

Technology-based interventions in health care

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There are several converging forces that create a particularly opportune time for technological solutions to enhance cost efficiency in healthcare. Health care costs are unsustainable, yet many patients do not have adequate access to state-of-the-art treatments or to ongoing disease management. Consumerism is an increasingly powerful force in healthcare and the emphasis on personalised medicine will help to define future research and clinical treatment strategies. At the same time, the phenomenal advances in internet utilisation and mobile device applications provide possibilities that have never before existed. We have reason to be very optimistic about these opportunities, but appropriate research will be required to develop scalable and sustainable methods as well as determine expected outcomes.

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Introduction

There is enormous need to increase access, reduce disparities and create greater cost efficiencies in healthcare. This presents particular challenges in the area of mental illness, where inadequate public knowledge, lack of insight, stigma and inconsistent reimbursement, etc. add additional obstacles.

Estimates suggest that one out of every four people will experience a mental illness and that a substantial proportion never receive treatment. Among those who are diagnosed and treated, there are often inordinate and costly (from a disease and societal perspective) delays, not just for weeks or months, but in many cases years (Compton *et al.* 2007). In addition, many chronic and severe mental illnesses (such as schizophrenia and bipolar disorder) have their onset in late adolescence or early adulthood adding another array of challenges for early detection and intervention (Kessler *et al.* 2007). When examining the leading causes of disability or loss of quality adjusted life years, mental illnesses and addictive disorders account for an enormous share (Murray & Lopez, 1996). This is a consequence of not only their prevalence and severity, but also the inconsistencies in access to quality care.

It has also become increasingly clear that a disproportionate share of medical expenditures are driven by a relatively small proportion of patients with

co-morbid medical and psychiatric conditions as well as psychosocial and environmental obstacles to consistent and coordinated care. Increased emphasis on a true integration of primary medical and psychiatric care has been a missed opportunity for many years, but it is possible that the Affordable Care Act which became law on 23 March 2010 will provide better and broader coverage to those affected and create enhanced incentives for optimum integration.

It is in this context that we need to consider the role of technology in improving the efficiency and effectiveness of systems of care (Steinhubl *et al.* 2013). For the purposes of this discussion, we will consider technologies which assist: the patient (and family or caregiver); the treating clinicians; the hospital, clinic (or other healthcare setting); and the payer. In addition, we can divide the domains of interest into: screening and access to services; treatment delivery and monitoring; patient self-assessment and disease management; and quality assurance/performance improvement.

High-throughput screening

The availability of web-based screening tablet or smart phone apps, which can allow large numbers of people to review their own subjective wellbeing and illness symptoms in a user friendly and non-intrusive fashion is an enormous potential asset in the struggle for more timely identification of mental illness (Ben-Zeev, 2012). Web-based surveys can be applied in schools and universities, by large employers and other organisations interested in increasing the early identification and treatment of those with psychiatric

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and addictive disorders (Loewy *et al.* 2012). The use of self-administered screening tools with mobile devices or a computer kiosk when making a visit to a primary care physician or specialist can help to screen large numbers of individuals without imposing on precious time with health professionals. Thresholds can be established for brief interventions and referral. The screening, brief intervention and referral to treatment (SBIRT) model which has been widely used in substance abuse is an example (Fleming *et al.* 2002).

Such surveys can also provide links to psychoeducational web sites and other resources. The availability of accurate, evidenced based information on the web is another challenge (Birnbau *et al.* in press). Prospective patients can be vulnerable to all types of misinformation and screening tools need to be linked to appropriate resources. The use of such tools also allows for epidemiologic surveys which can be conducted in real time and provide estimates of prevalence, severity and other metrics. These data can of course be helpful in public health planning, resource allocation, etc. as well as monitoring the success in linking people in need to appropriate resources.

There are initiatives underway to screen social media communications in order to identify bullying or various types of psychopathology (*New York Times*, 2013). This raises a number of ethical issues, but much of social media is public and, therefore, this is a natural outgrowth of such phenomena.

Treatment delivery and monitoring

There are widespread shortages of well-trained mental health personnel, particularly in areas such as child and adolescent or geriatric psychiatry. The use of telemedicine can offer considerable advantages in terms of increasing access and efficient use of practitioners' time. Even with those patients who are experiencing a psychotic episode, live, two-way video has been shown to be acceptable and reliable, with little or no decrement in the clinician's ability to accurately assess the nature and severity of relevant signs and symptoms (Zarate *et al.* 1997; Shen *et al.* 2008). From the perspective of the health care system, reducing the need for 24 h a day, 7 days a week, in-person coverage of emergency rooms in many community hospitals can reduce expenses substantially. Utilising two-way video in those circumstances where leaving the home is an impediment to seeking and receiving services, e.g., post-partum depression, agoraphobia, etc. can also help to reach those people who would otherwise be difficult to engage or retain in treatment. In addition, it has been suggested that a substantial proportion of office visits do not require face-to-face interaction and could be done via two-way video, particularly in

psychiatry. This could reduce the costs and inconvenience associated with travel, facilitate off-hour visits which might be more convenient for many who have difficulty taking time off from work, and, thereby, reduce the rate of no-shows and cancelled appointments. Office visits can also be reduced when large numbers of patients can be tracked by mobile devices with abnormalities or significant changes in their conditions relayed to their clinicians with the potential for text messages, e-mails, telephone calls or links to instructional web sites reducing the potential need for an office or clinic visit.

