Original Research

The Empirical Evidence for Telemedicine Interventions in Mental Disorders

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Abstract

Problem and Objective: *This research derives from the confluence of several factors, namely, the prevalence of a complex array of mental health issues across age, social, ethnic, and economic groups, an increasingly critical shortage of mental health professionals and the associated disability and productivity loss in the population, and the potential of telemental health (TMH) to ameliorate these problems. Definitive information regarding the true merit of telemedicine applications and intervention is now of paramount importance among policymakers, providers of care, researchers, payers, program developers, and the public at large. This is necessary for rational policymaking, prudent resource allocation decisions, and informed strategic planning. This article is aimed at assessing the state of scientific knowledge regarding the merit of telemedicine interventions in the treatment of mental disorders (TMH) in terms of feasibility/acceptance, effects on medication compliance, health outcomes, and cost.* ***Materials and Methods:*** *We started by casting a wide net to identify the relevant studies and to examine in detail the content of studies that met the eligibility criteria for inclusion. Only studies that met rigorous methodological criteria were included. Necessary details include the specific nature and content of the intervention, the research methodology, clinical focus, technological configuration, and the modality of the intervention.* ***Results:*** *The published scientific literature on TMH reveals strong and consistent evidence of the feasibility of this modality of care and its acceptance by its intended users, as well as uniform indication of improvement in symptomology and quality of life among patients across a broad range of demographic and diagnostic groups. Similarly, positive trends are shown in terms of cost savings.* ***Conclusion:*** *There is substantial empirical evidence for supporting the use of telemedicine interventions in patients with mental disorders.*

Key words: *telemental health, telepsychiatry, telemedicine, evidence, mental health disorders*

Introduction

This is the fourth in a series of articles reporting on the empirical evidence concerning the feasibility/acceptance and impact of telemedicine interventions in disease management and specified health disorders. This article focuses on the role of telemedicine interventions in mental health disorders, a major problem affecting over 450 million people worldwide, including over 60 million adults and 7 million children and adolescents in the United States. For diagnostic purposes, to qualify as a disorder, a mental or emotional state must cause dysfunction.[1] Throughout the article we use the term "telemental health" (TMH) rather than "telepsychiatry" (both are used in the literature) because we want to incorporate in our review of the empirical evidence the full range of mental health disorders, the modalities of treatment, and the other mental health providers in addition to psychiatrists, including psychologists, psychiatric social workers, therapists, and nurses.

We start the article with basic information on the nature of mental disorders and their etiology, classification, epidemiology, and cost, as well as resources and treatment. This is intended to serve as an appropriate background for understanding the role of telehealth interventions or TMH in the diagnosis and treatment of mental disorders and where and how TMH fits in the healthcare system. It may also shed light on the reasons behind the reported evidence in the research literature. The introductory information is followed by an initial review of the feasibility and acceptance of TMH by its intended target population, as well as a detailed analysis of the empirical evidence from robust scientific studies (defined as mostly randomized clinical trials [RCTs] with samples of ≥150) in terms of intermediate outcomes, health outcomes, and cost. The time frame for the analysis is the decade from 2005 to 2015. The information on feasibility/acceptance is sorted by age groups: children (usually 12 years of age and younger); adolescents (usually 12/13–17/18 years of age), adults (usually

18/19–64/65 years of age); and elderly/geriatric (usually 65 years of age or older). (The age limits are approximate for each group as specific age categories for each are not used uniformly in the literature.) The available evidence on health outcomes and cost is presented without differentiating age groups because it did not lend itself for this distinction.

A careful review of the research literature reveals that the TMH intervention is not monolithic or unidimensional. Instead, it consists of several combinations of mental health disorders (typically depression, anxiety, and substance-related disorders), treatment modalities, patient and provider mixes, technological configurations, and settings. Similarly, the effects of TMH are measured by various indicators, consisting of combinations of access, quality, and cost. The presentation of the evidence takes these complexities into account as it must. Hence, conclusions drawn from the empirical studies are tempered by the context and characteristics of each set of data under review. Accordingly, it was deemed necessary to include basic information on the research methodology used (research design, sample size, and measurement tools), technological configuration, study population (age and gender groups), specific attributes of the intervention (e.g., type of mental disorder, type of intervention, duration, and intensity), and statistical tools for presenting the findings. The conclusions drawn from these findings go beyond a simple tally or voting scheme whereby studies under review are given equal weights in confirming or rejecting an overarching hypothesis. Instead, they are related to the specific context and attributes of each study. We believe this justifies the level of detail provided in this review.

Mental Disorders

The American Psychiatric Association defines mental disorder as a major disturbance in an individual's thinking, feelings, or behavior that reflects a problem or disruption in mental function.[2] However, there is no uniformly explicit definition of what constitutes mental function in all circumstances. Mental disorders are usually viewed as being separate from neurological disorders, learning disabilities, or intellectual limitations. Frequently, they cause substantial distress or disruption in social, occupational, and/or family relationships. Hence, people with such disorders may fail to meet important obligations or expectations in everyday life, work, or school.

The diagnostic categories of mental disorders are normally presented as medical diseases, but they are not tested or validated the same way as other diseases. They include disorders in certain aspects of human behavior and personality such as abnormal depression, anxiety, and psychotic disorders. They involve *fears* that interfere with normal functioning, intense and sustained *sadness and despair* (unipolar) or fluctuations from abnormally "high" to depressed mood states (bipolar), *distorted views of reality*, including delusions, hallucinations, and thought disorders (schizophrenia), and abnormally *rigid or maladaptive behavior and personality* disorders such as paranoia, antisocial, borderline, or narcissism. They may also include a variety of other disorders, including aberrant behaviors in relation to food, sleep, impulse, sex, conduct, and development, as well as factitious, relational, and dissociative disorders. In addition, there are several uncommon psychiatric syndromes, typically named after the person first describing them. These include Capgras (misidentification delusion), DeClerambault (delusion of high status person in love with them), Othello (morbid jealousy regarding infidelity of a spouse or partner), Ganser (mimic of serious symptoms to attract attention), Cotard (delusion of being dead), Ekborn (involuntary movement or prickly sensations of legs), Couvade (sympathetic pregnancy), and Geschwind (temporal lobe epilepsy).

The disruptive manifestations of mental disorders are not uniform in all individuals, and the degree of associated disability in the same individual may vary over time and life conditions. Paradoxically, some mental disorders can have positive manifestations such as higher levels of creativity, unusual cognitive abilities as in the phenomenon of the unfortunate misnomer of "idiot savant" seen in autism, nonconformity, goal-striving, meticulousness, or empathy. Similarly, charismatic and powerful community leaders not uncommonly have strong antisocial and narcissistic personality traits, and some have been historically called "creative psychopaths."

It is important to note what is not a mental health disorder or psychiatric illness and therefore does not require treatment. For example, transient response to trauma or loss, as well as feelings of anxiety, distress, or anger in response to the loss of a loved one or to lack of success at work or sporting activities, may be normal and do not constitute, in and of themselves, mental disorders. Mental disorders are explicitly defined with specific sets of symptoms, and our understanding of these symptoms and associated problems will continue to evolve as our knowledge of biological, psychological, and social roots and manifestations develops.

ETIOLOGY OF MENTAL DISORDERS

The causes of mental disorders are complex, and they vary by particular disorder, individual, adversity experience, and challenging circumstances during early stages of growth and development. Biological, psychological, and environmental factors all contribute to the development and/or exacerbation of mental disorders, and most mental disorders are a result of a combination of several "biopsychosocial" factors rather than just a single factor. Moreover, there is no single diagnostic test

for mental illness. Some illnesses, such as schizophrenia and depression, have been linked to abnormal functioning of brain circuits and pathways related to both neuro-anatomical and neurophysiological abnormalities. Susceptibility to a range of disorders can be passed on genetically. However, an individual's genes interact with and respond to the environment in unique ways, even in identical twins, depending on cultural, ethnic, and social background and environment. Furthermore, although some combinations of factors may influence or trigger mental illness in some people, they do not in others. Physical illnesses, including infections, brain damage, prenatal defects, substance abuse, toxins, and poor nutrition, as well as psychological factors, such as childhood trauma, bereavement or separation of families, early parental neglect, rejection or harsh discipline, and drug abuse, may contribute as triggers or causes of mental disorders. All this is further complicated by the fact that particular pathways to mental disorders are not well understood, and psychoanalytic theories, as well as cognitive–behavioral and systemic paradigms, continue to evolve.

Classification of Mental Disorders

There are two prevailing systems for the classification of mental disorders:

1. *Diagnostic and Statistical Manual of Mental Disorders* (DSM), first published by the American Psychiatric Association since 1952.[2] The latest version, DSM-5, was published in 2013 after a 14-year process of revisions and editing. The purpose of the DSM is to create a common language for healthcare providers who diagnose mental illnesses. Just as new discoveries are made throughout medicine, the DSM is a living and constantly evolving set of classifications based on the available scientific knowledge and professional viewpoints.
2. *International Classification of Diseases (ICD-10), Chapter V*, issued by the World Health Organization since 1949 and widely used in health institutions for various functions.

In addition, there are other classifications, including the Chinese Classification of Mental Disorders and the *Psychodynamic Diagnostic Manual*, which classifies the general location an individual occupies on a continuum from healthier to more disordered functioning. The *Psychodynamic Diagnostic Manual* separates neurological disorders and learning or intellectual disabilities from mental disorders. It also considers cultural distinctions applied to psychiatric conditions. Of these classifications, DSM-5 is the most widely used by professional providers around the world to define and diagnose mental disorders.

DSM-5 is organized in sequential order over the developmental lifespan, and it reflects what has been learned about brain function and how genes and the environment influence a person's mental health and behavior. It contains 20 chapters with major groupings or headings, including the neurodevelopmental disorders, the schizophrenia spectrum and other psychotic disorders, bipolar and related disorders, depressive disorders, anxiety disorders, and substance-related disorders, among others.

Epidemiology of Mental Health Disorders

Attempting to determine the incidence and prevalence of mental disorders in any population or subset of the population has proven to be difficult. Numerous population-based surveys include questions pertaining to mental/behavioral issues. However, very few of these surveys provide prevalence estimates of *diagnosable disorders*. This is all the more problematic when trying to estimate the prevalence of specific mental illnesses in the general population.

The results from three large-scale national surveys have provided national estimates of the rates of diagnosable mental illnesses.[3] These include the National Comorbidity Survey Replication, the National Comorbidity Survey Replication Adolescent Supplement, and the National Survey on Drug Use and Health. As described by Bagalman and Napili,[3] the first two surveys have the advantage of identifying specific mental illnesses, but they are over a decade old. The National Survey on Drug Use and Health does not identify specific mental illnesses, but it has been conducted annually.

Mental disorders are common. For instance, in 2012 it was estimated that 43.7 million adults in the United States (nearly one in five, or 18.6% of all adults) had diagnosable mental disorders, excluding alcohol and substance abuse.[4] The 12-month prevalence rate of schizophrenia was 1.1%, whereas 4.1% of adults met the criteria for "serious mental illness," including schizophrenia and the major mood disorders that cause serious and persistent functional impairment.

Suicide is one extreme manifestation of mental disorder, and it ranks as the 10th leading cause of death in the United States. It is more common than homicide. Tragically, it is the third leading cause of death among those 15–24 years of age.[5] Military veterans make up 20% of deaths by suicide. Suicide rates have increased by about 10% since 1999, and in 2007 there were 11.2 per 100,000 people, or approximately 45,000 people per year, in the United States alone. In 2013, 16.8 million adults (7% of all U.S. adults) had an alcohol use disorder,[6] and 2.8% of adolescents 12–17 years of age had the same problem. About 13 million adults received service at a specialized alcohol treatment facility. Nearly 88,000 people died from alcohol-

related causes, making this problem the third leading preventable cause of death in the United States. Substance disorders are also commonplace,[7] with abuse of both licit and illicit drugs increasing over the past decade. For instance, over 40% of high school seniors reported drug abuse in 2014. These disorders are commonly associated with major unintended debilitating consequences, such as motor vehicle accidents, human immunodeficiency virus/AIDS, hepatitis C, various cancers, homicide, suicide, and incarceration, as well as "spillover" negative effects on the unborn, families, and society at large.

More than a quarter of homeless people are believed to have a "serious mental illness" (including schizophrenia, bipolar and major mood and anxiety disorders, and longstanding substance abuse), as do over 20% of both federal and state prisoners. Indeed the largest single "psychiatric institution" in the country is the Los Angeles County Jail, where more than 800 psychiatrically ill prisoners are housed.[8]

Globally, unipolar depression is the third leading cause of disability. Schizophrenia is the most individually disabling mental disorder, but it is less common in comparison with other disorders. Alcohol abuse accounts for 23.7 million daily adjusted life-years (DALYs) (number of life years lost due to premature death), schizophrenia for 16.8 million DALYs, bipolar disorder for 14.4 million DALYs, panic disorder for 7 million DALYS, obsessive compulsive disorder for 5.1 million DALYS, and posttraumatic stress disorder (PTSD) for 3.5 million DALYs.[7]

Mental Health Resources and Treatment

Currently, there are about 40,000 psychiatrists in the United States, as well as an estimated shortage of about 10,000–20,000. However, there are even more serious shortages of child and adolescent as well as geriatric psychiatrists.[9] The average age of the current cohort of psychiatrists is about 56 years. Over the next 10 years, large numbers of this cohort will retire at a time when insufficient replacements are being trained. Amid a growing demand for mental health services, the nation is at the threshold of a severe shortage of psychiatrists. Similar shortages are also occurring in the number of physicians entering primary care, where most patients with mental illness are treated. Fortunately, other mental health professionals, such as psychologists, nurse practitioners, and psychiatric social workers, are not in such short supply and are increasingly assuming primary treatment roles either independently or as physician extenders in a team.

The treatment of mental disorders has changed dramatically over the past several decades with the potential impact of improved prevention and early intervention, reduction of stigma associated with such disorders, mainstreaming mental illness back into the general health system, including the passage of mental health parity law (requiring health insurers to cover mental health and substance abuse services in no more restrictive terms than all medical/surgical benefits), and the development of new pharmacotherapies and psychotherapies. At the same time, in the United States, the mental health system is faced with the situation where most outpatient psychiatric care is provided in the local community in a primary care setting, whereas inpatient psychiatric care is provided in highly institutionalized or correctional settings. For example, in 2008 13.4% of U.S. adults received professional treatment for a mental health disorder, although only 58% of those with a serious mental illness and about half of children with a diagnosable psychiatric disorder did so. Nearly 25% of all patients seen in primary care have a psychiatric disorder, and increasing numbers of psychiatrists and other mental health providers are now involved in collaborative or integrated care programs with primary care providers (PCPs). Still, only 10% of mental health patients are treated by a psychiatrist. It is important that only an estimated 50% of the patients seen by PCPs are accurately diagnosed,[10] yet the primary care setting has become the *de facto* mental health outpatient system in the United States.[11] Typically, PCPs tend to undertreat and underprescribe appropriate medications.

