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Telemedicine: A Cost Analysis of Delivering Pronlonged Exposure Therapy to Combat Veterans With PTSD

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TELEMEDICINE: A COST ANALYSIS OF DELIVERING PRONLONGED EXPOSURE THERAPY TO COMBAT VETERANS WITH PTSD

BY

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A doctoral project submitted to the faculty of the Medical University of South Carolina in partial fulfillment of the requirements for the degree Doctor of Health Administration in the College of Health Professions

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Chair, Project Committee	Jillian Harvey, MPH, PhD	Date
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ABSTRACT

Abstract of Doctoral Project Presented to the
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TELEMEDICINE: A COST ANALYSIS OF DELIVERING PRONLONGED EXPOSURE THERAPY TO COMBAT VETERANS WITH PTSD

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Chairperson: Jillian Harvey, PhD
Committee: Ron Acierno, PhD, Libby Dismuke, PhD

Many veterans who need mental health treatment for posttraumatic stress disorder (PTSD) encounter significant barriers to care. Home-based telehealth is one of the solutions proposed to increase veterans access to care. This study examined the direct and indirect costs associated with delivering Prolonged Exposure (PE) for PTSD through home-based telehealth compared to standard in-person PE. Economic outcomes included comparing the total cost of both treatment modalities, and looking at the difference in health services utilization costs between 1-year post-intervention and 1-year pre-intervention. The home-based telehealth condition had a mean of $3,625.70 cost savings in total health care utilization costs from pre-post intervention per participant compared to participants receiving treatment in person. There was no significant difference in the cost of the intervention between home-based telehealth and in person care. While the intervention costs were stable among the two treatment modalities, veterans receiving PE over home-based telehealth had lower total health care utilization costs 1 year after the

intervention compared to the in-person condition. These results indicate that home-based telehealth is a cost saving method of delivering PE relative to in person delivery.

CHAPTER I

INTRODUCTION

Background and Need

Telemedicine, also known as telehealth, and when applied to treat psychopathology, telemental health, is the delivery of health care services at a distance using communication and information technology (Institute of Medicine, 2012). The use of telemedicine to disseminate specialized healthcare services has grown to meet the needs of the public. Home-based telemental health has been presented as a possible solution to providing specialized mental health treatments to those in geographically remote areas while eliminating stigma and reducing cost (Acierno, et al., 2017). Up to this point there has been little evidence regarding the costs of home-based telemental health compared to in person treatment.

Telemedicine is not a single technology or a set of related technologies; rather, telemedicine is a large and diverse collection of clinical practices, technologies, and organizational arrangements (Institute of Medicine, 2012). Telehealth enables remote interactions and information exchange among providers, and between patients and providers to support (Grube, Kaufman, Clarin, & O'Riordan, 2016):

- patient and clinician education,
- diagnosis and treatment,
- chronic disease management and monitoring,
- and consultation

The use of telemedicine to disseminate healthcare services has grown exponentially (Institute of Medicine, 2012). Core reasons to support the use of telemedicine include decreasing the cost of health care service delivery and reducing barriers to care (Wade, Karnon, Elshaug, & Hiller, 2010). In addition, telemedicine eliminates barriers to care for patients in geographically remote areas and those with physical disabilities who would find it difficult to travel to receive treatment (Morland et al., 2013). Telehealth also makes more efficient use of limited specialty healthcare workforce personnel who provide services such as evidence-based treatments for depression, anxiety, and posttraumatic stress disorder (PTSD; Osenbach, O'Brien, Mishkind, & Smolenski, 2013; Rees & Maclaine, 2015; Sloan, Gallagher, Feinstein, Lee, & Pruneau, 2011). Promising results from prior noninferiority trials indicate that telemedicine will play a vital role in meeting future healthcare needs and improving the quality of care patients receive (Acierno et al., 2016; Acierno, et al., 2017).

From a patient care perspective, there is convincing evidence of symptom reduction in patients who received treatment for PTSD, anxiety, and depression via telehealth (Osenbach et al., 2013; Rees & Maclaine, 2015; Sloan et al., 2011). However, the results for the cost-effectiveness of telemedicine have been mixed. A systematic review of the telemedicine studies between 1990 and 2010 found that there was no conclusive evidence that telemedicine interventions are cost-effective compared to conventional healthcare (Mistry, 2011). In contrast, Wade and colleagues (2010) found home-based telehealth and real-time video to on-call hospital specialists to be cost-effective. In addition, Egede and colleagues (2017) found no difference in outpatient healthcare costs between in person and telemedicine conditions over time. Using their

experience of delivering healthcare over telemedicine Sanabria and Orta (2012) found that programs with organized, coordinated telehealth services with training at the onset and continued follow up trainings for clinicians provided significant savings to society, the healthcare system, and patients. Considering these mixed results, it is important to note that the patient's alternative to receiving specialized treatments via telemedicine is usually no mental health treatment at all or receiving a treatment that is not evidence-based (Morland et al., 2013).

It is difficult to generalize the results of individual economic studies due to the variety of telehealth applications. These applications can include real time versus store and forward telehealth and home-based versus clinic-based telemedicine (Mistry, 2011). The method in which telehealth is delivered varies in conjunction with the purpose it is being used. Store and forward telemedicine refers to transferring digital images from one location to another (Myers, 2003). Store and forward telemedicine is used when CT scans are digitized and uploaded to a server for a health care provider to review and diagnose. Remote patient monitoring uses digital technologies to collect health data, such as, blood pressure, blood sugar, or heart rate at the patient's home. This health data is then electronically transmitted to a health care provider for assessment and recommendations (Institute of Medicine, 2012). Mobile health applications utilize smartphone applications to aid in the delivery of health care services to patients, such as an app for a patient to access their electronic health record. Videoconferencing also has many applications for telemedicine, and is often used to provide mental health treatments over telemedicine (Weger, MacInnes, Enser, Francis, & Jones, 2013). Videoconferencing is used for both home-based telemental health and hub and spoke telemental health. However, the cost

savings will be different for home-based telemental health compared to hub and spoke telemental health where the patient would still need to travel to a satellite clinic to receive telemental health services from a centralized clinic (Acierno et al., 2017; Morland et al., 2013).

In the past, many economic studies for telemedicine have had considerable methodological problems and inconsistencies that make it difficult to draw conclusions on the cost-effectiveness of telemedicine. Many of the cost-effectiveness studies have been short-term studies of two years or less or pilot studies with small sample sizes (Luxton, 2013; Mistry, 2011; Wade et al., 2010). In systematic reviews, it has been found that some economic studies assumed the effectiveness of telemedicine but did not have empirically supported evidence or provide information about the comparison group (Luxton, 2013; Mistry 2011). A surprising number of the previous economic studies had unclear aims and did not consider direct and indirect costs to the patient and the institution (Mistry, 2011). Statistically sound telemedicine economic studies need to have well-stated aims with clear definitions of the outcome variables, consideration of treatment effectiveness, appropriate research designs, and sensitivity analyses (Luxton, 2013).

Telemedicine and the VA. The Department of Veteran Affairs (VA) is the largest integrated healthcare system in the nation. The VA introduced telehealth to provide care to veterans while reducing costs, increasing quality, and improving access (Institute of Medicine, 2012). Telehealth utilization in the VA has garnered major support for mental health treatment, as more than 20% of veterans of the current Iraq and Afghanistan conflicts are affected by symptoms of PTSD (Hoge, Auchterlonie, &

Milliken, 2006; Hoge, et al., 2004; Milliken, Auchterlonie, & Hoge, 2007). Aside from the human suffering associated with PTSD symptoms, the economic cost resulting from PTSD is high, with these veterans utilizing higher levels of mental health services over the years. For example, veterans with a PTSD diagnosis in 2009 had outpatient costs that were $1,399 higher per year than veterans with other mental health diagnoses, not including PTSD (Chan, Cheadle, Reiber, Unutzer, & Chaney, 2009).

For PTSD, telemedicine has been shown to offer cost savings when providing veterans with evidence-based treatments for PTSD as compared to in-person treatment (Morland et al., 2013). The VA has begun to utilize home-based telemedicine for mental health care in addition to clinic-to-clinic telemedicine. Home-based telemedicine reduces barriers to patients engaging in and completing evidence-based therapy for PTSD, including those associated with: transportation costs, stigmatization for receiving mental health services, and rurality (Yuen et al., 2015). The few studies utilizing home-based telemedicine have found this treatment modality to be cost-effective (Egede et al., 2017; Luxton, 2013; Wade et al., 2010).

Problem Statement

Little evidence exists regarding the costs of telemental health. In addition, many of these studies have been methodologically flawed, insofar as these studies had small sample sizes, unclear aims, and did not consider the direct and indirect costs to patients and the institution (Luxton, 2013; Mistry, 2011; Wade et al., 2010). Future studies should examine direct and indirect costs to patients and institutions. If telemental health is cost prohibitive to either patients or institutions this method of treatment delivery is unlikely to continue even if it is does diminish barriers to care. Longer studies that include

treatment effectiveness variables to determine if telemental health is an effective method of treatment delivery are needed.

Although general telemental health has growing support, further research should examine if evidence-based treatments such as Prolonged Exposure therapy (PE) for PTSD can be delivered cost-effectively via telemedicine. Unfortunately, many veterans must travel long distances to access care at a VA hospital or clinic. To complicate matters, most evidence-based mental health treatments require a patient to meet with a therapist weekly. Home-based telemental health could expand the number of veterans with access to specialized treatments for illnesses such as PTSD, in turn decreasing barriers to care such as distance, physical disabilities, and stigmatization. *The proposed study seeks to determine the cost-effectiveness of an evidence-based treatment for PTSD (PE) delivered via home-based telemental health versus conventional in person treatment using the same intervention, considering direct and indirect costs to the Veterans Health Administration (VHA).*

Research Questions and Research Hypotheses

We predict that home-based telemedicine will be a cost-effective method of delivering PE for PTSD for veterans who would otherwise encounter barriers to care, rendering them unable to receive evidence-based treatment for PTSD. Therefore, this study attempts to answer the following research questions:

1. Is home-based telemedicine a cost-effective method of delivering Prolonged Exposure (PE) therapy for PTSD?

Hypothesis 1: The telemedicine intervention will not cost more compared to the in person intervention.

