Review

Human Behavior with Mobile Health: Smartphone/Devices, Apps and Cognition

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ABSTRACT
Mobile health, telemedicine and other services are considered part of a telehealth or e-health spectrum of care. Mobile health mental health options (i.e., smartphones/devices and apps) are part of a broader framework of e-mental health options. Technology usually offers portability for access anytime/anywhere, are relatively inexpensive and have additional features (e.g., context-aware interventions and sensors with real-time feedback). The evidence-based literature shows that many people have an openness to technology as a way to engage others, change behaviors and obtain clinical services. Skills/competencies for mobile health, smartphone/device and app have similarities and differences from in-person and telepsychiatric care. It is suggested that evidence-based apps be used with an evidence-based approach. Relatively few treatment studies evaluate outcomes for mobile health, directly compare it to in-person and e-behavioral healthcare or compare new technology-based care options to one another. Few studies have assessed the cognitive function related to smartphone/device and app use. At least three facets of cognition that are affected by these technologies: attention, memory and delay of gratification (reward processing). More research is needed with respect to health services delivery models, effectiveness, competency outcomes and how a paradigm shift like mobile health re-contextualizes digital healthcare.

Keywords
Apps, Behavior, Cognition, Devices, Mobile, Smartphones, Technology.

INTRODUCTION
Mobile health (mH) communications smartphones and other devices (SP/D) used for data transport, computing and integration are a force in business, entertainment and health communities. mH and social media are growing exponentially via the X, Millennial/Y and Z generations. They are delivering healthcare anytime/anywhere and surpassing geographical, cost, temporal and organizational barriers. This movement is consistent with not only patient-centered care, but participatory medicine, in which patients are responsible drivers of their health with physicians according to the Institute of Medicine.

mH, telemedicine and other services are considered part of a telehealth or e-health (eH) spectrum of care, including e-behavioral health (eBH). Traditional telehealthcare services have been provided synchronously by video conferencing or asynchronously. mH and its corresponding mobility components are central to healthcare monitoring and alerting systems, clinical and administrative data collection, record maintenance, delivery programs, medical information awareness, detection and prevention systems, drug-counterfeiting and theft. mH has been defined as “unwired e-med”, mobile communication and network technologies and now mobile or wireless communication technologies for health and healthcare. A worldwide review of the literature on eH through 2010 found four primary areas of service delivery:
| Level | Source/ Entry | Initiator Goals/Aims | Questions And Perspectives | Liabilities | Suggestions For Programs |
|-------|---------------|----------------------|-----------------------------|-------------|--------------------------|
| 1     | Website informa- | Health information; gain pers- | Do I need more information? How should | Quality of information and lack of regulation | Provide training on how to evaluate sites and to identify good ones; how to screen for patients’ use |
|       | tion      |pective, obtain standard and updated info | I approach the problem? What is out there? Better if referred by clinician who has checked it out |
| 2     | On-line formal educacional materials | Caregiver: education, supports, and advice Patient/patient: education | I learn easier this way? I need “sound” info to make decisions for loved ones CME implies good quality; peers’ opinion helpful | Some prefer in-person interaction (e.g., Q&A) May not fit learning style | Provide advice on good options, how to evaluate the materials and help patients do likewise. |
|       |       | Clinician: continuing medical education (CME) | | | |
| 3     | Support/chat groups or “communities” | Spontaneous, anonymity, gain answers/tips and greater perspective Socialization and networking | What should/can I do? What are others doing locally, regionally or globally? Can I connect easier with others? | Peer compatibility? Information quality? Who is talking on the other end? | Provide curricula in general and how to use at specific clinical sites (e.g., inpatient unit, outpatient care) |
| 4     | Self-directed assessment and decision-making options | Person/patient: tips to reflect, make changes and get help | What are my needs and resources? What is my next step in seeking help? Can my love ones/patients get help/support outside the office with help (i.e., with a nurse, mid-level or care coordinator)? | Not all problems can be self-assessed Some illnesses affect insight and reflection Quality is an issue: get a reference | Provide training on how to help patients consider options, take steps and share information with clinician; start self- and life-long learning options |
| 5     | Social media (SM)/ networking | Person/patient/caregiver: easy, convenient, and spontaneous Patient/patient/caregiver: easy, convenient, and spontaneous | Can impact therapeutic alliance positively/negatively Public information may be visible; it cannot be collected for analysis, though Discuss, weigh pros/cons, address privacy, when to use/not use (e.g., SI) and tracking (if any) Not billable care | Not HIPAA compliant? Undisclosed and/or impulsive use may indicate problems and boundary issues? Personal professional role diffusion? | Provide skills, knowledge and approaches in curriculum and with case conferences Focus on developing professional role in transition from past personal experience(s) |
| 6     | Assisted self-care assessment and decision-making de-identified | Person/patient/caregiver: feel ownership of care and better partnership is with clinician Person/patient/caregiver: feel ownership of care and better partnership is with clinician | Empowering, in general? Increased self-efficacy/ confidence? Feel part of a team? Do I have time to discuss issues with patient? Is there time to train team and share decision-making? | Occasional “bad” decision or poor outcome, partly due to lack of context? Doing more without time/ quality is a risk? | Provide training on how to screen what patients are doing and when to seek help, and when to make decisions together. |
| 7     | Asynchronous video or one-time synchronous consultation | Person/patient/caregiver: obtain good quality tips for primary provider to use | Feels good about getting “better” care; glad primary provider gets an opinion Primary provider learns and develops relationship with psychiatrist? | Can primary provider use tips? They will work for which patients? Learning curve takes some time? | Build into the regular care continuum, like an option on a stepped continuum |
| 8     | Asynchronous, between-sess- sion patient-clinician contact (e.g., mobile app or e-mail text) | Person/patient/caregiver has minor question, forget a question, or needs a detail | Convenient to reach the clinician or team member? Easier for team patients, who prefer texting over calling? Build into the EHR? Is the contact tracked, private, document ed and billable? | Some patients and/or clinicians do not use? Things taken out of context; errors? HIPAA compliant? Some see as a nuisance (i.e., extra time) | Provide training across the curriculum; boost at core training sites; enhance with subspecialty (e.g., child) Faculty development suggested for patient and trainee e-mail text |
| 9     | Continuous mobile health/ e-monitoring to database EHR | Person/patient/caregiver likes access | Patient feels glad to be tracked, part of treatment and ‘connected’ to clinician Integrated decision-making takes preparation and extra time? | Best in systematic care models with team-based approach? | Team training, coordination, communication and documentation is important |
| 10    | Synchronous or in-person ongoing care | Person/patient: it works and is much more convenient Person/patient: it works and is much more convenient | Allows synchronous decision-making (patient-clinician); links providers (e.g., primary care psychiatry) It always has to be scheduled (and paid for); not spontaneous | | Provide curriculum, and other experiences |
information provision; screening, assessment, and monitoring; intervention; and social support.13

