Review Article

DIGITAL HEALTH

Digital Health
Volume 2: 1–41

DOI: 10.1177/2055207616678498
dhj.sagepub.com

SAGE

'Pushed' self-tracking using digital technologies for chronic health condition management: a critical interpretive synthesis

Heather Morgan

Abstract

Introduction: Health policies internationally advocate health services provider support for health services users' 'self-management' of chronic health conditions. Digital technologies are beginning to have a role in delivering such support. 'Pushed' self-tracking of health-related information, including imposed measurement of biomedical and behavioural data, is one approach; however, there is little systematic or discursive research. The aim of this research was to explore factors relevant to the implementation of 'pushed' self-tracking technologies into support for self-management of chronic health conditions interventions.

Methods: This paper reports a critical interpretive synthesis of studies involving 'pushed' self-tracking using digital technologies to support the self-management of chronic health conditions. The review systematically identified relevant literature, characterised the technologies and discursively explored their implementation and impacts, and human technology interactions.

Findings: The literature ($n = 83$), including 'simple' ($n = 51$) and 'complex' ($n = 32$) interventions, perhaps unsurprisingly, concentrates on technical and clinical rather than sociological and behavioural perspectives, which limits understanding. Some attention is paid to experiences and views of providers and users about digital technologies implementation and impacts on the delivery of care, for example: consequences of having increased information; compatibility with current systems; implications for personnel; and human—technology negotiations.

Conclusions: This is a rapidly developing field and early technical and clinical insights are useful. There are opportunities for researchers to explore the sociological and behavioural aspects, and ethical challenges, of implementing 'pushed' self-tracking support programmes too. Detailed multidisciplinary research is needed to understand and guide technical and medical developments that integrate digital technologies into the delivery of care.

Keywords

Digital technologies, chronic health conditions, self-management, self-tracking, health monitoring

Submission date: 19 April 2016; Acceptance date: 18 October 2016

Introduction

Health policies internationally advocate health services provider (health professional) support for health services users' (patients') 'self-management' of chronic health conditions.[1] Finding better ways to deliver healthcare is becoming critical as pressures on health service providers to support people are increasing as populations grow,[2] live longer and more people have one or more chronic health condition(s). Chronic health conditions somehow have to be managed over the longer term, but the sustainability of services is uncertain and makes this a challenging area for

Health Services Research Unit (HSRU), University of Aberdeen, UK

Corresponding author:
Heather Morgan, Health Services Research Unit (HSRU), 3rd floor, Health Sciences Building, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD, UK.
Email: h.morgan@abdn.ac.uk, Twitter: @hm_morgan

service organisations and providers. Supporting people to self-manage can reduce pressures on health services at the same time as empowering and working with service users as partners.[1]

Digital technologies are beginning to have a role in delivering or facilitating such support. Digital technologies for health (e.g. mobile health interventions, such as short messaging service interactions; electronic health records and systems; smartphone apps to manage conditions; and wearable devices to monitor lifestyle) are rapidly proliferating and show wide-ranging promise for health and disease management.[3,4] The array of available and emerging digital technologies can be useful for health services providers in the delivery of care across a variety of medical domains: for supporting health service users to self-manage specific conditions, as well as for promoting healthy lifestyles. They may help people to achieve and sustain healthier behaviours through increased access to and awareness of personal health-related data. Many of these technologies allow individuals to self-track, make records of and respond to a range of previously invisible biomedical and behavioural data.[5] In addition to personal benefits of use, they offer new platforms for health service organisations and providers to observe health service users' signs and symptoms through ''pushed'' self-tracking.[6]

'Pushed' self-tracking, i.e. when a person is asked to self-track and the self-tracking is imposed,[7] is one approach to supporting the self-management of chronic health conditions. Technologies are now being piloted in intervention programmes in clinical practice and early studies have started to show health service providers requesting that health service users employ them in order for them to supply detailed data as part of their care package. This is more visible in the area of supporting the self-management of chronic health conditions than in preventive care at present, but there is a strong and growing commitment to using digital technologies across health and social care services, which has been signalled globally.[8–12] Like the self-management approach, technologies are appealing because they may also offer innovative means for engaging and empowering health service users in their health and care.[13]

There is little systematic or discursive applied health research that investigates how acts of 'pushed' electronic self-tracking are assimilated into existing medical models, or how they impact the delivery of care and daily life for users. Building on previous work that explored support for the self-management of chronic health conditions more generally,[1] the aim of this research was to explore factors relevant to the implementation of 'pushed' self-tracking technologies into support for self-management of chronic health conditions programmes.

Methods

This paper reports a critical interpretive synthesis of published health services research/medical literature involving service-provided digital technologies used in the context of supporting the self-management of chronic health conditions, i.e. support provided or facilitated through 'pushed' self-tracking. This literature was drawn upon as a subset from within a larger body, which was originally identified for a review on the breadth of approaches to health and social care support for self-managing chronic conditions. For that review, support was broadly defined and included interventions involving 'pushed' self-tracking.[1] For this more specific review, the focus was on 'pushed' self-tracking technologies used to deliver or facilitate support only. The studies reflected on in this review were systematically identified in a new and independent process of determining inclusion/exclusion criteria for titles/abstracts and full text papers, and a fresh approach to the appraisal of included studies.

Search, review and analysis proceeded in sequence. Potential papers were identified by an Information Specialist who designed and executed searches for papers indexed on Medline, CiNAHL, SCI and ASSIA databases. Search strategies combined terms relating to chronic conditions with self-management, patient involvement or provider–user relationships and practitioners' perspectives. They covered internationally published literature between 2000 and 2014 (please see Appendix 1 for full details). Conventional systematic reviewing techniques were first re-applied to the entire selection ($n = 5246$) by one researcher. A systematic two-stage process of inclusion/exclusion of titles/abstracts and full-text papers was undertaken to identify literature relevant for this review and critical interpretive synthesis. Checking of decision making was undertaken by two senior colleagues and queries were resolved through regular discussion.

Inclusion

Papers reporting 'pushed' self-tracking for all/any chronic health conditions and all study types were included. There were no search restrictions on country/language (although the search was restricted to English alphabet only) and the definition of 'technology' was kept deliberately broad to include the range of technologies that can be described as digital. This was to allow inclusion of diverse technologies, such as mobile health interventions, electronic health records and systems, smartphone apps to manage conditions and wearable devices to monitor lifestyle, and to facilitate classification of and comparisons within and across technology types. 5246 titles and abstracts were

reviewed, first manually, line by line, and then by using keyword searches to ensure that no relevant articles were missed. Manual checking was supplemented with searches for the following keywords: surveillance, self-monitoring, technology, wearable, device, application, computer, web-based, virtual, mobile, digital, telehealth, telecare, electronic, self-tracking, equipment, online, smartphone, cellular, Internet, ehealth, mhealth.

Exclusion

Papers featuring technologies that were not self-administered, assistive technologies or medical devices for physical therapy (defined as 'electrical or mechanical devices designed to help people recover movement') were excluded.[14] So were reports of shared decision making. Intervention studies where the emphasis was on health service providers performing the measurement or doing the monitoring, without the visibility of the patient (so not self-administered and/or part of a self-management promotion/scheme, i.e. to collect clinical data rather than inform/engage the patient), and studies involving health service user gathering/using data without health service provider intervention were also excluded. So were text/SMS reminder interventions. There must have been clear active data collection/input from health service users. Interventions must have provided more than decision aid advice, e.g. by email.

Process

Full texts of papers for relevant titles/abstracts were retrieved and reviewed in full by one researcher, again in discussion with two senior colleagues, to determine final inclusion of studies, which were appraised using a reviewer developed data extraction form that focused on: setting; study type; chronic condition; specific population; self-administered health monitoring technology description and/or name; self-administered health monitoring technology purpose; self-administered health monitoring technology functions; how does it work?; users involved in design?; can it be tailored/personalised by user?; key findings.

A critical interpretive synthesis approach,[15] using conventional systematic review methodology combined with traditional qualitative inquiry, was applied to make sense of what is a complex body of literature. This approach is oriented to conceptual or theoretical development and allows for critical consideration of diverse studies and the research traditions and assumptions that have influenced them.[1] Included studies were coded and comparisons were made within and across studies to identify themes. Again, these were agreed through regular discussion with two senior colleagues.

An additional layer of categorisation occurred as a clear cut distinction between 'simple' and 'complex' technologies emerged. Papers that focused on self-monitoring of blood glucose (diabetes), home blood pressure monitoring (hypertension), peak flow (asthma) or equivalent, i.e. one objective outcome measure which is expected and disease-specific, were grouped as 'simple'. Studies that included responses to self-administered data collection and focused on data/outcomes including subjective measures, not just the condition (i.e. broader lifestyle), were grouped as 'complex'.

This process was inductive. The evidence synthesis focused on characterising the technologies and the critical interpretive synthesis considered the implementation of technologies and their impacts on the delivery of care.

This review complies with the ENTREQ statement on reporting the synthesis of qualitative health research.[16]

Findings

Inclusion/exclusion of papers

From a total of 5246 studies identified, a number of papers ($n = 5060$), i.e. those not referring to self-tracking technologies, self-management and chronic health conditions, were excluded at the title/abstract screening stage. The remaining 186 papers were reviewed in full. From the full-text papers, a further 103 were excluded. See the flow diagram in Appendix 2 for details on the review process.

Characterisation of technologies

83 papers reporting the use of digital technologies to support the self-management of chronic conditions through 'pushed' self-tracking were selected. 51 used objective measures related to monitoring a single biological variable/clinical marker related to a condition and were part of clinical kit and care 'upgrade' (e.g. self-monitoring of blood glucose in diabetes, electronic peak flow log in asthma). Analysis helped to identify these as a homogeneous category of studies as they featured condition-specific technologies incorporated into well-documented medical regimens typical for diabetes, hypertension, asthma and thromboembolic disorders, which were designed to provide or improve insights into clinically relevant information for the condition. These were labelled 'simple' and were only included in the initial analysis and then set aside.

The remaining 32 papers appeared heterogeneous by comparison and are the main focus for this paper because they offered new and interesting insights into a range of systems and/or complex interventions targeting multiple biomarkers and/or behaviours for a

broader range of chronic health conditions, including subjectively measured data. These studies involved the use of digital technologies (e.g. telephone-linked communications system; electronic portal accessed through smart devices; various peripherals to measure vital signs) to uncover previously invisible data in supporting the self-management of diabetes, asthma, chronic heart failure, migraine, schizophrenia, cancers, COPD and chronic health conditions more generally.[5] Similar or comparable systems appeared to be utilised for different conditions. They were labelled 'complex'. The criteria for characteristics for categorisation of digital technologies are detailed in Table 1.

This 'simple' and 'complex' classification was primarily a device for distinguishing between narrowly biomedically-oriented (objectively measured) and broader complex interventions (including subjective measures), and the need to acknowledge the importance of theoretical underpinnings, use of behaviour change techniques and measures of acceptability, which are expanded on below.

Although 'simple' interventions using technologies may have changed usual care packages and associated clinical interactions in some ways, the conditions concerned necessitated the particular monitoring featured. By comparison, literature relating to 'complex' interventions appeared more diverse and reported a range of examples of various new 'pushed' self-tracking technologies being implemented across a number of medical domains. The analytical focus is therefore on this set of 32 papers.

These 32 papers comprised 15 evaluations, 5 feasibility studies, 4 randomised controlled trials, 3 development studies, 2 descriptions, 2 commentaries and 1 systematic review. Of these, 7 expressly used qualitative methodologies (including 1 ethnography) and a further 4 incorporated interviews within the study. See the descriptive table in Appendix 3 for further details of individual studies.[17–48]

Detailed description of precise interventions and the purpose(s) of various components and functions of technologies, aside from 'innovation', often seemed limited, as did discussion of health services provider and user implications apart from the technical. Theoretical underpinnings tended to extend clinical, or technological, rather than behavioural or sociological, discussions, which limits understanding of these aspects.

The implementation and integration of these 'complex' systems into care and their impacts on the delivery of care were developed further within the analysis.

Table 1. Characteristics of the two categories for new health technologies.

'Simple' ($n = 51$)	'Complex' ($n = 32$)
Single target (clinical marker)	Multiple target (clinical markers and/or lifestyle behaviours, emotions)
Clear links between clinical marker and condition management	Less clear or unclear links between clinical or behavioural markers targeted and condition management and/or lifestyle
Part of regular clinical kit	Additional kit
Incorporated into existing medical regime	New (part of) medical and lifestyle regime
Medically-oriented technology	Social aspects to technology
Provided to all as medical necessity	Experimental use
Technologies/devices	Systems
Provided through health service	Provided through health service, but commercial versions available or uses commercial device to operate (e.g. user's own mobile phone/ laptop)
Health and social care professionals already familiar	New system requires health and social care professional training to implement
Developed by/for clinical use	Users involved in design and tailoring for integration into lifestyle
Clinically grounded	Theoretically diffuse
Underdeveloped theoretical basis (clinical not social)	*Underdeveloped theoretical basis (technical not social or behavioural)*

Implementation into the delivery of care

The implementation of digital technologies into the delivery of care had several impact points at multiple levels across a number of often overlapping areas. These areas did not seem related to the specific condition or technology. Key themes under which the data were organised are: consequences of having increased information; compatibility with current systems; implications for personnel; and human–technology negotiations. Included studies seemed focused on clinical (improved health outcomes) and technical (does it work?) concerns, even where social and behavioural factors were implicated. The emerging themes for health service organisations (Figure 1), health service providers (Figure 2) and health service users (Figure 3) have been visualised below as summaries of the key findings from across and within studies.

