

The role of self-care and the use of smart sensors in the UK's health provision

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Self-care is an inseparable part of maintaining health, recovering from acute illnesses and living with long-term conditions. The individual's health literacy, personal goals, circumstances and opportunities all play a part. Person-centred healthcare recognizes this and seeks to work with the patient to help them achieve the best outcomes. This paper explores the evidence regarding how two-way electronic data flows between patients and their general practice may contribute to self-care, and explores new systems being developed to facilitate such flows.

1. Introduction

One of the many challenges facing the National Health Service (NHS) today is to help the growing number of patients with long term conditions¹ (LTC) achieve the best possible health outcomes. At least 50% of consultations in primary care are about LTCs. As the population ages, as better treatment prolongs life and diagnoses are made earlier in the course of disease, the prevalence of LTCs is increasing, stretching inadequate NHS resources. Self-care plays an essential role in enabling these patients achieve their health goals and may be able to relieve some of the strain on the NHS and social care. There are many barriers standing in the way of optimal self-care but some solutions may lie in better use of technology. This paper discusses the clinical context in which technology may be used to achieve better health outcomes.

The General Practice Forward View² published by NHS England in April 2016 sets out core requirements for English general practice to meet in 2016/17 and investment to be made in technology. Allocations to Clinical Commissioning Groups (CCGs) for the provision of general practice information technology (IT) and (other) technology will increase by 18% and £45 million

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¹ Definition of "long term condition": a condition that cannot, at present, be cured but is controlled by medication and/or other treatment or therapies.

² *General Practice Forward View*. NHS England (2016) [accessed 6 December 2016 at <https://www.england.nhs.uk/gp/gpfv/>]

will be invested as part of a multiyear programme to support the uptake of online consultations. The plan also calls for more patients to book appointments, order prescriptions and access their detailed medical records online and the development of a national library of approved apps to support clinicians and patients. There are “aspirations” to work with the supplier market “to create a wider and more innovative choice of digital services for general practice”.

However, with current pressures on GP services for more patient consultations with a static workforce and unfilled GP vacancies, it will be a challenge to find consultation time to address the personal preferences and capabilities of individual patients and provide the education and support required to enable patients to make the best use of new technologies.³ The Department of Health has estimated that in England, LTCs account for 50% of all GP appointments, 64% of outpatient appointments and 70% of hospital bed-days.⁴ In England, in 2013/4 the average consultation length was 9.2 minutes,⁵ and on average, each consultation dealt with 2.5 different issues.⁶

2. The digitally and technologically enabled patient

Building on research commissioned by NHS England, in 2016 the Nuffield Trust published *The Digital Patient: Transforming Primary Care*, reporting on how professionals and policy makers can make the most of the potential of new technologies to improve patient care, and the impact on primary care.⁷ They focused on the following digital tools, most of which will directly support self-care:

Online technology

- Online sources of information and peer support—e.g., social media, online patient networks and health advice such as NHS Choices
- Support for online transactions—e.g., booking appointments
- Online access to medical records and care plans
- Online support for self-triage and professionally-led triage
- Technology for remote consultations—including e-mail and video exchange.

Monitoring technology

- Wearable technology (also called wearable gadgets), often providing tracking information related to health and fitness

³ M. Baker and H. Jeffers, *Responding to the Needs of Patients with Multimorbidity*. London: Royal College of General Practitioners (2016) [accessed 1 December 2016 at <http://www.rcgp.org.uk/policy/rcgp-policy-areas/integration-of-care.aspx>]

⁴ *Long Term Conditions Compendium of Information*. Department of Health (2012) [accessed 1 December 2016 at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/216528/dh_134486.pdf]

⁵ F.D.R. Hobbs, C. Bankhead, T. Mukhtar, S. Stevens, R. Perera-Salazar, T. Holt and C. Salisbury, Clinical workload in UK primary care: a retrospective analysis of 100 million consultations in England, 2007–14. *The Lancet* **387** (2016) 2323–2330.

⁶ C. Salisbury, S. Procter, K. Stewart, L. Bowen, S. Purdy, M. Ridd, J. Valderas, T. Blakeman and D. Reeves. The content of general practice consultations: a cross sectional study based on video recordings. *British Journal of General Practice* **63** (2013) e751–e759.

