To increase and organize the evidence for the use of telehealth, the Center for Connected Health Policy (CCHP) has been examining published studies that have been designed to measure the use of telehealth in achieving one or more of the goals of the Triple Aim. Among the Triple Aim’s goals, cost-effectiveness is an area that has been less explored than the others, and yet frequently inquired about. This catalog is a collection of peer reviewed journal articles that examine telehealth cost-effectiveness studies that meet certain inclusion criteria established for quality control purposes.

CCHP employed several search parameters when selecting Cost-Effectiveness studies. All studies selected were U.S. based, published post 2007, have a sample size of no less than 50 (for studies with control groups, there needed to be a minimum of at least 30 subjects per group) if the study period was no less than 6 months, or have a sample size of no less than 100 if the study period was no less than 3 months, and a primary focus on costs of a selected telehealth modality. The perspective of cost from each study was also recorded; it indicated whether the perspective of cost impact was organized around society (either the patient perspective or the patient’s quality of life), health care systems, policy makers, or third-party insurers. Journal articles that were focused on telephonic, and care management environments were eliminated.

Pub Med, Google Scholar, Science Direct, SAGE, JSTOR, Gale Academic OneFile, and EBSCO were used in the peer-reviewed articles search.

The original catalogue was prepared by Laura Nasseri and the work supervised by Mei Wa Kwong and Christine Calouro. This catalogue was updated in Sept. 2015 by Taylor Whited and again in July 2018 by Michelle Grant.

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<tr>
<th>Study Length</th>
<th>State</th>
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<th>Telehealth Modality Type</th>
<th>Method</th>
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<tr>
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<td>SC</td>
<td>241</td>
<td>Video Conference</td>
<td>Randomized Controlled Trial</td>
<td>Patient (VA)</td>
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### Summary

**Background:** Little evidence exists regarding the costs of telemedicine, especially considering changes over time. This analysis aimed to analyze trajectory of healthcare cost before, during, and after a behavioral activation intervention delivered via telepsychology and same-room delivery to elderly Veterans with depression.

**Methods:** 241 participants were randomly assigned into one of two study groups: behavioral activation for depression via telemedicine or via same-room treatment. Patients received 8 weeks of weekly 60-min individual sessions of behavioral activation for depression. Primary outcomes were collected at 12-months. Inpatient, outpatient, pharmacy, and total costs were collected from VA Health Economics Resource Center (HERC) datasets for FY 1998–2014 and compared between the two treatment groups. Generalized mixed models were used to investigate the trajectories over time.

**Results:** Overall cost, as well as, outpatient and pharmacy cost show increasing trend over time. Unadjusted and adjusted trajectories over time for any cost were not different between the two treatment groups. There was a significant overall increasing trend over time for outpatient ($p<0.001$) and total cost ($p<0.001$) but not for inpatient ($p=0.543$) or pharmacy cost ($p=0.084$).

**Limitations:** Generalizability to younger, healthier populations may be limited due to inclusion criteria for study participants.

**Conclusion:** Healthcare costs before, during, and after intervention did not differ between the telemedicine and in-person delivery methods. Outpatient costs accounted for most of the increasing trend of cost over time. These results support policies to use both telehealth and in-person treatment modalities to effectively and efficiently provide high quality care.


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<th>Study Length</th>
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<td>338</td>
<td>Video Conference</td>
<td>Multi-Site Cross-Sectional Survey</td>
<td>Patient/Parent</td>
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**Summary**

**Background:** There is a critical shortage of pediatric rheumatologists in the US. Substantial travel to clinics can impose time and monetary burdens on families. The aim of this study was to evaluate the cost of in-person pediatric rheumatology visits for families and determine if telemedicine clinics resulted in time and cost savings. Factors associated with interest in telemedicine were also explored.

**Methods:** Surveys were offered to parents and guardians of patients in Pediatric Rheumatology follow-up clinics in Kansas City, Missouri, the primary site of in-person care, and at a telemedicine outreach site 160 miles away, in Joplin, Missouri. Survey questions were asked about non-medical, out-of-pocket costs associated with the appointment and interest in a telemedicine clinic.

**Results:** At the primary Kansas City clinic, the median distance traveled one-way was 40 miles [IQR = 18–80]. In the Joplin sample, the median distance traveled to the telemedicine clinic was 60 miles [IQR = 20–85] compared to 175 miles [IQR = 160–200] for the same cohort of patients when seen in Kansas City (p < 0.001). When the Joplin cohort was seen via telemedicine they missed less time from work and school (p = 0.028, p = 0.003, respectively) and a smaller percentage spent money on food compared to when they had traveled to Kansas City (p < 0.001). There was no statistical difference between the Joplin cohort when they had traveled to Kansas City and the Kansas City cohort in terms of miles driven to clinic, time missed from work and school, and percentage of subjects who spent money on food.

