Canadian Agency for Drugs and Technologies in Health

RAPID RESPONSE REPORT:
SUMMARY WITH CRITICAL APPRAISAL

TITLE: Telemedicine for the Treatment of Urgent Conditions: A Review of Clinical Effectiveness, Cost-Effectiveness, and Guidelines

DATE: 7 October 2015

CONTEXT AND POLICY ISSUES

With increasing access to high-speed technology and reports of success with a variety of models, it is not surprising that interest in the use of telemedicine is growing.[1-3] However, having been around for over 40 years, the uptake of telemedicine has been slow. Barriers to its implementation have included issues concerning cost, privacy, reimbursement, logistics, and a lack of evidence supporting its use.[1,2]

Telemedicine, a term used interchangeably with telehealth, can be divided into three broad categories: (1) "store-and-forward", also termed "e-care" or "asynchronous communication", refers to the transmission of stored patient data; (2) remote monitoring, refers to the transmission of patient data from sensors and monitoring equipment; and (3) "synchronous communication" or "interactive telemedicine", refers to interaction in real-time, including videoconferencing between a patient and clinician for example.[2,4]

Telemedicine in the emergency setting has many potential applications. It can allow access to remote emergency physicians, as well as a mechanism through which on-site emergency physicians can consult other specialists.[2] On-site access to clinicians presents a particular challenge in rural areas, making telemedicine a potentially effective and economic alternative to transporting patients elsewhere for care.[2] Three different models of telemedicine using interactive video communication in the emergency setting have been described in the literature.[5] The first involves linking a non-physician clinician in a distant or rural site to a physician in a "hub" emergency department for consultation on decisions regarding diagnosis, treatment, admission or disposition. The second model connects physicians and clinicians of several small and remote emergency departments to a hub emergency department, often concerning potential transfer to the hub emergency department. The third model connects emergency department physicians to distant specialists, such as cardiologists, neurologists, ophthalmologists and surgeons.[5]

A 2015 Cochrane review identified 93 randomized controlled trials (RCTs) assessing any form of interactive telemedicine in any setting, including 36 studies using interactive video. None of

these studies assessed video telemedicine in the emergency setting specifically, apart from a single RCT comparing video consultations to telephone or teleradiology in patients with various emergency neurosurgical conditions.[4]

Feasibility of telemedicine with a video component in the emergency department has been demonstrated. Marconi et al. found that physician telepresence was a feasible alternative to traditional nursing triage in a randomized cross-over study of 100 patients presenting to a pediatric emergency department.[6] Seidel et al. found agreement between psychiatrist consultations done face-to-face as compared to via telemedicine in 73 patients presenting to the emergency department, with respect to the perceived need for admission to hospital.[7] In a pilot study by Traub et al., triage by a telemedicine physician was performed in addition to traditional nurse triage in 36 patients over a 1 week period; these patients were compared to patients presenting to the emergency department 1 week before and 1 week after the pilot period. The telemedicine intervention was found to be feasible, was accepted by patients, and decreased time to physician evaluation.[8] However, the impact of telemedicine on patient health outcomes is less clear.

This report aims to review recent evidence and relevant practice guidelines surrounding the use of telemedicine with a video component in the emergency setting, for conditions other than stroke.

RESEARCH QUESTIONS

1. What is the clinical effectiveness of the use of telemedicine to facilitate the delivery of emergency health care?

2. What is the cost-effectiveness of the use of telemedicine to facilitate the delivery of emergency health care?

3. What are the evidence-based guidelines regarding the use of telemedicine to facilitate the delivery of emergency health care?

KEY FINDINGS

No randomized controlled trials, cost-effectiveness analyses, or evidence-based guidelines addressing the research questions were identified. Limited evidence from non-randomized studies suggests that telemedicine may facilitate a reduction of resource use in the emergency mental health population and increase quality of care in the critically ill pediatric population.

METHODS

Literature Search Strategy

A focused search with main concepts appearing in title, abstract or subject heading was conducted on key resources including PubMed, The Cochrane Library, University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2012 and September 3, 2015.

Selection Criteria and Methods

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed and potentially relevant articles were retrieved and assessed for inclusion. The final selection of full-text articles was based on the selection criteria presented in Table 1.