⁷ S. Castle-Clarke and C. Imison, *The Digital Patient: Transforming Primary Care?* The Nuffield Trust (2016) [accessed on December 2016 at <https://www.nuffieldtrust.org.uk/files/2017-01/the-digital-patient-web-final.pdf>]

- Apps designed to fulfil a particular purpose, often downloaded by a user to a mobile device
- Biosensors usually used for the detection of an analyte; they combine a biological component with a physicochemical detector.

One of the report's conclusions is that effective communication with patients is vital for successful patient engagement and health outcomes. Patients benefit from having a named contact to telephone, text or e-mail directly for help about day-to-day health issues of self-care, including the technology they are using. Many will choose a healthcare professional for advice but an experienced patient with a similar condition may also be very helpful.

3. Self-care for patients with long term conditions

Self-care includes making persisting changes to lifestyle such as weight loss, regular exercise, smoking cessation or reduced alcohol consumption; appropriate use of medication such as asthma inhalers, insulin or anti-Parkinsonian treatment; monitoring biological variables such as blood pressure, airways obstruction or blood glucose.

The availability of inexpensive, validated manometers has contributed to an increase in the proportion of GPs using self-monitoring for the diagnosis of hypertension. This has risen from 37% in 2011, when it was recommended in a new NICE hypertension guideline,⁸ to 58% in 2015.⁹ In asthma, self-monitoring of the severity of wheezing to adjust treatment and seek medical help is a routine part of self-care (see Box 1).¹⁰

Box 1: BTS/SIGN British Guideline on the Management of Asthma, 2016

Implementation in Practice: Commissioners and providers of services for people with asthma should manage. This should include strategies to proactively engage and empower patients and train and motivate professionals as well as providing an environment that promotes self-management and monitors implementation.

The electronic health record is one of the fundamental strengths of general practice in the United Kingdom.¹¹ The quality of the data and the potential for multiple healthcare professionals to write into the record through sharing of the record, supported by well-established IT primary care system suppliers, makes it an essential asset for high-quality patient

⁸ *Hypertension in Adults: Diagnosis and Management* (CG127) National Institute for Health and Care Excellence (2011) [accessed 1 December 2016 at <https://www.nice.org.uk/guidance/cg127?unlid=80569458620162252164>]

⁹ B.R. Fletcher, L. Hinton and E.P. Bray, Self-monitoring blood pressure in patients with hypertension: an internet based survey of GPs. *British Journal of General Practice* **66** (2016) e831–e837.

¹⁰ *British guideline on the management of asthma*. British Thoracic Society/Scottish Intercollegiate Guidelines Network (2016) [accessed 1 December 2016 at <https://www.brit-thoracic.org.uk/standards-of-care/guidelines/btssign-british-guideline-on-the-management-of-asthma/>]

¹¹ *Good Practice Guidelines for GP Electronic Patient Records* (v4). Royal College of General Practitioners, British Medical Association and Department of Health (2011) [accessed 6 December 2016 at <https://www.gov.uk/government/publications/the-good-practice-guidelines-for-gp-electronic-patient-records-version-4-2011>]

care. This is especially important to the management of complex long-term conditions, such as diabetes mellitus, integrated with complex social needs partly driven by changing demographics, particularly the aging population. Access to personal NHS electronic health records allows patients to remain up-to-date with laboratory test results, hospital reports and personal management plans; it provides feedback on the results of self-care and encourages better engagement by patients with their long-term healthcare. NHS England's goal is for at least 10% of patients to be using one or more online services from their GP practice by the end of 2016, rising to 20% by 2017/8.

