Draft Technical Brief

Number XX

Telehealth: An Evidence Map for Decisionmaking

Prepared for:
Agency for Healthcare Research and Quality
U.S. Department of Health and Human Services
540 Gaither Road
Rockville, MD 20850
www.ahrq.gov

Contract No. [To be added for final report]

Prepared by: [To be added for final report]

Investigators: [To be added for final report]

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.

This EPC evidence report is a Technical Brief. A Technical Brief is a rapid report, typically on an emerging medical technology, strategy or intervention. It provides an overview of key issues related to the intervention—for example, current indications, relevant patient populations and subgroups of interest, outcomes measured, and contextual factors that may affect decisions regarding the intervention. Although Technical Briefs generally focus on interventions for which there are limited published data and too few completed protocol-driven studies to support definitive conclusions, the decision to request a Technical Brief is not solely based on the availability of clinical studies. The goals of the Technical Brief are to provide an early objective description of the state of the science, a potential framework for assessing the applications and implications of the intervention, a summary of ongoing research, and information on future research needs. 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, 540 Gaither Road, Rockville, MD 20850, or by email to epc@ahrq.hhs.gov.

Richard G. Kronick, Ph.D.
Director
Agency for Healthcare Research and Quality

Arlene S. Bierman, M.D., M.S.
Director
Center for Evidence and Practice Improvement
Agency for Healthcare Research and Quality

Stephanie Chang, M.D., M.P.H.
Director, EPC Program
Center for Evidence and Practice Improvement
Agency for Healthcare Research and Quality

Elise Berliner, Ph.D.
Task Order Officer
Center for Evidence and Practice Improvement
Agency for Healthcare Research and Quality

Key Informants

In designing the study questions, the EPC consulted several Key Informants who represent the end-users of research. The EPC sought the Key Informant input on the priority areas for research and synthesis. Key Informants are not involved in the analysis of the evidence or the writing of the report. Therefore, in the end, 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.

The list of Key Informants who provided input to this report follows:
[List of Key Informants to be added for final]

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.

The list of Peer Reviewers follows:
[List of Peer Reviewers to be added for final]

Telehealth

Structured Abstract

Background. Telehealth includes a wide range of technologies used in health care, many of which 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 can be an impediment to understanding what is known about the effectiveness of telehealth and what questions remain unanswered.

Purpose. The purpose of this brief is to create an evidence map that is generated by identifying and then describing a limited number of key characteristics of the evidence that is available to inform practice and policy 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 created bubble plots to examine the distribution of the evidence in terms of volume and conclusions about benefit by clinical focus area and by telehealth function separately. We also determined how much evidence is available about combinations of clinical areas and telehealth functions and based on this developed assessments about the adequacy or need for evidence on selected topics.

Findings. We identified 1,305 citations about telehealth, of which 44 systematic reviews met our inclusion criteria. A comparatively large volume of research reported that telehealth interventions produce positive results when used for communication/counseling and monitoring and management for several chronic conditions and for psychotherapy as part of behavioral health. Topics with an evidence base that could be the focus of future systematic reviews include telehealth for consultation, in acute care, and 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 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 in organizations that are implementing these reforms.

Contents

Appendixes

Introduction

The existence of research on a topic does not guarantee that evidence can be used to support practice and policy decisions. In order to support decisionmaking, the research literature needs to be identified, evaluated, and synthesized. 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 they are used to expand access 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 (ICU), 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 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. There are currently over 14,000 articles and over 400 systematic reviews that have been assigned Telemedicine as a major subject heading indicating that this is the focus of the publication.

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

The format for completing these tasks and presenting the results in this brief is 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 or abbreviated review, evidence maps have been used by several organizations and are likely to become more common as the evidence base across health topics grows.[2-8]

Background

The State of Telehealth

Telehealth encompasses multiple technologies that have been applied to a wide range of health conditions, populations, and settings. Additionally, telehealth mirrors the rapidly changing technology environment, and the corresponding evidence base is rapidly expanding in both

8

volume and scope. Many different definitions of telehealth are used in the scientific literature, among policy leaders by industry and other stakeholders. The Health Resources and Services Administration (HRSA) provides the following well-accepted definition of telehealth: "the use of electronic information and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health, and health administration."[9] 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).[10]

Van Dyk illustrated the relationships among the many varied terms related to telehealth (Figure 1).[11] 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.[10] These telecommunications technologies can provide long-distance health care, educate patients and providers, and support management of chronic conditions in patient's homes. The wide-ranging capabilities also create one of the major challenges of systematically reviewing the literature on telehealth—the heterogeneity among existing studies. Studies of telehealth may vary by setting: rural or urban; home, community, clinic, nursing home, or hospital; radiology department; pharmacy;[12] and by clinical indication, health care delivery function, type of technology, and expected impact.

Figure 1. Scope of telehealth terminology[a]
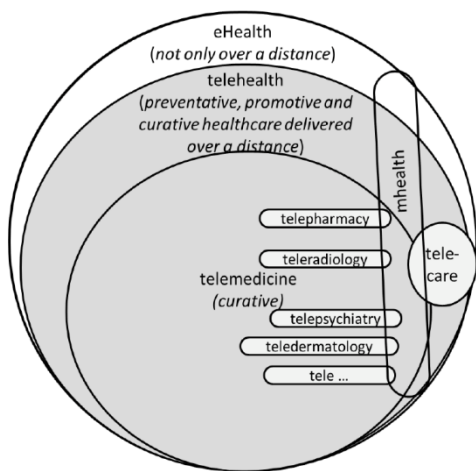
[a] Figure reprinted from *A Review of Telehealth Service Implementation Frameworks* by van Dyk[11]

Current Practice and Policy Issues

The motivation for this technical brief emanates from United States Senators Bill Nelson and John Thune, who asked 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.[13] A multi-stakeholder letter to Senators Bill Nelson and Susan Collins from several medical, patient advocacy, and industry groups supported the call for such a report.[14] 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 possible to quickly assess where there is sufficient

evidence to support policy and practice decisions through a full, comprehensive systematic review or where additional systematic reviews or primary research are needed. For this reason the Agency for Healthcare Research and Quality (AHRQ) Evidence-Based Practice Program commissioned an evidence map as the initial step in response to the Senate request, that would lead and help guide future work.

The request for a systematic review of "the growing body of evidence demonstrating the value of telehealth technologies"[13] 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.[15] While the potential benefits and possible uses have been extensively enumerated and described (e.g., improving quality, promoting safety, and expanding access),[16-18] there is also a body of literature that outlines barriers as well as challenges to implementation and widespread adoption of telehealth.[19,20]

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.[17,18,21]

Key issues involve identifying situations where telehealth use is supported by the evidence, obtaining sustainable funding for it use, and encouraging health care providers to apply it. Although telehealth promises great potential for improving health care delivery,[12,22,23] challenges include problems in reimbursement, scalability, and licensure.[19,20]

By definition, a technical brief must have a more narrow focus and content then a systematic review. 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 include some aspect of a patient interacting with the health care system and a health care provider for the purposes of treatment, management, or prevention of disease. This excluded applications such as informational Web sites, mobile applications that do not facilitate interaction, and 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. How these decisions were operationalized is described in the next sections on objective 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. Describe 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. Describe the gaps that 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 could be used to inform policy and practice decisions. For this reason we include consideration of the quality and the findings of systematic reviews in our map. However, quality and results are not addressed comprehensively as they would be in a full systematic review and these topics are often not included in technical briefs. For this reason we used and adapted approaches that have been used in other literature maps to including some elements of quality and results,[5-8] which we describe in methods.

Methods

An evidence map combines a systematic approach to identifying the existing literature on a topic with a description of key characteristics of the available evidence. Methodology and guidance for the creation of literature maps exist.[24,25] However, there are currently no accepted standards for this type of review, and, as one methods paper points out, the exact content and approach may vary based on the goals of the project: "Systematic maps aim to describe the existing literature, and gaps in the literature, in a broad topic area, and the literature quality and content can be analyzed in depth or more superficially as appropriate to individual projects."[24]

In order to achieve the objectives listed above and create an evidence map for telehealth, we developed a protocol based on adaptations of systematic review methods[26-28] and with input from Key Informants (KIs) and the Agency for Healthcare Research and Quality (AHRQ). 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, and two additional U.S. Senate staff, participated in interviews during the initial phase of the project. The purpose of these interviews was to identify the current major practice and policy issues surrounding telehealth. Knowing these issues was crucial to understanding how stakeholders would want to use research evidence about telehealth. In turn, these issues informed our searches and development of the review inclusion and exclusion criteria, and they also guided the collection and presentation of descriptive information in the evidence map.

During the interviews, KIs raised the following major points:

- 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 was used, including for which type of patients and it what situations telehealth was 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 for evidence reviews in Ovid MEDLINE®, the Cochrane Library 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 May 2015 with search date ranges ending in 2005 or later. This end 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. The cutoff date for publication of 2006 coincides with the publication date of a previous systematic review of telemedicine that our Evidence-based Practice Center performed.[29] These dates were discussed with the KIs, who agreed that older evidence would have very 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 (population, intervention, comparators, outcomes, timing, and setting) to outline our eligibility criteria. Inclusion and exclusion criteria are detailed in **Appendix B**. 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. 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 include the exchange of information or treatment or counseling, and it could occur over distance or at different times (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 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 since to a group of patients). This definition was applied to both systematic reviews and our later consideration of individual studies.

Study design. Our primary search was for systematic reviews that focused on telehealth and synthesized clinical or utilization outcomes across primary research studies. The overarching requirement for including a systematic review was its ability to help in decisionmaking. This was our rationale for focusing on systematic reviews, as a well-conducted 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. As such, where such systematic reviews exist and are recent, they are the pinnacle of the evidence hierarchy when it comes to informing decisions. Based on this rationale these systematic reviews form the basis of the core of our evidence map.

For a study to be considered a systematic review it had to have included a search of one or more citation databases, based study selection on prespecified inclusion and exclusion criteria, and assessed the quality (or risk of bias) of individual studies included in the review. We did not require that the review had to have conducted strength of evidence assessments of the body of evidence for each outcome, but we did abstract data on whether this was done, how it was done, and how this influenced the conclusions in those that did. As noted above, we also required that the review must have had search date ranges ending in 2005 or later to be included in the evidence map.

Outcomes. Included studies had to report clinical, resource utilization, or cost outcomes, corresponding to KI interest in research on the effectiveness of telehealth. We did not include studies of patient or provider satisfaction with or attitudes toward telehealth. We also excluded studies where the outcome was the extent or success of implementation. Studies of diagnostic accuracy were also excluded.