Table 1: Selection Criteria	
Population	Adults and children requiring emergency care for conditions other than strokes
Intervention	Telemedicine/telehealth/videoconference health consultations (inclusion of a video component required)
Comparator	In-person care at an emergency department
Outcomes	Clinical effectiveness (appropriate treatment, effective treatment, harms) Cost-effectiveness (transport avoided, reduction in wait times, etc.) Guidelines, best practice, treatment algorithms
Study Designs	Heath Technology Assessments (HTAs)/Systematic reviews/Meta-analyses, Randomized controlled trials (RCTs), Economic evaluations, Evidence-based guidelines

Exclusion Criteria

Reports not meeting selection criteria as outlined in Table 1, and reports published prior to January 2012 or in languages other than English were excluded. Studies included in a selected systematic review were excluded. Reports of telemedicine interventions not involving a video component were also excluded.

Critical Appraisal of Individual Studies

Quality of included studies was assessed using AMSTAR for the included systematic review,[9] and the Downs and Black checklist included non-randomized studies.[10] A numeric score was not calculated for each study, instead strengths and limitations were described narratively.

SUMMARY OF EVIDENCE

Quantity of Research Available

The electronic database search identified 506 records. Title and abstract screening revealed 18 potentially relevant reports for which full-texts were retrieved, in addition to three reports identified from other sources. Sixteen articles were excluded at full-text screening, leaving five reports eligible for inclusion: one systematic review, and four non-randomized studies. No economic evaluations or evidence-based guidelines were identified. The study selection process is outlined in a PRISMA flowchart presented in Appendix 1.[11]

Additional references of potential interest that did not meet the selection criteria are provided in Appendix 2.

Summary of Study Characteristics

A summary of characteristics of included studies is provided in Appendix 3.

Systematic reviews

Ward (2015) performed a systematic review of the use of telemedicine for hospital-based emergency care.[12] They included studies of any design assessing the effect or impact of telemedicine in the hospital emergency setting, excluding case studies, with a search date of September 2013. Telemedicine was defined in the review as "the delivery of healthcare services at a distance, using information and communication technology". The systematic review included 38 studies: five RCTs, 12 non-randomized comparative studies, and 21 non-comparative studies. A meta-analysis was not performed. Results were not presented separately by type of patient population or by study design.

Non-randomized studies

Narasimhan (2015) assessed the impact of a telepsychiatry program in the United States in a matched cohort study (n=14,522).[13] The telepsychiatry program was implemented in the emergency departments of 18 hospitals without on-site psychiatry services. Psychiatrists were available for consultations via video communication at all times. Patients receiving telepsychiatry services were compared to a matched sample of patients seen in emergency departments that did not participate in the telepsychiatry program. Variables on which the patients were matched included age, sex, race, psychiatric diagnosis, emergency room visits within the past year, and weekend versus weekday visit. Outcomes included outpatient psychiatric follow-up, inpatient admission or transfer to another facility, length of stay, inpatient costs, and hospital costs.

Southard (2014) assessed the impact of a telemedicine mental health evaluation service using interactive video in a single rural hospital emergency department in the United States.[14] In this before and after comparison, all eligible patients receiving a mental health evaluation in the seven months prior (n=24) and six months post (n=38) implementation of the telemedicine service were included. Outcomes of interest included time to treatment, door-to-consult time, and length of stay.

Dharmar and Kuppermann (2013) compared the frequency of physician-related medication errors in children receiving video telemedicine consultations versus telephone or no consultations.[15] This study included 234 seriously ill and injured children under 17 years of age from eight rural emergency departments in the United States. Telemedicine was recommended for all children in the highest triage category, but the decision to use the consult service was up to the discretion of the treating physician. All children receiving video telemedicine consultations were included (n=73). A similar number of children receiving telephone consultations (n=85) and no consultations (n=76) were selected randomly. The outcome of interest was medication errors per medication administered, as measured by a medication error instrument. Gender, week of admission, method of arrival to the emergency department and disposition were considered as potential confounding variables.

