Technology to assess and support self-management in serious mental illness

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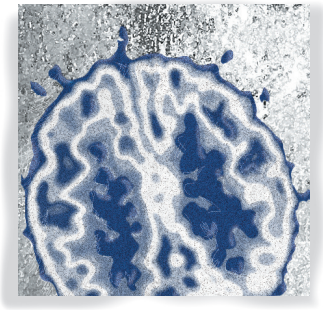

Introduction

Functional impairments associated with serious mental illnesses (SMIs) place an immense burden on individuals and society. Schizophrenia affects approximately 1% of the world population, is associated with direct and indirect costs in the United States of about $63 billion per year,[1] and is associated with a 20- to 25-year shorter life span than that of the general population.[2,3] Bipolar disorder affects approximately 1% to

The functional impairment associated with serious mental illness (SMI) places an immense burden on individuals and society, and disability often persists even after efficacious treatment of psychopathologic symptoms. Traditional methods of measuring functioning have limitations, and numerous obstacles reduce the reach and impact of evidence-based interventions developed to improve functioning in SMI. This review describes the potential of technological innovations for overcoming the challenges involved in both functional assessment and intervention in people with SMI. Ecological momentary assessment (EMA), which involves the repeated sampling of naturalistic behaviors and experiences while individuals carry out their daily lives, has provided a new window through which the determinants of day-to-day function in SMI can be observed. EMA has several advantages over traditional assessment methods and has in recent years evolved to use mobile-based platforms, such as text messaging and smartphone applications, for both assessment and promotion of self-management in people with SMI. We will review promising data regarding the acceptability, adherence, and efficacy of EMA-based mobile technologies; explore ways in which these technologies can extend the reach and impact of evidence-based psychosocial rehabilitative interventions in SMI; and outline future directions for research in this important area.

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Selected abbreviations and acronyms

EMA	*ecological momentary assessment*
IADL	*instrumental activities of daily living*
RCT	*randomized controlled trial*
SMI	*serious mental illness*
STEP-BD	*Systematic Treatment Enhancement Program for Bipolar Disorder*
UPSA	*University of California San Diego Performance-based Skills Assessment*
UPSA-M	*mobile app version of the UPSA*

2% of the population, is associated with $45 billion in annual direct and indirect costs,[4] and is associated with a 10- to 13-year shorter life expectancy than that of the general population.[5,6] Population aging may further increase the burden of disability associated with schizophrenia and bipolar disorder, given their greater risk for age-associated medical comorbidities.

Whereas SMIs have widespread consequences for a patient's well-being, the key drivers of costs and diminished quality of life in such patients include functional disabilities.[7-9] According to the *Global Burden of Disease* report from the World Health Organization, schizophrenia and bipolar disorders are among the top ten causes of life-years lost due to disability in the world.[10,11] Even when psychopathological symptoms resolve after efficacious treatment, functional disabilities persist.[12,13] As such, novel strategies to assess functional deficits and improve self-management in SMIs are needed; in this review, we focus on the role of technological innovations in addressing these important gaps.

Definitions and determinants of disability in SMI

According to the US Social Security Administration, disability places a severe limitation on normal everyday functioning, impairing instrumental activities of daily living (IADLs; eg, medication management, management of finances, household chores), social and civic engagement, social relationships, the ability to maintain employment, and the ability to reside independently. The primary foci of self-management behaviors in SMIs pertain to coping with specific psychotic or affective symptoms and attending to early warning signs of relapse, as well as compensating for cognitive impairments, as they affect participation in activities of daily living.

A variety of factors are associated with functional impairments in SMIs.[14-16] Among persons with schizophrenia, cognitive deficits and negative symptoms are the primary drivers of functional impairment.[17-20] Across studies, global cognitive deficits have been found to predict approximately 40% of variance in real-world functional outcomes (eg, work performance and IADLs),[21-24] whereas negative symptom severity predicts approximately 20% of this variance and partially mediates the relationship between cognition and real-world functioning.[25] Similarly, among persons with bipolar disorder, cognitive deficits—present during all phases of the illness, but worsening during manic and depressive episodes—are associated with reduced social and occupational functioning.[26,27] A more severe prior course of illness (eg, greater number of manic episodes) seems to predict worse cognition and functioning.[28,29]

