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Feasibility and Effectiveness of an Automated Telehealth Intervention to Improve Illness Self-Management in People With Serious Psychiatric and Medical Disorders

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Abstract

Objective—Effective monitoring and treatment are needed to address the elevated rates of medical comorbidity among individuals with serious mental illnesses. This study examined the feasibility and potential effectiveness of an automated telehealth intervention, supported by nurse health-care management, among adults with serious mental illnesses and chronic medical conditions.

Methods—We conducted a single-arm pilot trial with 70 individuals with serious mental illnesses and chronic medical conditions who were medically unstable (determined by treatment team or defined as multiple emergency room visits/hospitalizations within the past year). The telehealth intervention was delivered for 6 months with feasibility and acceptability as the primary

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outcomes. Measures of illness management self-efficacy, psychiatric symptoms, subjective health status, health indicators, and service use were also collected at baseline and at 6 months.

Results—Most individuals ($n = 62$; 89%) participated in at least 70% of the telehealth sessions. Participation was associated with improvements in self-efficacy for managing depression and diastolic blood pressure. Almost all participants ($n = 68$; 98%) rated their understanding of their medical condition as “much better” or “somewhat better” postintervention. Among a subgroup of individuals with diabetes, decreases in fasting blood glucose were achieved, and among those with diabetes and major depression or bipolar disorder there were reductions in urgent care and primary care visits.

Conclusions and Implications for Practice—These results demonstrate the feasibility and acceptability of automated telehealth supported by a nurse care manager and the potential effectiveness of this technology in improving self-management of psychiatric symptoms and chronic health conditions among these high-risk individuals.

Keywords

serious mental illness; telehealth; medical comorbidity; illness self-management; community mental health centers

Approximately 6% of Americans have a serious mental illness (Kessler, Chiu, Demler, Merikangas, & Walters, 2005), including 1.1% with schizophrenia (Regier, Narrow, Rae, & Manderscheid, 1993) and 2.6% with bipolar disorder (Kessler et al., 2005). On average, people with serious mental illnesses die between 8 (Druss, Zhao, Von Esenwein, Morrato, & Marcus, 2011) and 32 (Colton & Manderscheid, 2006) years earlier than individuals without mental illnesses, a mortality rate that is 2 to 3 times greater than that of the general population (De Hert et al., 2011; Mortensen & Juel, 1993). Factors contributing to early mortality include high prevalence of comorbid medical disorders, poor health behaviors, medication side effects, and inadequate health care (Lawrence & Kisely, 2010; Parks, Svendsen, Singer, & Foti, 2006). The greater costs (Fleury, Grenier, Bamvita, & Caron, 2010; Viron & Stern, 2010) and adverse outcomes (Viron & Stern, 2010) associated with the combination of mental illness and medical comorbidity in people with serious mental illnesses call for development of effective models to specifically address the needs of this high-risk group.

Estimates of the prevalence of medical comorbidity in people with serious mental illnesses are as high as 90% (Gold, Kilbourne, & Valenstein, 2008), with conditions such as diabetes (11–18%) (Chwastiak et al., 2006; Goff et al., 2005; Lamberti et al., 2004; Srihari, Tek, Chwastiak, Woods, & Steiner, 2007), hypertension (up to 20%), and heart disease (12%) (Dickey, Normand, Weiss, Drake, & Azeni, 2002; Dixon, Postrado, Delahanty, Fischer, & Lehman, 1999) occurring at much higher rates than in the general population (Dickey et al., 2002). Sedentary behavior, poor diet, and antipsychotic-related weight gain place individuals at significant risk for these cardiometabolic disorders (Colton & Manderscheid, 2006).

Despite the high incidence of medical comorbidity in this population, effective monitoring and treatment are often inadequate and highly variable (Vreeland, 2007). Further, these individuals are more likely to experience greater barriers to preventive and routine health

care, with over half (59%) reporting at least one barrier to accessing medical care compared with 19% of people without a psychiatric disorder (Dickerson et al., 2003). People with serious mental illnesses are often unable to afford prescription medications, lack transportation, have problems scheduling medical appointments (Dickerson et al., 2003), and have symptoms and associated difficulties that can affect health self-management, such as depression, cognitive impairment, and low motivation (Fagiolini & Goracci, 2009; Goff, 2007; Gold et al., 2008; Kane, 2009; Lambert & Newcomer, 2009).

Telehealth has emerged as an effective approach for assisting with the management of chronic conditions among other vulnerable patient groups who experience difficulty accessing routine health services, such as homebound adults, frail elderly, and people with physical disability (Finkelstein, Speedie, Zhou, Potthoff, & Ratner, 2011; Muncert et al., 2011; Sheeran et al., 2011). Diabetes is one of the most widely studied health conditions targeted by telehealth (Polisena et al., 2009), including interventions that have been used to detect potential and actual adverse events (Sarkar et al., 2008), send automated reminder messages (Mollon et al., 2008), deliver education (Nyenwe, Ashby, Tidewell, Nouer, & Kitabchi, 2011; Weinstock et al., 2011), monitor physical activity and promote a healthier diet (Luley, Blaik, Reschke, Klose, & Westphal, 2011), augment traditional phone monitoring (Polisena et al., 2009; Stone et al., 2010), automate data collection (Agarwal & Lau, 2010; Azar & Gabbay, 2009; Carter, Nunlee-Bland, & Callender, 2011; Kim & Kim, 2008), and monitor diabetic health indicators, including blood glucose, weight, blood pressure, and oxygen saturation (Bird et al., 2010; Bujnowska-Fedak, Puchala, & Steciwko, 2011; Cho, Lee, Lim, Kwon, & Yoon, 2009; Kwon et al., 2004; Mulvaney et al., 2010). Results from studies of these interventions are mixed, although in general, multicomponent interventions have been more effective than simple remote monitoring.

Among people with serious mental illnesses, telehealth, including video-based assessment (Chae, Park, Cho, Hong, & Cheon, 2000; Ruskin et al., 1998; Zarate et al., 1997) and interventions to promote treatment adherence (D'Souza, 2002; Frangou, Sachpazidis, Stassinakis, & Sakas, 2005), has been used to improve mental health outcomes. For example, telehealth has been used to reduce relapse and hospitalizations (Španiel et al., 2008), provide case management (Nieves, Godleski, Stack, & Zinanni, 2009), detect changes in behavior and routine (Prociow & Crowe, 2010a), and support personalized care (Prociow & Crowe, 2010b). Evidence supports telehealth as a feasible and potentially promising approach to providing multicomponent interventions through remote delivery of in-home psychotherapy and educational resources (Rotondi et al., 2010), including treatment of late-life mental disorders through multisensory therapy, reminiscence, and virtual cognitive stimulation (Westphal, Dingjan, & Attoe, 2010).