Dharmar and Romano (2013) compared the quality of care from video telemedicine consultation (n=58) to telephone (n=53) or no specialist consultation (n=199) in critically ill or injured children under 17 years of age presenting to five rural emergency departments in the United States.[16] Although it was not strictly a before and after comparison, medical records were reviewed for

eligibility from two years prior and two years after implementation of the video consultation service to ensure that an adequate number of patients receiving telephone consultations were included. In each of the five emergency departments, the use of video or telephone consultation was up to the discretion of the treating physician. Outcomes of interest included quality of care rated with a validated instrument, change in care from the consultation, and parent/guardian satisfaction. Investigators decided a priori to adjust analyses for age, severity of illness and consultation year.

Summary of Critical Appraisal

A summary of strengths and limitations of included studies is provided in Appendix 4.

Systematic reviews

Ward (2015) was deemed to be of low quality because it did not meet the majority of AMSTAR criteria.[12] There was no a priori design provided, inclusion was restricted to studies published in English, quality of included studies was not assessed, a list of excluded studies was not provided, publication bias was not assessed, and the search strategy did not appear to be comprehensive.

Non-randomized studies

Narasimhan (2015) was deemed to be of acceptable quality.[13] The intervention was described in detail, and the study included a large sample of patients (n=14,522). Although the investigators matched patients on several potential confounding variables, there is potential for substantial residual confounding due to the limited data available in the health care utilization database and the possibility of unknown or unforeseen confounders. Additionally, hospitals enrolling in the telepsychiatry program (the intervention group) would likely be different from those hospitals not participating in the program (the control group) with respect to the standard care provided.

Southard (2014) was deemed to be of low quality.[14] The telemedicine intervention was not described in detail, there was a relatively small sample size (n=62) with no sample size calculation, no adjustment for confounding was done in the analysis, and the before and after design further increases the risk of bias because of the potential for changes leading to a difference in outcomes apart from the intervention itself, such as in practice or in the environment, that can occur over time.

Dharmar and Kuppermann (2013) was deemed to be of low quality.[15] The intervention was described, and outcome assessors were blinded to intervention group. Although analyses adjusted for potential confounding variables, there is likely substantial residual confounding; treatment group was determined by the treating emergency physician, therefore it is likely that patients receiving telephone or video consultations would be different from those patients not receiving such consultations for a variety of reasons that were not captured in the data. Although the instrument used to evaluate the occurrence of medication errors was previously validated, clinical significance of the medication errors was not reported.
Dharmar and Romano (2013) was also deemed to be of low quality.[16] The intervention was described, and outcome assessors were blinded to intervention group. Similar to Dharmar and Kuppermann (2013) above, treatment group was determined by the treating emergency physician which likely led to substantial confounding. Although the total sample size was relatively large (n=320), there were only 58 patients in the telemedicine group. The instrument

used to assess quality of care has been shown to have fair-to-good inter-rater reliability and high content validity, however the clinical significance of a difference in quality of scare score is not known.

Summary of Findings

A summary of results and conclusions of included studies is provided in Appendix 5.

Systematic reviews

Ward (2015) did not report results separately by population.[12] All included studies, regardless of study design, were divided into three broad categories: general emergency room use, minor treatment clinics, and special patient populations. Outcomes were divided into five broad categories: technical quality, user perceptions, clinical processes and outcomes, disposition and throughput, and economic. Results were qualitatively summarized. With respect to clinical processes and outcomes, there was found to be 'weak positive' evidence of effectiveness and safety as compared to usual care in minor treatment clinics, and 'strongly positive' evidence for clinical outcomes in specialty patient populations across disease types. Evidence for economic outcomes was deemed to be inconclusive for both general ER use studies and minor treatment clinic studies, but 'weak positive' in special patient populations.

Non-randomized studies

Narasimhan (2015) matched 7261 patients with at least one telepsychiatry visit to 7261 patients at hospitals without telepsychiatry services. The intervention statistically significantly decreased inpatient admissions (odds ratio [OR] 0.41, 95% confidence interval [CI]: 0.19 to 0.88) and length of stay (-0.43 days, 95% CI: -0.71 to -0.14). Thirty- and 90-day outpatient follow-up visits were increased (OR 5.44, 95% CI: 4.40 to 6.72 and OR 5.65, 95% CI: 4.60 to 6.93, respectively). Inpatient charges were reduced (-$2388 per patient, 95% CI: -$4,852 to -$94) as were total health care charges (-$649 per patient, 95% CI: -$3,221 to -$1,902) at 30 days.[13]