Two areas that are growing exponentially are SP/D and mobile apps, social health networking – partly to help users change behaviors (e.g., nutrition/diet, stress reduction).14-15 Mobile apps offer: 1) portability for access anytime, anywhere, regardless of patient geography and transportation barriers; 2) an inexpensive option versus traditional desktop computers; and 3) additional features (e.g., context-aware interventions and sensors)16,17 with real-time feedback. Overall, a review of behavior change revealed 19 studies had a 65% or greater retention rate and 6 studies reported changes in planning and self-monitoring.18,19

A review of cognition and mH focused on three facets of cognition that are clearly implicated in public discourse regarding the impacts of mobile technology – attention, memory, and delay of gratification (reward processing).19 Regular engagement with these devices can lead to diminished attentional capacity – producing shorter attention spans and “scatter-brained” tendencies among those who are most invested with the devices – and worrying some that children and adolescents’ attention spans are shorter.20-21

This paper will help the reader by…

1) Defining and describing mH’s approach, core concepts, components (e.g., SP/D), operations and processes within an e-health spectrum of service delivery,
2) Providing an overview of some cognitive functions relevant to new technologies and SPs/Ds, and
3) Describing a range of app options (and a few in detail) and outlining competencies for mH, SPs/Ds and apps.

METHODS

The review of the literature was conducted as per previously described methods13-16 using title word searches within the MEDLINE, PubMed, PsychInfo, Embase, Science Citation Index, Social Sciences Citation Index, Telemedicine Information Exchange databases, Centre for Reviews and Dissemination and The Cochrane Library Controlled Trial Registry databases for the period of May 2003 to May 2018. Primary words: apps, behavior, cognition, cognitive, devices, function, mobile, patient, practice, quality, satisfaction, service, smartphones, and technology. Secondary words: care, centered, education, mental, e-behavioral, e-health, telehealth, telemedicine, telemental, and telebehavioral.

The evidence-based literature review followed the Agency for Healthcare Quality and Research (AHQR) and Cochrane Database of Systematic Reviews, which use a panel of multidisciplinary experts to rate two factors: 1) the quality of evidence (e.g., Levels I [best] to IV [least]); and 2) consensus, expert opinion. Level I (i.e., a high quality randomized trial or prospective study; testing of previously developed diagnostic criteria on consecutive patients; sensible costs and alternatives; values obtained from many studies with multi-way sensitivity analyses; and systematic reviews and Level II (i.e., lesser quality RCT; prospective comparative study; retrospective study; untreated controls from an RCT; lesser quality prospective study) was focused on randomized controlled (RCTs) with interventions using mH, SPs/Ds and apps. These key words were cross-searched with the cognitive primary terms.

MOBILE HEALTH’S APPROACH, CORE CONCEPTS AND COMPONENTS

Internet and Mobile Health Trends for Self-Directed Habit, Lifestyle or Illness Changes

Internet and mH tools typically target good habits/health promotion, disease prevention and informal management of symptoms or problems. Techniques might include use of a diary, questionnaire or survey to provoke reflection or “stepping back” to re-evaluate one’s assumptions in a conclusion. Exercise and substance use (i.e., alcohol) logs are popular, mood assessments (MoodyMe https://itunes.apple.com/us/app/moody-me-mood-diary-track-er/id411567371?mt=8), and those that map behavior patterns across time, including triggers, diet, sleep and other related factors.

Among the fastest growing areas are related to nutrition/diet (i.e., apps to count calories and keep a food diary like iFood and Calorie Counter) and sports statistics (such as distance, speed and calories consumed).14 Despite the popularity of physical activity apps available on the commercial market, there were substantial shortcomings in the areas of data safety and likelihood of effectiveness.22 A review of medication adherence apps in the Apple App Store and the Google Play Store (N=5,881) found of those accessible without payment (N=420), only 3 with an evidence base and there were 3 broad categories of adherence strategies (i.e., reminder, behavioral, and educational).23 A total of 250 apps utilized a single method, 149 apps used two methods, and only 22 apps utilized all 3 methods. In particular, young people may benefit from structured health information, web-based screening and assessment, and online treatment options to reduce medication non-adherence.24 Mental health promotion in children and adolescents is increasing, too (e.g., Kindertelefoon (www.kindertelefoon.nl)).6

mH Approaches and Themes

mH is able to incorporate qualities often associated with conventional health communication methods, such as personalization, tailoring, interactivity, and message repetition at a relatively low cost.25 An estimated 69% of the U.S. adult population track at least 1 health indicator, such as activity, weight, or symptoms26 at home or within primary care.27 Text messaging (short message service, SMS; containing 160 characters) varies in frequency (daily, weekly), interactivity (one-way vs. two-way), personalization and tailoring (all of the above).28-30 Text messages from web-based platforms allow for pre-scheduling of sending, automation, and better monitoring.

The SP/D is the core device linking people, communities and systems (Figure 1). They have the core functions of a modern computer paired with apps to facilitate day-to-day functions
for health and disease management. Integrative components of a
generic mobile health system potentially link: 1) a national health
network; 2) hospital and other acute care centers; 3) home-based
care; and 4) mobile health devices. The main functions SP/Ds
and apps are: voice/video calling to remotely communicate; SMS;
multimedia message services (MMS) with video clips/sound files
to deliver education; inbuilt sensors (e.g., touch, motion and GPS)
for clinical assessment, lifestyle and social activities; and device
connectivity for practical and less error-prone data entry. The
content of messages is of particular importance. Some character-
istics such as personalization, caring sentiments, and polite text are
associated with more successful preventative messages.

Figure 1. Integration of Information in the Technology Age through The Mobile/Smart
Phone and Other Technologies.

SP/Ds serve as organizing hubs that link patients’ health
data to other health services; the bi-directional flow enables routine
care or education from clinicians to patients in their own environ-
ment. Wireless monitoring devices gather data from sensors, input
that data into a mobile medical app on the SP/D, and then relay
the information to a centralized national health network. Theoret-
ically, the data would be organized and processed through clinical
decision support medical apps in a healthcare information system
for review and response by clinicians (e.g., feedback, reminders of
healthy behaviors, scheduled appointments, medications) 24-hours
da day and 7-days per week.

Ecological momentary assessment (EMA) is a method
for capturing more accurate accounts of a person’s or patient’s
emotions, functioning and activity by sampling of naturalistic
behaviors and experiences. Examples of EMA commonly used
are daily diary methods, signal-dependent reporting, and event-de-
pendent reporting. These reduce recall bias. Signal-dependent re-
porting involves the client reporting on symptoms at random in-
tervals during the day in response to an alarm. Event-dependent
reporting has the client report on symptoms after predetermined
interpersonal or challenging events during the day. Of the three,
signal-and event-dependent reports are more accurate and yet, they
demand a level of engagement and motivation that may exceed
the capacity of some participants. EMA data analysis use mood/
ffect changes to predict risk of suicidal ideation and provide a
portal into teenagers’ psychological symptoms.