The prevalence of mental health disorders and their serious consequences have not been matched by a commensurate expansion of resources for treatment. Indeed, the number of inpatient psychiatric beds has decreased dramatically throughout the country, a trend that started in the 1960s. For example, from 1995 through 2012 California lost 30%, or more than 2,800, of its mental health beds, while its population has increased by over 5 million.[12] Many patients, especially those with psychoses, have ended up incarcerated in jails or prisons, which have become America's "new asylums."[13] In 2012 there were an estimated 356,268 inmates with severe mental illness in prisons and jails. An estimated 35,000 patients with severe mental illness are housed in state psychiatric hospitals, whereas the number of mentally ill persons in correctional institutions was 10 times the number of residents in state hospitals.[13]

In brief, the majority of patients with mental health disorders are being treated either as outpatients in primary care settings or as inpatients in the correctional system, with emergency departments and acute care hospitals acting as overburdened and reluctant intermediaries, victims of the law of unintended consequences associated with the partial implementation of the community mental healthcare movement and the closing of mental hospitals starting in 1963. Access to expert mental healthcare in both primary care and correctional environments can be difficult as the majority of psychiatrists and therapists

work in other settings. Hence, it is not surprising that in 2015 TMH programs are increasingly being used to support patients within those environments—a move that expands on the original aim of most telepsychiatry programs, which was aimed largely to serve patients in geographically remote and medically underserved areas.

Cost of Mental Health Disorders

The costs of mental illness are enormous, with estimates from 2007 at almost $200 billion in lost earnings per year,[14] whereas mood disorders, such as depression, are the third most common cause of hospitalization in the United States.[15]

The total costs associated with mental illness are based on the direct expenditures for mental health services and treatment (direct costs) and from productivity losses due to disability caused by these disorders (indirect costs). In 2015 the National Institute of Mental Health estimated the total costs associated with serious mental illness to be in excess of $300 billion per year.[4] Moreover, the care of patients with comorbid medical and behavioral conditions accounts for up to one-half of all healthcare spending.[11] Patients with comorbid psychiatric disorders (such as depression) and chronic medical disorders (such as heart failure, chronic obstructive pulmonary disease [COPD], diabetes) are less likely than others to adhere to prescribed regimen, such as diet, exercise, smoking cessation among smokers, and medication compliance, and are more likely to have increased functional impairment and risk of medical complications and mortality.

In 2010, mental and behavioral disorders were estimated to make up 7.4% of the global burden of disease, with unipolar depressive disorders, anxiety disorders, and drug and alcohol use disorders (in order of decreasing burden) accounting for 76% of the burden of this category of disorders. The global cost of mental health disorders alone was estimated at $2.5 trillion in 2010, with a projected increase to over $6 trillion in 2020.[15]

TMH

Like telemedicine/telehealth,[16] TMH is a broad term referring to the provision of mental healthcare at a distance.[17] Also, as with telemedicine/telehealth, the distance involved can extend beyond geography and may include temporal, economic, cultural (e.g., language, acceptability), psychological (e.g., stigma, discomfort), or some combination of one or more of these aspects.

A burgeoning literature reveals that TMH includes a wide range of applications, providers, and settings. These incorporate mental health assessment, treatment, patient education, monitoring, and collaboration with PCPs. TMH providers and staff include psychiatrists, nurse practitioners, physician assistants, psychologists, and counselors, as well as PCPs and their teams. In turn, TMH patients can be located in free-standing clinics, hospitals, long-term care/assisted living facilities, prisons, schools, and homes.

Historically, the use of interactive television—the precursor of videoconferencing—in mental health can be traced to the 1956 and 1957 pioneering work of Wittson and Dutton[18,19] at the Nebraska Psychiatric Institute. In 1955, they used closed-circuit interactive television for live transmission of therapy sessions for educational and training purposes. Subsequently, through a "special hookup" engineered by the Northwestern Bell Telephone Company, they experimented with interactive television to extend psychiatric teaching to affiliated hospitals not only in Nebraska, but also in North and South Dakota as well as Iowa—perhaps the first interstate telecommunication network for health purposes. In 1968 telepsychiatry services were provided for airport employees and eventually the local community, via a microwave bidirectional television linking Massachusetts General Hospital in Boston with the Medical Station at Logan International Airport (about 2.7 miles distant).[20] In 1970 a second closed-circuit link was established between Massachusetts General Hospital and Bedford Veterans Administration Hospital some 20 miles distant as well as to junior high schools in the area.

Since that time, interest in and implementation of TMH have burgeoned. Today, TMH is one of the more active telemedicine applications in the United States. The primary impetus for this specific application now, as it was a few decades earlier, is similar to that of telemedicine generally—namely, to serve unmet health needs for professional resources, now aided by advancing capabilities of an ever-evolving and ubiquitous technology and the promise to improve access to quality healthcare while containing or restraining the rising cost of care.

Just as a wide range of distances, applications, providers, and settings are included under the TMH umbrella, so too are the modes of telecommunication. This is due in part to assumed "appropriateness" of each technology for each application—coupled with the continued evolution of telecommunication technologies. Of course, technology has evolved from the closed-circuit television and synchronous telephone connections of Wittson and Dutton[18,19] to today's multifaceted technology that enables the efficient capture, transmission, processing, and storage of vast amounts of information, also widely available on a mobile platform.[21] The emerging technologies and asynchronous applications hold considerable promise for expanding the reach of professional mental expertise and resources to a widely dispersed patient population.[22,23]

Feasibility and Acceptance of TMH

This initial discussion is directed toward studies that assessed the feasibility and/or acceptance of TMH in the diagnosis and treatment of mental health disorders. A systematic review of the literature published in 2004 found only 27 studies assessing videoconferencing in child and adolescent telepsychiatry; only 2 of these studies fell into the highest (RCT) category, whereas 24 represented descriptive studies or editorials. For the present analysis, we conducted a Medline/PubMed search using the terms (telemedicine or telehealth) and (psychotherapy or psychiatry or mental health) for the period 2005 through February 2015. In total, 1,362 abstracts were identified. Subsequently, within this group, a search was conducted for abstracts listing "feasibility or acceptance studies" in the Medical Subject Headings listing or for "feasibility" listed in the publication title, abstract, or conclusions. In total, 56 publications were identified as "feasibility studies," and an additional 42 publications included "feasibility" or "feasibility study" in the title or abstract. We did not use the sample size criterion ($n \geq 150$) for feasibility/acceptance studies. However, we limited this review to studies that had samples of 30 or more cases. This resulted in a final list of 22 publications for full review. The findings are presented by age group in chronological order.

PART I. CHILD AND ADOLESCENT

A small ($n = 30$) evaluation study published in 2007 assessed the feasibility/acceptance of a telephone-administered behavioral treatment (TAT) versus standard Triptan treatment (TT) for adolescent migraine.[24] The adolescents, 12–17 years of age, had persistent migraines with an average duration of 4 h per episode. They were randomly assigned to a 2-month TAT program ($n = 15$) or the standard TT ($n = 15$). Each participant maintained a daily migraine diary pertaining to the number, duration, and severity of migraines and migraine-related disability, and they completed a Migraine Specific Quality of Life Questionnaire–Adolescent. The TAT group showed improvements in key behavioral management skills following treatment, and both groups reported significant decreases in migraine and migraine disability and Migraine Specific Quality of Life Questionnaire–Adolescent score. Despite the small sample size, results suggested that telephone-based TAT is a promising platform for underserved adolescents.

Results from a 1-year observational study ($n = 172$) of the feasibility, acceptability, and sustainability of TMH for children and adolescents living in nonmetropolitan communities were published in 2007.[25] A high-resolution videoconferencing system connected psychiatrists at a children's hospital in Seattle, WA with patients (ranging from 2 to 21 years of age [mean age, 8.6 years]) served by primary care physicians in four nonmetropolitan sites in Washington State. In total, 387 sessions were conducted. Attention-deficit disorders accounted for 45% of the encounters; other problems were disruptive behavior disorders (8%), developmental disorders, including autism spectrum (14%), anxiety disorders (6%), adjustment disorders (5%), tic disorders (1%), and other disorders (5%). Referring physicians rated 11 items referring to their agreement/satisfaction with various aspects of the videoconferencing encounters. Physicians were satisfied or highly satisfied with 10 or 11 aspects of these encounters. Additionally, pediatricians were more supportive of TMH compared with primary care physicians. The study concluded that "telepsychiatry is a feasible and acceptable approach to providing psychiatric serves to youths in underserved communities."

As part of a larger study, a retrospective analysis ($n = 139$) was conducted of diagnostic and clinical outcomes of a convenience sample of children (mean age, 10.7 years) referred from PCPs in Northern California who received a complete psychiatric diagnosis via videoconferencing.[26] The study assessed changes in scores on the Child Behavior Checklist from time of intake to 3 months postconsultation. Each time a PCP sought a psychiatric consultation, "he or she could opt for either a curbside consultation via telephone or secure messaging or a live, two-way videoconference consultation using the traditional consultation-liaison model." Overall, attention-deficit (36%) and mood (28%) disorders were the most common diagnostic groupings. Using a "repeated-measures multivariate analysis of variance" design, results indicated high satisfaction with the program. More important is that a wide spectrum of psychiatric disorders in children, including anxiety, cognitive decline, depression, and psychosis, could be diagnosed via a multimedia program combining videoconferencing, telephone, and secure e-mail. The authors also reported that following a single videoconference consultation, a 3-month postintervention assessment showed improved mental health.

A small RCT ($n = 58$ rural children and their families) published in 2013 addressed the feasibility and acceptance of treating pediatric obesity through telemedicine.[27] This was the first study to examine the effectiveness of family-based behavioral group sessions delivered to rural children via videoconferencing. The targets were 3rd through 5th grade students. After the first set of sessions, intervention and control groups met for an additional 6 months of follow-up. Group leaders included licensed psychologists experienced with weight management issues or "graduate level students/postdoctoral fellows who had observed one group session and received training in weight management from a research team member." Children and families in the control group agreed to

meet with their PCP to discuss a standardized list of pediatric obesity-related topics. Baseline measures included body mass index, 24-h dietary recall, and physical activity via a small, light-weight device (ActiGraph, Pensacola, FL) worn on an adjustable belt that measures physical activity duration and intensity. There were no significant changes in baseline follow-up measures of child body mass index, 24-h diet recall, activity, Child Behavior Checklist, and behavioral pediatrics feeding assessment. However, both groups experienced positive changes in health behavior.

Unlike the feasibility studies reported thus far, included here is a special study initiated in 2008 and published in 2013 focusing on the feasibility of conducting RCTs of TMH among children diagnosed with attention-deficit/hyperactivity disorder (ADHD) in underserved communities.[28] This was the first such trial to target children aimed at assessing the degree to which TMH can improve treatment rendered "by primary care providers practicing in underserved non-metropolitan areas." Therefore, the findings from this study were also published in 2015 and will be reported here as well as later under "health outcomes."

Video teleconferencing was used in a Children's ADHD TMH Treatment Study in seven underserved communities ranging from 11 to 268 miles from Seattle. Initially, 150 referring PCPs and 223 predominantly white children (60 females and 163 males) suspected of having ADHD (ranging in age from 5.5 to 12.9 years) participated in the study. Those assigned to "active participation" (Group A) received six sessions of two components each spaced 4 weeks apart. One component consisted of an algorithm-driven pharmacological treatment for ADHD provided over video teleconferencing by a child psychiatrist and included education on the neurobiology of ADHD. The second component involved six in-person sessions of caregiver training adapted from evidence-based guidelines for treating ADHD in children. These sessions were conducted in-person by community therapists trained and supervised remotely by a clinical psychologist at the research hub. Children assigned to the control group (Group B) received treatment as usual (TAU) with the PCP video teleconferencing single consultation with a child psychiatrist who then communicated treatment recommendations to the PCP. Group A telepsychiatrists had 91.6% reliability in terms of adherence to protocol versus 89.3% for Group B. Therapists adhered to the intervention protocol with 94.2% reliability. The research concluded that video teleconferencing (and newer) technology can be reliably used to provide "efficacious intervention" to children deprived of specialty mental healthcare services and to train community-based therapists in evidence-based psychotherapies.

Depression among adolescents was the focus of a study published in 2014 that assessed the feasibility of a "brief web-based behavioral activation (BA) intervention."[29] This study was part of a larger investigation focusing on an evidence-based/informed Web intervention for adolescents and their families affected by disaster. Formal usability data were obtained from 24 local adolescents (recruited from psychiatric clinics on a university campus), and preliminary usage data were obtained from 2,000 adolescents recruited from tornado-affected locations in Alabama and Missouri. The participants' mean score on the Center for Epidemiologic Studies Depression Scale-10 was 13.5, and 29% obtained a clinical cutoff score of 15 or greater. (Screening test scores for the Center for Epidemiologic Studies Depression Scale were as follows: <15; 15–21 = mild to moderate depression; and >21 = major depression.) The behavioral intervention proved to be effective in treating depression. While focusing attention to the local environment and "triggers and maladaptive coping strategies," the intervention provided clues regarding the cause and persistence of depression. A qualitative assessment of the formal usability evaluation resulted in an estimated 96% positive response to the BA's helpfulness for depressed individuals, with 67% responding favorably in comparison with increasing knowledge about depression and treatment and 42% pertaining to applicability to a wide range of people.

PART II. ADULT

Published in 2006, a study conducted in Germany between 2002 and 2005 assessed the feasibility of an open-access Internet inquiry aimed at improving quality of life (QoL) for individuals with three or more upper or lower gastrointestinal symptoms.[30] QoL was evaluated using a general well-being inventory: a 22-item scale with six subscales (anxiety, depression, general well-being, self-control, health, and vitality). A total of 3,316 individuals completed the inventory assessment (2,160 females, 1,156 males; average age, 37.7 years). Their responses were compared with trends in the general population. Upon submission of the symptom questionnaire, individuals with more than two upper or lower gastrointestinal symptoms were offered a Patient General Well-Being Inventory, which assesses the psychological aspects of health-related QoL (HRQoL) and is not specific for gastrointestinal symptoms or diseases.[31] Women and non-working respondents reported significantly lower QoL than their counterparts. As well, males scored higher than females on the anxiety scale. The study concluded that an open Internet inquiry is feasible for symptom and QoL assessment and that it generates data comparable to other sources of assessment.