**Conclusions:** Traditional in-person visits can result in a financial toll on families, which can be ameliorated by the use of telemedicine. Telemedicine leveled the economic burden of clinic visits so that when the Joplin cohort was seen via telemedicine, they experienced costs similar to the Kansas City cohort.

**Access:** [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5029100/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5029100/)

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<td>1.5 years</td>
<td>MN, MO</td>
<td>391</td>
<td>Live Video</td>
<td>Cost Analysis</td>
<td>Health Care Providers (VA)</td>
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</table>

**Summary**

**Introduction:** The Veterans Affairs (VA) healthcare system provides beneficiary travel reimbursement ("travel pay") to qualifying patients for traveling to appointments. Travel pay is a large expense for the VA and hence the U.S. Government, projected to cost nearly $1 billion in 2015. Telemedicine in the VA system has the potential to save money by reducing patient travel and thus the amount of travel pay disbursed. In this study, we quantify this savings and also report trends in VA telemedicine volumes over time.

**Materials and Methods:** All telemedicine visits based at the VA Hospital in White River Junction, VT between 2005 and 2013 were reviewed (5,695 visits). Travel distance and time saved as a result of telemedicine were calculated. Clinical volume in the mental health department, which has had the longest participation in telemedicine, was analyzed.

**Results:** Telemedicine resulted in an average travel savings of 145 miles and 142 min per visit. This led to an average travel payment savings of $18,555 per year. Telemedicine volume grew significantly over the study period such that by the final year the travel pay savings had increased to $63,804, or about 3.5% of the total travel pay disbursement for that year. The number of mental health telemedicine visits rose over the study period but remained small relative to the number of face-to-face visits. A higher proportion of telemedicine visits involved new patients.

**Conclusions:** Telemedicine at the VA saves travel distance and time, although the reduction in travel payments remains modest at current telemedicine volumes.


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<td>6 years</td>
<td>MO, MN</td>
<td>391</td>
<td>Store and Forward</td>
<td>Randomized Control Trial (RTC)</td>
<td>Society and Health Care Provider (VA)</td>
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**Summary**

**Importance:** The costs and utility of teledermatology are important features of implementation. Such an analysis requires a description of the perspective of the entity that will bear the cost.

**Objective:** To assess the costs and utility of a store-and-forward teledermatology referral process compared with a conventional referral process from the perspectives of the Department of Veterans Affairs (VA) and society.

**Design, Setting, and Participants:** Three hundred ninety-one randomized participants were referred from remote sites of primary care to the dermatology services of 2 VA medical facilities for ambulatory skin conditions from December 2008 through June 2010, and follow-up was completed in March 2011. The time trade-off utility measures and costs were collected during a 9-month period among participants in a 2-site parallel group randomized clinical trial. The perspectives of the VA and society were evaluated. The multiple imputation procedure or weighted means were used for missing data elements. Data were analyzed from January to July 2014.

**Interventions:** Referrals were managed using store-and-forward teledermatology or a conventional text-based referral process.

**Main Outcomes and Measures:** Total costs from the perspectives of the VA and society incurred during the 9-month follow-up were used to derive per-participant costs. Utility, using the time trade-off method, was the measure of effectiveness.

**Results:** From the VA perspective, the total cost for conventional referrals was $66,145 (minimum, $58,697; maximum, $71,635), or $338 (SD, $291) per participant (196 participants); the total cost for teledermatology referrals was $59,917 (minimum, $51,794;
maximum, $70,398), or $308 (SD, $298) per participant (195 participants). The $30 difference in per-participant cost was not statistically significant (95% CI, -$79 to $20). From the societal perspective, the total cost for conventional referrals was $106,194 (minimum, $98,746; maximum, $111,684), or $542 (SD, $403) per participant (196 participants); the total cost for teledermatology referrals was $89,523 (minimum, $81,400; maximum, $100,400) or $460 (SD, $428) per participant. This $82 difference in per-participant cost was statistically significant (95% CI, -$12 to -$152). From baseline to the 9-month follow-up, the time trade-off utility value improved by 0.02 in the conventional referral group and 0.03 in the teledermatology group. This difference was not statistically significant (P = .50).

**Conclusions and Relevance:** Compared with conventional referrals, store-and-forward teledermatology referrals were performed at a comparable cost (VA perspective) or at a lower cost (societal perspective) with no evidence of a difference in utility as measured by the time trade-off method.