These categories are not neatly configured and there is a great deal of interaction, overlap and inconsistency between themes and the stakeholder groups. This is likely to be attributable to the heterogeneity of the included studies. However, they provide a useful framework for beginning to explore the impacts on the delivery of care and the critical interpretive synthesis approach is designed to make sense of a complex body of literature.

Impacts on the delivery of care

The impacts that digital technologies have on the delivery of health and social care can include what can be interpreted as both intended and unintended, positive and negative consequences. While there are broader, often overlapping and intersecting themes, the perspectives of health service organisations, providers and users can be compared and contrasted. Overall, the findings were often contradictory or inconsistent within and across categories. Some critical observations around consequences of having increased information, compatibility with current systems, implications for personnel and human–technology negotiations were noted.

Having increased information. There were often separate health service provider–user portals,[18,32] where different information was made available through different interfaces. Therefore 'having increased information' might not refer to the same information, meaning that organisations, providers and users were not necessarily 'on the same page'. In addition, technologies tended to collect structured rather than unstructured information,[20] sometimes resulting in limitations for supporting provider-user dialogues.[23] For health service providers, having data delivered on a daily basis could enable them to 'stay on top of things',[42] and some liked to review the information immediately prior to consultation.[37] For others, it caused tensions around how to respond compared with traditional, periodical, face-to-face appointments, where the 'rules of engagement' are well versed. These sparked trade-offs around distribution of time and resources.[34] Some providers saw additional information as a complement or extension to,[42,43] but not replacement for,[37] usual care practices.

For health service users, there seemed to be less provision of information than might be assumed or expected, despite interventions being self-administered and implying 'self'-tracking. It appeared that there was little personalised feedback/interpretation of data being provided,[21] although, where it was, being able to visualise changes was considered helpful.[28,47] Even then, having additional information did not necessarily equate with 'progress',[27] but progress was often quite narrowly defined in terms of improving quantities (metrics) rather than quality (engagement).[26] In one study, it was noted that having increased data increases honesty and improves clarity,[38] although sometimes professionals worried about patients' 'gaming' by trying to create false results or data that looks better (e.g. more exercise, healthier eating).[47] This could cause problems concerning trust.

Compatibility with current systems. Embracing new ways of working as a result of the using technologies was identified as a 'practice point' by health service providers in one study.[33] But providers' perceptions of integrating technologies did not always match those of the users.[45] According to one study, the technology should be offered as 'optional',[34] suggesting a perception of implementation sometimes considered 'compulsory' from a provider point of view. Some systems were designed to increase efficiency by preventing underdiagnosis.[17,18] In others, increased reporting of symptoms could be found.[19,29]

There were also concerns about obviating the need for routine interactions and having less human contact,[18,21] although this was linked positively with preventing health service users from having to make long journeys.[34] There were observed reductions in regular/scheduled appointments when service users were perceived to be able to 'manage' better through self-tracking.[38] While providers may have believed that users had better self-management, however, this might not have been the case.[24,37,45] As such, these technologies bring about some confusion about how services should be delivered, which do not necessarily fit with current conventions or expectations of service providers or users.

Implications for personnel. The changes technologies instigate challenge understandings of identity in

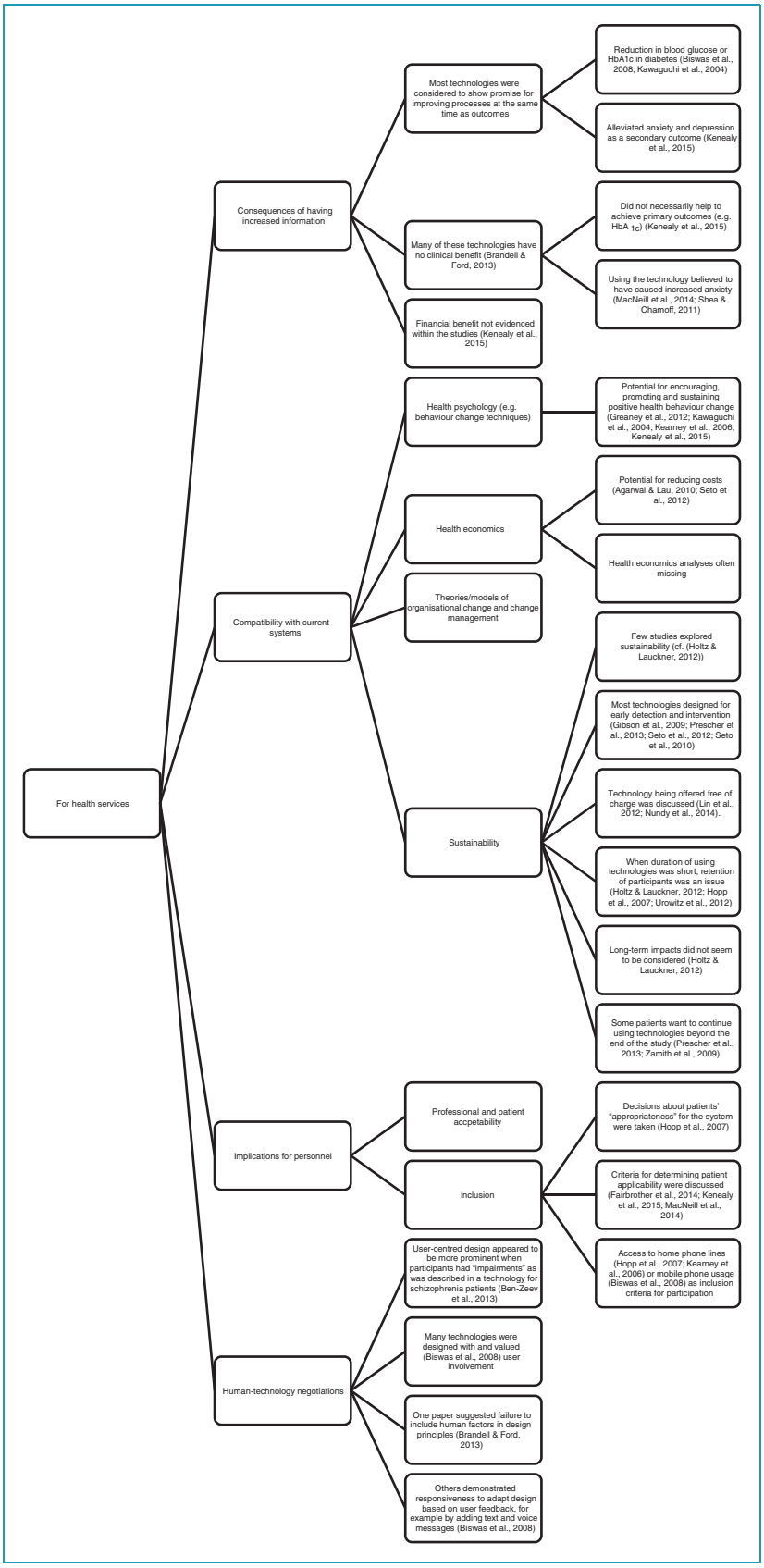


Figure 1. Impacts of implementation for health service organisations.

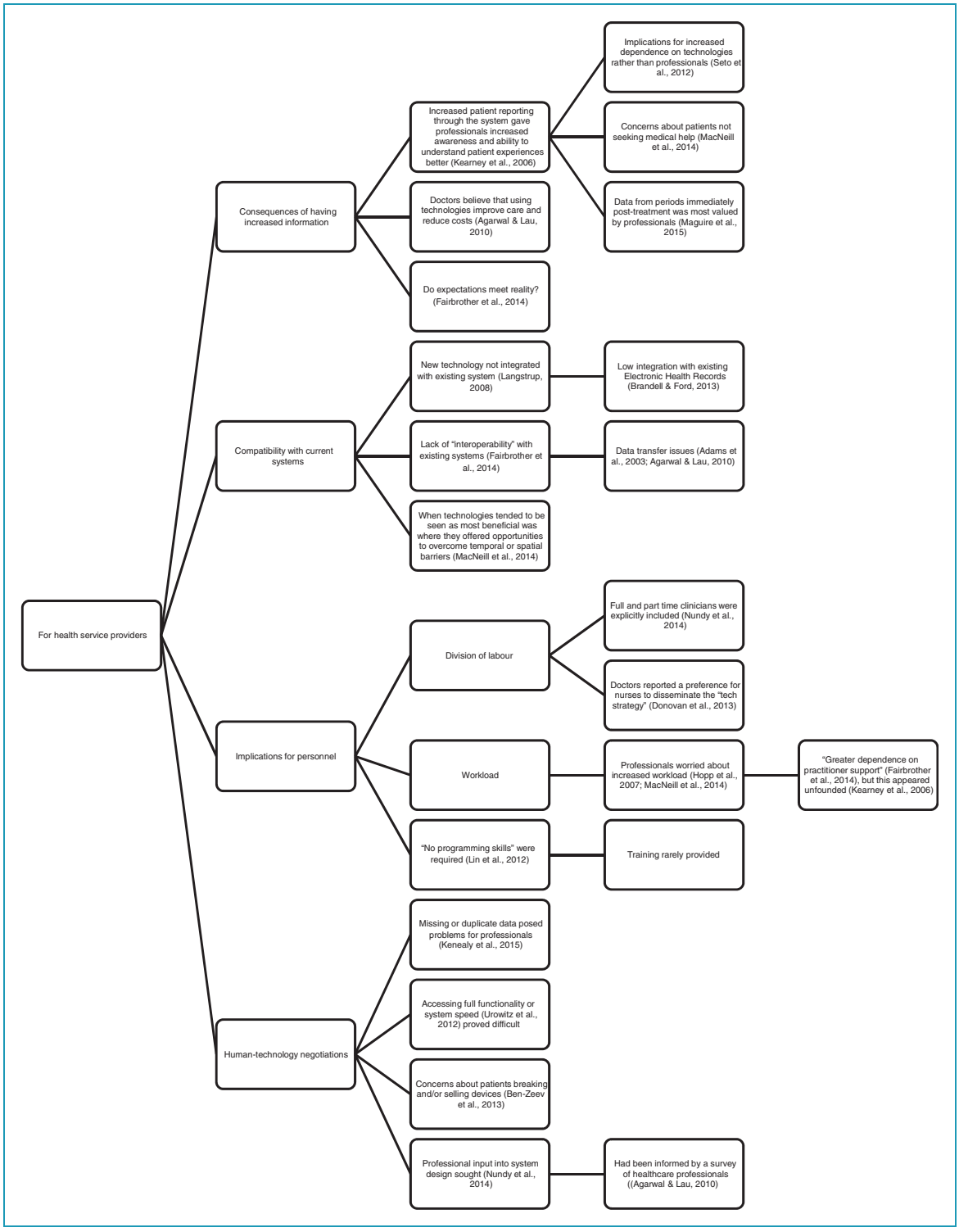


Figure 2. Impacts of implementation for health service providers.

provider-user relationships. Technologies alter the ways that service providers work in teams. In one study, a nurse reported that patients were more likely to approach her than a doctor, which she perceived to be a good thing, although it was not clear whether this was personal preference, better for service delivery or better for patients.[30] Some doctors thought that they, rather than nurses, should receive data,[37] perhaps creating power struggles within teams. Service providers identified using digital technologies as offering