This considerable variation in the strength of association between cognitive functioning or symptoms and everyday functional outcomes in schizophrenia speaks to the wide heterogeneity of the disorder, as well as to the need to identify other factors that probably mediate the relationship between neurocognitive ability and everyday functioning. Defeatist beliefs have also been reported to mediate the relationship between cognitive impairment and poor functioning in this population, and to add significantly to the prediction of everyday functioning above and beyond symptoms of the disease.[30] Other studies have found that the skills necessary to carry out functions of daily living (ie, functional capacity) mediate the relationship between cognitive ability and everyday functioning.[14,31,32]

Additional risk factors for poor everyday functioning include affective symptoms, lifestyle factors (eg, substance use, sedentary behavior), medical comorbidities, and limitations imposed by the environment. Although research focused on protective factors in persons with schizophrenia is limited, some studies have begun to examine the potential role of physical activity. For example, Kimhy et al[33] found evidence suggesting that aerobic exercise interventions could improve cognitive ability and everyday functioning. As such, a variety of potential determinants of disability exist, involving both risk and protection, which creates challenges for assessment, which will be discussed next.

Challenges to assessment of functioning in SMI

While clinician ratings and performance-based functional tests are both reasonably sensitive to functional disability in schizophrenia and bipolar disorder, questions remain regarding the extent to which these tests fully capture the complexities associated with everyday functioning. Since reduction of functional disability is the ultimate treatment target for clinical trials, it may seem obvious that some type of objective indicator of real-world functioning would be the most valid outcome measure. However, significant functional milestones, such as marriage or an equally stable relationship, full-time employment, and self-supported living, are insensitive indicators. Direct observation of more subtle aspects of real-world outcomes (eg, household management, social contacts, job-seeking activities) is considered the gold standard, but is resource-intensive and often not feasible.

As a result, self-report and informant-rated measures are the most common assessments for people with SMI. However, these instruments are subject to recall biases, overestimation of function, social desirability effects, and state-dependent biases.[34] Studies of clinical populations and healthy individuals have consistently found that more cognitively impaired individuals tend to overestimate their abilities,[35-37] individuals with mild depressive symptoms are fairly accurate ("sadder but wiser"),[38] and individuals with more severe depressive symptoms underestimate their abilities.[39] These inaccurate appraisals are especially pronounced among individuals with diminished insight.[40] Accordingly, self-reports of daily functioning have been found to be unrelated to performance-based measures of functioning.[36] Studies on the relationship between informant ratings and performance-based measures vary depending on the rating method and type of informant.[41,42] Reports by informants (ie, clinician, friend, relative, or caretaker) depend on the frequency and nature of contact with the patient. Furthermore, for some patients, reliable informants can often be difficult to identify.

Performance-based skills tests are increasingly used as proxy measures of real-world functioning. Defined as laboratory-based tests that simulate real-world everyday tasks (eg, medication management, financial skills), performance-based skills tests are based on the premise that skills competence (what one can do) is required for real-world skill performance (what one actually does). However, tests of functional competence are unable to capture the numerous risk and protective factors moderating the effects of SMI on an individual patient's daily tasks and activities. For example, performance-based measures such as the University of California San Diego Performance-Based Skills Assessment (UPSA)[7] have at best moderate correlations with measures of real-world functioning (eg, r=0.18 to 0.48).[43,44] Moreover, recent work by our group illustrated that there is a weak relationship between cognitive function and functional capacity among cognitively intact adults with bipolar disorder and schizophrenia.[45] These findings highlight the limitations of performance-based measures in capturing the heterogeneity that occurs between and within persons with SMI.