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<td><strong>Sample Size</strong></td>
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<td>18 months</td>
<td>AR</td>
<td>364</td>
<td>Video Conference</td>
<td>Randomized, Pragmatic Comparative-Effectiveness Trial</td>
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</table>

**Summary**

**Objective:** Collaborative care for depression in primary care settings is effective and cost-effective. However, there is minimal evidence to support the choice of on-site versus off-site models. This study examined the cost-effectiveness of on-site practice-based...
collaborative care (PBCC) versus off-site telemedicine-based collaborative care (TBCC) for depression in federally qualified health centers (FQHCs). **Methods:** In a multisite, randomized, pragmatic comparative cost-effectiveness trial, 19,285 patients were screened for depression, 2,863 (14.8%) screened positive, and 364 were enrolled. Telephone interview data were collected at baseline and at six, 12, and 18 months. Base case analysis used Arkansas FQHC health care costs, and secondary analysis used national cost estimates. Effectiveness measures were depression-free days and quality-adjusted life years (QALYs) derived from depression-free days, the 12-Item Short-Form Survey, and the Quality of Well-Being (QWB) Scale. Nonparametric bootstrap with replacement methods were used to generate an empirical joint distribution of incremental costs and QALYs and acceptability curves.

**Results:** The TBCC intervention resulted in more depression free days and QALYs but at a greater cost than the PBCC intervention. The disease-specific (depression-free day) and generic (QALY) incremental cost-effectiveness ratios (ICERs) were below their respective ICER thresholds for implementation, suggesting that the TBCC intervention was more cost effective than the PBCC intervention.

**Conclusions:** These results support the cost-effectiveness of TBCC in medically underserved primary care settings. Information about whether to insource (make) or outsource (buy) depression care management is important, given the current interest in patient-centered medical homes, value-based purchasing, and bundled payments for depression care.


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<td>MN</td>
<td>102, 103</td>
<td>Remote Patient Monitoring (RPM)</td>
<td>Randomized Control Trial (RTC)</td>
<td>Society (patient savings)</td>
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**Summary**

**Background:** From 1992 to 2008, older adults in the United States incurred more healthcare expense per capita than any other age group. Home telemonitoring has emerged as a potential solution to reduce these costs, but evidence is mixed. The primary aim of
the study was to evaluate whether the mean difference in total direct medical cost consequence between older adults receiving additional home telemonitoring care (TELE) (n=102) and those receiving usual medical care (UC) (n=103) were significant. Inpatient, outpatient, emergency department, decedents, survivors, and 30-day readmission costs were evaluated as secondary aim.

Materials and Methods: Multivariate generalized linear models (GLMs) and parametric bootstrapping methods were used to model cost and to determine significance of the cost differences. We also compared the differences in arithmetic mean costs.

Results: From the conditional GLMs, the estimated mean cost differences (TELE versus UC) for total, inpatient, outpatient, and ED were $-9,537 (p=0.068), $-8,482 (p =0.098), $-1,160 (p=0.177), and $106 (p=0.619), respectively. Mean post-enrollment cost was 11% lower than the prior year for TELE versus 22% higher for UC. The ratio of mean cost for decedents to survivors was 2.1:1 (TELE) versus 12.7:1 (UC).

Conclusions: There were no significant differences in the mean total cost between the two treatment groups. The TELE group had less variability in cost of care, lower decedents to survivors cost ratio, and lower total 30-day readmission cost than the UC group.


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<td>135</td>
<td>Live Video</td>
<td>Economic Evaluation</td>
<td>Health Care Provider</td>
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Summary

Background: Comprehensive economic evaluations have not been conducted on telemedicine consultations to children in rural
emergency departments (EDs).

Objective: We conducted an economic evaluation to estimate the cost, effectiveness, and return on investment (ROI) of telemedicine consultations provided to health care providers of acutely ill and injured children in rural EDs compared with telephone consultations from a health care payer prospective.

Methods: We built a decision model with parameters from primary programmatic data, national data, and the literature. We performed a base-case cost-effectiveness analysis (CEA), a probabilistic CEA with Monte Carlo simulation, and ROI estimation when CEA suggested cost-saving. The CEA was based on program effectiveness, derived from transfer decisions following telemedicine and telephone consultations.