A study (RCT; $n=282$) published in 2007 assessed the efficacy of supportive telephone calls postdischarge for addictive patients.[32] Subjects were selected from four National Institute on Drug Abuse short-term residential and inpatient addiction treatment centers. The intervention group received telephone counseling to encourage compliance with aftercare over a 12-week period postdischarge. Those in the control group were not contacted from the time of discharge, but they received a call to make an appointment at the end of the study period. Counselors encouraged compliance with the continuing care plan including attendance at outpatient counseling, participation in Alcoholics Anonymous, and other needs-dictated services. "No difference was found between groups in self-reported attendance at one or more counseling sessions after discharge."

Attitudes toward medical and mental healthcare delivered via telehealth among rural ($n=112$) and urban ($n=78$) primary care patients were examined in a study published in 2008.[33] Also examined were attitudes toward telehealth applications among a subset of patients with PTSD. Several instruments were used in the study: (1) the Stressful Live Events Screening Questionnaire—Modified; (2) the DMV-IV-based Posttraumatic Stress Disorder Syndrome Scale-Self Report; and (3) the Telehealth Attitudes Questionnaire developed for the study. Approximately 78% of rural patients and 72% of urban patients were "moderately" or "extremely" satisfied using TMH at the clinic. However, 44% of rural patients and just over 51% of urban patients strongly preferred face-to-face visits. Only 15.8% of rural respondents and 13.4% of urban respondents strongly preferred TMH visits. In each instance, however, these percentages increased significantly as proposed travel times increased to 2 h. The data suggest that both rural and urban patients are moderately receptive to TMH. There was a positive association between receptivity and distance from sources of care.

Following up on earlier studies on brief alcohol intervention (BI),[34,35] a study published in 2008 explored the feasibility and efficacy of interactive voice response (IVR) to enhance BI in primary care settings.[36] In total, 338 patients (≥21 years of age) served by 112 providers in 15 primary care clinics in Vermont were recruited from April 2000 to July 2003. They were randomized initially to one of four study groups: (1) no IVR (BI and standard follow-up treatment); (2) IVR (daily phone calls for 6 months to the automated IVR touchtone telephone to report alcohol consumption and other items in the previous 24 h); (3) IVR with feedback (6 months of daily calls plus monthly feedback [mailed printed graph of consumption pattern plus personal notes]); and (4) IVR with feedback and compensation (graph plus notes) plus financial incentive based on frequency of the participant's daily calls. Randomization to this group was discontinued. All providers were trained to inquire about drinking problems and how to conduct BI when appropriate.

There were no consistent differences in overall distribution of calls across the three IVR groups. However, the highest percentage of calls was made by Group 4 (57%) versus 37% by Group 1. Ninety percent of patients used the system regularly at least some of the time. For those remaining engaged with the IVR (95%), the calling rates were high. Feedback in the form of graphs received the highest ratings *vis-à-vis* awareness of drinking, more so than feedback from a physician. The authors concluded that the "technological simplicity, low cost, and easy accessibility of IVR make it an attractive option for use in primary care settings as an intervention or intervention supplement."

A study conducted at the Betty Ford Center published in 2008 assessed the feasibility of extending residential care through telephone-based focused continuing care (FCC) to assist and support patients transitioning from residential treatment to longer-term recovery in the "real world."[37] The study reports on FCC patient utilization and outcomes derived from scheduled telephone calls (twice monthly for 3 months and subsequently once a month for a year) to patients ($n=4,094$) who had successfully completed residential treatment. About three-quarters of the patients had alcohol problems. During each phone call, the patient's status was gauged via a short survey. This information was used to guide clinical responses. Thirteen percent of the patients completed only calls scheduled during the first 6 weeks. Conversely, 87% completed at least one call 8 or more weeks postdischarge. Overall, 95% of the patients reported attending 12-Step meetings at some point during the FCC period. Patients completing five or more FCC calls were more likely to report attending 12-Step meetings compared with those completing fewer calls. Also, with one exception, patients completing five or more FCC calls were significantly more likely to report maintaining sobriety. The number of completed FCC calls was a significant predictor of alumni contact and retaining a sponsor. Thus, the authors concluded that "a unique and positive effect of FCC 'dose' was demonstrated for some outcomes."

Videoconferencing-based smoking-cessation interventions for rural and remote areas was the focus of an observational study ($n=554$: 370 urban and 184 rural) conducted from 2005 through April 2008 in Alberta, Canada, and published in 2012.[38] Urban participants (Calgary) were offered in-person service, and rural residents received videoconferencing. Without the use of this technology, the rural participants would not have had access to group smoking cessation

programs. The program was conducted in eight 90-min sessions over a 15-week period. Upon program completion, continuous abstinence rates, using a conservative intent-to-treat method, were 27.5% in Calgary and 25.5% for the rural telehealth sites. Using only available data, the percentages of participants who quit smoking were somewhat higher in Calgary (39.2%) versus the rural sites (37.2%). No significant differences in smoking cessation rates were observed between the in-person and telehealth programs. Thus the study demonstrated the effectiveness of a behavioral smoking-cessation program using telehealth technology in terms of its equivalence to in-person treatment.

The feasibility and acceptance of clinic-based TMH for low-income Hispanic primary care patients with major depression were the subject of an Arizona study published in 2012.[39] In total, 167 adult patients recruited from a community health center were randomly assigned to receive mental health service through Webcams and the Internet (WEB) ($n=80$) or to TAU ($n=87$). The 6-month study consisted of monthly sessions at the community health center conducted by Hispanic psychiatrists. The usual care group received care from their usual PCPs, not psychiatrists. Acceptance was assessed in terms of appointment keeping, relationship with the provider, satisfaction with visit, and antidepressant use. Feasibility/effectiveness was assessed in terms of depression outcomes, opportunity costs (unproductive or days lost from work), and show-up rates. No significant differences were observed between the WEB and TAU groups in terms of keeping appointments. However, WEB patients used antidepressant medications more than TAU patients, and they were also more satisfied with their visits with psychiatrists.

An RCT study ($n=79$) investigated the feasibility and acceptance of a TMH among Latina women with depression during the perinatal period and was published in 2012.[40] A culturally sensitive, short-term Perinatal Mental Health Model was developed to ameliorate barriers to diagnosis and intervention. The Perinatal Mental Health Model combined on-site screening and obstetrics/gynecology clinic resources and follow-up designed specifically to be delivered by telephone. Emotional support was also provided during the telephone contacts. A subsample of the mothers ($n=31$) completed a satisfaction questionnaire at the end of the intervention. Nearly all reported that mental health workers were knowledgeable, understood their situation, and provided all the assistance required.

Also published in 2012, a 6-month RCT ($n=120$) was conducted in Australia among adults with type 2 diabetes. It used an automated, interactive telephone link to improve diabetes management as well as HRQoL.[41] Participants were randomly assigned to the intervention or usual care group. HRQoL was assessed by the participants at baseline and at 6 and 12 months. The summary score improved in the intervention group but decreased marginally in the usual care group. No differences were observed in the two groups in physical health indicators. The authors concluded that "with increasing accessibility to and feasibility of such telehealth interventions, the TLC diabetes has excellent potential to be 'scaled up' and deliverable to large numbers of individuals with diabetes."

A two-arm RCT ($n=400$) was conducted in Germany in 2013. It examined the feasibility, acceptability, and effectiveness of Web-based rehabilitation following inpatient psychosomatic treatment.[42] Self-report measures were observed at 3 and 12 months. Those in the intervention group were better able to stabilize or maintain their inpatient treatment outcomes than participants in the control group. The study concluded that the intervention was feasible, acceptable, and effective in sustaining treatment outcomes after hospitalization.

A study published in 2014 assessed the feasibility of adapting dissonance-based (DB) programs to reduce eating disorder risk for online use.[43] Undergraduate women ($n=333$) were recruited from a volunteer pool at a public university in the mid-Atlantic region of the United States. They were subsequently separated into three groups: face-to-face DB ($n=107$), online DB ($n=112$), and assessment-only ($n=114$). There were no significant differences between the two modes of program delivery in terms of "body dissatisfaction" or eating disorder symptoms. Hence, the authors concluded that DB prevention programs "can be successfully adapted for online use."

PART III. THE ELDERLY

Using the search terms "elderly," "older," "aged," and "geriatric" occurring in Medical Subject Heading terms accompanying abstracts or in titles and goals/objectives listed in a study abstract, a subset of 36 studies was identified among the feasibility/acceptability abstracts as being concerned with/focused on the elderly. Of these, only five studies had samples more than 50 cases, and these will be reported here.

A pilot observational study ($n=101$) published in 2006 assessed the feasibility of a nurse "double-disease" telephonic management program for depression and congestive heart failure.[44] It focused on collaborative care (CC) for patients who have both heart failure and depression.[45] Only 24 completed the program. The telephonic intervention included an initial call to establish a working relationship between the nurse and patient, an assessment of adherence to the physician's treatment plan, an evaluation of side effects from medication, and subsequent calls to administer the Patient Health

Questionnaire (PHQ). The telephonic nurse care manager assisted the patients in adhering to recommended treatments and also provided emotional support. The majority of depressed patients improved significantly PHQ scores. Elderly patients with heart failure and depression were willing to cooperate with the care coordination program. The investigators concluded that the nurse-based telephonic intervention was feasible and effective for patients with congestive heart failure and depression.

In 2008, an RCT ($n=58$) was conducted among Veterans Health Administration (VHA) patients with bipolar disorder and at high risk for cardiovascular disease.[46] The study focused on feasibility/acceptance of a manual-based medical care model (BCM) designed to improve medical outcomes among older patients. It was conducted at a large VHA mental health facility in western Pennsylvania. The nearest VHA general medical clinic was about 7 miles away. The intervention included three components: patient self-management, care management, and dissemination of guidelines for the treatment of bipolar disorder. These components were deemed necessary for optimal health outcomes. Patients assigned to the control group continued to receive care through their usual providers but did not receive the BCM self-management or care management components. Both intervention and usual care providers, however, did receive both guidelines. Telephonic intervention supplemented the BCM self-management. Two-hour sessions were held on a weekly basis in group format. The nurse care managers kept in contact with patients by telephone regarding health matters, and when indicated they referred urgent cases to appropriate providers. The study concluded that the BCM was feasible for older medically ill patients with bipolar disorder and that it could be an effective alternative to more costly treatment models.

From Spain, an observational study ($n=215$) published in 2012 assessed the feasibility and acceptance of a remote support system for diagnosing dementia in a primary care setting.[47] The major goal was to evaluate the concordance between PCPs and specialists regarding the measures taken for cognitive and functional treatment. The TMH intervention used a Computerized Support System for the Diagnosis of Dementia in Primary Care (*Sistema de apoyo informatizado para el diagnóstico de la demencia en Atención Primaria* [SISDDAP]). The program was aimed at establishing protocols for screening and diagnosing dementia. The components included a "memory impairment screen," a geriatric depression scale, a Mini-Mental State Examination test, and a dementia rating scale. Patients included those with suspected dementia or diagnosed dementia. The SISDDAP was feasible and well accepted by the professionals involved.

From Germany, an observational study ($n=3,578$) published in 2013 assessed the feasibility, internal consistency and covariates of a modified telephone interview as a screening tool to detect cognitive impairment among the elderly ranging in age from 65 to 94 years.[48] Data were collected in 2008–2009 from the participants in this program, entitled KORA-Age Study (Kooperative Forschung in der Region Augsburg—Cooperative Research in the Region of Augsburg). The research used a modified Telephone Interview for Cognitive Status to test cognitive level. It contained the following: name, date, age, and phone number; counting backward; 10-word learning list, recall list; serial sevens (counting down from 100 by sevens); major German political figures; and word opposites. Lower cognitive status was associated with being older, male, and less educated. It was determined that the modified Telephone Interview for Cognitive Status is a feasible and time-saving instrument in screening for cognitive impairment among older participants.

In 2014, "telehealth" was the focus of therapy for depression among low-income homebound elderly in central Texas.[49] The study evaluated the acceptance and effectiveness of in-home telehealth problem-solving-therapy (tele-PST). A total of 121 homebound individuals ≥50 years of age who scored ≥15 on the Hamilton Rating Scale for Depression took part in a three-arm RCT. The trial compared tele-PST with in-person PST and telephone support calls. Six 60-min sessions of PST-primary care were conducted for one group face-to-face in the person's home. A modified Treatment Evaluation Inventory was used to measure acceptance. Both PST groups reported high acceptance of the specific treatment modalities. The tele-PST group expressed a slightly higher level of acceptance than the in-person PST group. Both groups had significantly higher scores than the telephone support group. The study concluded that depressed homebound elderly accepted tele-PST, reporting extremely positive experiences.

Intermediate Outcome of TMH: Adherence

A total of seven studies (all from the United States and all but one were RCTs) met the selection criteria for inclusion here (*Table 1*). The focus in this section is on intermediate outcomes, which turned out to be medication adherence in the majority of cases. It may be appreciated that poor medication adherence among those with serious mental illness is usually associated with poor clinical outcomes and inappropriate use of resources.

A study published in 2008 (RCT; $n=282$) investigated patient adherence to discharge plans subsequent to inpatient substance abuse treatment[50] and specifically targeted gender

Table 1. Summary of Empirical Evidence in Telemental Health Research on Intermediate Outcomes

REFERENCE	DATE	COUNTRY	RESEARCH DESIGN	SAMPLE SIZE	STUDY POPULATION	TECHNOLOGY	INTERVENTION	ADHERENCE	COMMENTS
Carter et al.[50]	2008	United States	RCT	282	Substance abuse	Telephone	Counseling	↑	Aftercare attendance ↑, women more than men
Deen et al.[52]	2011	United States	RCT	360	VHA patients with depression	Dedicated video	Collaborative team	↑	Satisfaction did not mediate adherence.
Migneault et al.[53]	2012	United States	RCT	337	African Americans with hypertension	Telephone	Multibehavior counseling	↑	Dietary outcomes ↑ Physical activity ↑
Piete et al.[54]	2013	United States	RCT	208	Users of community-based clinics	Telephone/IVR	Automated health assessment	Not predictable	Depressive symptoms ↑ Health status↑
Guzman-Clark et al.[55]	2013	United States	Retrospective	248	Older VHA heart failure patients	Asynchronous device	Daily reporting	↑	Dissatisfaction using the device Adherence decreased over time.
Campbell et al.[56]	2014	United States	RCT	507	Substance abuse	Internet	Interactive modules/ prize-based	↑	Prizes precluded definitive conclusions.
Egede et al.[57]	2015	United States	RCT	241	Elderly VHA patients with major depression	Video	Behavior activation therapy	–	Telemedicine not inferior to in-person

An upward arrow (↑) indicates an improvement.