2. When comparing pre-treatment to post-treatment how is VA outpatient resource utilization affected by PE therapy for PTSD?

Hypothesis 2: Both in person and telemedcine interventions will have a similar reduction in the cost of outpatient resource utilization from pre-treatment to post-treatment.

3. How do the direct and indirect costs of telemedicine compare to in person delivery of PE therapy for PTSD?

Hypothesis 3: The telemedicine intervention will not cost more than the in person intervention even when considering the direct and indirect costs associated with both interventions.

The parent study has already shown the effectiveness of home-based telemedicine for providing PE to veterans (Acierno, 2017). Since home-based telemedicine can effectively eliminate barriers to care for veterans who are otherwise unable to receive treatment, home-based telemedicine must only be cost neutral compared to in person treatment in order to be utilized by hospitals. For this reason, the null hypotheses were selected for this study.

Participants

Participants in this study were male and female veterans of Vietnam, Persian Gulf, Operation Enduring Freedom (OEF), Operation Iraqi Freedom (OIF), and Operation New Dawn (OND) with a diagnosis of PTSD. This was an MUSC IRB approved randomized clinical trial based at the Ralph H. Johnson VA Medical Center in Charleston, South Carolina. Once enrolled, veterans were randomly assigned 1:1 to one

of two conditions: receiving PE via home-based telemedicine (PE-HBT) or PE via in person delivery (PE-IP).

CHAPTER 2

LITERATURE REVIEW

What is Telemedicine?

For the past 60 years telehealth has been evolving to deliver health care to patients and providers separated by geographic and socioeconomic barriers, while mitigating shortages in the healthcare workforce (Institute of Medicine, 2012). Unfortunately, rural and remote populations are aging at a faster rate than the population as a whole with higher rates of chronic illnesses (Speyer, et al., 2018). Moreover, patients in rural areas encounter many health care disparities that present barriers to receiving adequate access to health care services. These disparities include (Banbury, Roots, & Nancarrow, 2014) :

- geographical isolation,
- lower socioeconomic status,
- shortage of local health care providers,
- decreased ability to access health care services,
- and higher rates of unemployment.

Telemedicine seeks to reduce barriers to care for these patients using technological applications to provide healthcare services for an array of specialties and settings. Telemedicine significantly impacts many aspects of modern health care, utilizing a variety of methods including: store and forward telemedicine, real time videoconferencing, remote patient monitoring, and mobile health applications (Institute of Medicine, 2012). As telehealth has evolved it has proven to be useful in

providing treatment in a diverse range of specialties, such as: radiology, pathology, mental health, neurology, primary care, dermatology, and dentistry (Wade et al., 2010). In addition telehealth has been applied in a variety of settings from hospital-based telemedicine to home-based telemental health (Institute of Medicine, 2012).

The VA and Telemedicine

The Department of Veterans Affairs (VA) has been a pioneer in the field of telemedicine (Myers, 2013). Telemedicine in the VA dates back as far as 1977 when it piloted delivery of medical care remotely in Nebraska (Broderick, 2013). Telemedicine began rapidly expanding within the VA in the 1990s when it was introduced to meet the needs of the aging VA population (Institute of Medicine, 2012). Telehealth has been used in the VA to expand access, provide care as close as possible to a patient's community, and provide care at home when appropriate (Lindeman, 2010). The VA's home telehealth program has achieved high rates of patient satisfaction while reducing excess resource utilization, thereby decreasing patients' hospital admissions and their lengths of stay (Broderick, 2013; Lindeman, 2010).

Telemental health. Veterans are at a high risk for a broad range of mental health problems, such as PTSD, due to repeated exposure to traumatic events (Cohen et al., 2010; Fulton et al., 2015; Ramchand, Rudavsky, Grant, Tanielian, & Jaycox, 2015). More than 20% of the veterans from the current conflicts in Iraq and Afganistan are affected by symptoms of PTSD (Hoge, et al., 2006; Hoge et al., 2004; Milliken et al., 2007). Unfortunately, around 40-50% of veterans who need mental health treatment and are eligible to receive these services do not access mental health services, and many veterans who initiate mental health services drop out of treatment prematurely (Hoge, 2011;

Tanielian & Jaycox, 2008). This low level of treatment utilization is believed to be affected by veterans encountering significant barriers to care (Hoge et al., 2004; Seal et al., 2010). Barriers range from transportation costs, logistical problems such as parking, fear of stigmatization for receiving mental health services, and living in rural areas with provider shortages that lack specialty mental health services (Gros, et al., 2011; Hoge et al., 2004; Kim, Thomas, Wilk, Castro, & Hoge, 2010).

To increase veterans‘ access to care, the VA expanded its use of telemedicine services for mental health treatment (Gros, et al., 2013; Tuerk et al., 2010). “Hub and spoke“ telemental health was the first telemedicine solution the VA utilized to decrease veterans‘ barriers to mental health care. In hub and spoke telemental health, veterans travel to a satellite clinic (i.e., the spoke) to receive specialized telemental health treatment from a provider located at a centralized clinic (i.e., the hub). Research supports the feasibility and effectiveness of hub and spoke telemental health compared to in person treatment (Monnier, Knapp, & Frueh, 2003; Richardson, Frueh, Grubaugh, Egede, & Elhai, 2009). Hub and spoke telemental health has also been shown to effectively reduce barriers to care and decrease costs‘ for patients (Fortney, Maciejewski, Warren, & Burgess, 2005; Morland et al., 2013)

Though a promising avenue for eliminating some barriers to care, patients receiving services through hub and spoke telehealth are still burdened by the need to travel to satellite clinics to access their healthcare services. Stigma as well as logistical barriers, such as parking issues, travel time, and lost work time, are still present in hub and spoke telehealth models (Acierno, et al., 2017). Home-based telemental health, by contrast, may better address the stigma and logistical barriers associated with access to

mental health treatment (Acierno et al., 2016; Acierno et al., 2017; Egede et al., 2015; Shore et al., 2014). In home-based telemental health, care is delivered using videoconferencing technology to non-clinic based settings, such as a patient's home (Shore, Goranson, Ward, & Lu, 2014).

There is growing evidence to support the use of home-based telemental health (Hilty, et al., 2013). Research has found telemental health to be an effective method of providing evidence-based psychotherapy for a range of mental health disorders, including mood disorders (Choi, et al., 2013; Egede, et al., 2015; Luxton, et al., 2016), anxiety disorders (Yuen et al., 2013), and PTSD (Acierno, et al., 2016; Acierno, et al., 2017; Luxton, Pruitt, O'Brien, & Kramer, 2015; Strachan, Gros, Ruggiero, Lejuez, & Acierno, 2012; Yuen et al., 2015). However, very limited data are available that speak to the cost effectiveness of home based telemental health.

Health Economics and Telemental Health

It is important to consider the economic cost of telemedicine because one of the primary rationales for its use has been to decrease the cost of delivering health care while making more efficient use of the healthcare workforce (Wade et al., 2010). These economic evaluations may then be used to inform the healthcare system on ways to decrease the costs of delivering healthcare service, improve patients' access to care, and make decisions about how resources should be allocated (Luxton, 2013). While telehealth is believed to be a less expensive treatment modality, few studies have actually investigated the cost-effectiveness of telehealth delivered interventions (Bergmo, 2009; Mistry, 2012;Wade, et al., 2010; Whitten, et al, 2002). Many previous economic

evaluations of telehealth have had numerous methodological flaws and had contradictory outcomes (Mistry, 2012; Wade et al, 2010; Wooton, 2012).

The results of economic analyses related to telemedicine have been mixed. A systematic review of economic analyses of telehealth services that used real time video communication observed that nearly two thirds of the studies reviewed found cost savings in utilizing telehealth compared to a non-telehealth alternative (Wade et al., 2010). In contrast, a systematic review looking at the cost-effectiveness of telemedicine over the last 20 years found that there is no conclusive evidence that telemedicine interventions are cost-effective compared to conventional health care (Mistry, 2012). Both of these reviews, and other researchers have noted that there are numerous methodological flaws and inconsistencies that limit the ability to make generalized conclusions about the costs and benefits of telehealth programs (Luxton, 2013; Mistry, 2012; Wade et al., 2010). These methodological flaws include (Luxton, 2013; Mistry, 2012; Wade et al., 2010):

- short term studies of two years or less that fail to consider longer term effects and outcome;
- lack of clearly defined aims and cost perspective;
- lack of standardized outcomes to generalize and compare results across studies;
- inadequate details about study design and methodologies.

For telemental health and home-based telemedicine the data on costs has lagged behind the ever growing data on clinical efficacy (Bergmo, 2009; Wade et al., 2010). The few economic analyses that have been conducted have generally supported the cost-effectiveness of telemental health. For veterans with PTSD, telemedicine has been shown

to be significantly less costly than in person treatment (Morland et al., 2013). In the systematic review of telehealth studies using real time video conducted by Wade and colleagues (2010), eight studies delivered home-based care. Of the studies reviewed, seven home-based trials showed cost savings, and one study showed no difference in costs between the home-based telehealth condition and the non-telehealth alternative. In addition, a recent study aimed at older veterans with depression analyzed healthcare costs before, during, and after treatment and showed no difference in costs between home-based telemental health and in-person treatment (Egede et al., 2017).

