[Title page]

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Technological Innovations in Mental Healthcare: Harnessing the Digital Revolution

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Sarah Amani is a mental health nurse with a special interest in early intervention and youth mental health. Her recent work includes the co-development of mobile health apps, telehealth solutions and piloting the use of social media in mental health services.
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Mike Denis has recently joined Oxford AHSC/AHSN bringing successful experience in electronic medical records and patient health records design and leading an Oxford, Cambridge, London research informatics programme
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Chris Hollis has research grant funding from National Institute of Health Research, European Union and Shire Pharmaceuticals that is paid to his employing institution. He has no other competing interests.
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Jennifer Martin: None
Rebecca Cotton is employed by the Mental Health Network which receives funding from providers of NHS funded mental health services in England by way of membership fees. RC

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Summary

Digital technology has the potential to transform mental healthcare by connecting patients, services and health data in new ways. Digital online and mobile applications can offer patients greater access to information and services and enhance clinical management and early intervention through access to real-time patient data. However, substantial gaps exist in the evidence base underlying these technologies. Greater patient and clinician involvement is needed to evaluate digital technologies and ensure they target unmet needs, maintain public trust and improve clinical outcomes.

[Main body of text]

The digital revolution

Advances in technology and particularly mobile digital information and communication technology (ICT) continue at an exponential rate, making it possible to communicate, obtain information and access and buy goods and services in new ways. In 2013, 36 million adults in the UK (73%) accessed the Internet every day and 72% of all adults bought goods or services online [1]. Access to the Internet using a mobile phone more than doubled between 2010 and 2013 to 53%. 51% of UK adults now own a smartphone (almost doubled from 2011) and 24% own a tablet. 43% of adults now use the Internet to seek health related information, an increase from 18% in 2007 [1]. Significant sections of society are becoming increasingly familiar and comfortable with using technology for a wide range of transactions.

eHealth and mHealth (increasingly collectively referred to as "connected health") (see Table 1.) describe the delivery of health care by electronic means via the Internet using a variety of devices including mobile phones, remote monitoring devices and other wireless devices. These digital technologies can greatly improve access to mental healthcare and treatment adherence by enabling services to be delivered more flexibly and tailored to individual patient needs. Recent developments in sensor technology, on-line psychological therapy and remote video consultation, mobile apps and gaming all present real opportunities to engage and empower patients and create novel approaches to both assessment and intervention for mental health problems.

The drivers for technological transformation in mental health services

The growth in demand for mental healthcare exceeds available NHS resources, and this gap is likely to increase up to 2020. Cost pressures require that more is done for less and providers therefore must find innovative ways to deliver services. The UK Government's mental health strategy 'No health without mental health' [2] recommends the increased use of Information and Communication Technology (ICT) to improve care and access to services. UK Government initiatives such as 'Digital First' aim to reduce unnecessary face-to-

face contact between patients and healthcare professionals with NHS trusts encouraged to replace these unnecessary face-to-face contacts with video-based remote consultations. However, service users consistently report dissatisfaction with a 'top-down' one-size-fits-all approach. Connected health innovations have the potential to offer great flexibility and to be more patient-centred.

Digital Mental Healthcare

E-mental health is not just about technology, but represents a cultural change in mental healthcare by empowering patients to exercise greater choice and control. For example, the provision of on-line psychological interventions, potentially accessible 24/7, is increasing rapidly using synchronous video/voice or asynchronous text communication. Examples of providers to the NHS include *Xenzone* (www.xenzone.com), *PsychologyOnline* (www.psychologyonline.co.uk) and *Big White Wall* (BWW) (www.bigwhitewall.com)

Mental health professionals have historically been reliant on face-to-face consultations in clinic settings away from the normal lives of their patients. Mobile applications (hereafter 'Apps') are now available that allow patients to record their mood, behaviour and activities in real-time using well validated measures such as the PHQ-9 depression scale. Patients can track their condition using their own mobile device over time and share this information with their clinician. Potential benefits to patients include greater engagement in their care and earlier detection of problems, more timely adjustment of treatment and shared decision making. Sensors such as accelerometers, gyroscopes, microphones and cameras, which are now standard parts of smartphones and other mobile devices, mean that it will be possible to continuously and passively collect objective data that can give additional insight into a person's behaviour and activities. For example, detecting subtle changes in sleep and activity patterns constitute important early warning signs of relapse and can prompt early intervention in depression and bipolar disorder[3].

In mental healthcare, assessment and diagnosis is still largely based on subjective clinical judgements about symptoms and behaviour. Technological innovations have the potential to bring more objectivity and reliability to these processes of assessment, diagnosis and monitoring. Affective Computing is a branch of computer science that aims to develop automated assessment of a person's mood by analysis of their facial expression, speech rate, and tone of voice [4]. Automated analysis of facial expression has been shown to

correspond closely with clinical ratings of depression [4] and could potentially augment clinical assessment in the near future.

ICT can also address issues such as social isolation and the relative inaccessibility of mental health services to young people. The rapid increase in popularity of social media platforms means that people are increasingly able to access information and support from peers and professionals in new and informal ways. Mental health problems disproportionately affect younger people, yet this group is also the biggest user of ICT; social media may widen access for groups who find it difficult to access traditional services.

It is critical, however, to consider the challenges of introducing new technology to mental healthcare. The so-called 'digital divide', describing a gulf between those who have ready access to computer and the Internet and those who do not, means that some groups of patients (e.g. older adults, persons who are homeless and people with intellectual disabilities) could experience barriers to accessing mental healthcare delivered using ICT. A study of mental health patients found that their use of technology (computers, mobile and smartphones) was similar to the general population, with older people reporting less familiarity, access and confidence with these technologies [5]. Older people experiencing psychosis report a significant desire to increase their use of computers, suggesting that a cost and skills gap, rather than indifference, is the reason for lower rates of computer usage [5]. Tailoring the device to the needs of the individual is particularly important, as witnessed by the rapid uptake of tablet devices by older people.