Technologies for assessing self-management abilities

Technology can be useful for overcoming many of the barriers to accurate assessment in SMI described above. One method, ecological momentary assessment (EMA),[46] involves the repeated sampling of naturalistic behaviors and experiences. EMA has evolved from paper-and-pencil diary methods (eg, medication calendars) to current use of smartphones that capture immediate self-reports while respondents carry out their daily lives. Typical dimensions that are concurrently assessed are time use, socioenvironmental context (location, social participation), and self-rated performance (eg, impairment, need for assistance). Compared with traditional retrospective self-reports of functional behaviors, EMA diminishes recall biases by capturing ratings of current or recent behaviors while they are experienced in the naturalistic environment. By diminishing the extent to which respondents evaluate past experiences, biases related to social desirability are also mitigated. Moreover, frequently repeated data collection also enables modeling of within-person trajectories and temporal sequences of behavior.[47]

Patients with SMIs accept and are capable of participating in EMA studies, even if they are not users of mobile devices.[48,49] Study completion rates have been high in both schizophrenia (eg, 92%, Swendsen et al[50]; 96%, Johnson et al[49]) and bipolar disorder (eg, 80%, Husky et al[51]) samples. Furthermore, Granholm et al[52] and Johnson et al[49] found that 87% of participants with

schizophrenia met standards of good compliance with computerized EMA procedures. Husky et al found a similarly high level of compliance (89%) in people with bipolar disorder. Device loss has been minimal in both populations (eg, 2% in both the Granholm et al[52] and Johnson et al[49] studies).

Applications of EMA have been quite broad across self-management domains in SMI. Longitudinal tracking of mood symptoms and their concomitants has long been clinically indicated in bipolar disorder, and translation from paper-and-pencil "mood charts" has proven feasible and acceptable via text messaging[53] or smartphone applications.[54,55] Indeed, Depp et al[54] found greater concordance between smartphone-captured mood ratings and clinician-rated affective symptoms than between paper-and-pencil mood ratings and clinician ratings. More complex systems have been tested[56]; such systems elicit data on multiple aspects of symptoms and their self-management and present summary feedback to respondents in graphical form. Apart from symptoms, monitoring of longitudinal medication adherence via mobile devices is effective in persons with comorbid bipolar disorder and human immunodeficiency virus (HIV), both in terms of concordance with gold-standard adherence measures (eg, use of microelectronic-monitoring–enabled medication dispensers) and in promoting regularization of the timing of medication taking.[57] Social participation has also been effectively queried via EMA in schizophrenia, revealing new insights about the nature of social dysfunction. Such studies have revealed that people with schizophrenia spend a substantial amount of time alone,[58] and positive appraisals of social function predict increased social participation, whereas negative symptoms of schizophrenia predicted diminished anticipation of positive functionally relevant activities.[59] Thus, in addition to quantifying self-management behavior in the real world, the psychological mechanisms underlying problems in social participation can also be modeled.

Finally, the data generated via mobile health applications extends beyond self-report. Faurholt-Jepsen et al[55] found a positive association between the frequency of text messages and mania symptoms in bipolar disorder. Vocal prosody gathered by device microphone has been used to detect fluctuations in mood states as well.[60] Other device-based sensors include global positioning, accelerometers, and light sensors, which have been proposed as means of monitoring activity and mobility and time spent in various settings, such as the home.

Translation of performance-based measures to technological platforms has been accomplished as well. For example, the UPSA[61-65] is perhaps the most commonly used functional capacity measure in SMI,[66,67] yet it requires several props and examiner materials, which can make it burdensome and impractical in clinical settings. To increase the portability and ease of administration and scoring of this measure, a mobile application version of the UPSA (UPSA-M) that employed virtual, functionally relevant scenarios on the device was developed and tested in a pilot study. Middle-aged and older adults with schizophrenia performed nearly equivalently on the UPSA-M as they did on the traditional version of the test, indicating that the UPSA-M is feasible and acceptable for use in this population.[68]

Challenges to the reach and impact of psychosocial rehabilitation in SMI

Moving beyond assessment, there are a variety of barriers that limit both the reach and the impact of functional rehabilitative interventions that could be mitigated by technology. Even though there is a growing evidence base regarding the positive impact of intensive psychosocial interventions on symptoms and functioning in schizophrenia and bipolar disorder, the rate of participation in psychotherapy in the community appears to be declining. People with bipolar disorder are less likely to participate in psychotherapy than are people with major depression, for example.[69] There remains a small and concentrated group of practitioners who are trained in intensive psychosocial interventions for SMI.[70] Even when interventions are accessed and are efficacious, such as in the successful STEP-BD psychotherapy trial (Systematic Treatment Enhancement Program for Bipolar Disorder), participants, on average, attended only 50% of possible psychotherapy sessions.[71] In more effectiveness-based studies in public health settings, about half of the participants attend less than half of sessions,[72,73] citing barriers such as transportation difficulties. Technology could enhance the reach of psychosocial interventions by diminishing the resources needed to deliver psychosocial interventions and extending clinical contacts outside of the clinical setting.