Despite the high prevalence of medical comorbidity in this population and evidence supporting the use of telehealth interventions for managing chronic health conditions, there is little research on the feasibility, acceptability, and potential effectiveness of telehealth for people with serious mental illnesses and co-occurring chronic health conditions. One recent trial demonstrated the potential feasibility and effectiveness of the Health Buddy[®], a telehealth disease management program supported by nurse care management, as evidenced by reductions in the total number of hospitalizations and emergency department visits

among a group of veterans with mental health illness at the VA Connecticut Health Care System (Godleski, Cervone, Vogel, & Rooney, 2012). The 76 participants in this study were predominantly male (89%) and most had major depression (71%) or substance use disorder (18%), although a small number had schizophrenia (7%) or posttraumatic stress disorder (PTSD; 4%) (Godleski et al., 2012).

The current study expands on the work by Godleski et al. (2012) by evaluating the feasibility, acceptability, and effectiveness of this automated telehealth intervention in a sample of participants with diagnosed chronic medical conditions and medical instability, defined as having multiple emergency room visits or hospitalizations within the past year. In addition, we sought to include a sample with a more balanced distribution of psychiatric diagnoses including depression, bipolar disorder, schizophrenia, schizoaffective disorder, and PTSD. Specifically, we conducted a pilot trial addressing the following hypotheses: The telehealth intervention will be associated with greater disease management self-efficacy, improvements in measures of medical and psychiatric symptoms and outcomes, and decreased health service utilization among people with serious mental illnesses and comorbid chronic health conditions.

Methods

This single-arm pilot study assessed the feasibility and effectiveness of an automated telehealth intervention supported by a nurse care manager over a 6-month period. The study was described to participants in detail, and written informed consent was obtained through procedures approved by the Dartmouth College and New Hampshire Bureau of Behavioral Health Committees for the Protection of Human Subjects.

Study Participants

Participants ($n = 70$) were adult consumers (aged 18 and older) at a Community Mental Health Center in Concord, New Hampshire, between November 2008 and April 2011. Inclusion criteria were serious mental illness defined by a primary *Diagnostic and Statistical Manual of Mental Disorders* (4th edition; *DSM-IV*) Axis I diagnosis of PTSD, schizophrenia, schizoaffective disorder, major depressive disorder, or bipolar disorder and at least moderate impairment in multiple domains of life functioning; medical diagnosis of diabetes, chronic pain, chronic obstructive pulmonary disease (COPD), or congestive heart failure; medical or psychiatric instability determined by the treatment team or indicated by at least two emergency room visits or two hospitalizations in the prior 12 months; and the ability to read. All participants had a landline telephone or were willing to have one installed in their residence, paid for by the study. Exclusion criteria were terminal illness expected to result in death within 1 year; plans to relocate out of Concord, New Hampshire, within 1 year; primary diagnosis of dementia or significant cognitive impairment defined as a Mini-Mental State Examination (MMSE) score less than 24 (Folstein, Folstein, & McHugh, 1975); psychiatric diagnosis secondary to a medical condition; current substance dependence; or serious visual impairment.

The research team screened 290 potential participants, 133 of whom were ineligible because they did not have a diagnosed chronic medical condition or because they did not meet the

medical or psychiatric instability inclusion criteria defined above. Among the 157 eligible individuals, 110 were contacted and 72 agreed to enroll. Participant demographic information including gender, age, race, and level of education were recorded and participant diagnoses were confirmed through chart review and by the team psychiatrist. Seventy participants completed the baseline assessment and received the telehealth intervention for 6 months.

Intervention

The automated telehealth intervention, was developed by Robert Bosch Health Care, Palo Alto, California. This electronic device has four buttons and a high-resolution LCD screen, is connected to a home telephone line, and is programmed with a library of medical information and questions specific to users' health conditions. This device has been used in diverse population groups and has contributed to fewer inpatient admissions and emergency department visits as well as improvements in quality of life in a sample of indigent and economically disadvantaged adults with diabetes (Cherry, Moffatt, Rodriguez, & Dryden, 2002); reductions in hospital admissions and exacerbations among middle-aged and older adults with moderate to severe COPD (Koff, Jones, Cashman, Voelkel, & Vandivier, 2009; Trappenburg et al., 2008); and improvements in measures of cardiovascular health among adults with congestive heart failure (LaFramboise, Todero, Zimmerman, & Agrawal, 2003).

In the current study, the telehealth device was supported by a nurse at the mental health center. Participants with serious mental illnesses completed daily telehealth sessions with tailored questions regarding medical and psychiatric symptoms, vital signs, disease-specific health indicators (e.g., blood glucose, oxygen saturation, weight), self-management knowledge, and health behaviors. Although a full assessment of fit and usability was not conducted as part of this pilot study, the telehealth device has been used with individuals with a wide range of cognitive and intellectual abilities, and all of the content was written at a fourth-grade reading level. In addition, at the start of the study, the telehealth nurse visited all consumers in their homes to install the unit, ensuring that it was properly connected to a telephone landline, and to guide them through a standard orientation session, which introduces users to the procedures for completing the daily sessions. The nurse provided coaching on use of the unit until all consumers felt comfortable independently completing their sessions. All participants were assigned to content libraries on the basis of their specific psychiatric and medical conditions. For example, there were 5 psychiatric diagnoses and 4 medical illnesses, resulting in 16 possible combinations of psychiatric and medical illnesses.

The daily telehealth sessions lasted between 5 and 10 min and consisted of reminders and educational information intended to help users better understand their psychiatric and medical conditions and manage them proactively. The sessions also included prompts or questions relating to illness management behaviors (e.g., "Have you taken your medications today?"), questions about critical symptoms of the user's condition (e.g., "Have you had any thoughts of suicide in the past 24 hours?"), prompts to enter objective indicators of health such as glucose or weight, and questions designed to provide education about the user's illness (e.g., "True or false? Problems with mood, such as depression and anxiety, are common among people with schizophrenia."). Many of the questions also included

branching logic based on user responses. For example, users who responded that they had not taken their medications were asked why and were provided with different feedback depending on the reason indicated. Sessions concluded with a trivia question or fun fact designed to enhance engagement and motivation to complete the sessions.