Currently, there have been few studies investigating the cost-effectiveness of telemedicine, and in particular the cost-effectiveness of home-based telemental health (Luxton, 2013; Wade et al., 2010; Whitten et al., 2002). The current study is an economic analysis of a randomized clinical trial conducted by Acierno and colleagues (2017) for veterans with PTSD using Prolonged Exposure (PE) therapy, comparing in-person treatment to home-based telemental health. I served as a protocol therapist and research coordinator for this study. This study found that patients randomized to receiving treatment via telemental health had similar reductions in symptoms as those in the in-person condition (Acierno, et al., 2017). In the present study, we used the data from this clinical trial to perform an economic analysis comparing home-based telemental health care to in-person care for the treatment of PTSD using PE. In addition, we analyzed patients‘ healthcare resource utilization prior to treatment and at the conclusion of treatment to look at the long term economic outcomes of both in person and home-based telemental health conditions.

CHAPTER 3

METHODOLOGY

Study Design

This project is an analysis of data from a randomized, non-inferiority trial that is registered with ClinicalTrials.gov, number NCT01112764 (Acierno et al., 2017). In the parent trial participants were treated using PE for PTSD, and were randomly assigned (1:1) to receive this treatment either by home-based telemental health or office-based in person delivery (PE-HBT vs. PE-IP). For this analysis we compared the costs and benefits between the two conditions (PE-HBT and PE-IP). In addition, an IRB amendment was submitted and approved (IRB approval number: 19695 #29) to collect inpatient, outpatient, pharmacy, and total health care costs from the VA Health Economics Resource Center (HERC) datasets for FY 2009-2016 and compared between the two groups.

Participants

Participants had a diagnosis of combat-related PTSD as assessed by the Clinician Administered PTSD Scale (CAPS; Blake et al., 1995). The participants were also assessed using the Structured Clinical Interview for DSM-IV (SCID-IV; First, Spitzer, Gibbon, & Williams, 1996), and those who were actively psychotic, acutely suicidal, or met criteria for current substance dependence were were excluded from participation. To enhance the generalizability of study findings participants receiving psychotropic mediation or case management services for PTSD, mental health treatment for other

psychiatric disorders, or those who met criteria for substance abuse were not excluded from participation. However, veterans were required to have been on a stable medication regimen for at least four weeks prior to study entry, and were asked to maintain their medication dosages at current levels.

Recruitment and Randomization

Participants were recruited from the Ralph H. Johnson Veterans Affairs Medical Center and the Medical University of South Carolina via provider referral to the VA PTSD clinic. Participant data were collected from November 2010 through April 2015. Consented participants were randomly assigned to either PE-IP or PE-HBT. The senior statistician on the study generated the randomization scheme using permuted block randomization, stratified by race, with block size varied to minimize threats to blinded group assignment.

Procedures

Both IP and HBT conditions followed the identical PE manual (Foa, Hembree, & Rothbaum, 2007), and treatment consisted of 10-12, 1.5 hour sessions. PE is an evidence-based, cognitive-behavioral treatment protocol for PTSD. Treatment involves, psychoeducation regarding symptom, breathing retraining, and exposure to traumatic cues. In PE, therapists help patients expose themselves to safe but anxiety inducing situations and memories, using in vivo and imaginal exposure activities, in order to overcome their trauma-related fear and anxiety. PE has consistently been found to be an efficacious treatment for PTSD (Foa, Rothbaum, Riggs, & Murdock, 1991; Powers, Halpern, Ferenschak, Gillihan, & Foa, 2010; Schnurr & Friedman, 2008).

All therapists provided equal proportions of PE-IP and PE-HBT treatment. Therapists were master's level counselors who completed a 32 hour workshop in PE. Therapists met weekly for supervision for PE throughout the duration of the study. A random sampling of 20% of therapy session audiotapes was audited for treatment fidelity and rated according to session-specific procedures directly corresponding to the PE treatment manual. Treatment fidelity was maintained at or above 90% across and within conditions.

IP treatment was provided face to face at the VA Medical Center. Treatment sessions for the HBT condition were conducted using HIPAA compliant in-home videoconferencing software available free to VA Medical Center patients and providers. PE-HBT utilized participants' own equipment (e.g., home computer, laptop, tablet, or smartphone). In circumstance where participants did not have the necessary equipment it was provided for them during the treatment phase of the study (e.g., webcams, videophones, or tablets with high speed cellular internet plans).

Masters level psychologists, blinded to treatment condition, conducted interviews to assess primary outcomes at baseline, post-treatment, and at 3 month and 6 month follow ups. However, therapists gathered PCL and BDI data for weeks 2, 4, 6, 8, and 10 as part of standard treatment procedures.

Limitations

A limitation of this study is in order to be eligible, participants had to be open receiving treatment in either treatment condition, in person or over home-based telemental health. Since this is a randomized clinical trial particpants were randomly assigned to receive treatment in person or over home-based telemental health. For this

reason, the travel savings for this study is likely to under represent the travel savings relative to the population that utilizes home-based telemental health from the Ralph H. Johnson VAMC in Charleston, SC. Many potential participants who lived farther away from Charleston were unwilling to consent to the research study because they were unwilling to travel to Charleston for weekly therapy sessions.

Dataset Description

This project is an analysis of data from a randomized, non-inferiority trial that is registered with ClinicalTrials.gov, number NCT01112764 (Acierno et al., 2017). As a member of the research study the Principal Investigator, Dr. Ron Acierno, allowed access to the dataset. The original dataset included patients‘ demographic information, and clinical measures, such as the CAPS. An IRB amendment was submitted and approved (IRB approval number: 19695 #29) to collect inpatient, outpatient, pharmacy, and total health care costs from the VA Health Economics Resource Center (HERC) datasets for FY 2009-2016 and compared between the two groups. A Data Access Request was submitted to the Department of Veterans Affairs requesting the HERC data on the VA Infomatics and Computing Infrastructure (VINCI) platform. Once the request was approved the HERC dataset was uploaded to the VINCI platform, and the data was cleaned to allow for merging. The dataset from the parent study was uploaded onto VINCI, and was then merged with the HERC dataset to create the dataset used in this study to compare the costs and benefits of PE-IP to PE-HBT.

Measures

Cost measures. A number of cost variables were calculated to compare PE-IP to PE-HBT clinical and cost outcomes. Costs and benefits were adjusted to 2016-dollar

values using the U.S. Department of Labor Consumer Price Index (United States Department of Labor, n.d.)

Therapist cost was calculated using an hourly rate. Therapist cost was estimated using the average master's level therapist salary and adjusting for the cost of benefits (base salary + 30% for benefits). This hourly rate was then multiplied by the number of hours participants were seen (1.5 hours) to arrive at a therapist per session cost. The therapist per session cost was then multiplied by the number of sessions a participant received to arrive at the therapist cost per participant.

Office cost were calculated using the overhead cost of an office space at the Ralph H. Johnson VAMC during the years the study was conducted. The price per square foot was multiplied by the square footage of the office where treatment occurred. Per person room cost was calculated to be total annual room cost divided by the number of participants.

Equipment cost were calculated for the telehealth equipment that was used over the duration of the study. Most participants already had the necessary telehealth equipment, such as a computer or tablet with a camera, and did not incur these equipment costs. Six tablets and six webcams were purchased for this study and loaned to participants if they did not have the necessary equipment to engage in the PE-HBT condition. This equipment was only loaned to the participant for the duration of the treatment phase of the study and participants returned the equipment once they had completed treatment. The six webcams and six iPads were included in the equipment costs for PE-HBT. The cost of the equipment was then divided by the participants who were loaned equipment to arrive at a telehealth equipment per participant cost. In PE

participants are required to record their sessions and listen to portions of the recording between sessions. Therefore, participants in both conditions incurred the cost of a digital recorder.

Travel costs was estimated using the 2016 government rate per mile. PE-IP participants distance round trip from the Ralph H. Johnson VAMC was then multiplied by the mileage rate to get the participants per session travel cost. The participants per session travel cost was then multiplied by the number of sessions to arrive at the participant's overall travel cost.

Total cost per participant. The cost per person for the PE-IP condition included therapist cost per participant, the per person room cost, the cost of the recorder, and the participant's overall travel cost. The cost per person for the PE-HBT condition included therapist cost per participant, the per person room cost, the recorder cost, and the telehealth equipment per participant cost.

Benefit measures. Benefits were measured by the differences in the pre and post intervention VA health care service utilization costs for inpatient, outpatient, pharmacy, and mental health services. An additional benefit for the PE-HBT condition was the travel savings associated with not having to go to the hospital to receive treatment.

HERC data. Inpatient, outpatient, inpatient mental health, outpatient mental health, and pharmacy costs were collected from VA Health Economics Resource Center (HERC) datasets for FY 2009-2014 and compared between the two treatment groups. A total of 100 out of the 154 originally randomized patients (51 PE-IP and 49 PE-HBT) initiated Prolonged Exposure therapy and were matched with HERC cost information, and therefore included in the analysis. HERC developed an average cost methodology to

estimate the costs of healthcare encounters since the VA does not routinely bill veterans for the care they receive (Chen & Shane, 2014). Using this method, an inpatient cost is estimated by averaging the costs of all inpatient stays that have the same demographic and discharge characteristics, and an outpatient cost is estimated by averaging outpatient appointments with the same CPT codes and visit types. Costs during the year prior to a veterans participation in the study was classified at the participant's pre-intervention utilization costs. Costs from the year following the veterans participation in the research study was classified as the participants post-intervention costs.

Clinical measures. The Clinician-administered PTSD scale (CAPS)-IV is a semi-structured interview designed to diagnose current and lifetime PTSD (Blake et al., 1995). For this study the CAPS was used to define inclusion criteria, providing a diagnosis of PTSD and symptom severity level.