Cognitive Function Relevant to New
Technologies and the SP/D

Overview

Our ability to contemplate the future through cortical function
and we have higher levels of happiness and lower levels of stress
than at other times. How we learn is dependent on our personal
experience and professional training, and reflection with evaluation
of our strengths and weaknesses is a key part of development.
Learners progress to critical thinking via a series of developmental
steps, from gathering information in rote, analyzing, and recon-
structing data in a laborious manner; later algorithms are used to
guide decision-making and mental shortcuts (or heuristics). Skills
needed to solve a problem is developed by education, mentoring
and practice.

The problems in researching the use of SP/Ds include
trouble employing true experimental methods with random assign-
ment, literature based on topical and cross-sectional investigation
of momentary rather than long-term impact for SP/D users, dis-
parities in technology users’ backgrounds, biased (self) reporting
of behaviors and a limited “half-life” of research questionnaires.
The SP/D era is also very short, so there is little broadly generaliz-
able longitudinal evidence.

The Range From Healthy to Unhealthy Behaviors

Social media and networking options like Twitter and Facebook
are common among the Digital Native (Z), Millennial (Y) and X
Generations. Today’s youth engage with media through television,
computer/video games, text/e-mail, mobile apps and video sharing platforms. On a typical day, American teenagers (13 to 18
year-olds) average about nine hours of entertainment media use,
excluding time spent at school or for homework; tweens (8 to 12
year-olds) use an average of about six hours of entertainment me-
dia daily.

While many aspects of this new media landscape can be
positive, others are problematic. Positive aspects of technology
for youth include speaking more freely, learning/knowledge gains,
communication/engagement with others and creative exploration.
Youth also use technology for depression, obesity and/or suicidal
thinking, but the evidence base is limited. Concerns about me-
dia use – especially excess use of television and computer games –
have arisen due to potential changes in mood, sedentary lifestyles,
withdrawal from other activities and impaired sleep patterns.
Problematic social media behaviors may range from disinhibition
and the posting of ill-advised photos, to more extreme examples
like online bullying, sexting, frank exploitation and other addictive behaviors.46-50 There are also negative effects on physical and mental health, neurological development and personal relationships, not to mention safety on roads and sidewalks.51-52 Finally, borrowing from business, the “opportunity costs” need to be assessed, as time spent on one thing limits the opportunity to spend it on another (better?) thing.

Attention

There are different times of inattention and/or interruptions. Some occur when the user’s own thoughts drift toward a SP/D-related activity for immediate gratification. Users often then engage in a chain of subsequent task-unrelated acts on the SP/D. Importantly, SP/Ds are capable of interfering with focused attention even when the user attempts to ignore them (e.g., e-mail alert). Such notifications (i.e., the sound or feeling the vibration) significantly decrease performance on a concurrent attention-based task, even when the participant did not take the time to view the notification.54

Further evidence suggests that even the mere awareness of the physical presence of a SP/D may impact cognitive performance. Thornton et al55 conducted a study in which participants were asked to complete two neuropsychological tasks designed to measure executive function and attention – a digit cancelation task and a trail-making task. At the start of the experiment, the experimenter “accidentally” left a SP/D on the participant’s desk. Participants in the SP/D condition performed significantly worse on the more difficult parts of the digit cancelation and trail-making task. The researchers replicated these findings in a follow-up study for which half of the participants were asked to place their own SP/D on their desks. Texting during driving most likely parallels distractions in past simulation studies.56

Addictive Process

We are governed by the subconscious in many ways including addictions. The connection between an individual’s degree of “addiction” to a SP/D and the ability to achieve “flow” has been studied.57 A flow state relates to sustained attention in that it is “a state of concentration so focused that it amounts to absolute absorption in an activity”.58 Long-term, those who scored highest on the SP/D addiction scale scored significantly lower on the self-regulated learning and flow scales; they also do poorly with self-regulated learning.

Multi-Tasking

Media multitasking involves the simultaneous use of more than one media technology – and studies are assessing basic cognitive skills and the tendency to engage in simultaneous media-related habits. Computer-based behavioral tasks have been used to measure participants’ attentional functioning.59 The data revealed that those who reported engaging in more media multitasking were also less able to filter environmental distractions. Media multi-taskers exhibited higher switch-costs in a task-switching paradigm, indicating that they were less able to suppress the activation of task set representations that were no longer relevant to performance.60

Memory and Knowledge

There is less research investigating the relationships between SP/D habits related to memory and knowledge. SP/Ds provide constant access to an endless and ever-improving database of collective knowledge.61 The “Google Effect”, and later referred to by other researchers as “digital amnesia” demonstrates that the expectation of having later access to information can make us less inclined to encode and store that information in long-term memory. Humans are “cognitive misers”62 who rely on simple heuristics and mental shortcuts. Studies of heavy users of SP/Ds show less analytical “cognitive style” and poorer performance on knowledge measures.62

Another potential impact of digital media on memories showed that taking photographs diminishes memory for observed objects.63 Recent trends in social media and networking use have prioritized ephemeral photo-sharing (e.g., Snapchat, Instagram).64 These allow users to send/post pictures, videos or messages that can only be viewed a limited number of times or for a finite period. Little is yet known about the specific effects of this, but it may act on memory in a way that is akin to the soon-to-be-erased files.

Delay of Gratification and Reward:

In addition to their effects on memory and attention, SP/Ds and related media are often implicated as the cause of a perceived cultural shift toward a necessity for immediate gratification.65 Studies are tentative/in process related to media multi-tasking and uses and gratifications theory. Subjects rate specific “motivation” (i.e., emotional, cognitive, social, or habitual) that drive them to engage in each media interactions, but often those needs are not met, which infers other factors may have been more influential.66

Other Cognitive Functions

Studies are exploring the relationship between technology habits and general academic performance. Studies on this front generally support the conclusion that poor academic performance (e.g., grade point average) can be predicted by higher levels of SP/D use, instant messaging, social networking, media multitasking, and general electronic media usage.67 Some of this may depend on the person’s cognitive skill set, ability to exert self-regulatory control over behavior, interruptions and resultant stress and working memory capacity as a predictor of the speed of task resumption following an interruption.68 Other things like diet, exercise, sleep and mood may also indirectly affect measurement of these issues.