Participant responses were transmitted to a secure website and were hierarchically arranged based on risk level before being reviewed by the telehealth nurse. Individuals were informed that the nurse monitored responses only on weekdays. The nurse contacted participants in the high- or moderate-risk category by phone or via text message to follow-up with additional questions, provide advice, or facilitate referrals for health-care or emergency services. The nurse was able to send custom messages through the telehealth device to provide feedback or ask participants questions. The nurse sent such messages or called participants if more than 24 h passed between completed telehealth sessions to encourage compliance.

The telehealth device also automatically provided specific instructions (e.g., “Call your doctor right away.”) to participants demonstrating signs of relapse. Examples of signs of relapse included current suicidal thoughts, weight gain of more than 3 lb in 24 h, and paranoia (e.g., “Do you feel that people are plotting against you?”). The telehealth nurse was also responsible for facilitating integration of participants’ medical and psychiatric care. The nurse was an existing member of the mental health treatment team who collaborated with other providers when mental health issues arose, but he/she was the primary team member to make direct contact with participants when medical issues required follow-up. The nurse was responsible for making decisions about how to intervene when participants were experiencing crises or exhibiting signs of relapse of illness that nonmedically trained case managers were not equipped to handle. The nurse also established relationships with the primary care providers for each participant to facilitate coordination of care, and he/she made home visits or accompanied participants to medical appointments when necessary.

Measures

The primary outcome was feasibility of using the telehealth device among adults with serious mental illnesses and medical comorbidity. Feasibility was assessed using the rate of participant adherence, calculated as the total number of sessions completed divided by the number of possible sessions over 6 months (7 days per week for 6 months). Secondary outcomes included disease self-efficacy, which was assessed using the Stanford Chronic Disease Self-Efficacy Scale (Lorig et al., 1996) comprising 33 items rated on a scale of 1 (*not at all confident*) to 10 (*totally confident*); knowledge of mental illness evaluated with 10-item scales developed for this study; subjective physical and emotional health status assessed with the Mental Component and Physical Component scores on the Short Form Health Survey (SF-12) with a mean of 50 and standard deviation of 10 (Ware, Kosinski, & Keller, 1998); and psychiatric symptoms assessed with factor scores from the Brief Psychiatric Rating Scale (BPRS) ranging from 1 to 7 with higher scores indicating greater symptom severity (Lukoff, Nuechterlein, & Ventura, 1986; Overall & Gorham, 1962). Trained research interviewers completed these measures at baseline and at the 6-month follow-up.

Service use over the prior 30 days (hospitalizations, emergency room visits, routine health care visits and urgent care visits) was self-reported by participants on the telehealth device at baseline and at 6 months. Participants also self-reported objective health measures, including blood pressure, weight, and blood glucose, onto the telehealth device at regular intervals ranging from daily to weekly. For example, participants with diabetes were prompted daily by the telehealth device to measure their blood sugar level with a glucometer, which they then entered on the telehealth unit. Finally, at the conclusion of the telehealth intervention only, the device asked participants to rate their knowledge of illness, their ability to manage their illness, and their willingness to continue using the device.

Statistical Analyses

Data were examined for missing and outlying values. Measures of central tendency, variability, and distributional form were computed for each outcome variable. Estimations of treatment effect sizes (ES) are reported here because the study was not powered to detect statistically significant outcomes. The thresholds defined by Cohen (1988) were used to determine whether ES were considered small (.20), moderate (.50), or large (.80) (Cohen, 1988). We ran paired *t* tests to assess for differences among participants before using the telehealth device and after using the telehealth device for 6 months. Statistical significance was based on a *p* value of .05 or less. All statistical analyses were performed with SPSS release 19.0.

Results

Of the 110 people invited to participate in the study, 70 (64%) agreed to participate and were enrolled. This high rate of agreement represents excellent acceptability of the telehealth device. Reasons for refusing participation varied, but issues related to psychiatric symptoms such as paranoia accounted for surprisingly few refusals.

Average adherence to the telehealth sessions over 6 months was 71%. One third ($n = 23$) of participants had adherence rates greater than 90%, and 89% ($n = 62$) had adherence rates over 70%. Participants' mean age was 52.7 years ($SD = 10.6$), most were female ($n = 54$; 77%), and nearly all ($n = 69$; 99%) were White. The overall fitness of study participants was relatively poor, with prevalence of tobacco smoking ($n = 28$; 41%) nearly twice that of the general population and high rates of being overweight and obese (mean body mass index = 38.4; $SD = 11.3$). Participants were prescribed a mean of 8.4 ($SD = 3.5$) medications, including medications for medical as well as psychiatric illness. Baseline characteristics are listed in Table 1.

Half of all participants ($n = 35$) rated their understanding of their medical condition as "much better" and 48% ($n = 33$) as "somewhat better", and 83% ($n = 58$) rated their ability to manage their medical condition as "much better" postintervention. Most participants ($n = 56$; 80%) stated that they were "very willing to continue using the telehealth device," providing further evidence of acceptability of the device. Most participants ($n = 60$; 86%) completed both baseline and follow-up assessments. Table 2 shows the ES associated with the intervention with respect to psychiatric symptoms, health indicators, and service use. There were significant improvements in self-management of depression ($t(59) = 2.33$; $p = .$

023), although the ES was small ($ES = -0.33$). A significant decrease in diastolic blood pressure was observed ($t(59) = 2.81$; $p = .008$), with a medium ES of 0.60.

Findings in a Subsample With Diabetes

Diabetes was the most common comorbid medical disorder among our study participants ($n = 46$; 66%); thus, we explored whether different outcomes were observed within this subgroup. Results from these subgroup analyses are presented in Table 3. The intervention appeared to be especially effective in helping participants with diabetes manage their illness because mean fasting glucose levels for this subgroup dropped significantly from baseline ($M = 138.6$; $SD = 88.4$) to 6 months ($M = 113.0$; $SD = 74.4$; $t(42) = 2.52$; $p = .016$). The size of this effect was in the medium range ($ES = 0.43$). Of the 30 participants with diabetes who reported daily glucose levels, 21 (70%) had a weekly average glucose that would be considered uncontrolled (fasting glucose > 140) at baseline. At 3 months, eight (38%) participants had reduced their average weekly glucose by more than 20%, including three participants who each achieved a decrease of over 100 points. At 6 months, half had reduced their average weekly glucose levels by more than 20%. Mean fasting glucose for those with uncontrolled diabetes at baseline decreased from 191.9 ($SD = 72.9$) to 153.4 ($SD = 60.9$) at 6 months ($t(20) = 3.01$; $p = .007$).