Data protection, privacy and security: Establishing public and patient trust.
Maintaining public trust when handling and sharing personal health data is paramount and this requires serious public engagement over issues of consent, data security and privacy. There is an even greater need to address these ethical issues in the field of mental healthcare as the data is often highly sensitive personal information. Although technological developments hold great promise, the lessons from the aborted initial roll out of *Care.data* by NHS England [6] demonstrate that public acceptance and adoption to scale are unlikely unless steps are taken to safeguard the legal and ethical rights of the public and patients.

mHealth Apps
The last five years have seen a rapid increase in the number of mHealth Apps, including many targeted at mental health and wellbeing. Some of these are aimed at healthcare

professionals but the majority are targeted at the general public although many are developed without significant user (patient or clinician) involvement [7]. The majority of Apps are sold via commercial marketplaces but the NHS has also established a health apps library, which contains (as of 1st April 2014) 17 Apps categorised under mental health although the safety and efficacy of many of these appears unproven.

The rapid emergence of Apps combined with the relative low cost and speed with which they can be developed and placed on the market, has resulted in the NHS and regulatory bodies struggling to keep pace with the evolving field of mHealth. Guidance on the regulatory requirements for mHealth Apps was only published by The Medicines and Healthcare products Regulatory Agency (MHRA) in March 2014 [8] and NHS England is currently working with the US Food and Drug Administration on a bilateral framework for regulation of mHealth Apps. Evaluating the safety and efficacy of m-health interventions should be subject to the same rigour as evaluations required for new drug or psychological treatments.

Some examples of Apps that have been developed for mental health include *ClinTouch (*www.clintouch.com), *My Journey* (www.sabp.nhs.uk/eiip/app), *Buddy App* (www.buddyapp.co.uk) and *WellHappy* (apps.nhs.uk/app/wellhappy/). Typically, these Apps include a symptom tracker and diary function, appointment and medication reminders and motivational prompts. These examples have been developed with user and clinician involvement and incorporate evidence-based principles of care (e.g. early-intervention improves outcome in psychosis). Although early-stage pilot evaluations suggest that these Apps are safe and their use is acceptable to patients and clinicians, further research is needed to demonstrate clinical and cost-effectiveness at scale in routine NHS settings. The task of building an evidence base and framework for evaluating the rapidly increasing number of mHealth Apps and other digital products is being led by NIHR MindTech Healthcare Technology Co-operative and should be a priority area for NHS applied health research.

The 'Big Data' Challenge for Mental Health

Digital health technologies, including, electronic medical records, imaging, e-prescribing and the increasingly prevalent use of connected devices to monitor health, have the potential to

generate large amounts of data that could be of considerable benefit to researchers and policy makers.

There are three processes required to achieve these benefits: unlocking value in electronic medical records (EMRs); new forms of records that allow direct inout/access from patients (Patient Health Records, PHRs); and pervasive computing and connected devices (mHealth) to enable expansion of the 'real-time' patient data.

Increasingly data accessed through the EMR is being used within clinical, epidemiological and public health research. In each case use of the EMR enables scaling of such studies; sometimes by orders of magnitude in both size and speed. Challenges to the use of the EMR in such research are not trivial and include technical (can data be accessed and linked- in a format that enables analysis from multiple data sources?), governance (security, privacy, access control) and scientific (is the data of sufficient quality?). However, these challenges are being met both for meta-data such as diagnosis and hospital episodes and patient level data including complex text or narrative data [10]

An example of the use of complex EMR data is the Case Records Interactive Search (CRIS) system established by the Maudsley Biomedical Research Centre in London [10]. CRIS allows researchers to view de-identified records, provided research studies are approved by an oversight committee with full user engagement. The system has been used in many studies, an example being the extraction of data from a single NHS Trust to show substantially increased mortality in people with serious mental illness [9].

Conclusion

Despite the clear potential of digital technology to connect people and health data in new ways, there is currently insufficient evidence to suggest that this potential is being fully realised, with uptake being limited and outcomes being largely anecdotal and unpublished. There are a number of key challenges; first, ensuring that patients and their needs remain at the centre of technology development and implementation; second, rapidly increasing the evidence-base for the clinical effectiveness of digital technology; third, ensuring that the opportunity provided by data sharing between patients, carers and clinicians doesn't threaten privacy and undermine public trust. Finally, patients, clinicians and NHS

commissioners require an agreed framework to evaluate the core features of new technologies including usability, content, safety, clinical- and cost- effectiveness.

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Table 1. Definitions in Digital Healthcare

eHealth: the transfer of health resources and health care by electronic means [1].

It encompasses three main areas:

- The delivery of health information, for health professionals and health consumers, through the Internet and telecommunications.
- Using the power of IT and e-commerce to improve public health services, e.g. through the education and training of health workers.
- The use of e-commerce and e-business practices in health systems management.

m-Health (2]: medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices. mHealth involves the use and capitalization on a mobile phone's core utility of voice and short messaging service (SMS) as well as more complex functionalities and applications including general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), global positioning system (GPS), and Bluetooth technology.

E-mental health: the use of information and communication technologies (ICT) to support and improve mental health, including the use of online resources, social media and smartphone applications. Two types of e-mental health are commonly referred to; web interventions and mobile applications.

Telemental health: a subset of telehealth that uses videoconferencing technology to provide mental health services from a distance. It includes telepsychology, telepsychiatry, telemental health nursing and telebehavioural health.

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