SMARTPHONE/DEVICE APPS IN MENTAL HEALTH AND CLINICAL SKILLS/COMPETENCIES

Broad areas of research are clinician-to-clinician, clinician-to-patient and patient as mobile compared to stationery. Clinicians need
a framework and skills/competencies to meet needs of consumers, patients, caregivers and other providers related to technology. mH and other technologies alter care in terms of communication, boundaries and privacy/confidentiality. Overall, clinicians are encouraged to screen what technology is being used, how and when. Second, there are questions about how mH care fits with traditional care and affects the therapeutic relationship. Third, people and patients need education on using the “right” technology at the “right” time (e.g., not using an app or text to express suicidal ideation). Fourth, the advantages of empowerment, in-time learning and increased self-efficacy need to outweigh liabilities. Finally, clinicians (and patients) need research, select and evaluate technology as part of a treatment plans.

Participants in care need to evaluate how good the technology is (e.g., psych/mental health apps for SP/Ds). A review of 5465 abstracts on mental health apps (i.e., depression, anxiety, substance use, sleep disturbances, suicidal behavior, self-harm, psychotic disorders, eating disorders, stress, and gambling) delivered on mobile devices with a pre- to posttest design or compared with a control group. Only 8 papers describing 5 apps met the criteria (e.g., depression, anxiety and substance abuse) and 4 apps provided support from a mental health professional.

Mobile BH (mBH) or m Mental Health (mMH)

With regard to mBH, a review of 677 mobile phone and web-based text messaging papers in BH found 36 data-based ones, revealing that text messaging was used in a wide range of mental health situations, notably substance abuse (31%), schizophrenia (22%) and affective disorders (17%). Studies have described four ways in which text messages are used from the clinician to the patient: 1) reminders (14%); 2) information (17%); 3) supportive messages (42%); and 4) prompts for self-monitoring procedures (42%); combination use was common, too. Apps are also used for other functions, including: 5) communicating with other patients, caregivers, social supports or providers; 6) augmenting psychotherapy; 7) (smart) monitoring, that is, to use tools to predict relapse behavior or worsening affective symptoms, through sensors and data activity; 8) practicing self-assessment and care through reflection about their symptoms; and 9) facilitating interactive learning.

Various mobile apps, especially those focusing on self-help in dealing with anxiety disorders, wellness and stress reduction, are not designed to act as a substitute for treatment. But they have been adjusted to specific patient groups (e.g., “Fear Fighter”), computer guided self-exposure approach to treat phobia/panic disorder; e.g., PTSD Coach from the National Center for Telehealth and Technology to learn about and manage trauma. Exposure therapy is effective for phobia/panic, but some patients prefer technology and qualified therapists are scarce; this increases healthcare efficiency. Soldiers prefer to complete psychometric measures (e.g., Patient Health Questionnaire or PHQ-9) and other military population measures by iPhone rather than paper or computer due to its interface, portability, and convenience.

A systematic review of the effectiveness of online services in facilitating MH help-seeking in young people aged 14-25, emphasizing rigorous designs (N=18) showed high satisfaction and higher use by females. Many patients migrate to sites like PatientsLikeMe (http://www.patientslikeme.com/), a consumer driven site where individuals connect with others in the community who are experiencing similar medical issues. Young people with developmental challenges may have few traditional care options and feel more comfortable anonymously or at a distance, to share experiences and try to learn new behaviors. Comfortable with internet-based chats and groups, they may even express ideas of self-harm, negative affective states, or pessimistic cognitions of other peers. This is concerning, though, if these things are not shared with parents and/or professionals.

Common prejudice is that psychotic patients are not eligible for mH options due to poor concentration, lack of energy and paranoia. Non-attendance to treatment is common due to stigma and poor insight, but direct or remote education, motivation and support may increase attendance via treatment readiness and greater recognition of treatment benefits. Seriously mentally ill patients have also successfully used the Internet to learn about illness and medication (e.g., side effects and the hope of finding better medication) via EMA options. Research shows better concordance between clinician-rated affective symptoms and SP/D-captured mood ratings (compared to paper-and-pencil ratings by patients). Presentation of summary feedback in graphical form helps users learn about temporal sequencing of behaviors.

Competencies, Education and Training

The international organization for migration (IOM)’s core competencies for the health professions include the ability to provide patient-centered care, work in interdisciplinary teams, employ evidence-based practice, apply quality improvement and use information technology. Learner-centered skills more than knowledge require that teaching and assessment methods align. The most common US framework used being the Accreditation Council for Graduate Medical Education (ACGME), which uses domains of patient care, medical knowledge, practice based learning and improvement, systems based practice, professionalism, and interpersonal skills and communication. Another useful framework is the evidence-based CanMEDS, which frames knowledge, skills and abilities into seven roles that all physicians play: medical expert, communicator, collaborator, manager, health advocate, scholar and professional.

TP competencies have been published using the ACGME domains and with a teaching, supervisory and evaluation plan; medication competencies have also been added. Novice/advanced beginner, competent/proficient (and expert levels were suggested. Subsequently, an interprofessional, evidence-based framework for measurable TBH competencies organizes seven Competency Domains: 1) Clinical Evaluation & Care; 2) Virtual Environment & Telepresence; 3) Technology; 4) Legal & Regulatory Issues; 5) Evidence-Based & Ethical Practice; 6) Mobile
Health and Apps and 7) Telepractice Development. The competency literature has also recently grown with specific additions to social media competencies and mH and app competencies.

mH poses challenges for competencies compared to in-person and telepsychiatric care, mainly as it is synchronous and anytime/anywhere — conceivably organized in a 24-hours per day and 7-days per week framework. Since many professionals often use the same SP/D for professional and personal life — mH is therefore “live”. mH care may also be “outside” the clinical visit, but it may affect the therapeutic frame and create additional boundary issues and be disruptive. If it is conducted over public, private

| Table 2. Tips on Evaluating Outcomes Related to New Technology Options (e.g., SP/D, APPS). |
| --- |
| **Fundamental issues and components of evaluating care** |
| 1. | Keep it simple by picking 1-2 foci to evaluate (e.g., depression as a diagnosis; the impact of one technology like mobile apps). |
| 2. | Use a known standard of evaluation (i.e., Patient Health Questionnaire-9; PHQ-9 for depression; adapt a telepsychiatric satisfaction instrument for a mobile app). |
| 3. | Customize patient outcome targets (e.g., social engagement if that had lessened due to depression; how the mobile health helped). |
| 4. | Measure satisfaction with an existing 5–10-item survey for regular care and one technology options (e.g., a chat room or a diary for depression). |
| 5. | Contextualize the evaluation with a specific population or clinical setting |
| a. Age or population (e.g., for patients over 60; outpatient; use of substance by screening with the Alcohol Use Disorders Identification Test (AUDIT)). |
| b. Disorder-specific (e.g., plan for tracking suicidal ideation for a depressed patient, in general, or if a teenager due to high risk). |
| 6. | Employ a log/diary by the patient and the clinician about |
| a. The experience, overall; |
| b. How and what technology was used and the relative frequency, too (e.g., texting 3 times/week). |
| 7. | Can the technology help us use resources better, as interdisciplinary teams’ members (e.g., care coordinators) help us in providing a range of services in stepped care? |
| 8. | What additional resources (i.e., time, $, staff/manager/medical director/administrative director, trainings) are necessary to use new technologies? |