Results were especially striking for the four individuals with the highest baseline glucose levels (221, 290, 326, and 285) who had a mean glucose of 281. At 6 months, the average glucose levels for these participants were 102, 188, 120, and 149, respectively. The mean decrease for these four participants from baseline to 6 months was 145 points.

The telehealth device was programmed to periodically ask people with diabetes and either major depression or bipolar disorder about their service use. Over the 6-month study duration, these individuals experienced significant reductions in urgent care visits ($t(42) = 2.34$; $p = .007$), with a medium ES of 0.64, and significantly fewer routine primary care visits ($t(42) = 3.10$; $p = .03$), with a large ES of 1.11.

Discussion

Several studies (Chae et al., 2000; Ruskin et al., 1998; Zarate et al., 1997) have used technology to assess psychiatric symptoms and to collect information needed to make psychiatric diagnoses. Others have used telehealth to improve adherence to treatment (D'Souza, 2002) or medication (Frangou et al., 2005), resulting in greater adherence, increased treatment satisfaction, and reduced hospitalizations. One study evaluating a telehealth intervention for individuals with serious mental illnesses and co-occurring diabetes examined progress notes and the content of semistructured interviews to identify factors affecting participants' use of telehealth (Kahn et al., 2009). The challenges related to successfully implementing telehealth that emerged included transience of the population, complex needs stemming from medical and psychiatric conditions, inadequate housing and transportation, mistrust and suspicion, and difficulties obtaining medical care (Kahn et al., 2009).

Despite these challenges, results from our pilot study suggest that automated telehealth supported by a nurse care manager is feasible, acceptable, and potentially effective in improving illness self-management for individuals with serious mental illnesses and comorbid medical conditions. These findings are also consistent with those of a recent pilot study that similarly considered the utility of the same telehealth device among a sample of mostly male veterans with mental illness (Godleski et al., 2012). This prior study demonstrated the feasibility of automated telehealth because participants reported improved ability to manage their mental health condition, a greater understanding of their mental health condition, and overall satisfaction with using the device (Godleski et al., 2012). Effectiveness was evidenced by decreases in hospital admissions and emergency department visits (Godleski et al., 2012). Our study advances these prior findings by demonstrating the feasibility and effectiveness of the same telehealth device for use among a more medically unstable sample with a more balanced distribution of psychiatric diagnoses representative of people with serious mental illnesses served in public sector mental health settings and by reporting significant improvement in health outcomes.

In our study, the feasibility and acceptability of the telehealth device were supported by the high rates of willingness to participate, excellent adherence with telehealth sessions, and willingness to continue using the device; specifically, most of the 110 people invited ($n = 70$; 64%) agreed to participate, most participants ($n = 62$; 89%) completed at least 70% of sessions, and most ($n = 56$; 80%) were willing to continue using the device. The nurse care manager conducted a home visit to install the telehealth device and to provide instruction in its use, which may have minimized feelings of mistrust or suspicion and may have helped to ensure high rates of adherence and acceptability. Participants also felt they benefitted from using the device. Almost all participants rated their understanding of their medical condition and their ability to manage their medical condition as much better or somewhat better.

Although our pilot study was not powered to detect statistically significant differences, we found significant improvement in the self-efficacy for managing depression and diastolic blood pressure. Also, participants with diabetes experienced significant mean decreases in fasting blood glucose from baseline, and among diabetics with either major depression or bipolar disorder significant decreases in the number of primary and urgent care health visits were observed. Overall, these results suggest the potential effectiveness of telehealth with nurse care management for individuals with serious mental illnesses and medical comorbidity; however, this pilot study was not designed to evaluate the relative contribution of the major intervention components (nurse and telehealth device). The telehealth nurse was very enthusiastic and invested in the intervention, and she was well liked by the study participants. On the other hand, participants also valued the telehealth device, and many seemed to form a personal connection with it (e.g., one consumer referred to his device as his “guardian angel”). Attempting to disentangle the unique effect of the nurse versus the telehealth device would be difficult given that the device was not designed to be used in isolation; rather, it is inherently part of a system that includes oversight by a nurse of user vital signs, symptom management, education, and behavior. It might be possible to isolate the effect of the nurse by randomly assigning some participants to a nurse only and some to a nurse plus telehealth. However, the nurses in each arm would have different sources of information about client status, so the “nurse component” in each arm would be different.

The telehealth program and content that participants receive would require considerable redesign to stand in isolation apart from the nurse.

Despite the promising nature of these results, there are several limitations to consider. First, our pilot study was underpowered to test effectiveness. For example, we did not adjust for multiple comparisons in our tests of statistical significance; therefore, our findings should be considered descriptive and exploratory. In addition, estimates of ES that are based on modest sample sizes are potentially unstable and should be interpreted with caution (Kraemer, Mintz, Noda, Tinklenberg, & Yesavage, 2006). Second, in some instances substantial ES differences were found only for the subset of individuals with diabetes. These inconsistencies may simply reflect the underlying comparisons; alternatively, they may reflect instability of the findings. Third, data on routine and urgent care visits for the subgroup with diabetes were only collected by the telehealth device for people with either major depression or bipolar disorder, making it impossible to evaluate decreases in primary and urgent care visits among people with diabetes and a schizophrenia-spectrum disorder or diabetes and PTSD. Fourth, we enrolled a predominantly White, middle-aged, and diagnostically heterogeneous sample receiving services from a community mental health center in Concord, New Hampshire; thus, results may not be generalizable. Fifth, as described earlier, the intervention consisted of a telehealth device coupled with weekday monitoring and intervention by a nurse, a combination that does not allow for determination of the effectiveness of either component alone or generalization to other telehealth devices. Sixth, our inclusion criteria targeted adults with serious mental illnesses and unstable chronic health conditions; therefore, they may not apply to the broader population of people with serious mental illnesses who have less severe or more stable chronic health conditions. Lastly, although the high rates of willingness to participate in the study, to use the device consistently, and to continue to use it likely support the feasibility and acceptability of this telehealth intervention, an evaluation of ongoing utilization over a longer follow-up period is necessary to fully establish feasibility and acceptability of the telehealth device for use in this at-risk group.