Technology could also enhance the *impact* of psychosocial interventions for SMI. Self-management interventions depend upon enhancing generalization of

skills learned in clinical settings to the outside world. In psychosocial rehabilitation, cognitive deficits and diminished motivation limit the degree to which in-session skills are employed in daily life.[74] Interventions that provide cues to initiate self-management behaviors outside of the clinical setting may increase transfer of training.[75] Technological approaches could also facilitate personalization of interventions[76]; eg, manualized interventions can be flexibly delivered to accommodate between- and within-individual differences (eg, mood state, preferences). Observational research suggests that self-management practices are varied and highly personalized in SMI,[77] and technology is well suited to adapt content to individual variation through tailoring of intervention material.

Research on technologies to enhance self-management in SMI

Studies of mobile health and remote telehealth interventions in bipolar disorder (n=5), schizophrenia spectrum and other psychotic disorders (n=10), and mixed SMIs (n=3) are summarized in *Table I*.[57,78-93] The great majority of these studies were proof-of-concept trials designed to evaluate feasibility and acceptability, with only 7 of 18 studies (38.9%) being randomized controlled trials (RCTs). The study populations were almost exclusively outpatients, and exclusion criteria frequently included maximum levels of symptom severity. Trial length ranged broadly, but intervention periods were typically short term (from 1 to 3 months).

The design of mobile health interventions was diverse and varied by communication channel, clinician involvement, and source of initiation of interactive elements. Three main communication channels were employed: text messaging via feature phones, smartphone applications, and home-based dedicated communication devices. Some of the text messaging interventions were delivered on the patient's own device, but the majority of devices were provided as part of the research study. The variation in the role of the clinician reveals the flexibility of the approach and potential for integration into various clinical models. Some interventions involved no clinician involvement after setup, whereas others extended content from in-person sessions. In a home-device intervention, participants were connected remotely through the device to a clinician throughout the duration of the study, and the clinician used the data entered on the device to inform providers about participants' conditions and triage care.[94]

Most studies involved interactions that were initiated by the device system, in particular in "ecological momentary interventions." These interventions (eg, Granholm et al)[83] extend the EMA approach frequently to intraday assessment in order to link intervention content with user-specified states. For example, a query about whether medications have been taken is followed by an algorithm with targeted intervention content that differs according to whether adherence lapses were intentional or unintentional. On the other hand, some interventions were user-initiated. Ben-Zeev et al[79] evaluated a smartphone intervention with preloaded applications concerning mental health recovery; despite the potential concern that patients with schizophrenia might not self-initiate engagement with such a system, patients used the system an average of five times per day for 1 month.

Most interventions had multiple targets of intervention, with foci on improving self-management and uptake of mental health care (medication adherence, treatment attendance), adherence and uptake of medications for comorbid conditions, symptom monitoring and relapse prevention, and/or recovery promotion such as through increasing socialization or physical activity. Additional functions involved facilitation of clinician contact and follow-up in case of crisis.

Given the limited number of RCTs, it is premature to draw any conclusions about the effectiveness and sustainability of mobile health interventions for SMI. However, when aggregated, the indicators of feasibility and acceptability offer positive support for mobile health interventions in SMI, although the specific indicators of engagement were reported in varied ways (eg, rate of daily response, dropout, satisfaction). The rates of adherence and attrition are similar to those reported in mobile health trials for other conditions[95] and compare favorably to dropout rates in short-term trials of in-person interventions for SMI. In the studies that targeted symptoms, the results were generally positive; four of six open trials and two of three RCTs evidenced significant effects of mobile interventions on at least one of the target symptoms. Two of the three RCTs that targeted medication adherence and both of the RCTs that targeted hospitalizations also showed positive effects on those outcomes. Only four studies included functioning measures as outcomes and only one

