Cost-Effectiveness of Behavioral Activation for Depression in Older Adult Veterans:
In-Person Care Versus Telehealth

Leonard E. Egede, MD, MS[a,b,*]; Clara E. Dismuke, PhD[c]; Rebekah J. Walker, PhD[a,b]; Ron Acierno, PhD[c,d]; and B. Christopher Frueh, PhD[e,f]

ABSTRACT

Background: This study examined whether delivering behavioral activation for depression through telehealth is cost-effective compared to in-person care.

Methods: This was a randomized, noninferiority trial, with participants assigned to 1 of 2 arms of 8-week behavioral activation therapy: in-person or via telehealth. Primary clinical outcomes included measures of depression (Geriatric Depression Scale, Beck Depression Inventory, and Structured Clinical Interview for *DSM-IV*) at 12 months follow-up. Quality of life was assessed using the 36-Item Short Form Health Survey. Economic outcomes included the difference in health services utilization costs between 1 year post-intervention and 1 year pre-intervention, as quality-adjusted life-years (QALYs), and incremental cost-effectiveness ratios for differences in cost based on mean travel and median travel relative to the 3 primary outcomes and QALYs.

Results: 241 participants were enrolled and completed study procedures between April 2007 and July 2012. Post-intervention, veterans treated in-person had a mean of $2,998 higher VA health care utilization costs relative to their pre-intervention utilization costs, while veterans treated via telehealth had a mean of $870.91 higher costs post-intervention relative to pre-intervention. The difference between bootstrap mean and median QALYs was not significantly different from zero.

Conclusions: Although the intervention costs for telehealth were higher relative to in-person care, veterans receiving behavioral activation via telehealth had lower health utilization costs 1 year after the intervention than those receiving care in person while QALYs were approximately the same. These results demonstrate the noninferiority of telehealth in treating depression in veterans with respect to QALYs and a large and significant cost benefit of using telehealth in terms of health services utilization post-intervention.

Trial Registration: ClinicalTrials.gov identifier: NCT00324701

J Clin Psychiatry 2018;79(5):17m11888

To cite: Egede LE, Dismuke CE, Walker RJ, et al. Cost-effectiveness of behavioral activation for depression in older adult veterans: in-person care versus telehealth. *J Clin Psychiatry.* 2018;79(5):17m11888.

To share: https://doi.org/10.4088/JCP.17m11888

[a]Department of Medicine, Division of General Internal Medicine, Medical College of Wisconsin, Milwaukee, Wisconsin

[b]Center for Advancing Population Science, Medical College of Wisconsin, Milwaukee, Wisconsin

[c]Health Equity and Rural Outreach Innovation Center, Ralph H. Johnson Veterans Affairs Medical Center, Charleston, South Carolina

[d]College of Nursing, Medical University of South Carolina, Charleston, South Carolina

[e]Department of Psychology, University of Hawaii, Hilo, Hawaii

[f]Department of Psychology, The Menninger Clinic, Houston, Texas

**Corresponding author:* Leonard E. Egede, MD, MS, Department of Medicine, Division of General Internal Medicine, Medical College of Wisconsin, 9200 W. Wisconsin Ave, Milwaukee, WI 53226 (legede@mcw.edu).

Worldwide, depression is one of the leading causes of disability.[1] The burden of depression results from high prevalence, increased risk for additional disorders, and an increased risk of mortality.[2,3] However, undertreatment of depression is consistently noted, particularly in the context of primary care, where patients often initially present.[2,4] Monetary costs of depression have been estimated at $210.5 billion, 45% of which are direct costs, 50% of which are related to lowered productivity in the workplace, and 5% of which are due to suicide-related costs.[5] Despite being more prevalent in younger people, depression exerts a serious burden on the elderly, compounding the impacts of cognitive impairment, disability, and other medical illnesses and leading to suicide rates nearly twice those at younger ages.[6–9] As the population ages, effective and efficient methods for treating depression in the elderly are needed to address the burden of disease, particularly considering the significant shortage of mental health providers.[10,11]

Telehealth can offer an option for increasing access to mental health treatment, by allowing providers to see patients living in remote areas or unable to travel.[12] Advantages of telehealth also include the ability to overcome stigma associated with obtaining mental health care, and decreasing costs to the patient resulting from transportation or missed work.[12] In general, patients report similar levels of patient satisfaction for mental health care delivered via telehealth, and a growing base of evidence shows that clinical outcomes are similar for in-person or telehealth-based treatment in both posttraumatic stress disorder (PTSD) and depression.[13–22] For example, a recent randomized controlled trial of behavioral activation for depression found that treatment response for telehealth delivered care was noninferior to in-person care in terms of both at least 50% reduction in symptoms from baseline to 12 months and no longer having a diagnosis of major depressive disorder at 12 months.[13] In addition, there were no differences in patient satisfaction, treatment credibility, or quality of life between those receiving in-person care vs telehealth, and though

Clinical Points

- Older adults receiving behavioral activation via telehealth had lower health utilization costs 1 year after the intervention than those receiving care in person.
- Quality-adjusted life-years were similar for telehealth and in-person behavioral activation.
- Telehealth delivered behavioral activation is a cost-effective alternative compared to in-person delivery for older adults with depression.

