Comparative Effectiveness Review
Number 216

Telehealth for Acute and Chronic Care Consultations

Evidence Summary

Background

Telehealth is the use of information and telecommunications technology to provide or support healthcare across time and/or distance. Telehealth's potential benefits are frequently cited,[1,2] and there is a sizable body of research on telehealth, including systematic reviews and reviews of reviews.[3-8] Despite this potential, implementation and spread has been slower than expected,[9,10] though recent trends suggest that use of telehealth may be increasing.

With improvement in technologies,[11] changes in payment policies,[12,13] and evolving models for healthcare in general and telehealth in particular, the possibility exists for a rapid acceleration in implementation and wider use of telehealth. However, targeting, supporting, and sustaining increased use of telehealth requires organized and accessible information on the impact of different uses of telehealth. Specifically, synthesis of existing research evidence can help inform decisions about where, in terms of settings and clinical indications, telehealth is likely to improve access, quality, and efficiency. One approach is to assess the evidence about the different roles telehealth can play in healthcare.

Telehealth for consultations allows medical expertise to be available where and when it is needed, minimizing potential time or geographic barriers to care and maximizing the efficient use of scarce resources. Telehealth for consultations has been studied across a range of clinical situations but not previously assessed in a systematic review.

Purpose of Review

To assess the effectiveness of telehealth consultations and explore supplemental decision analysis.

Key Messages

- Results vary by setting and condition, with telehealth consultations producing generally either better outcomes or no difference from comparators in settings and clinical indications studied.
  - Remote intensive care unit consultations likely reduce mortality.
  - Specialty telehealth consultations likely reduce patient time in the emergency department.
  - Telehealth consultations in emergency services likely reduce heart attack mortality.
  - Remote consultations for outpatient care likely improve access and clinical outcomes.
- More detailed telehealth consultation costs and outcomes data would improve modeling assumptions.
- Future research should employ rigorous methods and standardized outcomes for consistent measurement of telehealth consultation effectiveness.

Agency for Healthcare Research and Quality

Objective

The objective of this report is to identify and summarize the available evidence about telehealth consultations. The overarching goal is to maximize the utility of available information by presenting the results in formats that support decision makers at various levels (e.g., regulators, providers, and payers) as they consider policy and practice changes related to telehealth for consultation. To accomplish this we combined a broad systematic review, covering a range of clinical indications, with an exploratory decision model for one selected clinical application. Both systematic reviews and decision analyses have accepted methodologies, but they are not frequently used in tandem. In this sense, this project is experimental as it strives to provide the results of a traditional systematic review of the available research and explore how the addition of decision analysis might be used to increase the utility of evidence for decision makers.

This review focuses on the effectiveness of telehealth for provider-to-provider consultations. ***Telehealth consultations*** are defined as the use of telehealth to facilitate collaboration between providers, often involving a specialist consultant, or among clinical team members, across time and/or distance, on the assessment, diagnosis, and/or clinical management of a specific patient or group of patients. While the patient may or may not be involved in the consultation, the consultation is required to be related to a specific patient or group of patients in order to differentiate this activity from training or education (which would not meet our definition of telehealth). Limited information provided by one clinician to another that does not contribute to collaboration (e.g., interpretation of an electroencephalogram, report on an x-ray or scan, or reporting the results of a diagnostic test) is not considered a consultation for this review.

Systematic Review Key Questions

The Key Questions for the review were:

1. **Are telehealth consultations effective in improving clinical and economic outcomes?**

   Clinical and economic outcomes may include, but are not limited to, mortality and morbidity, patient-reported outcomes, quality of life, utilization of health services, and cost of services.

2. **Are telehealth consultations effective in improving intermediate outcomes?**

   Intermediate outcomes include both outcomes that precede the ultimate outcomes of interest (e.g., mediators) and secondary outcomes. Intermediate outcomes may include, but are not limited to, access to care, patient and provider satisfaction, behavior, and decisions (e.g., patient completion of treatment, provider antibiotic stewardship); volume of services; and healthcare processes (e.g., time to diagnosis or treatment).

3. **Do telehealth consultations result in harms, adverse events, or negative unintended consequences?**

4. **What are the characteristics of telehealth consultations that have been the subject of comparative studies?**

   These characteristics may include clinical conditions, characteristics of the providers and patients and their relationships, telehealth modalities, and characteristics of settings, including the type of care and healthcare organization, payment models, as well as geographic and economic characteristics.