Study	Sample	Study design	Intervention	Duration	Feasibility, acceptability, adherence	Outcome measurement	Outcome findings
Beebe et al,[78] 2014	N=30 outpatients with SZ or SZA	RCT	Text messaging to promote medication adherence.	3 mo	28 subjects completed the study.	Medication adherence (pill counts) and symptoms.	Significant improvement in symptoms, but not in adherence.
Ben-Zeev et al,[79] 2014	N=33 outpatients with SZ or SZA	Open trial	Smartphone app (self-initiating and automated) targeting symptom management, mood regulation, medication adherence, social functioning, and improved sleep.	1 mo	Mean daily use rate for app = 86.5% 90% of participants rated intervention as highly acceptable and usable.	Psychiatric symptom severity.	Significant reductions in psychotic symptoms, depression, and general psychopathology.
Ben-Zeev et al,[80] 2014	N=17 outpatients with SZ or SZA and past or present substance abuse	Open trial	Text messaging to improve illness self-management.	3 mo	87% mean response rate to texts. >90% found the intervention easy to use and useful.	Working alliance.	Therapeutic ratings provided for the mobile intervention were significantly higher than for community-based treatment-team clinicians.
Depp et al,[81] 2015	N=82 outpatients with BD and less than severe affective symptoms	RCT	Smartphone app designed to extend 4-session in-person self-management intervention.	6 mo	93% completed the study. 65% mean response rate. High satisfaction.	Affective symptoms.	Smartphone intervention group showed significantly greater reductions in depressive symptoms at 6 (mid) and 12 (posttreatment), but not 24 weeks (follow-up) vs paper-and-pencil control. No significant difference for manic symptoms or functioning.
Faurholt-Jepsen et al,[82] 2015	N=78 outpatients with BD and less than severe affective symptoms	RCT	Smartphone app for daily self-monitoring app linked with nurse contact.	6 mo	93% response rate.	Affective symptoms.	No significant impact on depressive or manic symptoms compared with control group.
Granholm et al,[83] 2012	N=55 outpatients with SZ or SZA	Open trial	MATS study: text messaging to promote socialization, symptom management, and medication adherence.	3 mo	77% completed the study. 86% mean response rate. Greater participation increased likelihood of positive ratings for helpfulness.	Device and clinician-rated measures of medication adherence, socialization, and psychiatric symptom severity.	Significant improvement in medication adherence in participants living independently and in social interactions. Significant decrease in hallucinations and dysfunctional beliefs.

Study	Sample	Study design	Intervention	Duration	Feasibility, acceptability, adherence	Outcome measurement	Outcome findings
Komatsu et al,[84] 2013	N=45 outpatients with SZ	RCT	ITAREPS study: weekly mobile phone telemonitoring identifying prodromal symptoms of relapse to enable intervention and prevent unnecessary hospitalizations.	12 mo	N/A (excluded user adherence)	No. of rehospitalizations based on worsening of psychiatric symptoms, period until rehospitalization, and total No. of rehospitalization days. BPRS at the time of rehospitalization.	Risk of rehospitalization was lower in the ITAREPS group than in the control group. The total No. of rehospitalization days was significantly lower in the ITAREPS group (37 d) than in the control group (710 d). No. of inpatient days on each rehospitalization was significantly lower in the ITAREPS group (18.5 d) than in the control group (88.8 d).
Macias et al,[85] 2015	N=11 outpatients with mixed SMIs	Open trial	Android app promoting physical activity.	1 mo	94% mean daily use rate for app. 73% mean response rate across all electronic messages and prompts.	Physical activity and self-rated health.	Overall improvement in stage of exercise (motivation), with modest improvement in self-health ratings.
Miklowitz et al,[86] 2012	N=19 outpatients with BD and less than severe affective symptoms	NCT	Text messaging intervention targeting early warning sign identification, sleep-wake cycle regularization, and medication adherence.	17 wk	81% mean response rate for daily messages.	Knowledge of mood-management strategies and affective symptoms.	Significant increase in mood-management strategies. Trend for reduction in depression.
Montes et al,[87] 2012	N=340 with SZ and self-rated medication nonadherence	RCT	Text messaging reminders promoting medication adherence.	6 mo	75% completed the study.	Self-rated medication adherence, illness severity, attitude toward medication, insight, quality of life.	Significant improvement in self-rated medication adherence and attitude toward medication. Significant reduction in negative, cognitive, and global symptoms at month 3.
Moore et al,[57] 2015	N=58 outpatients with BD and HIV	RCT	Text messaging reminders for psychiatric and HIV medication.	1 mo	>90% mean response rate to messages.	Medication adherence and dose timing.	Significant improvement in dose timing for antiretrovirals, but not psychotropics with text message intervention. No difference in adherence for either medication.