Population. We included studies of adults and 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 followup. We included review studies 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 assess 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 the telehealth function. 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, except 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 plays in health care, telehealth modality/technology, and two indicators of the rigor of the review (i.e., was there a strength of evidence assessment and was there 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 as indicators of the size of the evidence base.

For areas we identified as not covered by included systematic reviews, we reviewed the clinical focus and telehealth function for excluded reviews and also searched for potentially relevant primary research studies.

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 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 healthcare function. We selected these two categorizations because decisions about telehealth are usually made about its use with particular types of patients (clinical focus) or to deliver a type of health care service (health care function). Each of the two bubble plots then convey three 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), and (3) finding of effect. The figure presents how the clinical focus and function categories intersect. This creates groupings of the evidence that are more specific, for example is shows what evidence is available about telehealth for monitoring and management (function) for people with chronic conditions (clinical area). This figure reports for each grouping (1) the number of 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 studies. 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, counseling).While both of these 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) or 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 table will 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 results of systematic reviews involved more interpretation and decision rules. First we reviewed the conclusion of each review. Many reviews include multiple outcomes and while more details are provided in the Evidence Tables (**Appendix E**) the conclusions needed to be summarized. The systematic review results were coded as 1=no effect, 2=unclear, 3=possible positive effect, 4=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 1=no effect, or 4=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 2=unclear. If either some primary outcomes or the majority of all outcomes showed a positive effect the conclusion was coded as 3=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 based on that discussion a code was assigned.

The weighted estimate of reported effect used in the bubble plots was created by multiplying the overall conclusion code (1 to 4) by the number of studies in the review, and then averaging the scores for all reviews of given clinical area or function. While this does 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 further to the right the position of the bubble is on the plot, the more consistently positive are the conclusions of the reviews, where further 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. This is discussed in more detail in the Discussion section of this brief. For this reason we have included other tables and charts, as well as 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 used 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 1,122 potentially relevant articles. We identified an additional 183 potentially relevant articles through the grey literature search and search of Web sites for telehealth organizations and government agencies. After dual review of abstracts and titles, 562 articles and grey literature reports were selected for full-text dual review. Of these, 44 systematic reviews were determined to meet the inclusion criteria and were included 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. Reviews were excluded (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 of interest to us, or (2) they did not meet our requirements for a systematic review (as differentiated from a narrative or general review). These excluded reviews are listed in Appendix D.

Figure 2. Literature flow diagram
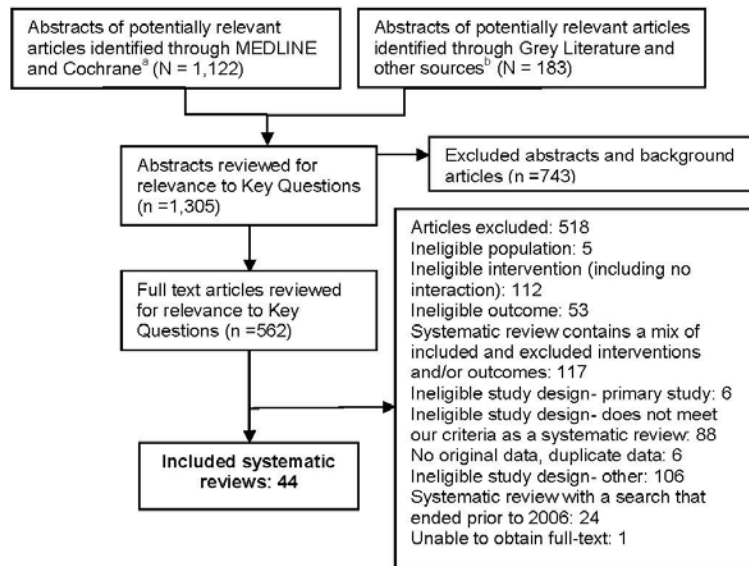
[a] Cochrane Database of Systematic Reviews.
[b] Grey literature search included the New York Academy of Medicine Grey Literature Collection, Web sites for the American Telemedicine Association, U.S. Department of Health & Human Services, Healthcare Information and Management Systems Society, U.S. Office 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 44 included reviews met the strict criteria we established to distinguish systematic reviews that provided content that was organized, analyzed, and presented in a way that could support policy and practice decisions about telehealth.[30-73] Information abstracted from each included systematic review is detailed in the evidence tables in **Appendixes E and F**. **Figure 3** presents the publication year of the included reviews, showing that 70 percent published since 2011.

Figure 3. Publication dates for included systematic reviews
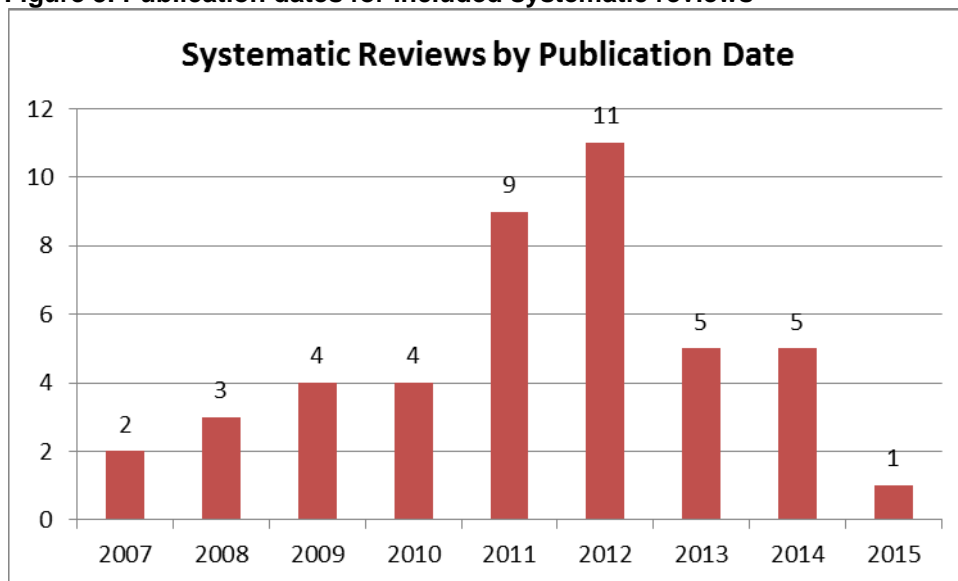

Table 1 includes descriptive information on basic characteristics of the included reviews, such as the final year of the searches performed in the review, which we used as a means of checking how current the information was that formed the basis for the reviews. Table 1 also reports the setting (i.e., where the patients were located). In the majority of reviews, the patients were in their home (63%), while a small number of reviews addressed telehealth when the patient was hospitalized (4%), and some included a mixture of settings (30%). In terms of the types of outcomes reported, 50 percent reported clinical outcomes, 16 percent reported cost outcomes, and 34 percent reported both clinical and cost outcomes.

Table 1 also includes three characteristics that could be used to consider the rigor and utility of the reviews. The current standards for systematic reviews require more than simply cataloging studies.[26-28] We defined "strength of evidence" as synthesis across studies that incorporates prespecified criteria. Quality assessment of individual studies can contribute to strength of evidence but alone is often not sufficient. Half of the included reviews reported some form of strength of evidence 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 14 (32%) reviews. The final characteristic of the included reviews reported in Table 1 is whether the review was or was not able to draw a conclusion about the effectiveness of telehealth. Just under one fifth (18%) reported that the evidence was inconsistent or contradictory (we used the neutral term, unclear) 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	2.3
	2006	1	2.3
	2007	5	11.4
	2008	1	2.3
	2009	11	25.0
	2010	7	15.9
	2011	10	22.7
	2012	1	2.3
	2013	5	11.4
	2014	2	4.6
Setting – Location of patient	Home	28	63.6
	Hospital	3	6.8
	Mixed Locations	13	29.6
Telehealth Modality	Asynchronous communication	12	27.3
	Mobile phone	2	4.6
	Videoconferencing	11	25.0
	More than one technology	19	43.2
Outcome type	Clinical	22	50.0
	Cost	7	15.9
	Both	15	34.1
Strength of evidence reported in systematic review	No	22	50.0
	Yes	22	50.0
Meta-analysis conducted in systematic review	No	30	68.2
	Yes	14	31.8
Conclusion reported in systematic review	Conclusion drawn	36	81.8
	Unable to draw conclusion	8	18.2

The modality or technology used for telehealth is included in Table 1 and also in **Figure 4**. Many reviews (43%) included several modalities either within or across studies;[33-37,39,42-44,47,48,57,63,64,66,69,72-74] however, studies of asynchronous communication (27%)[30,38,41,51,52,56,58-60,62,65,70] and videoconferencing (25%)[31,32,40,49,50,53,54,61,67,68,71] also accounted for a sizable proportion of the reviews.