Statistical Analysis

Unadjusted means of the HERC variables cost differences by treatment modality were tested using Student's *t* test. In addition, Students *t* tests were performed to examine the total cost and total benefit by treatment modality. Next, unadjusted longitudinal analyses were performed for each of the HERC cost variables, as well as total cost and total benefit, to investigate differences in cost over times between PE-IP and PE-HBT. In order to examine the cost of PE-IP relative to PE-HBT while not sacrificing clinical outcomes the longitudinal analyses were repeated after adjusting for the CAPS score and demographic characteristics. A generalized linear model with a gaussian distribution and identity link was used for each of the adjusted medical services cost analyses (Polgreen & Brooks, 2012). We used three adjusted models to examine the cost of PE-HBT relative to

PE-IP. Model 1 adjusts for PE-HBT only. Model 2 adjusts for PE-HBT and CAPS score. Model 3 adjusts for PE-HBT, CAPS score, and demographic characteristics, including, age, sex, race, marital status, and theatre. All analyses were performed using STATA version 14.0.

Telemedicine: A cost analysis of delivering Prolonged Exposure to combat veterans with PTSD

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Running head: Cost analysis of PE via Telemedicine

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Telemedicine: A cost analysis of delivering Prolonged Exposure to combat veterans with PTSD

Abstract

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Background: Many veterans who need mental health treatment for posttraumatic stress disorder (PTSD) encounter significant barriers to care. Home-based telehealth is one of the solutions proposed to increase veterans access to care.

Objective: To examine the direct and indirect costs associated with delivering Prolonged Exposure (PE) treatment for PTSD through home-based telehealth compared to standard in-person PE.

Methods: This study is a cost analysis of a randomized, noninferiority trial of PE for PTSD delivered via home-based telehealth or in person. The parent trial found that home-based telehealth participants reported results comparable to those who received treatment in person. Economic analyses included comparing the total cost of both treatment modalities, and investigating the difference in health services utilization costs between 1-year post-intervention and 1-year pre-intervention.

Results: Cost savings associated with home-based telehealth averaged $3,625.70 per participant total health care utilization from pre-to-post intervention. There was no significant difference in the cost of the intervention, per se, between home-based telehealth and in person care.

Conclusion: While the intervention costs were stable among the two treatment modalities, veterans receiving PE over home-based telehealth had lower total health care utilization costs 1 year after the intervention compared to the in-person condition. These results indicate that PTSD treatment via home-based telehealth is a cost saving method of care relative to in person delivery of the same treatment.

Introduction

Veterans are at a high risk for a broad range of mental health problems, such as Posttraumatic Stress Disorder (PTSD), due to repeated exposure to traumatic events.[1,2] More than 20% of the veterans from the current conflicts in Iraq and Afganistan are significantly affected by symptoms of PTSD.[3,4] Unfortunately, around 40-50% of veterans in need of, and eligible to receive mental health treatment do not access these services; and many veterans who initiate mental health services drop out of treatment prematurely.[5,6] This low level of treatment utilization is believed to be related to significant barriers to care.[3,7] Ranging from transportation costs, logistical problems such as parking, fear of stigmatization for receiving mental health services, and living in rural areas with provider shortages that lack specialty mental health services.[3,8,9] Aside from the human suffering associated with PTSD symptoms, the economic costs are high, with these veterans utilizing higher levels of mental health services over the years. For example, veterans with a PTSD diagnosis in 2009 had outpatient costs that were $1,399 higher per year than veterans with other mental health diagnoses.[10]

The Department of Veterans Affairs (VA) introduced telemedicine to meet the needs of its ageing population.[11] The rationale being that telemedicine can increase access to healthcare for patients in geographically remote areas and those with physical disabilities who would find it difficult to travel to receive treatment.[12,13] In addition, telemedicine makes more efficient use of limited specialty healthcare workforce personnel who provide services such as evidence-based treatments for depression,[14] anxiety,[15] and PTSD.[16]

To further increase veterans' access to care, the VA expanded its use of telemedicine services to mental health treatment. "Hub and spoke" telehealth was the first telemedicine solution the VA utilized to decrease veterans' barriers to mental health care.[17] In hub and spoke telehealth, veterans travel to a satellite clinic (i.e., the spoke) to receive specialized mental health treatment from a provider located at a centralized clinic (i.e., the hub). Research supports the feasibility and effectiveness of hub and spoke telehealth compared to in person treatment.[18,19]

Though a promising avenue for eliminating some barriers to care, patients receiving services through hub and spoke telehealth are still burdened by the need to travel to satellite clinics to access their healthcare services. Stigma associated with a mental health clinic visit, as well as logistical barriers, such as parking issues, travel time, and lost work time, are still present in hub and spoke telehealth models.[20] Home-based telehealth, by contrast, may better address the stigma and logistical barriers associated with access to mental health treatment.[21,22] In home-based telehealth care is delivered using videoconferencing technology to non-clinic based settings, such as a patient's home. Research has found home-based telehealth to be an effective method of providing evidence-based psychotherapy for a range of mental health disorders, including mood disorders,[22,23] anxiety disorders,[24] and PTSD.[20,21,25] However, very limited data are available that speak to the cost effectiveness of home-based telehealth.

It is important to consider the economic cost of telemedicine because one of the primary rationales for its use has been to decrease the cost of delivering health care while making more efficient use of the healthcare workforce. These economic evaluations may then be used to inform the healthcare system on ways to decrease the costs of delivering

healthcare services, improve patients‘ access to care, and make resource allocation decisions.[26] While telemedicine is believed to be a less expensive treatment modality, few studies have actually investigated the cost-effectiveness of telemedicine delivered interventions.[12,27,28]

The results of the few economic analyses that have been conducted on telemedicine have been mixed. A systematic review of economic analyses of telemedicine services that used real time video communication observed that nearly two thirds of the studies reviewed found cost savings in utilizing telehealth compared to a non-telehealth alternative.[12] In contrast, a systematic review looking at the cost-effectiveness of telemedicine over the last 20 years found that there is no conclusive evidence that telemedicine interventions are cost-effective compared to conventional health care.[28] Researchers have noted that there are numerous methodological flaws and inconsistencies in previous telemedicine cost analyses that limit the ability to make generalized conclusions about the costs and benefits of telemedicine programs.[12,26,28] These methodological flaws include: short term studies of two years or less that fail to consider longer term effects and outcome, lack of clearly defined aims and cost perspective, lack of standardized outcomes to generalize and compare results across studies, and inadequate details about study design and methodologies.[12,26,28] Additionally, technology costs have changed chile capability has increased, and these factors also influence the overall cost of telemedicine.

For telemental health and home-based telehealth the data on costs have lagged behind the ever growing data on clinical efficacy.[12,27] The few economic analyses that have been conducted have generally supported the cost-effectiveness of telemental

health. For veterans with PTSD, telemedicine has been shown to be significantly less costly than in-person treatment.[13] In the systematic review of telehealth studies using real time video conducted by Wade and colleagues,[12] 8 studies delivered home-based care. Of the studies reviewed, 7 home-based trials showed cost savings, and 1 study showed no difference in costs between the home-based telehealth condition and the non-telehealth alternative.[12] In addition, a recent study aimed at older veterans with depression analyzed healthcare costs before, during, and after treatment and showed no difference in costs between home-based telehealth and in-person treatment.[29]

As there have been few studies investigating the cost-effectiveness of telemedicine, and in particular the cost-effectiveness of home-based telehealth.[12,27,30] The aim of this study was to compare the costs and benefits associated with delivering Prolonged Exposure (PE), an evidence-based treatment for PTSD, via home-based telehealth (PE-HBT) versus in-person treatment (PE-IP).

Methods

Study Design, Participants, and Randomization

This project is an analysis of data from a randomized, non-inferiority trial (ClinicalTrials.gov, number NCT01112764).[20] Participants were treated using PE for PTSD, and were randomly assigned (1:1) to receive this treatment either by home-based telehealth or office-based in-person delivery (PE-HBT vs. PE-IP). More information on the study procedures and clinical outcomes has been published previously.[20] Participants were recruited from the Ralph H. Johnson Veterans Affairs Medical Center and the Medical University of South Carolina via provider referral to the VA PTSD clinic. Participant data were collected from November 2010 through April 2015. Veterans

meeting diagnostic criteria for combat-related PTSD as assessed by the Clinician Administered PTSD Scale (CAPS)[31] were eligible for this study. The participants were also assessed using the Structured Clinical Interview for DSM-IV (SCID-IV),[32] and those who were actively psychotic, acutely suicidal, or met criteria for current substance dependence were excluded from participation. To enhance the generalizability of study findings participants receiving psychotropic medication or case management services for PTSD, mental health treatment for other psychiatric disorders, or those who met criteria for substance abuse were not excluded from participation. However, veterans were required to have been on a stable medication regimen for at least 4 weeks prior to study entry, and were asked to maintain their medication dosages at current levels. Consented participants were randomly assigned to either PE-IP or PE-HBT. The senior statistician on the study generated the randomization scheme using permuted block randomization, stratified by race, with block size varied to minimize threats to blinded group assignment.

Procedures

Both PE-IP and PE-HBT conditions followed the identical PE manual,[33] and treatment consisted of 10-12, 1.5-hour sessions. PE is an evidence-based, cognitive-behavioral treatment protocol for PTSD.[33] In PE, therapists help patients expose themselves to safe but anxiety inducing situations and memories, using in vivo and imaginal exposure activities, to overcome their trauma-related fear and anxiety.[33] PE has consistently been found to be an efficacious treatment for PTSD.[34,35] All therapists provided equal proportions of PE-IP and PE-HBT treatment. Therapists were master's level counselors who completed a 32-hour workshop in PE. Therapists met weekly for supervision for PE throughout the duration of the study. A random sampling of 20% of

therapy session audiotapes was audited for treatment fidelity and rated according to session-specific procedures directly corresponding to the PE treatment manual. Treatment fidelity was maintained at or above 90% across and within conditions.