Table I. Mobile health intervention studies in serious mental illnesses.[57,78-93] app, application; ARV, antiretroviral; BD, bipolar disorder; HIV, human immunodeficiency virus; ITAREPS, Information Technology Aided Relapse Prevention Program in Schizophrenia; NCT, nonrandomized controlled trial; RCT, randomized controlled trial; SMI, serious mental illness; SZ, schizophrenia; SZA, schizoaffective disorder.

Study	Sample	Study design	Intervention	Duration	Feasibility, acceptability, adherence	Outcome measurement	Outcome findings
Naslund et al,[88] 2015	N=10 outpatients with mixed SMI and obesity	Open trial	Wearable fitness monitor with goal-setting mobile app.	5 mo	1 subject dropped out of the study due to medical reasons. High satisfaction rate among participants.	Weight loss .	10 participants wore the devices for a mean of 89% of days in study. 5 wore the devices 100% of the time. Mean weight loss = 2.7 kg.
Pijnenborg et al,[89] 2010	N=62 with mixed psychotic disorders	NCT	Text messaging intervention to enhance recovery goal implementation.	18 wk	18 subjects dropped out of the study. Subject-rated effectiveness of intervention: 41%, effective; 33%, neutral; 26%, ineffective.	% Goals achieved, psychiatric symptom severity, self-esteem, social community functioning.	Overall % of goals achieved increased with prompting and returned to baseline after removing prompts. No change in symptoms, self-esteem, functioning.
Pratt et al,[90] 2014	N=38 outpatients with mixed SMIs	Open trial	In-home messaging device targeting symptom management and adherence.	6 mo	Participation in mean of 128.5 sessions (71.4%) out of 180 possible.	Psychiatric symptom severity and illness self-management skills.	Significant improvements in psychiatric symptoms and illness self-management skills. 82% decrease in hospital admissions and 75% decrease in emergency room visits compared with before entry.
Spaniel et al,[91] 2008	N=45 outpatients with mixed psychotic disorders	Open trial	Weekly mobile telehealth monitoring for early warning signs of relapse.	1 y	90% completed the study.	Psychiatric hospitalizations.	Significant 60% decrease in the no. of patient hospitalizations compared with before entry.
Spaniel et al,[92] 2012	N=146 outpatients with SZ or SZA deemed at higher risk for relapse	RCT	Weekly mobile telehealth monitoring for early warning signs of relapse.	1 y	N/A	Psychiatric hospitalizations and medication adherence.	Significantly lower rate of hospitalizations in active arm.
Wenze et al,[93] 2014	N=14 outpatients with BD	Open trial	PDA intervention to enhance medication adherence through daily prompts.	2 wk	92% response rate.	Adherence and affective symptom severity.	Significant reduction in depressive symptoms. No change in adherence.

Table I. (continued) Mobile health intervention studies in serious mental illnesses.[57,78-93] app, application; ARV, antiretroviral; BD, bipolar disorder; HIV, human immunodeficiency virus; ITAREPS, Information Technology Aided Relapse Prevention Program in Schizophrenia; NCT, nonrandomized controlled trial; RCT, randomized controlled trial; SMI, serious mental illness; SZ, schizophrenia; SZA, schizoaffective disorder.

study reported follow-up evaluations of outcomes. Of note, Depp et al[81] found that after mobile monitoring was ceased in a mobile health intervention for bipolar disorder, the effect diminished at follow-up, indicating that the sustainment of effects may require continued use of the device.