5. **Do clinical, economic, intermediate, or negative outcomes (i.e., the outcomes in Key Questions 1, 2, and 3) vary across telehealth consultation characteristics (Key Question 4)?**

Systematic Review Methods

The conduct of this systematic review followed the *Methods Guide for Effectiveness and Comparative Effectiveness Reviews*,[14] and it is reported according to the PRISMA checklist. The scope, Key Questions, and inclusion criteria of this review were developed in consultation with a group of technical experts. Detailed methods are available in the full report and the posted protocol (https://effectivehealthcare.ahrq.gov/topics/telehealth-acute-chronic/research-protocol/). The protocol was registered with PROSPERO (CRD42017058304).

A research librarian created the search strategy and another research librarian reviewed it before searching Ovid MEDLINE®, the Cochrane Central Register of Controlled Trials (CCRCT), and the Cumulative Index to Nursing and Allied Health Literature (CINAHL®) to identify studies published from 1996 through May 2018. We also reviewed reference lists of identified studies and systematic reviews, and solicited suggestions through an announcement in the *Federal Register*.

We limited our study inclusion to the use of telehealth for consultations and outcomes that measure clinical and cost effectiveness. Otherwise our criteria were broad, and we included any technology and any comparative study, including before-after and retrospective as well as prospective designs, with quantitative outcomes data. Studies could compare telehealth consultations to consultations done in a different mode (e.g., in-person or telephone), no access to specialty care, or usual care which could be an unspecified mix of these options. We excluded descriptive studies, studies assessing only diagnostic concordance, studies where there was no nontelehealth comparison, and modeling studies that used hypothetical data.

Two team members independently reviewed all abstracts and two reviewers independently assessed each full-text article. Disagreements were resolved by discussion among investigators. For included articles, investigators abstracted key characteristics and data about the studies for quantitative and qualitative synthesis. We were able to conduct meta-analyses for some but not all topics and outcomes due to the heterogeneity of outcome measures, study designs, and telehealth interventions. Two investigators independently rated the risk of bias of each study using predefined criteria consistent with the chapter, "Assessing the Risk of Bias of Individual Studies When Comparing Medical Interventions" in the *Methods Guide for Effectiveness and Comparative Effectiveness Reviews*.[14] Risk of bias for economic evaluations were assessed using a modified version of the Consensus Health Economic Criteria.[15,16] Disagreements were resolved by consensus.

Strength of evidence was assessed for each outcome and Key Question as described in the *Methods Guide for Effectiveness and Comparative Effectiveness Reviews*.[14] We assigned a strength of evidence grade of high, moderate, low, or insufficient for the body of evidence for each Key Question, based on evaluation of four domains: study limitations, consistency, directness, and precision. High, moderate, and low ratings reflect our confidence in the accuracy and validity of the findings and whether future studies might alter these findings (magnitude or direction). We gave a rating of insufficient when we were unable to draw conclusions due to serious inconsistencies, serious methodological limitations, or lack of evidence. We considered applicability and the strength of evidence when making general assessments across the studies and use qualifiers in key messages and conclusions such as 'likely' for moderate strength of evidence and/or some applicability concerns or 'may' for low strength of evidence and/or significant applicability concerns.

Systematic Review Results

The literature searches yielded 9,366 potentially relevant citations. Upon review of the article titles and abstracts, 8,356 were excluded and the full text of 1,010 articles were pulled for review. Of these,

233 articles met our inclusion criteria. The most frequent reasons for excluding an article were that the intervention was not a telehealth consultation (ineligible intervention) or that the study did not compare telehealth consultations to usual care or another intervention (ineligible comparison). A list of the included studies is provided in Appendix C of the full report, and the citations for excluded studies are in Appendix D of the full report.

The included studies are diverse in terms of location, technology, and design. The most frequent geographic location for the included studies of telehealth consultations was the United States (110 articles or 47%); however, more than half of the studies were conducted in other countries. The most common mode or technology used for telehealth consultations was video, which was used in more than half of the studies (55%). The majority of the studies (66%) were observational, including prospective cohorts, retrospective cohorts, and before/after studies in which a group of patients from before the implementation of telehealth consultations are compared to a different group of patients after telehealth implementation. In these studies, the comparator was often usual care, that is, care without telehealth, and the studies rarely provided more detail (e.g., if consultations were in-person, if care was delivered without consultation, or a mix of both). About one-fifth (19%) were randomized controlled trials, 12 percent were economic evaluations, and approximately 3 percent were pre-post studies in which outcomes for the same patients were compared pre (without telehealth) and post telehealth consultations. Table 1 in the full report provides more information on the characteristics of the included studies, and detailed information abstracted from each study is provided in Appendix F of the full report.