PE-IP treatment was provided face to face at the VA Medical Center. Treatment sessions for the PE-HBT condition were conducted using HIPAA compliant in-home videoconferencing software available free to VA Medical Center patients and providers. PE-HBT utilized participants own equipment (e.g., home computer, laptop, tablet, or smartphone). In circumstances where participants did not have the necessary equipment it was provided for them during the treatment phase of the study (e.g., webcams, videophones, or tablets with high speed cellular internet plans). Masters level psychologists, blinded to treatment condition, conducted interviews to assess primary outcomes at baseline, post-treatment, and at 3 month and 6 month follow ups.

Cost measures

Various cost variables were calculated to compare PE-IP to PE-HBT clinical and cost outcomes. Costs and benefits were adjusted to 2016-dollar values using the U.S. Department of Labor Consumer Price Index.[36]

Therapist cost was calculated using an hourly rate. Therapist cost was estimated using the average master's level therapist hourly salary and adjusting for the cost of benefits (base salary + 30% for benefits). This hourly rate was then multiplied by the number of hours participants were seen (1.5 hours) to arrive at a therapist per session cost. The therapist per session cost was then multiplied by the number of sessions a participant received to arrive at the therapist cost per participant.

Office cost were calculated using the overhead cost of an office space at the Ralph H. Johnson VAMC during the years the study was conducted. The price per square foot was multiplied by the square footage of the office where treatment occurred. Per person room cost was calculated to be total annual room cost divided by the number of participants.

Equipment cost were calculated for the telehealth equipment that was used over the duration of the study. Most participants already had the necessary telehealth equipment, such as a computer or tablet with a camera, and did not incur these equipment costs. Six tablets and 6 webcams were purchased for this study and loaned to participants if they did not have the necessary equipment to engage in the PE-HBT condition. This equipment was loaned to the participant for the duration of the treatment phase of the study and participants returned the equipment once they had completed treatment. The 6 webcams and 6 iPads were included in the equipment costs for PE-HBT. The cost of the equipment was then divided by the participants who were loaned equipment to arrive at a telehealth equipment per participant cost. In PE participants are required to record their sessions and listen to portions of the recording between sessions. Therefore, participants in both conditions incurred the cost of a digital recorder. Therapist utilized the VA videoconferencing software directly from their standard workspace desktop in their office and did not have to purchase any additional equipment.

Travel costs were estimated using the 2016 government rate per mile. PE-IP participants distance round trip from the Ralph H. Johnson VAMC to their home address was then multiplied by the mileage rate to get the participants per session travel cost. The

participants per session travel cost was then multiplied by the number of sessions to arrive at the participant's overall travel cost.

Total cost per participant. The cost per person for the PE-IP condition included therapist cost per participant, the per person room cost, the cost of the recorder, and the participant's overall travel cost. The cost per person for the PE-HBT condition included therapist cost per participant, the per person room cost, the recorder cost, and the telehealth equipment per participant cost. The therapist cost and office cost were the same for both conditions since the same office space and therapist were used for both conditions.

Benefit measures

Inpatient, outpatient, inpatient mental health, outpatient mental health, pharmacy, and total healthcare utilization costs were collected from VA Health Economics Resource Center (HERC) datasets for FY 2009-2016 and compared between the two treatment groups. A total of 100 out of the 154 originally randomized patients (51 PE-IP and 49 PE-HBT) initiated PE and were matched with HERC cost information, and therefore included in the analysis. HERC developed an average cost methodology to estimate the costs of healthcare encounters since the VA does not routinely bill veterans for the care they receive.[37] Using this method, an inpatient cost is estimated by averaging the costs of all inpatient stays that have the same demographic and discharge characteristics, and an outpatient cost is estimated by averaging outpatient appointments with the same CPT codes and visit types.[37] Costs during the year prior to a veterans participation in the study was classified at the participant's pre-intervention utilization costs. Costs from the year following the veteran's participation in the research study was classified as the

participants post-intervention costs. Benefits were measured by the differences in the pre- and post-intervention inpatient, outpatient, inpatient mental health, outpatient mental health, pharmacy, and total healthcare service utilization. An additional benefit for the PE-HBT condition was the travel savings associated with not having to go to the hospital to receive treatment.

Clinical measures

The CAPS is a semi-structured interview designed to diagnose current and lifetime PTSD.[31] For this study the CAPS was used to define inclusion criteria, providing a diagnosis of PTSD and symptom severity level.

Statistical Analysis

A sum of the costs associated with PE-HBT and PE-IP was conducted first. Unadjusted means of the HERC variables cost differences by treatment modality were tested using Student's t test. In addition, Students t tests were performed to examine the total cost and total benefit by treatment modality. Next, unadjusted longitudinal analyses were performed for each of the HERC cost variables, as well as total cost and total benefit, to investigate differences in cost over times between PE-IP and PE-HBT. To examine the total health care utilization costs of PE-IP relative to PE-HBT while accounting for possible demographic differences and not sacrificing clinical outcomes, we estimated 3 regression models to examine the association of PE-HBT compared to PE-IP. Model 1 adjusts for PE-HBT only. Model 2 adjusts for PE-HBT and CAPS score. Model 3 adjusts for PE-HBT, CAPS score, and demographic characteristics, including, age, sex, race, marital status, and theatre. A generalized linear model with a gaussian

distribution and identity link was used for each of the adjusted medical services cost analyses.[38] All analyses were performed using STATA version 14.0.[39]

Results

Table 1 shows the demographics and baseline characteristics of the study population. Participants were predominantly male (96%), White (56%), and married (53%) with a mean age of 42 years old. There were no significant differences between the two groups, except for gender (p=0.04). With all the female participants in the PE-IP arm of the study. The differences in cost of the intervention between PE-HBT and PE-IP are presented in Table 2. The PE-HBT arm of the study had lower mean intervention cost ($460.25) and median intervention cost ($575.19). The cost differential between PE-HBT and PE-IP are thus $17.04 for mean intervention cost per veteran and $3.68 for median intervention cost per veteran.

Table 3 shows the unadjusted post-pre difference in VA health care utilization costs between PE-HBT and PE-IP. PE-HBT had lower health care utilization costs in every category, with the difference in healthcare costs between PE-HBT and PE-IP being significantly lower for pharmacy (p=0.04) and total cost (p=0.02). PE-HBT had a mean of $332.05 cost savings in pharmacy health care utilization costs from pre-post intervention per participant compared to PE-IP participants. PE-HBT also had a mean of $3,625.70 cost savings in total health care utilization costs from pre-post intervention per participant compared to PE-IP participants. The adjusted cost of PE-HBT relative to PE-IP for each of the 3 regression models is reported in Table 4. The significant (p=0.04) decrease in total health care utilization associated with PE-HBT was found to be relatively stable across the three models, ranging from -$3,625.71 to -$3,888.10. Our

finding that the cost savings in total health care utilization cost for PE-HBT remained stable is robust to the specification of the regressions, therefore increasing our confidence that this finding is reliable.

Discussion

This analysis of cost data from a randomized, noninferiority trial found that PE delivered by HBT is a cost-effective alternative to in-person treatment and resulted in lower total health care utilization costs. Acierno and colleagues had previously reported that participants in PE-HBT and PE-IP reported similar clinical outcomes.[20] Considering veterans current barriers to receiving PTSD treatment, including the shortage of specialized mental health providers in rural areas, stigma associated with receiving treatment, and transportation difficulties this study adds to the limited research that HBT can clinically and economically deliver an evidence-based treatment for PTSD.

This examination found that total health care utilization costs for participants in the HBT arm of the study were significantly lower than those receiving the intervention in-person. A recent cost-effectiveness analysis comparing the delivery of a behavioral activation intervention for depression in older adult veterans over telehealth or in-person also found significantly lower health care utilization costs for the veterans receiving treatment over telehealth.[40] Considering these results, it appears that receiving telehealth treatment impacts how patients interact with the health care system in the future. A previous study, looking at this same cohort, found that participants in the PE-HBT condition of the study completed more sessions of therapy before dropping out compared to participants in the PE-IP condition.[41] It appears that PE-HBT participants received a stronger dose of treatment. Future studies will be needed to further understand why

engaging in telehealth treatment results in lower health care utilization following treatment.

In this analysis the HBT arm did cost slightly less than in-person treatment (Table 2). However, there was no significant difference in intervention cost between the 2 conditions. A limitation of this study is that all participants in both treatment conditions were required to be willing to attend session in person prior to randomization. Therefore, limiting the engagement of more rural/geographically remote participants for whom the HBT treatment modality would be the most relevant. Due to this limitation, this analysis likely underestimates the cost-effectiveness of HBT. A further limitation to the present study is that gender was not well represented in this study with only 4 female veterans in the study, and all 4 were in the PE-IP condition.

There are also several strengths to the present study. First, the randomized controlled design, and the ability to compare the identical treatment (PE) across 2 treatment modalities (PE-HBT vs. PE-IP). Second, the patient sample was not "diluted", as our inclusion/exclusion criteria was the same as the VA PTSD clinic where participants were recruited. These factors make our findings extremely relevant to the real world, showing that HBT can be utilized to deliver high quality, cost-effective treatment.

In conclusion, considering the number of veterans encountering barrier to mental health care this study justifies the need to increase access to care by providing evidence-based treatments, such as PE, over HBT. This study found no significant difference in cost for providing PE over HBT versus in-person care. Furthermore, HBT participants

had significantly lower total health care utilization costs 1 year after the intervention compared to the in-person condition.