Future directions

Emerging directions likely to transform mobile health assessments and interventions for SMI in the next decade include developments in sensor technology, new models for leveraging the volumes of intraindividual data generated, and increased use of mobile health technology between respondents and their health systems. The staggering progress in mobile technology has opened remarkable avenues for data capture; there are dozens of sensors embedded on a modern commercial smartphone, each collecting near continuous data on location, activity, social context, and other ambient characteristics that could provide information about self-management behaviors. Externally linked sensors can collect similarly high-frequency data on physiological parameters (eg, cardiac function, biochemicals) through increasingly lower-cost devices. One possibility is that sensors could collect data that is concordant with symptoms, thereby obviating the need for self-reports. Another possibility is that sensors could help compensate for deficits by delivering compensatory interventions when certain contexts are sensed, such as mitigating planning deficits when individuals initiate the behavior of accessing transportation or other self-care.

The volume and velocity of data generated by mobile interventions should generate new insights into determinants of the short-term temporal course of SMI and make possible more individualized care. For example, the "warning signs" of mood episodes or behavioral crises in bipolar disorder are highly variable across patients, yet they seem to recur within patients over time. Thompson et al[96] found that a predictive analytic approach and functional data analysis applied to EMA data on negative and positive affect predicted subsequent increases in suicidal ideation several weeks before its occurrance.[96] Once such predictive models can be validated, self-management interventions could assist individuals or their caregivers in responding to future risks that are sensed specific to an individual's own history.

The utility of mobile technology for an individual could be enhanced by increasing the reward experienced while engaging in systems, as well as by integrating with clinical health systems. A key limiting factor for the utility of mobile health systems is the degree to which patients engage with such systems, and efforts are increasingly being undertaken to teach skills or motivate participation by incorporating game-like elements and other incentives. Finally, the information gathered and recorded in mobile interventions to date has not typically been integrated with clinician involvement or linked with electronic health records, with notable exceptions (eg, home-based telehealth systems). For example, notifications of exacerbations of symptoms or lapses in medication use can be provided to care teams. Integrating with ongoing treatment introduces challenges around data security, as well as the provider's role, and the burden added by remote monitoring, but remote data and interactions could enhance the care team's ability to facilitate self-management in between (or in lieu of) clinic visits.

Current limitations

Despite many reasons for enthusiasm about the potential for mobile health assessments and interventions to enhance rehabilitation in SMI, there are a number of barriers facing the field. As noted above, both assessment and intervention studies have a limited evidence base beyond "proof of concept," and rigorous validation studies and controlled trials are rare. A number of authors have noted that the typical time horizon for intervention development to Phase 3 trials is incompatible with the far more rapid pace of mobile technology development.[97,98] Moreover, there exists a gulf between technologies developed in academic research settings and those developed and marketed directly to consumers. There are dozens of "apps" available to consumers for bipolar disorder and psychotic disorders, and many of these lack policies around data safety, offer conflicting information about treatments, and have not been subjected to clinical trials.[99] This concern is evident across chronic illnesses; for example, a 2014 study found that none of the downloadable applications available for consumers for self-management of pain had been subjected to clinical trials, and none of the pain applications that had been evaluated in research had been made available from app stores.[100]

Another consideration is the readiness of people with SMI to adopt technology. There have been a few reports that have suggested that the rate of use of mobile devices in patients with SMI is lower than that in the general adult population. In a 2013 study with a large outpatient population, a total of 72% of adults with SMI reported owning a cellular phone[101]; this was 12% lower than that seen in the general adult population at the time. The rate of ownership of mobile devices among middle-aged and older adults with schizophrenia who resided in supported living settings was considerably lower (28%), although almost three-quarters had previously used such a device.[102] Participants who had not used mobile devices were considerably more cognitively and functionally impaired. Relatedly, Granholm et al[83] found that patients with more severe negative symptoms were less likely to adhere to a mobile health intervention. As such, the subpopulations of people with SMI with the most need for assistance in self-management may be the least likely to own devices that provide platforms for mobile health interventions.

Finally, the field of mobile health monitoring tools and interventions has been criticized for limited inclusion of behavioral change theories.[103] Most of the interventions described above incorporated some theory of behavior change strategy (eg, goal setting, cognitive behavioral approaches to altering dysfunctional beliefs) but were somewhat limited in examining whether those strategies affected outcomes. It is also frequently not clear whether interventions were designed to compensate for limitations (eg, forgetfulness), and therefore intended to be used indefinitely, or to reinforce skills in self-management over a defined period so that the skills generalize to behavior change. As such, the active ingredients of self-management interventions in SMI remain an area in need of future study.