**Questions, reflections and considerations for patients**

| 9. | What am I seeking when I choose to view a website, visit a chat room, get an informal suggestion or work with a clinician directly? |
| 10. | What are my means: time, $, and other resources? |
| 11. | What is my learning style: alone vs. group of learners, reading versus doing something, prefer a little versus a lot of instruction? |
| 12. | Am I self-assessing, part of a support group or engaging in “real” treatment – in which I work with a clinician? |
| 13. | How do I pick the “best” technology option? |

**Clinical care issues for the provider related to patient care**

| 14. | Do the new technologies and associated behaviors affect the therapeutic relationship, clinical approach and treatment plan? |
| 15. | What are the technology pros and cons? |
| 16. | Did the patient and I talk about the options, work together to select the plan, and how should be continue to discuss this? |

and health system sites/apps, data integration and security may be difficult. Not all patients may be suitable for mH, which is very different than for in-person and telepsychiatric care. Finally, ethical issues are involved as SP/Ds collect sensitive information (e.g., personal information, geo-location, physiological activity, self-reports of mood and cravings and the consumption of drugs).

An example mH, SP/D and Apps Competency for Patient Care Evaluation and Treatment would include history taking, engagement and interpersonal skills, assessment, education and management and treatment planning. It also includes administration, documentation and medico-legal issues such as privacy, confidentiality, safety, data protection/integrity and security. Clinicians reflect with patients on the pros/cons of the use of mH, SP/D and apps as part of treatment document this in the consent form or progress notes. This may include, but not be limited to, the competent/proficient clinician selecting the SP/D option based on patient preference, skill and need (i.e., purpose). S/he may also find it helpful to know if the patient uses SP/D and apps for personal life, healthcare and/or BH care, and seeing if the patient is aware of risks (e.g., privacy, self-disclosure, potential for cyberbullying).

Evidence-based Practice and Research

Parameters and methods fall into three basic frameworks that naturally overlap with one another: 1) research measures, in the form of feasibility, validity, reliability, satisfaction, costs and outcomes; 2) clinical care measures (e.g., mood questionnaires; habit diaries; utilization of health services); and 3) customized measures for technologies. Suggestions are to:
• Pick 1-2 things to measure rather than trying to measure everything; for an app for substance issues, monitor how frequently is the app used, frequency of near misses of or actual use of substances.
• Pick an outcome that has high heuristic value (e.g., substance relapse; averted suicide; frequency of increased visits cued by using an app).
• Adopt standardized measures already used in the literature; they typically have undergone multiple iterations, levels of review and psychometric testing.
• Use a readily available, easy to use self-report instrument or program.
• Collect data prospectively rather than retrospectively, with some exceptions.
• If possible, pick a regular evaluation interval (e.g., beginning and then 3-, 6- and 12-months).
• Identify who has the responsibility to prevent, identify, and correct the issues: patients, providers, or programs?

DISCUSSION

Technology is frequently used, is readily accessible and satisfies persons, patients and caregivers and is transforming the way health information is accessed, delivered and managed. The healthcare industry is able to distribute and deliver services, partly due to cloud computing via fourth-generation (4G) mobile communications systems is the main responsible for enabling these advents. When people and patients – or trainees and clinicians/supervisors – use technology, personal experience may only partially translate to professional skill, hence the need for competencies. All participants, too, must reflect on when, why and how to use technology, in terms of getting things done versus engaging with others. Furthermore, they have to consider the cognitive pros and cons (e.g., attentional problems that make multi-tasking not really true multi-tasking).

Clinicians have to adapt clinical care using these new technology options in order to provide the best care – this means new advisory roles to explore patients’ experiences, preferences and skills in using them with regular in-person care. Standards for professionalism, privacy/confidentiality, tracking of data, evaluation and general practice management are affected by most of these technologies – not just by social media, texting and e-mail. Evidence-based research for a common vocabulary and set of quality standards for health apps would benefit both end users, industry participants and governments. Relatively few studies assess outcomes, compare in-person and eMH care, and or compare technology-based care options to one another; hybrid models of care have emerged, but have not been studied.

A dilemma exists, currently, in which neither public nor private, top-down nor bottom-up, and country-specific nor international approaches related to apps is providing a framework to develop, evaluate and regulate to eMH care – the result is a chaotic mix of apps of varying degrees of usefulness, quality, effectiveness and danger. Ideally, such a consortium would be open to all who are involved in healthcare, including consumers, clinicians, academia, business, technology, education, and professional and advocacy organizations. Creation and adoption of review standards by an international, interdisciplinary consortium could reduce many of the barriers currently keeping eMH technologies from becoming routine in providing healthcare worldwide.

Limitations to this review of mH, SP/Ds and apps are many. The scope and methods of the review was limited. Second, the metrics of a more detailed approach to design, implementation and evaluation need to be spelled out, preferably with users’ competencies measured. Third, for both cross-sectional and longitudinal trajectories, with qualitative and quantitative evaluation of participants is suggested to iteratively improve the process. Research is needed on organization change with technology and how a paradigm shift like mH re-contextualizes digital healthcare. Finally, a broader consensus across organizations (e.g., American Medical Association, American Telemedicine Association) is needed.

CONCLUSIONS

mH, telemedicine and other services are considered part of a tele-health or e-health spectrum of care. Technology usually offers portability for access anytime/anywhere, are relatively inexpensive and have additional features (e.g., context-aware interventions and sensors with real-time feedback). The evidence-based literature shows that many people have an openness to technology as a way to engage others, change behaviors and obtain clinical services. Skills/competencies for mobile health, SP/Ds and app have similarities and differences from in-person and telepsychiatric care. Cognitive function related to SP/Ds and app use may be affected by these technologies – particularly attention, memory and delay of gratification. More research is needed with respect to health services delivery models, effectiveness, competency outcomes and how a paradigm shift like mobile health re-contextualizes digital healthcare.

DISCLOSURE(S)/CONFLICTS OF INTEREST(S)

None.

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REFERENCES

1. Hilty DM, Chan S, Hwang T, et al. Advances in mobile mental health: Opportunities and implications for spectrum of e-mental health services. MHealth. 2017; 21(3): 34. doi: 10.21037/mhealth.2017.06.02
2. Tachakra S, Wang XH, Istepanian RS, et al. Mobile e-health: The
unwired evolution of telemedicine. Telemed J E Health. 2003; 9(3): 247-257. doi: 10.1089/153056203322502632

3. Frydman GJ. Patient-driven research: Rich opportunities and real risks. J Participat Med. 2009.

4. Institute of Medicine. The Core Competencies Needed for Health Care Professionals. Health Professions Education: A Bridge to Quality. Washington, DC, USA: The National Academies Press, 2003.