Figure 4. Telehealth modality of included systematic reviews
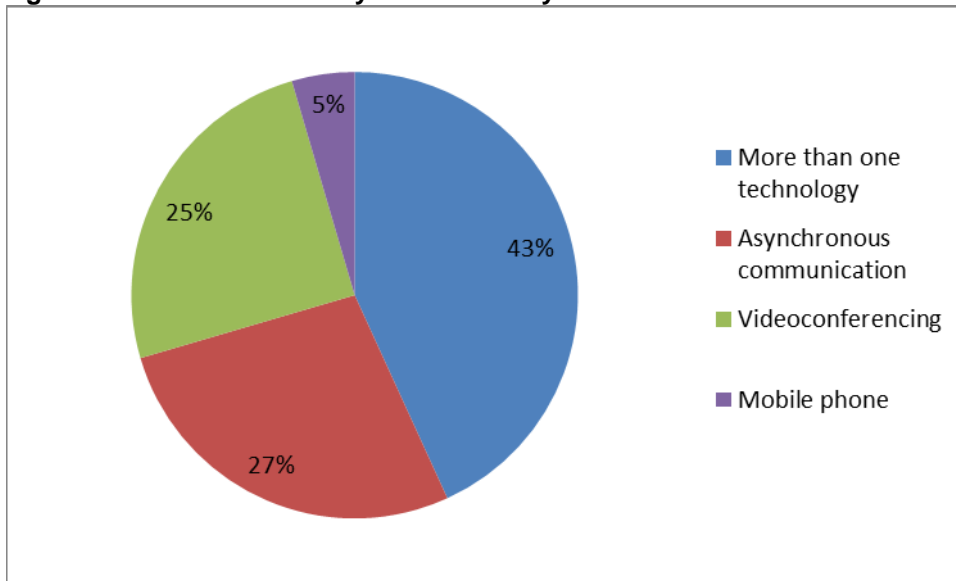
As technology has changed over time, we also looked at the distribution of the modalities covered by the included reviews by publication date **(Figure 5)**. The number of reviews published that look at several technologies (mixed) increased through 2012, then declined to one per year in 2013 and 2014, and none so far in 2015. One or more 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. Distribution of systematic reviews by telehealth modalities and publication year
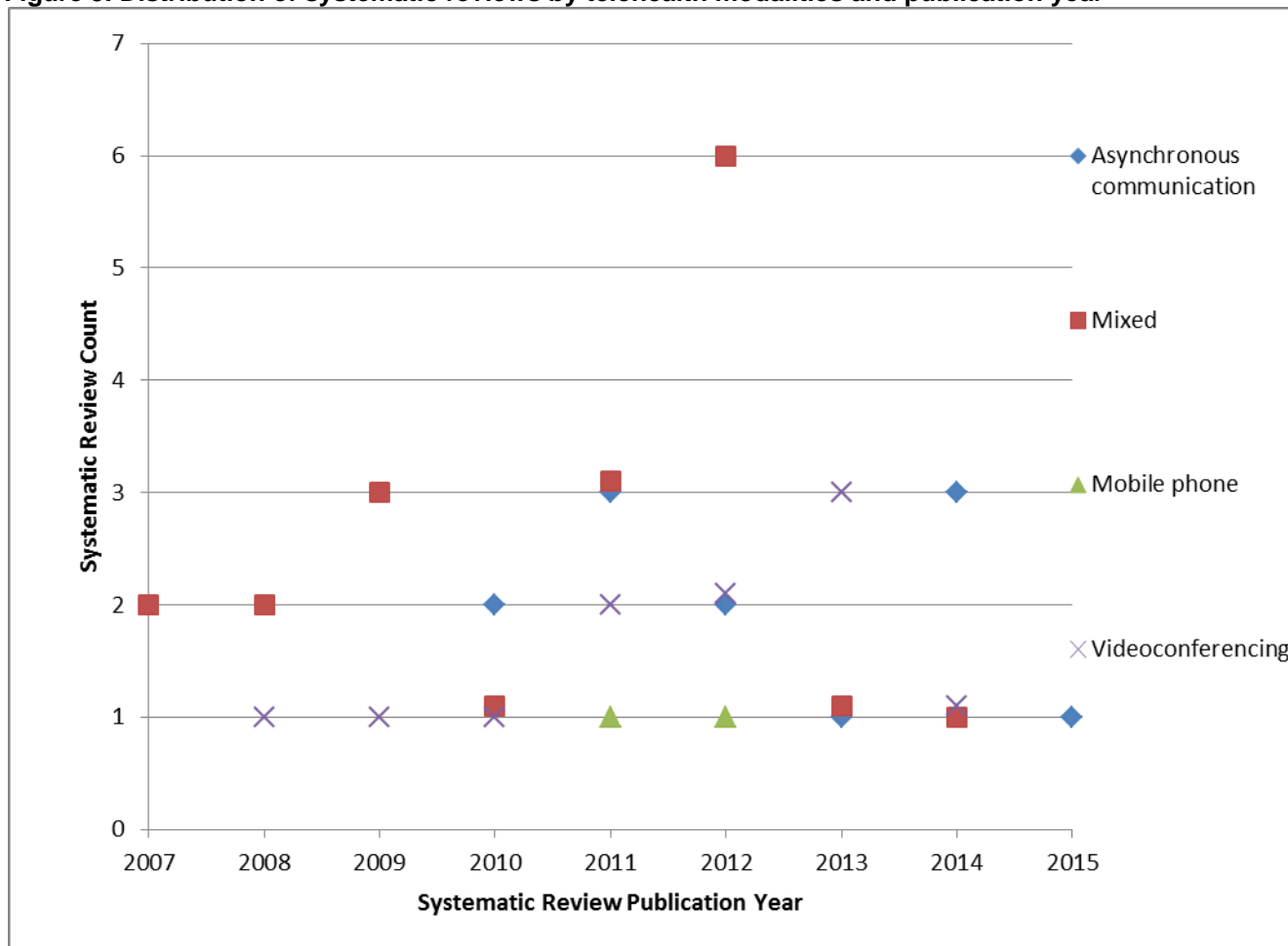
In **Table 2** we provide the classifications of the included systematic reviews according to the clinical focus and telehealth function. "Clinical focus" is the clinical condition, indication, or situation telehealth was used to address. Function is the role telehealth played in healthcare. These characteristics are described in more detail below. 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.

The most frequent clinical focus is "mixed chronic conditions." These nine systematic reviews all defined their inclusion criteria such that the reviews combined studies of multiple individual conditions, included primary studies with patients with more than one condition, or both. For example, the review by de Jong that evaluates internet communication between health providers and patients with chronic conditions includes studies in which all patients have the same condition (e.g., diabetes), studies in which patients have related conditions (e.g., chronic neurological conditions), and studies in which included patients have different conditions (e.g., chronically ill women with a variety of clinical conditions).[38] The similarity in all these reviews is that their scopes are limited to chronic conditions. Mixed conditions is the label given to reviews that included a wide range of conditions, all of which may not typically be 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, with diabetes, with congestive heart failure, and patients without specific conditions.[30] Another review of electronic symptom reporting included studies of patients with several conditions including cancer and diabetes.[48]

In telehealth function, there is a similar category, multiple functions. Six reviews were coded this way when the included studies stated telehealth was used for more than one function. In two reviews the focus was on a specific technology, video conferencing[67,71] or the internet,[41] but the technology was used to monitor, communicate with, and treat patients.

Table 2. Clinical focus and telehealth function of included systematic reviews

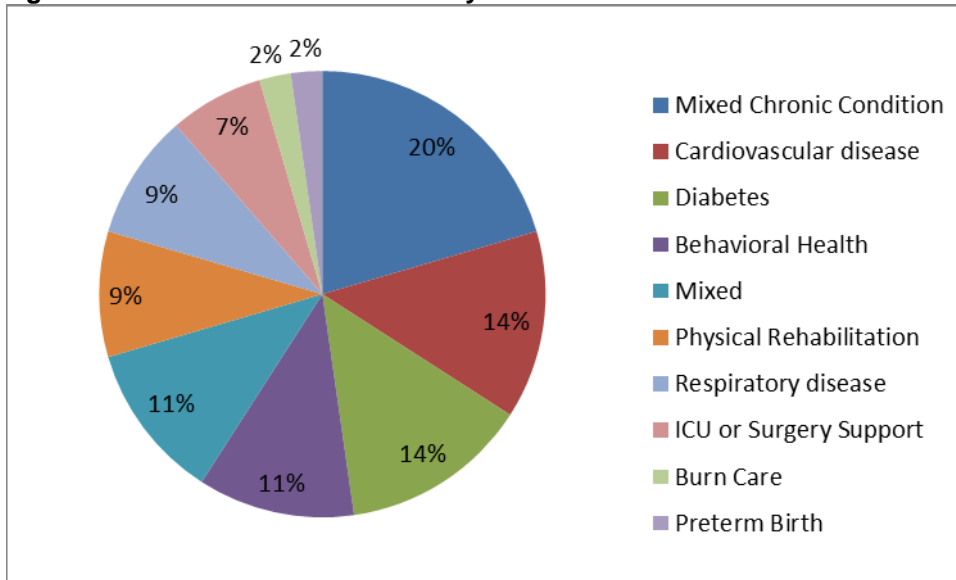| Study Characteristic		Systematic Reviews (N)	Percent of Systematic Reviews by Category	Individual Studies included in Systematic Reviews[a] (N)	Patients[a] (N)
Totals	--	44		732	182,397
Clinical Focus	Mixed Chronic Condition	9	20.5	199	54,166
	Cardiovascular Disease	6	13.6	41	21,563
	Diabetes	6	13.6	92	17,261
	Behavioral Health	5	11.4	134	35,713
	Mixed Conditions (not all chronic)	5	11.4	120	38,135
	Physical Rehabilitation	4	9.1	69	5,302
	Respiratory Disease	4	9.1	44	2,962
	ICU or Surgery Support	3	6.8	19	193
	Burn Care	1	2.3	24	6,782
	Preterm Birth	1	2.3	15	6,026
Telehealth Function	Communication and Counseling	14	31.8	254	85,014
	Monitoring and Management	12	27.3	165	33,765
	Multiple functions	6	13.6	120	22,052
	Psychotherapy	5	11.4	118	29,293
	Consultation	3	6.8	37	13,709
	Telerehabilitation	3	6.8	53	4,152
	Telementoring	1	2.3	10	118

ICU=intensive care unit
[a] These are deduplicated numbers, 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.

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 mixed chronic conditions (20%),[38,40-42,44,52,61,67,69] followed by cardiovascular disease (14%),[33,34,37,39,59,66] diabetes (14%),[35,45,55,60,62,73] behavioral health (11%),[31,43,57,63,65] and mixed clinical conditions (11%).[30,48,51,56,71] Focus areas that represent less than 10 percent of included systematic reviews included physical rehabilitation (9%),[49,54,64,74] respiratory disease (9%),[36,47,50,58] intensive care unit (ICU) or surgery support (7%),[32,53,68] burn care (2%),[72] and preterm birth (2%).[70] Nearly one-third of included systematic reviews (31%) focused on mixed chronic or mixed but not 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 communication and counseling (32%)[30,35,38,48,51,52,55,56,59,60,62,64,65,73] and monitoring and management (27%).[33,34,37,44,47,50,58,61,66,68-70] Some of the reviews combined research on multiple functions (14%).[36,41,42,45,67,71]