Conclusions

Technology could help fill tremendous gaps in care for SMI, with a number of creative solutions already field tested for both assessing and mitigating functional deficits. These applications could play a key role in mental health care by fostering engagement with the health care system, in deciding among treatment options, in reinforcing or extending evidence-based therapies, and in sustaining gains after the conclusion of intensive rehabilitation.[104] In aggregate, the data seem to suggest that people with SMI capably and enthusiastically use mobile devices and related technology in proof-of-concept studies. Rigorous validation studies or RCTs will be needed to understand how these technologies could help transform self-management of SMI in the coming decades. ❑

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La tecnología para evaluar y apoyar el automanejo en enfermedades mentales graves

El deterioro funcional asociado con la enfermedad mental grave (EMG) implica una inmensa carga para los individuos y la sociedad, y la discapacidad persiste aun después de tratamientos exitosos de los síntomas psicopatológicos. Los métodos tradicionales para medir funcionamiento tienen limitaciones y hay numerosos obstáculos que reducen el alcance e impacto de intervenciones basadas en la evidencia que se han desarrollado para mejorar el funcionamiento en las EMG. Esta revisión describe el potencial de las innovaciones tecnológicas para superar los desafíos involucrados tanto en la evaluación funcional como en las intervenciones en las EMG. La evaluación ecológica instantánea (EEI), que consiste en el muestreo repetido de conductas y experiencias naturalísticas mientras los sujetos desarrollan su vida diaria, ha aportado una nueva ventana a través de la cual se pueden observar los determinantes del funcionamiento día a día en las EMG. La EEI tiene algunas ventajas sobre los métodos de evaluación tradicional y ha evolucionado en los últimos años hacia el empleo de plataformas en base a móviles, como mensajes de texto y aplicaciones de teléfonos inteligentes, tanto para la evaluación como para la promoción del auto-manejo de personas con EMG. Se revisan datos prometedores en relación con la aceptabilidad, adherencia y eficacia de tecnologías móviles basadas en la EEI; se exploran vías en las que estas tecnologías pueden extender el alcance e impacto de las intervenciones de rehabilitación psicosocial basada en la evidencia en la EEI, y se describen las futuras direcciones de la investigación en esta importante área.

Les technologies d'évaluation et de soutien pour une gestion autonome des maladies mentales graves

Le handicap fonctionnel lié aux maladies mentales graves impose un immense fardeau aux individus et à la société et l'invalidité persiste souvent même après un traitement efficace des symptômes psychopathologiques. Les méthodes traditionnelles de mesure du fonctionnement ont des limites et de nombreux obstacles diminuent la portée et l'incidence des interventions basées sur des preuves développées pour améliorer le fonctionnement des personnes atteintes de maladies mentales graves. Cet article explique comment les innovations technologiques peuvent permettre de surmonter les défis liés à l'évaluation et à l'intervention fonctionnelles chez les personnes atteintes de maladies mentales graves. L'évaluation écologique momentanée (EEM), qui comporte des échantillonnages répétés d'expérience et de comportements naturalistes, les individus continuant à vivre leur vie quotidienne, permet d'observer les déterminants du fonctionnement quotidien des personnes atteintes de maladies mentales graves. L'EEM présente plusieurs avantages sur les méthodes d'évaluation traditionnelles et a récemment évolué pour utiliser des platesformes mobiles, comme les SMS et les applications pour smartphone, pour l'évaluation et la promotion d'une gestion autonome des personnes atteintes de maladies mentales graves. Nous analyserons les données prometteuses concernant l'acceptabilité, l'observance et l'efficacité des technologies mobiles basées sur l'EEM ; nous explorerons la façon dont ces technologies peuvent prolonger la portée et l'incidence des interventions de réhabilitation psychosociale basées sur des preuves des personnes atteintes de maladies mentales graves ; et nous donnerons les grandes lignes des axes de recherche à venir dans ce domaine important.

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