Notwithstanding these limitations, we found that automated telehealth supported by nurse care management appears to be feasible, acceptable, and perceived by people with serious mental illnesses and medical comorbidity as contributing to improved self-management abilities and knowledge. The potential effectiveness of this intervention may be most promising for improving symptoms of depression and chronic health conditions of hypertension and diabetes. Participation in this intervention may be associated with reduced use of urgent and acute care services, especially among individuals with serious mental illnesses and diabetes. We speculate that the positive results related to better management of diabetes may result from daily prompting by the device to measure glucose, frequent feedback on glucose levels displayed on trend charts from the telehealth device and provided by the nurse to primary care physicians, or prompts to remain adherent with medications.

Conclusions

The results from the current study, combined with those from the prior evaluation of this device (Godleski et al., 2012), provide preliminary evidence for the feasibility and

acceptability of using automated telehealth across diverse mental health patient populations and across differing health-care systems. This is particularly important when considering the imperative to evaluate and implement interventions targeting high-cost and medically unstable patient groups that are scalable and relevant to these high-risk individuals. Because adults with serious mental illnesses and medical comorbidity constitute the most costly Medicare and Medicaid beneficiaries (Bartels, Clark, Peacock, Dums, & Pratt, 2003), identifying new methods for improving health care and reducing service use are warranted. Telehealth interventions may be cost-effective for use among adults with serious mental illnesses, offering the potential to alleviate workforce shortages (Bartels & Naslund, 2013) or generate acute care savings as demonstrated in a recent large-scale study of an integrated telehealth and care management program among Medicare beneficiaries with chronic conditions (Baker, Johnson, Macaulay, & Birnbaum, 2011). The promising results of our pilot study combined with those from a prior evaluation of the same telehealth intervention in people with serious mental illnesses (Godleski et al., 2012) emphasize the need for future large-scale randomized studies to evaluate the effectiveness and potential cost savings of telehealth technologies for use among people with serious mental illnesses and medical comorbidity.

References

- Agarwal S, Lau CT. Remote health monitoring using mobile phones and Web services. *Telemedicine and e-Health*. 2010; 16:603–607. [PubMed: 20575728]
- Azar M, Gabbay R. Web-based management of diabetes through glucose uploads: Has the time come for telemedicine? *Diabetes Research & Clinical Practice*. 2009; 83:9–17. DOI: 10.1016/j.diabres.2008.09.055 [PubMed: 19056140]
- Baker LC, Johnson SJ, Macaulay D, Birnbaum H. Integrated telehealth and care management program for medicare beneficiaries with chronic disease linked to savings. *Health Affairs*. 2011; 30:1689–1697. DOI: 10.1377/hlthaff.2011.0216 [PubMed: 21900660]
- Bartels SJ, Clark REFE, Peacock WJ, Dums AR, Pratt SI. Medicare and Medicaid costs for schizophrenia patients by age cohort compared with costs for depression, dementia, and medically ill patients. *The American Journal of Geriatric Psychiatry*. 2003; 11:648–657. [PubMed: 14609805]
- Bartels SJ, Naslund JA. The underside of the silver tsunami—Older adults and mental health care. *The New England Journal of Medicine*. 2013; 368:493–496. DOI: 10.1056/NEJMp1211456 [PubMed: 23343039]
- Bird D, Oldenburg B, Cassimatis M, Russell A, Ash S, Courtney MD, ... Friedman RH. Randomised controlled trial of an automated, interactive telephone intervention to improve type 2 diabetes self-management (Telephone-Linked Care Diabetes Project): Study protocol. *BMC Public Health*. 2010; 10:599.doi: 10.1186/1471-2458-10-599 [PubMed: 20937148]
- Bujnowska-Fedak MM, Puchala E, Steciwko A. The impact of telehome care on health status and quality of life among patients with diabetes in a primary care setting in Poland. *Telemedicine and e-Health*. 2011; 17:153–163. [PubMed: 21375410]
- Carter EL, Nunlee-Bland G, Callender C. A patient-centric, provider-assisted diabetes telehealth self-management intervention for urban minorities. *Perspectives in Health Information Management*. 2011; 8:1b.
- Chae YM, Park HJ, Cho JG, Hong GD, Cheon KA. The reliability and acceptability of telemedicine for patients with schizophrenia in Korea. *Journal of Telemedicine & Telecare*. 2000; 6:83–90. DOI: 10.1258/1357633001935095 [PubMed: 10824375]
- Cherry JC, Moffatt TP, Rodriguez C, Dryden K. Diabetes disease management program for an indigent population empowered by telemedicine technology. *Diabetes Technology & Therapeutics*. 2002; 4:783–791. DOI: 10.1089/152091502321118801 [PubMed: 12685802]