overtime cost increased, trajectories of cost over time were not different between the two groups.[22,23]

Although telehealth delivered care has been shown to be effective, one of the limiting factors to implementing telehealth treatment for depression at a large scale is having both the clinical and cost-effectiveness evidence to support reimbursement for care.[24] Many studies complete a cost analysis, showing overall cost savings, but have not shown the cost-effectiveness of interventions.[25] For example, a telehealth intervention involving antidepressant medication management, psychoeducation, and brief supportive counseling was associated with significantly less use of overall health care during the study period.[26] A different telephone-based program involving care coordination plus telephone psychotherapy showed significant clinical benefit, with only a modest increase in cost over care coordination alone.[27] Also, a recent study of the cost and time savings of telehealth in the Veterans Affairs health care system showed that telehealth saves travel time and reduces travel payments made to veterans for health care.[28] In addition, methodological challenges of evaluating costs and conducting cost-effectiveness analyses limit the generalizability of some studies. This includes the comprehensiveness of costs taken into account; for example, whether only provider costs are considered or if travel costs and opportunity costs for patients to reach the provider are also accounted for in overall cost estimates. Additionally, the follow-up time for accounting costs also differs by study; for example, whether reduced medical costs post-intervention are considered part of cost savings.

Studies that have completed cost-effectiveness studies show conflicting results, suggesting that the type of depression treatment and situation-specific aspects of care may have an impact on cost-effectiveness.[29] A telephone supported program designed to encourage participants to use internet resources including a self-directed cognitive-behavioral therapy (CBT) course and an online forum with trained health advisors found a small incremental quality-adjusted life-year (QALY) gain after 12 months and determined that the intervention was not cost-effective in its current format.[30] Similarly, a stepped-care model for depression treatment using an off-site depression team was found to be effective, but expensive, with an incremental cost-effectiveness ratio (ICER) above the generally accepted $50,000 per QALY definition of cost-effectiveness.[31] Alternatively, when comparing telehealth versus in-person collaborative care, Pyne et al[32] found that the telehealth based program resulted in more depression-free days, but at a higher cost. As a result, the ICER for multiple methods of calculating QALYs was below the generally accepted $50,000 per QALY definition of cost-effectiveness.[32]

A recent randomized controlled trial found that treatment of depression through the simpler technique of behavioral activation was no less effective than CBT and was more cost-effective than CBT.[33] In this study, we investigate whether delivering behavioral activation for depression through telehealth is cost-effective compared to in-person care for elderly veterans. As the burden of depression for older adults continues to grow, results from this study will offer insight into whether health care systems can deliver behavioral activation via telehealth to address the need to increase access to evidence-based care for depression and lower the costs of the health care system while maintaining high-quality treatment.

METHODS

Study Setting, Participants, and Randomization

In this randomized, noninferiority trial, participants were recruited from a southeastern Veterans Affairs Medical Center (VAMC) and its surrounding community outpatient-based clinics and randomized to one of 2 arms of 8-week behavioral activation therapy delivered via in-person or via telehealth. Noninferiority designs investigate whether the experimental arm (in this case, telehealth delivered behavioral activation) is not unacceptably less efficacious than the control arm (in this case, in-person delivered behavioral activation). Study design and methods were published previously,[34] and all study procedures were approved by the local institutional review board and local Veterans Affairs Research and Development Committee. The study is registered at ClinicalTrials.gov (identifier: NCT00324701). A summary of study procedures and intervention overview is included below.

Veterans ages 58 years and older meeting diagnostic criteria for major depressive disorder as determined by a clinical assessment using the Structured Clinical Interview for *DSM-IV* (SCID)[35] were eligible for participation. Individuals who met criteria for substance dependence, had both suicidal ideation and clear intent, or had active psychosis or dementia were excluded from participation; however, other forms of psychopathology (for example, comorbid anxiety disorders or PTSD) were not used as exclusion criteria. Eligible participants were mailed a letter of invitation, and those who contacted study staff were provided a summary of the study and offered clinic-based services as an alternative to study participation. Participants were randomly assigned (1:1) to behavioral activation either in person or via telehealth. The randomization sequence used a permuted-block randomization, stratified by race, with a block size of 2–6. Medication stabilization was required prior to randomization, and patients were asked to maintain dosage of present medications at the discretion of their treatment provider and when medically possible. Any participant who indicated initiation of a new prescription within the prior 4 weeks waited 4 weeks after the initial assessment before randomization to ensure stabilization. Study staff completing baseline and 12-month psychiatric interviews and those assessing outcomes were masked to assignment.

Intervention

Once informed consent and randomization were completed, participants received the same individualized behavioral activation for depression for 8 weeks based on previously published manuals.[36,37] Participants were screened and gave written consent between April 2007 and July 2011, with study procedures and follow-up continuing through July 2012. No modification was made for the telehealth group, and sessions were 60 minutes per week. Behavioral activation involves the use of daily planners and valued activity lists to schedule both positively and negatively reinforcing behaviors. Theoretically, behavioral activation increases the likelihood of successful completion of activities, which impact mood and decrease depressive symptoms.[36,37]

Those randomized to telehealth delivered treatment received the intervention via a videophone. Videophones were analog based and operated using standard telephone services. The video screen was a 4-inch LCD color screen, and the phone included a built-in camera, duplex speakerphone, and oversized touchtone buttons.