We categorized the systematic review results into three patient settings: inpatient, emergency department (ED) or emergency medical services (EMS), and outpatient. We chose to organize the systematic review results by patient setting as the settings are likely to have different telehealth technology and requirements as well as differences in payment structures, staffing, and organization of care delivery. The results are summarized by setting in Tables A, B, and C and in the accompanying text.

Inpatient Telehealth Consultations

Remote Intensive Care Units

- Clinical outcomes: Intensive care unit (ICU) and hospital mortality are lower with remote ICU (moderate strength of evidence).
- Economic outcomes: Not all studies analyzed costs of remote ICUs or their impact on revenue; those that did used differing methods, and conclusions were inconsistent (insufficient evidence).
- Intermediate outcomes: ICU and hospital length of stay (LOS) are not statistically different with remote ICU (moderate strength of evidence).
- Adverse effects: None of the included studies specifically addressed potential harms or unintended consequences (insufficient evidence).

We identified 21 studies reported in 22 articles evaluating the use of telehealth to provide remote ICU services. Remote ICU services involve off site staff (intensivists, critical care nurses, and sometimes administrative assistants) who monitor ICU patients and provide consultation and management assistance with the care of these patients. Thirteen of these studies used before-after designs comparing outcomes from a period before implementation of remote ICUs to the period after this model of care was in operation in the same hospital or hospitals. The remaining studies

include four retrospective and two prospective cohort studies, one cross sectional survey, and one pre-post survey. These studies did not provide details on the nontelehealth care, though it likely included a mix of care by clinicians who are not specialists, less frequent care by specialists, and transfers to other hospitals. We reviewed selected key factors that could help explain the differences in outcomes across studies, including information on the hospitals that were the sites for the studies, the coverage and staffing of the remote ICU interventions, and the time periods in which outcomes were measured. For example, the majority of included studies were conducted in larger teaching hospitals or hospitals affiliated with an academic center; and all of the studies included a physician intensivist, most included nursing, and about half included administrative support. However, none of these factors clearly differentiate between studies reporting a clear benefit from remote ICUs and those reporting no benefit or possible benefits. Furthermore, this limitation means we cannot compare the ICUs included in these studies to all ICUs that might consider employing telehealth based on our data.

Inpatient Specialist Consultations

- Clinical outcomes: Mortality or serious morbidity (e.g., cardiac arrest, low birthweight, falls, and disability) improve with telehealth consultations across specialties, but differences are not statistically significant in most studies (low strength of evidence).
- Economic outcomes: Cost savings were realized due to avoided transfers or travel, but telehealth did not save money in all studies (low strength of evidence).
- Intermediate outcomes: The impact of telehealth consultations on intermediate outcomes such as hospital LOS, transfer rate or satisfaction of patients, relatives, or healthcare providers is also positive, but not convincing with differences that are close to significant and estimates that are less precise (low strength of evidence).
- Adverse effects: Only studies of surgery explicitly examined harms, but the study limitations were high based on small sample sizes and high risk of bias (insufficient evidence).

We identified 31 studies (32 articles) that reported the use of telehealth to provide specialty consultations for inpatients. Specialty consultations are provided when the input of a specialist is needed for diagnosis, care planning, or treatment, and a physician with the specialized knowledge is not available at the hospital where the patient is located or at the time when the consultation is needed. The studies of inpatient specialist consultations cover a wide range of clinical indications, ranging from neonatal to geriatric care and from care planning to remote proctoring of surgery. Studies of inpatient consultations were predominately cohort studies, including ten retrospective and 15 prospective cohort designs that compare hospitals with and without telehealth. There were also three before-after studies and three randomized trials that studied inpatient consultations. Most of the cohort studies included multiple sites with the largest prospective study including 3,060 patients in 5 intervention and 5 matched comparison hospitals. Overall, inpatient telehealth consultations are not well-described, making it problematic to relate characteristics of the intervention or environment to effectiveness and to assess the generalizability of the study results to either hospitals that may differ in important ways from those included in the studies or to the use for other specialties not studied.

