2009	151	Yes
Alkema	2007	781	Yes
Al-Khatib	2010	151	Yes
An	2008	517	Yes
Andersen	2013	160	Yes
Anderson	2010	295	Yes
Andersson	2002	117	Yes
Andersson	2003	52	Yes
Andersson	2005	117	Yes
Angermann	2007	708	Yes
Antonicelli	2008	56	Yes
Antypas	2014	52	Yes
Appel	2002	27	Yes
Appel	2011	415	Yes
Artinian	2003	18	Yes
Artinian	2007	387	Yes
Avdal	2011	122	Yes
Balk	2008	214	Yes
Barnason	2009	232	Yes
Barnett	2007	212	Yes
Bartholomew	2000	133	Yes
Bell	2004	171	Yes
Bell	2011	433	Yes
Benatar	2003	216	Yes
Bendixen	2009	128	Yes
Benhamou	2007	30	Yes
Bennete	2010	101	Yes
Bennett	2011	145	Yes
Bennett	2012	365	Yes
Bennett	2013	194	Yes
Berger	2011	81	Yes
Bergmo	2009	73	Yes
Bergström	2010	65	Yes
Berman	2009	78	Yes
Berry	2011	660	Yes
Bewick	2008	317	Yes
Biermann	2000	48	Yes
Biermann	2002	43	Yes
Blasco	2012	203	Yes
Blondel	1992	168	Yes
Blum	2007	204	Yes
Boaz	2009	35	Yes
Bogner	2012	180	Yes
Bond	2006	62	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Bond	2007	62	Yes
Boriani	2013	154	Yes
Boter	2004	486	Yes
Bourbeau	2003	191	Yes
Bove	2011	465	Yes
Bove	2013	241	Yes
Bowles	2011	218	Yes
Bowns	2006	165	Yes
Boyes	2006	80	Yes
Boyne	2012	382	Yes
Brattberg	2006	60	Yes
Brendryen	2008	396	Yes
Brendryen	2008	290	Yes
Broekhuizen	2012	340	Yes
Bromberg	2011	144	Yes
Brown	1999	343	Yes
Buhrman	2004	51	Yes
Buhrman	2011	50	Yes
Buhrman	2013	56	Yes
Buhrman	2013	61	Yes
Buller	2008	1234	Yes
Buller	2008	2077	Yes
Bunjnowska-Fedak	2011	95	Yes
Butler	2009	62	Yes
Capomolla	2004	133	Yes
Carey	2007	20	Yes
Carlbring and Smit	2008	66	Yes
Carpenter	2012	131	Yes
Carrasco	2008	143	Yes
Casas	2006	155	Yes
Chambers	2006	30	Yes
Chan	2003	10	Yes
Chan	2007	120	Yes
Chandler	1990	13	Yes
Charpentier	2011	120	Yes
Chase	2003	63	Yes
Chau	2012	53	Yes
Chaudry	2010	1653	Yes
Chiantera	2009	200	Yes
Chiauzzi	2005	265	Yes
Chiauzzi	2010	186	Yes
Cho	2006	71	Yes
Cho	2009	69	Yes
Cho	2011	64	Yes
Chong	2012	167	Yes
Christian	2011	323	Yes
Chua	2001	Undetermined	Yes
Chumbler	2012	44	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
CHUMS	1995	1165	Yes
Claes	2013	314	Yes
Cleland	2005	426	Yes
Cook	2007	419	Yes
Corwin	1996	377	Yes
Cross	2012	41	Yes
Crossley	2011	1997	Yes
Crow	2009	Undetermined	Yes
Cruz	2007	21	Yes
Cussler	2008	135	Yes
Dale	2009	231	Yes
Dallolio	2008	137	Yes
Dansky	2001	171	Yes
Dansky	2008	182	Yes
Dansky	2008	157	Yes
Dansky	2009	284	Yes
Dar	2009	182	Yes
David	2011	235	Yes
Davis	2010	165	Yes
Day	2002	80	Yes
De Jongste	2009	151	Yes
De Las Cuevas	2006	130	Yes
de Lusignan	2001	20	Yes
De San Miguel	2013	71	Yes
de Toledo	2006	157	Yes
Dear	2013	62	Yes
DeBusk	2004	462	Yes
Dekkers	2011	276	Yes
Del Prato	2012	241	Yes
Dendale	2012	160	Yes
Deng	2012	16	Yes
Devi	2014	74	Yes
Devineni	2005	86	Yes
DeVito Dabbs	2009	34	Yes
DeWalt	2006	123	Yes
Di Biase	1997	20	Yes
Digenio	2009	300	Yes
Donohue	2004	104	Yes
Doumas & Hannah	2008	82	Yes