Master's-level counselors with at least 5 years of clinical experience delivered the intervention, overseen by a clinical psychologist. Training occurred prior to initiation of the study, and counselors participated in weekly supervision meetings. Twenty percent of sessions were analyzed for fidelity with the treatment manual. On-site mental health professionals and primary-care physicians were not involved in providing care specific to the intervention procedures. Participants were permitted to see mental health professionals or primary care physicians outside the scope of this study if they desired.

Measurement of Outcomes

The primary clinical outcome of interest assessed measures of depression (Geriatric Depression Scale [GDS], Beck Depression Inventory [BDI], and SCID) at 12 months follow-up. The GDS and BDI are both self-administered: GDS is a 30-item measure with a validated cutoff score for depression of 11,[38] and the BDI is a 21-item measure with scores of 19–29 indicating moderate depression and 30–63 indicating severe depression.[39,40] The SCID was used to assess major depressive disorder and other psychopathologies based on the *DSM-IV*.[41] Those assessing participants were master's-level counselors trained to 90% agreement on rating scores.

Quality of life was assessed using the 36-Item Short Form Health Survey (SF-36). The SF-36 is a 36-item scale using both dichotomous (yes/no) and 6-point Likert scale responses.[42–44] The scale measures health status and functioning over the previous 4 weeks and can be compiled into 8 dimensions or kept as 1 overall score. Final scores range from 0 to 100, with the highest level of functioning represented by 100.[42–44] The SF-36 has been shown to be sensitive to changes in health status and can distinguish between groups.[42–44]

Measurement of Cost

The economic outcomes included the difference in VA health services utilization costs between 1 year post-intervention and 1 year pre-intervention, as well as QALYs. VA health services utilization costs included any costs incurred by the VA, including inpatient, outpatient, and pharmacy costs. These costs included any mental health or primary care visits conducted outside the confines of the intervention. Cost-effectiveness of the intervention was estimated using the methodology proposed by the Second Panel on Cost-Effectiveness in Health and Medicine.[45] All cost values were adjusted for inflation using the US Department of Labor inflation calculator.[46]

Device costs for the telehealth arm at the time of the study ranged between $800 and $900, and thus low, moderate, and high estimates ($800, $850, and $900, respectively) were used in the calculation of cost differentials. However, it is important to note that the cost of these analog videophones have dropped dramatically and currently retail at $100–$300. As the in-person treatment arm required no home video-teleconferencing technology, their device costs were fixed at $0. Individuals traveling for in-person therapy received $0.415 per mile each way, based on mileage from home address to the VAMC, which was calculated as real-time driving distance via Google Maps technology in order to more accurately reflect true travel burden and reimbursement.[47] We multiplied travel distance by 2 to obtain the round-trip travel distance, multiplied the round-trip travel distance by $0.415 to obtain the round-trip reimbursement estimate, and then lastly multiplied this by the 8 weekly visits to obtain an overall travel reimbursement estimate per veteran across the study. For individuals receiving telehealth, the overall travel reimbursement estimate was fixed at $0.

Individuals randomized to receive therapy in-person who were employed at the time could reasonably have endured lost wages due to travel. For individuals who indicated current employment, we estimated this loss in wages by multiplying the total travel time across the study by the mean wage rate for Charleston, South Carolina.[48] Individuals who received therapy via telehealth were assumed to have $0 in lost wages due to travel.

Statistical Analyses

Total VA health services utilization costs procedures between 1 year pre-intervention through 1 year post-intervention were obtained for all participants. The difference in costs per veteran (post-intervention – pre-intervention) was calculated as the change from the year immediately preceding behavioral activation therapy through participation in the trial and the year immediately

Table 1. Demographic and Baseline Characteristics of the Study Sample[a]