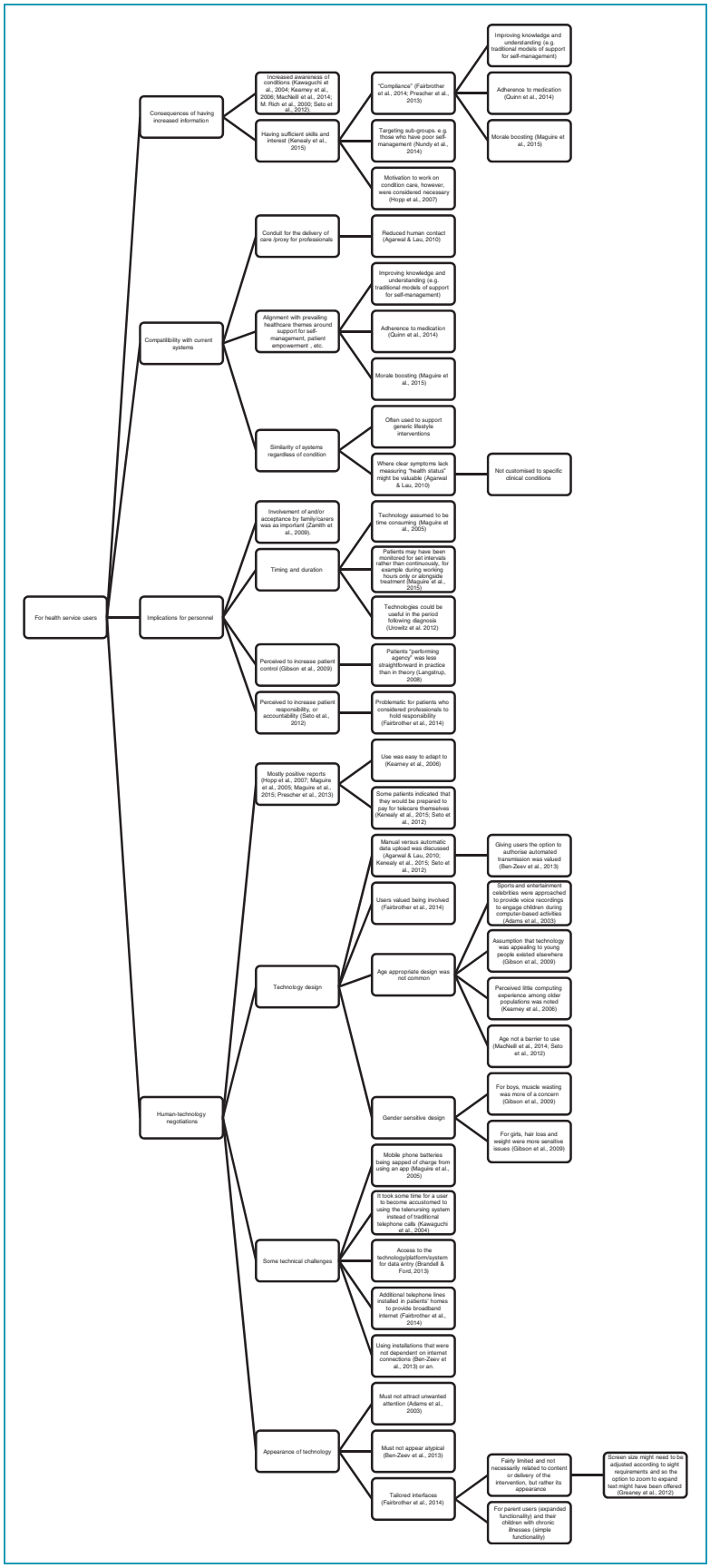


Figure 3. Impacts of implementation for health service users.

potential for professional and career development,[34] but whether this was for career progression or patient benefit was unclear.

In terms of changing roles and responsibilities, and their transfer from organisations and providers to users, technologies seemed to cause increased burden for health service users.[25] The perceived ability to manage symptoms using the technology,[35] however, suggested that tracking multiple behaviours was not actually as effortful as some seemed to imply (through their delivery of a 'complex intervention' implicating a number of biomedical and behavioural targets).

Technologies were perceived to have improved health service provider-user time together and could improve contacts between parties.[38,39] Conversely, as noted, interactions between health service providers and health service users could become more limited and a decrease in contact time was found elsewhere.[26,47] Indeed, use of technologies did not correspond with 'real' support, which might have meant reduced burden on and for health services organisations and providers. For instance, where an automated technology initiated a call if the patient failed to register,[17] the division of labour would have been delegation to a system rather than a person. However, some service users felt and liked what they perceived to be additional monitoring as they interpreted follow up calls as someone actively monitoring them and considered it a 'confidence booster'.[42] Providers suggested that they wanted service users to be more engaged, feel listened to, perceive that what they had to say was important, and to seek help.[24] But they could also become judgemental when they felt that patients' attitudes had not changed (e.g. no greater motivation to take on more responsibility) as a result of using the technology,[31] thus causing some tensions. Technologies could allow more trust by the provider of the user, however, and in some cases service users may have been able to go home rather than remain in hospital.[27] This can bring about benefits for all stakeholders: when hospital beds are in short supply and patients wish to return home, using technologies can be mutually beneficial. Elsewhere, it seemed, however, that service users were often being monitored through a form of increased health surveillance, although they might place faith in this approach.[23]

Recording symptoms might lead to enhanced communication, particularly between professionals and young people,[24] but it often seemed unidirectional, focused on tracking/checking rather than responding to/being interactive or responsive,[25,27] or related to increased demand for support.[24] This may have had implications for perceptions of privacy, particularly if patients were concerned about increased monitoring and confidentiality,[24,42] or feeling constantly watched.[47] However, they did not always seem to negatively affect patient dignity, but social (impacts on services and resources) and ethical (data protection) consequences were inevitably caused by the implementation of digital technologies. Care and relationships are transformed and provoke new questions about best practice, quality and safety. Medicolegal implications are initiated through the creation and communication of new forms of medical data,[43] bringing about security, storage, transmission, ownership concerns, although these were not discussed critically or in great depth.

Differences between health service users in terms of their personal characteristics and digital inclusion (i.e. equality of access to relevant technologies and equity in use) were mixed and unpredictable – there seemed to be no specific correlations.

Human–technology negotiations. Technical issues Studies tended to report interventions that aimed to deliver care through a technology, either thus reducing or in order to reduce face-to-face time. In one study, the introduction of new technologies into the care relationship increased dependence through the need for greater support,[24] rather than creating greater independence, although it was not clear whether the support required was technical or clinical (through increased awareness of health-related data). In another study, health service users felt more cared for and safer – but as a result of the technology, not their connection with healthcare provider(s).[23] Some patients may have preferred having access to their existing GP and to feel that there was continuity of care,[23] or more clinical expertise inputted into the technology.[47] Most patient interest was in the 'ask the expert' feature in one study,[22] and so traditional medical expertise was valued. From the perspectives of GPs, however, the investment required to input into or support technologies' use might have outweighed the benefits. A number of GPs ended up not using the technology in one study because they were disappointed that patients had failed to stay connected.[31]

Discussion

This paper offers a characterisation and critical interpretation of a range of illustrative literature on digital technologies used, through 'pushed' self-tracking, for supporting the self-management of chronic health conditions, paying particular attention to implementation and integration of technologies into the delivery of care from a health services research perspective. It focused on the consequences of having increased information, compatibility with current systems, implications for personnel and human–technology negotiations.

Perhaps unsurprisingly, the literature concentrates on technical and clinical rather than sociological and behavioural perspectives, which limits understanding. However, for the purposes of this review and to generate richer insights, the technologies examined were categorised as 'simple' or 'complex' because of key differences regarding their purpose in relation to existing medical models. Questions arose around 'complex' technologies, particularly the implementation and integration of technologies into the delivery of care. These were investigated in more detail. Although traditional approaches do not always appear to work well, e.g. peak flow consistently causes problems,[17,25] and new technologies show promise, e.g. a Personal Digital Assistant (PDA) works better than paper,[25] it seems that there is little meaningful integration (e.g. shared interpretation of data, shared decision making based on data) and a great deal of contradictions and inconsistencies in implementation at this early stage in the field of digital technologies for 'pushed' self-tracking of health-related data, particularly in the context of supporting self-management of chronic health conditions.

The review showed the use of technologies as ultimately still focused on compliance and the construction of 'health threats',[23,49] i.e. 'red flags' for professionals to respond to user risk factors when they are indicated by specific data, rather than user experiences or allowing patients to genuinely take control or participate more actively in their (self-)care,[3] although this is not always welcomed by health service providers or users.[50] Language of non-compliance will need to adapt, however, if the focus becomes less on single time points and more on a continuum, particularly if there is a growth of non-disease specific programmes (e.g. focus on lifestyle behaviours), it will mean that new and more flexible approaches are required. We will need to take care in how more directive approaches concentrating on 'good' habit formation are framed and fit with everyday life.[51] In keeping with the findings of a review of support for self-management of chronic health conditions,[1] which looked more generally at provision of support for self-management, purpose can underpin more hierarchical practitioner-patient communication and more limited views of patient empowerment. These are often associated with experiences of failure and frustration. Broader approaches support people to manage well with their condition(s). They can keep work on disease control in perspective as attention focuses on what matters to people and how they can be supported to shape their own lives. Like other interventions, technologies tend to offer new ways of managing conditions, rather than managing or living (well) with conditions.[1] This, of course, depends on how we as developers, researchers, users (organisations, professionals and patients) collaborate to harness technologies; it's not a fault of technology itself, but it is important to attend to the nuanced and subtle difference between the two approaches and to attend to the conceptualisation of healthcare delivery.[52]

There was limited consideration of long-term use or implications for medical education and professional training, guidelines and regulation.[53–55] The personal, relational, social and ethical intended and unintended positive and negative consequences of use will also need more careful attention as availability, use and possibilities expand.[56] There was little detailed description of how clinical interactions changed (or not) or of how any changes were managed when technologies were integrated.[23] What appeared as implementation factors (i.e. adding information, compatibility with current service, personnel and technical aspects) were reframed as different ways of enacting the technology or the clinic.[31] This contrasts with previous research that has found a focus on the micro level impacts of 'quantified self' activities.[57] 'Interactions or interviews between doctors and patients are the cornerstone of medical practice',[58] but this notion was not directly addressed. As such, the personal, relational, social and ethical aspects of introducing new technologies into care packages, particularly those grounded in tenets of empathy and trust, seemed to be overlooked and the prevailing models involved 'transactional medicine' that appears standardised rather than context dependent.[49] This does not align easily with discourses of genuine patient empowerment and seems more Foucauldian, where the aim is to instil discipline through the introduction of technological regimens in order that they breed self-discipline;[6] the technologies are not necessarily being implemented to improve relationships. A recent review found that upfront consideration should be given to how technologies may enable or limit relationships between health service providers and health service users.[59] Mitigation of changes to, or the demise of, such relationships,[60] and organisation of services, is recommended.

Relational aspects of care are distinguishable from clinical and technical aspects and need to be explored in more depth. While clinical/technical evaluations are important in terms of improving outcomes and service development, we need to know more about the behavioural/sociological theories that underpin the phenomenon of 'pushed' self-tracking, as well as understanding derived through social scientific understandings of human experiences of it and their meaning. These analyses would offer explanations of the mechanisms of action, help to identify and possibly resolve ethical tensions and provide insights into digital human being, as well as uncovering directions for improving acceptability and usefulness. In terms of how these impacts of implementation affect the delivery of care, at this

early stage in the development of the 'digital health' field within medicine, and in the absence of detailed data that goes beyond investigating clinical or technical factors, it seems that it may be more beneficial to focus on the collaborative construction and making sense of using digital technologies through applying and developing sociological theories within a health services research context. There may be more useful ways in which to think about and conceptualise the implementation of digital technologies in this multidisciplinary field. It will be important to look beyond the medical literature to develop understandings of the emerging application of new technologies within health services going forward.

Strengths and limitations

The strengths of this paper include the development of categories for classifying digital technologies – as 'simple' or 'complex'. To date, categorisation has been diffuse and so these may be helpful for practice and research. The detailed exploration of those considered 'complex', which has not previously been a focus of systematic research, may also be useful. A new focus on how 'pushed' self-tracking transforms the delivery of care, where previous applied research has been more concerned with efficiency, is novel. This is an emerging area and very topical as the increased use of self-tracking technologies is indicated, particularly for managing chronic health conditions, multi-morbidities and lifestyles.

The limitations include the inclusion of a broad range of applied health services literature, which was concerned with self-management of chronic conditions. The focus on chronic health conditions and health service provided technologies – 'pushed' self-tracking – not technologies for use in relation to health in general, means that insights may be restricted to specific groups of technologies and/or conditions rather than digital technologies more generally, including those commercially available outside of health services. The variation and diversity of technologies included here, however, may mean that the findings are still too broad in terms of classification and this research may have raised more questions than answers. Clearly, another limitation is that by undertaking this research following a strict health services systematic reviewing methodology, potentially relevant research papers from other fields were not included in the review.

Suggested directions for future research

Overall, the findings were contradictory and indicate a need for both multidisciplinary and detailed qualitative, including ethnographic, research into integration of technologies into care models and the personal, relational, social and ethical consequences of use, for example how our bodies might be integrated with or commodified by technologies, discrimination, what is acceptable and/or measured by interpretations of good and bad health behaviour, and how that impacts on health *and* social care. This is consistent with the conclusions of other papers within this evolving field.[61] There may be a need to develop a focus on or framework for assessing/analysing how precise technologies are implemented and/or a model to guide medically-located interactions,[62] as well as for evaluating them. This may draw on the health psychology of behaviour change,[63,64] as well as social scientific approaches. In particular, detailed work to define optimal settings, with attention to the importance of place,[65] duration of use, and consideration of power dynamics through the availability of previously unknown information, is required. Approval/regulation is also an issue: there are currently a number of technologies with FDA approval in the USA,[54] with some being available on prescription. In the UK, the NHS apps library has recently come under criticism for products leaking data,[66] although this has since been closed down.