4. The prevalence of long term conditions

*Analysis conducted by the College [RCGP] has shown that by the year 2025 the number of people living with one or more serious long-term conditions in the UK will increase by nearly one million, rising from 8.2 million to 9.1 million. Combined with the currently aging population, the increased prevalence of long-term conditions is having a significant impact on health and social care, and could cost general practice an extra £1200 million a year over the next decade.*³

Multimorbidity is generally defined as two or more LTCs that coexist independently in the same person. Estimates of the prevalence of multimorbidity vary depending upon which LTCs were included in the calculation. A retrospective study of approximately 100,000 adult patients across 182 practices in England in 2011 found that 16% of patients had multimorbidity, defined as two or more of the chronic diseases in the Quality and Outcomes Framework.¹² 58% had multimorbidity when a wider list of 114 chronic conditions was considered.¹³ In Scotland, in 2012 data on 40 LTCs in 1.75 million people in 2012 found that 23.2% of the population studied had multimorbidity.¹⁴

The prevalence of multimorbidity in the general population increases with age, female sex and social deprivation. In the 2011 study, the prevalence of two or more Quality and Outcomes Framework LTCs in over-75-year-olds was 44%. Patients in the most deprived quintile for deprivation were almost twice as likely to have multimorbidity as those in the least deprived quintile (odds ratio 1.91 [95% CI = 1.78 to 2.04] adjusted for age and sex).¹¹

5. Multimorbidity, the burden of illness

For many patients, the everyday challenge of living with one or more LTCs is *managing the burden of illness*. They may have to change their lifestyle to control their illnesses or adapt to limitations placed on them by their conditions or their treatment.

The best health outcomes in the presence of multimorbidity are only possible with considerable effort from patients, their caregivers and their extended social networks. Patients,

¹² *Quality and Outcomes Framework*. NHS Employers (2016) [accessed 6 December at <http://www.nhsemployers.org/your-workforce/primary-care-contacts/general-medical-services/quality-and-outcomes-framework>]

¹³ C. Salisbury, J.M. Valderas and A.A. Montgomery, Epidemiology and impact of multimorbidity in primary care: a retrospective cohort study. *British Journal of General Practice* **61**(2011) e12–e21.

¹⁴ K. Barnett, S.W. Mercer, M. Norbury, G. Watt, S. Wyke and B. Guthrie, Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross sectional study. *The Lancet* **380** (2012) 37–43.

or their caregivers, often have to monitor and manage their symptoms at home. This may include collecting and inputting clinical data into self-monitoring data collection booklets, which are commonly used in the management of diabetes and asthma.¹⁵

LTCs require patients to take prescribed medication to extend life and improve their quality of life. One study in 2015 reported that approximately 20% of patients with two conditions were prescribed four to nine drugs, and 1% of patients were prescribed ten or more drugs. For patients with at least six long-term conditions this increased to 48% and 42%, respectively;¹⁶ It is called polypharmacy and is associated with increased drug-related morbidity, adverse drug events, potentially inappropriate prescribing, and reduced adherence to treatment plans.¹⁷ A fifth of preventable hospital admissions are due at least in part to patients not adhering to their medication.¹⁸ Adhering to complex treatment regimens and coordinating multiple drugs can also contribute to the burden of treatment.¹⁹ The requirement for medication can be reduced by effective self-care, losing weight, adequate exercise, ceasing to smoke or reducing alcohol intake.

Effective self-care is time-consuming and calls for high levels of engagement, numeracy, literacy and, sometimes, technical knowledge. Manual dexterity and practical skills are often required. People who are frail or lack practical skills, are socially isolated, poorly educated, have low health literacy, are cognitively impaired, do not speak the local language, or have sensory or physical disabilities are disadvantaged. People who work three jobs to pay the rent may find it hard to meet to the requirements of multiple clinical guidelines. Such people will struggle to adhere to self-management recommendations, thereby risking poor outcomes.

6. Multimorbidity and person-centred care

Detailed, evidence-based guidelines have been developed for the management of many individual diseases and conditions.²⁰ Much less research has been done on optimizing health outcomes for patients with multimorbidity, and the suitability of individual disease guidelines for individual patients with multiple conditions is not always clear.²¹

The nature of the coexisting conditions that a patient has is important. For example, the likelihood of having a depressive illness is increased in the presence of physical LTCs. People

¹⁵ S.F. Mair and C.R. May, Thinking about the burden of treatment. *British Medical Journal* **349** (2014) g6680.

¹⁶ E. Wallace, C. Salisbury, B. Guthrie, C. Lewis, T. Fahey and S. Smith, Managing patients with multimorbidity in primary care. *British Medical Journal* **350** (2015) h176.