Characteristic	Total (N = 241)	Telemedicine (n = 120)	In Person (n = 121)	*P* Value
Age, mean (SD), y	63.9 (5.1)	63.5 (4.4)	64.2 (5.6)	.28
Male sex	235 (98)	116 (97)	119 (98)	.40
Race				.47
White	143 (60)	68 (58)	75 (63)	
Black	94 (40)	49 (42)	45 (38)	
Married	165 (69)	83 (70)	82 (68)	.82
Education, mean (SD), y	13.7 (2.6)	13.5 (2.3)	13.8 (2.9)	.37
Insurance coverage				.49
Private	67 (28)	32 (27)	35 (29)	
Medicaid or Medicare	72 (30)	41 (34)	31 (26)	
Private and Medicaid or Medicare	22 (9)	9 (8)	13 (11)	
VA only	80 (33)	38 (32)	42 (35)	
Employed	50 (21)	23 (20)	27 (23)	.55
Working hours per week (if employed)	30.3 (14.8)	29.3 (16.1)	31.0 (14.1)	.38
Income, US $				.70
< $15,000	49 (21)	25 (21)	24 (20)	
$15,000–$24,999	56 (24)	24 (20)	32 (27)	
$25,000–$49,999	93 (39)	49 (42)	44 (37)	
≥ $50,000	40 (17)	20 (17)	20 (17)	
Health status				.03
Better than last year	39 (16)	20 (17)	19 (16)	
About the same	104 (44)	61 (51)	43 (36)	
Worse than last year	96 (40)	38 (32)	58 (48)	
Smoker				.94
Present	49 (21)	25 (21)	24 (20)	
Former	132 (56)	65 (55)	67 (57)	
Never	56 (24)	29 (24)	27 (23)	
Days with at least 20 min moderate or vigorous activities per week, mean (SD)	1.2 (1.2)	1.1 (1.1)	1.3 (1.2)	.18
Service-connected disability rating, mean (SD), %	45.1 (40.4)	47.8 (39.7)	42.5 (41.1)	.31
Years being a VA patient, mean (SD)	16.2 (12.2)	16.1 (12.0)	16.3 (12.4)	.90
In Vietnam War	209 (87)	107 (89)	102 (84)	.27
Disabled	167 (70)	82 (69)	85 (70)	.75
Charlson comorbidity score, mean (SD)	4.2 (3.4)	4.3 (3.6)	4.2 (3.3)	.82
Mental status questionnaire score				.65
0 error, normal mental function	162 (67)	80 (67)	82 (68)	
1 error	64 (27)	34 (28)	30 (25)	
≥ 2 errors	15 (6)	6 (5)	9 (7)	
Baseline depression severity, mean (SD)				
GDS	20.8 (4.8)	20.9 (4.8)	20.6 (4.8)	.63
BDI	26.8 (10.0)	26.7 (9.8)	26.8 (10.3)	.94
Psychiatric comorbidity				
Lifetime prevalence				
Generalized anxiety disorder	99 (42)	50 (42)	49 (42)	.85
Panic disorder	19 (8)	9 (8)	10 (9)	.83
Alcohol misuse	59 (25)	30 (25)	29 (24)	.85
Alcohol dependence	29 (12)	13 (11)	16 (13)	.57
Cannabis misuse	18 (8)	6 (5)	12 (10)	.15
Cannabis dependence	6 (3)	4 (3)	2 (2)	.40
PTSD	147 (63)	75 (65)	72 (62)	.63
Symptomatic diagnosis of panic disorder in the past month	12 (17)	6 (17)	6 (18)	.99
Symptomatic diagnosis of PTSD in the past month	143 (79)	76 (83)	67 (76)	.21
GAF scale				.94
≤ 50	4 (2)	2 (2)	2 (2)	
51–60	103 (50)	51 (48)	52 (52)	
61–75	98 (48)	51 (49)	47 (47)	

[a]Data presented as n (%) unless otherwise noted. The n is the absolute number of patients in the category, and the percentage reflects that number among the total number of patients with information for that category.
Abbreviations: BDI = Beck Depression Inventory, GAF = Global Assessment of Functioning, GDS = Geriatric Depression Scale, PTSD = posttraumatic stress disorder, VA = Veterans Affairs.

following. Both the mean cost difference and median cost difference are reported due to the sensitivity of the mean to extreme cost values.

To assess QALYs, life expectancy was obtained from National Vital Statistics Report tables according to race/ethnicity and sex. Weights derived from EQ-5D responses at baseline and at 12 months were applied to the expected life years to calculate the QALYs.[49] The difference in QALYs (post − pre) was calculated for each individual.

Finally, we estimated ICERs, which summarize the cost-effectiveness of a health care intervention. An ICER is calculated as the difference in cost between the intervention and the control group divided by the difference in outcomes between the intervention and the control group. One limitation of the ICER is when there is a zero difference between the intervention and the control group in the outcome, the ICER statistically approaches infinity. ICERs were calculated for differences in cost based on mean travel and median travel relative to the 3 primary outcomes and QALYs, following the methodology used in a prior telehealth intervention study.[31] As typical standard error estimation methods do not apply to cost-effectiveness ratios due to the possibility of having a zero or near-zero denominator, and cost and effectiveness estimates are rarely independent, we assumed nonparametric distribution of errors. Therefore, we used a nonparametric bootstrap with replacement and 1,000 replications to generate an empirical distribution of incremental costs and QALYs, from which the mean, median, 10% percentile, and 90% percentile for estimates of cost, QALY, and ICER ratios were determined. Generalized linear models are a flexible general analytic framework for inferential analyses that accommodates a wide range of distributional assumptions. As medical cost data are generally positively skewed, generalized linear models using gamma, normal, and identity links were specified to create an incremental effect in the entire sample without generating biased estimates that would result if assuming normality.[31]

RESULTS

Table 1 shows the demographics and baseline characteristics of the sample of adults participating in the study. Mean age was 63.9 years, with most participants being male. Sixty percent of participants were non-Hispanic white, and 40% were non-Hispanic black. Twenty-one percent of participants were employed, and the mean number of years of education was 13.1 years, indicating a high school diploma.

The differences in cost of the behavioral intervention between the telehealth and in-person delivery are presented in Table 2. The cost of the device used in the telehealth arm ranged from $800 to $900 per veteran, with a zero cost for the in-person arm. The mean travel reimbursement for the in-person arm was $258.56 per veteran, while the mean wage loss associated with travel was $179.36 per veteran, with a zero cost for the telehealth arm. The cost differential between the in-person and telehealth arms was thus a low of $362.08, a moderate of $412.08, and a high of $462.08 per veteran, in 2016 US dollar value.