Results: The average cost for a telemedicine consultation was $3,641 per child/ED/year in 2013 US dollars. Telemedicine consultations resulted in 31% fewer patient transfers compared with telephone consultations and a cost reduction of $4,662 per child/ED/year. Our probabilistic CEA demonstrated telemedicine consultations were less costly than telephone consultations in 57% of simulation iterations. The ROI was calculated to be 1.28 ($4,662/$3,641) from the base-case analysis and estimated to be 1.96 from the probabilistic analysis, suggesting a $1.96 return for each dollar invested in telemedicine. Treating 10 acutely ill and injured children at each rural ED with telemedicine resulted in an annual cost-savings of $46,620 per ED.

Limitations: Telephone and telemedicine consultations were not randomly assigned, potentially resulting in biased results.

Conclusions: From a health care payer perspective, telemedicine consultations to health care providers of acutely ill and injured children presenting to rural EDs are cost-saving (base-case and more than half of Monte Carlo simulation iterations) or cost-effective compared with telephone consultations.


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<td>566</td>
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<td>Randomized Controlled Trial (RCT)</td>
<td>Society (patient savings)</td>
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**Summary**

**Background**: In rural America, cigarette smoking is prevalent and health care providers lack the time and resources to help smokers quit. Telephone quitlines are important avenues for cessation services in rural areas, but they are poorly integrated with local health care resources.

**Objective**: The intent of the study was to assess the comparative effectiveness and cost effectiveness of two models for delivering expert tobacco treatment at a distance: telemedicine counseling that was integrated into smokers’ primary care clinics (Integrated Telemedicine—ITM) versus telephone counseling, similar to telephone quitline counseling, delivered to smokers in their homes (Phone).

**Methods**: Smokers (n=566) were recruited offline from 20 primary care and safety net clinics across Kansas. They were randomly assigned to receive 4 sessions of ITM or 4 sessions of Phone counseling. Patients in ITM received real-time video counseling, similar to Skype, delivered by computer/webcams in clinic exam rooms. Three full-time equivalent trained counselors delivered the counseling. The counseling duration and content was the same in both groups and was available in Spanish or English. Both groups also received identical materials and assistance in selecting and obtaining cessation medications. The primary outcome was verified 7-day point prevalence smoking abstinence at month 12, using an intent-to-treat analysis.

**Results**: There were no significant baseline differences between groups, and the trial achieved 88% follow-up at 12 months. Verified abstinence at 12 months did not significantly differ between ITM or Phone (9.8%, 27/280 vs 12%, 34/286; P=.406). Phone participants completed somewhat more counseling sessions than ITM (mean 2.6, SD 1.5 vs mean 2.4, SD 1.5; P=.0837); however,
participants in ITM were significantly more likely to use cessation medications than participants in Phone (55.9%, 128/280 vs 46.1%, 107/286; P=.03). Compared to Phone participants, ITM participants were significantly more likely to recommend the program to a family member or friend (P=.0075). From the combined provider plus participant (societal) perspective, Phone was significantly less costly than ITM. Participants in ITM had to incur time and mileage costs to travel to clinics for ITM sessions. From the provider perspective, counseling costs were similar between ITM (US $45.46, SD 31.50) and Phone (US $49.58, SD 33.35); however, total provider costs varied widely depending on how the clinic space for delivering ITM was valued.

**Conclusions:** Findings did not support the superiority of ITM over telephone counseling for helping rural patients quit smoking. ITM increased utilization of cessation pharmacotherapy and produced higher participant satisfaction, but Phone counseling was significantly less expensive. Future interventions could combine elements of both approaches to optimize pharmacotherapy utilization, counseling adherence, and satisfaction. Such an approach could commence with a telemedicine-delivered clinic office visit for pharmacotherapy guidance, and continue with telephone or real-time video counseling delivered via mobile phones to flexibly deliver behavioral support to patients where they most need it—in their homes and communities.


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<td>Retrospective</td>
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**Summary**

**OBJECTIVE** To report the use of telemedicine to deliver general urologic care to remote locations within the Veterans Affairs Greater Los Angeles Healthcare System. We describe the diagnoses managed, patient satisfaction, safety, and benefit to patients in terms of
saved travel time and expense.

**METHODS** We conducted a retrospective chart review examining care delivered through urology telemedicine clinics over a 6-month period. We examined the urologic conditions, patient satisfaction, and emergency department visits within 30 days of the visit. We estimated patient benefit by calculating travel distance and time and the saved travel-associated costs using Google Maps and US Census income data.

**RESULTS** Ninety-seven unique telemedicine visits were conducted and a total of 171 urologic diseases were assessed. The most common conditions were lower urinary tract symptoms (35%), elevated prostate-specific antigen level (15%), and prostate cancer (14%). One patient was seen in the emergency department within 30 days with an unpreventable urologic complaint. Patient satisfaction was “very good” to “excellent” in 95% of cases, and 97% would refer another veteran to the urology telemedicine clinic. Patients saved an average of 277 travel miles, 290 minutes of travel time, $67 in travel expenses, and $126 in lost opportunity cost.