Dunton & Robertson	2008	156	Yes
Dyson	1991	251	Yes
Dyson	1998	2422	Yes
Eberl	2006	23	Yes
Egan	2002	66	Yes
Egner	2003	27	Yes
Ekman	1998	158	Yes
Elkjaer	2010	303	Yes
Ellison	2004	56	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Ellison	2007	270	Yes
Eminovic	2009	369	Yes
Estabrooks	2005	469	Yes
Faridi	2008	30	Yes
Farmer	2005	94	Yes
Farrero	2001	122	Yes
Fell	2000	160	Yes
Finfgeld-Connett & Madsen	2008	29	Yes
Finkelstein	2004	68	Yes
Finkelstein	2006	53	Yes
Finkelstein	2006	68	Yes
Forducey	2012	9	Yes
Fortney	2007	395	Yes
Franklin	2006	91	Yes
Franklin	2006	59	Yes
Frederix	2015	66	Yes
Frederix	2015	80	Yes
Friedman	1996	267	Yes
Frueh	2007	74	Yes
Furber	2010	222	Yes
Galbreath	2004	1069	Yes
Gattis	1999	181	Yes
GESICA	2005	1518	Yes
Ghahari	2010	95	Yes
Giordano	2007	461	Yes
Giordano	2009	460	Yes
Glasgow	2003	320	Yes
Glasgow	2005	886	Yes
Glasgow	2012	463	Yes
Glasgow	2012	234	Yes
Goldberg	2003	280	Yes
Goodarzi	2012	81	Yes
Grant	2008	244	Yes
Gray	2000	75	Yes
Green	2012	778	Yes
Grzincich	2010	60	Yes
Guédon-Moreau	2013	473	Yes
Guendelman	2002	134	Yes
Guendelman	2002	134	Yes
Guendelman	2004	134	Yes
Hageman	2005	31	Yes
Halimi	2008	379	Yes
Hanauer	2009	40	Yes
Hansen	2012	12,287	Yes
Harno	2006	175	Yes
Harrison	1999	132	Yes
Harvey-Berino	2002	690	Yes
Harvey-Berino	2004	232	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Harvey-Berino	2010	481	Yes
Hebert	2006	44	Yes
Hedborg	2011	76	Yes
Hee-Sung	2007	51	Yes
Hermen	2008	81	Yes
Hermens	2007	81	Yes
Hesser	2012	99	Yes
Hester & Delaney	1997	40	Yes
Hill	2006	111	Yes
Hill	1990	299	Yes
Hindricks	2014	720	Yes
Holbrook	2009	511	Yes
Hollandare	2011	84	Yes
Homer	2000	137	Yes
Homko	2007	57	Yes
Hopp	2006	37	Yes
Huang	2006	497	Yes
Huijgen	2008	Undetermined	Yes
Hunt	2009	54	Yes
Hunter	2007	446	Yes
Hurling	2007	77	Yes
Huss	2003	101	Yes
Hyman	1998	123	Yes
Iams	1987	309	Yes
Iams	1990	76	Yes
IDEATel trial	2007	1665	Yes
Inglis	2004	152	Yes
Inglis	2006	297	Yes
Istepanian	2009	137	Yes
Izquierdo	2003	46	Yes
Izquierdo	2009	41	Yes
Jacklin	2003	Undetermined	Yes
Jacobs	2011	314	Yes
Jan	2007	196	Yes
Jansa	2006	40	Yes
Japuntich	2006	248	Yes
Jarab	2012	171	Yes
Jerant	2001	37	Yes
Jerant	2001	Undetermined	Yes
Jerant	2005	54	Yes
Jódar-Sánchez	2013	45	Yes
Johnston	2000	212	Yes
Johnston	2000	29	Yes
Joseph	2007	314	Yes
Kaldo	2008	51	Yes
Kamei	2011	37	Yes
Kashem	2008	48	Yes
KcKay	2001	78	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Kearney	2009	112	Yes
Kessler	2009	255	Yes
Khan	2011	129	Yes
Khanna and Kendall	2010	49	Yes
Kielblock	2007	502	Yes
Kim	2003	50	Yes
Kim	2006	51	Yes
Kim	2007	60	Yes
Kim	2007	34	Yes
Kim	2008	51	Yes
Kim	2009	37	Yes
Kim	2010	100	Yes
Kim and Kang	2006	73	Yes
Kim and Kim	2008	34	Yes
Kim CJ	2006	73	Yes
Kim HS	2003	36	Yes
Kim SI	2008	34	Yes
King	2006	335	Yes
King	2009	37	Yes
Kiselev	2012	199	Yes
Koehler	2011	710	Yes
Koff	2009	40	Yes
Krier	2011	34	Yes