In future research, it would be of benefit to conduct detailed exploration of use outside health services too: 'Research could explore if there is a difference in outcomes between an individual independently deciding to use an app versus having an app recommended by his/her healthcare provider.'[26] More and more within the grey literature, the prevalence of commercial health technologies is reported, with much speculation about the growth of their role. The heterogeneity within this study was evident and should be unpacked and distilled to progress classification in this field. There may be individuals who prefer not to use them at all and this population should also be consulted. Similarly, issues of equity, equality of access and (the creation of new and different) health inequalities in the context of digital technologies need to be addressed. Features and designs of technologies should also be considered, especially regarding consumer vs. citizen agendas, where people, patients, might prefer to choose their own technologies. User-centred design was more common in social care than health care contexts,[19] reflecting differences found between broader compared with narrower approaches to supporting the self-management of chronic conditions.[1] As found in the included studies, co-design of digital health technologies does already happen and in-depth qualitative research, conducted alongside other research designs within studies, is evident in the literature included in this review. There is a useful framework for mitigating problems of implementing and normalising technologies that outlines

the value of these kinds of approaches.[67] It would be beneficial for the research community, as well as for practice, if those engaging in technology co-design and/or qualitative inquiry around implementation reported these processes in detail to uncover the detail to allow in-depth analysis. Finally, research design and conduct that is flexible to accommodate concepts of performativity, co-construction of identities and new repertoires of 'being human' will be crucial.

Conclusions

The technologies featured appeared largely as a conduit for the delivery of care and proxy for health care professional support for the self-management of chronic conditions, which seem to be substituted for traditional models of delivery and to impact on human contact. As such, they did not seem to be well integrated and did not align easily with other healthcare discourses around support for self-management, patient empowerment, etc. This may not be universal or the case beyond chronic condition self-management support, however, there may be wider-ranging implications for digital technologies provided by health services in other clinical areas. There is a need for detailed qualitative research to explore user perspectives, likely involving ethnographic and longitudinal work. Co-design of technologies also requires further exploration.

While this review focused on technologies, the findings imply that the focus of future work should not be on technologies or data *per se*, but what integration of self-tracking technologies means for the delivery of care. As pacey proliferation of technologies continues, there may be a need to look at 'innovolution', evolution through innovation, rather than discrete innovations.[38] More unpacking and conceptualisation, drawing on both health services research and sociological perspectives, is required as digital technologies transform health and care, continually raising new personal, relational, social and ethical questions, as well as technical and clinical concerns.

There are opportunities for health services researchers to focus more on the sociological and behavioural aspects, and ethical challenges, of implementing 'pushed' self-tracking support programmes. Detailed multidisciplinary research is needed to understand and guide technical and medical developments that integrate digital technologies into the delivery of care.

Acknowledgements

This review drew on a body of literature originally identified in The Health Foundation-funded project: 'Concept: SSM – conceptualising support for self-management', led by Professor Vikki Entwistle, University of Aberdeen. Many thanks to Professors Lorna McKee and Marion Campbell, Health Services Research Unit, University of Aberdeen, for helpful discussions regarding analysis and for commenting on earlier drafts of this paper. Thanks also to Cynthia Fraser, Information Specialist, and Lara Kemp, Secretary, Health Services Research Unit, University of Aberdeen, for their help with reference retrieval and management.

Contributorship: HM led the design and conduct of this research and wrote this paper. The literature was identified by an Information Specialist who designed and executed searches for papers indexed on Medline, CiNAHL, SCI and ASSIA databases.

Declaration of Conflicting Interests: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval: This paper reports secondary research, which did not require ethical approval. This review complies with the ENTREQ statement on reporting the synthesis of qualitative health research.[25]

Funding: The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was funded by an award made to Heather Morgan, Health Services Research Unit, University of Aberdeen, through the Wellcome Trust Institutional Strategic Support Fund (RG12724-13). The Health Services Research Unit is core funded by the Chief Scientist Office of the Scottish Government's Health and Social Care Directorates. The author accepts full responsibility for this work.

Guarantor: HM

Peer review: This manuscript was reviewed by Leanne Morrison, University of Southampton, Panagiotis Balatsoukas, University of Manchester & Nikki Newhouse, University of Oxford.

References

1. Morgan HM, Entwistle V, Cribb A, et al. We need to talk about purpose: a critical interpretive synthesis of health and social care professionals' approaches to self-management support for people with long-term conditions. *Health Expect*, Epub ahead of print 1 March 2016. DOI: 10.1111/hex.12453.
2. García-Lizana F and Sarría-Santamera A. New technologies for chronic disease management and control: a systematic review. *J Telemed Telecare* 2007; 13: 62–68.
3. Lupton D. Apps as artefacts: towards a critical perspective on mobile health and medical apps. *Societies* 2014; 4: 606–622.
4. Husain I and Spence D. Can healthy people benefit from health apps? *BMJ* 2015; 350: h1887.
5. Uotinen J. Senses, bodily knowledge, and autoethnography: unbeknown knowledge from an ICU experience. *Qual Health Res* 2011; 21: 1307–1315.
6. Foucault M. *The birth of the clinic: an archaeology of medical perception*. London: Routledge, 1973.
7. Lupton D. *Self-tracking modes: reflexive self-monitoring and data practices*. Social Science Research Network (SSRN). http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2483549 (2014, accessed November 2015).
8. European Commission. Digital agenda for Europe: EH policy eHealth, https://ec.europa.eu/digital-agenda/en/eu-policy-ehealth (2015, accessed November 2015).
9. UK Department of Health. Digital health: working in partnership – promotional material, www.gov.uk/government/publications/digital-health-working-in-partnership/

digital-health-working-in-partnerships (2014, accessed November 2015).
10. US Department of Health and Human Services. Digital strategy at Health and Human Services (HHS), www.hhs.gov/web/governance/digital-strategy/index.html (2015, accessed November 2015).
11. Australian Government Department of Health. eHealth program, www.health.gov.au/internet/main/publishing.nsf/content/ehealth (2015, accessed November 2015).
12. NHS Scotland. *eHealth strategy 2011–2017*. Edinburgh: Scottish Government. www.gov.scot/resource/doc/357616/0120849.pdf (2011, accessed November 2015).
13. Sosnowy C. Practicing patienthood online: social media, chronic illness and lay expertise. *Societies* 2014; 4: 316–329.
14. Demain S, Burridge J, Ellis-Hill C, et al. Assistive technologies after stroke: self-management or fending for yourself? A focus group study. *BMC Health Serv Res* 2013; 13: 334.
15. Dixon-Woods M, Cavers D, Agarwal S, et al. Conducting a critical interpretive synthesis of the literature on access to healthcare by vulnerable groups. *BMC Med Res Methodol* 2006; 6: 35.
16. Tong A, Flemming K, McInnes E, et al. Enhancing transparency in reporting the synthesis of qualitative research: ENTREQ. *BMC Med Res Methodol* 2012; 12: 181.
17. Adams WG, Fuhlbrigge AL, Miller CW, et al. TLC-Asthma: an integrated information system for patient-centered monitoring, case management, and point-of-care decision support. *AMIA Ann Symp Proc* 2003; 1–5.
18. Agarwal S and Lau CT. Remote health monitoring using mobile phones and Web services. *Telemed J E-Health* 2010; 16: 603–607.
19. Ben-Zeev D, Kaiser SM, Brenner CJ, et al. Development and usability testing of FOCUS: a smartphone system for self-management of schizophrenia. *Psych Rehab J* 2013; 36: 289–96.47.
20. Biswas R, Maniam J, Lee EW, et al. User-driven health care: answering multidimensional information needs in individual patients utilizing post-EBM approaches: an operational model. *J Eval Clin Pract* 2008; 14: 750–760.
21. Brandell B and Ford C. Diabetes professionals must seize the opportunity in mobile health. *J Diabetes Sci Technol* 2013; 7: 1616–1620.
22. Donovan E, Mehringer S and Zeltzer LK. Assessing the feasibility of a web-based self-management program for adolescents with migraines and their caregivers. *Clin Pediatr* 2013; 52: 667–670.
23. Fairbrother P, Ure J, Hanley J, et al. Telemonitoring for chronic heart failure: the views of patients and healthcare professionals – a qualitative study. *J Clin Nurs* 2014; 23: 132–144.
24. Gibson F, Aldiss S, Taylor RM, et al. Involving health professionals in the development of an advanced symptom management system for young people: the ASyMS-YG study. *Eur J Oncol Nurs* 2009; 13: 187–192.
25. Greaney ML, Sprunck-Harrild K, Bennett GG, et al. Use of email and telephone prompts to increase self-monitoring in a web-based intervention: randomized controlled trial. *J Med Internet Res* 2012; 14: e96.
26. Holtz B and Lauckner C. Diabetes management via mobile phones: a systematic review. *Telemed J E-Health* 2012; 18: 175–184.
27. Hopp FP, Hogan MM, Woodbridge PA, et al. The use of telehealth for diabetes management: a qualitative study of telehealth provider perceptions. *Implement Sci* 2007; 2: 14.
28. Kawaguchi T, Azuma M and Ohta K. Development of a telenursing system for patients with chronic conditions. *J Telemed Telecare* 2004; 10: 239–244.
29. Kearney N, Kidd L, Miller M, et al. Utilising handheld computers to monitor and support patients receiving chemotherapy: results of a UK-based feasibility study. *Support Care Cancer* 2006; 14: 742–752.
30. Kenealy TW, Parsons MJG, Rouse APB, et al. Telecare for diabetes, CHF or COPD: effect on quality of life, hospital use and costs. A randomised controlled trial and qualitative evaluation. *PLoS One* 2015; 10: e0116188.
31. Langstrup H. Making connections through online asthma monitoring. *Chron Illn* 2008; 4: 118–126.
32. Lin YH, Chen RR, Guo SH, et al. Developing a web 2.0 diabetes care support system with evaluation from care provider perspectives. *J Med Syst* 2012; 36: 2085–2095.
33. Lyndon H and Tyas D. Telehealth enhances self care and independence in people with long term conditions. *Nurs Times* 2010; 106: 12–13.
34. MacNeill V, Sanders C, Fitzpatrick R, et al. Experiences of front-line health professionals in the delivery of telehealth: a qualitative study. *Br J Gen Pract* 2014; 64: e401–e407.
35. Maguire R, Miller M, Sage M, et al. Results of a UK based pilot study of a mobile phone based advanced symptom management system (ASyMS) in the remote monitoring of chemotherapy related toxicity. *Clin Effect Nurs* 2005; 9: 202–210.
36. Maguire R, Ream E, Richardson A, et al. Development of a novel remote patient monitoring system: The advanced symptom management system for radiotherapy to improve the symptom experience of patients with lung cancer receiving radiotherapy. *Cancer Nurs* 2015; 38: E37–E47.
37. Nundy S, Lu CYE, Hogan P, et al. Using patient-generated health data from mobile technologies for diabetes self-management support: provider perspectives from an academic medical center. *J Diabetes Sci Technol* 2014; 8: 74–82.
38. Ovretveit J, Keller C, Hvitfeldt FH, et al. Continuous innovation: developing and using a clinical database with new technology for patient-centred care: the case of the Swedish quality register for arthritis. *Int J Qual Health Care* 2013; 25: 118–124.
39. Prescher S, Deckwart O, Winkler S, et al. Telemedical care: feasibility and perception of the patients and physicians: a survey-based acceptance analysis of the Telemedical Interventional Monitoring in Heart Failure (TIM-HF) trial. *Eur J Prevent Cardiol* 2013; 20(2 Suppl): 18–24.
40. Quinn CC, Sareh PL, Shardell ML, et al. Mobile diabetes intervention for glycemic control: impact on physician prescribing. *J Diabetes Sci Technol* 2014; 8: 362–370.