**CONCLUSION** Telemedicine was successfully and safely used to evaluate and treat a wide range of urologic conditions within the Veterans Affairs Greater Los Angeles Healthcare System, and saves patients nearly 5 hours and up to $193 per visit. Further investigation of the potential of telemedicine for the delivery of urologic care in a cost-effective manner is warranted.

Access: [http://dx.doi.org/10.1016/j.urology.2015.04.038](http://dx.doi.org/10.1016/j.urology.2015.04.038)

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</table>
Background: The Veterans Administration (VA) has been using telehealth to enhance Veteran access to high quality VA care for over a decade. Clinical video telehealth (CVT) is one such telehealth tool that allows Veterans the opportunity to be evaluated by specialists at the Indianapolis VA while they actually remain in their community (in their local healthcare setting). Such tools are reported to improve satisfaction by avoiding the need to make the long, stressful, and often costly trips to the Medical Center. Our goal is to describe the results of CVT implementation at the Indianapolis VA.

Methods: A retrospective review of the data from 2011-2014 related to the use of CVT at the Indianapolis VA was undertaken. The data collected during this time period included: the number of CVT visits per year by specialty, the number of miles in travel avoided per visit, and patient satisfaction survey data, which are obtained after each CVT visit.

Results: A total of 14,708 Veterans have enrolled in our CVT telehealth program since 2011. There were 23,267 visits in 2013. 486,170 miles related to travel were avoided (calculating the number of miles avoided in travel from home to a local satellite site as compared to having to travel from home to the Indianapolis VA). At the current Government reimbursement rate of $0.42/mile, this is expressed in a cost avoidance of $209,053. In total, since 2011, the telehealth CVT program has saved the Government $331,132, a total of 770,075 miles saved in travel for our Veterans. In addition, the CVT program has been very well received by our Veterans with an overall satisfaction score of 96%.

Conclusion: Our results indicate that the implementation of CVT is cost effective and is well received by Veterans. Telehealth modalities such as CVT are viable options that enhance Veteran satisfaction by decreasing the time and the costs related to travel while continuing to offer high quality health care.


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<td>Randomized Controlled Trial (RCT)</td>
<td>Policy Makers (Medicare/Medicaid)</td>
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Summary

Hospitalizations of nursing home residents are frequent and result in complications, morbidity, and Medicare expenditures of more than a billion dollars annually. The lack of a physician presence at many nursing homes during off hours might contribute to inappropriate hospitalizations. Findings from our controlled study of eleven nursing homes provide the first indications that switching from on-call to telemedicine physician coverage during off hours could reduce hospitalizations and therefore generate cost savings to Medicare in excess of the facility’s investment in the service. But those savings were evident only at the study nursing homes that used the telemedicine service to a greater extent, compared to the other study facilities. Telemedicine service providers and nursing home leaders might need to take additional steps to encourage buy-in to the use of telemedicine at facilities with such services. At the same time, closer alignment of the stakeholders that bear the costs of telemedicine and those that might realize savings because of its use could offer further incentives for the adoption of telemedicine.

OBJECTIVE: To explore the cost-effectiveness of telemedicine for the screening of diabetic retinopathy (DR) and identify changes within the demographics of a patient population after telemedicine implementation.

DESIGN: A retrospective medical chart review (cohort study) was conducted.

PARTICIPANTS: A total of 900 type 1 and type 2 diabetic patients enrolled in a medical system with a telemedicine screening program for DR.

METHODS: The cost-effectiveness of the DR telemedicine program was determined by using a finite horizon, discrete time, discounted Markov decision process model populated by parameters and testing frequency obtained from patient records. The model estimated the progression of DR and determined average quality-adjusted life years (QALYs) saved and average additional cost incurred by the telemedicine screening program.

MAIN OUTCOME MEASURES: Diabetic retinopathy, macular edema, blindness, and associated QALYs.

RESULTS: The results indicate that telemedicine screening is cost-effective for DR under most conditions. On average, it is cost-effective for patient populations of >3500, patients aged <80 years, and all racial groups. Observable trends were identified in the screening population since the implementation of telemedicine screening: the number of known DR cases has increased, the overall age of patients receiving screenings has decreased, the percentage of nonwhites receiving screenings has increased, the average
number of miles traveled by a patient to receive a screening has decreased, and the teleretinal screening participation is increasing.