¹⁷ M. Duerden, T. Avery and R. Payne, *Polypharmacy and Medicines Optimisation*. King's Fund (2013) [accessed 6 December at <https://www.kingsfund.org.uk/publications/polypharmacy-and-medicines-optimisation>]

¹⁸ M. van den Akker and C. Muth, How common is multimorbidity? In: *ABC of Multimorbidity* (eds S.W. Mercer, C. Salisbury and M. Forton), pp. 5–7. Wiley Blackwell (2014).

¹⁹ K. Gallacher, G.D. Batty, G. McLean, S.W. Mercer, B. Guthrie, C.R. May, P. Langhorne and F.S. Mair, Stroke, multimorbidity and polypharmacy in a nationally representative sample of 1,424,378 patients in Scotland: implications for treatment burden. *BMC Medicine* **12** (2014) 151.

²⁰ *Guidance for Conditions and Diseases*. National Institute for Health and Care Excellence [accessed 6 December 2016 at <https://www.nice.org.uk/guidance/conditions-and-diseases>]

²¹ *Multimorbidity, Clinical Assessment and Management* (CG56). National Institute for Health and Care Excellence (2016) [accessed 6 December 2016 at <https://www.nice.org.uk/guidance/conditions-and-diseases/multiple-long-term-conditions>]

with both a physical LTC and depression tend to be less physically and socially active and less likely to comply with medical care than are people with physical conditions alone, impairing long-term health outcomes.^{22,23}

Multimorbidity also influences how the outcomes of medical care need to be assessed. Individuals assessed by health professionals to have equally severe diseases can vary widely in their symptoms and level of dysfunction and distress. Person-centred outcomes such as “wellbeing”, self-rated health status, quality of life and social functioning are as important to the individual as objective measures of disease progression. They can predict mortality more strongly than, and independently of, medical measures of disease risk or progression. Single disease guidelines can lead to multiple drugs prescriptions for patients who may have less to gain from them because their life expectancy may be limited by poor health or frailty. Individuals and their carers need appropriate information on their conditions, health services, benefits and risks of treatment and their options for self-care. There is a need for accessible, consistent and trusted information delivered through recognized sources designed to meet their needs. The aim is to produce a management plan shared between an engaged, informed patient and their health professionals that includes the patients’ preferences and capabilities for self-care.

This presents a challenge for primary care teams. During the average consultation of less than ten minutes most GPs only have time to offer an information-sourcing, doctor-led and solution-delivery consultation better suited to more acute, urgent problems. There is not time to embrace a holistic person-centred approach and, yet,²⁴

The aging population and the increased prevalence of chronic diseases require a strong reorientation away from the current emphasis on acute and episodic care towards prevention, self-care, and care that is well coordinated and integrated.

Evidence from studies that have looked at improving outcomes for patients with multimorbidity have reported consistent themes, summarized in the *Collaborative Care and Support Planning: Ready to be a Reality* report from the Royal College of General Practitioners (RCGP) in 2016:²⁵

- Shared decision making between patients and clinicians
- Proactive goal setting that reflects what is most important to the patient
- Use of multidisciplinary teams that draw on the expertise of a range of health and social care professionals as part of a coordinated approach
- Longer consultations
- Continuity of care with a named professional.

²² D. Osborn, G. Levy and I. Nazareth, Relative risk of cardiovascular and cancer mortality in people with severe mental illness from the United Kingdom’s General Practice Research Database. *Archives of General Psychiatry* **64** (2007) 242–249.

²³ F. Lespérance, N. Frasure-Smith, M. Talajic and M.G. Bourassa, Five-year risk of cardiac mortality in relation to initial severity and one-year changes in depression symptoms after myocardial infarction. *Circulation* **105** (2002) 1049–1053.

²⁴ C. Imison, C. Naylor, N. Goodwin, D. Buck, N. Curry, R. Addicott and P. Zollinger-Read, *Transforming our Health Care System: Ten Priorities for Commissioners*. The King’s Fund (2011) [accessed 1 December 2016 at http://www.kingsfund.org.uk/publications/articles/transforming_our.html]

²⁵ *Collaborative Care and Support Planning: Ready to be a Reality*. Royal College of General Practitioners (2016) [accessed 1 December 2016 at <http://www.rcgp.org.uk/care-planning>]

Similar recommendations have been made recently in the NICE Guidance *Multimorbidity: Clinical Assessment and Management*,²⁶ and the *Person-Centred Care Made Simple* report from the Health Foundation.²⁷

7. Digital exclusion

Not everyone who would benefit from self-care will choose to do it. It may not be a priority for them in their life. Some see the necessary lifestyle changes as impossible to achieve, or remain unconvinced that it will be worthwhile or effective.