41. Rich M, Lamola S, Gordon J, et al. Video intervention/prevention assessment: a patient-centered methodology for understanding the adolescent illness experience. *J Adolesc Health* 2000; 27: 155–165.
42. Seto E, Leonard KJ, Cafazzo JA, et al. Perceptions and experiences of heart failure patients and clinicians on the use of mobile phone-based telemonitoring. *J Med Internet Res* 2012; 14: e25.
43. Seto E, Leonard KJ, Masino C, et al. Attitudes of heart failure patients and health care providers towards mobile phone-based remote monitoring. *J Med Internet Res* 2010; 12: e55.
44. Shea K and Chamoff B. Patient reactions to vital sign measures: comparing home monitoring technology to face-to-face delivery. *Home Health Care Manag Pract* 2011; 23: 454–460.
45. Shea K and Chamoff B. Telehomecare communication and self-care in chronic conditions: moving toward a shared understanding. *Worldviews Evid Based Nurs* 2012; 9: 109–116.
46. Thomas CL, Man MS, O'Cathain A, et al. Effectiveness and cost-effectiveness of a telehealth intervention to support the management of long-term conditions: study protocol for two linked randomized controlled trials. *Trials* 2014; 15: 36.
47. Urowitz S, Wiljer D, Dupak K, et al. Improving diabetes management with a patient portal: a qualitative study of diabetes self-management portal. *J Med Internet Res* 2012; 14: e158.
48. Zamith M, Cardoso T, Matias I, et al. Home telemonitoring of severe chronic respiratory insufficient and asthmatic patients. *Rev Port Pneumol* 2009; 15: 385–417.
49. Cakici B. Detecting the visible: the discursive construction of health threats in a syndromic surveillance system design. *Societies* 2014; 4: 399–413.
50. Protheroe J, Brooks H, Chew-Graham C, et al. 'Permission to participate?' A qualitative study of participation in patients from differing socio-economic backgrounds. *J Health Psychol* 2013; 18: 1046–1055.
51. Stawarz K, Cox AL and Blandford A. Beyond self-tracking and reminders: designing smartphone apps that support habit formation. In: *Proceedings of the 33rd annual ACM conference on human factors in computing systems*, Seoul, 18–23 April 2015.
52. May CR. Making sense of technology adoption in healthcare: meso-level considerations. *BMC Med* 2015; 13(92): 1–3.
53. Hopia H, Punna M, Laitinen T, et al. A patient as a self-manager of their personal data on health and disease with new technology – challenges for nursing education. *Nurs Educ Today* 2015; 35: e1–e3.
54. US Food and Drug Administration (FDA). FDA proposes health "app" guidelines, www.fda.gov/ForConsumers/ConsumerUpdates/ucm263332.htm (2015, accessed November 2015).
55. US Food and Drug Administration (FDA). Mobile medical applications, hwww.fda.gov/medicaldevices/digitalhealth/mobilemedicalapplications/default.htm (2015, accessed November 2015).
56. Austen K. What could derail the wearables revolution? *Nature* 2015; 525: 22–24.
57. Till C. Exercise as labour: quantified self and the transformation of exercise into labour. *Societies* 2014; 4: 446–462.
58. Thompson JA and Anderson JL. Patient preferences and the bedside manner. *Med Educ* 1982; 16: 17–21.
59. Vassilev I, Rowsell A, Pope C, et al. Assessing the implementability of telehealth interventions for self-management support: a realist review. *Implement Sci* 2015; 10: 59.
60. Wachter R. *The digital doctor*. McGraw-Hill Publishing.
61. Lupton D. *Beyond techno-Utopia: critical approaches to digital health technologies*. Basel: MDPI Books, 2015.
62. Hanna L, May C and Fairhurst K. The place of information and communication technology-mediated consultations in primary care: GPs' perspectives. *Family Pract*2011; cmr087.
63. Michie S, Richardson M, Johnston M, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med* 2013; 46: 81–95.
64. Michie S and West R. *A guide to development and evaluation of digital behaviour change interventions in healthcare*. London: Silverback Publishing, 2016.
65. Oudshoorn N. How places matter. Telecare technologies and the changing spatial dimensions of healthcare. *Soc Studies Sci* 2011; 42: 121–142.
66. Huckvale K, Prieto J, Tilney M, et al. Unaddressed privacy risks in accredited health and wellness apps: a cross-sectional systematic assessment. *BMC Med* 2015; 13: 214.
67. Greenhalgh T, Procter R, Wherton J, et al. What is quality in assistive living technology? The ARCHIE framework for effective telehealth and telecare services. *BMC Med* 2015; 13: 91.

Appendix 1

Search strategies for review

2000–2014

Embase, Ovid MEDLINE(R) without Revisions, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

Search Strategy:

1 Long-Term Care/ (84652)
2 long$ term care.tw. (20713)
3 Chronic Disease/ (206880)
4 (chronic or degenerative).tw,hw. (1466624)
5 ((persistent or long term or ongoing) adj3 (disease? or ill$ or condition? or insufficienc$ or disorder?)).tw. (35848)
6 Comorbidity/ (177720)
7 (comorbidity or co morbidity or multimorbidity or multi morbidity or multiple conditions).tw. (77221)
8 Polypharmacy/ (8600)

9 exp Cardiovascular Diseases/ (2836081)
10 (heart disease? or heart failure or myocardial isch?emia or myocardial infarction or coronary disease? or coronary artery disease? or hypertension or high blood pressure).tw. (938820)
11 exp Lung Diseases, Obstructive/ use medf (84038)
12 exp Lung Fibrosis/ use emef (27086)
13 (obstructive lung disease? or obstructive pulmonary disease? or copd or asthma or bronchitis).tw. (248552)
14 exp Emphysema/ (23024)
15 exp pulmonary emphysema/ or pulmonary fibrosis/ use medf (17294)
16 emphysema.tw. (20686)
17 exp Nervous System Diseases/ use medf (1067412)
18 exp neurologic disease/ use emef (1575904)
19 (brain adj (disease? or damage? or injur$)).tw. (98268)
20 (cerebrovascular or brain isch?emia or cerebral infarction or carotid artery disease? or stroke or epilepsy or epileptic or seizure?).tw. (521160)
21 (neurodegenerative or huntington$ or parkinson$ or amyotrophic lateral sclerosis or multiple sclerosis or motor neuron disease).tw. (303584)
22 (paralys$ or quadriplegi$ or teraplegi$ or paraplegi$ or locked-in syndrome).tw. (58223)
23 ((communication or learning or peceptual or speech or voice or vision or sight or hearing or auditory or psychomotor) adj disorder?).tw. (8146)
24 (hearing loss or hearing aid? or deaf$ or bind$ or stutter$).tw. (1397218)
25 ((communication or learning or peceptual or speech or voice or vision or sight or hearing or auditory or psychomotor) adj impair$).tw. (19549)
26 cerebral palsy.tw. (23130)
27 exp anemia, sickle cell/ or exp thalassemia/ (42596)
28 Cystic Fibrosis/ (46327)
29 exp Renal Insufficiency, Chronic/ use medf (47088)
30 ((renal or kidney) adj (failure or insufficen$)).tw. (107668)
31 exp Diabetes Mellitus/ (614541)
32 (diabetes or diabetic).tw. (675333)
33 exp nutrition disorders/ (545708)
34 (underweight or malnutrition or malnourished or overweight or obesity or obese).tw. (357519)
35 exp arthritis/ (299885)
36 exp rheumatic diseases/ use medf (81082)
37 (arthritis or osteoarthritis or rheumati$ or fibromyalgia).tw. (269050)
38 exp back pain/ or exp chronic pain/ use medf (71515)
39 exp backache/ use emef (51862)
40 exp neck pain/ (15429)
41 exp Thyroid Diseases/ (142093)
42 exp Neoplasms/ (3453276)
43 malignan$.tw. (591604)
44 exp HIV Infections/ use medf (147714)
45 exp human immunodeficiency virus/ use emef (100861)
46 exp Hypersensitivity/ (418178)
47 exp Mental Disorders/ use medf (514228)
48 exp mental disease/ use emef (1032196)
49 (psychos?s or neuros?s psychotic or schizo$ or neurotic or delusion$ or depression or depressive or bipolar or mania or manic or compulsi$ or phobic or phobia or anorexia or bulimia or autis$ or asperger$ or tourette$ or affective or suicid$ or self injur$ or self harm or adhd$).tw. (802871)
50 exp Behavioral Symptoms/ use medf (143648)
51 or/1-50 (12388333)
52 ''Attitude of Health Personnel''/ use medf (61273)
53 exp health personnel attitude/ use emef (104811)
54 (health$ professional? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (2765)
55 (provider? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (7299)
56 (doctor? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (5694)
57 (practitioner? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (6550)
58 (clinician? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (8924)
59 (physician? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (19970)
60 (therapist? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (2759)
61 (nurse? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (20159)
62 (gp? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (3536)
63 (cardiologist? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (1076)

64 (psychiatrist? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (1549)
65 (psychologist? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (531)
66 (neurologist? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (718)
67 (pharmacist? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (2612)
68 (carer? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (1807)
69 (worker? adj3 (attitude? or view? or perception? or perceiv$ or experience? or perspective? or opinion? or norms)).tw. (4604)
70 or/52-69 (228102)
71 51 and 70 (73264)
72 exp Self Care/ (62730)
73 (self adj3 (manag$ or monitor$ or test$ or care or medicat$)).tw. (60137)
74 decision making/ use medf (45405)
75 (share$ adj3 (decision or decid$)).tw. (5123)
76 Patient-Centered Care/ use medf (9302)
77 (patient? adj3 involv$ adj3 (decision$ or decid$ or plan$)).tw. (1548)
78 self administration/ or self medication/ (18843)
79 *health care delivery/ use emef (32876)
80 (comanag$ or co manag$ or co produc$ or coproduc$).tw. (4779)
81 or/72-80 (199423)
82 71 and 81 (4876)
83 limit 82 to yr = ''2000 -Current'' (4498)
84 remove duplicates from 83 (3775)
85 84 not conference abstract.pt. (3613)

CINAHL

S77 S66 AND S74 Limiters - Published Date: 20000101-20131231; Exclude MEDLINE records
S76 S66 AND S74 Limiters - Published Date: 20000101-20131231
S75 S66 AND S74
S74 S67 OR S68 OR S69 OR S70 OR S71 OR S72 OR S73
S73 TX (comanag* or co manag* or co produc* or coproduc*).
S72 TX (patient* N3 involv*)
S71 (MH ''Patient Centered Care'')
S70 (MH ''Decision Making, Patient'')
S69 TX (share* N3 (decision or decid*)).
S68 TX (self N3 (manag* or monitor* or test* or care or medicat*)).
S67 (MH ''Self Care+'')
S66 (S47 AND S65)
S65 S48 OR S49 OR S50 OR S51 OR S52 OR S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63 OR S64
S64 TX (worker* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S63 TX (carer* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S62 TX (pharmacist* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S61 TX (neurologist* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S60 TX (psychologist* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S59 TX (psychiatrist* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S58 TX (cardiologist* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S57 TX (gp* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S56 TX (nurse* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S55 TX (therapist* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S54 TX (physician* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S53 TX (clinician* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S52 TX (practioner* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S51 TX (doctor* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S50 TX (provider* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).
S49 TX (health* professional* N3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).

S48 (MH ''Attitude of Health Personnel+'')
S47 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46
S46 (MH ''Behavioral Symptoms+'')
S45 TX (psychos?s or neuros?s psychotic or schizo* or neurotic or delusion* or depression or depressive or bipolar or mania or manic or compulsi* or phobic or phobia or anorexia or bulimia or autis* or asperger* or tourette* or affective or suicid* or self injur* or self harm or adhd*).
S44 (MH ''Mental Disorders+'')
S43 (MH ''Hypersensitivity+'')
S42 (MH ''HIV Infections+'')
S41 malignan*
S40 (MH ''Neoplasms+'')
S39 (MH ''Thyroid Diseases+'')
S38 (MH ''Back Pain+/SS'') OR (MH ''Neck Pain'')
S37 TX (arthritis or osteoarthritis or rheumati* or fibromyalgia).
S36 (MH ''Rheumatic Diseases+'')
S35 (MH ''Arthritis+'')
S34 (underweight or malnutrition or malnourished or overweight or obesity or obese).
S33 (MH ''Nutrition Disorders+'')
S32 TX diabetes or diabetic
S31 (MH ''Diabetes Mellitus+'')
S30 TX ((renal or kidney) N1(failure or insufficen*)).
S29 (MH ''Renal Insufficiency, Chronic+'')
S28 (MH ''Cystic Fibrosis'')
S27 (MH ''Anemia, Sickle Cell+'')
S26 TX cerebral palsy
S25 TX ((communication or learning or peceptual or speech or voice or vision or sight or hearing or auditory or psychomotor) N1 impair*)
S24 TX (hearing loss or hearing aid* or deaf* or bind* or stutter*).
S23 TX ((communication or learning or peceptual or speech or voice or vision or sight or hearing or auditory or psychomotor) N1 disorder*)
S22 TX (paralys* or quadriplegi* or teraplegi* or paraplegi* or locked-in syndrome).
S21 TX (neurodegenerative or huntington* or parkinson* or amyotrophic lateral sclerosis or multiple sclerosis or motor neuron disease).
S20 (cerebrovascular or brain isch?emia or cerebral infarction or carotid artery disease* or stroke or epilepsy or epileptic or seizure*).
S19 TX (brain N1 (disease* or damage* or injur*)).
S18 (MH ''Nervous System Diseases+'')
S17 TX emphysema
S16 (MH ''Pulmonary Fibrosis'')
S15 (MH ''Emphysema+'')
S14 TX obstructive lung disease* or obstructive pulmonary disease* or copd or asthma or bronchitis
S13 (MH ''Lung Diseases, Obstructive+'')
S12 TX (heart disease* or heart failure or myocardial isch?emia or myocardial infarction or coronary disease* or coronary artery disease* or hypertension or high blood pressure).
S11 (MH ''Cardiovascular Diseases+'')
S10 (MH ''Polypharmacy'')
S9 TX (comorbidity or co morbidity or multimorbidity or multi morbidity or multiple conditions)
S8 (MH ''Comorbidity'')
S7 ((persistent or long term or ongoing) N/3 (disease* or ill* or condition* or insufficienc* or disorder*)).
S6 ((persistent or long term or ongoing) N3 (disease* or ill* or condition* or insufficienc* or disorder*)).
S5 TX ((persistent or long term or ongoing) N3 (disease* or ill* or condition* or insufficienc* or disorder*))
S4 TX (chronic or degenerative) OR MW (chronic or degenerative)
S3 (MH ''Chronic Disease'')
S2 TX long* term care
S1 (MH ''Long Term Care'')