Figure 6. Clinical focus of included systematic reviews

ICU=intensive care unit

Figure 7. Telehealth function of included systematic reviews
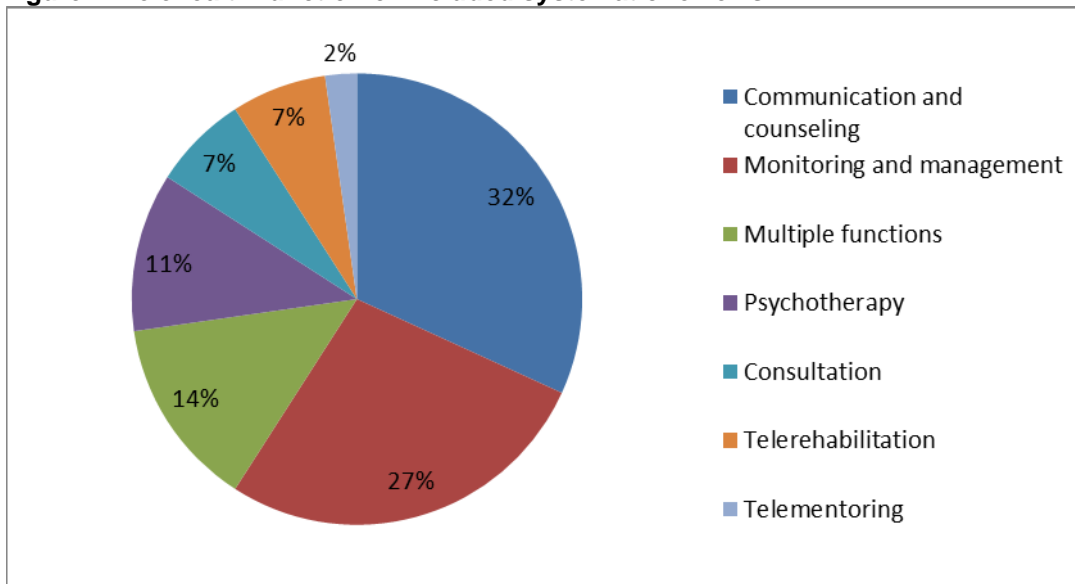
Indicators of Rigor of the Reviews

In **Table 1** we reported selected characteristics of the included reviews that could be interpreted as indicators of the rigor of the review. Specifically assessing the results across studies using either a "strength of evidence approach" or considering quantitative synthesis (i.e., a meta-analysis) are of interest, as reviews that incorporate these approaches may be more sophisticated and in accordance with contemporary standards. Additionally, these tools 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 randomized controlled trials (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 RCT is often an indication both of interest in the topic and the quality of the evidence.

Table 4 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, have been the focus of at least one systematic review, but that these reviews contain no or few RCTs and do not report meta-analyses. However, of the three reviews about ICU/surgery support, two of the three included a strength of evidence assessment. Reviews of other areas have a large proportion of RCTs such as cardiovascular disease (78%).

Table 3. Data synthesis methods for systematic reviews by clinical focus

Telehealth Clinical Focus	Number of Systematic Reviews (N=44)	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 (%)
Behavioral Health	5	67/134 (50)	1/5 (20)	1/5 (20)
Burn Care	1	0/24 (0)	0/1(0)	0/1 (0)
Cardiovascular Disease	6	32/41 (78)	3/6 (50)	4/6 (67)
Diabetes	6	67/92 (73)	2/6 (33)	3/6 (50)
ICU or Surgery Support	3	1/19 (5)	0/0 (0)	2/3 (67)
Mixed Chronic Condition	9	129/199 (65)	3/9 (33)	5/9 (56)
Mixed Condition	5	90/120 (75)	1/5 (20)	1/5 (20)
Physical Rehabilitation	4	28/69 (41)	1/4 (25)	2/4 (50)
Preterm Birth	1	15/15 (100)	1/1 (100)	1/1 (100)
Respiratory Disease	4	22/44 (50)	2/4 (50)	3/4 (75)

ICU=intensive care unit, RCT=randomized controlled trial

Table 5 includes the same information by telehealth functions. Reviews of telehealth for consultation and telerehabilitation have fewer RCTs. Reviews of communication and counseling studies contain 86 percent RCTs.

Table 4. Data synthesis methods for systematic reviews by telehealth function

Telehealth Function	Number of Systematic Reviews	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 (%)
Communication and Counseling	14	219/254 (86)	6/14 (43)	5/14 (36)
Consultation	3	1/37 (3)	1/3 (33)	1/3 (33)
Mixed	6	51/120 (43)	0/6 (0)	4/6 (67)
Monitoring and Management	12	109/165 (66)	5/12 (42)	8/12 (67)
Psychotherapy	5	51/118 (43)	1/5 (20)	2/5 (40)
Telementoring	1	0/10 (0)	0/1 (0)	1/1 (100)
Telerehabilitation	3	20/53 (38)	1/3 (33)	1/3 (33)

RCT=randomized controlled trial

We also evaluated the included reviews (n=44) for relationship between the conclusion (i.e., whether the telehealth provided benefit) and several independent variables, including setting (home vs. not); use of quantitative analysis (meta-analysis or 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 coded to report these independent and dependent variables. Chi square tests were used to explore if there were differences between the observed counts and the expected counts in pivot tables generated by Excel®. We found no statistically significant relationships (p>0.05) across all eight chi-square analyses; however, the cell sizes for some comparisons were less than 10, suggesting that this quantitative approach is 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 plots for clinical focus and for telehealth function. After examining the results, we decided that the category clinical focus and the intersection plot provided the insights that most closing matched current stakeholder interests in telehealth and provided the best way to summarize and assess the state of the evidence. Hence, we provided a more detailed analysis of this based on these after providing the 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, such that each patient is counted only once in the plot. 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 horizontal placement along the x-axis is determined by weighting the overall

conclusion of each review (coded as 1=no benefit, 2=unclear, 3=potential benefit, and 4= positive benefit) by the number of studies in the review. As stated above in the Methods section, the 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 are unclear or found no benefit. While the weighting does not create a value with absolute meaning, it allows comparisons of the consistency and direction of the conclusions by clinical area or function.

Figure 8. Telehealth literature map by clinical focus
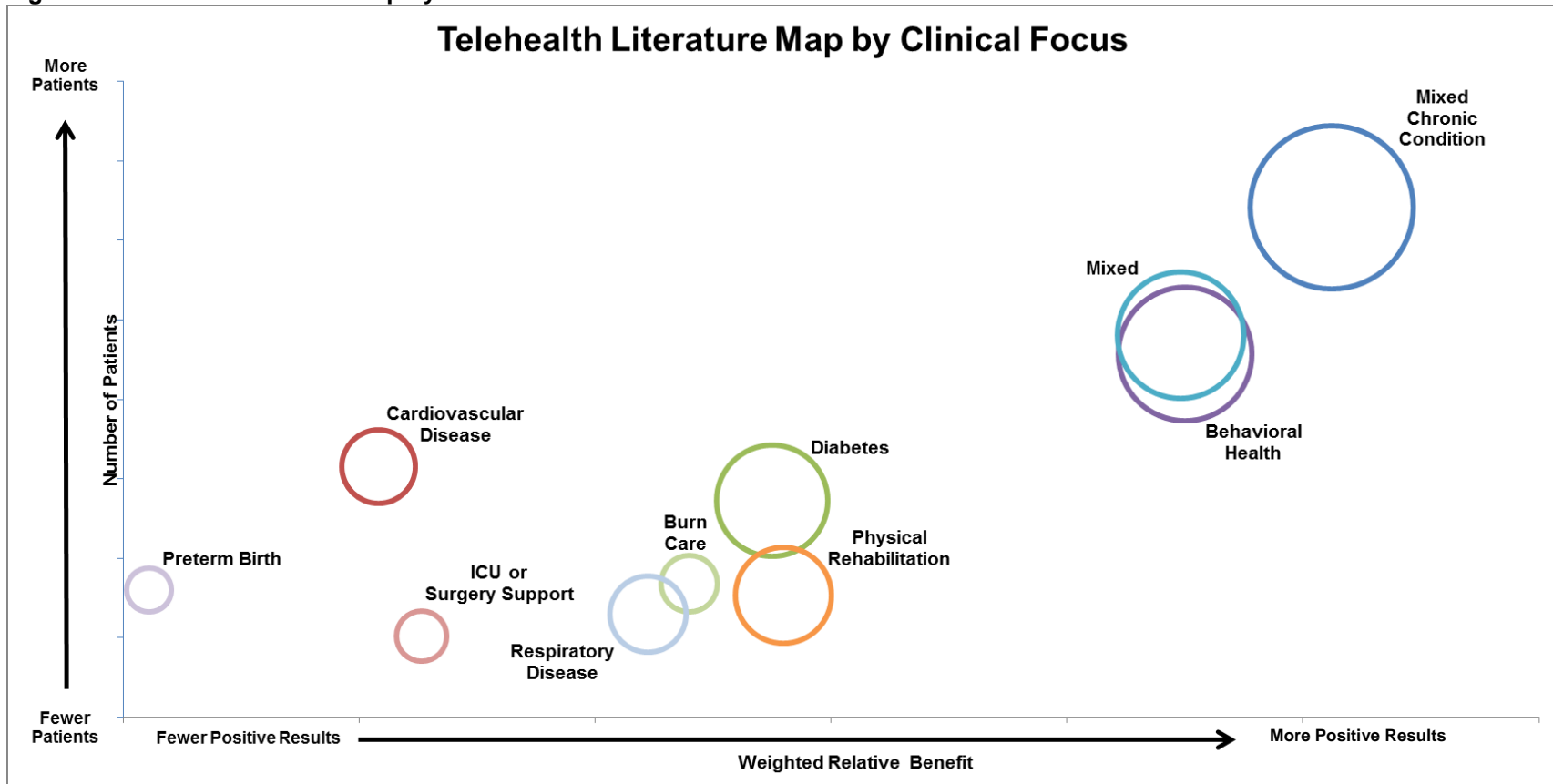
Notes:
a.   Bubble size reflects the number of individual studies included in the systematic reviews. Smaller bubbles indicate fewer studies, larger bubbles indicate more studies.
b.   Weighted relative benefit is calculated by weighting the overall conclusion of each review by the number of studies 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

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 chronic conditions, followed by behavioral health. The third category, mixed conditions, includes reviews that combined studies across various acute and chronic conditions with no limitations on types of patients. This finding is represented on the plot by the fact that the bubbles are large and higher up on the y-axis. These bubbles are also further 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 the most studies (size of bubble) that have included over 10,000 patients (y-axis). The position in the middle of the plot area represents that in general the reviews found positive or potentially positive benefits.