5. Institute of Medicine. Health Professions Education Summit. Health Professions Education: A Bridge to Quality. Washington, DC, USA: The National Academies Press, 2003.

6. Hilty DM, Chan S, Torous J, et al. New frontiers in healthcare and technology: Internet- and web-based mental options emerge to complement in-person and telepsychiatric care options. J Health Med Informat. 2015; 6: 1-14. doi: 10.4172/2157-7420.1000200

7. Hilty DM, Ferrer D, Callahan EJ. The effectiveness of telen mental health: A 2013 review. Telemed J E Health. 2013; 19(6): 444-454. doi: 10.1089/tmj.2013.0075

8. Yellowlees PM, Odor A, Iosif AM, et al. Transcultural psychiatry made simple: Asynchronous telepsychiatry as an approach to providing culturally relevant care. Telemed J E Health. 2013; 19: 1-6. doi: 10.1089/tmj.2012.0077

9. Silva BMC, Rodrigues JPC, de la Torre I, et al. Mobile-health: A review of current state in 2015. JM Biomed Inform. 2015; 56: 265-272. doi: 10.1016/j.jbima.2015.06.003

10. Laxminarayan S, Istepanian RS. UNWIRED E-MED: The next generation of wireless and internet telemedicine systems. IEEE Trans Inf Technol Biomed. 2000; 4: 189-193.

11. Istepanian RSH, Lalac J. Emerging mobile communication technologies for health: some imperative notes on m-health. In: Proceedings of the 25th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 1414-1416, 2003; IEEE, USA.

12. Steinhubl SR, Muse ED, Topol EJ. Can mobile health technologies transform health care? JAMA. 2013; 310: 2395-2396. doi: 10.1001/jama.2013.281078

13. Lal S, Adair CE. E-mental health: A rapid review of the literature. Psychiatr Serv. 2014; 65: 24-32. doi: 10.1176/appi.ps.201300009

14. Bert F, Giacometti M, Gualano MR, Smartphones and health promotion: A review of the evidence. J Med Syst. 2014; 38(1): 9995. doi: 10.1007/s10916-013-9995-7

15. Laranjo L, Arguel A, Neves AL, et al. The influence of social networking sites on health behavior change: A systematic review and meta-analysis. J Am Med Inform Assoc. 2015; 22: 243-256. doi: 10.1136/amiajnl-2014-002841

16. Torous J, Chan RS, Yee-Marie Tan S, et al. Patient smartphone ownership and interest in mobile apps to monitor symptoms of mental health conditions: A survey in four geographically distinct psychiatric clinics. JMIR Ment Health. 2014; 1: e5. doi: 10.2196/mental.4004

17. Luxton D, Hansen RN, Stanfill K. Mobile app self-care versus in-office care for stress reduction: a cost minimization analysis. J Telemed Telecare. 2014;20:431-435. doi: 10.1177/1357633X14555616

18. Zhao J, Freeman B, Li M. Can mobile phone apps influence people's health behavior change? An evidence review. J Med Internet Res. 2016; 18(11): e287. doi: 10.2196/jmir.5692

19. Wilmer HH, Sherman LE, Chein JM. Smartphones and cognition: A review of research exploring the links between mobile technology habits and cognitive functioning. Front Psychol. 2017; 8: 605. doi: 10.3389/fpsyg.2017.00605

20. Egan T. The Eight-Second Attention Span. New York, NY: The New York Times, 2016.

21. Nikken P, Schols M. How and why parents guide the media use of young children. J Child Fam Stud. 2015; 24(11): 3423-3435. doi: 10.1007/s10826-015-0144-4

22. Bondaronek P, Alkhaldi G, Slec S, et al. Quality of publicly available physical activity apps: Review and content analysis. JMIR Mhealth Uhealth. 2018; 6(3): e53. doi: 10.2196/mhealth.9069

23. Ahmed I, Ahmad NS, Ali S, et al. Medication adherence apps: Review and content analysis. JMIR Mhealth Uhealth. 2018; 6(3): e62. doi: 10.2196/mhealth.6432

24. Badawy SM, Barrera I, Sinno MG, et al. Text messaging and mobile phone apps as interventions to improve adherence in adolescents with chronic health conditions: A systematic review. JMIR Mhealth Uhealth. 2017; 5(5): e66. doi: 10.2196/mhealth.7798

25. Free C, Phillips G, Felix L, et al. The effectiveness of m-health technologies for improving health and health services: A systematic review protocol. BMC Res Notes. 2010; 3: 250. doi: 10.1186/1756-0500-3-250

26. Fox S, Duggan M. Tracking for health. Pew Research Center. 2013.

27. Bauer AM, Rue T, Keppel GA, et al. Use of mobilehealth (mHealth) tools by primary care patients in the WWAMI region practice and research network (WPRN). J Am Board Fam Med. 2014; 27: 780-8. doi: 10.3122/jabfm.2014.06.140108
28. Hall AK, Cole-Levis H, Bernhardt JM. Mobile text messaging for health: A systematic review of reviews. *Ann Rev Public Health*. 2015; 36: 393-415. doi: 10.1146/annurev-publhealth-031914-122855

29. Lim MS, Wright C, Hellard ME. The medium and the message: Fitting sound health promotion methodology into 160 characters. *JMIR Mhealth Uhealth*. 2014; 2: e40. doi: 10.2196/mhealth.3888

30. Honeyman E, Ding H, Varnfield M, et al. Mobile health applications in cardiac care. *Interv Cardiol*. 2014; 6(2): 227-240.

31. Odén TA, Newman M, Bukusi EA, et al. Developing content for a mHealth intervention to promote postpartum retention in prevention of mother-to-child HIV transmission programs and early infant diagnosis of HIV: A qualitative study. *PLoS One*. 2014; 9: e106383. doi: 10.1371/journal.pone.0106383

32. Carlson EB, Field NP, Ruzek JI, et al. Advantages and psychometric validation of proximal intensive assessments of patient-reported outcomes collected in daily life. *Qual Life Res*. 2016; 25: 507-516. doi: 10.1007/s11136-015-1170-9

33. Van Os J, Delespaul P, Barge D, et al. Testing an mHealth momentary assessment routine outcome monitoring application: A focus on restoration of daily life positive mood states. *PLoS One*. 2014; 9: e115254. doi: 10.1371/journal.pone.0115254

34. Moskowitz DS, Young SN. Ecological momentary assessment: what it is and why it is a method of the future in clinical psychopharmacology. *J Psychiatry Neurosci*. 2006; 31: 13-20.