Even motivated patients may not have the capacity to use technological tools that can help them self-care. Although currently 75% of the UK population go online for health information and 50% use the Internet for self-diagnosis²⁸—Fitbit is now the third largest publicly-traded digital health company,²⁹ and more than 165,000 health-related apps are on the market³⁰—many people feel excluded because they are not familiar with or able to use digital tools.

In 2016 the Office of National Statistics found that 10.2% of the general population of the UK had not used the Internet. Among people over 75 years of age only 32.6% were recent users of the Internet. Two thirds of women over 75 and 25% of people with disabilities had never used the Internet.³¹ Digital literacy and access to the Internet are linked to age and socio-economic status, exactly the demographic characteristics of people who are most likely to be living with long-term conditions. Of people who do not use the Internet, 49% are disabled, 60% have no educational qualifications and 57% are over 65 years of age.¹⁸

Enabling these groups of patients to make use of digital tools is not easy. The Good Things Foundation has had some success. The percentage of learners who feel they can manage their health increased from 65% before being introduced to online resources to 87% three months afterwards,²⁵ but such improvement requires sustained effort in community settings. It needs investment in training, infrastructure and committed staff. At a time when NHS finances are stretched there is a risk this agenda could be dropped. The *GP Forward View* promises funding “to support education and support for patients and practitioners to utilize digital services to best effect and impact—by December 2017”.³²

²⁶ *Multimorbidity: Clinical Assessment and Management* (CG 56). National Institute for Health and Care Excellence (2016) [accessed 1 December 2016 at <https://www.nice.org.uk/guidance/ng56/chapter/recommendations>]

²⁷ *Person-Centred Care Made Simple: What Everyone Should Know About Person-Centred Care*. The Health Foundation (2014) [accessed 1 December 2016 at: <http://www.health.org.uk/sites/default/files/PersonCentredCareMadeSimple.pdf>]

²⁸ *The UK: Your Partner for Digital Health Solutions*. Department of Health and UK Trade & Investment (2015) [accessed 6 December 2016 at <https://www.gov.uk/government/publications/the-uk-your-partner-for-digital-health-solutions/the-uk-your-partner-for-digital-health-solutions>]

²⁹ *Digital Health Funding: 2015 Year in Review*. Rock Health (2016) [accessed 6 December 2016 at <http://rockhealth.com/reports/digital-health-funding-2015-year-in-review/>]

³⁰ ‘What’s App Doc?’ The use of mobile health apps in primary care. Information Daily (2016) [accessed 6 December 2016 at <http://www.theinformationdaily.com/content/post/whats-app-doc-the-use-of-mobile-health-apps-in-primary-care/>]

³¹ *Internet Users in the UK 2016*. Office of National Statistics (2016) [accessed 28 March 2017 at <https://www.ons.gov.uk/businessindustryandtrade/itandinternetindustry/bulletins/internetusers/2016>]

³² *General Practice Forward View*. NHS England (2016) [accessed 6 December 2016 at <https://www.england.nhs.uk/gp/gpfov/>]

In the short term, patient engagement will be enhanced by:

- Professional support and encouragement
- Intuitive technology that is appropriate for a range of patient groups
- Changing patient expectations about the relevance of Internet and digital use to health—driven by focusing on scale first rather than minorities and improving the digital offer.

8. Online record access

Online access to electronic health records can play an important part in engaging patients in taking a more active role in their healthcare.³³ Online access is available to encoded information about diagnoses, laboratory test results, allergies, adverse drug reactions, immunization records and medication.³⁴ Some general practices also offer access to consultation records and clinical correspondence such as hospital reports. This service is actually currently available at 95% of GP practices in England although so far uptake by patients is slow: only 214,012 patients (0.4%) had registered for access to their records by June 2016.³⁵ Some hospital departments offer online access to key information through systems such as PatientView.³⁶ Patients have been able to book and cancel appointments at their GP practice and order repeat prescriptions online for several years and uptake is much greater. In June 2016 8,665,349 patients in England (15.0%) were registered to be able to order repeat prescriptions online.