References

1. Fulton JJ, Calhoun PS, Wagner HR, et al. The prevalence of posttraumatic stress disorder in Operation Enduring Freedom/ Operation Iraqi Freedom (OEF/OIF) Veterans: A meta-analysis. J Anxiety Disord 2015; 31: 98-107. doi:10.1016/j.janxdis.2015.02.003

2. Ramchand R, Rudavsky R, Grant S, et al. Prevalence of mental health problems in military populations deployed to Iraq and Afghanistan. Curr Psychiatry Rep 2015; 17: 1-11. doi:10.1007/s11920.015.0575

3. Hoge CW, Castro CA, Messer SC, et al. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. N Engl J Med 2004; 351: 13-22. doi:10.1056/NEJMoa040603

4. Miliken, CS, Auchterlonie JL, Hoge CW. Longitudinal assessment of mental health problems among active and reserve component soldiers returning from the Iraq war. JAMA 2007; 298: 2141-2148. doi:10.1001/jama.298.18.2141

5. Hoge CW. Interventions for war-related posttraumatic stress disorder: Meeting veterans where they are. JAMA 2011; 306: 549-551. doi:10.10001/jama.2011.1096

6. Tanielian T, Jaycox LH. Invisible wounds of war: Psychological and cognitive injuries, their consequences, and services to assist recovery. Santa Monica: RAND Center for Military Health Policy Research; 2008.

7. Seal KH, Maguen S, Cohen B, et al. VA mental health services utilization in Iraq and Afghanistan veterans in the first year of receiving new mental health diagnoses. J Trauma Stress 2010; 23: 5-16. doi:10.1001/archinte.167.5.476

8. Gros DF, Stachan M, Ruggiero KJ, et al. Innovative service delivery for secondary prevention of PTSD in at-risk OIF-OEF service men and women. Contemp Clin Trials 2011; 32: 122-128. doi: 10.1016/j.cct.2010.10.003

9. Kim PY, Thomas JL, Wilk JE, et al. Stigma, barriers to care, and use of mental health services among active duty and national guard soldiers after combat. Psychiatr Serv 2010; 61: 582-588. doi:10.1176/appi.ps.61.6.582

10. Chan D, Cheadle A, Reiber G, et al. Health care utilization and its costs for depressed veterans with and without comorbid PTSD symptoms. Psychiatr Serv 2009; 60: 1612-1617. doi:10.1176/appi.ps.60.12.1612

11. Institute of Medicine. The role of telehealth in an evolving health care environment: Workshop summary. Washington, DC: The National Academies Press; 2012. Available at: http://www.nap.edu/catalog.php?record_id=13466. Accessed October 10, 2018.

12. Wade VA, Karnon J, Elshaug AJ, et al. A systematic review of economic analyses of telehealth services using real time video communication. BMC Health Serv Res 2010; 10: 1-14. doi:10.1186/1472.6963.10.233

13. Morland LA, Raab M, Mackintosh M, et al. Telemedicine: A cost-reducing means of delivering psychotherapy to rural combat veterans with PTSD. Telemed J E Health 2013; 19: 754-759. doi:10.1089/tmj.2012.0298

14. Osenbach JE, O'Brien KM, Mishkind, M, et al. Synchronous telehealth technologies in psychotherapy for depression: A meta-analysis. Depress Anxiety 2013; 30: 1058-1067. doi:10.1002/da.22165

15. Rees CS, Maclaine E. A systematic review of videoconference-delivered psychological treatment for anxiety disorders. Aust Psychol 2015; 50: 259-264. doi:10.1111/ap.12122

16. Sloan DM, Gallagher MW, Feinstein BA, et al. Efficacy of telehealth treatments for posttraumatic stress-related symptoms: A meta-analysis. Cogn Behav Ther 2011; 40: 111-125. doi:10.1080/16506073.2010.550058

17. Tuerk PW, Fortney J, Bosworth HB, et al. Toward the development of national telehealth services: The role of Veteran's Health Administration and future directions for research. Telemed J E Health 2010; 6: 1-3. doi:10.1089/tmj.2009.0144

18. Monnier J, Knapp RG, Frueh BC. Recent advances in telepsychiatry: An updated review. Psychitr Serv 2003; 53: 1604-1609. doi:10.1176/appi.ps.54.12.1604

19. Richardson LK, Frueh BC, Grubaugh AL, et al. Current directions in videoconferencing tele-mental health research. Clin Psychol 2009; 16: 323-338. doi:10.1111/j.1468-2850.2009.01170.x

20. Acierno R, Knapp R, Tuerk P, et al. A non-inferiority trial of Prolonged Exposure for Posttraumatic Stress Disorder: In person versus home-based telehealth. Behav Res Ther 2017; 89: 57-65. doi:10.1016/j.brat.2016.11.009

21. Acierno R, Gros DF, Ruggiero KJ, et al. Behavioral activation and therapeutic exposure for Posttraumatic Stress Disorder: A noninferiority trial of treatment delivered in person vs home-based telehealth. Depress Anxiety 2016; 33:415-433. doi:10.1002/da.22476

22. 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: 693-701. doi:10.1016/52215.0366.15.00122.4

23. Luxton DD, Pruitt LD, Wagner A, et al. Home-based telebehavioral health for U.S. military personnel and veterans with depression: A randomized controlled trial. J Consult Clin Psychol 2016; 84: 923-934. doi:10.1037/ccp0000135

24. Yuen EK, Herbert JD, Forman EM, et al. Acceptance based behavior therapy for social anxiety disorder through videoconferencing. J Anxiety Disord 2013; 27: 389-397. doi:10.1016/j.janxdis.2013.03.002

25. Luxton DD, Pruitt LD, O'Brien K, et al. An evaluation of the feasibility and safety of a home-based telemental health treatment for Posttraumatic Stress in the U.S. military. Telemed J E Health 2015; 21: 880-886. doi:10.1089/tmj.2014.0235

26. Luxton DD. Considerations for planning and evaluating economic analyses of telemental health. Psychol Serv 2013; 10: 276-282. doi:10.1037/a0030658

27. Bergmo TS. Can economic evaluation in telemedicine be trusted? A systematic review of the literature. Cost Eff Resour Alloc 2009; 7: 18-29. doi:10.1186/1478.7547.7.18

28. Mistry H. Systematic review of studies of the cost-effectiveness of telemedicine and telecare: Changes in the economic evidence over twenty years. J Telemed Telecare 2012; 18: 1-6. doi:10.1258/jtt.2011.110505

29. 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. doi:10.1016/j.jad.2016.09.044

30. Whitten PS, Mair FS, Haycox A, et al. Systematic review of cost effectiveness studies of telemedicine interventions. BMJ 2002; 324:1434-1437. doi:10.1036/bmj.324.7351.1434

31. Blake DD, Weathers FW, Nagy LM, et al. The development of a clinician-administered PTSD scale. J Trauma Stress 1995; 8: 75-90. doi: 10.1002/jts.2490080106

32. First MB, Spitzer RL, Gibbon M, et al. Structured clinical interview for DSM-IV Axis I disorders. Clinical version (SCID-CV). Washington, DC: American Psychiatric Press, Inc; 1996.

33. Foa EB, Hembree EA, Rothbaum BO. Prolonged exposure therapy for PTSD. New York: Oxford University; 2007.

34. Foa E, Rothbaum B, Riggs D, et al. Treatment of posttraumatic stress disorder in rape victims: A comparison between cognitive-behavioral procedures and counseling. J Consult Clin Psychol 1991; 59: 715-732. doi:10.1037/0022-006X.59.5.715

35. Powers M, Halpern J, Ferenschak M, et al. A meta-analytic review of prolonged exposure for posttraumatic stress disorder. Clin Psychol Rev 2010; 30: 635-641. doi:10.1016/j.cpr.2010.04.007

36. Consumer Price Index (CPI) Inflation Calculator [database online]. Washington, DC: United States Department of Labor. Available from: https://www.bls.gov/data/inflation_calculator.htm.

37. Chen S, Shane A. Guidebook for the HERC person-level cost dataset FY1998-Present. VA Palo Alto, Health Economics Resource Center; Menlo Park, CA; 2014.

38. Polgreen LA, Brooks GM. Estimating incremental cost with skew: A cautionary note. Appl Health Econ Health Policy 2012; 10: 319-329. doi:10.2165/11632430-000000000-00000

39. STATA [computer program]. Version 14. College Station, TX: StataCorp LP; 2015.

40. 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: 17m11888. doi: 10.4088/JCP.17m11888.

41. Hernandez-Tejada MA, Zoller JS, Ruggiero KJ, et al. Early treatment withdrawal from evidence-based psychotherapy for PTSD: Telemedicine and in-person parameters. Int J Psychiatry Med 2014; 48: 33-55. doi: 10.2190/PM.48.1.d.

Table 1. Patient demographics at baseline.

Characteristics	Mean / Total N (SD / %)	PE-HBT n (%)	PE-IP n (%)	*P* Value
Mean Age (years)	42.0 (SD=13.7)	42.2 (SD=14.3)	41.8 (SD=13.2)	0.44
Gender (%)				
Male	96 (96.0)	49 (100)	47 (92.2)	0.04
Female	4 (4.0)	0 (0)	4 (7.8)	
Race/Ethnicity (%)				
White	56 (56.0)	27 (55.1)	29 (56.9)	0.90
Black	37 (37.0)	19 (38.8)	18 (35.3)	
Others	7 (7.0)	3 (6.1)	4 (7.8)	
Marital status (%)				
Never married	20 (20.0)	9 (18.0)	11 (22.0)	0.77
Married	53 (53.0)	27 (54.0)	26 (52.0)	
Sep./Div./Wid.	27 (27.0)	14 (28.0)	13 (26.0)	
War theatre (%)				
OEF/OIF	64 (64.0)	31 (63.3)	33 (64.7)	0.93
Persian Gulf	15 (15.0)	7 (14.3)	8 (15.7)	
Vietnam	21 (21.0)	11(22.4)	10 (19.6)	
Baseline CAPS	68.7 (SD=13.3)	69.2 (SD=12.2)	68.3 (SD=14.5)	0.37

Note: Statistics are F-test for continuous variables (means) and chi-square for categorical (%) variables.