The lack of consistent availability of practitioners to deliver specific types of therapy, such as cognitive behaviour therapy or family and patient psychoeducation for patients suffering from schizophrenia (Gottlieb *et al.* 2013), can be addressed by providing web-based tools for patients to access and utilise at their own convenience, thereby reducing need for practitioner time as well as increasing overall access (Rotondi *et al.* 2010). Though concerns have been raised about diminishing the clinician patient relationship, such options serve to extend clinicians' reach and empower patients to do as much as possible on their own with necessary backup from professionals. In addition, it can improve access to evidence-based techniques that vary in availability depending on geography, etc.

There is certainly considerable demand on the part of consumers for health and wellness resources, which suggests the acceptability of such technological approaches; however, there is also an important concern as suggested previously that such resources need to be designed and/or vetted by responsible professionals or oversight bodies. As suggested by Steinhubl *et al.* (2013), there are tens of thousands of healthcare related apps available for download, whereas the food and drug administration (FDA) has reviewed approximately 100. This raises the concern that apps might be made available to patients which are not necessarily helpful and might even be harmful (Wolf *et al.* 2013). It is incumbent upon academic medicine and professional societies as well as state and federal agencies responsible for overseeing healthcare to be proactive in assuring that technological advances live up to their potential, while at the same time reducing risks associated with irresponsible and non-evidence-based applications.

Patient self-assessment and disease management

If patients can facilitate their own diagnoses and monitor their own illnesses as well as access and benefit from treatments that lend themselves to self-administration, the implications for cost efficiency and personalisation are enormous. It is very difficult

for clinicians to have an accurate picture of the severity and frequency of various subjective experiences. Experience sampling or ecological assessment methods can be used on a broad scale to create real time data that are useful in establishing and confirming diagnosis as well as monitoring response to treatment and the natural history of untreated illness. Hence mHealth (mobile health) technologies can enhance consumer convenience and satisfaction while at the same time empowering patients to participate in the management of their own condition and facilitating better control over chronic illnesses (Swendsen *et al.* 2011). For clinics and health care systems as well as payers, the ability to reduce the risk of relapse or exacerbations and the resultant increase in the use of expensive emergency services or inpatient hospitalisation is of enormous potential importance. Monitoring patients in real time (passively or actively) with mobile devices can provide early signs to caregivers or health professionals, which can be used to trigger an intervention that might prevent or at least delay the need for increasingly costly levels of care (Spaniel *et al.* 2008). This provides personalised monitoring well beyond the intermittent visits to a clinic or office.

Numerous studies across healthcare and especially in the management of psychiatric disorders have identified the actual taking of medication as prescribed as one of the major challenges in promoting public health. Non-adherence plays a tremendous role in precipitating avoidable visits to emergency departments and unnecessary hospital admissions. Osterberg & Blaschke (2005) in their comprehensive review of this topic, suggested that, of all medication-related hospital admissions in the USA, 33–69% are due to poor medication adherence, with a resulting cost of approximately \$100 billion per year. The inability of either patients or physicians to accurately estimate the degree of adherence is limited. Existing methods that are the simplest (questioning the patient or having them complete a self-assessment form) tend to be inaccurate, whereas those that are potentially more accurate (blood levels, urine markers, etc.) tend to be intrusive, costly and not easily scalable. The new digital health technologies such as the 'digital health feedback system' (Kane *et al.* 2013) offers tremendous advantages. In this approach, a digital tablet consisting of the patient's medication with an ingestion sensor that is embedded in each tablet and activated by stomach fluids after ingestion allows for a unique signal to be communicated from the sensor to an adhesive receiver worn on the torso which automatically logs the date and time of each ingestion. The wearable sensor can also collect data on activity levels and physiologic measures such as heart rate. Such a system can provide valuable information to carers and clinicians, but of equal importance

can provide the patient with data to help empower and inform their own efforts at disease management.

Quality assurance and performance improvement

As healthcare reform places more and more emphasis on linking quality of care, patient satisfaction and better outcomes to actual payments for services, the need to monitor these domains in a seamless, meaningful, consistent and inexpensive fashion is of greater importance than ever. The capabilities that new technologies bring to this effort are enormous. Patients' symptoms, well-being and overall level of functioning can be tracked in real time with appropriate data capture and analysis providing needed metrics to all components of the healthcare system. Patient (and family/caregiver) satisfaction can be obtained with greater ease than ever before. The ability to aggregate and analyse large data sets to inform service development and delivery, resource allocation, physician (and other health professional) continuing education, patient and family education can add enormously to the overall success and cost-effectiveness of the health care enterprise.

Summary and conclusions

Clearly, we are in the midst of one of the great transformations in health care. The use of new technologies has the potential to alter every component of the health care enterprise while enhancing quality, fostering patient convenience and empowerment and at the same time reducing overall costs.

The ways in which we take advantage of this opportunity, including the thoroughness and thoughtfulness of our ongoing research and evaluation will have a profound effect on the lives of present and future generations.

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