Patients use record access to improve and monitor their health and their care, such as:

- To check laboratory results to self-monitor long term conditions;
- To look for specific data recorded by the practice about key medical information, including preferences about healthcare such as those relevant to palliative care;
- To read clinical correspondence between their GP and hospital consultants and prepare for hospital visits, which is especially helpful for patients with complex health problems who attend more than one out patient department or hospital;
- To read shared care plans for the management of long term conditions that they have agreed with their GP practice;
- To use portable access to the record on tablet computers or smartphones to share data and care plans with other health professionals in all health settings;
- To provide record access to family members and carers who are supporting the patient.

The uptake of online record access is hampered by a number of factors. They can be roughly divided into patient, technological and health professional. There are also reservations among general practice teams about providing record access in GP practices. The Royal College of General Practitioners explored the concerns of GP practice team members about record access; the results are summarized in Figure 1. Access to medical records and clinical

³³ Video of Graeme's Story. GP Online Services, NHS England (2016) [accessed 6 December 2016 at <http://www.nhs.uk/NHSEngland/AboutNHSservices/doctors/Pages/gp-online-services.aspx>]

³⁴ *Patient Online*. NHS England [accessed 1 December 2016 at <https://www.england.nhs.uk/ourwork/pe/patient-online/>]

³⁵ *NHS Digital Indicators*. Patient Online Management Information (POMI) [accessed 6 December at <https://indicators.hscic.gov.uk/webview/>]

³⁶ PatientView. Renal Information Exchange Group [accessed 1 December 2016 at <http://rixg.org/patientview2/>]

data is more likely to be used by those (or carers of those) in regular contact with their healthcare team.³⁷ The technology is not straightforward and can exclude the patients who could benefit most (see above).

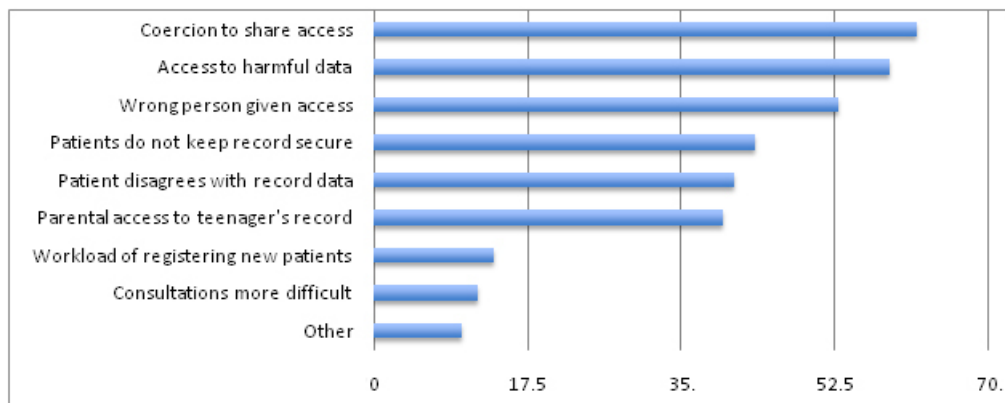


Figure 1. GP Practice Team Members' Perception of Risk from Patient Online Record Access. Percentage of 168 respondents reporting concerns (RCGP Survey August 2016, unpublished)

Patients may need help to understand the data in their record. A report on health literacy from the Royal College of General Practitioners published in 2014 emphasized that it is essential for doctors to make careful use of effective communication skills when they convey information to their patients, and back up verbal messages with information leaflets or documents provided in a format (on paper or electronically) that the patient finds accessible.³⁸ There are reliable sources of health information online, such as the very flexible Information Prescription Service on the NHS Choices website³⁹ or Lab Tests Online, which is available in a number of languages⁴⁰ or via a mobile app.