PE-HBT: Prolonged Exposure-Home Based Telehealth; PE-IP: Prolonged Exposure-In Person; Sep: Separated; Div: Divorced; Wid: Widowed; OEF: Operation Enduring Freedom; OIF: Operation Iraqi Freedom; CAPS: Clinician Administered PTSD Scale.

Table 2. Differences in intervention total costs between PE-HBT and PE-IP

	PE-HBT	PE-IP
	n=49	n=51
Mean Intervention Cost	460.25	477.29
Median Intervention Cost	575.19	578.87

All values are in 2016 US dollars.
PE-HBT: Prolonged Exposure-Home Based Telehealth; PE-IP: Prolonged Exposure-In person

Table 3. Unadjusted differences in VA health care utilization costs between PE-HBT and PE-IP*

	PE-HBT			PE-IP			P-Value
	Mean	Median	95% CI	Mean	Median	95% CI	
Inpatient	-747.23	0	-2038.22, 543.76	953.58	0	-1068.88, 2976.04	0.08
Outpatient	1239.61	351.44	-424.59, 2903.82	3160.91	2132.79	1226.62, 5095.20	0.07
Inpatient MH	0	0	0	953.58	0	-1068.88, 2976.04	0.18
Outpatient MH	780.47	326.26	-276.66, 1837.61	1159.63	747.05	249.75, 2069.50	0.29
Pharmacy	186.01	57.03	-58.49, 430.51	518.06	258.34	217.15, 818.96	0.04
Total	488.72	311.45	-1643.16, 2620.59	4114.42	2132.79	1197.26, 7031.59	0.02

*The difference was calculated from the year prior to treatment and the year immediately following treatment. All values are in 2016 US dollars.
PE-HBT: Prolonged Exposure-Home Based Telehealth; PE-IP: Prolonged Exposure-In person; Inpatient MH: Inpatient Mental Health; Outpatient MH: Outpatient Mental Health

Table 4. Adjusted generalized linear models of total VA healthcare utilization costs.

	Model 1			Model 2			Model 3		
	Estimate	95% CI	P-Value	Estimate	95% CI	P-Value	Estimate	95% CI	P-Value
PE-HBT[a]	-3625.71	-7173.21- -78.20	0.04	-3628.80	-7196.50- -61.11	0.04	-3888.10	-7551.77- -224.44	0.04
CAPS	-	-	-	3.48	-130.86- 137.83	0.96	10.94	-132.54- 154.42	0.88
Age	-	-	-	-	-	-	-235.48	-506.77- 35.81	0.09
Male	-	-	-	-	-	-	-589.73	-12236.22- 11056.77	0.92
Race									
White	-	-	-	-	-	-	reference	-	-
Black	-	-	-	-	-	-	1461.92	-2533.23- 5457.07	0.47
Other	-	-	-	-	-	-	-346.36	-7898.18- 7205.46	0.93
Marital Status									
Single	-	-	-	-	-	-	reference	-	-
Married	-	-	-	-	-	-	2976.48	-2503.83- 8456.78	0.29
Sep/Div/Wid	-	-	-	-	-	-	-318.69	-6489.12- 5851.74	0.92
Theatre									
OEF/OIF	-	-	-	-	-	-	reference	-	-
Persian Gulf	-	-	-	-	-	-	7131.87	1162.63- 13101.12	0.02
Vietnam	-	-	-	-	-	-	7104.18	-1622.29- 15830.65	0.11

PE-HBT relative to PE-IP
All values are in 2016 US dollars.
PE-HBT: Prolonged Exposure- Home based telehealth; CAPS: Clinician Administered PTSD Scale; Sep: Separated; Div: Divorced; Wid: Widowed; OEF: Operation Enduring Freedom; OIF: Operation Iraqi Freedom.

REFERENCES

Acierno, R., Gros., D. F., Ruggiero, K. J., Hernandex-Tejada, M. A., Knapp, R. G., Lejuez, C. W., . . . Tuerk, P. W. (2016). Behavioral activation and therapeutic Exposure for Posttraumatic Stress Disorder: A noninferiority trial of treatment delivered in person vs home-based telehealth. *Depression & Anxiety, 33*, 415-433. doi:10.1002/da.22476

Acierno, R., Knapp, R., Tuerk, P., Gilmore, A. K., Lejuez, C., Ruggiero, K. . . . Foa, E. B. (2017). A non-inferiority trial of Prolonged Exposure for Posttraumatic Stress Disorder: In person versus home-based telehealth. *Behaviour Research and Therapy, 89*, 57-65. doi:10.1016/j.brat.2016.11.009

Banbury, A., Roots, A., & Nancarrow, S. (2014). Rapid review of applications of e-health and remote monitoring for rural residents. *The Australian Journal of Rural Health, 22*, 211-222. doi:10.1111/ajr.12127

Bergmo, T. S. (2009). Can economic evaluation in telemedicine be trusted? A systematic review of the literature. *Cost Effectiveness Resource Allocation, 7*, 18-29. doi:10.1186/1478.7547.7.18

Blake, D. D., Weathers, F. W., Nagy, L. M., Jaloupek, D. G., Gusman, F. D., Charney, D. S., & Keane, T. M. (1995). The development of a clinician-administered PTSD scale. *Journal of Traumatic Stress, 8*, 75-90. doi: 10.1002/jts.2490080106

Broderick, A. (2013). The veterans health administration: Taking home telehealth services to scale nationally. *The Commonwealth Fund, 4*, 1-11.

Chan, D., Cheadle, A., Reiber, G., Unutzer, J., & Chaney, E. (2009). Health care

utilization and its costs for depressed veterans with and without comorbid PTSD symptoms. *Psychiatric Servies, 60*, 1612-1617. doi:10.1176/appi.ps.60.12.1612

Chen, S. & Shane, A. (2014). *Guidebook for the HERC person-level cost dataset FY1998-Present*. VA Palo Alto, Health Economics Resource Center; Menlo Park, CA.

Choi, N. G., Hegel, M. T., Marti, N., Marinucci, M. L., Sirrianni, L., & Bruce, M. L. (2014). Telehealth problem-solving therapy for depressed low-income homebound older adults. *The American Journal of Geriatric Psychiatry, 45*, 340-346. doi:10.1037/a0035461

Cohen, B., Gima, K., Bertenthal, D., Kim, S., Marmar, C. R., & Seal, K. H. (2010). Mental health diagnoses and use of VA non-mental health medical services among returning OIF/OEF veterans. *Journal of General Internal Medicine, 25*, 18-24. doi: 10.1007/s11606.009

Egede, L. E., Acierno, R., Knapp, R. G., Lejuez, C., Hernandez-Tejada, M., Payne, E. H., & Frueh, B. C. (2015). Psychotherapy for depression in older veterans via telemedicine: A randomised, open-label, non-inferiority trial. *Lancet Psychiatry, 2*, 693-701. doi:10.1016/52215.0366.15.00122.4

Egede, L. E., Gebregziabher, M., Walker, R. J., Payne, E. H., Acierno, R., & Freuh, B. C. (2017). Trajectory of cost overtime after psychotherapy for depression in older veterans via telemedicine. *Journal of Affective Disorders, 207*, 157-162. doi:10.1016/j.jad.2016.09.044

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1996). *Structured clinical interview for DSM-IV Axis I disorders. Clinical version (SCID-CV).* Washington,

DC: American Psychiatric Press, Inc.

Foa, E. B., Hembree, E. A., & Rothbaum, B. O. (2007). *Prolonged exposure therapy for PTSD.* New York: Oxford University.

Foa, E., Rothbaum, B., Riggs, D., & Murdock, T. (1991). Treatment of posttraumatic stress disorder in rape victims: A comparison between cognitive-behavioral procedures and counseling. *Journal of Consulting and Clinical Psychology, 59*, 715-732. doi:10.1037/0022-006X.59.5.715

Fortney, J., Maciejewski, M., Warren, J., & Burgess, J. F. (2005). Does improving geographic access to VA primary care services impact patients‘ patterns of utilization and costs? *Inquiry, 42*, 29-42. doi:10.5034/inquiryjrnl_42.1.29

Fulton, J. J., Calhoun, P. S., Wagner, H. R., Schry, A. R., Hair, L. P., Feeling, N., . . . Beckham, J. C. (2015). The prevalence of posttraumatic stress disorder in Operation Enduring Freedom/ Operation Iraqi Freedom (OEF/OIF) Veterans: A meta-analysis. *Journal of Anxiety Disorders, 31*, 98-107. doi:10.1016/j.janxdis.2015.02.003

Gros, D. F., Morland, L. A., Greene, C. J., Acierno, R., Strachan, M., Egede, L. E., . . . Frueh, B. C. (2013). Delivery of evidence-based psychotherapy via video telehealth. *Journal of Psychopathology and Behavioral Assessment, 35*, 506-521. doi:10.1007/s10862-013-9363-4

Gros, D. F., Strachan, M., Ruggiero, K. J., Knapp, R. G., Frueh, B. C., Egede, L. E., . . . Acierno, R. (2011). Innovative service delivery for secondary prevention of PTSD in at-risk OIF-OEF service men and women. *Contemporary Clinical Trials, 32*, 122-128. doi: 10.1016/j.cct.2010.10.003

Grube, M. E., Kaufman, K., Clarin, D., & O'Riordan, J. (2016). Health care on demand: Four telehealth priorities for 2016. *Healthcare Financial Management, 70*, 42-51.