Southard (2014) compared 38 patients receiving telemedicine mental health evaluations to 24 patients receiving mental health evaluations prior to implementation of the telemedicine service. The intervention statistically significantly decreased order-to-consult time in the intervention versus the control groups (mean 5.4 versus 16.2 hours), as well as door to consult time (mean of 10.5 versus 22.7 hours), and length of stay (mean of 17.0 versus 31.7 hours), with $P < 0.001$ for all three comparisons.[14]

Dharmar and Kuppermann (2013) compared telemedicine consultations (n=73) to telephone consultations (n=85) and no consultations (n=76) in a retrospective cohort study of children presenting to emergency in the highest triage category. The occurrence of physician-related medication errors was statistically significantly reduced with telemedicine as compared to no consultation, with an OR of 0.13 (95% CI: 0.02 to 0.74). The clinical significance or outcome of the errors was not assessed.[15]

Dharmar and Romano (2013) also compared critically ill children receiving video telemedicine consultation (n=58) to telephone (n=53) or no specialist consultation (n=199) in a retrospective cohort study. Quality of care, as assessed by a validated tool, was statistically significantly improved in children receiving video telemedicine consultation versus no consultation, with a mean difference of 0.5 (95% CI: 0.17 to 0.84). The clinical relevance of this difference is not clear.[16]

Limitations

No RCTs addressing the research questions were identified in this report, and the lack of RCT data is confirmed by a recent Cochrane review.[4]

The only included systematic review was of low quality.[12] All relevant included studies were non-randomized, and many were not comparative. Results of the systematic review were not reported separately by study design or patient population, and it was therefore not possible to draw any conclusions regarding the research questions of interest for this report from the systematic review.

All four non-randomized studies were conducted in the United States. Of the four included non-randomized studies, only one study of a telepsychiatry program was deemed to be of acceptable quality.[13] The other three non-randomized studies, one in mental health and two in pediatric populations, were deemed to be of low quality owing to the risk of confounding bias.[6,14,16]

No practice guidelines or economic evaluations were identified.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING

Evidence surrounding the use of telemedicine in the emergency setting is limited. No relevant RCTs, economic analyses or clinical practice guidelines were identified. Non-randomized studies point towards a reduction of resource use with telemedicine as compared to usual in-person care in the emergency mental health population, and possibly increased quality of care in the critically ill pediatric population. Further research surrounding the clinical and cost-effectiveness of telemedicine as compared to in-person care in the emergency setting would reduce uncertainty.