Table A. Inpatient telehealth consultations: strength of evidence

Topic	Outcome (KQ)	Number of Studies (N)	Main Findings	Strength of Evidence (Insufficient, Low, Moderate, High)
Inpatient remote ICU	ICU Mortality (KQ1)[a]	11	Lower ICU mortality RR 0.69 (95% CI 0.51, 0.89)	Moderate
	Hospital Mortality (KQ1)[a]	12	Lower hospital mortality RR 0.76 (95% CI, 0.60, 0.95)	Moderate
	Cost (KQ1)	6	Unable to summarize across studies: different methods and inconsistent results.	Insufficient
	ICU LOS (KQ2)[a]	12	No significant difference in ICU LOS Mean difference (days) -0.39 (95% CI -0.99, 0.15)	Moderate
	Hospital LOS (KQ2)[a]	12	No significant difference in hospital LOS Mean difference (days) -0.14 (95% CI -0.96, 0.63)	Moderate
	Harms (KQ3)	0	None reported in identified articles	Insufficient
Inpatient specialty consultations	Mortality (KQ1)	12	No significant difference in mortality	Low
	Other clinical outcomes (KQ1)	6	Clinical outcomes better with telehealth but small differences and most not significantly different	Low
	Cost (KQ1)	7	Cost savings due to avoiding transfers or travel when telehealth is used but not in all studies	Low
	Intermediate outcome (KQ2)	27	Reductions in LOS and waiting time but all not significantly different; satisfaction measures good but not excellent	Low
	Harms (KQ3)	3	Complications from telehealth in surgery was compared with standard procedures in small studies with high risk of bias	Insufficient

CI = confidence interval; ICU = intensive care unit; KQ = Key Question; LOS = length of stay; RR = risk ratio

[a] Based on studies included in the meta-analysis

Emergency Care Telehealth Consultations

We split emergency care into three subtopics, as follows.

Telestroke

- Clinical outcomes: The evidence suggests that telestroke does not result in differences in either in-hospital or 3-month mortality (moderate strength of evidence)
- Intermediate outcomes: Changes in thrombolytic therapy (tPA) use and time to treatment with telestroke were not significantly different (low strength of evidence).
- Adverse events: No increased harms, specifically hemorrhage (moderate strength of evidence).

Specialty Consultations in Emergency Departments

- Clinical outcomes: The impact on clinical outcomes including mortality and functional status is generally positive, though the results are not always statistically significant (low strength of evidence).
- Economic outcomes: Analysis of costs were available only in a few studies, and the results favored savings (low strength of evidence).
- Intermediate outcomes: Teleconsultations have a positive effect on intermediate outcomes such as appropriate triage and transfers and shorter time in the emergency department (moderate strength of evidence).
- Adverse events: No information was available about harms (insufficient evidence).

EMS and Urgent Care

- Clinical outcomes: Telehealth reduces mortality for heart attack patients (moderate strength of evidence).
- Economic outcomes: Reductions in air transfers and referrals contributed to estimates of lower costs (low strength of evidence).
- Intermediate outcomes: Telehealth led to more timely provision of care and a reduction in air transfers and referrals to higher-level care following urgent care (moderate strength of evidence), and these
- Adverse effects: Information on harms was very limited (insufficient evidence).

Telestroke refers to the use of telemedicine to convey information about a patient to a vascular neurologist/stroke specialist for assessment and diagnosis with a focus on time sensitive treatment and transport decisions. The 29 studies that investigated telestroke all compared outcomes from a prior time period or another hospital without telestroke with those with telestroke. All patients were treated, but in the cases without telestroke, patients received care for their stroke but after a delay, which may have limited their treatment options. Ten studies of EMS evaluated an approach similar to telestroke for patients potentially experiencing heart attacks. Fifteen of the 19 studies of specialist consultations in EDs were before-after or cohort studies that did not provide detailed information on the care without telehealth. In the 21 studies of telehealth consultations for EMS or urgent care, in the groups without telehealth, emergency personnel or clinicians made decisions about transfer or treatment without consultant input.