SCI

33 304 #32 AND #26
32 1,168,151 #31 OR #30 OR #29 OR #28 OR #27
31 2,136 (TS = polypharm*) AND Document Types = (Article).
30 124,573 (TS = (comorbidity or co morbidity or multimorbidity or multi morbidity or multiple conditions)) AND Document Types = (Article)
29 560,193 (TS = (long term or longterm)) AND Document Types = (Article)
28 27,018 (TS = degenerative) AND Document Types = (Article)
27 524,155 (TS = chronic) AND Document Types = (Article)
26 1,307 #25 AND #9
25 32,300 #24 OR #23 OR #22 OR #21 OR #20 OR #19 OR #18 OR #17 OR #16 OR #15 OR #14 OR #13 OR #12 OR #11 OR #10
24 2,153 (TS = (worker* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or

perspective* or opinion* or norms)).) AND Document Types = (Article)

23 539 (TS = (carer* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or

22 753 (TS = (pharmacist* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

21 281 (TS = (neurologist* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

20 182 (TS = (psychologist* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

19 620 (TS = (psychiatrist* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

18 383 (TS = (cardiologist* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

17 6,445 (TS = (nurse* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

16 775 (TS = (therapist* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

15 9,704 (TS = (physician* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

14 3,225 (TS = (clinician* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

13 3,327 (TS = (practitioner* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

12 2,472 (TS = (doctor* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

11 2,778 (TS = (provider* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

10 1,373 (TS = (health* NEAR/1 professional* NEAR/3 (attitude* or view* or perception* or perceiv* or experience* or perspective* or opinion* or norms)).) AND Document Types = (Article)

9 163,866 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8) AND Document Types = (Article)

8 135,661 (TS = (comanag* or co manag* or co produc* or coproduc*).) AND Document Types = (Article)

7 623 (TS = (patient* NEAR/3 involv* NEAR/3 (decision* or decid* or plan*)).) AND Document Types = (Article)

6 2,029 (TS = (share* NEAR/3 (decision or decid*)).) AND Document Types = (Article)

5 7,518 (TS = (self NEAR/3 care)) AND Document Types = (Article)

4 2,914 (TS = (self NEAR/3 medicat*)) AND Document Types = (Article)

3 6,675 (TS = (self NEAR/3 test*)) AND Document Types = (Article)

2 3,749 (TS = (self NEAR/3 monitor*)) AND Document Types = (Article)

1 8,157 (TS = (self NEAR/3 manag*)) AND Document Types = (Article)

ASSIA

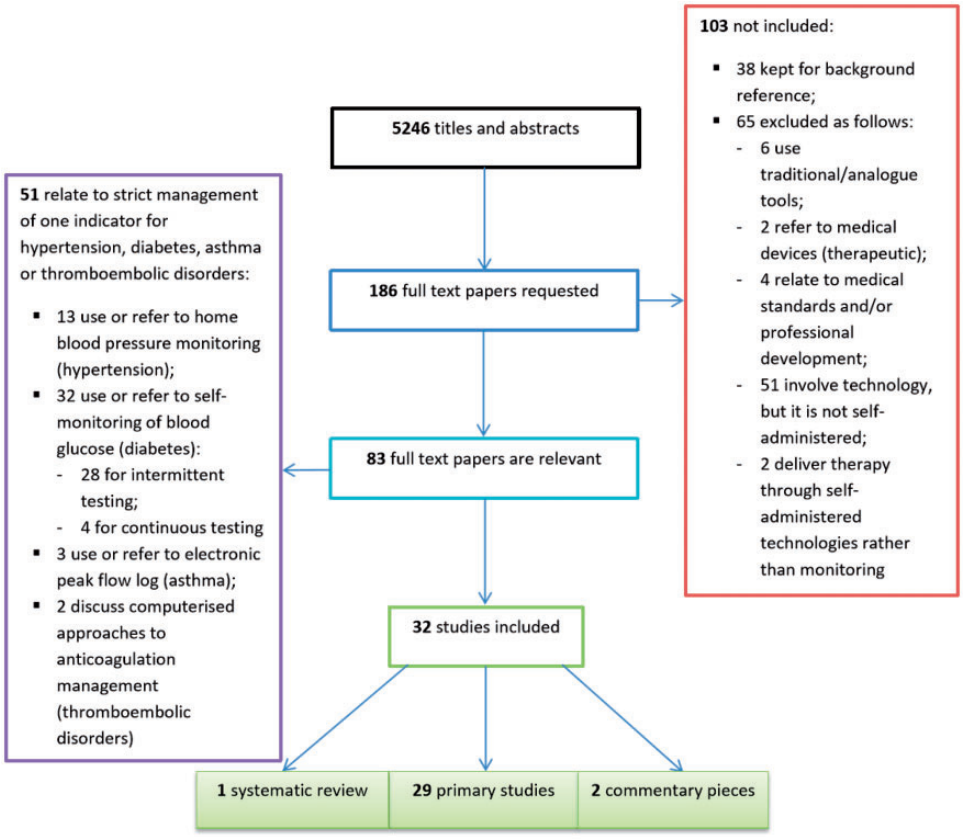
(((SU.EXACT(“Selfmedicalion”) OR SU.EXACT (“Selfmanagerement”) OR SU.EXACT(“Selfmonitoring”) OR SU.EXACT.EXPLODE(“Selfcare”) OR SU.EXACT(“Selfmanagerement programmes”)) OR (share* N3 (decision OR decide*)) OR (self N3 (manager* OR monitor* OR test* OR care OR medical*)) OR (patient* N3 involve*) OR (commonage* OR co manage* OR co produc* OR coproduce*)) OR (SU.EXACT(“Collaborative decision making”) OR SU.EXACT(“Patient centredness”))) AND (((health* professional* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (provider* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms))) OR (doctor* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (practitioner* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (clinician* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (physician* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (therapist* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (nurse* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR

perspective* OR opinion* OR norms)) OR (gp* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (cardiologist* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (psychiatrist* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (psychologist* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (neurologist* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (pharmacy* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (carer* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms)) OR (worker* N3 (attitude* OR view* OR perception* OR perceive* OR experience* OR perspective* OR opinion* OR norms))) OR

(((SU.EXACT(''Selfmedicalion'') OR SU.EXACT (''Selfmanagerement'') OR SU.EXACT(''Selfmonitoring'') OR SU.EXACT.EXPLODE(''Selfcare'') OR SU.EXACT(''Selfmanagerement programmes'')) OR (share* N3 (decision OR decide*)) OR (self N3 (manager* OR monitor* OR test* OR care OR medical*)) OR (patient* N3 involve*) OR (commonage* OR co manage* OR co produc* OR coproduce*)) OR (SU.EXACT(''Collaborative decision making'') OR SU.EXACT(''Patient centredness''))) AND ((chronic OR degenerative) OR (SU.exact(''CHRONIC ILLNESSES'') OR SU.exact(''CHRONIC ILLNESS'') OR SU.exact(''CHRONICALLY ILL'') OR SU.exact(''CHRONIC DISEASES'')) OR ((persistent OR long term OR ongoing) N3 (disease* OR ill* OR condition* OR insufficient* OR disorder*)) OR (comorbidity OR SU.EXACT(''Comorbidity'')) OR (comorbidity OR co morbidity OR multimorbidity OR multi morbidity OR multiple conditions) OR polypharmacy)

Appendix 2

Flow diagram of review process



Appendix 3

Descriptive table of included studies

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Adams 2003[17]	MA, USA	Description of design of the system, features and considerations prior to evaluation in a randomised clinical trial of $n = 300$ children with persistent asthma.	Asthma Designed for children (aged 5—16) and their parents/ guardians — tailored for educational level and provides education for both child and parent/guardian. Based on asthma guidelines.	Computer-based Telephone-Linked Communications system (TLC-Asthma).	To ask the patient questions to monitor their health conditions; to provide education and behavioural counselling for targeted health-related behaviours, such as recognising symptoms, and triggers, medication taking at prescribed times, dealing with exacerbations, pre-treatment, appropriate use of healthcare system, diet and exercise — assesses knowledge to target education.	At-home monitoring device, educator and counsellor for patients with chronic health conditions comprising: 1. Patient-centred telephone-linked communication system; 2. Web-based alert reporting and nurse case-management system; 3. Electronic Medical Record (EMR)-based provider commuciation to support clinical decision making at the point-of-care.	TLC carries out totally automated conversations with patients. The system speaks to patients usinf computer-controlled digitised human speech. Patients communicate with TLC by pressing the keys on their telephone keypads or speaking into the telephone. The patient or TLC may initiate a conversation. A typical conversation lasts between 3-5 minutes. TLC stores the information the user has communicated in a database. Full technical specification reported.	No No	System offers model for new level of connectivity for health information that supports customised monitoring. IT-enabled nurse case-managers, and the delivery of longitudinal data to clinicians to support the care of children with persistent asthma. Systems like the one described are well-suited, perhaps essential, technologies for the care of children with chronic conditions such as asthma.
Agarwal 2010[18]	Singapore, Singapore	Description of a remote health-monitoring services that provides and end-to-end solution.	Hypertension (also refers to diabetes) N/A	Web service; mobile client; and website client.	To collect health data and relay feedback; to allow doctors to monitor and manage their patients' health.	Device-based interface for patients to input health data (blood pressure) for remote monitoring; to show patient graph of recent blood pressure trends and log of entries.	The service: 1. collects blood pressure readings from the patient through a mobile phone; 2. provides these data to doctors through a web interface; and 3. enables doctors to manage the chronic condition by providing feedback to the patients remotely. Full technical specification reported.	No (health professional survey) No	Recommends further research to explore acceptability and feasibility.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Ben Zeev 2013[19]	IL and NH, USA	Development and usability testing study with 12 individuals using the FOCUS smartphone system.	Schizophrenia patients ($n = 904$) and practitioners ($n = 8$) surveyed about use; co-development; user testing ($n = 12$).	The FOCUS smartphone system.	To prompt individuals to engage with the system daily to launch a brief self-assessment of status in each of five target domains: medication adherence; mood regulation; sleep; social functioning; and coping with persistent auditory hallucinations.	Mobile phone programme with several applications that develop an array of adapted psychosocial intervention techniques that target five general domains: medication adherence; mood regulation; sleep; social functioning; and coping with persistent auditory hallucinations.	System-initiated illness self-management prompts individuals with auditory signal and large visual notification equesting user check-in where agreeing a launch initiates user self-assesment in any domain followed by feedback; on-demand resources are made available with 'quick tips' text messages; summary dashboard time/date stamped can be viewed via web page and shared (or not) with practitioners. All informationm shared through secure web page.	Yes (plus surveys of patients and health professionals) No	Production of an mHealth illness self-management intervention that is likely to be successful, ready for deployment and systemic evaluation in real-world conditions.
Biswas 2008[20]	Kuala Lumpur and Melaka, Malaysia	Mixed methods position paper describing an operational prototype in development and pre-trial planning.	Diabetes N/A	Answering multidimensional information needs (AMIN) portal accessed through phone, mobile phone, PC/ laptop or embedded system.	To provide a web-based learning solution that addresses the problem of multidimensional information needs.	Web trackers that maintain non-conventionally structured personal disease logs using regular short messaging service (SMS/ emails) from patients conveying their daily thoughts on their disease; thought partner matching for community creation; responses to health queries — all integrated into a personalised health record with structured summary of health status (mostly monitored by health	System provides continuous virtual connection with physicians and support group.Patient has access to support and care in the following: self-monitoring blood pressure, blood glucose, weight, waist, medication); e-diary goals and expectations (meal plan and control log, recipes, education); e-diary information needs (keying in day to day queries to build dialogue); patient profile; fitness diary.	Yes No	Post-evidence-based medicine (EBM) approach, which is user-driven, may help achieve better health outcomesd through collaboration by multiple stakeholders. Sharing with Government stakeholders for user-driven developments for mutliple stakeholders in public and private sectors.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
						professionals) with non-structured evolving narratives inserted by the patient/thought partner/care giver.			
Brandell 2013[21]	*OR and CA, USA*	*Commentary paper*	*Diabetes*	*Mobile health apps — 'diabetes management' apps*	*N/A*	*N/A*	*Insulin and medication recording; data export and communication; diet and medication recording; and weight management functionalities. Less self-monitoring of blood glucose = less holistic approach*	*N/A N/A*	*Most lack personalised feedback There are data entry challenges Lack of integration with electronic health records Failure to include human factors in design to improve usability and perceived usefulness, adoption of the technology, patients' expectations and professionals' needs Lack of regulation by FDA (so not 'medical devices') and many do not follow established medical guidelines Many make efficacy claims, but lack clinical trial evidence and many ignore evidence-based best practices Might steepen the learning curve for patients and result in disillusionment rather than empowerment 'Technological solutionism' needs to be kept in check Benefits of logging diabetes data has been recast as need for more information and 'big data' solutions, but lack of real utility of the data in decisions and action planning*