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 are designed to explore what evidence is available for clinical focus areas not covered by our included systematic reviews.
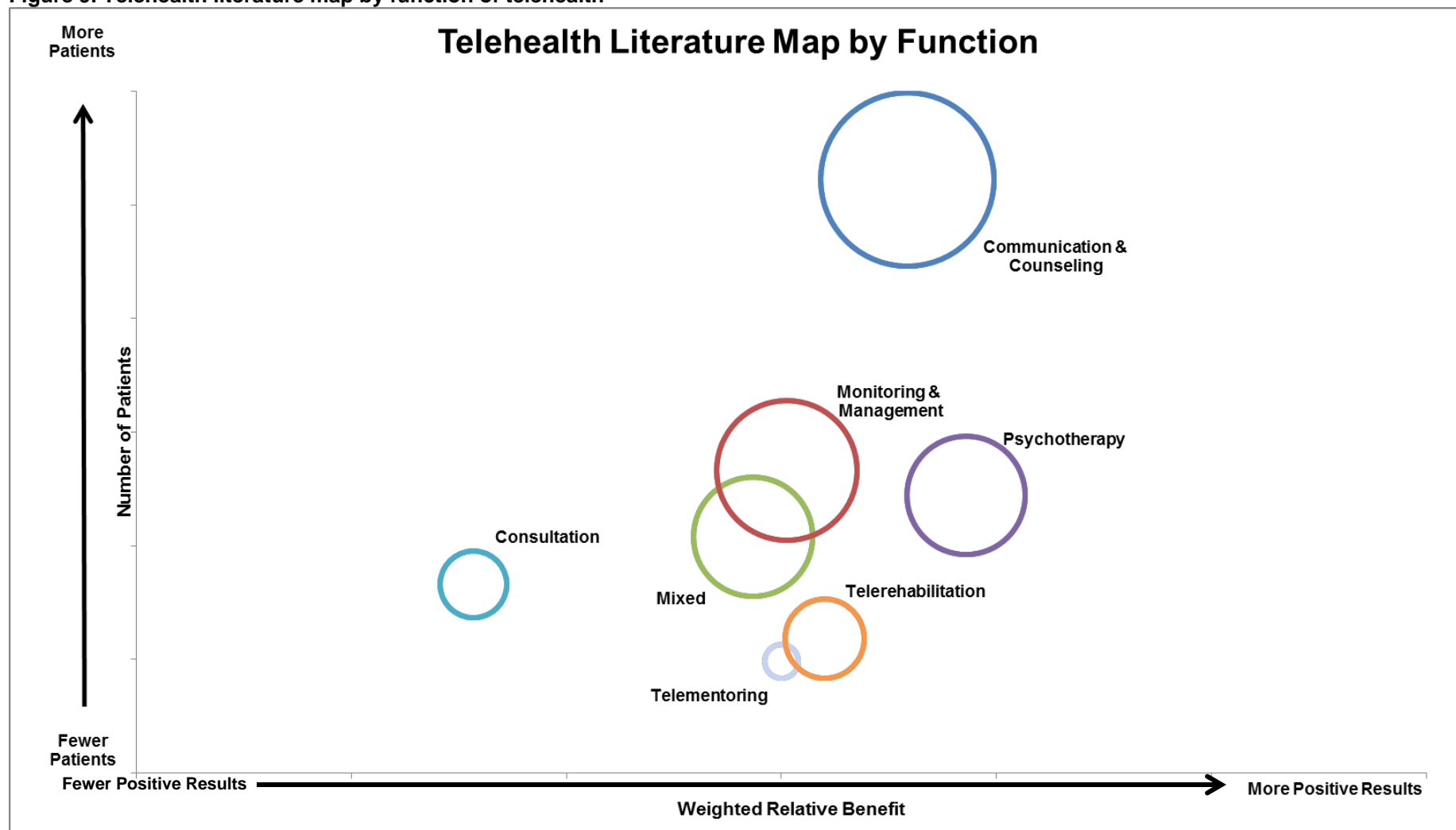
Telehealth Function

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 7 except the reviews are summarized by the function telehealth played instead of clinical focus.

Each bubble is a function for telehealth. The other variables are the same as in Figure 6. The y-axis is the number of patients in a deduplicated list of studies in the systematic reviews; the size of the bubble is the number of unique studies included in the reviews about that function. 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, psychotherapy and communication and counseling are the function bubbles furthest to right, indicating the most reports of positive benefits of telehealth when used for these purposes. However, the psychotherapy bubble is smaller and lower on the y-axis than the communication and counseling bubble, meaning that there are fewer studies and fewer patients in these reviews. Communication and counseling is the largest and highest bubble, indicating a high number of studies that evaluated this function, and it is also closest to the top of the plot area, indicating that these studies included the largest number of patients. Its location in the center on the x-axis suggests the conclusions tend toward potential benefit.

Figure 9. Telehealth literature map by function of telehealth

Telehealth Literature Map by Function

More Patients

Number of Patients

Fewer Patients

Communication & Counseling

Monitoring & Management

Psychotherapy

Consultation

Mixed

Telerehabilitation

Telementoring

Fewer Positive Results → More Positive Results

Weighted Relative Benefit

Notes:

a. Bubble size reflects the number of individual studies included in the systematic reviews. Smaller bubbles indicate fewer studies, larger bubbles indicate more studies.

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.

The Intersection of Clinical Areas and Telehealth Intervention Function

While 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, examining the intersection of clinical areas and functions provides additional, more finely grained and potentially more useful insight, in terms of 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 small bubbles. 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 "Diabetes and Communication/Counseling". There are five circles in this cell representing five systematic reviews. The shading indicates that the conclusions included two finding telehealth provided benefit, two citing potential benefit, and one did not reach a conclusion. The reviews are small to medium sized including 14 to 35 studies.

Identifying this subgroup of reviews allows more details to be examined in order to better understand patterns and diversity within the pairs. Using the diabetes and communication pair as an example, of the reviews that concluded that telehealth resulted in benefit or potential benefit three focused on a specific technology. One 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 II patients.[55] The second examined patient web portals and how they supported self-management, education and communication and found this type of telehealth has a positive impact on patient outcomes, communication, access, and patient satisfaction.[60] A third review of web-based interventions for type 2 diabetes concluded the web could be used for behavioral interventions and to support self-management but that the favorable results were enhanced if these were supplemented by other interventions such as case managers or mobile phone support and follow-up.[62] The other review that reported potential benefits included studies that that evaluated the use of a range of technologies to promote physical activity as part of type 2 diabetes management and concluded that research suggests 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.[35] The fifth study in this pair also included studies of different technology (e.g., electronic messaging, websites, and video conferencing) used to support glycemic control in patients with type 2 diabetes, but concluded the evidence in their review of was 'unconvincing' due to concerns about publication bias and a small effects.[73] The sixth review related to diabetes is in the mixed function group as it included studies of mobile phone use both for communication as well as monitoring and management. This review concluded that telehealth show promise in this area but the evidence was lacking due to lack of rigorous study designs, specifically insufficient sample sizes and short interventions and follow-up.[45]

Empty cells include both potentially important topics for which 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 not applicable. (e.g., psychotherapy and physical rehabilitation).

Examining this plot shows where synthesized bodies of evidence (that is systematic reviews) about telehealth are available 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 we use this information to create categories related to the sufficiency and need for research in selected areas.

Figure 10. Evidence for the intersection of clinical focus and telehealth function

	Communication and Counseling	Monitoring and Management	Mixed	Psychotherapy	Consultation	Telerehabilitation	Telementoring
Mixed Chronic Condition	15 studies[38] 23 studies[52]	78 studies[69] 24 studies[44] 9 studies[61]	10 studies[41] 21 studies[42] 35 studies[67]	15 studies[40]	None	None	None
Cardiovascular Disease	13 studies[59]	9 studies[37] 12 studies[66] 11 studies[34] 4 studies[33]	None	None	5 studies[39]	None	None
Diabetes	21 studies[55] 15 studies[60] 15 studies[35] 14 studies[62] 35 studies[73]	None	21 studies[45]	None	None	None	None
Behavioral Health	33 studies[65]	None	None	9 studies[43] 39 studies[63] 12 studies[57] 45 studies[31]	None	None	None
Mixed	15 studies[51] 39 studies[56] 5 studies[30] 31 studies[48]	None	36 studies[71]	None	None	None	None
Physical Rehabilitation	16 studies[64]	None	None	None	None	28 studies[49] 27 studies[46] 10 studies[54]	None

	Communication and Counseling	Monitoring and Management	Mixed	Psychotherapy	Consultation	Telerehabilitation	Telementoring
Respiratory Disease	None	(Positive Benefit) 7studies[50] (Potential Benefit) 10 studies[58] (Positive Benefit) 23 studies[47]	(No Benefit) 7 studies[36]	None	None	None	None
ICU or Surgery Support	None	(No Benefit) 1 study[68]	None	None	(Unclear) 8 studies[53]	None	(Positive Benefit) 10 studies[32]
Burn Care	None	None	None	None	(Unclear) 24 studies[72]	None	None
Preterm Birth	None	(No Benefit) 15 studies[70]	None	None	None	None	None

Legend: (Positive Benefit) Positive Benefit (Potential Benefit) Potential Benefit (Unclear) Unclear (No Benefit) No Benefit

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 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, 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 may not directly correlate with our clinical focus areas and our definition of telehealth, and that the domains across these lists may overlap. While this could be problematic if mutually exclusive categories were needed, 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 key sources

American Telemedicine Association workgroups[75]	Institute of Medicine[18]	Telehealth Round Table Testimony[17]	Center for Connected Health Policy Report[76]
• 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, 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.[77] We searched from August 1, 2013, to the present for any ongoing reviews with the following words in any field: "telehealth" OR "telecare" OR "telemedicine" OR "eHealth" OR "mHealth." We reviewed the resulting 84 protocols and excluded nine that were not relevant, leaving 75 reviews that are underway that have been registered. A complete list of the topics identified is in **Appendix H**. The most frequent specific topic not well-represented in our included completed reviews was maternal/child health. Other topics such as diabetes (6 reviews in progress) and chronic obstructive pulmonary disease (COPD) (2 reviews in progress) are already represented in our included reviews, however, the PROSPERO entry 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 that there are additional areas not well covered in our included reviews such as cancer, chronic pain, autism, and pregnancy (limited to one review on uterine monitoring to prevent preterm birth). At the same time, this list also includes many of the areas are 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 studies in these reviews could be useful if reanalyzed. Specifically, the studies in these reviews that have telehealth interventions that meet the definition could be presented in subgroup analysis and/or the reviews could be redone to include quality assessments.

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 has been proposed as appropriate or studied that were not well-represented: (1) triage for urgent care/primary care; (2)maternal health; (3) pediatric cancer and chronic pediatric health conditions. 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 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.

Clinical Focus Priority Topics

In creating the plots and tables, we sorted the included reviews into 10 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 key policy and practice questions. In this section we describe in more detail the findings of 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 straight forward, 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.