IVR, interactive voice response; RCT, randomized controlled trial; VHA, Veterans Health Administration.

differences. Participants were randomly allocated to a brief telephone intervention (telephone call group) or a standard care group. The telephone calls were made by counselors at 2-week intervals for 3 months. The key findings indicated that the individuals in the intervention group "tended to have a higher rate of verified aftercare attendance" than those in the control group. Postdischarge attendance rates were 56% and 45%, respectively, for the two groups, and women were more likely than men to attend follow-up visits.

Results published in 2010 were derived from data collected between 2005 and 2008 in an RCT "noninferiority" trial ($n = 125$) among male veterans at three VHA outpatients clinics diagnosed with PTSD and anger management problems.[51] The focus of the study was to demonstrate the "noninferiority" of videoconferencing in a group psychotherapy context compared with traditional in-person service. Participants selected for the study were randomly assigned to receive anger management therapy either in-person or remotely via videoconferencing. Anger management and process variable assessments (attrition, adherence, satisfaction, and treatment expectancy) were conducted at baseline, midtreatment (3 weeks), posttreatment (6 weeks), and 3 and 6 months posttreatment. Similar reductions in anger symptoms were observed in both two groups. Hence, the authors concluded that videoconferencing was not inferior to in-person care insofar as anger management is concerned. Moreover, it serves as an effective and feasible modality to increase access to evidence-based care for veterans residing in rural or remote locations. However, in view of the small sample size ($n = 125$), these findings were not included in the empirical findings listed in *Table 1*.

A VHA RCT ($n = 360$) published in 2011 assessed the relationship among satisfaction, patient-centered care, adherence, and outcomes among primary care patients in a CC model for depression.[52] Of particular interest here is the hypothesis that "satisfaction will partially mediate the intervention effect on adherence to antidepressant medication." Patients randomized to the intervention received a "stepped-care" model of depression treatment for up to 12 months. The intervention involved on-site PCPs located at community-based outpatient clinics and an off-site depression team composed of depression nurse care managers, clinical pharmacists, and telepsychiatrists located at a VHA Medical Center. This TMH intervention significantly predicted treatment adherence, but satisfaction with the service did not mediate antidepressant medication adherence.

Results from an RCT ($n = 337$) conducted between 2003 and 2007 were published in 2012. Hypertensive primary care patients were allocated to an 8-month automated, multi–behavior intervention or to education-only as controls.[53] The intervention was a computer-based, interactive telephone counseling system referred to as "Telephone-Linked-Care" and designed to monitor, educate, and counsel African American

adults with hypertension and to provide summary data about them to their PCPs on a regular basis. Control group patients received standard care only. All outcomes were assessed at baseline/randomization and at 4, 8 (end of intervention), and 12 months. Significant improvement in dietary outcomes at the 8-month assessment was observed in the intervention group but not in the control group. Similarly, moderate or greater physical activity was observed among those in the intervention group only. Also, changes in medication adherence scores changes were higher in the intervention group relative to the controls by 0.35 points.

Poor antidepressant adherence was one of four outcomes assessed among patients diagnosed with moderate/severe depression (RCT; $n=208$).[54] Patients were enrolled between 2010 and 2012 from 13 university-affiliated and community-based primary care practices. Results were published in 2013. The content of the calls was developed with input from psychiatrists, PCPs, and experts in IVR program design and health behavior change. Specifically, the research evaluated whether frequent (i.e., weekly) IVR assessments were predictive of patients' subsequent reports of depressive symptoms and perceived health status. Patients' reports pertaining to their depressive symptoms and perceived health status were highly predictable. Medication adherence was somewhat less predictable, with only small differences between assessments attempted weekly, biweekly, and monthly. The researchers concluded that "the next generation of automated health assessment services should use data mining techniques to avoid redundant assessments, and should gather data at a frequency that maximizes the value of information collected."

A retrospective observational study ($n=248$) assessed predictors and outcomes of early adherence among users of a home telehealth device, published in 2013.[55] The subjects were older (≥65 years) veterans with heart failure. The analysis was based on secondary VHA databases that included their adherence rates and patterns in the first 90 days subsequent to enrollment. The device was an asynchronous communication tool allowing in-home messaging and transmission of information. Patients were expected to report daily and to respond (by pressing buttons) to questions pertaining to a predetermined disease management protocol. Adherence to the use of the home telehealth device was defined as the number of days the patient completed a home telehealth session in each 30-day period. Patient adherence rates tended to be highest in the early phases of the intervention, dropping 20% between the first and second time frame and to 7% between the second and third 30-day period. The primary reason for the early dropout was dissatisfaction with using the device. Hence, the authors suggested that further studies were necessary to determine those patients likely to adhere to daily monitoring by a home telehealth device and to develop innovative approaches to make daily use more acceptable.

An RCT ($n=507$) published in 2014 evaluated the effectiveness of the Therapeutic Education System (TES), an Internet-delivered behavioral intervention that includes motivational incentives, as a clinician extender in the treatment of substance use disorders.[56] The TES consisted of 62 computerized interactive modules, based on the community reinforcement approach, each requiring 20–30 min to complete, and covered skills for achieving and maintaining abstinence, plus "prize-based" motivational incentives contingent on abstinence and treatment adherence. Incentives took the form of providing participants with the opportunity to draw vouchers from a virtual "fishbowl." Vouchers ranged from congratulatory messages to cash rewards in variable amounts. These were awarded for abstinence or number of modules completed. Patients in the TES group completed a mean of 36.6 computer-delivered modules out of a recommended 48. These patients also earned a mean of 118 voucher draws (out of a possible 252 draws). The fact that only patients in the TES program received motivations in the form of vouchers for prizes would seem to preclude any meaningful distinction in adherence between the intervention and control groups, and none was reported.

Another VHA study (RCT; $n=241$) published in 2015 described results of a 4-year assessment of treatment effectiveness and cost-effectiveness of an in-home videoconferencing technology ("telepsychology") service for elderly veterans living in rural areas (71%) and suffering from major depressive disorder versus "same room" treatment.[57] The subjects were predominantly male (98%) and elderly (60 years of age or older) meeting DSM-IV criteria for major depressive disorder. A protocol-driven individual Behavioral Activation Therapy for depression was administered over an 8-week period, and subsequent follow-up lasted for 12 months to ascertain longer-term effects on clinical outcomes, process variables, and economic outcomes. Accounting for patients who discontinued treatment, analyses were conducted on 100 in the telemedicine group and 104 in the "same room" group.

According to the Geriatric Depression Scale, treatment response did not differ significantly between the telepsychology group (22.45%) and the "same room" group (23.17%). Similarly, according to the Beck Depression Inventory, the telepsychology group (24.05%) did not differ from the "same room" patients (23.17%). It was determined that "telemedicine-delivered psychotherapy for older adults with major depression is not inferior to same-room treatment" and, furthermore, that evidence-based psychotherapy can be delivered without

modification via home-based telemedicine. It can be used to overcome barriers of mobility, stigma, and geographical isolation associated with attendance at in-person sessions for older adults.

Health Outcomes of TMH

In total, 25 studies (15 from the United States, 3 from Australia, 2 each from Sweden and The Netherlands, and 1 each from the United Kingdom, Spain, and Italy) met the selection criteria for this review. All but two were RCTs.

Although five studies, all based on an RCT (three from the United States and one each from Sweden and the United Kingdom) were published in 2005 with samples over 100 cases, only one met the requisite sample size of ≥150 for inclusion in this analysis. The findings from the four studies will be described here briefly, but only the results from the larger study will be used in the empirical analysis and presented in *Table 2*.

We start with the study that met the sample size criterion. It was an RCT ($n=191$) conducted between July 2000 and April 2002 among adults (18–64 years of age) with panic and/or generalized anxiety disorder. They were recruited from four Pittsburgh area primary care practices linked by a common electronic medical record system.[58] The objective of the study was to determine whether a telephone-based CC model for panic and generalized anxiety disorders would improve clinical and functional outcomes for the patients. The clinicians were non–physician health professionals who provided educational materials, assessed patient preferences for guideline-based care, monitored treatment responses, and informed their regular physicians of their preferences and progress in dealing with their problems via an electronic medical record. Outcome measures included "blinded" assessments of anxiety and depressive symptoms, mental HRQoL, and employment status. After 12 months, patients in the intervention group had reduced anxiety and depressive symptoms as well as increased work hours and reduced absenteeism. Furthermore, among those who were working at baseline, a significantly larger percentage in the intervention group remained working compared with the control group (94% versus 79%).

The findings from the other four RCT studies published in 2005 will be described briefly. From the United Kingdom, an interesting study ($n=108$) investigated the effect of telemonitoring for medical adherence among patients with schizophrenia.[59] Patients were randomized into three groups based on approaches for assessing medication adherence: self-report, pill counting, and telemonitoring. Telemonitoring was based on a platform that offered clinicians early warnings regarding nonadherence and the pattern of medication taking. Those in the telemonitoring group had fewer emergency visits, fewer medical appointments, and improved symptoms.

Another RCT ($n=117$) in Sweden assessed an Internet-based self-help cognitive–behavioral therapy (CBT) program for depression.[60] Minimal therapist contact was available, but participants were invited to a moderated online discussion group. The Internet-based intervention resulted in diminished depressive symptoms and improved QoL immediately after treatment and at 6-month follow-up. The study concluded that Internet-based CBT should be pursued further "as a complement, or treatment alternative for mild-to moderate depression."

An RCT ($n=139$) in the United States conducted in 2003 and published in 2005 was aimed at assessing the impact of an Internet-delivered behavioral regimen for headaches. The intervention consisted of progressive relaxation, limited biofeedback with autogenic training, and stress management.[61] The control group consisted of individuals on a waiting list who received symptom monitoring only. Participants with tension-type migraine or mixed headache experienced reductions in anxiety/depression, headache-related symptoms, and disability, as well as a notable reduction in headache medication. The results of the study "demonstrate the efficacy of an online behavioral intervention for recurrent headache disorders."

Finally, in 2005, an RCT ($n=127$) in northern California evaluated an in-home telephone-administered CBT among patients with depression and functional impairments due to multiple sclerosis.[62] Those in the intervention group showed significant improvement in all outcome measures as well as an increase in the Positive Affect Score, but these improvements were not observed in the control group. However, differences between the two groups were not maintained after 12 months. Hence, the authors cautioned against generalization from their findings due to the fact that the study population had multiple sclerosis, a serious comorbidity.

A secondary analysis of the data from this study was published in 2007.[63] Disability was measured using Guy's Neurological Disability Scale, fatigue by the Fatigue Impact Scale, and depression by the Hamilton Depression Rating Scale and the Beck Depression Inventory-II. Patients in both groups showed significant improvements in disability and fatigue. These were also related to reductions in depression. This analysis suggested that significant reductions in disability and fatigue could be achieved by reducing depression in patients with multiple sclerosis. Evidence also supported the notion that reductions could be achieved through CBT-specific interventions that focus on symptoms such as fatigue management.

Table 2. Summary of the Empirical Evidence in Telemental Health Research on Health Outcomes

REFERENCE	YEAR	COUNTRY	RESEARCH DESIGN	SAMPLE SIZE	STUDY POPULATION	TECHNOLOGY	INTERVENTION	OUTCOMES		COMMENTS
								SYMPTOMS	QOL	
Rollman et al.[58]	2005	United States	RCT	191	Adults with anxiety	Telephone	Collaborative care with non-mental health professionals	↑	↑	Measured by effect size
Trief at al.[64]	2006	United States	RCT	1,665	Medicare population with diabetes	Web and video	Nurse case manager	–	–	Depression did not predict A1C.
Sherwood et al.[66]	2006	United States	RCT	1,801	Overweight adults	Telephone and mail plus telephone	Lessons and homework	–	–	Participation significant predictor of outcomes
De Las Cuevas et al.[67]	2006	Spain	RCT	140	Psychiatric outpatients	Videoconferencing	Consultations	Good treatment provided in both TMH and in-person	–	TMH efficacy is equivalent to in-person.
Lyneham et al.[68]	2006	Australia	RCT	100 children + parents	Children with anxiety	Telephone and e-mail	CBT	Therapist-supplemented bibliotherapy is efficacious.	–	Same psychiatrist in both modes
Fortney et el.[69]	2007	United States	RCT	395	VHA/depression	Dedicated video	Collaborative care for depression	↑	↑	Medication adherence ↑ Treatment response ↑
Seligman et al.[70]	2007	United States	RCT	240	Students at risk for depression	Web-based workshop	CBT	↑	Life satisfaction ↑	Happiness ↑
Onor et al.[71]	2008	Italy	Survey	162	Frail elderly	Telephone	Day care Nursing home Telecare	–	Satisfaction highest with telecare	Elderly desire greater social contact.
Rollman et al.[72]	2009	United States	RCT	302	Post-CABG depression	Telephone	Collaborative care management	↑	↑	Physical functioning ↑
Furmark et al.[73]	2009	Sweden	RCT	235	Adults	Internet	Guided versus unguided	↑	↑	Bibliotherapy alone and Internet-based were better than usual care.
Weigand et al.[74]	2010	United States	RCT	562	Adult women 25–45 years old with stress	Internet	Online coaching	↑	Mood states ↑	Stress ↑
Van Basterlaar et al.[76]	2011	The Netherlands	RCT	255	Diabetes types 1 and 2	Oral, written, and video lessons	CBT	↑	–	Diabetes-related depression ↑
Jackson et al.[77]	2012	United States	RCT	573	Hypertension	Telephone	Behavioral and medication management	–	–	Systolic BP declined among African Americans but not whites.
Moreno et al.[78]	2102	United States	RCT	167	Hispanic patients with depression	Internet video	Teleconsults	↑	↑	Improvement in both groups; significant interaction with time of intervention favored the Webcam group.

continued →

Table 2. Summary of the Empirical Evidence in Telemental Health Research on Health Outcomes *continued*

REFERENCE	YEAR	COUNTRY	RESEARCH DESIGN	SAMPLE SIZE	STUDY POPULATION	TECHNOLOGY	INTERVENTION	OUTCOMES		COMMENTS
								SYMPTOMS	QOL	
Mohr et al.[79]	2012	United States	RCT	325	Primary care patients with major depressive disorder	Telephone	CBT by psychologists	Equal		Less attrition in the intervention group
Powell et al.[80]	2013	United Kingdom	RCT	3070	Adults 18+ years old with depression	Internet	CBT by Web	↑	Webcam ↑3 points higher	Mental well-being not disaggragated by depression and anxiety
Glozier et al.[81]	2013	Australia	RCT	562	Depression at risk for cardiovascular disease	Internet	CBT	↑	↑	Small but consistent improvement in depression symptoms and adherence. No effect on disability
Hedman et al.[82]	2013	Sweden	Prospective; repeat measurement	570	Patients with panic disorder	Internet	CBT	Panic disorder ↑	–	Sustained improvement in panic disorder
Fortney et al.[84]	2013	United States	Pragmatic RCT	364	Patients with depression	Telephone and video	Collaborative team	↑	–	Greater improvement in outcomes with off-site team
Blumenthal et al.[84]	2014	United States	RCT	326	COPD (18–81 years old) with anxiety	Telephone	Coping skills	↑	↑	Greater improvement in pulmonary function, fatigue, shortness of breath, and distance walked
Huffman et al.[85]	2014	United States	RCT	183	Cardiac patients with depression and anxiety	Telephone	Social work case manager	↑	↑	More likely to get adequate treatment for mental health disorder
Kramer et al.[86]	2014	The Netherlands	RCT	263	Young (12–22 years old) with depression	Internet	Chat sessions: solution-focused therapy	↑	–	Very high attrition rate: inconclusive
Crisp et al.[87]	2014	Australia	RCT	298	Adults with depression	Internet	Support group	–	↑	Self-esteem, empowerment ↑
Fortney et al. [88]	2015	United States	RCT	265	VHA with PTSD	Telephone	Nurse care managers: cognitive processing therapy	PTSD ↑	–	Model can engage rural veterans with PTSD.
Myers et al.[90]	2015	United States	RCT	223	Children with ADHD	Video	Combined medication and behavior training	ADHD ↑	–	Both groups improved, but intervention more

An upward arrow (↑) indicates an improvement.