- Cho JH, Lee HC, Lim DJ, Kwon HS, Yoon KH. Mobile communication using a mobile phone with a glucometer for glucose control in Type 2 patients with diabetes: As effective as an Internet-based glucose monitoring system. *Journal of Telemedicine and Telecare*. 2009; 15:77–82. DOI: 10.1258/jtt.2008.080412 [PubMed: 19246607]
- Chwastiak LA, Rosenheck RA, McEvoy JP, Keefe RS, Swartz MS, Lieberman JA. Interrelationships of psychiatric symptom severity, medical comorbidity, and functioning in schizophrenia. *Psychiatric Services*. 2006; 57:1102–1109. DOI: 10.1176/appi.ps.57.8.1102 [PubMed: 16870960]
- Cohen, J. *Statistical power analysis for the behavioral sciences*. 2. Hillsdale, NJ: Erlbaum; 1988.
- Colton CW, Manderscheid RW. Congruencies in increased mortality rates, years of potential life lost, and causes of death among public mental health clients in eight states. *Preventing Chronic Disease: Public Health Research, Practice, and Policy*. 2006; 3:A42.
- De Hert M, Correll CU, Bobes J, Cetkovich-Bakmas M, Cohen D, Asai I, ... Leucht S. Physical illness in patients with severe mental disorders. I. Prevalence, impact of medications and disparities in health care. *World Psychiatry*. 2011; 10:52–77. [PubMed: 21379357]
- Dickerson FB, McNary SW, Brown CH, Kreyenbuhl J, Goldberg RW, Dixon LB. Somatic healthcare utilization among adults with serious mental illness who are receiving community psychiatric services. *Medical Care*. 2003; 41:560–570. DOI: 10.1097/01.MLR.0000053440.18761.F0 [PubMed: 12665719]
- Dickey B, Normand ST, Weiss RD, Drake RE, Azeni H. Medical morbidity, mental illness, and substance use disorders. *Psychiatric Services*. 2002; 53:861–867. DOI: 10.1176/appi.ps.53.7.861 [PubMed: 12096170]
- Dixon L, Postrado L, Delahanty J, Fischer PJ, Lehman A. The association of medical comorbidity in schizophrenia with poor physical and mental health. *Journal of Nervous and Mental Disease*. 1999; 187:496–502. DOI: 10.1097/00005053-199908000-00006 [PubMed: 10463067]
- Druss BG, Zhao L, Von Esenwein S, Morrato EH, Marcus SC. Understanding excess mortality in persons with mental illness: 17-year follow up of a nationally representative US survey. *Medical Care*. 2011; 49:599–604. DOI: 10.1097/MLR.0b013e31820bf86e [PubMed: 21577183]
- D'Souza R. Improving treatment adherence and longitudinal outcomes in patients with a serious mental illness by using telemedicine. *Journal of Telemedicine & Telecare*. 2002; 8(Suppl 2):113–115. DOI: 10.1258/135763302320302280 [PubMed: 12217162]
- Fagioli A, Goracci A. The effects of undertreated chronic medical illnesses in patients with severe mental disorders. *Journal of Clinical Psychiatry*. 2009; 70(Suppl, 3):22–29. DOI: 10.4088/JCP.7075su1c.04 [PubMed: 19570498]
- Finkelstein SM, Speedie SM, Zhou X, Potthoff S, Ratner ER. Perception, satisfaction and utilization of the VALUE home telehealth service. *Journal of Telemedicine and Telecare*. 2011; 17:288–292. DOI: 10.1258/jtt.2011.100712 [PubMed: 21844178]
- Fleury MJ, Grenier G, Bamvita JM, Caron J. Professional service utilisation among patients with severe mental disorders. *BMC Health Services Research*. 2010; 10:141.doi: 10.1186/1472-6963-10-141 [PubMed: 20507597]
- Folstein MF, Folstein SE, McHugh PR. Mini Mental State: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*. 1975; 12:189–198. DOI: 10.1016/0022-3956(75)90026-6 [PubMed: 1202204]
- Frangou S, Sachpazidis I, Stassinakis A, Sakas G. Telemonitoring of medication adherence in patients with schizophrenia. *Telemedicine and e-Health*. 2005; 11:675–683. [PubMed: 16430387]
- Godleski L, Cervone D, Vogel D, Rooney M. Home telemental health implementation and outcomes using electronic messaging. *Journal of Telemedicine and Telecare*. 2012; 18:17–19. DOI: 10.1258/jtt.2011.100919 [PubMed: 22052966]
- Goff DC. Integrating general health care in private community psychiatry practice. *Journal of Clinical Psychiatry*. 2007; 68(Suppl 4):49–54. DOI: 10.4088/JCP.0707e19 [PubMed: 17539701]
- Goff DC, Sullivan LM, McEvoy JP, Meyer JM, Nasrallah HA, Daumit GL, ... Lieberman JA. A comparison of ten-year cardiac risk estimates in schizophrenia patients from the CATIE study and matched controls. *Schizophrenia Research*. 2005; 80:45–53. DOI: 10.1016/j.schres.2005.08.010 [PubMed: 16198088]

- Gold KJ, Kilbourne AM, Valenstein M. Primary care of patients with serious mental illness: Your chance to make a difference. *Journal of Family Practice*. 2008; 57:515–525. [PubMed: 18687227]
- Kahn LS, Fox CH, Carrington J, Desai U, Bartlett DP, Lyle H, Kowalski M. Telephonic nurse case management for patients with diabetes and mental illnesses: A qualitative perspective. *Chronic Illness*. 2009; 5:257–267. DOI: 10.1177/1742395309350229 [PubMed: 20156943]
- Kane JM. Creating a healthcare team to manage chronic medical illnesses in patients with severe mental illness: The public policy perspective. *Journal of Clinical Psychiatry*. 2009; 70(Suppl 3): 37–42. DOI: 10.4088/JCP.7075su1c.06 [PubMed: 19570500]
- Kessler RC, Chiu WT, Demler O, Merikangas KR, Walters EE. Prevalence, severity, and comorbidity of 12-month *DSM-IV* disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*. 2005; 62:617–627. DOI: 10.1001/archpsyc.62.6.617 [PubMed: 15939839]
- Kim SI, Kim HS. Effectiveness of mobile and internet intervention in patients with obese type 2 diabetes. *International Journal of Medical Informatics*. 2008; 77(6):399–404. DOI: 10.1016/j.ijmedinf.2007.07.006 [PubMed: 17881285]
- Koff PB, Jones RH, Cashman JM, Voelkel NF, Vandivier R. Proactive integrated care improves quality of life in patients with COPD. *European Respiratory Journal*. 2009; 33:1031–1038. DOI: 10.1183/09031936.00063108 [PubMed: 19129289]
- Kraemer HC, Mintz J, Noda A, Tinklenberg J, Yesavage JA. Caution regarding the use of pilot studies to guide power calculations for study proposals. *Archives of General Psychiatry*. 2006; 63:484–489. DOI: 10.1001/archpsyc.63.5.484 [PubMed: 16651505]
- Kwon HS, Cho JH, Kim HS, Song BR, Ko SH, Lee JM, ... Yoon KH. Establishment of blood glucose monitoring system using the Internet. *Diabetes Care*. 2004; 27:478–483. DOI: 10.2337/diacare.27.2.478 [PubMed: 14747232]
- LaFramboise LM, Todero CM, Zimmerman L, Agrawal S. Comparison of Health Buddy (R) with traditional approaches to heart failure management. *Family & Community Health*. 2003; 26:275–288. DOI: 10.1097/00003727-200310000-00005 [PubMed: 14528134]
- Lambert TJ, Newcomer J. Are the cardio-metabolic complications of schizophrenia still neglected? Barriers to care. *Medical Journal of Australia*. 2009; 190(Suppl 4):S39–S42. [PubMed: 19220173]
- Lamberti JS, Crilly JF, Maharaj K, Olson D, Wiener K, Dvorin S, ... Dietz MB. Prevalence of diabetes mellitus among outpatients with severe mental disorders receiving atypical antipsychotic drugs. *Journal of Clinical Psychiatry*. 2004; 65:702–706. DOI: 10.4088/JCP.v65n0517 [PubMed: 15163259]
- Lawrence D, Kisely S. Inequalities in healthcare provision for people with severe mental illness. *Journal of Psychopharmacology*. 2010; 24(Suppl):61–68. DOI: 10.1177/1359786810382058 [PubMed: 20923921]
- Lorig, K., Stewart, A., Ritter, P., González, V., Laurent, D., Lynch, J. Outcome measures for health education and other health care interventions. Thousand Oaks, CA: Sage; 1996.
- Lukoff D, Nuechterlein KH, Ventura J. Manual for the expanded Brief Psychiatric Rating Scale (BPRS). *Schizophrenia Bulletin*. 1986; 12:594–602.
- Luley C, Blaik A, Reschke K, Klose S, Westphal S. Weight loss in obese patients with type 2 diabetes: Effects of telemonitoring plus a diet combination—the Active Body Control (ABC) Program. *Diabetes Research & Clinical Practice*. 2011; 91:286–292. DOI: 10.1016/j.diabres.2010.11.020 [PubMed: 21168231]
- Mollon B, Holbrook AM, Keshavjee K, Troyan S, Gaebel K, Thabane L, Perera G. Automated telephone reminder messages can assist electronic diabetes care. *Journal of Telemedicine and Telecare*. 2008; 14:32–36. DOI: 10.1258/jtt.2007.070702 [PubMed: 18318927]
- Mortensen PB, Juel K. Mortality and causes of death in first admitted schizophrenic patients. *The British Journal of Psychiatry*. 1993; 163:183–189. DOI: 10.1192/bjp.163.2.183 [PubMed: 8075909]
- Mulvaney D, Woodward B, Datta S, Harvey P, Vyas A, Thakker B, Farooq O. Mobile communications for monitoring heart disease and diabetes. *Conference Proceedings of the Institute of Electrical and Electronics Engineers Engineering in Medicine and Biology Society*. 2010; 2010:2208–2210.
- Muncert ES, Bickford SA, Guzik BL, Demuth BR, Bapat AR, Roberts JB. Enhancing the quality of life and preserving independence for target needs populations through integration of assistive