**CONCLUSIONS:** The current teleretinal screening program is effective in terms of being cost-effective and increasing population reach. Future screening policies should give consideration to the age of patients receiving screenings and the system's patient pool size because our results indicate it is not cost-effective to screen patients aged older than 80 years or in populations with <3500 patients.


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<td>Remote Patient Monitoring (RPM)</td>
<td>Pilot Project</td>
<td>Society (patient’s quality of life)</td>
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</table>

**Summary**

Home telemonitoring can augment home health care services during a patient's transition from hospital to home. Home health care agencies commonly use telemonitors for patients with heart failure although studies have shown mixed results in the use of telemonitors to reduce rehospitalizations. This randomized trial investigated if older patients with heart failure admitted to home health care following a hospitalization would have a reduction in rehospitalizations and improved health status if they received telemonitoring. Patients were followed up to 180 days post-discharge from home health care services. Results showed no difference in the time to rehospitalizations or emergency visits between those who received a telemonitoring vs. usual care. Older heart failure patients who received telemonitoring had better health status by home health care discharge than those who received usual care. Therefore for older adults with heart failure telemonitoring may be important adjunct to home health care services to improve

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<td>659</td>
<td>RPM</td>
<td>Pilot Project</td>
<td>Society (patient perspective)</td>
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**Summary**

Life in mountainous, rural areas poses unique obstacles for ophthalmic care--notably, a lack of access to ophthalmologists and cost of care. Using telemedicine as a screening tool addresses both issues for diabetic retinopathy (DR) screening, as fundus photography has been determined to be sensitive and specific when screening for DR. The American Diabetes Association places a Grade E recommendation on fundus photography as a screening tool. We analyze the financial impact of ophthalmic telemedicine in a mountainous, rural health clinic in West Virginia over a seven year period from 2003-2009. At-risk patients are screened with a fundus camera during routine clinic visits, and the image is interpreted off-site by an ophthalmologist. Patients are either advised to follow up yearly or receive an immediate ophthalmic referral. Considering the number of patients screened, travel costs, work missed, overhead, and billing considerations yields a savings of $153.43 per patient visit.

Access: [http://europepmc.org/abstract/med/23930563](http://europepmc.org/abstract/med/23930563)

<table>
<thead>
<tr>
<th>Study Length</th>
<th>State</th>
<th>Sample Size</th>
<th>Telehealth Modality Type</th>
<th>Method</th>
<th>Perspective of Cost</th>
</tr>
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<tbody>
<tr>
<td>1 year</td>
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<td>611</td>
<td>Store-and-Forward</td>
<td>Comparative Study</td>
<td>Society (patient perspective) and Health Care Providers</td>
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</table>

**Summary**

**OBJECTIVE:** To study the cost benefit analysis of using a telemedicine-based digital retinal imaging evaluation compared to conventional ophthalmologic fundus examination of diabetic patients for diabetic retinopathy.

**METHODS:** In this study, diabetic patients from Community Health Center, Inc. (CHCI), a large multi-site Federally Qualified Health Center) were evaluated by teleophthalmology using the Canon CR-1 nonmydriatic fundus camera. Digital images were acquired in the CHCI offices and saved on the EyePACS server network. The images were later evaluated by retinal specialists at the Yale Eye Center, Yale University Department of Ophthalmology and Visual Science. The costs for the standard of care ophthalmic examinations were calculated based on 2009 Medicaid reimbursement rates. The process of telemedicine-based diagnosis was based on a take-store-forward-visualize system. The cost of telemedicine-based digital retinal imaging examination included cost for devices, training, annual costs and a transportation fee. Current Medicaid reimbursement, transportation, and staff labor costs were used to calculate the conventional retinal examination cost as a comparison.

**RESULTS:** Among the 611 patients digital retinal images screened in the first year of this program and for whom data are available, 166 (27.2%) cases of diabetic retinopathy were identified. Seventy-five (12.3%) patients screened positive with clinically significant disease and were referred for further ophthalmological evaluation and treatment. The primary direct cost of the telemedicine was $3.80, $15.00, $17.60, $1.50, and $2.50 per patient for medical assistant, ophthalmologist, capital cost (Equipment + Training), equipment maintenance, and transportation fee, respectively. The total cost in the telemedicine-based digital retinal imaging and evaluation was $40.40. The cost of conventional retinal examination was $8.70, $65.30, and $3.80 per patients for round-trip
transportation, 2009 national Medicaid Physician Fee Schedule allowable for bilateral eye examination, and medical assistant personnel, respectively. The total costs of conventional fundus examination were $77.80. An additional conventional ophthalmologic retinal examination was required for 75 (12.3%) patients with clinically significant disease on telemedicine evaluation, which involves an averaged additional cost of $9.55 per patient for all the patients in the study. If the cost of subsequent examination was added, the total cost of telemedicine-based digital fundus imaging was $49.95 per patient in our group of 611 patients evaluated.