Krishna	2003	228	Yes
Krum	2009	Undetermined	Yes
Krumholz	2002	88	Yes
Kulick	2013	61	Yes
Kumar	2004	40	Yes
Kunkler	2007	Undetermined	Yes
Kwok	2004	67	Yes
Kwon	2004	80	Yes
Kypri	2004	104	Yes
Kypri	2008	576	Yes
Kypri	2008	247	Yes
Kypri & McAnally	2005	218	Yes
Ladyzynski	2007	30	Yes
LaFramboise	2003	90	Yes
Landau	2012	70	Yes
Landolina	2012	200	Yes
Lange	2001	25	Yes
Lapp	2012	46	Yes
Laramee	2003	287	Yes
Lawrence	2003	513	Yes
Lear	2014	66	Yes
Leibreich	2009	49	Yes
Leveille	2009	141	Yes
Lewis	2007	142	Yes
Lewis	2008	22	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Lewis	2010	40	Yes
Lewis & Neighbors	2007	53	Yes
Lim	2011	103	Yes
Lin	2005	606	Yes
Lindsay	2009	108	Yes
Liu	2005	274	Yes
Ljótsson	2010	85	Yes
Ljótsson	2011	61	Yes
Ljótsson	2011	75	Yes
Ljótsson	2011	195	Yes
Loane	2000	Undetermined	Yes
Loane	2001	274	Yes
Loane	2001	203	Yes
Loane	2001	Undetermined	Yes
Loane	2001	Undetermined	Yes
Lombard	2010	250	Yes
Lorig	2002	580	Yes
Lorig	2006	958	Yes
Lorig	2008	641	Yes
Lorig	2008	855	Yes
Lorig	2010	761	Yes
Luley	2011	70	Yes
Lusignan	2001	20	Yes
Lyneham	2006	100	Yes
Lyons	1990	62	Yes
Mabo	2012	1501	Yes
Maddison	2014	139	Yes
Madigan	2013	99	Yes
Madsen	2008	236	Yes
Mair	2005	36	Yes
Maljanian	2005	336	Yes
Man	2006	109	Yes
Mangunkusumo	2007	495	Yes
March	2009	73	Yes
Marcus	2007	249	Yes
Marrero	1995	106	Yes
Mashima	2003	72	Yes
Mayo	2008	157	Yes
McCarrier	2009	77	Yes
McConnon	2007	221	Yes
McCrossan	2012	59	Yes
McKay	2001	78	Yes
McKay	2002	66	Yes
McKay	2008	2318	Yes
McMahon	2005	104	Yes
Meer	2009	200	Yes
Meigs	2003	598	Yes
Mermelstein and Turner	2006	351	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Meyer	2008	222	Yes
Mitchell	2008	128	Yes
Moattari	2013	48	Yes
Mobley	2006	172	Yes
Moore	2005	100	Yes
Moore	2007	25	Yes
Moreno	2009	2169	Yes
Morgan	2009	65	Yes
Morland	2010	125	Yes
Mortara	2009	461	Yes
Mullan	2003	119	Yes
Mulvaney	2010	52	Yes
Nagey	1993	59	Yes
Napolitano	2003	65	Yes
Neighbors	2004	252	Yes
Neighbors	2006	185	Yes
Neighbors	2009	282	Yes
Nguyen	2008	51	Yes
Nguyen	2009	17	Yes
Nguyen	2013	124	Yes
Noble	2005	Undetermined	Yes
Noel	2004	104	Yes
Noh	2010	40	Yes
Nolan	2011	680	Yes
Nolan	2012	387	Yes
Norman	2008	1402	Yes
O'Neill	2008	58	Yes
O'Reilly	2007	Undetermined	Yes
Oakley	2000	203	Yes
Oenema	2008	2159	Yes
Oenema	2008	547	Yes
Oenema	2005	782	Yes
Oerlemans	2011	76	Yes
Ohinmaa	2002	Undetermined	Yes
O'Reilly	2007	495	Yes
Ostojic	2005	16	Yes
Pak	2009	698	Yes
Parati	2009	329	Yes
Paschall & Bersamin	2006	370	Yes
Patrick	2008	65	Yes
Patten	2006	140	Yes
Pearson	2006	762	Yes
Pedone	2013	99	Yes
Perini	2009	45	Yes
Perl	2013	151	Yes
Phillips	2001	111	Yes
Piette	2000	280	Yes
Piette	2001	272	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Piron	2008	10	Yes
Piron	2009	36	Yes
Polzien	2007	28	Yes
Poon	2005	22	Yes
Porto	1987	136	Yes
Prabhakaran	2010	120	Yes
Pressman	2014	198	Yes