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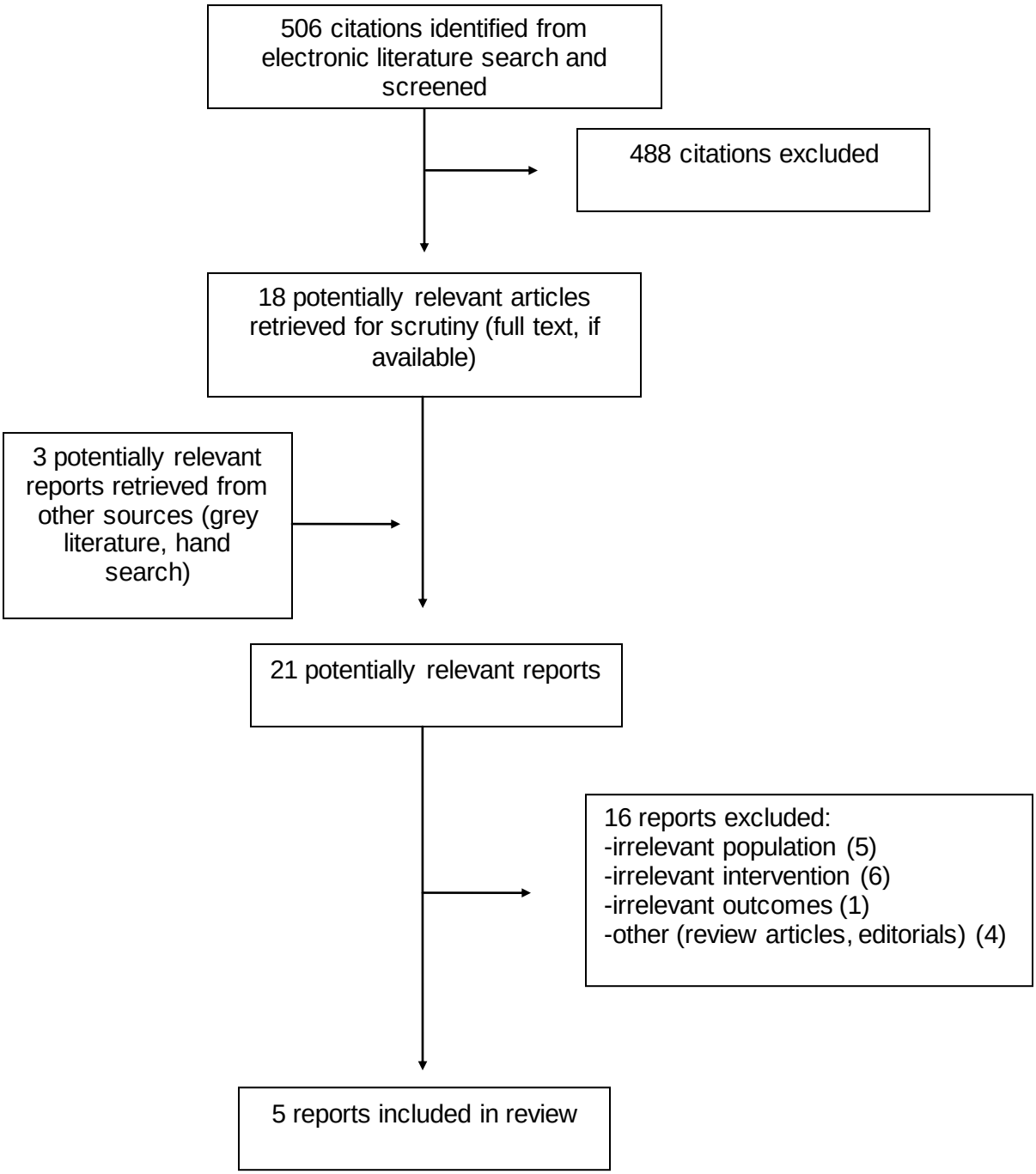
APPENDIX 1: Selection of Included Studies



APPENDIX 2: Additional references of potential interest

Narrative reviews

Amadi-Obi A, Gilligan P, Owens N, O'Donnell C. Telemedicine in pre-hospital care: a review of telemedicine applications in the pre-hospital environment. Int J Emerg Med [Internet]. 2014 [cited 2015 Sep 16];7:29. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4306051

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APPENDIX 3: Characteristics of Included Studies

First Author, Year, Country	Study Design	Patient Characteristics	Intervention	Comparator (s)	Clinical Outcomes
Ward, 2015[12]	Systematic Review	Patients in the emergency setting (38 studies included)	Any telemedicine intervention ("the delivery of healthcare services at a distance, using information and communication technology")	Any (or no) comparator	Technical quality, user perceptions, clinical processes and outcomes, disposition and throughput, economic
Narasimhan, 2015[13] United States	Non-randomized (matched cohort study) Follow up: 90 days	Patients presenting with a psychiatric condition to an emergency department without on-site psychiatry services (n=14,522)	Telepsychiatry: Psychiatrists available for video consultations 24 hours per day	Patients presenting to hospitals without telepsychiatry services	Outpatient psychiatric follow-up, inpatient admission or transfer to another facility, length of stay, inpatient costs, and hospital costs
Southard, 2014[14] United States	Non-randomized (before and after comparison) Follow up: not reported	Patients receiving a mental health evaluation in a rural emergency department (n=62)	Telemedicine mental health evaluation	On-site mental health evaluation	Time to treatment, door-to-consult time, and length of stay
Dharmar and Kuppermann, 2013[15] United States	Non-randomized (retrospective cohort study) Follow up: not reported	Children under 17 years of age presenting to eight rural emergency departments at the highest triage category (n=234)	Telemedicine consultation with an academic children's hospital pediatric critical care physician	Telephone consultation, or no consultation	Physician-related medication errors
Dharmar and Romano, 2013[16] United States	Non-randomized (retrospective cohort study) Follow up: not reported	Children under 17 years of age presenting to five rural emergency departments at the highest triage category (critically ill or critically injured) (n=320)	Telemedicine consultation with an academic children's hospital pediatric critical care physician	Telephone consultation, or no consultation	Quality of care according to a validated instrument, change in care from the consultation, and parent/guardian satisfaction