ADHD, attention-deficit hyperactivity disorder; BP, blood pressure; CABG, coronary artery bypass graft; CBT, cognitive–behavioral therapy; COPD, chronic obstructive pulmonary disease; QoL, quality of life; PTSD, posttraumatic stress disorder; RCT, randomized controlled trial; TMH, telemental health; VHA, Veterans Health Administration.

In total, four studies (all RCTs) met the selection criteria in 2006, two from the United States and one each from Spain and Australia. We start with the U.S. studies.

An RCT ($n = 1,665$) investigated the significance of depression on glycemic control among Medicare beneficiaries suffering from both diabetes and depression.[64] We reported earlier on the parent project (IDEATel) in our diabetes article,[65] which focused on glycemic control. This analysis was concerned with the relationship between depression and glycemic control. Several approaches were used to analyze this relationship. In each analysis, the two groups were assessed to determine whether depression predicted A1C. An initial hypothesis posited that depressed patients would derive fewer benefits from the intervention because the hopelessness/helplessness of depression would prevent them from taking an active role in managing their health. "Depression did not predict change in A1C when other factors were controlled."

Heralded by the authors as "…the first ever large-scale randomized trial examining the efficacy of non-clinic-based weight-loss interventions in a healthcare delivery system," this RCT (United States; $n = 1,801$) investigated the effects of two types of intervention on weight loss.[66] The participants (all overweight) were assigned randomly to one of three groups—telephone, mail, and usual care—and observed over 2 years. The three groups were compared on the basis of level of participation, weight loss, and cost. Once activated, both mail and telephone interventions ran parallel. They consisted of 10 interactive lessons coupled with feedback from a health counselor. Lessons focused on nutrition, physical activity, and behavioral management techniques (e.g., behavioral assessment, goal setting, stimulus control, and self-motivation). Counseling was provided via mail and telephone. Usual care participants had access only to weight management opportunities provided to members of the health plan. They received a "resource sheet" with community weight management information that included free general telephone counseling, structured telephone-based weight management, and group classes. Researchers concluded that "…at best, the 24-month results indicated that the intervention as well as the usual care groups served as weight gain prevention rather than weight loss…." The telephone and mail interventions proved to be viable options in terms of cost and logistics. However, weight loss outcomes were not achieved. The authors identified several study limitations as well as suggestions for future research.

The other two studies in 2006 (both RCTs) were from Spain and Australia. We chose to include the Spanish study here with some caution because sample size ($n = 140$) was close to the requisite 150. Conducted in the Canary Islands, this study compared TMH videoconferencing with face-to-face psychiatric treatment.[67] The intervention consisted of eight consultations lasting 30 min each over 24 weeks, including the use of psychotropic medication. Patients in both groups were diagnosed and treated by the same psychiatrist. Videoconferencing was conducted between a university hospital in Tenerife (the psychiatrist's location) and the mental health center in San Sebastian de la Gomera (the patients' location). The study involved 534 teleconsultations and 522 in-person consultations. Significant improvements were observed in both groups, demonstrating the equivalence of videoconferencing with in-person consultation. The study concluded that TMH was "effective in delivering mental health services to psychiatric outpatients living in remote areas with limited resources."

A somewhat unique study from Australia (RCT; $n = 100$ children, including 100 mothers and 74 fathers) evaluated the efficacy of supplementing "bibliotherapy" (an expressive therapy involving the use of literature often combined with writing therapy) for child anxiety disorders. Therapists initiated the CBT sessions via telephone or e-mail.[68] The control group consisted of volunteer clients on a waitlist. Participants were children (6–12 years of age) with anxiety disorders together with their parents (80.5% were from two-parent families) living in rural and remote communities. Anxiety was measured by the Anxiety Disorders Interview Schedule for Children for DSM-IV and completed by two parents (where possible). Only the parent (usually the mother) was interviewed. The treatment protocol was adapted from a standard CBT group treatment program, which facilitated parental involvement as substitute therapists for their children. Seventy-nine percent of the children attending telephone sessions became free of anxiety, compared with 33% of those receiving e-mail and 31% of volunteer participants on a waiting list. The results of the evaluation demonstrated the efficacy of this intervention in addressing child anxiety disorders.

In 2007, two studies (both from the United States) met the selection criteria for this analysis. An RCT ($n = 395$ VHA primary care patients) investigated the effectiveness of a telemedicine-based CC for treating depression.[69] Patients (diagnosed with depression at community-based clinics without an on-site psychiatrist) were followed up for 2 months. Those with current substance dependence and more serious mental illness were excluded from the study. The intervention consisted of a Telemedicine Enhanced Antidepressant Management (TEAM) CC model adapted for small clinics without a resident psychiatrist. Matched sites (clinics) were randomly allocated to intervention or usual care. The TEAM intervention consisted of a "stepped-care model of depression treatment for up to two months." That is, the treatment

used an increased intensity model whereby additional personnel with advanced mental health expertise were utilized for unresponsive patients. Five levels of care were provided: (1) PCPs located at the community clinic; (2) consulting telepsychiatrists; (3) an off-site depression nurse (registered nurse) care manager; (4) an off-site clinical pharmacist (PharmD); and (5) an off-site supervising psychiatrist. The latter provided weekly face-to-face supervision for the registered nurses and PharmDs. Data were collected on medication adherence, treatment response, remission, health status, HRQoL, and satisfaction with treatment. Multivariate analysis suggested that TEAM patients were more likely to be adherent than their counterparts at both 6 and 12 months. TEAM patients also demonstrated/reported greater improvements in mental health status, HRQoL, and higher satisfaction.

A group prevention approach to depression and anxiety was the focus of an RCT ($n=249$) study aimed at assessing whether a cognitive–behavioral workshop would help college students (undergraduates; 65% female and 35% male) at risk for depression.[70] Depression was measured subjectively by self-reports. The intervention consisted of 16 2-h weekly meetings, access to a Web-based supplement, and coaching by mail for 2 years. The control group received assessments only. After completion of the workshop, participants had access to a Web-based supplement to reinforce acquired skills and to stem the decline of intervention effects over time. Workshop participants also stayed in touch with "coaches" via e-mails. The workshop group had significantly fewer symptoms of depression at postworkshop and 6-month follow-up. They also had significantly higher life satisfaction scores and were more optimistic at postworkshop and at 6-month follow-up. Similar trends were observed in terms of happiness ratings. Altogether, the intervention group had significantly lower levels of depression and anxiety after the workshop experience, but "there was no significant difference between the conditions on depression or anxiety *episodes* [emphasis ours] at 6 month follow up." However, this observation was based on episodes with a sample size of only 41 cases (17 with moderate levels of depression and 24 with moderate levels of anxiety). The authors concluded that the "improved explanatory style was a significant mediator of the prevention effects from pre- to postworkshop for depressive and anxiety symptoms, as well as for improved well-being."

In 2008, one study from Italy met the selection criteria. This was a comparative study ($n=162$) from Italy aimed at assessing satisfaction with three types of care among the frail elderly: (1) daycare center ($n=30$), (2) nursing home ($n=66$), and (3) telecare ($n=66$).[71] The sample of the study population was homogeneous in terms of age, choice of service, physical problems, and presence of depressive symptoms, but it varied in terms of cognitive impairment, social support, and functional status. Group 1 had access to care 5 days per week during the day with meals and recreational activities. Group 2 lived in the facility with a hotel-like service but without recreational activities. Group 3 lived at home and received daily telephone calls and a telemonitoring service operating 24/7. Each participant received a necklace with an emergency alert button. At the conclusion of the study, all participants were asked to complete a questionnaire to elicit their satisfaction with the service and suggestions for improvement. Nearly all (98.5%) of telecare users were satisfied or very satisfied, compared with 75.3% of nursing home and 76.5% of daycare users.

In 2009, two studies met the criteria for analysis, one each from the United States and Sweden. An RCT ($n=302$) in Pennsylvania investigated the effectiveness of a telephone-delivered CC for treating depression associated with post–coronary artery bypass graft.[72] Participants were recruited between March 2004 and September 2007 from seven university-based and community hospitals. The intervention consisted of telephone-delivered CC provided by nurses working with patients' primary care physicians. The usual care patients (and their providers) were informed of their depression status. No treatment advice was provided when there was no indication of suicidal tendencies. The major outcome measure, mental HRQoL, was obtained via the Short Form-36 Mental Component Summary. Secondary outcome measures included mood (depression) symptoms, functional status, and hospital re-admissions. Compared with the usual care patients, the intervention patients reported significantly greater improvements (50%) in mental condition (HRQoL), physical functioning, and mood symptoms. The study supported the hypothesis that telephone-delivered CC is effective in treating post–coronary artery bypass graft depression.

The Swedish study (RCT; $n=235$) assessed the effectiveness of an Internet-delivered self-help CBT program in relieving social anxiety disorder among adults.[73] The main comparison was between an Internet-delivered self-help program with added therapist guidance and online group discussions and unguided self-help. The participants were recruited by advertisements and Internet links to the Swedish National Anxiety Association and the Swedish Association for Behavior Therapy. They were randomized into three arms in Trial 1 and to four in Trial 2. These included Internet-delivered self-help CBT, bibliotherapy alone, waiting list control, bibliotherapy with access to an online discussion group, and Internet-delivered relaxation drills. Data from Trials 1 and 2 were pooled in order to increase sample size. In Trial 1, both intervention

groups showed significant improvement over the waiting list, but they did not differ from each other. In Trial 2, all groups showed improvement from pre- to posttreatment, but no differences were observed among them. This was a complex study. Overall, it was determined that "bibliotherapy and the Internet-based treatment were better than waiting list on measures of social anxiety, general anxiety, depression, and quality of life." The authors concluded that "unguided self-help bibliotherapy can produce enduring improvement for individuals with social anxiety disorder."

In 2010, one RCT ($n=562$) investigated the efficacy of a comprehensive program for reducing stress among women.[74] The participants were highly motivated individuals between the ages of 25 and 45 years who reported moderate to high stress levels in their daily lives. They were randomized into one of three groups: (1) Internet-based coaching focused on behavior modification, daily use of proprietary olfactive-based personal care products, and periodic feedback reports; (2) online coaching only; and (3) no active stress management program. At baseline and throughout the study, all participants completed validated psychometric assessments, including the Perceived Stress Scale, the Profile of Mood States, the St. Mary's Hospital Sleep Questionnaire, the Trier Inventory of Chronic Stress, the Sielberger State-Trait Anxiety Inventory, the Short-Form-36, and the Work Productivity and Activity Impairment. At the end of 14 weeks, Group 1 had greater improvement in the stress score than Group 2, as well as greater improvement in mood states work overload and social responsibility subscales, anxiety, and night awakenings. Self-reported program efficacy was also significantly higher in Group 1 compared with their Group 2 and 3 counterparts.

In 2011, data from a VHA study discussed earlier[62] were analyzed to assess the association between satisfaction and health outcomes.[75] The analysis suggested that satisfaction did not mediate antidepressant adherence.

Also, in 2011, a Dutch study (RCT; $n=255$) assessed the effectiveness of a minimally guided Web-based CBT among patients with type 1 and type 2 diabetes and depression.[76] Adult diabetic patients with elevated depression symptoms were recruited from July 2008 through September 2009. The primary outcome was depressive symptoms, and the secondary outcomes were diabetes-specific emotional distress and glycemic control. The subjects were randomized to the Web-based intervention ($n=125$) or to a waiting list that served as a control group ($n=130$). Assessments took place directly after the completion of the study and at 1-month follow-up. The Web-based intervention consisted of eight consecutive lessons that provided both written and spoken information as well as video recordings of depressed diabetic patients showing how they learned from the course. Certified health psychologists served as coaches providing timely feedback on homework assignments. Waiting list patients completed postassessment measurements 8 weeks and 12 weeks after randomization. At the latter date, patients with elevated depression were given a password allowing them access to the Web-based intervention. Compared with the control group, a significantly higher percentage of the Web-based intervention group showed clinically significant improvement in depressive symptoms both postassessment and at 1-month follow-up. The intervention resulted in reduced depressive symptoms as well as diabetes-related distress equally for individuals with type 1 and type 2 diabetes.

Three studies met the selection criteria in 2012, all RCTs from the United States.