Table B. Emergency care telehealth consultations: strength of evidence

Topic	Outcome (KQ)	Number of Studies (N)	Main Findings	Strength of Evidence (Insufficient, Low, Moderate, High)
Emergency Care: Telestroke	Mortality In-hospital (KQ1)	9	RR 0.89 (95% CI 0.63, 1.43) No difference	Moderate
	Mortality 3-month (KQ1)	7	RR 0.94 (95% CI 0.82, 1.16) No difference	Moderate
	tPA administration (KQ2)	13	Reported tPA use increases; four significant; majority not statistically significant or not tested	Low
	Time to Treatment (KQ2)	23	Time to treatment is shorter but not significant in the majority of studies; a minority report longer times	Low
	Harms (all Hemorrhage) (KQ3)	11	No difference in hemorrhage, the only potential harm reported	Moderate
Emergency Care: Specialty Consultations	Clinical outcomes (KQ1)	13	Lower mortality reported in most studies but not statistically significant; Four studies reporting other clinical outcomes that were better with telehealth; one reported significant differences	Low
	Cost (KQ1)	5	Lower costs with better or no change in clinical outcome in most (4) studies; one study reported higher costs	Low
	Intermediate outcomes (KQ2)	19	Increase in appropriate transfers, decrease in time to decision and time in ED with telehealth compared with standard care	Moderate
	Harms (KQ3)	0	No studies reported data on harms from telehealth	Insufficient
Emergency Care: EMS or Urgent Care	Clinical Outcomes (KQ1)	10	Telehealth reduced mortality for STEMI patients	Moderate
	Cost (KQ1)	5	Lower costs due to avoided transfers or lower staff costs when telehealth is used	Low
	Intermediate Outcomes (KQ2)	20	Treatment is more timely and fewer air transfers or referrals to higher level of care	Moderate
	Harms (KQ3)	1	One study reported data that could be interpreted as harms, but not defined as such by the authors	Insufficient

CI = confidence interval; ED = emergency department; EMS = emergency medical services; KQ = Key Question; RR = risk ratio; STEMI = ST-elevation myocardial infarction; tPA = tissue plasminogen activator

Outpatient Telehealth Consultations

- **Clinical outcomes**: Clinical outcomes were reported in just over one-quarter of the studies of telehealth consultations and in 7 of 11 clinical topics. In three topics, there is moderate strength of evidence of the benefits of telehealth (better healing in wound care, higher response to treatment in psychiatry, and improvement in chronic condition outcomes), and in dermatology the findings show no difference in clinical outcomes (low strength of evidence). In three topics (cancer, infectious disease, and multiple specialties) studies were identified, but the results were inconsistent (insufficient evidence).
- **Intermediate outcome**s
  - Access: Telehealth consultations improved access by reducing wait times and time to treatment and by increasing the number of patients receiving indicated diagnostic tests or treatment (moderate strength of evidence).
  - Management and utilization: Telehealth consultations reduced utilization (the number of in-person specialist and hospital visits; number of hospitalizations, and shorter lengths of stay) in most studies. Findings were inconsistent about agreement on diagnosis and management (low strength of evidence).
  - Satisfaction: Patients were generally more satisfied with telehealth consultations, particularly when telehealth saved time or expense compared with the alternative. Clinicians tended to be less satisfied with telehealth than in-person consultations, though differences were rarely statistically significant (low strength of evidence).
- **Costs**: Studies report lower costs and in most cases savings are attributable to reductions in transfers or less transportation. However, the rigor of the measurement, imprecision of estimates and inconsistency in the magnitude of the effects limits confidence in these findings (low strength of evidence).
- **Harms**: Only two of studies explicitly examined harms, reporting lower rates of complications with telehealth (insufficient evidence).

The 106 included articles evaluating telehealth consultations in the outpatient setting are summarized in Table C. Detailed results split into 11 clinical topics are provided in the full report. All of these studies addressed at least one intermediate outcome, and we organized these into three categories: access, management and utilization, and satisfaction.

For the 11 clinical topics, seven reported clinical outcomes (dermatology, wound care, orthopedics, cancer, psychiatry, infectious disease and single specialties). In four of these seven the body of evidence supports better outcomes with telehealth. For 10 topics there were improvements in at least one intermediate outcome. Cost outcomes were identified for nine out of 11 topics, but the conclusions are mixed with lower costs reported across studies for four topics (wound care, orthopedics, cancer, single specialties with diagnostic technology), while for the other five topics the results were inconsistent or cost savings were either minimal or not realized.