APPENDIX 4: Critical Appraisal of Included Studies

First Author, Publication Year	Strengths	Limitations
Systematic Reviews		
Ward, 2015[12]	• Characteristics of included studies were provided	• restricted to studies published in English • quality of included studies was not assessed • a list of excluded studies was not provided • unclear whether study selection was done in duplicate • unclear whether search was comprehensive
Non-randomized studies		
Narasimhan, 2015[13]	• Intervention was clearly described • Large sample size	• Non-randomized • Adjusted for a limited number of confounding variables; potential for substantial residual confounding
Southard, 2014[14]	• No major strengths	• Non-randomized • Before and after design with no adjustment for confounding variables • Intervention was not described in detail • Patient characteristics not reported separately by treatment group • Small sample size
Dharmar and Kuppermann, 2013[15]	• Intervention was clearly described	• Non-randomized • Adjusted for a limited number of confounding variables; potential for substantial residual confounding • Clinical significance of the medication errors is not known
Dharmar and Romano, 2013[16]	• Intervention was clearly described	• Non-randomized • Adjusted for a limited number of confounding variables; potential for substantial residual confounding • Clinical significance of the physician rated quality of care tool is not known

APPENDIX 5: Results and Conclusions of Included Studies

First Author, Year	Main Study Findings	Authors' Conclusions
Ward, 2015[12]	General ER use category: No clinical outcomes reported, 'inconclusive' economic evidence Minor treatment clinics category: 'weak positive' evidence of effectiveness and safety as compared to regular practice, inconclusive economic evidence Specialty patient populations category: 'strongly positive' evidence for clinical outcomes in specialty patient populations across disease types, and 'weakly positive' evidence for economic outcomes	"despite limitations in their research methodology, the studies on tele-emergency indicate an application with promise to meet the needs of small and rural hospitals to address infrequent but emergency situations requiring specialist care. Similarly, studies indicate that tele-emergency has considerable potential to expand use of minor treatment clinics to address access issues in remote areas and overcrowding of urban ERs."(pg 601)
Narasimhan, 2015[13]	Inpatient admissions: OR 0.41 (95% CI: 0.19, 0.88) Length of stay: -0.43 days (95% CI -0.71, -0.14), 30 day outpatient follow-up visits: OR 5.44 (95% CI: 4.40, 6.72) 90 day outpatient follow-up visits: OR 5.65 (95% CI 4.60, 6.93) Inpatient charges: -$2388 (95% CI: -$4,852, -$94) Total health care charges: -$649 (95% CI: -$3,221, -$1,902)	"…a telepsychiatry visit increased outpatient follow-up and may have even reduced resource use."(pg 5)
Southard, 2014[14]	Mean hours (SD) by treatment group; all comparisons statistically significant with p<0.001 Order to consult time: Control= 16.2 (13.3), intervention= 5.4 (6.4) Door to consult time: Control= 22.7(12.6), intervention= 10.5(10.2) Length of stay: Control= 31.7(14.1), intervention= 17.0(18.0)	"Telemedicine appears to be an effective intervention for mentally ill patients by providing more timely access to mental health evaluations in rural hospital emergency departments."(pg 664)
Dharmar and Kuppermann, 2013[15]	Physician-related medication errors (telemedicine vs no consultation): OR 0.13 (95% CI: 0.02, 0.74)	"The use of telemedicine to provide pediatric critical care consultations to rural EDs was associated with significantly fewer physician-related medication errors than providing critical care consultations by telephone or providing care to similarly ill children without pediatric critical care consultations." (pg 1095)
Dharmar and Romano, 2013[16]	Overall quality of care score (telemedicine vs no consultation): Mean difference 0.5 (95% CI: 0.17, 0.84)	"The use of telemedicine was associated with higher physician-rated quality of care, more frequent changes in diagnostic and therapeutic interventions by referring physicians, and higher referring physician and parental perceptions of quality of care."(pg 2394)

CI= confidence interval; OR= odds ratio; SD= standard deviation; pg= page number