Table 3 shows the treatment effect for the 3 depression outcomes, and Table 4 shows the post-pre difference in VA health care utilization costs between telehealth and in-person arms of the study. Post-intervention, veterans treated in person had a mean of $2,998 higher VA health care utilization costs relative to their pre-intervention VA health utilization costs, while veterans treated via telehealth had a mean of $870.91 higher post-intervention VA health care utilization costs relative to their pre-intervention VA health care utilization costs. As expected, the health care utilization costs were skewed such that a greater number of smaller costs existed than larger costs and the mean was larger than the median. The spread between the median was narrower between the 2 delivery modes, with a higher median cost of $1,359.49 for in-person care and $687.91 for telehealth.

Table 5 shows the change in QALYs from baseline to 12 months post-intervention for the 2 delivery modes. The mean ending QALYs were slightly higher for in-person care at 8.74, with telehealth having 8.42 QALYs at 12 months post-intervention. This represented an increase of 0.31 QALYs for in-person care and 0.13 QALYs for telehealth from baseline.

Table 6 shows the bootstrap mean and median costs, QALYs, and ICERs for incremental cost of telehealth relative to face-to-face care by mean and median travel distance and outcome. The bootstrap incremental cost of telehealth relative to in-person care is always positive while the bootstrap incremental QALY is not significantly different from zero. The bootstrap ICER ranges from positive to negative with a mean of $5,982.34 and a median of −$787.85.

Table 2. Cost Differentials Between Telemedicine and In-Person Care per Veteran

	Telemedicine	In Person
Device cost, US $		
Low estimate	800	0
Moderate estimate	850	0
High estimate	900	0
Travel reimbursement		
Per mile, US $	0	0.415
Mean travel distance, miles	0	38.94
Median travel distance, miles	0	23.25
Mean reimbursement over 8 weeks, US $	0	258.56
Mean lost wages for patient due to travel, US $[a]	0	179.36
Cost per veteran, US $	800–900	437.92

[a]Mean lost wages for patient due to travel is estimated among those patients who have indicated they are currently working; the mean income for Charleston, South Carolina ($19.51) was used in this calculation.

Table 3. Treatment Response at 12 Months of the Primary Outcomes

	Telemedicine, n (% [90% CI])	In Person, n (% [90% CI])	Difference, % (90% CI)
Intention to treat			
BDI	27 (22.54 [15.40 to 29.69])	26 (21.49 [14.72 to 28.25])	1.05% (−8.30 to 10.41)
GDS	25 (20.96 [14.45 to 27.47])	23 (19.30 [13.29 to 25.31])	1.66% (−7.20 to 10.52)
SCID	53 (44.17 [35.78 to 52.55])	58 (47.85 [39.63 to 56.07])	−3.68% (−15.53 to 8.16)
Per protocol			
BDI	19 (24.05 [16.14 to 31.96])	19 (23.17 [15.51 to 30.83])	0.88% (−10.13 to 11.89)
GDS	22 (22.45 [15.52 to 29.38])	21 (20.39 [13.86 to 26.92])	2.06% (−7.46 to 11.58)
SCID	39 (43.34 [37.74 to 51.93])	46 (48.42 [39.99 to 56.85])	−5.09% (−17.13 to 6.95)

Abbreviations: BDI = Beck Depression Inventory, GDS = Geriatric Depression Scale, SCID = Structured Clinical Interview for *DSM-IV*.

Post-intervention, veterans treated in person had a mean of $2,998 higher VA health care utilization costs relative to their pre-intervention utilization costs, while veterans treated via telehealth had a mean of $870.91 higher post-intervention costs relative to pre-intervention. The difference between bootstrap mean and median QALYs was not significantly different from zero, while bootstrap mean and median estimates for the ICERS ranged from positive to negative.

DISCUSSION

This analysis of a randomized, noninferiority trial found that behavioral activation for depression is a cost-effective alternative to in-person treatment and may result in lower overall health utilization costs for patients. As behavioral activation can be delivered by master's-level trained counselors under the supervision of a clinical psychologist, and telehealth offers a method to reach populations with less access to the health care system, this study offers further information on treatment alternatives for depression. Given the shortage of mental health providers in the United States, particularly in rural areas, the growing need for treatment of mental health conditions, and the increasing cost of health care, this study provides evidence for a clinically and economically effective method to treat depression.

Table 4. Difference in VA Health Care Utilization Costs Between Telemedicine and In Person[a]

	Overall (n = 238)	Telemedicine (n = 117)	In Person (n = 121)
Mean cost difference, US $	1,952.37	870.91	2,998.08
Median cost difference, US $	1,002.66	687.91	1,359.49

[a]The difference was calculated from the year prior to treatment and the year immediately following (post-intervention – pre-intervention).

Table 5. Quality-Adjusted Life-Years (QALYs)[a]

	Telemedicine, Mean (95% CI)	In Person, Mean (95% CI)
QALYs at 12 months	8.42 (7.68 to 9.16)	8.74 (7.93 to 9.56)
Change in QALYs from study start	0.13 (−0.39 to 0.65)	0.31 (−0.34 to 0.95)

[a]QALYs were calculated based on life expectancy tables stratified by sex and race/ethnicity.