Table C. Outpatient care telehealth consultations: strength of evidence

Outcome (KQ)	Number of Studies (N)	Main Findings	Strength of Evidence (Insufficient, Low, Moderate, High)
Clinical Outcomes (KQ1): Dermatology	3	No significant different in clinical course	Low
Clinical Outcomes (KQ1): Wound Care	5	Better healing and fewer amputations	Moderate
Clinical Outcomes (KQ1): Ophthalmology	0	No studies reported data on clinical outcomes	Insufficient
Clinical Outcomes (KQ1): Orthopedics	0	No studies reported data on clinical outcomes	Insufficient
Clinical Outcomes (KQ1): Dental	0	No studies reported data on clinical outcomes	Insufficient
Clinical Outcomes (KQ1): Cancer	1	Rate of serious side effects from chemotherapy reported in 1 study.	Insufficient
Clinical Outcomes (KQ1): Psychiatry	3 (in five articles)	Decrease in symptoms and high remission rates	Moderate
Clinical Outcomes (KQ1): Infectious Disease	3	Inconsistent results for virologic suppression across studies	Insufficient
Clinical Outcomes (KQ1): Single Conditions with Diagnostic Technology	0	No studies reported data on clinical outcomes	Insufficient
Clinical Outcomes (KQ1): Single Specialties	6	Positive effects on clinical outcomes such as response to treatment.	Moderate
Clinical Outcomes (KQ1):Multiple Specialties	4	Inconsistent results across studies for unanticipated or avoidable health services utilization	Insufficient
Cost (KQ1)	32	Most studies report cost saving with telehealth but calculations vary and most are dependent on patient avoided travel and loss of time	Low
Intermediate Outcomes: Access (KQ2)	35	Access in terms of time to, or comprehensiveness of, service is improved with telehealth	Moderate
Intermediate Outcomes: Management and Utilization (KQ2)	31	Mixed results with majority finding some benefit in terms of avoiding visits and similar diagnosis or management but a subset of studies report differences in diagnosis and management with telehealth compared with standard care	Low
Intermediate Outcomes: Satisfaction (KQ2)	22	Satisfaction generally the same; patients higher with telehealth if time/travel is avoided. Providers the same or slightly worse for telehealth.	Low
Harms (KQ3)	2	Rates of complications and serious adverse events reported in two studies.	Insufficient

KQ = Key Question

Exploratory Cost Model for Telehealth Neurosurgical Consultations

The purpose of exploring decision analysis was to address questions the systematic review alone could not answer. We attempted to construct a model to address the following questions for one selected use:

1. What is the predicted impact on clinical, economic, and intermediate outcomes of telehealth consultations?
2. What is the predicted effect of various proposed payment reforms on clinical, economic, and intermediate outcomes of telehealth consultations?

We selected the use of telehealth for neurosurgical consultations by rural or community hospitals for patients with moderate to severe traumatic brain injury (TBI) for this exploratory model. This topic was selected for two reasons: (1) the systematic review did not identify a body of existing evidence that could adequately inform decisions about this use; and (2) neurosurgery is a specialty that is not widely available in all locations (such as rural areas) where people sustain TBIs, making it the type of use often suggested as appropriate for telehealth. We considered the comparison of (1) immediate transfer after stabilization from the community hospital with no access to neurosurgical consultations to a level I or II trauma center (standard care model) and (2) telehealth consultation to determine if the patient can be managed at the local hospital or should be transferred to a level I or II trauma center (telemedicine model).

The model was built as a decision tree. When data were available in the studies included in the systematic review these were used, but the decision modeling team also undertook targeted searches for published data for specific parameters. Data from the literature were used as input parameters to calculate incremental costs for the two different possibilities from the perspective of the healthcare system. The decision analytic model assumed equivalent patient outcomes (details provided in Appendix I). However, the framework was constructed to allow for future inclusion of differences in patient outcomes based on the Glasgow Outcome Scale (GOS) at 6 months: (1) death, (2) persistent vegetative state, (3) severe disability (lost independence) (4) moderate disability, and (5) good outcome (healthy post-TBI) if and when this evidence becomes available.

The model specification and results of this analysis are included in Appendix I of the full report. Insights from our efforts to model cost outcomes are included in the Discussion summary below with more detail in the Discussion section of the full report.