**CONCLUSIONS:** Our cost analysis indicates that telemedicine-based diabetic retinopathy screening cost less ($49.95 vs $77.80) than conventional retinal examination and the telemedicine-based digital retinal imaging examination has the potential to provide an alternative method with greater convenience and access for the remote and indigent populations. Diabetes mellitus and diabetic retinopathy are growing problems in the United States and worldwide. Large scale adoption of telemedicine should be encouraged as a means toward providing improved access, increasing compliance with annual evaluation, at a low cost for patients with diabetes with direct access to an eye care specialist.


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<td>Video Conference</td>
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<td>Health Care Providers (VA)</td>
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**Fortney, J., Maciejewski, M., Tripathi, S., Deen, T., & Pyne, J. (2011). A budget impact analysis of telemedicine-based collaborative care for depression. Medical Care, 49(9), 872-80.**

Background: Patients with depression use more health services than patients without depression. However, when depression symptoms respond to treatment, use of health services declines. Most depression quality improvement studies increase total cost in
the short run, which if unevenly distributed across stakeholders, could compromise buy-in and sustainability. The objective of this budget impact analysis was to examine patterns of utilization and cost associated with telemedicine-based collaborative care, an intervention that targets patients treated in small rural primary care clinics.

Methods: Patients with depression were recruited from VA Community-based Outpatient Clinics, and 395 patients were enrolled and randomized to telemedicine-based collaborative care or usual care. Dependent variables representing utilization and cost were collected from administrative data. Independent variables representing clinical casemix were collected from self-report at baseline.

Results: There were no significant group differences in the total number or cost of primary care encounters. However, as intended, patients in the intervention group had significantly greater depression-related primary care encounters (marginal effect = 0.34, P= 0.004) and cost (marginal effect = $61.4, P = 0.013) to adjust antidepressant therapy for nonresponders. There were no significant group differences in total mental health encounters or cost. However, as intended, the intervention group had significantly higher depression-related mental health costs (marginal effect = $107.55, P=0.03) due to referrals of treatment-resistant patients. Unexpectedly, patients in the intervention group had significantly greater specialty physical health encounters (marginal effect = 0.42, 0.001) and cost (marginal effect =$490.6, P=0.003), but not depression-related encounters or cost. Overall, intervention patients had a significantly greater total outpatient cost compared with usual care (marginal effect = $599.28, P=0.012).

Conclusions: Results suggest that telemedicine-based collaborative care does not increase total workload for primary care or mental health providers. Thus, there is no disincentive for mental health providers to offer telemedicine-based collaborative care or for primary care providers to refer patients to telemedicine-based collaborative care.

Access: [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5029100/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5029100/)

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<td>Observational Study</td>
<td>Healthcare System</td>
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Summary

PURPOSE: The purpose of this study is to estimate the costs and cost-effectiveness of a telemedicine intensive care unit (ICU) (tele-ICU) program.

MATERIALS AND METHODS: We used an observational study with ICU patients cared for during the pre–tele-ICU period and ICU patients cared for during the post–tele-ICU period in 6 ICUs at 5 hospitals that are part of a large nonprofit health care system in the Gulf Coast region. We obtained data on a sample of 4142 ICU patients: 2034 in the pre–tele-ICU period and 2108 in the post–tele-ICU period. Economic outcomes were hospital costs, ICU costs and floor costs, measured for average daily costs, costs per case, and costs per patient.

RESULTS: After the implementation of the tele-ICU, the hospital daily cost increased from $4302 to $5340 (24%); the hospital cost per case, from $21,967 to $31,318 (43%); and the cost per patient, from $20,231 to $25,846 (28%). Although the tele-ICU intervention was not cost-effective in patients with Simplified Acute Physiology Score II 50 or less, it was cost-effective in the sickest patients with Simplified Acute Physiology Score II more than 50 (17% of patients) because it decreased hospital mortality without increasing costs significantly.

CONCLUSIONS: Hospital administrators may conclude that a tele-ICU program aimed at the sickest patients is cost-effective.