Pronovost	2009	Undetermined	Yes
Quinn	2008	30	Yes
Quinn	2011	163	Yes
Ralston	2009	83	Yes
Ralston	2009	74	Yes
Ramachandran	2007	50	Yes
Rami	2006	36	Yes
Rasmussen	2005	200	Yes
Rasmussen	2005	258	Yes
Rasmussen	2005	300	Yes
Rea	2004	135	Yes
Reid	2012	188	Yes
Richardson	2007	35	Yes
Richardson	2010	324	Yes
Riegel	2006	134	Yes
Riegel	2008	135	Yes
Riper	2008	261	Yes
Ritterband	2003	24	Yes
Robinson	2007	154	Yes
Rodriguez-Idigoras	2009	328	Yes
Rogers	2001	121	Yes
Rogers	2002	74	Yes
Ross	2004	81	Yes
Ross	2004	107	Yes
Rossi	2010	119	Yes
Rossi	2010	130	Yes
Rothert	2006	2862	Yes
Ruehlman	2012	241	Yes
Ruffin	2011	3382	Yes
Ruland	2003	52	Yes
Ruland	2010	145	Yes
Ruskin	2004	119	Yes
Ruskin	2004	Undetermined	Yes
Russell	2003	21	Yes
Ruwaard	2009	45	Yes
Sainsbury	2013	189	Yes
Salazar	2000	119	Yes
Sanford	2004	22	Yes
Sanford	2006	49	Yes
Sanford	2006	65	Yes
Santamore	2007	321	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Schechter	2012	526	Yes
Scherr	2009	120	Yes
Schinke	2004	327	Yes
Schneider	1990	579	Yes
Schwarz	2008	102	Yes
Scioscia	1988	72	Yes
Senesael	2013	57	Yes
Seto	2012	100	Yes
Severson	2008	2523	Yes
Shany	2010	40	Yes
Shea	2006	1417	Yes
Shea	2006	1665	Yes
Shea	2009	1665	Yes
Shetty	2011	144	Yes
Sisk	2006	406	Yes
Slootmaker	2009	102	Yes
Slootmaker	2010	87	Yes
Smith	2012	32	Yes
Sone	2010	2033	Yes
Soran	2008	315	Yes
Soran	2008	345	Yes
Southard	2003	78	Yes
Southard	2003	100	Yes
Spaeder	2006	49	Yes
Sparks	1993	20	Yes
Spence	2006	72	Yes
Spittaels	2007	526	Yes
Stallard	2011	20	Yes
Stevens	2008	878	Yes
Stone	2010	150	Yes
Strecher	2005	3971	Yes
Strom	2000	45	Yes
Svetkey	2008	1032	Yes
Swartz	2006	351	Yes
Tanaka	2010	51	Yes
Tang	2013	415	Yes
Tasker	2007	37	Yes
Tate	2006	192	Yes
Taylor	2006	160	Yes
Te Poel	2009	615	Yes
Theissing	2013	164	Yes
Thompson	1999	46	Yes
Thompson	2009	138	Yes
Thompson	2010	40	Yes
Tildesley	2010	47	Yes
Titov	2010	141	Yes
Tjam	2006	57	Yes
Tsuyuki	2004	176	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Tuil	2007	180	Yes
Ueki	2009	29	Yes
van Bastelaar	2011	410	Yes
van den Berg	2006	160	Yes
van der Meer	2009	200	Yes
Van der Meer	2010	200	Yes
Van Egmond-Fröhlich	2006	521	Yes
van Wier	2009	924	Yes
Varma	2010	1339	Yes
Varnfield	2014	82	Yes
Velikova	2004	216	Yes
Verheijde	2004	146	Yes
Verheijden	2004	146	Yes
Vernmark	2010	88	Yes
Vernooij	2012	246	Yes
Villani	2007	60	Yes
Vitacca	2009	101	Yes
Wade	2006	44	Yes
Wade	2010	35	Yes
Wade	2011	2200	Yes
Wade	2011	120	Yes
Wade	2008 and 2009	9	Yes
Wagner	2006	55	Yes
Wakefield	2008	148	Yes
Wakefield	2008	101	Yes
Wakefield	2011	302	Yes
Waldman	2008	1541	Yes
Waldmann	2008	1500	Yes
Wallace	2002	2094	Yes
Walters	2007	106	Yes
Walters	2009	136	Yes
Wangberg	2006	11	Yes
Wapner	1995	218	Yes
Warren	2000	28	Yes
Weinert	2008	176	Yes
Weinert	2011	209	Yes
Weintraub	2005	188	Yes
Weintraub	2010	188	Yes
Weitzel	2007	39	Yes
Whited	2002	275	Yes