Discussion

This review summarizes a large volume of literature and explores the potential for supplementing systematic reviews with decision models. The 233 included articles cover a diversity of clinical uses and settings for telehealth even when the function is focused only on telehealth consultations. The size, diversity, and other characteristics of these studies of telehealth consultations are important to consider when assessing the utility of the evidence base, potential next steps in research, and what overall conclusion can be drawn from this literature.

Applicability

Our results and synthesis of this large number of studies was organized based on our assessment of the applicability of different subgroups of results. For telehealth consultations we found that the setting is often of primary importance, and we analyzed and presented the studies by setting—inpatient, emergency, and outpatient care. We also made some distinctions within settings. For example, for inpatient care we considered the remote ICU studies separately as remote ICU consultation is a very specialized, specific use, but we combined other specialty consultations for

inpatient care as they are similar in terms of the function (e.g., to diagnose a condition or to provide direction during a surgery) of the consultation and the types of outcomes. For emergency care we separated telestroke, specialty consults for ED patients, and EMS/urgent care for similar reasons. The issues of applicability for outpatient consultations and our approach were slightly different. We reported the details separately by specialty to allow readers to see the results in these groupings, as people are often interested in a particular specialty. Then we combined the results across specialties in the strength of evidence assessment by outcomes in grouping that we felt were appropriate in terms of findings that are likely applicable across specialties.

Limitations

There are important limitations to the evidence base on the effectiveness of the use of telehealth for consultations. The most significant is the variation in study designs and the level of rigor of the research methodology. The literature on telehealth consultations consists primarily of studies that are considered weaker designs such as before and after studies without a comparison group and retrospective cohort studies. Very few studies were rated as low risk of bias; most were moderate or high. Importantly, the comparison treatment was poorly described in these studies; such that it was often impossible to know whether usual care referred to in-person care by a consultant, no consultant involvement, or a combination of both. Other limitations are that the outcomes used to evaluate telehealth are inconsistent and the best or most appropriate outcome is not always used when data are limited to what is routinely collected. Also, the studies provide very little information on the context or the environment in which telehealth for consultations was implemented.

There are also limitations to the review process and decision modeling. Searching for telehealth use for a specific function is difficult as the indexing terms in MEDLINE and other citation databases do not exactly match our scope. Also, given the variation in study designs, environments, and outcomes, we completed quantitative synthesis using meta-analysis for some topics, but used qualitative approaches for the majority; we acknowledge that qualitative synthesis is more open to interpretation and judgment.

In exploring the utility of decision models, we modeled the costs of neurological consultation for acute traumatic brain injury, using an analysis that assumes equivalence in patient outcomes. Other assumptions are possible (i.e., that outcomes are better or worse with telehealth), and this model does not help the decision maker consider these possible variations. However, the model was built to allow inclusion of patient outcomes following treatment for cost benefit analyses in the future. When data become available, the impact on mortality or quality adjusted life years could be incorporated into the model and used to inform judgements about the value of additional costs given patient benefits.

Future Research Needs

While we identified 233 articles that evaluated the effectiveness of telehealth consultations, several questions remain to be addressed in future research. A key priority is the need for rigorous, multi-site studies of telehealth consultations in clinical areas and in the types of organizations where the lack of evidence may be a barrier to wider spread implementation.

Future studies are also needed that both expand and standardize outcomes and clarify their objectives. Agreeing on some common metrics across uses of telehealth for consultation would facilitate comparisons across clinical areas and help identify priorities for future expansion of telehealth consultations. Given the wide range of clinical topics, these common metrics may need to be intermediate outcomes, such as measures of access or satisfaction or cost effectiveness. While costs are not the only important outcome, collecting more cost economic data would allow more direct

comparisons across clinical topics and both facilitate and inform additional decision analyses, whether these are done for publication of for organizations' internal consideration. At the same time this needs to be balanced with attention to the most important outcomes for a given condition. There are examples, such as telestroke, where the most frequently reported outcome (mortality) may not be the most important, either to patients or in terms of the expected impact of changing care. The assessment of telehealth consultations would also be strengthened by more studies that include contemporary comparison groups, either groups of patients or other organizations, so that the effect of the telehealth consultations could be more successfully isolated from historical changes or the idiosyncrasies of a specific organization. This could involve adding comparison or control sites to pre and post telehealth studies.