Twenty-three of the systematic reviews we identified for this report examined telehealth in either multiple chronic conditions or specific chronic conditions. This included the nine reviews we classified as mixed chronic conditions,[38,40-42,44,61,67,69] all six of the reviews that focused specifically on diabetes,[35,45,55,60,62,73] four[33,34,37,66] of the six reviews on cardiovascular disease (those not considered chronic include one about acute myocardial infarction[39] and one about primary prevention),[59] and three of four about respiratory illness (one included telehealth use in transplant),[47] including two about COPD[50,58] and one about cystic fibrosis.[36] Only two of these reviews, one about diabetes[45] and one about cystic fibrosis[36] included studies with children as well as adults, while one additional review included one study of the parents of diabetic children.[60] 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 (9 of 22) included telehealth interventions used for monitoring and management: seven reviews focused on telehealth used to provide counseling or facilitate other communication and five reviews included multiple functions, while one review examined the use of telehealth for psychological therapies.

As a group, the conclusions of the systematic reviews of research on the effectiveness of telehealth for chronic conditions were generally positive. Eight of the 22 studies (36%) reported benefits in primary or most outcomes, nine reported potential benefits, three found no benefit, and two stated that it was unclear. Details on the findings from the eight reviews reporting benefits are included in **Table 6** below. These eight reviews have characteristics associated with rigorous systematic review methods: six of the eight included some approach to assessing the evidence across studies and four of the eight included a quantitative meta-analysis.

Table 6. Selected results: Telehealth for chronic conditions

Author, Year Number of RCTs/Total Number of Included Studies Clinical Focus Telehealth Function	Selected Results: Clinical Outcomes	Selected Results: Cost and/or Utilization
Kamei, 2013[,50] 7/9 COPD Monitoring and Management	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, 58] 10/10 COPD Monitoring and Management	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
Dang, 2008[37] 9/9 Heart Failure Monitoring and Management	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)
Seto, 2008[66] 4/10 Heart Failure Monitoring and Management	None reported	Lower direct costs Reduced compared to usual care in all nine 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
Tran, 2008[69] 18/34 Mixed Chronic Conditions Monitoring and Management	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[38] 15/15 Mixed Chronic Conditions Communication and Counseling	Improvement in clinical outcomes (5 studies) Improvement in symptoms (5 trials) Positive psychosocial outcomes (5 trials)	Physician visits: difference not significant 2 trials
Osborn, 2010[60] 8/15 Diabetes Communication and Counseling	Improvement in clinical outcomes, 5 studies improvement in disease management (10 studies)	Lower hospitalizations and emergency room visits: 1 trial
Liang, 2010[55] 11/22 Diabetes Communication and Counseling	Improvement in clinical outcomes, meta-analysis of 22 studies (diabetes)	None reported

COPD=chronic obstructive pulmonary disorder, RCT=randomized controlled trial
[a] Two individual studies are repeated in these reviews

Monitoring and Management

Remote monitoring and management is a telehealth functions frequently studied. Twelve of the included reviews assessed telehealth use for monitoring and managing illnesses[33,34,37,44,47,50,58,61,66,68-70] and three assessed multiple functions that included monitoring and management.[41,42,71] 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 allows patients to provide more data to providers, in a more timely way than could be obtained in outpatient visits or allows 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 care itself.

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 internet connections). Most, but not all of the reviews we identified used remote monitoring and management 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 pre term births[70] and monitoring that allowed parents to monitor babies in neonatal ICU and communicate with providers.[68]

Of the 15 reviews that synthesized studies of monitoring, five concluded telehealth lead to positive benefits, five concluded benefits were possible, one was inconclusive, and four reported no benefit from telehealth. The five that reported benefits overlapped with those discussed in relation to chronic disease and are in the first five rows in Table 6 and the five that concluded potential benefit for remote monitoring and management also addressed chronic conditions.

Three of the four that reported not finding benefits explored very different applications of remote monitoring: a review of the use of home uterine monitors to prevent pre-term birth that found no impact on maternal and perinatal outcomes,[70] a review of the addition of real time video as part of home care,[61] and a review that identified only one study of the use of monitoring with 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).[68]

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, but one that may require more attention, development or more adaptation for other uses.

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.[78] Indeed, the US Centers for Medicare and Medicaid Services has a stated a goal of increasing Medicare and Medicaid reimbursement to value-based models that share risk with provider organizations and give incentive for more coordinated and efficient care.[79] 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).[80]

Many of the evaluations of telehealth we identified considered a variety of outcomes, including clinical outcomes as well as 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 are

relatively new to healthcare in the US and abroad, and no studies of telehealth have been able to assess the contribution of telehealth to value-based models yet.

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 are 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 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 also from a population health management one as well.

Discussion

Summary and Implications

This technical brief was designed to characterize the existing literature available to inform decisions about telehealth, using an evidence map approach. Various stakeholders, including federal and state policymakers, health care provider organizations, and insurers and payers, are faced with making decisions related to supporting, implementing, and paying for telehealth. To the extent that research can be used as evidence to support these decisions, the literature is helpful and important. 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 multifactor process used to identify existing, relevant evidence and to initiate the process of developing a research agenda that can address any existing gaps.

This broad overview focuses on 44 systematic reviews that evaluate studies of telehealth, defined as the use of technology in interactions 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 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 and behavioral health), where the evidence is more moderate (e.g., diabetes), and areas with a smaller evidence base and less positive conclusions (e.g., intensive care unit or surgery support).

We categorized abstracts of reviews in progress, reviews that mixed different interventions or did not consider the quality of the included studies, and primary studies in order to determine if

more evidence was available for either the identified clinical focus areas or for areas that telehealth is likely being used or considered that were not covered by the included reviews. We identified protocols for 75 reviews in progress that would likely both increase the evidence for clinical areas we identified, but would also add new 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 were cancer, chronic pain, autism, and pregnancy.

Based on a combination of these assessments including the first bubble plot, we identified three areas that telehealth is being most studied, and we conducted a search and scan of research primary literature. We identified 33 studies in maternal health, 12 in complex pediatrics, and 5 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 counseling and prevention, but the overall benefit was moderate. A smaller evidence base of fewer studies and patients was available for the use of telehealth in psychotherapy, but these studies reported more positive results.

Our third plot depicts the evidence at the intersection of clinical 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. Communication/Diabetes had the most evidence followed by Cardiovascular disease/Monitoring, Communication/Mixed clinical conditions and Psychotherapy and Behavioral health.

We describe 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 monitoring and management. Now we draw on these results as well as the lack of results in some areas to develop recommendations related to the next steps in developing an evidence base for telehealth.

Considering all the plots and additional analysis, we have created 3 categories for our overall assessment. These are defined as follows:

Category A: Topics that have a body of evidence 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.

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. However these have not been a) synthesized in systematic reviews to date; b) have been included in reviews that did not meet the inclusion criteria (e.g. mixed interventions together or did not consider the quality of the included studied); or c) were include in reviews that were unable to draw conclusions.

Category C: Topics that have too few primary studies to constitute a body of evidence that could support policy decisions. Systematic reviews in these areas would likely be small until more primary research is done. Because this category is defined by a lack of evidence or evidence that is very disparate it is necessarily open to speculation and topics would need to be assessed in term of importance to the field and potential reasons for the difficulty in locating or the lack of primary studies (e.g. methodological or practical barriers to study).

In **Table 7** below we sort several topics into these three categories and provide a brief rational for the placement in the assigned category. .

Table 7:   Telehealth topics: Evidence based categories

Category	Topic	Rationale
A	Monitoring/Management for Chronic Conditions	Systematic reviews available (10), consistent findings of benefit or potential benefit from most reviews
A	Communication/Counseling for Chronic Conditions	Systematic reviews available (8), consistent findings of benefit or potential benefit from most reviews Systemic
A	Psychotherapy for Behavioral Health	3 systematic reviews report benefit or potential benefit; 1 review finds insufficient evidence for a uses in forensic and correctional psychiatry.
B	Consultation for Acute and Chronic Management	Three of the included reviews addressed telehealth for consultations and two of these did not come to a conclusion. Also consultation is a use that crosses clinical areas and maybe address in enough excluded and ongoing studies or reviews to be a viable topic for future syntheses.
B	Applications for Acute/ICU care including remote monitoring and telementoring	The reviews identified for ICU/Surgery and Burn Care combined with reviews in progress in critical care and post-operative care suggest a growing literature base on this potentially important use of telehealth to expand access to high tech care in areas where it is lacking.
B	Maternal and child health	Pregnancy and newborn routine health care monitoring is a frequent reason for health care visits and access can be challenging in some areas. A preliminary search identified studies that cover a multiple technologies and uses. A review may be able to organize the literature in a way that it would be useful for policy and decision making.
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 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
	Applications relevant to the integration of mental and physical health	While integration of mental and physical health is an important goal in many health care reform efforts we did not identify overlap in telehealth research (e.g., telehealth to address depression in people with diabetes or to help patients struggling with addition to obtain preventive care).

Limitations of Evidence Maps

Evidence maps by definition 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 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 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. However, which characteristics are chosen and how data are simplified can also potentially mislead or at least not respond to the questions they 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 variable that help plan a route, but they do not select the route for the user. Similarly, 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 we cannot address all possible goals and priorities, these plots and the data in this report and the appendix 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 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 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 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 intervention and 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., such as 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).

Another limitation is that systematic reviews should identify, describe, and synthesize individual studies so that the collective results are accessible and more useful. Not all reviews

achieve this. Many reviews we examined did not go beyond cataloging the research in detailed 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 conclusion that is not at the 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 can become viewed by policy and decisionmakers as an academic exercise rather than a useful tool

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, and the stability of findings cannot be tested through sensitivity analysis.

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., US government agency sites) we did not identify any other efforts to map the literature on telehealth though there have been numerous systematic reviews. To date 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.[81-87] Some of these asked research questions that differed from the focus of this literature map. One review 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.[85] 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,[84] 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.[87] Another targeted study summarized the findings of 10 systematic reviews of telepsychiatry.[81] 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."[82] 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[83] updated a 2010 review of reviews by Ekeland[88] 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; seven 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 have more definite proof of effectiveness, the evidence has been and continues to be promising and that 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.[86] Their conclusion was that "While reported improvements in surrogate clinical endpoints and hospitalizations are encouraging, the evidence overall remains equivocal."[86] 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 studies in other clinical focus areas that have been included in reviews in ways that have made them less useful for decisionmaking, as these reviews have identified and grouped existing research together. 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 basis 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 the future of 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 11**. 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. One 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, a challenge for future telehealth research will be to evaluate the contributions of telehealth across care contexts, and within increasingly integrated care delivery models, where telehealth may be but one of many modes of care that a patient may simultaneously experience.