To our knowledge, this is the first cost-effectiveness analysis of behavioral activation for depression delivered via telehealth versus in person. A recent randomized, controlled, noninferiority trial of behavioral activation versus CBT for patients with depression found that behavioral activation was no less effective in terms of reducing depressive symptoms and is more cost-effective than CBT.[33] Richards et al[33] reported the economic analysis was largely differentiated by lower costs associated with delivery of behavioral activation. Both this study and the trial conducted by Richards et al ensured medication stabilization prior to study procedures, suggesting that results were driven by the psychological therapy and not antidepressant medications.[13,33] The results of this study, combined with that of Richards et al and the extensive literature citing the efficacy of behavioral activation,[50–53] challenge the focus on in-person CBT as the main front-line treatment for depression.[13,33] This study shows that delivery of behavioral activation via telehealth with no modifications from in-person treatment can be a clinically and economically effective alternative to current depression treatment options.

Additionally, this analysis found that health services costs 1 year after intervention were significantly lower for participants randomized to telehealth compared to those receiving care in person. Studies of collaborative care interventions for depression found increased expenditures, and a study of telephone based psychotherapy found higher outpatient costs for participants in the intervention arm.[27,31,54] A societal perspective budget impact analysis of collaborative care for depression found that telehealth collaborative care increased patient costs due to non–depression-related specialty care visits.[54] It is possible that

Table 6. Incremental Cost and Incremental Cost-Effectiveness Ratios (ICERs) at 12 Months[a]

	Incremental Cost of Telemedicine Relative to In Person (Mean Travel Distance)	Incremental Cost of Telemedicine Relative to In Person (Median Travel Distance)	Incremental Change in Outcome Score[b] of Telemedicine Relative to In Person	ICER (Mean)	ICER (Median)
QALYs	362–462	466–566	−0.18	−2,011 to −2,566	−2,588 to −3,144
Intention to treat					
BDI	362–462	466–566	1	362 to 462	466 to 566
GDS	362–462	466–566	2	181 to 231	233 to 283
SCID	362–462	466–566	−5	−72 to −92	−93 to 113
Per protocol					
BDI	362–462	466–566	0	∞	∞
GDS	362–462	466–566	1	362 to 462	466 to 566
SCID	362–462	466–566	−7	−52 to −66	−67 to −81
Bootstrap cost	575.58	573.70			
Bootstrap QALYs	−0.213	−0.214			
Bootstrap ratio				5,892.34[c]	−787.85

[a]As the cost estimate for telemedicine is always positive, negative ratios indicate that the QALYs are lower for the telemedicine group, while positive ratios indicate that the QALYs are higher for the telemedicine group. Based on the bootstrap distribution, which spans from negative to positive, we do not have significant evidence of other than a zero difference between the QALYs for each group.
[b]Change in score for each outcome was considered separately.
[c]Mean may be driven upward by some very small QALY estimates in the denominator.
Abbreviations: BDI = Beck Depression Inventory, GDS = Geriatric Depression Scale, QALY = quality-adjusted life-year, SCID = Structured Clinical Interview for *DSM-IV*.

behavioral activation, based on implementing reinforcing behaviors to improve how patients feel, may change how patients interact with the health care system in the future. Those engaged in treatment through telehealth may have incorporated behaviors differently or in more domains of their life given the ability to receive care in their home. More research is needed to understand the possible benefits, beyond decreased cost, of delivering care via telehealth.

Though strengthened by the randomized controlled design and the ability to compare 2 modalities of the same psychological treatment, this study has limitations. First, participants with substance dependence, suicidal concerns, and active psychosis were excluded from inclusion. Second, the population may be sicker and have more comorbidities than the general population. Third, given the speed with which technology has changed, the device used in this study is obsolete for clinical care. However, treatment can easily be delivered through newer technologies with the same protocol, and the newer devices are likely to be cheaper and have better video quality.

In conclusion, given the need for evidence to support reimbursement of telehealth delivered services, and the burden of depression particularly in older adults, this study offers important justification for increasing access to evidence-based depression treatment through new technologies. This study found that veterans receiving behavioral activation via telehealth had lower health utilization costs 1 year after the intervention than those receiving care in person. QALYs were similar for the 2 arms, and ICERs indicate that behavioral activation via telehealth is a cost-effective option for treating older adults with depression.

Submitted: August 25, 2017; accepted January 17, 2018.

Published online: August 28, 2018.

Author contributions: Study concept and design: Drs Egede, Dismuke, and Frueh. Acquisition of data: Drs Egede and Acierno. Analysis and interpretation of data: Drs Egede, Dismuke, and Walker. Drafting of the manuscript: Drs Walker and Dismuke. Critical revision of the manuscript for important intellectual content: all authors. Study supervision: Dr Egede.

Potential conflicts of interest: Authors have no financial disclosure or conflict of interest to report.

Funding/support: This study was supported by grant #IIR 04-421 funded by the Veterans Affairs (VA) Health Services Research and Development program.

Role of the sponsor: The funding agency did not participate in the design and conduct of the study, collection, management, analysis and interpretation of the data; and preparation, review, or approval of the manuscript.

Disclaimer: The manuscript represents the views of the authors and not those of the VA or Health Services Research and Development.