9. Monitoring technology

Monitoring technology has been used in ambulatory healthcare for many years by GPs, community nurses and in hospital outpatient care. Monitoring devices may be active, where the patient operates the device (such as pendant alarms) or uses the data to monitor their condition

³⁷ J. Wyatt, S. Sathanandam, P. Rastall, J. Hoogewerf and D. Wooldridge, Personal Health Record Landscape Review: Final report. Royal College of Physicians (2015) [accessed 6 December 2016 at <https://www.rcplondon.ac.uk/projects/outputs/personal-health-record-phr-final-report>]

³⁸ *Health Literacy*. Royal College of General Practitioners (2014) [accessed 1 December 2016 at <http://www.rcgp.org.uk/clinical-and-research/clinical-resources/health-literacy-report.aspx>]

³⁹ *Create an Information Prescription*. NHS Choices [accessed 1 December 2016 at <http://www.nhs.uk/IPG/Pages/IPStart.aspx>]

⁴⁰ Lab Tests Online, global sites and mobile apps (2016) [accessed 6 December 2016 at <http://labtestsonline.org.uk>]

(e.g., blood-pressure checks) and manage their health, or passive, where the device is fitted and data is collected and sent back to a healthcare professional without any patient interaction (24 h ambulatory monitoring). Work is ongoing to explore ways of conveniently transferring health data from patients' devices to their GP records.⁴¹

Among the most commonly used devices for monitoring and diagnosing LTCs are weighing scales, peak expiratory air flow meters (to monitor airway obstruction in asthma), manometers (to monitor blood pressure), glucometers (to measure blood sugar levels), pulse oximeters (a noninvasive method for monitoring a person's blood oxygen saturation) and heart rate and rhythm monitors. They may be recommended by a health professional or chosen by patients themselves.

There is evidence that information from the Internet and mobile devices enables patients to improve their diet, become more active, lose body weight/fat, reduce tobacco use and cut excessive alcohol use.^{42–44} This may reduce demand on health services, although as yet the evidence is not strong.⁴⁵ There are indications that individuals' engagement with wearables diminishes over time.⁴⁶ Many of the trials have only reported on follow-up for as little as six months; there is as yet limited evidence on long-term outcomes.²⁷

The challenge for healthcare professionals is to realize the benefit that may accrue to patients if they make effective use of monitoring technologies and to encourage each patient to focus on the sustainable behavioural changes that will be most useful to them. This requires a person-centred care approach, which uses every opportunity to help patients self-care.

The difficulty that could confront health and social care commissioners if the use of such technologies becomes widespread, especially those that support assisted living, is that the supporting evidence (including evidence of effectiveness) requires complex evaluation of both health and social impacts of the intervention. Combined with the fast-paced nature of the evolution of technology, these factors make decision-making and planning difficult.⁴⁷ Of course, the financial burden of providing the technology to support living may fall to the patient

⁴¹ Smartphone tech signals white coat syndrome solution. EMIS Health Ltd (2016) [accessed 6 December 2016 at <https://www.emishealth.com/news-events/news/smartphone-tech-signals-white-coat-syndrome-solution/>]

⁴² M. Casey, P.S. Hayes, F. Glynn, G. O'Laighin, D. Heaney, A.W. Murphy and L.G. Glynn. Patients' experiences of using a smartphone application to increase physical activity: the SMART MOVE qualitative study in primary care. *British Journal of General Practice* **64** (2014) e500–e508.

⁴³ Mobile technology may help people improve health behaviors. American Heart Association (2015) [accessed 6 December 2016 at <http://newsroom.heart.org/news/mobile-technology-may-help-people-improve-health-behaviors>]

⁴⁴ Internet and mobile devices prompt positive lifestyle changes. American Heart Association (2016) [accessed 6 December 2016 at <http://newsroom.heart.org/news/internet-and-mobile-devices-prompt-positive-lifestyle-changes>]

⁴⁵ M. Bardsley, A. Steventon and H. Doll. Impact of telehealth on general practice contacts: findings from the whole systems demonstrator cluster randomised trial. *BMC Health Serv. Res.* (2013) [accessed 6 December 2016 at <http://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-13-395>]

⁴⁶ D. Ledger and D. McCaffrey. *Inside Wearables*. Endeavour Partners (2014) [accessed 6 December 2016 at: <http://endeavourpartners.net/assets/Endeavour-Partners-Wearables-White-Paper-20141.pdf>]