Hilty, D.M., Ferrer, D. C., Parish, M. B., Johnston, B., Callahan, E. J., & Yellowlees, P. M. (2013). The effectiveness of telemental health: A 2013 review. *Telemedicine Journal and E-Health, 19*, 444-454. doi:10.1089/tmj.2013.0075

Hoge, C. W. (2011). Interventions for war-related posttraumatic stress disorder: Meeting veterans where they are. *JAMA: Journal of the American Medical Association, 306*, 549-551. doi:10.10001/jama.2011.1096

Hoge, C. W., Auchterlonie, J. L., & Milliken, C. S. (2006). Mental health problems, use of mental health services, and attrition from military service after returning from deployment to Iraq or Afghanistan. *JAMA; Journal of the American Medical Association, 295*, 1023-1032. doi:10.1001/jama.295.9.1023

Hoge, C. W., Castro, C. A., Messer, S. C., McGurk, D., Cotting, D. I., & Koffmann, R. L. (2004). Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *New England Journal of Medicine, 351*, 13-22. doi:10.1056/NEJMoa040603

Institute of Medicine. (2012). *The role of telehealth in an evolving health care environment: Workshop summary*. Washington, DC: The National Academies Press. Retrieved from: http://www.nap.edu/catalog.php?record_id=13466

Kim, P. Y., Thomas, J. L., Wilk, J. E., Castro, C., & Hoge, C. (2010). Stigma, barriers to care, and use of mental health services among active duty and national guard soldiers after combat. *Psychiatric Services, 61*, 582-588. doi:10.1176/appi.ps.61.6.582

Lindeman, D. (2010). Interview: Lessons from a leader in telehealth diffusion: A conversation with Adam Darkins of the Veterans Health Administration. *Ageing International, 36*, 146-154. doi:10.1007/s12126.010.9079.7

Luxton, D. D. (2013). Considerations for planning and evaluating economic analyses of telemental health. *Psychological Services*, *10*, 276-282. doi:10.1037/a0030658

Luxton, D. D., Pruitt, L. D., O'Brien, K., & Kramer, G. (2015). An evaluation of the feasibility and safety of a home-based telemental health treatment for Posttraumatic Stress in the U.S. military. *Telemedicine and e-Health, 21*, 880-886. doi:10.1089/tmj.2014.0235

Luxton, D. D., Pruitt, L. D., Wagner, A., Smolenski, D. J., Jenkins-Guarnieri, M. A., & Gahm, G. (2016). Home-based telebehavioral health for U.S. military personnel and veterans with depression: A randomized controlled trial. *Journal of Consulting and Clinical Psychology, 84*, 923-934. doi:10.1037/ccp0000135

Milliken, C. S., Auchterlonie, J. L., & Hoge, C. W. (2007). Longitudinal assessment of mental health problems among active and reserve component soldiers returning from the Iraq war. *JAMA: Journal of the American Medical Association, 298*, 2141-2148. doi:10.1001/jama.298.18.2141

Mistry, H. (2012). Systematic review of studies of the cost-effectiveness of telemedicine and telecare: Changes in the economic evidence over twenty years. *Journal of Telemedicine and Telecare, 18*, 1-6. doi:10.1258/jtt.2011.110505

Monnier, J., Knapp, R. G., & Frueh, B. C. (2003). Recent advances in telepsychiatry: An updated review. *Psychiatric Services, 53*, 1604-1609. doi:10.1176/appi.ps.54.12.1604

Morland, L. A., Raab, M., Mackintosh, M., Rosen, C. S., Dismuke, C. E., Greene, C. J., & Frueh, B. C. (2013). Telemedicine: A cost-reducing means of delivering psychotherapy to rural combat veterans with PTSD. *Telemedicine and e-Health, 19*, 754-759. doi:10.1089/tmj.2012.0298

Myers, M. B. (2003). Telemedicine: An emerging health care technology. *Health Care Manager, 22*, 219-223.

Osenbach, J. E., O'Brien, K. M., Mishkind, M., & Smolenski, D. J. (2013). Synchronous telehealth technologies in psychotherapy for depression: A meta-analysis. *Depression and Anxiety, 30*, 1058-1067. doi:10.1002/da.22165

Polgreen, L. A., & Brooks, G. M. (2012). Estimating incremental cost with skew: A cautionary note. *Applied Health Economics Health Policy, 10*, 319-329. doi: 10.2165/11632430-000000000-00000

Powers, M., Halpern, J., Ferenschak, M., Gillihan, S., & Foa, E. (2010). A meta-analytic review of prolonged exposure for posttraumatic stress disorder. *Clinical Psychology Review, 30*, 635-641. doi: 10.1016/j.cpr.2010.04.007

Ramchand, R., Rudavsky, R., Grant, S., Taniellian, T., & Jaycox, L. (2015). Prevalence mental health problems in military populations deployed to Iraq and Afghanistan. *Current Psychiatry Reports, 17*, 1-11. doi:10.1007/s11920.015.0575

Richardson, L. K., Frueh, B. C., Grubaugh, A. L., Egede, L., & Elhai, J. D. (2009). Current directions in videoconferencing tele-mental health research. *Clinical Psychology, 16*, 323-338. doi:10.1111/j.1468-2850.2009.01170.x

Rees, C. S., & Maclaine, E. (2015). A systematic review of videoconference-delivered

psychological treatment for anxiety disorders. *Australian Psychological Society, 50*, 259-264. doi:10.1111/ap.12122

Sanabria, T. J., & Orta, M. (2012). The MANIAPURE program – Lessons learned from a rural experience: Two decades delivering primary healthcare through telemedicine. *Telemedicine and e-Health, 18*, 544-548. doi:10.1089/tmj.2011.0192

Schnurr, P., & Friedman, M. (2008). Treatments for PTSD: Understanding the evidence. *PTSD Research Quarterly, 19*, 1-11. Retrieved from: https://www.ptsd.va.gov/professional/newsletters/research-quarterly/V19N3.pdf

Seal, K. H., Maguen, S., Cohen, B., Gima, K. S., Metzler, T. J., Ren, L., … Marmar, C. R. (2010). VA mental health services utilization in Iraq and Afghanistan veterans in the first year of receiving new mental health diagnoses. *Journal of Traumatic Stress, 23*, 5-16. doi:10.1001/archinte.167.5.476

Shore, P., Goranson, A., Ward, M. F., & Lu, M. W. (2014). Meeting veterans where they're @: A VA home-based telemental health (HBTMH) pilot program. *International Journal of Psychiatry in Medicine, 48*, 5-17. doi:10.2190/PM.48.1.b

Sloan, D. M., Gallagher, M. W., Feinstein, B. A., Lee, D. J., & Pruneau, G. M. (2011). Efficacy of telehealth treatments for posttraumatic stress-related symptoms: A meta-analysis. *Cognitive Behaviour Therapy, 40*(2), 11-125. doi:10.1080/16506073.2010.550058

Speyer, R., Denman, D., Wilkes-Gillian, S., Chen, Y., Bogaardt, H., Kim, J., …Cordier, R. (2018). Effects of telehealth by allied health professionals and nurses in rural and remote areas: A systematic review and meta-analysis. *Journal of*

Rehabilitation Medicine, 50, 225-235. doi:10.2340/16501977.2297

Strachan, M., Gros, D. F., Ruggiero, K. J., Lejuez, C. W., & Acierno, R. (2012). An integrated approach to delivering exposure-based treatment for symptoms of PTSD and depression in OIF/OEF veterans: Preliminary findings. *Behavior Therapy, 43*, 560-569. doi:10.1016/j.beth.2011.03.003

Tanielian, T., & Jaycox, L. H. (2008). *Invisible wounds of war: Psychological and cognitive injuries, their consequences, and services to assist recovery.* Santa Monica, CA: RAND Center for Military Health Policy Research.

Tuerk, P. W., Fortney, J., Bosworth, H. B., Wakefield, B., Ruggiero, K. J., Acierno, R., & Frueh, B. C. (2010). Toward the development of national telehealth services: The role of Veteran's Health Administration and future directions for research. *Telemedicine Journal and E-Health, 6*, 1-3. doi:10.1089/tmj.2009.0144

United States Department of Labor. (n.d.) *Consumer Price Index (CPI) Inflation Calculator.* Available from: https://www.bls.gov/data/inflation_calculator.htm.

Wade, V. A., Karnon, J., Elshaug, A. G., & Hiller, J. E. (2010). A systematic review of economic analyses of telehealth services using real time video communication. *BMC Health Services Research, 10*(233), 1-14. doi:10.1186/1472.6963.10.233

Weger, E., MacInnes, D., Enser, J., Francis, S. J., Jones, F. W. (2013). Implementing videoconferencing in mental health practice. *Journal of Psychiatric and Mental Health Nursing, 20*, 448-454. doi:10.1111/j.1365-2580.2012.01947.x

Whitten, P. S., Mair, F. S., Haycox, A., May, C. R., Willismas, T. L., & Hellmich, S. (2002). Systematic review of cost effectiveness studies of telemedicine interventions. *British Medical Journal, 324*, 1434-1437.

doi:10.1036/bmj.324.7351.1434

Wooton, R. (2012). Twenty years of telemedicine in chronic disease management: An evidence synthesis. *Journal of Telemedicine and Telecare, 18*, 211-220. doi:10.1258/jtt.2012.120219

Yuen, E. K., Gros, D. F., Price, M., Zeigler, S., Tuerk, P. W., Foa, E. B., & Acierno, R. (2015). Randomized controlled trial of home-based telehealth versus in-person prolonged exposure for combat-related PTSD in veterans: Preliminary results. *Journal of Clinical Psychology,71*, 500-512. doi:10.1002/jclp.22168

Yuen, E. K., Herbert, J. D., Forman, E. M., Goetter, E. M., Juarascio, A. S., Rabin, S., . . . Bouchard, S. (2013). Acceptance based behavior therapy for social anxiety disorder through videoconferencing. *Journal of Anxiety Disorders, 27*, 389-397. doi:10.1016/j.janxdis.2013,03,002