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
									Developed predominantly by digital consumerists not medical device development *Measurable behaviour change has not been harnessed* *Few apps provide clinical benefit* *Health care providers must not only educate patients about these resources, but take steps to ensure that mobile apps follow accepted best practices and guidelines.*
Donovan 2013[22]	MA and CA, USA	Interview and concept mapping study to inform the development of a prototype (12 adolescents; 9 caregivers; 12 clinicians). Evaluation of a prototype (7 adolescents; mothers; clinicians).	Migraine Adolescents, caregivers and clinicians.	Web-based self-management programme.	To provide a combination of treatment approaches and self-management skills training.	Web-based prototype with the following content and delivery: quizzes focusing on self-efficacy that generates personalised motivational feedback; audio and video-based tools such as relaxation podcasts and video-based lessons; social networking features that allow adolescents and caregivers to connect with peers or submit questions to an expert; virtual 'toolbox' of coping strategies that adolescents could personalise; a mobile application that included a headache diary and toolbox access.	18 (adolescent) screens with the following content areas: basics (diagnosis, aetiology, prognosis); taking control (emphasising empowerment); causes; lifestyle (prevention strategies); treatment (pharmaceutical and non-pharmaceutical, practical coping strategies); communication (friends, school, health care providers, family). 21 (caregiver) screens: education; parenting a child who has migraines (encouraging independent self-management; self-care for parents); causes; lifestyle management; treatment; communication.	Yes No	Results suggest that an online skills training programme may be useful for the self-management of adolescent migraines.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Fairbrother 2014[23]	Lothian, Scotland, UK	Qualitative study with 18 patients; 5 healthcare professionals using technology.	Chronic heart failure Patients and healthcare professionals.	Intel® Health Guide to enable patients to undertake a daily self-assessment of symptoms.	To reduce hospital admissions resulting from unmanaged exacerbations; improve quality of life for patients; foster increased patient self-management.	Online, touch screen questionnaire and a number of linked peripheral devices: pulse oximeter to measure pulse rate and oxygen saturation; an electronic sphygmomanometer for blood pressure; and electronic weighting scales. Also integrates educational content.	Patients take readings using devices on a daily basis.	No No	System is useful, but with some caveats. Popular with patients as reassured by perceived continuous practitioner surveillance. Professional concern about patient dependence. Increased workloads also a concern.
Gibson 2009[24]	London, England, UK	Mixed methods study of young people's and health professionals' input into the design of the technology using pre-study review of symptoms chosen by young people to be included in the personal digital assistant; post-development questionnaire of its perceived feasibility; post-study qualitative	Cancer Young people (aged 13-18).	Advanced symptom management system ASyMS© for the remote monitoring of chemotherapy-related symptoms (mobile technology).	To support and promote self-care and to detect problems early to prevent hospitalisation.	Personal digital assistant using a daily symptom questionnaire.	Patients complete a32 symptom questionnaire daily whilst undergoing chemotherapy. Responses are sent to the study server. Automatic alerts are sent to a pager at the clinical site and the speed of response depends on the symptom. The health professional is prompted to contact the patient and give advice and support.	Yes No	Device is acceptable to health professionals and overall perceptions are positive.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
		interview study of health professionals' perceptions of use.							
Greaney 2012[25]	MA, NC and ON, USA	Study of 100 patients who completed the web-based intervention in three (non-randomised) arms: observation only (OO); automated assistance (AA); and automated assistance plus calls (AAC).	Cancer prevention	Healthy Directions 2 web-based intervention.	To introduce interventions targeting multiple cancer risk factors.	Web-based programme with user-friendly self-monitoring section to enable patients to track physical activity, red meat intake, fruit and vegetable consumption, daily multivitamin use and smoking; endorsement of behaviour change by health care provider; intervention materials for patient; intervention materials for patient's friends and family members; links to community-based resources. All participants given bottle of multivitamins, a pedometer, login details and a $5 gift card.	All participants received one week's access with no prompts and those logging at least one behaviour three times per week were assigned to OO (n = 14), whereas the remaining participants were randomly assigned to AA (n = 36) or AAC (n = 50). All participants were followed for a further two weeks: observation only (OO) = no prompts; automated assistance (AA) = 2 weeks of daily emails encouraging tracking behaviour and use of study website and 2 tailored self-monitoring reports at the ends of the weeks; Automated Assistance plus calls (AAC) = AA plus two technical assistance <5 minute calls at the end of each week focusing on trouble-shooting technical problems.	No Yes	Prompting can increase self-monitoring rates, which decreases when prompts stop. Calls appear to work better than email reminders.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Holtz 2012[26]	*USA; UK; Ireland; France; Italy; Norway; Finland*	*Systematic review of 21 articles*	*Diabetes*	*Management via mobile phones*	*To understand the most common uses and functions of mobile phones in monitoring and managing diabetes, their potential role in a clinical setting and the current state of research in this area*	*Study-specific applications with a range of/ multiple functions (e.g. diary/log, reminders, information); reminder messages; educational messages; diary to record data (Bluetooth or manual entry)*		*N/A*	
Hopp 2007[27]	MI and IN, USA	Qualitative interview study with clinicians who use MMD telehealth pro grammes.	Diabetes	Monitoring and Messaging Devices (MMDs) telehealth systems.	To promote patient self-management, patient education and clinical monitoring and follow-up activities.	Electronic table-top device to enable response to text questions, including questions that provide information to telehealth providers about how they are feeling and their blood sugar results as well as questions designed for education.	Patients turn on the machine and respond to text questions, including questions that provide information to telehealth providers. Machines are configured individually for each patient who chooses to participate by selecting questions from areas such as general health, glucose testing results, weight, self-management and education. The MMD system is not monitored at night and during weekends and so it is not designed to address urgent issues.	No Yes	Enrollment in MMD programmes is limited by both clinical and non-clinical factors. They are a useful tool for patients who are interested in working on management of their disease, but there are technical challenges and the time commitments required can be problematic.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Kawaguchi 2004[28]	Tsukuba, Kobe and Nishinomiya, Japan	Feasibility study with 1 male patient with type 2 diabetes; patient, nurse and physician and physiological and biochemical data evaluations.	Chronic conditions	Internet-based telenursing system.	To enhance self-management of the condition.	Internet-based system using email (form with questions about health); vital signs data (blood pressure, pulse rate and ear temperature plus finger plethysmography); video-mail (non-verbal information).	The system handles three types of information sent by patientse to the telenurse: 1. email to report health status and any concerns; 2. Vital signs data; 3. video-mail. Patients enter their information on the website berfore going to bed every night. The information is then collected at the regional healthcare centre on the following day by the nurse, who decides whether to provide care via telenursing or personal visit. The physician can also access the information.	No No	The system is feasible and demonstrated significant improvements in blood glucose, glycosylated haemoglobin and blood pressure (n = 1).
Kearney 2006[29]	Glasgow, Scotland, UK	Feasibility study to evaluate the acceptability of using handheld computers as a symptom assessment and management tool for patients receiving chemotherapy for cancer involving 18 patients and 9 health pro fessionals.	Cancer	Handheld computer system (HCS).	To facilitate recording and sending of symptom reports; provision of self-management (symptoms) advice.	Handheld computer incorporating symptom questionnaire completion; viewing self-care information derived from symptom score.	Patients complete a daily symptom questionnaire based on an adaptation of an existing measure. Using a modem, patients send reports to a project nurse. Patient symptoms monitored by project nurse daily. If score out of range, nurse makes contact to offer advice. Data incorporated into patient record for subsequent chemotherapy review.	Yes No	The tool is feasible and acceptable to both patients and health professionals and complements the care of patients receiving chemotherapy.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
							*All data encrypted to ensure confidentiality and password protected access only		
Kenealy 2015[30]	Auckland, Waikato and Tairawhiti/ East Coast, New Zealand	RCT (171 patients) and qualitative evaluation of telecare for diabetes, chronic heart failure or chronic obstructive pulmonary disease.	Diabetes, chronic heart failure or chronic obstructive pulmonary disease.	Commercially available electronic device (Docobo 'health hub').	To enable patients to enter data into a device to be monitored by a nurse-led monitoring station.	Device asks pre-programmed disease-specific questions or conveys short messages from nurses; patients enter data manually following use of electronic weighing scales, a blood pressure monitor, glucometer and pulse oximeter.	A small device with LCD display provides instructions, asks pre-programmed disease-specific questions and conveys messages from nurses monitoring the data. Nurses set up the equipment following baseline assessment. Patients manually enter the data once per day (morning). Nurses review the following day. Option for patients to send additional data. Nurses received green, amber, red warnings according to match of data with targets. Black for no data. Nurses record their response.	No No	Patient and staff reported positive experiences. Patients and families take a more active role in self-management. Some subgroups likely to have benefited more in ways that are not quanitifiable (feelings of safety and being cared for).

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Langstrup 2008[31]	Copenhagen, Denmark	Observational study using ethnographic methods with participants (asthma patients) and semi-structured interviews with general practitioners (n = 8) and a nurse (n = 1).	Asthma	Online asthma monitoring system LinkMedica (LM)	To monitor and support decision making in asthma care.	LM was a Danish online asthma and allergy portal developed by AstraZeneca in collaboration with patients and health professionals. It provided impartial information and debate options for users in addition to data — mainly peak flow readings — entered by patients in an online diary.	The system was accessible from home through a personal log in and patients were advised to log in every day. Based on the data entered, patients would receive a 'daily status' with advice about regulating drug treatment. The health professional also had access to this as well as a decision support tool that provided a 'control status', which was a calculation of asthma severity that suggested an appropriate level of pharmaceutical treatment.	Yes No	The technology never became a durable part of any of the studied practices. It was used in different ways as a patient tool, nurse intervention tool or tool associated with doing clinical research, providing actors with different kinds of agency. It was decommissioned despite a 5 year development and implementation period.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Lin 2012[32]	Taoyuan and Hsinchu, Taiwan	Reports on the development of a web 2.0 diabetes care support system.	Diabetes	Web 2.0 Diabetes Care Support (DCS) system.	To facilitate diabetic patients with managing daily self-care activities and to facilitate care managers at a health service centre with patient support operations.	DCS comprises tools for patients to generate own self-care content, receive diabetes care news feeds and dynamically interact with other operations of the DCS system. Widget-based software that a patient can download from a website and install on their computer. The software contains graphic user interfaces, rules for conducting self-care activities, contacts of care supporting resources and a data store for daily physiological information such as blood glucose level and calorie intake. Blogs and website tools were used for the care managers' part with a function for monitoring patients.	Patients log in daily to input blood glucose level (can also set a reminder at a preset time, which is evaluated and then sent to care providers. DCS calculates calorie requirement and will recommend different types of exercise. There is a simple symptom assessment programme that patients can use to appraise unusual situations. In addition, there is an integrated health news feed, links to the care manager's and other patients' blogs, with functionality for leaving comments. Care managers log in to monitor a patient's status, including self-care activities in order to classify patients into risk groups to differentiate support for individual patients. Care managers can also edit diabetes care knowledge and communicate with patients. Full specification reported.	Yes Yes	Perceived as relatively easy to use and useful for self-care activities. Supports social and interactive care needs of diabetic patients. Overcomes temporal and spatial barriers to care delivery. Individualised and provides continuous support.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Lyndon 2010[33]	*Cornwall, UK*	*Commentary paper*	*Long term conditions* *Ageing population.*	*Telecare and telehealth (including passive sensors and devices in patients' homes and equipment installed in homes that enable patients to take their own biometric readings accompanied by a set of questions about condition/symptoms fed back for health professional monitoring).*				*N/A* *N/A*	*Health professionals need to embrace new technology and ways of working.* *Telecare and telehealth provide ways to increase service capacity and support patients.*
MacNeill 2014[34]	Kent, Cornwall and London, UK	Qualitative study of health professionals' (n = 32) experiences of delivering telehealth care using grounded theory approach.	Long-term and complex conditions (chronic heart disease, COPD and diabetes).	Telehealth monitoring system (Whole System Demonstrator).	To provide telehealth care for people with long-term conditions.	Monitor unit and peripheral devices (pulse oximeter, glucometer and weighing scales) connected to remote nurse service for monitor and review of biometric data where patients were not under the care of community matrons. Community matrons monitor where	Patients record daily biometric readings of blood pressure, weight, oxygen and blood glucose levels. Readings are securely transmitted electronically to healthcare professionals, but are	- -	Mixed views reported, but seem to reflect level of engagement. Welcomed if supplemented rather than substituted traditional roles. Mostly seen as increasing work burden and undermining professional autonomy.