An 18-month VHA study ($n=573$; 284 African Americans and 289 non-Hispanic whites) assessed changes in blood pressure (BP) in response to a medication management and tailored nurse-delivered telephone behavioral program.[77] Patients had to have a diagnosis of hypertension, were using a BP-lowering medication, and were unable to control their BP over the preceding year. They were randomized to one of three intervention arms: (1) remote medication management plus behavioral management; (2) a wireless home BP monitor and telephone advice to take BP once every other day; (3) a combination of 1 and 2; and (4) usual care. Relative to usual care, at 12 months the mean systolic BP was significantly lower in the combined intervention Group 3. At 12 months the non-Hispanic white patients in the intervention group had a significantly lower systolic BP. The only significant difference in diastolic BP between any intervention relative to the usual care group was observed at 18 months among the African American patients, whose mean diastolic BP was 4.8 mm Hg lower, but there was no analogous differences among non-Hispanic whites. Researchers concluded that behavioral intervention management programs addressing medical and behavioral aspects of hypertension beyond those of traditional care may increase access to care, enhance chronic illness management, and be especially beneficial for African Americans.

The second was an RCT ($n=167$) conducted among Hispanic patients in Arizona.[78] It compared the effectiveness of depression treatment delivered by a psychiatrist via Internet videoconferencing (Webcam intervention) versus usual care/treatment by a primary care provider. Patients were recruited from a local community clinic. Those with a diagnosis of bipolar affective disorder, schizophrenia, dementia, substance abuse dependence, or symptoms of serious medical or neurological

illness were excluded from the study. Psychiatrists met with patients via Webcam each month throughout the 6-month intervention. Usual care patients received care from their PCPs. Depression scores were derived from several questionnaires (PHQ-9 item, Montgomery–Asberg Depression Rating Scale, Quality of Life Enjoyment and Satisfaction Questionnaire, and self-rated Sheehan Disability Scale). Assessments were made at baseline and at 3 and 6 months. Over the 6-month period patients in both groups experienced significant reductions in symptom severity. However, the intervention group experienced greater improvement in depression and QoL compared with the control group. "On all four measures, a significant interaction of time by intervention favoring the Webcam group was noted."

The third study was a comparison of the effects of delivering CBT by telephone versus face to face.[79] The sample consisted of patients with major depressive disorder in four primary care clinics in the Chicago area ($n=325$). The intervention consisted of 18 weekly telephone sessions. Two weekly sessions were scheduled for the first 2 weeks. All participants received a workbook covering various aspects of CBT. The telephone sessions were conducted by nine psychologists who received 2 days of special training. Patients in the intervention group had lower attrition rates than those in the control group (20.9% versus 32.7%) and close to equivalent improvement in depression. At 6 months, those receiving in-person therapy were less depressed than those receiving therapy by telephone, "but at the cost of some increased risk of poorer maintenance of gains after treatment cessation."

Four studies meeting the selection criteria were published in 2013, one each from the United Kingdom, Australia, Sweden, and the United States.

A large RCT ($n=3,070$) investigated the effectiveness of a Web-based cognitive behavioral tool in improving mental well-being in the general population.[80] The subjects were recruited through advertisements on a national health portal and were willing to give their e-mail address. They were randomly allocated to the intervention and control groups. The latter were placed on a waiting list. The intervention consisted of five interactive educational modules concerning cognitive behavioral principles. The participants received weekly e-mails reminding them to use the intervention. After 12 weeks of follow-up, retention was higher in the control group (73.1% versus 46.4%), but there was no relationship between baseline measures and withdrawal. Overall, the study had high attrition rates. Still, significant improvements in self-scores of depression and anxiety were observed in the intervention group. Nonetheless, the study did not differentiate between mental well-being and depression and anxiety.

An Australian study (RCT; $n=562$) investigated the effectiveness of Internet-delivered CBT on depression and compliance with medical advice, anxiety, and physical activity.[81] Participants had mild to moderate depression with a concomitant high risk for cardiovascular disease. The intervention consisted of an Internet-delivered health information package, and the primary outcome was depressive symptoms. Participation in the intervention "produced a small, but robust, improvement in depressive symptoms, adherence (to medical advice) and some health behaviors," and a greater proportion engaging in physical activity but having no effect on disability.

Similarly, the effectiveness of an Internet-delivered CBT was investigated in Sweden in relation to panic disorder.[82] This was a prospective cohort study with repeated measurements ($n=570$) over 6 months. In addition, the effects in this cohort were compared with those of previous RCTs for panic disorders in order to ascertain the "expected course of spontaneous improvement." The same subjects were compared pre- and postintervention, and the primary outcome was the Panic Disorder Severity Scale-Self-Report (PDSS-SR). "Participants made large improvements from screening to pretreatment to posttreatment (Cohen's d range on the PDSS-SR = 1.07–1.55). Improvements were sustained at 6-month follow-up."

A similarly designed study by Fortney et al.[69] reported earlier was published in 2013.[83] Here again, it was an RCT ($n=364$), but these subjects were patients of federally qualified health centers. Everything else was the same (including patients with depression, as well as a comparison between on-site primary care versus an off-site telemedicine team linked by telephone). Again, outcome measures were treatment response, remission, and change in depression severity. Insofar as the treatment of depression is concerned, the findings of the two studies were similar. "Contracting with an off-site telemedicine-based collaborative care can yield better results than implementing practice-based collaborative care with locally available staff."

A total of four studies (all RCTs) met the inclusion criteria for 2014 (two from the United States and one each from The Netherlands and Australia).

A dual-site RCT from the United States ($n=326$ adults, 38–61 years of age) assessed the effects of a telehealth-based coping skills intervention on outcomes among individuals with COPD as it pertained to psychological distress ($n=326$).[84] The patients were randomly assigned to coping skills training provided via telehealth or to COPD education and stratified by availability of a caregiver, forced expiratory volume in the first second (the amount of air that can be forcefully blown),

and the 6-min walk test. Specially trained clinical psychologists provided the training on cognitive–behavioral coping skills via telephone weekly for 12 weeks and biweekly for 1 month. Patients were followed up for up to 4.4 years to assess health outcomes, including stress, pulmonary function, coping skills, and physical activity. The usual care group received care through local physicians. The weekly education sessions focused on topics such as pulmonary physiology, medication usage, nutrition, and symptom management. No specific coping strategies were included. Participants in the intervention group exhibited greater improvements in psychological QoL and somatic QoL, including greater improvement in pulmonary function, less fatigue, less shortness of breath, and greater improvement in distance walked in 6 min, compared with those in the control group. They exhibited less depression and anxiety and better overall mental health and role functioning. Thus, researchers concluded that the telehealth-based coping skills training intervention "produced clinically meaningful improvements in quality of life and functional capacity…but no overall improvement in risk of COPD-related hospitalization and all-cause mortality."

An RCT ($n=183$) compared a low-intensity telephone-based multicomponent CC intervention targeting depression and anxiety disorders among patients with recent cardiac events.[85] Patients were recruited from inpatient cardiac units in an urban academic hospital for acute coronary syndrome, arrhythmia, or heart failure and, based on a structured assessment, accompanied by a diagnosis of any of these mental disorders. The CC intervention was delivered by trained social work case managers in concert with team psychiatrists. CC patients received recommendations through their medical providers for pharmacotherapy or by telephone for "manualized" CBT specific to their conditions. Enhanced usual care was provided to patients in the usual care group through serial notification of primary medical providers. The case manager informed the primary inpatient treatment team regarding the patient's diagnosis and suggested the benefits of treatment. For patients in the CC group pharmacotherapeutic drugs were administered in conjunction with recommended cardiovascular drugs. Patients in the intervention group displayed significantly greater improvement in mean Short Form Mental Health Composite Score compared with the control group. Patients in the intervention group were more likely to have adequate treatment for psychiatric disorders at discharge from the hospital (75% in the CC group versus 7% in the usual care group). Additionally, CC patients displayed significantly greater improvement in PHQ-9 item scores but not in Hospital Anxiety and Depression Scale Questionnaire-A scores. In this study, CC was associated with higher rates of treatment deemed adequate and significant improvements in mental HRQoL, depression symptoms, overall QoL, and general functioning.

From The Netherlands an RCT ($n=264$ adolescents and young adults 12–22 years of age) evaluated a Web-based Solution-Focused Brief Treatment (SFBT) (CHAT) for depression compared with a waiting list as controls.[86] Candidates younger than 18 years of age needed parental consent. Those with suicidal ideation were excluded from the study. The SFBT CHAT treatment was delivered by trained professionals. It consisted of individual real-time chat sessions in a secure room. At the end of each session, the participants decided if their goal had been reached. If not, an additional chat session was scheduled with the therapist. Both groups were allowed to seek additional help on their own. Both groups showed considerable improvements in symptoms over time, but more so for the SFBT CHAT group. Between-group effects were small at 9 weeks but increased after 4 months. Despite these improvements, patients were still struggling with depression. Researchers concluded that adolescents and young adults with depression can benefit from access to Web-based SFBT chat treatment. But, it was not a panacea.

Recognizing the evidence for the increased use of the Internet as an effective tool for psychological interventions in the treatment and prevention of depression, an Australian study (RCT; $n=298$) investigated possible secondary benefits in terms of self-esteem, empowerment, and QoL.[87] Participants were adults manifesting increased distress based on a Kessler Psychological Distress questionnaire with a score of greater than 22. The intervention consisted of an Internet support group (ISG), an automated Internet psychoeducational training program for depression (e-couch), a combination of these conditions (e-couch + ISG), or an attention control Web site (HealthWatch) composed of questions and information relating to well-being (while avoiding mention of depression or stress). For ethical reasons, participants in the control group were provided with access to the depression Internet training program after the 6-month assessment. Assessments were conducted at baseline and postintervention, at 6 and 12 months, to examine depressive symptoms, social support, self-esteem, QoL, depression literacy, stigma, and help-seeking. Self-esteem improved across all groups over time. Participants in the e-couch + ISG group demonstrated greater improvement in self-esteem than those in the control group. Empowerment did not change. QoL improved in all groups. The authors suggested the need for expanding the focus of effectiveness studies beyond symptoms to secondary benefits of online interventions and the inclusion of psychological well-being and resilience.

In 2015, two RCT studies were conducted at the VHA. The first was an investigation of a telemedicine-based collaborative care intervention for PTSD.[88] The subjects ($n=265$) were recruited from 11 VHA community-based outpatient clinics serving predominantly rural veterans in Arkansas, Louisiana, and California. This VHA study paralleled one discussed above that focused on depression among rural veterans.[69] This study assessed whether the intervention improved rural veterans' access to and engagement in evidence-based treatment of PTSD. Similar to the earlier study, in this study a Telemedicine Outreach for PTSD (TOP) intervention was conducted and supervised by an off-site PTSD team. Again, in parallel fashion to the 2007 study,[63] the teams consisted of telephone nurse care managers, telephone pharmacists who reviewed medication histories, "telepsychologists" who delivered cognitive processing therapy via interactive video, and "telepsychiatrists" who supervised the team and conducted interactive video psychiatric consultations. At the 6-month follow-up TOP patients experienced a 5.31 decrease in PTSD severity compared with a 1.07 decrease for usual care patients (unpaired two-tailed $t=3.42$; Cohen $d=0.45e$). When controlled for case mix, group differences were significant at both the 6-month ($\beta=-3.81$) and 12-month ($\beta=2.49$) follow-up. Researchers concluded that the TOP and similar intervention programs "can increase access to and successfully engage rural veterans in evidence-based psychotherapy for PTSD, thereby improving clinical outcomes."

A similarly designed study, conducted by the same senior author and colleagues, was published in 2013.[89] Here again, it was an RCT ($n=364$), but the subjects were patients of federally qualified health centers. Everything else was similar, including patients with depression, and a comparison between on-site primary care versus an off-site telemedicine team linked by telephone. Again, outcome measures were treatment response, remission, and change in depression severity. The findings were also similar. Insofar as the treatment of depression was concerned, "…contracting with an off-site telemedicine-based collaborative care can yield better results than implementing practice-based collaborative care with locally available staff."

Finally, an RCT ($n=223$ children) assessed the effectiveness of a TMH model for treating ADHD among children.[90] The subjects were referred by 88 PCPs in seven communities. Those in the experimental group received six sessions over 22 weeks of combined pharmacotherapy and caregiver training provided by child psychiatrists via videoconferencing. Those in the control group received treatment from their PCPs augmented with a remote TMH consultation. After 25 weeks, children in both group improved. However, those in the experimental group "…improved significantly more than children in the augmented primary care arm…" in terms of inattention, hyperactivity, and combined ADHD and caregiver performance.

TMH: Cost

A total of five studies met the selection criteria for inclusion in the analysis of TMH cost, typically comparing the costs of TMH with in-person care. All studies, with the exception of one in Australia, were conducted in the United States and were published from 2007 to 2014 (*Table 3*).

We start with the Australian study, published in 2007.[91] This was a cost minimization analysis based on 1,499 consultations in several subspecialties, which compared the actual cost of telepediatric care with that of seeing the specialists in person over a 5-year period. The analysis involved cases in several pediatric subspecialties, including pediatric psychiatry. It concluded that "…telepaediatrics was a cheaper method for the delivery of outpatient services when the workload exceeded 774 consultations." In other words, sensitivity analysis indicated the importance of patient volume, distance (or patient travel costs), coordinator salaries, and the cost of videoconferencing equipment. Substantial cost savings were achieved by reducing travel.

Two studies, both from the United States, published in 2010 met the eligibility criteria for inclusion in this analysis. The first was an assessment of potential cost and time savings associated with TMH consultations among rural nursing home residents.[92] The data for 278 consultations rendered to 106 nursing home residents were analyzed. Travel savings were accrued by the providers by avoiding trips to the nursing homes, estimated at $3,700 for gasoline to provide all 278 consultations. However, these cost savings would decrease to $925 if four visits could be scheduled during a single trip. Total cost savings for personnel ranged from $33,739 to $67,477. Estimates of physician costs incurred as a result of travel time ranged from $84,347 to $253,040, but the cost was less when four visits could be conducted during in a single trip. Perhaps the most significant finding in this analysis has to do with the observation that TMH would fill a gap by allowing "…many nursing homes to provide essential care that would not otherwise be available."

The second study in 2010 was an RCT ($n=588$) conducted at the VHA.[93] Patients with hypertension were randomly allocated to a telephone-based behavioral intervention or a nonbehavioral intervention. The behavioral intervention was administered bimonthly for 2 years. Outcome measures included use of service and costs. The results suggested that "…a nurse-administered, tailored behavioral intervention

can be implemented at nominal cost and be cost-effective; however, there was no apparent lowering of healthcare utilization and costs during the two years of follow-up."