⁴⁷ T. Greenhalgh, T. Shaw, J. Wherton, G. Hughes, J. Lynch, C. A'Court, S. Hinder, N. Fahy, E. Byrne, A. Finlayson, T. Sorell, R. Procter and R. Stones. SCALS: a fourth-generation study of assisted living technologies in their organisational, social, political and policy context. *BMJOpen* **6** (2015) e010208.

and their family; the evidence base regarding which devices are effective may not be the most important factor in their decision-making. Even the simplest and most intuitive health advice may be controversial.⁴⁸

Health professionals also have concerns about the numbers of devices and apps already available on the market, and the numbers are steadily increasing.^{49,50} Some of their legitimate questions are:

- Are the data they produce accurate and consistent?
- Is the advice offered by devices or apps sound and are patients encouraged to make appropriate lifestyle changes?
- Can the data be uploaded into health record systems safely and effectively?
- Is the personal health data of patients stored securely and used ethically and legally by the device and app suppliers?
- Might they be held responsible for adverse outcomes that may occur if they engage with a patient who has chosen a device or app to rely on?
- Will they be inundated with data by the “worried well”?

Accreditation of apps has proven to be problematical. The Royal College of Physicians have advised that doctors should only recommend medical apps that have a CE mark;⁵¹ most do not have such “accreditation”, which is anyway self-affirmed by the manufacturer. The Health Apps Library originally hosted on NHS Choices was closed down in October 2015 amid concerns about the security of patient data associated with some apps.

Alternative models of accreditation are being explored. In August 2016 the Medicines and Healthcare Products Regulatory Agency updated their guidelines on when medical apps and devices require a CE mark,⁵² and in September 2016 Jeremy Hunt, the UK Secretary of State for Health, announced that a new NHS library for apps and wearables would open in March 2017.

10. Summary and conclusions

Patients and health professionals alike are interested in apps, biosensors and wearables that can be used to monitor markers of health and illness, because they can help engaged patients make persistent behavioural changes that will improve their health outcomes. This also has the prospect of reducing the burden of illness on both the patient and the NHS.

However, there are many barriers that must be overcome before this technology becomes a routine part of everyday healthcare. Digital exclusion, poor health literacy, disability and access

⁴⁸ 10,000 steps a day is a meaningless fitness goal, says science. BBC (2017) [accessed 22 February 2017 at <http://www.bbc.co.uk/newsbeat/article/39041576/10000-steps-a-day-is-a-meaningless-fitness-goal-says-science>]

⁴⁹ Mobile and app news in brief. Digital Health (2016) [access 6 December 2016 at http://www.digitalhealth.net/digital_patient_48194/mobile-and-app-news-in-brief]

⁵⁰ *Using Apps in Clinical Practice Guidance*. Royal College of Physicians (2015) [accessed 6 December 2016 at <https://www.rcplondon.ac.uk/news/rcp-issues-new-guidance-using-medical-apps>]

⁵¹ *Using Apps in Clinical Practice Guidance*. Royal College of Physicians (2015) [accessed 6 December 2016 at <https://www.rcplondon.ac.uk/guidelines-policy/using-apps-clinical-practice-guidance>]

⁵² Medical Device Stand-Alone Software Including Apps. Medicines and Healthcare Products Regulatory Agency (2016) [accessed 6 December 2016 at <https://www.gov.uk/government/publications/medical-devices-software-applications-apps>]

to the technology pose problems that will not be easily surmounted. The patients who should benefit most, namely older patients with multimorbidity, disabilities and poor technical skills, are maybe the least able to take advantage of new technologies.

Most health professionals are not well-informed about all the types of devices and apps currently available and are uncertain which of them, in the absence of independent accreditation, they can safely recommend or work with. Nor do they routinely have the time to offer the personalized care often necessary to help patients make the best use of them. They are also concerned about how to deal with the flood of data that they may receive from them.

Commissioners are concerned about the potential costs and lack of evidence of long-term benefit and impact on the healthcare system.

The NHS may not have the resources, despite current investment plans, to overcome the danger of digital exclusion. The help of social and educational service, the voluntary sector and commercial suppliers of the technologies will be necessary to realize the potential of these nevertheless exciting new technologies.