- technology devices. *Telemedicine and e-Health*. 2011; 17:478–483. DOI: 10.1089/tmj.2010.0206 [PubMed: 21631385]
- Nieves JE, Godleski LS, Stack KM, Zinanni T. Videophones for intensive case management of psychiatric outpatients. *Journal of Telemedicine and Telecare*. 2009; 15:51–54. DOI: 10.1258/jtt.2008.080706 [PubMed: 19139221]
- Nyenwe EA, Ashby S, Tidewell J, Nouer SS, Kitabchi AE. Improving diabetes care via telemedicine: Lessons from the Addressing Diabetes in Tennessee (ADT) project. *Diabetes Care*. 2011; 34:e34.doi: 10.2337/dc10-2260 [PubMed: 21357359]
- Overall JE, Gorham DR. The Brief Psychiatric Rating Scale. *Psychological Reports*. 1962; 10:799–812. DOI: 10.2466/pr0.1962.10.3.799
- Parks, J., Svendsen, D., Singer, P., Foti, M. Morbidity and mortality in people with serious mental illness. Alexandria VA: National Association of State Mental Health Program Directors (NASMHPD) Medical Directors Council; 2006. p. 1-87.
- Polisena J, Tran K, Cimon K, Hutton B, McGill S, Palmer K. Home telehealth for diabetes management: A systematic review and meta-analysis. *Diabetes, Obesity, and Metabolism*. 2009; 11:913–930. DOI: 10.1111/j.1463-1326.2009.01057.x
- Prociow PA, Crowe JA. Development of mobile psychiatry for bipolar disorder patients. Conference Proceedings of the Institute of Electrical and Electronics Engineers Engineering in Medicine and Biology Society. 2010a; 2010:5484–5487.
- Prociow PA, Crowe JA. Towards personalised ambient monitoring of mental health via mobile technologies. *Technology and Health Care*. 2010b; 18:275–284. [PubMed: 21209476]
- Regier DA, Narrow WE, Rae DS, Manderscheid RW. The de facto US mental and addictive disorders service system: Epidemiologic catchment area prospective 1-year prevalence rates of disorders and services. *Archives of General Psychiatry*. 1993; 50:85–94. DOI: 10.1001/archpsyc.1993.01820140007001 [PubMed: 8427558]
- Rotondi AJ, Anderson CM, Haas GL, Eack SM, Spring MB, Ganguli R, Newhill C, Rosenstock J. Web-based psychoeducational intervention for persons with schizophrenia and their supporters: One-year outcomes. *Psychiatric Services*. 2010; 61:1099–1105. DOI: 10.1176/appi.ps.61.11.1099 [PubMed: 21041348]
- Ruskin PE, Reed S, Kumar R, Kling MA, Siegel E, Rosen M, Hauser P. Reliability and acceptability of psychiatric diagnosis via telecommunication and audiovisual technology. *Psychiatric Services*. 1998; 49:1086–1088. [PubMed: 9712219]
- Sarkar U, Handley MA, Gupta R, Tang A, Murphy E, Seligman HK, Shojania KG, Schillinger D. Use of an interactive, telephone-based self-management support program to identify adverse events among ambulatory diabetes patients. *Journal of General Internal Medicine*. 2008; 23:459–465. DOI: 10.1007/s11606-007-0398-7 [PubMed: 18373145]
- Sheeran T, Rabinowitz T, Lotterman J, Reilly CF, Brown S, Donehower P, ... Bruce ML. Feasibility and impact of telemonitor-based depression care management for geriatric homecare patients. *Telemedicine and e-Health*. 2011; 17:620–626. DOI: 10.1089/tmj.2011.0011 [PubMed: 21780942]
- Španiel F, Vohlidka P, Hrdlicka J, Kozeny J, Novak T, Motlova L, ... Hoschl C. ITAREPS: Information Technology Aided Relapse Prevention Programme in Schizophrenia. *Schizophrenia Research*. 2008; 98:312–317. DOI: 10.1016/j.schres.2007.09.005 [PubMed: 17920245]
- Srihari VH, Tek C, Chwastiak LA, Woods SW, Steiner JL. Best practices: Surveillance and management of diabetes in a CMHC population. *Psychiatric Services*. 2007; 58:1151–1153. DOI: 10.1176/appi.ps.58.9.1151 [PubMed: 17766557]
- Stone RA, Rao RH, Sevic MA, Cheng C, Hough LJ, Macpherson DS, ... Derubertis FR. Active care management supported by home telemonitoring in veterans with type 2 diabetes: The DiaTel randomized controlled trial. *Diabetes Care*. 2010; 33:478–484. DOI: 10.2337/dc09-1012 [PubMed: 20009091]
- Trappenburg JCA, Niesink A, de Weert-van Oene GH, van der Zeijden H, van Snippenburg R, Peters A, ... Schrijvers AJP. Effects of telemonitoring in patients with chronic obstructive pulmonary disease. *Telemedicine and e-Health*. 2008; 14:138–146. [PubMed: 18361703]
- Viron MJ, Stern TA. The impact of serious mental illness on health and healthcare. *Psychosomatics: Journal of Consultation Liaison Psychiatry*. 2010; 51:458–465.