A third study was focused on cost savings in psychiatric consultations ($n = 257$ consultations for 132 children and adolescents).[94] Travel time costs for parents who accompanied their children to either location were included. "The cost savings in travel time and other expenses to patients and parents were substantial." However, the study was conducted over 6 months only and did not capture marginal costs of services. Hence, in view of the small sample size, this study will not be included in *Table 2* or the assessment of the empirical evidence regarding the effects of TMH on cost.

In 2012, a retrospective cost analysis compared three psychiatric consultation models: synchronous telepsychiatry, asynchronous telepsychiatry (ATP), and in-person in the primary care setting.[95] This analysis was based on the theory that asynchronous consultations would be more cost-effective due to flexibility in collecting patient data and "the substitution of the time of specialists with that of lower-cost providers." Fixed and marginal costs were compared for the three models, including equipment costs, provider and support staff time, and salaries. Fixed costs for the ATP were $7,000 versus $2,000 for the synchronous telepsychiatry, whereas marginal costs were $68.18 and $107.50, respectively; costs were $96.36 for the in-person care. "ATP became the most cost-effective model… beyond 249 consultations." The authors concluded that ATP allows "more affordable health care to be delivered to a larger population of patients."

Finally, a cost-minimization analysis compared a self-care mobile application (app) with in-office care for stress reduction.[96] The investigators estimated the total cost of treating 1,000 patients with the app (Breathe2Relax) for stress disorders to the military to be $106,397, whereas in-office care would be $6,882. However, the treatment would become less expensive when used by approximately 1,500 individuals. "A total of 47,000 users had accessed the app for 10 to 30 min sessions in the 2.5 years since the release of the app, thereby resulting in savings of $2.7 million." If all 47,000 users were civilian, the savings would be $2.9 million.

Table 3. Summary of Empirical Evidence in Telemental Health Research on Cost

REFERENCE	YEAR	COUNTRY	DESIGN	SAMPLE SIZE	STUDY POPULATION	TECHNOLOGY	FINDINGS
Smith et al.[91]	2007	Australia	Cost-minimization analysis	1,499 consultations	Pediatric	Telephone	Telepediatrics was cheaper when workload exceeds 774 consultations. Cost was sensitive to patient travel costs, salaries, and equipment costs.
Rabinowitz et al.[92]	2010	United States	Cost-effectiveness analysis	278 consultations	Nursing home residents	Video	Travel savings accrued from obviated trips to the nursing homes. TMH made care available to nursing homes without access to psychiatric care.
Dalta et al.[93]	2010	United States	RCT	588	VHA patients with hypertension	Telephone	Cost-effectiveness of behavioral intervention was $42,457 per life-year saved for normal weight women, versus $87,300 for men, with no apparent lowering of use of service.
Butler and Yellowlees[95]	2012	United States	Retrospective cost analysis	125	Nonurgent psychiatric problems	Asynchronous, synchronous	Asynchronous was most cost-effective beyond 249 consultations.
Luxton et al.[96]	2014	United States	Cost savings	1,000	Stress, military	Mobile phone app	Cost savings accrue at approximately 1,600 users.

app, application; RCT, randomized controlled trial; TMH, telemental health; VHA, Veterans Health Administration.

Summary and Conclusions

This article is the fourth in a series of in-depth literature reviews aimed at assessing the empirical evidence regarding the impact of telemedicine interventions on access, quality, and cost of care. In order to arrive at definitive conclusions, each of these reviews is focused on a set of disease manifestations as the basis for organizing and presenting the empirical evidence, which is limited to studies with sufficient statistical power (defined as samples of ≥150), robust research designs (RCT or other appropriate methodology that enables hypothesis testing), and published between 2005 and 2015. This article is focused on TMH. As in the other articles, the review process consisted of an initial screening of relevant abstracts and a subsequent reading of research articles that met the inclusion criteria for final review and analysis.

Basic background information is provided regarding the nature of mental health disorders, their epidemiology, classification, resources, and cost. This is followed by a presentation and analysis of the evidence organized on the basis of feasibility/acceptance of TMH, as well as the research findings from eligible studies related to intermediate outcomes, health outcomes, and cost.

Mental disorders refer to diagnosable mental conditions including "alterations in thinking, mood, or behavior associated with distress and impaired functioning." DSM-5 contains 18 major disorders. These disorders "are generally characterized by a combination of abnormal thoughts, perceptions, emotions, behavior and relationships with others."[97] These disorders are typically viewed as being separate from neurological disorders, learning disabilities, and intellectual limitations. Yet, there is wide agreement that they constitute a disturbance or disruption in mental function that affects an individual's ability to cope effectively with the demands of everyday life. The most common forms are depression, anxiety, mood disorders, and substance abuse. According to the World Health Organization, "mental illness results in more disability in developed countries than any other group of illnesses, including cancer and heart disease…," and "about 25% of all U.S. adults have a mental illness and nearly 50% of U.S. adults will develop at least one mental illness during their lifetime."[97] The Centers for Disease Control and Prevention estimated the economic burden of serious illness at 317.6 billion[98] in 2002. Furthermore, "mental illness is associated with lower use of medical care, reduced adherence to treatment therapies for chronic diseases, and higher risks of adverse health outcomes."

Effective approaches to the long-term management of mental illness include monitoring, surveillance, mental health promotion, mental illness prevention, and biopsychosocial treatment programs. The empirical evidence presented in this article demonstrates the capability of TMH to perform these functions more efficiently and as well as or more effectively than in-person care.

For the period under review, we selected 22 studies that investigated the feasibility/acceptance of TMH, 7 that investigated intermediate outcomes (typically related to medication adherence), 25 that focused on health outcome (symptom and QoL improvement), and 5 dealing with cost issues.

A brief listing of notable methodological issues and intervention attributes of the studies in this field illustrates not only the complexity of this research process but also the importance of establishing a contextual basis for interpreting the results:

- TMH research has relied heavily on RCTs, far exceeding comparable research related to the effects of telemedicine interventions in other diseases and health conditions.
- The telephone seems to be the technology of choice in the majority of studies, with the Internet in second place, especially when the providers are psychologists, nurses, therapists, and collaborative teams.
- CBT was the typical therapeutic modality in TMH interventions, especially when treating depression, anxiety and mood disorders. It was administered by various providers, including nurse case managers[64] and collaborative teams.[69,72] One study investigated the effects of bibliotherapy in two modalities, alone and Internet-based.[73]
- The majority of the TMH studies focused on depression, anxiety, and mood disorders. This may be explained by (1) their high prevalence as well as their impact on disability in the population at large, (2) their amenability to remote treatment, and (3) their potential for successful management by nonpsychiatrists. However, this eligibility criterion may have excluded other studies with smaller samples but with an expanded scope and a broader set of disorders and technological modalities. Hence, the strict domain of TMH research as defined in this review may not be coterminous with that of telepsychiatry in general.

Nearly all studies affirmed the feasibility and acceptance of TMH, involving children/adolescents, adults, and elderly patients, with different disorders (migraine, attention-deficit disorders, bipolar disorders, anxiety, depression, substance abuse, and postdischarge for somatic problems), rural and urban residents, and different technologies (telephone, Internet, and video). Studies reach similar conclusions regarding satisfaction with TMH. Without exception, all studies that investigated the effects of TMH on medication adherence reported positive

results, as did studies that investigated depressive symptoms and QoL. Depressive symptoms and functional performance also improved among patients with comorbid conditions such as diabetes, COPD, and cardiovascular problems.

General conclusions that can be drawn from the research evidence detailed in this article can be organized by access, efficiency, and quality, as follows:

ACCESS

- TMH makes care accessible in areas with limited or no professional mental health resources, especially psychiatrists.
- TMH provides a useful link for patients with special needs, including the young, minority populations, and the elderly.

EFFICIENCY

- Direct service to patients in chat rooms and using instructional material saves on professional expenses.
- Nonprofessional providers can play an effective role in therapy.
- Collaborative teamwork is an effective model for TMH.
- Telephone and Internet-based applications serve as effective tools in rendering behavioral therapies.
- TMH becomes increasingly more cost-effective with a larger volume of patients, more usage, and longer travel to care.

QUALITY

TMH demonstrates

- Improved mental healthcare in primary care settings
- Effective treatment for depression and anxiety disorders (particularly CBT)
- Improved outcomes where patients have comorbid medical conditions
- Compliance, medication adherence

Only five studies investigating the cost implications of TMH met the eligibility criteria for inclusion in this analysis. In addition to demonstrating the cost-effectiveness of TMH in terms of making care available to nursing home residents without access to psychiatric care, it appears that cost-effectiveness and cost savings are volume sensitive. The minimal volume for savings is 250 consultations.

Nearly all studies affirmed the feasibility and acceptance of TMH, involving children/adolescents, adults, and elderly patients, with different disorders (migraine, attention-deficit disorders, bipolar disorders, anxiety, depression, substance abuse, and postdischarge for somatic problems), rural and urban residents, and different technologies (telephone, Internet, and video). Studies reach similar conclusions regarding satisfaction with TMH. Without exception, all studies that investigated the effects of TMH on depressive symptoms reported positive outcomes. Depressive symptoms and functional performance also improved among patients with comorbid conditions such as diabetes, COPD, and cardiovascular problems. Similar effects were observed in terms of QoL, stress symptoms, anxiety, panic disorders, and self-esteem.

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REFERENCES

1. National Alliance on Mental Illness. Fact sheet. Available at http://www2.nami.org/factsheets/mentalillness_factsheet.pdf (last accessed July 22, 2015).
2. *Understanding Mental Disorders: Your Guide to DSM-5*. Arlington, VA: American Psychiatric Association, **2015.**
3. Bagalman E, Napili A. *Prevalence of mental illness in the United States: Data sources and estimates*. Washington, DC: Congressional Research Service, Library of Congress, **2015.**
4. National Institute for Mental Health. Available at www.nimh.nih.gov/health/statistics/prevalence/any-mental-illness-ami.among-adults.shtml (last accessed June 15, 2015).
5. Scientific Advisory Board of the Executive Committee of the Grand Challenges on Mental Health. Global challenges on global mental health. **2011.** Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3173804 (last accessed August 3, 2015).
6. National Institute on Alcohol Abuse and Alcoholism. Available at www.niaa.nih.gov/alcohol-health (last accessed June 15, 2015).
7. National Institute on Drug Abuse. Available at www.drugabuse.gov/related-topics/trends-statistics (last accessed June 25, 2015).
8. http://america.aljazeera.com/watch/shows/america-tonight/articles/2014/7/25/l-a-county-jail-psychiatricward.html (last accessed June 5, 2015).
9. Konrad T, Ellis A, Thomas K, et al. County-level estimates of need for mental health professionals in the United States. *Psychiatr Serv* **2009;**60: 1303–1314.
10. Moyer K. Primary care doctors carrying heavier mental health load. American Medical News. **2010.** Available at www.amednews.com/article/20101025/profession/310259962/2/ (last accessed August 29, 2015).
11. Katon WJ. Epidemiology and treatment of depression in patients with chronic medical illness. *Dialogues Clin Neurosci* **2011;**13:7–23.
12. Available at www.calhospital.org/sites/main/files/file-attachments/psychbeddata.pdf (last accessed May 25, 2015).
13. Available at http://tacreports.org/storage/documents/treatment-behind-bars.pdfs (last accessed May 25, 2015).