Figure 11. Levels of context influencing telehealth use and evaluation
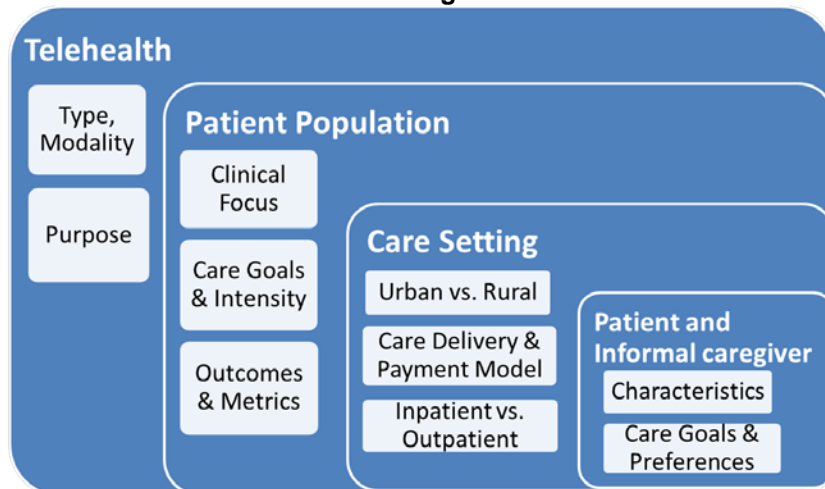
The implementation of the triple aim, concurrent with move to value-based care, has elevated the cost of care and the patient experience to equal footing with clinical outcomes of care. This focus has implications for telehealth in that future research should help providers and health systems differentiate 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, the industry 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 contribution and 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—44 systematic reviews that covered several important clinical focus areas and met our inclusion criteria. The largest volume of research reported that telehealth interventions produce 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 we suggest advancing telehealth maybe best serviced by a two-pronged approach. One approach is to continue to elaborate on our findings as well as develop additional research in a variety of clinical topics and for different healthcare functions for telehealth. In areas where we did not find sufficient synthesized research, such as telehealth for consultation, in acute care, 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 reviews that could address practice and policy considerations related to these issues. Finally, there clinical areas and roles for telehealth that do not yet have a sufficient evidence base to support important decisions about practice and policy 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.

In addition to considering future systematic reviews and promoting primary research in key areas telehealth research needs to expand its orientation 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 evaluate the specific contribution telehealth can make in these contexts.

References

1. Hetrick SE, Parker AG, Callahan P, et al. Evidence mapping: illustrating an emerging methodology to improve evidence-based practice in youth mental health. J Eval Clin Pract. 2010 Dec;16(6):1025-30. PMID: 20337833.

2. Bates S, Coren E. Systematic Map Report 1: The extent and impact of parental mental health problems on families and the acceptability, accessibility and effectiveness of interventions. Great Britain: 2006.

3. Carr S, Clapton J. Systematic Map Report 2: The recovery approach in community-based vocation and training adult mental health day services. Great Britain: 2007.

4. Sharif N, Brown W, Rutter D. Systematic Map Report 3: The extent and impact of depression on BME older people and the acceptability, accessability and effectiveness of social care provision. Great Britain: 2008.

5. Coeytaux RR, McDuffie J, Goode A, et al. VA Evidence-based Synthesis Program Reports. Evidence Map of Yoga for High-Impact Conditions Affecting Veterans. Washington (DC): Department of Veterans Affairs (US); 2014.

6. Hempel S, Taylor SL, Solloway MR, et al. Evidence Map of Acupuncture. VA Evidence-based Synthesis Program Reports. Washington, DC: Department of Veterans Affiars;. 2014 JanuaryPMID: 24575449.

7. Hempel S, Taylor SL, Marshall NJ, et al. Evidence Map of Mindfulness. VA Evidence-based Synthesis Program Reports. Washington, DC: Department of Veterans Affairs. 2014 OctoberPMID: 25577939.

8. Hempel S, Taylor SL, Solloway MR, et al. VA Evidence-based Synthesis Program Reports. Evidence Map of Tai Chi. Washington (DC): Department of Veterans Affairs (US); 2014.

9. HRSA. Telehealth. 2015. http://www.hrsa.gov/ruralhealth/about/telehealth/. Accessed March 9 2015.

10. HealthIT.gov. What is telehealth? How is telehealth different from telemedicine? http://www.healthit.gov/providers-professionals/faqs/what-telehealth-how-telehealth-different-telemedicine. Accessed March 9 2015.

11. van Dyk L. A review of telehealth service implementation frameworks. Int J Environ Res Public Health. 2014 Feb;11(2):1279-98. PMID: 24464237.

12. Lustig T. The Role of Telehealth in an Evolving Health Care Environment - Workshop Summary. 2012 Washington, DC: Institute of Medicine; .

13. Nelson B, Thune J. In: Kronick R, editor. Washington D.C.: United States Senate; 2014.

14. Multistakeholder Letter to Senate Committee on Aging. 2015. http://www.tiaonline.org/sites/default/files/pages/Multistakeholder%20Letter%20to%20Senate%20Ageing%20re%20AHRQ%20Lit%20Review%20120514.pdf. Accessed August 28 2015.

15. Bashshur RL. Guest editorial: compelling issues in telemedicine. Telemed J E Health. 2013 May;19(5):330-2. doi: 10.1089/tmj.2013.9998. Epub 2013 Feb 5.

16. Dixon B, Hook J, McGowan J. Using Telehealth to Improve Quality and Safety: Findings from the AHRQ Health IT Portfolio (Prepared by the AHRQ National Resource Center for Health IT under Contract No. 290-04-0016). AHRQ Publication No. 09-0012-EF. Rockville, MD: Agency for Healthcare Research and Quality. 2008.

17. Roundtable: Harnessing the Power of Telehealth: Promises and Challenges?

Testimony from Participants. Washington, DC: United States Senate Special Committee on Aging,; 2014. http://www.aging.senate.gov/hearings/roundtable-harnessing-the-power-of-telehealth-promises-and-challenges Accessed August 25 2015.

18. . The Role of Telehealth in an Evolving Health Care Environment: Workshop Summary. . 2012; Washington, DC: The National Academies Press. The National Academies Press.

19. Adler-Milstein J, Kvedar J, Bates DW. Telehealth among US hospitals: several factors, including state reimbursement and licensure policies, influence adoption. Health Aff (Millwood). 2014 Feb;33(2):207-15. PMID: 24493762.

20. Broderick A, Lindeman D. Scaling Telehealth Programs: Lessons from Early Adopters. New York, NY: Commonwealth Fund; 2013. http://www.commonwealthfund.org/Publications/Case-Studies/2013/Jan/Telehealth-Synthesis.aspx. Accessed August 24th 2015.

21. Hersh WR, Hickam DH, Severance SM, et al. Diagnosis, access and outcomes: Update of a systematic review of telemedicine services. J Telemed Telecare. 2006;12 Suppl 2:S3-31. PMID: 16989671.

22. Schwamm LH. Telehealth: seven strategies to successfully implement disruptive technology and transform health care. Health Aff (Millwood). 2014 Feb;33(2):200-6. PMID: 24493761.

23. Kvedar J, Coye MJ, Everett W. Connected health: a review of technologies and strategies to improve patient care with telemedicine and telehealth. Health Aff (Millwood). 2014 Feb;33(2):194-9. PMID: 24493760.

24. Clapton J, Rutter D, Sharif N. SCIE Systematic Mapping Guidance. London: SCIE;. 2009PMID: No PMID.

25. Bragge P, Clavisi O, Turner T, et al. The Global Evidence Mapping Initiative: scoping research in broad topic areas. BMC Med Res Methodol. 2011;11:92. PMID: 21682870.

26. National Research Council. Finding What Works in Health Care: Standards for Systematic Reviews. Washington, DC: The National Academies Press; 2011.

27. Agency for Healthcare Research and Quality. Methods Guide for Effectiveness and Comparative Effectiveness Reviews. AHRQ Publication No. 10(13)-EHC063-EF. Rockville, MD; 2014.

28. Nelson H. Systematic Reviews to Answer Health Care Questions. Philadelphia, PA: Wolters Kluwer; 2014.

29. Hersh WR, Hickam DH, Severance SM, et al. Diagnosis, access and outcomes: Update of a systematic review of telemedicine services. J Telemed Telecare. 2006;12 Suppl 2:S3-31. PMID: 16989671.

30. 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.

31. Antonacci DJ, Bloch RM, Saeed SA, et al. Empirical evidence on the use and effectiveness of telepsychiatry via videoconferencing: implications for forensic and correctional psychiatry. Behav Sci Law. 2008;26(3):253-69. PMID: 18548519.

32. Antoniou SA, Antoniou GA, Franzen J, et al. A comprehensive review of telementoring applications in laparoscopic general surgery. Surg Endosc. 2012 Aug;26(8):2111-6. PMID: 22350150.

33. Chaudhry SI, Phillips CO, Stewart SS, et al. Telemonitoring for patients with chronic heart failure: a systematic

review. J Card Fail. 2007 Feb;13(1):56-62. PMID: 17339004.

34. Clarke M, Shah A, Sharma U. Systematic review of studies on telemonitoring of patients with congestive heart failure: a meta-analysis. J Telemed Telecare. 2011;17(1):7-14. PMID: 21097564.

35. Connelly J, Kirk A, Masthoff J, et al. The use of technology to promote physical activity in Type 2 diabetes management: a systematic review. Diabet Med. 2013 Dec;30(12):1420-32. PMID: 23870009.

36. Cox NS, Alison JA, Rasekaba T, et al. Telehealth in cystic fibrosis: a systematic review. J Telemed Telecare. 2012 Mar;18(2):72-8. PMID: 22198961.

37. Dang S, Dimmick S, Kelkar G. Evaluating the evidence base for the use of home telehealth remote monitoring in elderly with heart failure. Telemed J E Health. 2009 Oct;15(8):783-96. PMID: 19831704.

38. de Jong CC, Ros WJ, Schrijvers G. The effects on health behavior and health outcomes of Internet-based asynchronous communication between health providers and patients with a chronic condition: a systematic review. J Med Internet Res. 2014;16(1):e19. PMID: 24434570.