Whited	2003	275	Yes
Whitlock	2000	28	Yes
Whitten	2007	83	Yes
Wilkinson	2008	7	Yes
Willems	2007	110	Yes
Willems	2008	109	Yes
Williams	2010	106	Yes
Williamson	2006	37	Yes

Author	Year	Patients, N	Randomized Controlled Trial (Yes/No)
Wing	2006	104	Yes
Wister	2007	611	Yes
Wojcicki	2001	32	Yes
Wolf	2004	147	Yes
Womble	2004	47	Yes
Wong	2005	60	Yes
Wong	2005	120	Yes
Wong	2005	101	Yes
Wong	2006	475	Yes
Wong	2013	105	Yes
Woodend	2008	121	Yes
Woodend	2008	249	Yes
Woodend	2008	249	Yes
Woodruff	2007	136	Yes
Wooten	2000	204	Yes
Wright	2005	45	Yes
Wylie-Rosett	2001	474	Yes
Yardley	2010	714	Yes
Yoo	2009	111	Yes
Yoo	2009	111	Yes
Yoon	2008	51	Yes
Yoon	2008	51	Yes
Yoon an Kim	2008	51	Yes
Zolfaghari	2011	80	Yes
Zugck	2005	Undetermined	Yes
Zutz	2007	15	Yes

Appendix H. Summary of PROSPERO Search for Ongoing Systematic Reviews

The search resulted in 82 protocols. The protocols were sorted by clinical focus. Counts of protocols by clinical focus are below.

Clinical Focus	Number of Protocols
Not specified	9
Diabetes	6
Cardiovascular disease	4
Weight loss	4
Cancer	3
Chronic pain	3
Maternal and child health	3
Musculoskeletal disorders	3
Physical activity	3
PTSD	3
Asthma	2
Chronic diseases	2
Health behavior	2
Mental Health Care, general	2
Nutrition	2
Aging	1
Alcohol and tobacco use	1
Cervical cancer screening	1
Contraception	1
COPD	1
Critical Care	1
Depression, populations with chronic illness	1
Dermatology	1
Dietary assessment	1
Emergency Medical Dispatch	1
General Practice	1
Genetics	1
Headache	1
Heart failure	1
Insomnia	1
Interventions for caregivers	1
Knee arthroplasty	1
Low Vision	1
Not specified- Adverse events	1
Pediatric special needs	1
Postoperative care	1
Psychological distress	1
Rehabilitation, Brain injury	1
Rehabilitation, athletes	1
Rheumatic disease	1
Sleep apnea	1
Smoking cessation	1
Spinal pain	1
STIs	1
Stress	1
Stroke	1

Appendix I. Clinical Focus Areas of Excluded Reviews

Clinical Focus	Excluded Reviews (N)
Mixed	24
Diabetes	23
General	20
Congestive heart failure	18
Psychiatry/psychology	12
Addiction	11
Diet/weight management/obesity	10
Chronic disease	6
Prevention	6
Stroke	6
Asthma	5
Cancer	5
Critical care	5
Cardiovascular disease prevention	4
COPD	4
Depression	4
Hypertension	4
Anxiety	3
Chronic pain	3
Depression and anxiety	3
Dermatology	3
Economics - general telehealth	3
Elderly	3
Heart disease - implantable devices	3
Pain	3
Rural health	3
Autism	2
HIV	2
Mixed chronic conditions	2
Rehabilitation	2
Acute injury	1
Audiology	1
Behavioral health mixed	1
Breastfeeding	1
Cardiovascular unspecified	1
Diagnostic testing	1
Emergency	1

Clinical Focus	Excluded Reviews (N)
Hospice care	1
Inflammatory bowel	1
Injuries	1
Mixed behavioral health	1
Multiple Sclerosis	1
Neurological disorders	1
Physical rehabilitation	1
Plastic surgery	1
Pregnancy	1
Sexual health, teen	1
Tuberculosis	1