Acknowledgments: The authors deeply appreciate the veterans and Veterans Affairs primary care and mental health providers who contributed to this research effort.

REFERENCES

1. GBD 2015 DALYs and HALE Collaborators. Global, regional, and national disability-adjusted life-years (DALYs) for 315 diseases and injuries and healthy life expectancy (HALE), 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*. 2016;388(10053):1603–1658.
2. Kessler RC. The costs of depression. *Psychiatr Clin North Am*. 2012;35(1):1–14.
3. Kessler RC, Bromet EJ. The epidemiology of depression across cultures. *Annu Rev Public Health*. 2013;34(1):119–138.
4. Egede LE. Failure to recognize depression in primary care: issues and challenges. *J Gen Intern Med*. 2007;22(5):701–703.
5. Greenberg PE, Fournier AA, Sisitsky T, et al. The economic burden of adults with major depressive disorder in the United States (2005 and 2010). *J Clin Psychiatry*. 2015;76(2):155–162.
6. Blazer D, Hughes DC, George LK. The epidemiology of depression in an elderly community population. *Gerontologist*. 1987;27(3):281–287.
7. Alexopoulos GS. Depression in the elderly. *Lancet*. 2005;365(9475):1961–1970.
8. Fiske A, Wetherell JL, Gatz M. Depression in older adults. *Annu Rev Clin Psychol*. 2009;5(1):363–389.
9. Bottino CM, Barcelos-Ferreira R, Ribeiz SR. Treatment of depression in older adults. *Curr Psychiatry Rep*. 2012;14(4):289–297.
10. Hanrahan NP, Sullivan-Marx EM. Practice patterns and potential solutions to the shortage of providers of older adult mental health services. *Policy Polit Nurs Pract*. 2005;6(3):236–245.
11. Bureau of Health Workforce. US Department of Health and Human Services, Designated Health Professional Shortage Areas Statistics: Designated HPSA Quarterly Summary. Health Resources and Services Administration (HRSA) website. https://ersrs.hrsa.gov/ReportServer?/HGDW_Reports/BCD_HPSA/BCD_HPSA_SCR50_Qtr_Smry_HTML&rc:Toolbar=false Accessed June 15, 2017.
12. Gros DF, Morland LA, Greene CJ, et al. Delivery of evidence-based psychotherapy via video telehealth. *J Psychopathol Behav Assess*. 2013;35(4):506–521.
13. Egede LE, Acierno R, Knapp RG, et al. Psychotherapy for depression in older veterans via telemedicine: a randomised, open-label, non-inferiority trial. *Lancet Psychiatry*. 2015;2(8):693–701.
14. Fortney JC, Pyne JM, Mouden SB, et al. Practice-based versus telemedicine-based collaborative care for depression in rural federally qualified health centers: a pragmatic randomized comparative effectiveness trial. *Am J Psychiatry*. 2013;170(4):414–425.
15. Frueh BC, Monnier J, Yim E, et al. A randomized trial of telepsychiatry for post-traumatic stress disorder. *J Telemed Telecare*. 2007;13(3):142–147.
16. Richardson LK, Frueh BC, Grubaugh AL, et al. Current directions in videoconferencing tele-mental health research. *Clin Psychol (New York)*. 2009;16(3):323–338.
17. Hilty DM, Ferrer DC, Parish MB, et al. The effectiveness of telemental health: a 2013 review. *Telemed J E Health*. 2013;19(6):444–454.
18. García-Lizana F, Muñoz-Mayorga I. Telemedicine for depression: a systematic review. *Perspect Psychiatr Care*. 2010;46(2):119–126.
19. Jenkins-Guarnieri MA, Pruitt LD, Luxton DD, et al. Patient perceptions of telemental health: systematic review of direct comparisons to in-person psychotherapeutic treatments. *Telemed J E Health*. 2015;21(8):652–660.
20. Deen TL, Fortney JC, Schroeder G. Patient acceptance of and initiation and engagement in telepsychotherapy in primary care. *Psychiatr Serv*. 2013;64(4):380–384.
21. Greene CJ, Morland LA, Macdonald A, et al. How does tele-mental health affect group therapy process? secondary analysis of a noninferiority trial. *J Consult Clin Psychol*. 2010;78(5):746–750.
22. Egede LE, Acierno R, Knapp RG, et al. Psychotherapy for depression in older veterans via telemedicine: effect on quality of life, satisfaction, treatment credibility, and service delivery perception. *J Clin Psychiatry*. 2016;77(12):1704–1711.
23. Egede LE, Gebregziabher M, Walker RJ, et al. Trajectory of cost overtime after psychotherapy for depression in older veterans via telemedicine. *J Affect Disord*. 2017;207:157–162.
24. Chakrabarti S. Usefulness of telepsychiatry: a critical evaluation of videoconferencing-based approaches. *World J Psychiatry*. 2015;5(3):286–304.
25. Whitten PS, Mair FS, Haycox A, et al. Systematic review of cost effectiveness studies of telemedicine interventions. *BMJ*. 2002;324(7351):1434–1437.
26. Ruskin PE, Silver-Aylaian M, Kling MA, et al. Treatment outcomes in depression: comparison of remote treatment through telepsychiatry to in-person treatment. *Am J Psychiatry*. 2004;161(8):1471–1476.
27. Simon GE, Ludman EJ, Rutter CM. Incremental benefit and cost of telephone care management and telephone psychotherapy for depression in primary care. *Arch Gen Psychiatry*. 2009;66(10):1081–1089.
28. Russo JE, McCool RR, Davies L. VA telemedicine: an analysis of cost and time savings. *Telemed J E Health*. 2016;22(3):209–215.
29. Bergmo TS. Can economic evaluation in telemedicine be trusted? a systematic review of the literature. *Cost Eff Resour Alloc*. 2009;7(1):18.
30. Dixon P, Hollinghurst S, Edwards L, et al. Cost-effectiveness of telehealth for patients with depression: evidence from the Healthlines randomised controlled trial. *BJPsych Open*. 2016;2(4):262–269.
31. Pyne JM, Fortney JC, Tripathi SP, et al. Cost-effectiveness analysis of a rural telemedicine collaborative care intervention for depression. *Arch Gen Psychiatry*. 2010;67(8):812–821.
32. Pyne JM, Fortney JC, Mouden S, et al. Cost-effectiveness of on-site versus off-site