39. de Waure C, Cadeddu C, Gualano MR, et al. Telemedicine for the reduction of myocardial infarction mortality: a systematic review and a meta-analysis of published studies. Telemed J E Health. 2012 Jun;18(5):323-8. PMID: 22468983.

40. Eccleston C, Fisher E, Craig L, et al. Psychological therapies (Internet-delivered) for the management of chronic pain in adults. Cochrane Database Syst Rev. 2014;2:CD010152. PMID: 24574082.

41. Eland-de Kok P, van Os-Medendorp H, Vergouwe-Meijer A, et al. A systematic review of the effects of e-health on chronically ill patients. J Clin Nurs. 2011 Nov;20(21-22):2997-3010. PMID: 21707807.

42. Gaikwad R, Warren J. The role of home-based information and communications technology interventions in chronic disease management: a systematic literature review. Health Inform J. 2009 Jun;15(2):122-46. PMID: 19474225.

43. Gainsbury S, Blaszczynski A. A systematic review of Internet-based therapy for the treatment of addictions. Clin Psychol Rev. 2011 Apr;31(3):490-8. PMID: 21146272.

44. Garcia-Lizana F, Sarria-Santamera A. New technologies for chronic disease management and control: a systematic review. J Telemed Telecare. 2007;13(2):62-8. PMID: 17359568.

45. Holtz B, Lauckner C. Diabetes management via mobile phones: a systematic review. Telemed J E Health. 2012 Apr;18(3):175-84. PMID: 22356525.

46. Institute of Health Economics. Evidence on the effectiveness of telerehabilition applications. 2010.

47. Jaana M, Pare G, Sicotte C. Home telemonitoring for respiratory conditions: a systematic review. Am J Manag Care. 2009 May;15(5):313-20. PMID: 19435399.

48. Johansen MA, Berntsen GKR, Schuster T, et al. Electronic symptom reporting between patient and provider for improved health care service quality: a systematic review of randomized controlled trials. part 2: methodological quality and effects. J Med Internet Res. 2012;14(5):e126. PMID: 23032363.

49. Kairy D, Lehoux P, Vincent C, et al. A systematic review of clinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation. Disabil Rehabil. 2009;31(6):427-47. PMID: 18720118.

50. Kamei T, Yamamoto Y, Kajii F, et al. Systematic review and meta-analysis of studies involving telehome monitoring-

based telenursing for patients with chronic obstructive pulmonary disease. Jpn J Nurs Sci. 2013 Dec;10(2):180-92. PMID: 24373441.

51. Knowles SR, Mikocka-Walus A. Utilization and efficacy of internet-based eHealth technology in gastroenterology: a systematic review. Scand J Gastroenterol. 2014 Apr;49(4):387-408. PMID: 24494974.

52. Kodama S, Saito K, Tanaka S, et al. Effect of Web-based lifestyle modification on weight control: a meta-analysis. Int J Obes (Lond). 2012 May;36(5):675-85. PMID: 21694698.

53. Kumar G, Falk DM, Bonello RS, et al. The costs of critical care telemedicine programs: a systematic review and analysis. Chest. 2013 Jan;143(1):19-29. PMID: 22797291.

54. Laver KE, Schoene D, Crotty M, et al. Telerehabilitation services for stroke. Cochrane Database Syst Rev. 2013;12:CD010255. PMID: 24338496.

55. Liang X, Wang Q, Yang X, et al. Effect of mobile phone intervention for diabetes on glycaemic control: a meta-analysis. Diabet Med. 2011 Apr;28(4):455-63. PMID: 21392066.

56. Lustria MLA, Noar SM, Cortese J, et al. A meta-analysis of web-delivered tailored health behavior change interventions.[Erratum appears in J Health Commun. 2013;18(11):1397]. J Health Commun. 2013;18(9):1039-69. PMID: 23750972.

57. Martin S, Sutcliffe P, Griffiths F, et al. Effectiveness and impact of networked communication interventions in young people with mental health conditions: a systematic review. Patient Educ Couns. 2011 Nov;85(2):e108-19. PMID: 21239133.

58. McLean S, Nurmatov U, Liu JL, et al. Telehealthcare for chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2011(7):CD007718. PMID: 21735417.

59. Merriel SWD, Andrews V, Salisbury C. Telehealth interventions for primary prevention of cardiovascular disease: a systematic review and meta-analysis. Prev Med. 2014 Jul;64:88-95. PMID: 24726502.

60. Osborn CY, Mayberry LS, Mulvaney SA, et al. Patient web portals to improve diabetes outcomes: a systematic review. Curr Diab Rep. 2010 Dec;10(6):422-35. PMID: 20890688.

61. Peeters JM, Mistiaen P, Francke AL. Costs and financial benefits of video communication compared to usual care at home: a systematic review. J Telemed Telecare. 2011;17(8):403-11. PMID: 22025744.

62. Ramadas A, Quek KF, Chan CKY, et al. Web-based interventions for the management of type 2 diabetes mellitus: a systematic review of recent evidence. Int J Med Inf. 2011 Jun;80(6):389-405. PMID: 21481632.

63. Richards D, Richardson T. Computer-based psychological treatments for depression: a systematic review and meta-analysis. Clin Psychol Rev. 2012 Jun;32(4):329-42. PMID: 22466510.

64. Rietdijk R, Togher L, Power E. Supporting family members of people with traumatic brain injury using telehealth: a systematic review. J Rehabil Med. 2012 Nov 5;44(11):913-21. PMID: 23027316.

65. Rooke S, Thorsteinsson E, Karpin A, et al. Computer-delivered interventions for alcohol and tobacco use: a meta-analysis. Addiction. 2010 Aug;105(8):1381-90. PMID: 20528806.

66. Seto E. Cost comparison between telemonitoring and usual care of heart failure: a systematic review. Telemed J E Health. 2008 Sep;14(7):679-86. PMID: 18817497.

67. Steel K, Cox D, Garry H. Therapeutic videoconferencing interventions for the treatment of long-term conditions. J

Telemed Telecare. 2011;17(3):109-17. PMID: 21339304.

68. Tan K, Lai NM. Telemedicine for the support of parents of high-risk newborn infants. Cochrane Database Syst Rev. 2012;6:CD006818. PMID: 22696360.

69. Tran K, Canadian Agency for Drugs, Technologies in Health. Home telehealth for chronic disease management: Canadian Agency for Drugs and Technologies in Health Ottawa; 2008.

70. Urquhart C, Currell R, Harlow F, et al. Home uterine monitoring for detecting preterm labour. Cochrane Database Syst Rev. 2015(1)PMID: 00075320-100000000-04918.

71. Wade VA, Karnon J, Elshaug AG, et al. A systematic review of economic analyses of telehealth services using real time video communication. BMC Health Serv Res. 2010;10:233. PMID: 20696073.

72. Wallace DL, Hussain A, Khan N, et al. A systematic review of the evidence for telemedicine in burn care: with a UK perspective. Burns. 2012 Jun;38(4):465-80. PMID: 22078804.

73. Zhai Y-k, Zhu W-j, Cai Y-l, et al. Clinical- and cost-effectiveness of telemedicine in type 2 diabetes mellitus: a systematic review and meta-analysis. Medicine (Baltimore). 2014 Dec;93(28):e312. PMID: 25526482.

74. Institute of Health Economics. Telehealth in substance abuse and addiction review of the literature on smoking, alcohol, drug abuse and gambling. 2010.

75. American Telemedicine Association. Standards and Guidelines Working Groups. Washington, DC: The American Telemedicine Association; 2012. http://www.americantelemed.org/resources/telemedicine-practice-guidelines/standards-working-groups#.VeC0F_lVhHx. Accessed August 28 2015.

76. Center for Connected Health Policy. State Telehealth Laws and Medicaid Program Policies: A Comprehensive Scan of the 50 States and District of Columbia. Sacramento; ; 2015.

77. Center for Reviews and Dissemination. PROSPERO. 2015. http://www.crd.york.ac.uk/PROSPERO/. Accessed August 28th 2015.

78. Fisher ES, McClellan MB, Safran DG. Building the path to accountable care. N Engl J Med. 2011 Dec 29;365(26):2445-7. doi: 10.1056/NEJMp1112442.

79. Burwell SM. Setting value-based payment goals--HHS efforts to improve U.S. health care. N Engl J Med. 2015 Mar 5;372(10):897-9. doi: 10.1056/NEJMp1500445. Epub 2015 Jan 26.

80. Medicare.gov. Hospital Compare: Hospital value-based purchasing. https://www.medicare.gov/hospitalcompare/Data/hospital-vbp.html. Accessed October 29 2015.

81. Chipps J, Brysiewicz P, Mars M. Effectiveness and feasibility of telepsychiatry in resource constrained environments? A systematic review of the evidence. Afr J Psychiatry (Johannesbg). 2012 Jul;15(4):235-43. PMID: 22829225.

82. Conway A, Inglis SC, Chang AM, et al. Not all systematic reviews are systematic: a meta-review of the quality of systematic reviews for non-invasive remote monitoring in heart failure. J Telemed Telecare. 2013 Sep;19(6):326-37. PMID: 24163297.

83. Elbert NJ, van Os-Medendorp H, van Renselaar W, et al. Effectiveness and cost-effectiveness of ehealth interventions in somatic diseases: a systematic review of systematic reviews and meta-analyses. J Med Internet Res. 2014;16(4):e110. PMID: 24739471.

84. Jones KR, Lekhak N, Kaewluang N. Using mobile phones and short message service to deliver self-management

interventions for chronic conditions: a meta-review. Worldviews Evid Based Nurs. 2014 Apr;11(2):81-8. PMID: 24597522.

85. Mair FS, May C, O'Donnell C, et al. Factors that promote or inhibit the implementation of e-health systems: an explanatory systematic review. Bull World Health Organ. 2012 May 1;90(5):357-64. PMID: 22589569.

86. McLean S, Sheikh A, Cresswell K, et al. The impact of telehealthcare on the quality and safety of care: a systematic overview. PLoS ONE. 2013;8(8):e71238. PMID: 23977001.

87. Morrison D, Wyke S, Agur K, et al. Digital asthma self-management interventions: a systematic review. J Med Internet Res. 2014;16(2):e51. PMID: 24550161.

88. Ekeland AG, Bowes A, Flottorp S. Effectiveness of telemedicine: a systematic review of reviews. Int J Med Inform. 2010 Nov;79(11):736-71. PMID: 20884286.