14. Insel TR. Assessing the economic costs of serious mental illness. *Am J Psychiatry* **2008;**165:663–665.
15. National Institute for Mental Health. Available at www.nimh.nih.gov/about/director/2011/psychiatry-where-are-we-going.shtml (last accessed September 15, 2015).
16. Bashshur R. Telemedicine nomenclature: What does it mean? *Telemed J* **2000;**6:1–2.
17. Clarke G, Yarborough B. Evaluating the promise of health IT to enhance/expand the reach of mental health services. *Gen Hosp Psychiatry* **2013;**35:339–344.
18. Wittson CL, Dutton R. A new tool in psychiatric education. *Psychiatr Serv* **1956;**7:11–14.
19. Wittson C, Dutton R. Interstate telecommunication. *Psychiatr Serv* **1957;**8:15–17.
20. Dwyer T. Telepsychiatry: Psychiatric consultation by interactive television. *Am J Psychiatry* **1973;**130:865–869.
21. Luxton D, McCann R, Bush N, Mishkind M, Reger G. mHealth for mental health: Integrating smartphone technology in behavioral healthcare. *Prof Psychol Res Pract* **2011;**42:505–512.
22. Malhotra S, Chakrabarti S, Shah R. Telepsychiatry: Promise, potential, and challenges. *Indian J Psychiatry* **2013;**55:3–11.
23. Hilty D, Ferrer D, Burke M, et al. The effectiveness of telemental health: A 2013 review. *Telemed J E Health* **2013;**19:444–454.
24. Cottrell C, Drew J, Gibson J, Holroyd K, O'Donnell F. Feasibility assessment of telephone-administered behavioral treatment for adolescent migraine. *Headache* **2007;**47:1293–1302.
25. Myers K, Valentine J, Melzer S. Feasibility, acceptability and sustainability of telepsychiatry for children and adolescents. *Psychiatr Serv* **2007;**58:1493–1496.
26. Yellowlees P, Hilty D, Marks S, Neufeld J, Bourgeois J. A retrospective analysis of a child and adolescent eMental Health program. *J Am Acad Child Adolesc Psychiatry* **2008;**47:103–107.
27. Davis A, Sampilo M, Gallagher K, Landrum Y, Malone B. Treating rural pediatric obesity through telemedicine: Outcomes from a small randomized controlled trial. *J Pediatr Psychol* **2013;**38:932–942.
28. Myers K, Vander Stoep A, Lobdell C. Feasibility of conducting a randomized controlled trial of telemental health with children diagnosed with attention-deficit/hyperactivity disorder in underserved communities. *J Child Adolesc Psychopharmacol* **2013;**23:372–378.
29. Davidson T, Yuen E, Felton J, McCauley J, et al. Feasibility assessment of a brief, Web-based behavioral activation intervention for adolescents with depressed mood. *Int J Psychiatry Med* **2014;**48:69–82.
30. Enck P, Kowalski A, Martens U, Klosterhalfen S. Internet-based assessment of bowel symptoms and quality of life. *Eur J Gastroenterol Hepatol* **2006;**18:1263–1269.
31. Grossi E, Groth N, Mosconi P, Cerutti R, et al. Development and validation of the Short Version of the Psychological General Well-Being Index (PGWB-S). *Health Qual Life Outcomes* **2006;**4:88.
32. Hubbard R, Leimberger J, Haynes L, Patkar A, et al. Telephone enhancement of long-term engagement (TELE) in continuing care for substance abuse treatment: A NIDA clinical trials network (CTN) study. *Am J Addict* **2007;**16:495–502.
33. Grubaugh A, Cain G, Elhai J, Patrick S, Frueh C. Attitudes toward medical and mental health care delivered via telehealth applications among rural and urban primary care patients. *J Nerv Ment Dis* **2008;**196:166–170.
34. Searles J, Perrine M, Mjundt J, Helzer J. Self-report of drinking using touch-tone telephone: Extending the limits of reliable daily contact. *J Stud Alcohol* **1995;**56:375–382.
35. Searles J, Hellzer J, Walter D. Comparison of drinking patterns measured by daily reports and timeline follow back. *Psychol Addict Behav* **2000;**14:277–286.
36. Helzer J, Rose G, Badger G, Searles J, et al. Using interactive voice response to enhance brief alcohol intervention in primary care settings. *J Stud Alcohol Drugs* **2008;**69:251–258.
37. Cacciola J, Camilleri A, Carise D, Rikoon S, et al. Extending residential care through telephone counseling: Initial results from the Betty Ford Center Focused Continuing Care Protocol. *Addict Behav* **2008;**33:1208–216.
38. Carlson L, Lounsberry J, Maciejewski O, Wright K, et al. Telehealth-delivered group smoking cessation for rural and urban participants: Feasibility and cessation rates. *Addict Behav* **2012;**37:108–114.
39. Chong J, Moreno F. Feasibility and acceptability of clinic-based telepsychiatry for low-income Hispanic primary care patients. *Telemed J E Health* **2012;**18:297–304.
40. Baker-Ericzen M, Connelly C, Hazen A, Duenas C, et al. A collaborative care telemedicine intervention to overcome treatment barriers for Latina women with depression during the perinatal period. *Fam Syst Health* **2012;**30:222–240.
41. Williams E, Bird D, Forbes A, Russell A, et al. Randomised controlled trial of an automated, interactive telephone intervention (TLC Diabetes) to improve type 2 diabetes management: Baseline findings and six-month outcomes. *BMC Public Health* **2012;**12:602.
42. Ebert D, Hannig W, Tarnowski T, Sieland B, et al. Web-based rehabilitation aftercare following inpatient psychosomatic treatment. *Rehabilitation (Stuttg)* **2013;**52:164–172.
43. Serdar K, Kelly N, Palmberg A, Lydecker J, et al. Comparing online and face-to-face dissonance-based eating disorder prevention. *Eating Disorders* **2014;**22:244–260.
44. Cole S, Garber N, Weiner J, Sulfaro M, et al. Double-disease management or one care manager for two chronic conditions: Pilot feasibility study of nurse telephonic disease management for depression and congestive heart failure. *Dis Manag* **2006;**9:266–276.
45. Katon W, Von Korff M, Lin E, Simon G, et al. The Pathways Study: A randomized trial of collaborative care in patients with diabetes and depression. *Arch Gen Psychiatry* **2004;**61:1042–1049.
46. Kilbourne A, Post E, Nossek A, Sonel E, et al. Service delivery in older patients with bipolar disorder: A review and development of a medical care model. *Bipolar Disord* **2008;**10:672–683.
47. Vilalta-Franch J, Garre-Olmo J, Lopez-Pousa S, Llinas-Regla J, et al. Feasibility of a telemedicine support system for diagnosing dementia in primary care [in Spanish]. *Rev Neurol* **2012;**55:263–269.
48. Lacruz M, Emeny R, Bickel H, Linkohr G, Ladwig K. Feasibility, internal consistency and covariates of TICS-m (Telephone Interview for Cognitive Status-Modified) in a population-based sample: Findings from the KORA-Age Study. *Int J Geriatr Psychiatry* **2013;**28:971–978.
49. Choi NG, Hegel MT, Marti CN, Marinucci ML. Telehealth problem-solving therapy for depressed low-income homebound older adults. *Am J Geriatr Psychiatry* **2014;**22:263–273.
50. Carter R, Haynes L, Back S, Herrin A, et al. Improving the transition from residential to outpatient addiction treatment: Gender differences in response to supportive telephone calls. *Am J Drug Alcohol Abuse* **2008;**34:47–59.
51. Morland L, Greene C, Rosen C, Foy D, et al. Telemedicine for anger management therapy in a rural population of combat veterans with post-traumatic stress disorder: A randomized noninferiority trial. *J Clin Psychiatry* **2010;**71:855–863.
52. Deen T, Fortney J, Pyne J. Relationship between satisfaction, patient-centered care, adherence and outcomes among patients in a collaborative care trial for depression. *Adm Policy Ment Health* **2011;**38:345–355.
53. Migneault J, Dedier J, Wright J, Heeren T, et al. A culturally adapted telecommunication system to improve physical activity, diet quality, and medication adherence among hypertensive African-Americans: A randomized controlled trial. *Ann Behav Med* **2012;**43:62–73.

54. Piete JD, Sussman JB, Pfeiffer PN, Silveira MJ, et al. Maximizing the value of mobile health monitoring by avoiding redundant patient reports: Prediction of depression-related symptoms and adherence problems in automated health assessment services. *J Med Internet Res* **2013;**15:e118.

55. Guzman-Clark JR, van Servellen G, Chang B, Mentes J, Hahn TJ. Predictors and outcomes of early adherence to the use of a home telehealth device by older veterans with heart failure. *Telemed J E Health* **2013;**19:217–223.

56. Campbell AN, Nunes EV, Matthews AG, Stitzer M, et al. Internet-delivered treatment for substance abuse: A multisite randomized controlled trial. *Am J Psychiatry* **2014;**171:683–690.

57. Egede L, Acierno R, Knapp R, Lejuez C, et al. Psychotherapy for depression in older veterans via telemedicine: A randomized, open-label, non-inferiority trial. *Lancet Psychiatry* **2015;**2:693–701.

58. Rollman B, Belnap B, Mazumbar S, Houck P, et al. A randomized trial to improve the quality of treatment for panic and generalized anxiety disorders in primary care. *Arch Gen Psychiatry* **2005;**62:1332–1341.

59. Frangou S, Sachpazidis I, Stassinakis A, Sakas G. Telemonitoring of medication adherence in patients with schizophrenia. *Telemed J E Health* **2005;**11:675–683.

60. Andersson G, Bergstgrom J, Hollandare F, Carflbring P, et al. Internet-based self-help for depression: Randomized controlled trial. *Br J Psychiatry* **2005;**187:456–461.

61. Devineni T, Blanchard E. A randomized controlled trial of an Internet-based treatment for chronic headache. *Behav Res Ther* **2005;**43:277–292.

62. Mohr D, Hart S, Julilan L, Catledge C, et al. Telephone-administered psychotherapy for depression. *Arch Gen Psychiatry* **2005;**62:1007–1014.

63. Mohr D, Hart S, Vella L. Reduction in disability in a randomized controlled trial of telephone-administered cognitive-behavioral therapy. *Health Psychol* **2007;**26:554–563.

64. Trief P, Morin P, Izquierdo R, Teresi J, et al. Depression and glycemic control in elderly ethnically diverse patients with diabetes. *Diabetes Care* **2006;**29: 830–835.

65. Bashshur RL, Shannon GW, Smith BR, Woodward MA. The empirical evidence for the telemedicine intervention in diabetes management. *Telemed J E Health* **2015;**21:321–354.

66. Sherwood NE, Jeffery RW, Pronk NP, Boucher JL, et al. Mail and phone interventions for weight loss in a managed-care setting; weigh-to-be 2-year outcomes. *Int J Obesity (Lond)* **2006;**30:1565–1573.

67. De Las Cuevas C, Arredondo MT, Cabrera MF, Sulzenbacher H, Meise U. Randomized clinical trial of telepsychiatry through videoconference versus face-to-face conventional psychiatric treatment. *Telemed J E Health* **2006;**12:341–350.

68. Lyneham H, Rapee R. Evaluation of therapist-supported parent-implemented CBT for anxiety disorders in rural children. *Behav Res Ther* **2006;**44:1287–1300.

69. Fortney JC, Pyne JM, Edlund MJ, Williams DK, et al. A randomized trial of telemedicine-based collaborative care for depression. *J Gen Intern Med* **2007;**22:1086–1093.

70. Seligman M, Schulman P, Tryon A. Group prevention of depression and anxiety symptoms. *Behav Res Ther* **2007;**45:1111–1126.

71. Onor ML, Trevisiol M, Urciuoli O, Misan S, et al. Effectivness of telecare in elderly populations—A comparison of three settings. *Telemed J E Health* **2008;**14: 164–169.

72. Rollman BL, Belnap BH, LeMenager MS, Mazumdar S, et al. Telephone-delivered collaborative care for treating post-CABG depression: A randomized controlled trial. *JAMA* **2009;**302:2095–2103.

73. Furmark T, Calbrng P, Hedman E, Sonnensten A, et al. Guided and unguided self-help for social anxiety disorder: Randomized controlled trial. *Br J Psychiatry* **2009;**195:440–447.

74. Wiegand B, Luedtke K, Friscia D, Nair M, Aleles M, McCloskey R. Efficacy of a comprehensive program for reducing stress in women: A prospective randomized trial. *Curr Med Res Opin* **2010;**26:991–1002.

75. Deen TL, Fortney JC, Pyne JM. Relationship between satisfaction, patient-centered care, adherence and outcomes among patients in a collaborative care trial for depression. *Adm Policy Ment Health* **2011;**38:344–355.

76. Van Bastelaar KM, Pouwer F, Cuijpers P, Riper H, Snoek FJ. Web-based depression treatment for type 1 and type 2 diabetic patients. *Diabetes Care* **2011;**34:320–325.

77. Jackson GL, Oddone EZ, Olsen MK, Powers BJ, et al. Racial differences in the effect of a telephone-delivered hypertension disease management program. *J Gen Intern Med* **2012;**27:1682–1689.

78. Moreno FA, Chong J, Dumbauld J, Humke M, Byreddy S. Use of standard webcam and internet equipment for telepsychiatry treatment of depression among underserved Hispanics. *Psychiatr Serv* **2102;**63:1213–1217.

79. Mohr DC, Ho J, Duffecy J, Reifler D, et al. Effect of telephone-administered vs face-to-face cognitive behavioral therapy on adherence to therapy and depression outcomes among primary care patients: A randomized trial. *JAMA* **2012;**307:2278–2285.

80. Powell J, Hamborg T, Stallard N, Burls A, et al. Effectiveness of a web-based cognitive-behavioral tool to improve mental well-being in the general population: Randomized controlled trial. *J Med Internet Res* **2013;**15:e2.

81. Glozier N, Christensen H, Naismith S, Cockayne N, et al. Internet-delivered cognitive behavioural therapy for adults with mild to moderate depression and cardiovascular disease risks: A randomised attention-controlled trial. *PLoS One* **2013;**8:e59139.

82. Hedman E, Ljotsson B, Ruck C, Bergstrom J, et al. Effectiveness of Internet-based cognitive behavior therapy for panic disorder in routine psychiatric care. *Acta Psychiatr Scand* **2013;**128:457–467.

83. Fortney JC, Pyne JC, Mouden S, Mittal D, 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;**170:414–425.

84. Blumenthal JA, Emery CF, Smith PJ, Keefe FJ, Welty-Wolf K, et al. The effects of a telehealth coping skills intervention on outcomes in chronic obstructive pulmonary disease: Primary results from the INSPIRE-II study. *Psychosom Med* **2014;**76:581–592.

85. Huffman JC, Mastromauro CA, Beach SR, Celano CM, et al. Collaborative care for depression and anxiety disorders in patients with recent cardiac events: The management of sadness and anxiety in cardiology. *JAMA Intern Med* **2014;**174:927–935.

86. Kramer J, Conijn B, Oijevaar P, Riper H. Effectiveness of a web-based solution-focused brief chat treatment for depressed adolescents and young adults: Randomized controlled trial. *J Med Internet Res* **2014;**16:e141.

87. Crisp D, Griffiths K, Mackinnon A, Bennett K, Christensen H. An online intervention for reducing depressive symptoms: Secondary benefits for self-esteem, empowerment and quality of life. *Psychiatr Res* **2014;**216:60–66.

88. Fortney JC, Pyne JM, Kimbrell TA, Hudson TJ, Robinson DE, et al. Telemedicine-based collaborative care for posttraumatic stress disorder: A randomized clinical trial. *JAMA Psychiatry* **2015;**72:58–67.

89. Fortney JC, Pyne JM, Mouden SB, Mittal D, et al. Practice-based versus telemedicine-based collaborative care for depression I rural federally qualified health centers: A pragmatic randomized comparative effectiveness trial. *Am J Psychiatry* **2013;**170:414–425.

90. Myers K, Vander Stoep A, Zhou C, McCarty C, Katon W. Effectiveness of a telehealth service delivery model for treating attention deficit/hyperactivity disorder: A community-based randomized controlled trial. *J Am Acad Child Adolesc Psychiatry* **2015;**54:263–274.

91. Smith A, Scuffham P, Wooton R. The cost and potential savings of a novel telepaediatric service in Queensland. *BMC Health Serv Res* **2007;**7:35.

92. Rabinowitz T, Murphy K, Amour J, Ricci M, et al. Benefits of a telepsychiatry consultation service for rural nursing home residents. *Telemed J E Health* **2010;**16:34–40.

93. Datta SK, Oddone EZ, Olsen MK, Orr M, et al. Economic analysis of a tailored behavioral intervention to improve blood pressure control for primary care patients. *Am Heart J* **2010;**160:257–263.

94. Spaulding R, Belz N, Delurgio S, Williams AR. Cost savings of telemedicine utilization for child psychiatry in a rural Kansas community. *Telemed J E Health* **2010;**16:867–871.

95. Butler TN, Yellowlees P. Cost analysis of store-and-forward telepsychiatry as a consultation model for primary care. *Telemed J E Health* **2012;**18:74–77.

96. Luxton D, Hansen R, Stanfill K. Mobile app self-care versus in-office care for stress reduction: A cost-minimization analysis. *J Telemed Telecare* **2014;**20:431–435.

97. World Health Organization. WHO Mental Disorders, Fact Sheet No. 396. Updated September 2015. Available at www.who.int/mediacentre/factsheets/fs396/en/ (last accessed September 9, 2015).

98. The National Institute of Mental Health. Annual direct and indirect costs of serious mental illness. **2002.** Available at http://www.nimh.nih.gov/health/statistics/cst/file148243.pdf (last accessed August 3, 2015).

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