collaborative care for depression in rural FQHCs. *Psychiatr Serv*. 2015;66(5):491–499.
33. Richards DA, Ekers D, McMillan D, et al. Cost and outcome of behavioral activation versus cognitive behavioral therapy for depression (COBRA): a randomized, controlled, non-inferiority trial. *Lancet*. 2016;388(10047):871–880.
34. Egede LE, Frueh CB, Richardson LK, et al. Rationale and design: telepsychology service delivery for depressed elderly veterans. *Trials*. 2009;10(1):22.
35. American Psychiatric Association. *Diagnostic and Statistical Manual for Mental Disorders*. Fourth Edition, Text Revision. Washington, DC: American Psychiatric Association; 2000.
36. Lejuez CW, Hopko DR, Hopko SD. A brief behavioral activation treatment for depression: treatment manual. *Behav Modif*. 2001;25(2):255–286.
37. Lejuez CW, Hopko DR, Acierno R, et al. Ten year revision of the brief behavioral activation treatment for depression: revised treatment manual. *Behav Modif*. 2011;35(2):111–161.
38. Yesavage JA, Brink TL, Rose TL, et al. Development and validation of a geriatric depression screening scale: a preliminary report. *J Psychiatr Res*. 1982-1983;17(1):37–49.
39. Beck AT, Steer RA. *Beck Depression Inventory manual*. San Antonio: Psychological Corporation; 1987.
40. Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. *J Am Geriatr Soc*. 1975;23(10):433–441.
41. Spitzer M, Williams RL, Gibbon M. *Structured Clinical Interview for DSM-IV (SCID)*. Washington, DC: American Psychiatric Association; 1995.
42. Ware JE, Snow KK, Kosinski M, et al. *SF-36 Health Survey Manual and Interpretation Guide*. Boston, MA: The Health Institute; 1993.
43. Brazier JE, Harper R, Jones NM, et al. Validating the SF-36 health survey questionnaire: new outcome measure for primary care. *BMJ*. 1992;305(6846):160–164.
44. Lyons RA, Perry HM, Littlepage BN. Evidence for the validity of the Short-form 36 Questionnaire (SF-36) in an elderly population. *Age Ageing*. 1994;23(3):182–184.
45. Sanders GD, Neumann PJ, Basu A, et al. Recommendations for conduct, methodological practices, and reporting of cost-effectiveness analyses: second panel on cost-effectiveness in health and medicine. *JAMA*. 2016;316(10):1093–1103.
46. US Department of Labor inflation calculator. US Inflation Calculator website. http://www.usinflationcalculator.com/ Accessed: June 15, 2017.
47. Veterans Affairs Beneficiary Travel. VA.gov website. https://www.va.gov/healthbenefits/resources/benetravelfaq.pdf Accessed June 15, 2017
48. Occupational Employment Estimates. Bureau of Labor Statistics website. https://www.bls.gov/oes/current/oes_16700.htm Accessed June 15, 2017.
49. EuroQual-5D. EQ-5D website. https://euroqol.org Accessed June 15, 2017.
50. Cuijpers P, van Straten A, Warmerdam L. Behavioral activation treatments of depression: a meta-analysis. *Clin Psychol Rev*. 2007;27(3):318–326.
51. Ekers D, Richards D, Gilbody S. A meta-analysis of randomized trials of behavioural treatment of depression. *Psychol Med*. 2008;38(5):611–623.
52. Mazzucchelli T, Kane R, Rees C. Behavioral activation treatments for depression in adults: a meta-analysis and review. *Clin Psychol Sci Pract*. 2009;16(4):383–411.
53. Sturmey P. Behavioral activation is an evidence-based treatment for depression. *Behav Modif*. 2009;33(6):818–829.
54. Fortney JC, Maciejewski ML, Tripathi SP, et al. A budget impact analysis of telemedicine-based collaborative care for depression. *Med Care*. 2011;49(9):872–880.

Editor's Note: We encourage authors to submit papers for consideration as a part of our Focus on Geriatric Psychiatry section. Please contact Jordan F. Karp, MD, at jkarp@psychiatrist.com, or Gary W. Small, MD, at gsmall@psychiatrist.com.