The research on telehealth could have more impact if its objectives were clearer. Evaluations of telehealth consultations can consider different perspectives and different levels of implementation and evaluation, but failing to be clear leads to studies with confusing results and lessens the impact of positive results. For example, the work on the decision analyses highlighted the importance of clearly specifying the options being compared, or what is "usual care. In the studies we evaluated for this systematic review, the nontelehealth or "usual care" option consisted of was often not specified and was not always clear what care these patients received.

The decision analysis also highlighted the importance of perspective and the need for better information. Most studies did not clearly state their perspective, though it was often implied that is was a single organization (e.g., a hospital or practice group). This seems unnecessarily limiting, and more studies at higher levels seem warranted. In many ways telehealth consultations could be viewed as a systems-level intervention, more similar to health information exchange and electronic health records, than to a condition-specific treatment.

A major evolution of the research in this area would be to focus on hybrid studies, that is, studies that combine effectiveness and implementation assessments. While the results may be uneven across specific clinical areas, telehealth consultations do generally improve access and clinical outcomes and are likely to improve other outcomes. What is missing is much of the specific information asked for in Key Questions 4 and 5 of this review; that is, what are the characteristics of the context and how do they impact outcomes? A hybrid approach to future research could focus on the information needed to promote successful implementation while still continuing to collect better data demonstrating effectiveness and economic impact.

Reviewing background material for this report and discussing telehealth with the Technical Expert Panel and other experts has convinced us that telehealth consultation are being used, particularly in smaller and rural health systems, and that data are often being collected. However, these organizations and data are not represented in the published literature due to lack of research and analysis capacity. Given the importance to policy and practice issues related to telehealth consultations (e.g., payment, scope of work, cross organization, and state licensing), identifying and facilitating the analysis of these data should be a priority and may help strengthen what conclusions can be made about telehealth consultations.

Also during the time period covered in the review and during our work, policies that facilitate telehealth consultation and the number of publications about telehealth increased. However, many of these are descriptive or less rigorous approaches to research. Continuing in this vein will not contribute to the next level of telehealth expansion. Given that more and more resources are being invested in telehealth, it is reasonable to suggest that research evaluating its effectiveness should both increase and improve. The current situation seems to require an organized effort by telehealth advocates, researchers, and policy makers

to identify where there are still gaps in the research base and prioritize these in terms of their potential to move the field forward, toward increasing use of telehealth in those settings and instances where it is likely to be beneficial for patients, healthcare providers, health systems or society.

Conclusions

Although the literature evaluating telehealth consultations is large, it is not possible to make a global, general statement about the clinical and economic effectiveness of telehealth consultations for several reasons. These include the diversity of settings, clinical topics, and outcomes; the limited number of high-quality studies; different approaches to measurement, particularly of costs; and how the perspective may impact the estimation of outcomes. It is possible to conclude it is likely that telehealth is more effective than usual care in several specific situations: Remote ICUs reduce ICU and in-hospital mortality; emergency medical services access to telehealth reduces mortality in patients having heart attacks; remote consultations in emergency care decrease time from presentation to decision, reducing ED time and increasing appropriate transfers and admissions; remote consultations as part of outpatient care improve clinical outcomes in some clinical disciplines and increase access to care in those that have been studied.

For other uses and outcomes the strength of evidence is less definitive. Telehealth consultations may improve inpatient care, emergency stroke care and the management of and satisfaction with outpatient consultations across several specialties. Potential harms or unintended consequences were rarely addressed and future research should address this, if only to confirm they are not significant. Studies of economic outcomes including costs produced mixed results due to major differences in definitions and methods as well as the fact that costs and savings may not accrue to the same organization in an interdependent healthcare system.

Decision models have the potential to build on systematic review results and use evidence in ways that would make it more applicable by tailoring the question, base case, and perspective to the decision maker's situation. But our experience demonstrates that the literature may not be available to provide all the data needed to fully execute a functioning model for all topics of interest. However, decision modeling can provide some insight by quantifying differences in costs across settings and estimating where savings are likely to accrue in the system. While our exploratory assessment was limited to costs, expansion of this approach could allow more targeted identification of scenarios in which telehealth could improve the range of outcomes including clinical outcomes, access, and cost.

Future research about telehealth consultations needs to be more rigorous if it is to inform policy and practice decisions. Specifically, more studies should include multiple sites, collect information on the context and environment, and consistently measure a more comprehensive range of economic impacts and costs using standard practices.

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Full Report

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