Summary

The costs of pediatric telemedicine services remain underreported and understudied; however, there is evidence that telepediatric services can be cost competitive with traditional ones. For 15 years, the University of Kansas Center for Telemedicine and Telehealth has been providing telemental health outreach from the University of Kansas Medical Center (KUMC). One service site is located in Crawford County, Kansas, which provides telepsychiatry services to children and adolescents. The purpose of this study was to examine the costs of operating the Crawford County site relative to accessing services at KUMC, the likely alternative service location. The cost of travel time to parents who accompanied a dependent to either location also was estimated. Patients and parents were examined over a 6-month period in 2006. One hundred thirty-two patients received 257 telemedicine psychiatric consultations during this period. Cost estimates for using the pediatric telemedicine service were assessed for all patients; however, travel and related costs were collected from a sample of 26 patient-parent dyads. The estimated costs of services were obtained using standard cost-accounting procedures. An average cost per consultation in Crawford County was $168.61. The cost savings in travel time and other expenses to parents and patients were substantial between use of the county site and KUMC. Subtracting average savings in travel costs to patients and parents produced an average cost of a telepsychiatry consult in Crawford County of only $30.99. This study was conducted over 6 months with a small number of observations; it should be replicated over a longer study period, with more patients, and with more data that might capture marginal costs of services.


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We evaluated the impact of a 15-hospital, rural, multi-state intensive care unit (ICU) telemedicine program. Acute Physiology, Age, and Chronic Health Evaluation (APACHE III) scores, raw mortality rates, and actual-to-predicted length of stay (LOS) ratios and mortality ratios were used. Surveys evaluated program impact in smaller facilities and satisfaction of the physicians staffing the remote center. Smaller facilities' staff reported improvements in the quality of critical care services and reduced transfers. In regional hospitals, acuity scores increased (retention of sicker patients) while raw mortality was the same or lower. Length of stay ratios were reduced in these hospitals. In the tertiary hospital, actual-to-predicted ICU and hospital mortality and LOS ratios decreased.


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**OBJECTIVE:** A number of effective treatments for bulimia nervosa have been developed, but they are infrequently used, in part due to problems with dissemination. The goal of this study was to examine the cost effectiveness of telemedicine delivery of cognitive behavior therapy for bulimia nervosa.
behavioral therapy for bulimia nervosa.

**METHOD:** A randomized controlled trial of face-to-face versus telemedicine cognitive behavioral therapy for bulimia nervosa. One hundred twenty eight women with DSM-IV bulimia nervosa or eating disorder, not otherwise specified subsyndromal variants of bulimia nervosa were randomized to 20 sessions of treatment over 16 weeks. A cost effectiveness analysis from a societal perspective was conducted.

**RESULTS:** The total cost per recovered (abstinent) subject was $9324.68 for face-to-face CBT, and $7300.40 for telemedicine CBT. The cost differential was accounted for largely by therapist travel costs. Sensitivity analyses examining therapy session costs, gasoline costs and telemedicine connection costs yielded fundamentally similar results.

**DISCUSSION:** In this study, CBT delivered face-to-face and via telemedicine were similarly effective, and telemedicine delivery cost substantially less. These findings underscore the potential applicability of telemedicine approaches to eating disorder treatment and psychiatric treatment in general.


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**Summary**

**OBJECTIVE:** To evaluate the cost-effectiveness of a telephonic disease management (DM) intervention in heart failure (HF).
STUDY DESIGN: Randomized controlled trial of telephonic DM among 1069 community-dwelling patients with systolic HF (SHF) and diastolic HF performed between 1999 and 2003. The enrollment period was 18 months per subject.

METHODS: Bootstrap-resampled incremental cost effectiveness ratios (ICERs) were computed and compared across groups. Direct medical costs were obtained from a medical record review that collected records from 92% of patients; 66% of records requested were obtained.

RESULTS: Disease management produced statistically significant survival advantages among all patients (17.4 days, P = .04), among patients with New York Heart Association (NYHA) class III/IV symptoms (47.7 days, P = .02), and among patients with SHF (24.2 days, P = .01). Analyses of direct medical and intervention costs showed no cost savings associated with the intervention. For all patients and considering all-cause medical care, the ICER was $146,870 per quality-adjusted life-year (QALY) gained, while for patients with NYHA class III/IV symptoms and patients with SHF, the ICERs were $67,784 and $95,721 per QALY gained, respectively. Costs per QALY gained were $101,120 for all patients, $72,501 for patients with SHF, and $41,348 for patients with NYHA class III/IV symptoms.

CONCLUSIONS: The intervention was effective but costly to implement and did not reduce utilization. It may not be cost-effective in other broadly representative samples of patients. However, with program cost reductions and proper targeting, this program may produce life-span increases at costs that are less than $100,000 per QALY gained.

Access: http://europepmc.org/abstract/med/18269306