- Vreeland B. Treatment decisions in major mental illness: Weighing the outcomes. *Journal of Clinical Psychiatry*, 68 Suppl. 2007; 12:5–11.
- Ware, JE., Kosinski, M., Keller, SD. The SF-12 users manual: How to score the SF-12 physical and mental health summary scales. 3. Boston, MA: Quality Metric Inc; 1998.
- Weinstock RS, Brooks G, Palmas W, Morin PC, Teresi JA, Eimicke JP, ... Shea S. Lessened decline in physical activity and impairment of older adults with diabetes with telemedicine and pedometer use: Results from the IDEATel study. *Age and Ageing*. 2011; 40:98–105. DOI: 10.1093/ageing/afq147 [PubMed: 21081539]
- Westphal A, Dingjan P, Attoe R. What can low and high technologies do for late-life mental disorders? *Current Opinion in Psychiatry*. 2010; 23:510–515. DOI: 10.1097/YCO.0b013e32833d74d4 [PubMed: 20717039]
- Zarate CA Jr, Weinstock L, Cukor P, Morabito C, Leahy L, Burns C, Baer L. Applicability of telemedicine for assessing patients with schizophrenia: Acceptance and reliability. *Journal of Clinical Psychiatry*. 1997; 58:22–25. DOI: 10.4088/JCP.v58n0104

Table 1

Baseline Demographic Characteristics of Participants Receiving the Telehealth Intervention

Characteristic	Total Sample (N = 70)	
	n	%
Age, years ($M \pm SD$)	52.7 $\pm$ 10.6	
Weight, lb ($M \pm SD$)	227.1 $\pm$ 65.7	
Body mass index (lb/in ²)*703 ($M \pm SD$)	38.4 $\pm$ 11.3	
Systolic blood pressure, mmHg ($M \pm SD$)	134.7 $\pm$ 15.3	
Diastolic blood pressure, mmHg ($M \pm SD$)	80.8 $\pm$ 9.3	
Number of medications, n ($M \pm SD$)	8.4 $\pm$ 3.5	
Gender		
Male	16	23
Female	54	77
Ethnicity		
White	69	99
Non-White	1	1
Latino		
Yes	5	7
No	65	93
Marital status		
Married	57	81
Never married	13	19
Education		
Less than high school	11	16
High-school graduate	59	84
Residential		
Living independently	66	94
Supervised/supported housing	4	6
Psychiatric diagnosis		
Schizophrenia	11	16
Bipolar disorder	12	17
Major depression	29	41
PTSD	18	26
Medical diagnosis		
Diabetes mellitus	46	66
Chronic pain	11	16
COPD	7	10
Congestive heart failure	6	9
Tobacco use		
Smoking	28	41

Table 2

Pre/Post Comparisons After Receiving the Telehealth Intervention for 6 Months

Outcome Measure	Baseline (N = 60)		6-Month Follow-Up (N = 60)		ES ^a	Test Statistic	p
	M	SD	M	SD			
Disease management self-efficacy							
Total self-efficacy ^b	57.6	18.9	60.0	16.7	-.17	-1.205	.23
Self-efficacy-manage depression ^c	4.7	2.6	5.3	2.4	-.33	-2.329	.02
Self-efficacy-get information on diseases ^d	7.1	2.4	7.6	2.2	-.20	-1.194	.24
Psychiatric symptoms							
BPRS-depression ^e	3.1	1.0	3.1	1.1	.05	.342	.73
BPRS-psychosis ^f	1.8	.8	1.7	.8	.09	.593	.56
SF-12 mental health component ^g	35.1	12.3	37.1	11.6	-.22	-1.3	.20
SF-12 physical health component ^h	33.8	12.2	32.7	11.8	.10	.938	.35
Health outcome ⁱ							
Weight	222.7	62.1	224.9	66.1	-.10	-.751	.46
Systolic blood pressure	147.2	8.9	143.4	18.4	.32	1.269	.22
Diastolic blood pressure	85.0	4.2	81.5	8.1	.60	2.812	.008
Service use ^j							
Hospital stays and emergency department visits	1.4	.3	1.3	.3	.30	.026	.80

^aES calculated for endpoint ES.^bStanford Chronic Disease Self-Efficacy Scales, with possible scores ranging from 10 to 100, with higher scores indicating greater overall self-efficacy.^cStanford Chronic Disease Self-Efficacy Scale, with possible scores ranging from 1 to 10, with higher scores indicating greater confidence in managing depression.^dStanford Chronic Disease Self-Efficacy Scale: Possible scores range from 1 to 10, with higher scores indicating greater confidence in getting information about diseases.^ePossible scores range from 1 to 7, with higher scores indicating more severe depressive symptoms.^fPossible scores range from 1 to 7, with higher scores indicating more severe psychosis.^gPossible scores range from 0 to 100, with higher scores indicating better subjective mental health functioning.^hPossible scores range from 0 to 100, with higher scores indicating better subjective physical health functioning.

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On the basis of on self-reported health outcomes at baseline and at 6 months.
On the basis of self-reported service use over the prior 30 days at baseline and at 6 months.

Table 3Key Outcomes Among the Subsample of Participants ($n = 46$) With Diabetes

Outcome Measure	<i>n</i>	Baseline		6-Month Follow Up			<i>p</i>
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>ES^a</i>	
Glucose ^b	43	138.6	88.4	113.0	74.4	.43	2.520 .02
Depression ^c	20	3.9	3.0	3.3	2.7	.24	.824 .42
Routine visits ^d	17	2.6	1.6	1.8	1.5	.64	2.340 .03
Urgent visits ^e	17	.8	.8	.1	.3	1.11	3.096 .007

^aES calculated for endpoint ES.^bBlood glucose collected by patients using a glucometer and values entered into the telehealth device.^cDepression level as reported on a scale from 1 to 10 by participants on the telehealth device.^dRoutine visits measured through self-report over the prior 30 days and entered onto the telehealth device at baseline and at the 6-month follow-up.^eUrgent visits measured through self-report over the prior 30 days and entered onto the telehealth device at baseline and at the 6-month follow-up.