35. Torous J, Staples P, Shanahan M, et al. Utilizing a custom application on personal smartphones to assess PHQ-9 depressive symptoms in patients with major depressive disorder. *JMIR Ment Health*. 2015; 2(1): e8. doi: 10.2196/mental.3889

36. Berkman ET, Giuliani NR, Pruitt AK. Comparison of text messaging and paper-and-pencil for ecological momentary assessment of food craving and intake. *Appetite*. 2014; 81: 131-137. doi: 10.1016/j.appet.2014.06.010

37. Thompson WK, Gershon A, O'Hara R, et al. The prediction of study emergent suicidal ideation in bipolar disorder: A pilot study using ecological momentary assessment data. *Bipolar Disord*. 2014; 16: 669-677. doi: 10.1111/bdi.12218

38. Magallón-Neri E, Kirchner-Nebot T, Forns-Santacana M, et al. Ecological momentary assessment with smartphones for measuring mental health problems in adolescents. *World J Psychiatry*. 2016; 6(3): 303-310. doi: 10.5498/wjp.v6.i3.303

39. Seligman MEP, Tierney J. *We aren't Built to Live in the Moment*. New York, NY: The New York Times, 2017.

40. Hilty DM. Technology and the brain: What can we learn from our life experience, patient care, social media and Internet use? *Psychol Cogn Sci Open J*. 2017; 3(3): 89-93. doi: 10.17140/PCSOJ-3-128

41. Kahneman D. *Thinking, Fast and Slow*. New York, NY: Farrar, Straus and Giroux, 2012.

42. Välimäki M, Anttila K, Anttila M, et al. Web-based interventions supporting adolescents and young people with depressive symptoms: Systematic review and meta-analysis. *JMIR Mhealth Uhealth*. 2017; 5(12): e180. doi: 10.2196/mhealth.8624

43. Keating SR, McCurry MK. Systematic review of text messaging as an intervention for adolescent obesity. *J Am Assoc Nurse Pract*. 2015; doi: 10.1002/janp.2017.11.003

44. Grist R, Porter J, Stallard P. Mental healthmobile apps for preadolescents and adolescents: A systematic review. *J Med Internet Res*. 2017; 19(5): e176. doi: 10.2196/jmir.7332

45. Carson NJ, Gansner M, Khang J. Assessment of digital media use in the adolescent psychiatric evaluation. *Child Adolescent Psychiatr Clin N Am*. 2018; 27: 133-143. doi: 10.1016/j.jche.2017.11.003

46. Mihajlov M, Vejmelka L. Internet addiction: A review of the first twenty years. *Psychiatr Danub*. 2017; 29(3): 260-272. doi: 10.24869/psyd.2017.260

47. Pontes HM. Investigating the differential effects of social networking site addiction and internet gaming disorder on psychological health. *J Behav Addict*. 2017; 6(4): 601-610. doi: 10.1556/2006.6.2017.075

48. Van Geel M, Vedder P, Tanilon J. Relationship between peer victimization, cyberbullying, and suicide in children and adolescents: a meta-analysis. *JAMA Pediatr*. 2014; 168(5): 435-442. doi: 10.1001/jamapediatrics.2013.4143

49. Englander E. Risky business talking with your patients about cyberbullying and sexting. *Child Adolescent Psychiatr Clin N Am*. 2018; 27(2): 287-305. doi: 10.1016/j.jche.2017.11.010

50. United States Stop Bullying. Website: https://www.stopbullying.gov/cyberbullying/establishing-rules/index.htmlhttps://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/resilience/Pages/Bullying-and-Cyberbullying.aspx. Accessed June 1, 2018.

51. Sapa@ova D. Motivating, influencing, and persuading patients through personal health records: A scoping review. *Percept Health Inf Manag*. 2012; 9: 1f.

52. Carli V, Hoven CW, Wasserman C, et al. A newly identified group of adolescents at “invisible” risk for psychopathology and suicidal behavior: Findings from SEYLE study. *World Psychiatry*. 2014;13(1): 78-86. doi: 10.1002/wps.20088
53. Hilty DM, Hwang T, Turvey C. Staying abreast of information in the information age: Digital continuing education and leveraging technology to stay current for clinical psychiatric practice. *Curr Psychiatr Rep*. 2018; 12(3): 15. doi: 10.1007/s11920-018-0878-y

54. Stothart C, Mitchum A, Yehnert C. The attentional cost of receiving a cell phone notification. *J Exp Psychol Hum Percept Perform*. 2015; 41(4): 893-897. doi: 10.1037/xhp0000100

55. Thornton B, Faires A, Robbins M, et al. The mere presence of a cell phone may be distracting: Implications for attention and task performance. *Soc Psychol*. 2014; 45: 479-488. doi: 10.1027/1864-9335/a000216

56. Caird JK, Johnston KA, Willness CR, et al. A meta-analysis of the effects of texting on driving. *Accid Anal Prev*. 2014; 71: 311-318. doi: 10.1016/j.aap.2014.06.005

57. Lee YK, Chang CT, Lin Y, et al. The dark side of smartphone usage: Psychological traits, compulsive behavior and technostress. *Comput Hum Behav*. 2014; 31: 373-383. doi: 10.1016/j.chb.2013.10.047

58. Csikszentmihalyi M, Abuhamedeh S. *Flow and the Foundations of Positive Psychology*. Dordrecht, Netherlands: Springer. 2014.

59. Ophir E, Nass C, Wagner AD. Cognitive control in media multitaskers. *Proc Natl Acad Sci U S A*. 2009; 106(37): 15583-15587. doi: 10.1073/pnas.0903620106

60. Monsell S. Task switching. *Trends Cogn Sci*. 2003; 7(3): 134-140.

61. Özkul D, Humphreys L. Record and remember: Memory and meaning-making practices through mobile communication. *Mob Med Commun*. 2015; 3: 351-365. doi: 10.1177%2F2050157914565846

62. Barr N, Pennycook G, Stolz JA, et al. The brain in your pocket: Evidence that smartphones are used to supplant thinking. *Comput Hum Behav*. 2015; 48: 473-480. doi: 10.1016/j.chb.2015.02.029

63. Henkel LA. Point-and-shoot memories: The influence of taking photos on memory for a museum tour. *Psychol Sci*. 2013; 25: 396-402. doi: 10.1177%2F0956797613504438

64. Lenthart A. Teens, *Social Media and Technology Overview 2015*. Smartphones Facilitate Shifts in Communication Landscape for Teens. Washington DC, USA: Pew Research Center. 2015.

65. Alsop R. Instant Gratification & Its Dark Side. Website: http://www.bucknell.edu/communications/bucknell-magazine/instant-gratification-and-its-dark-side.html. Accessed June 1, 2018.

66. Katz E, Blumler JG, Gurevitch M. Uses and gratifications research. *Public Opin Q*. 1973; 37: 509-523.

67. Wang Z, Tchernev JM. The “Myth” of media multitasking: Reciprocal dynamics of media multitasking, personal needs, and gratifications. *J Commun*. 2012; 62: 493-513. doi: 10.1111/j.1460-2466.2012.01641.x

68. Werner NE, Cades DM, Boehm-Davis DA, et al. What makes us resilient to interruptions? Understanding the role of individual differences in resumption. Presented at: Proceed Human Factors Ergonomics Soc Ann Meeting. Thousand Oaks, CA, 296-300; 2011.

69. Hilty DM, Belitsky R, Cohen MB, et al. Impact of the information age residency training: The impact of the generation gap. *Acad Psychiatry*. 2015; 39(1): 104-107. doi: 10.1007/s40596-014-0196-6

70. Chan SR, Torous JB, Hinton WL, et al. Psychiatric apps: Patient self-assessment, communication, and potential treatment interventions. In: Mucic D, Hilty DM (eds). *e-Mental Health*. New York, NY: Springer Publishing, 2015; 217-229.

71. Donker T, Petrie K, Proudfoot J, et al. Smartphones for smarter delivery of mental health programs: A systematic review. *J Med Internet Res*. 2013; 15(11): e247. doi: 10.2196/jmir.2791

72. Berrouiguet S, Baca-García E, Brandt S, et al. Fundamentals for future mobile-health (mHealth): A systematic review of mobile phone and web-based text messaging in mental health. *J Med Internet Res*. 2016; 18: e135. doi: 10.159/1/journal.pone.0163796

73. Luxton DD, McCann RA, Bush NE, et al. mHealth for mental health: Integrating smartphone technology in behavioral healthcare. *Prof Psychol Res Practice*. 2011; 42: 505-512. doi: 10.1037/a0024485

74. Hilty DM, Yellowlees PM, Parish MB, et al. Telepsychiatry: Effective, evidence-based and at a tipping point in healthcare delivery. *Psychiatr Clin North Am*. 2015; 38: 559-592. doi: 10.1016/j.psc.2015.05.006

75. Bush NE, Skopp N, Smolenski D, et al. Behavioral screening measures delivered with a smartphone app: Psychometric properties and user preference. *J Nerv Ment Dis*. 2013; 201: 991-995. doi: 10.1097/NMD.0000000000000039

76. Kaiser SD, Mangan C, Sani L. Do online mental health services improve help-seeking for young people? A systematic review. *J Med Internet Res*. 2014; 16: e66. doi: 10.2196/jmir.3103

77. Berger M, Wagner TH, Baker LC. Internet use and stigmatized illness. *Soc Sci Med*. 2005; 61: 1821-1827. doi: 10.1016/j.socscimed.2005.03.025

78. Griffiths KM, Calear AL, Banfield M. Systematic review on internet support groups (ISGs) and depression (1): Do ISGs reduce depressive symptoms? *J Med Internet Res*. 2009; 11: e40. doi: 10.2196/jmir.1270
79. Agyapong VI, Rogers C, Machale S, et al. Factors predicting adherence with psychiatric follow-up appointments for patients assessed by the liaison psychiatric team in the emergency department. *Int J Psychiatry Med.* 2010; 40: 217-228. doi: 10.2190/PM.40.2.g

80. Gonzalez J, Williams JW, Noel PH, et al. Adherence to mental health treatment in a primary care clinic. *J Am Board Fam Pract.* 2005; 18: 87-96.

81. Schrank B, Sibitz I, Unger A, et al. How use patients with schizophrenia the internet: Qualitative study. *J Med Internet Res.* 2010; 12: e70. doi: 10.2196/jmir.1550

82. Koivunen M, Välimäki M, Pitkänen A, et al. A preliminary usability evaluation of Web-based portal application for patients with schizophrenia. *J Psychiatr Ment Health Nurs.* 2007; 14: 462-469. doi: 10.1111/j.1365-2850.2007.01111.x

83. Depp CA, Moore RC, Perivoliotis D, et al. Technology to assess and support self-management in serious mental illness. *Dialogues Clin Neurosci.* 2016; 18: 171-183.

84. Cain AE, Depp CA, Jeste DV. Ecological momentary assessment in aging research: A critical review. *J Psychiatr Res.* 2009; 43: 987-996. doi: 10.1016/j.jpsychires.2009.01.014

85. Frank JR, Mungrue R, Ahmad Y, et al. Toward a definition of competency-based education in medicine: A systematic review of published definitions. *Med Teach.* 2010; 32(8): 631-637. doi: 10.3109/0142159X.2010.500898

86. Accreditation Council on Graduate Medical Education. Common Program Requirements. Website: https://www.acgme.org/acgmeweb/Portals/0/PAAssets/ProgramRequirements/CPRs2013.pdf. Accessed June 1, 2018.

87. Royal College of Physicians and Surgeons, CanMEDS Framework. Website: http://www.royalcollege.ca/portal/page/portal/rc/canmeds/framework. Accessed June 1, 2018.

88. Hilty DM, Crawford A, Teshima J, et al. A framework for telepsychiatric training and e-health: Competency-based education, evaluation and implications. *Int Rev Psychiatry.* 2015; 27: 569-592. doi: 10.3109/09540261.2015.1091292

89. Hilty DM, Maheu M, Drude K, et al. Telebehavioral health, telemental health, e-therapy and e-health competencies: The need for an interdisciplinary framework. *J Tech Behav Sci.* 2017. doi: 10.1007/s41347-017-0036-0

90. Maheu M, Drude K, Hertlein K, et al. An interdisciplinary framework for telebehavioral health competencies. *J Tech Behav Sci.* 2018. doi: 10.1007/s41347-017-0038-y

91. Hilty DM, Zalpuri I, Stubbe D, et al. Social media/networking as part of e-behavioral health and psychiatric education: Competencies, teaching methods, and implications. *J Tech Behav Sci.* 2018. doi: 10.1007/s41347-018-0061-7

92. Hilty DM, Chan S, Torous J, et al. A competency-based framework for psych/behavioral health apps for trainees, faculty, programs and health systems. *Acad Psychiat.* In Press.

93. Capon H, Hall W, Fry C, et al. Realising the technological promise of smartphones in addiction research and treatment: An ethical review. *Int J Drug Policy.* 2016; 36: 47-57. doi: 10.1016/j.drugpo.2016.05.013

94. Istepanaian RSH, Zhang YT. Guest editorial introduction to the special section: 4G health – the long-term evolution of m-health. *IEEE Trans Inf Technol Biomed.* 2012; 16: 1-5. doi: 10.1109/TITB.2012.2183269

95. Bahga A, Madisetti VK. A cloud-based approach for interoperable electronic health records (EHRs). *IEEE J Biomed Health Inform.* 2013; 17: 894-906. doi: 10.1109/JBHI.2013.2257818

96. Pullier MR, Daviss S. A call for a digital health consortium. *J Tech Behav Sci.* 2017; 1: 16. doi: 10.1007/s41347-017-0011-9