(continued)

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
						conditions more advanced. No action for biometric data within specific parameters. Where outside, health professional: telephones patient to discuss, refers to healthcare services or visits patient.	automatically classified according to pre-set parameters. Healthcare providers monitor and take action if data falls outset specified parameters.		
Maguire 2015[36]	Fife and Forth Valley, Scotland, UK	Repeated-measures, single-arm, mixed-methods study design involving interviews and patient-reported outcome measures (n = 16 patients; n = 13 clinicians).	Radiotherapy for lung cancer.	ASyMS-R mobile phone-based symptom monitoring system.	To monitor patient symptoms remotely.	Two-way system comprising e-survey of toxicity sent by patient and self-care advice sent by clinicians using mobile phone handset.	Patients use the system at home during working hours, 7 days per week for the duration of radiotherapy and for 1 month after treatment. Patients complete daily questionnaire on phone and real-time data are sent to central server where an integrated risk model analysed the symptom reports. Patients receive self-care advice directly related to severity of symptoms. For symptoms of clinical concern, an alert is generated to clinician pager. Amber alerts prompt contact with patient within 8 hours; red alerts prompt contact as soon as possible.	Yes No	Few technical problems reported by patients, who mostly felt that relevant symptoms were covered and that the system helped to manage them and to effectively communicate with clinicians. Clinical improvements were observed. Clinicians perceived the system to positively contribute to clinical care. However, reducing the system's complexity would promote utility.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Maguire 2005[35]	Scotland, UK	RCT to compare mobile phone intervention with standard care (n = 10 patients). Patient and health professional (n = 4) perceptions were evaluated throughout.	Chemotherapy Colorectal, lung and breast cancer.	Advanced symptom management system (ASyMS).	To assess and manage symptoms caused by chemotherapy (chemotherapy related toxicity).	Two-way system comprising e-survey of toxicity sent by patient and self-care advice sent by clinicians using mobile phone handset.	On days 1-14 following the first cycle (in morning, evening and any time they feel unwell), patients complete electronic symptom questionnaire on mobile phone, take their temperature using an electronic thermometer and enter the value into the phone and send this to server using GPRS connection. Risk model incorporated into system alerts health professionals using 24 hour pager system. Uses amber or red alerts to prompt appropriate contact/intervention. Patients also receive tailored self-care advice.	Yes No	Patients believed that the system improved management of symptoms and felt reassured by being monitored at home. Health professionals found the system beneficial for managing symptoms and promoting timely interventions.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Nundy 2014[37]	IL, USA	Survey (n = 12) and in-depth interview (n = 11) study with primary care physicians and endocrinologists following pilot test of patient-generated health data report.	Diabetes Type 1 or type 2.	CareSmarts patient-generated health data reports created using mobile technologies.	To enhance diabetes self-management support.	Mobile phone-based technology that uses patient text messages to generate a report.	Patient receives automated text messages on personal mobile phones consisting of reminders and educational messages and text back responses to self-assessment questions. These include questions on medication, glucose monitoring and reflections on barriers to self-care. Self-assessments are monitored by nurse care managers and they contact patient if the technology alerts them to do so. The report generated fits on one page and is designed for interpretation within 1 minute.	No No	Perceived to offer multiple benefits in overcoming common barriers to self-management support that exist in clinical practice.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Ovretveit 2013[38]	Stockholm, Sweden	Longitudinal case study 1993-2009 reporting continuous innovation in the Swedish quality register for arthritis.	Arthritis	Clinical quality database with new technology for patient-centred care involving different methods for inputting and storing clinical and patient data and for analysing and presenting the data to providers and patients.	To develop and improve clinical care through incorporating patient home self-assessment and other patient-controlled functionality.	Database accessible through patient's own online interface.	Self-assessment entry (data entry system for patients to enter pain scores), control of scheduled appointments based on self-assessment of pain, a self-assessment system that allows more accurate tracking of disease activity that allows patients to do personal experiments, formulate and test hypotheses, online programmes/ activities, involvement of patients in suggesting improvements and designing changes in the system, self-assessment data entry at home with their own online user interface.	Yes Yes	Limited interview data, but shows positive patient and provider perceptions.
Prescher 2013[39]	Berlin, Germany	Post-trial survey based analysis of telemedical care with patients (n = 288) and physicians (n = 102).	Heart Failure	Telemedical Interventional Monitoring in Heart Failure (TIM-HF).	To reduce morbidity and mortality in stable out-patient heart failure patients by detecting clinical deterioration and using early intervention To support interactions between healthcare providers to generate a balanced and structured treatment concept.	The system consists of a three-lead electrocardiogram, blood pressure device, weighing scale, mobile phone for data transmission and self-assessment of health status, in house emergency call with direct connection to telemedical centre and electronic health record in telemedical centre.	System installed in patient's home, patient receives training (60m) and instructed to measure daily body weight, blood pressure, electrocardiogram and self-assessed health status. Measurements transmitted automatically to telemedical centre.	No No	Positively perceived by patients and physicians. Easy to use, robust, improves patient confidence, improves patient contact with physician. Suggests will become part of care in near future, but optimal setting and duration of intervention to be defined.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Quinn 2014[40]	MD, USA	Secondary data analysis based on a cluster RCT that provided patients with mobile self-management.	Diabetes (type 2)	Mobile Diabetes Intervention for Glycemic Control.	To determine how a mobile-phone-based coaching system for diabetes management influences physician prescribing behaviour.	Mobile phone comprising coaching software integrating blood glucose levels, carbohydrates consumed, diabetes medication taken and comments about self-care in a real-time web-based logbook.	Patients manage diabetes using system to enter data for biomedical indicators and receive real-time or personalised feedback from physicians. Physicians have access to patient data through a web portal. Physicians receive quarterly (or more frequently if necessary) reports on patient entered data, which summarised glycaemic and metabolic profile, self-management skills, adherence to prescribed medication and other aspects of health care, e.g. vaccinations and eye tests. The report also contained recommendations for individualised medication regimens.	No No	No significant changes I prescribing, but mobile diabetes interventions can encourage physicians to modify and intensify antihyperglycemic medications.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Rich 2000[41]	MA, USA	Video technology and qualitative research study.	Chronic health conditions (asthma) Adolescents.	Video Intervention/ Prevention Assessment (VIA).	To better understand the issues and needs of adolescents with chronic health conditions.	Interview for condition-specific verbal reports (CSVRs) and using standardised health-related quality of life (HRQL) instruments, video camcorders to record visual narratives of illness experiences, documenting daily life, interviews with family and friends, personal monologues. Post-intervention HRQL evaluation.	Participants were taught to use the video camcorder (mechanics only to avoid bias in film-making norms/style). Used day-to-day for 4-8 weeks. Interviews with family members, friends, etc. (interview questions provided) plus audio-visual personal participant diaries.	No Yes	Identified a number of issues not identified by standard clinical tools. Improved patient quality of life. Helped to show 'counterproductive' behaviours in context of real life. Can help patient with self-management, educate clinicians, families and students of health care professions about adolescents' realities of living with a chronic health condition.
Seto 2012[42]	ON, Canada	Semi-structured interview study with 22 heart failure patients and with 5 clinicians.	Heart Failure	Mobile Phone-Based Telemonitoring.	To identify features that enable successful heart failure telemonitoring.	A custom designed and built software application on a mobile phone used to store data and transmit information to the data repository at the hospital. Patients were provided with the telemonitoring. Patients were provided with ECG recorder if they did not have one.	Patients are required to take daily weight and blood pressure readings, weekly single-lead ECGs and to answer daily symptom questions on a mobile phone. Instructions are sent to patient based on their values. Alerts also sent to the cardiologist's mobile phone when required. Used for 6 months.	No No	Features and design matter. The characteristics of this intervention should be considered in the development of an intervention.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Seto 2010[43]	ON, Canada	Questionnaire study regarding attitudes towards home monitoring and technology. Semi-structured interviews with 20 heart failure patients and 16 clinicians to determine perceived benefits and barriers to using mobile phone based remote monitoring.	Heart Failure	Mobile Phone-Based Telemonitoring.	To assess attitudes of heart failure patients and their health care providers towards mobile phone based remote monitoring.	The heart function home monitoring system consists of special wireless (Bluetooth) home medical devices, a pre-programmed BlackBerry cell phone, and a central data storage system that is located in the hospital. Weight, blood pressure/ pulse, and symptoms are taken at home and then transmitted wirelessly to the BlackBerry. Patients might also be instructed to take an Electrocardiogram (ECG) at home as well.	The BlackBerry processes the readings and sends the information automatically to the computer at the hospital. The BlackBerry also stores the results and displays graphs of the measurements. Patients are provided with instructions on the Blackberry screen once they have completed all the daily measurements. The healthcare team at the Heart Function Clinic will also be alerted if measurements are out of the goal range.	No No	Patients and clinicians want to use mobile phone-based monitoring and believe that they would be able to use the technology. Reservations are potential clinical workload, medicolegal issues and difficulty of use for some patients.
Shea 2012[45]	AZ, USA	Secondary descriptive correlational analysis of patient, home help and nurse ratings of each other on communication and the use of patients' daily telemonitored information.	Chronic conditions	Telemonitoring. Home-based monitoring system.	To support patients in integrating daily self-care behaviours.	Freestanding data collection hub used to collect patients' vital signs (blood pressure, weight, pulse, glucose levels, oxygenation) and other symptoms (sleep, oedema, shortness of breath, pain) using peripheral monitoring tools or patient report.	Daily use involving taking biomeasurements and inputting data, which are then transmitted via telephone line to a remote telehomecare nurse. The nurse reviews the data with the assistance of a computer programme that flags out-of-range data to determine whether the patient needs to be contacted and directed to take action.	No No	Frequent phone communication may lead the nurse to believe that the patient is integrating daily self-care behaviours when they are not. More attention to patient education and best practices for nurses are recommended.

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Shea 2011[44]	AZ, USA	Comparative content expert analysis of reactions to technologically-delivered health-risk measures.	Chronic conditions	Home Monitoring Technology.	To provide vital sign measures.	-	-	No No	Patients have a similar reaction, but may be more likely to accept without considering threats to health.
Thomas 2014[46]	Bristol, Sheffield and Southampton, England, UK	Study protocol for evaluation of the effectiveness and cost-effectiveness of a telehealth intervention.	Depression or raised cardiovascular disease (CVD) risk	Telehealth intervention: NHS Direct Healthlines.	To support patients in setting and addressing their goals.	Uses advice derived from computerised protocols and support scripts, including guiding patients to relevant resources available online, e.g. NHS Choices and interactive programmes such as computerised CBT and relevant apps and widgets. Individualised web portal with information about service, patient condition and with function to record blood pressure readings (CVD patients) collected using a home based monitor.	For CVD, patients take blood pressure twice daily for one week and weekly thereafter. The portal calculates average readings and provides analysis and advice. For depression, a series of interactive sessions, which include monitoring of symptoms, medication adherence, exercise and alcohol use. Both twinned with regular phone calls to support use.	Yes Yes	-

(continued)

Continued.

Author Date	Setting	Study type	Chronic condition Specific population	Self-administered health monitoring technology description and/or name	Self-administered health monitoring technology purpose	Self-administered health monitoring technology functions	How does it work?	Users involved in design? Can it be tailored/ personalised by user?	Key findings
Urowitz 2012[47]	ON, Canada	Evaluation of the experience of patients and providers using an online diabetes management portal for patients.	Diabetes	Patient portal/ online site.	To engage patients in self-care and empower them to take a more active role in their diabetes management.	Disease management tools that allow patients to log health metrics and providers to monitor these patient-entered health metrics, which include blood glucose, blood pressure and body weight. Comprises 'health library', which hosts interactive diabetes education materials for patients and providers and access to personal health records through a secure online system for patients.	Patients are categorised into green, yellow or red based on severity of condition and self-management needs. Green patients use the portal 1-2 times weekly, yellow 3-6 times weekly and red 7 times per week to record health metrics (tailored by providers).	No No	Online portals increase patient access to information and engagement in their health care. Improvements in usability are required. The role of professionals in the facilitation of use is a grey area.
Zamith 2009[48]	Lisbon, Portugal	Evaluation of the use and acceptance of a portal device questionnaires to solicit patients' and health professionals' opinions.	Chronic respiratory insufficient (CRI) (n = 51) and asthmatic patients (n = 21)	Portable device: The Doc@Home	To reduce hospital admissions and improve quality of life.	Telemonitoring equipment set up in the patient's home consisting of 3''x2'' screen with a series of pre-programmed questions, buttons used to answer and lateral sensors to capture ECG via palm contact. CRI patients were also given an oximeter to measure blood oxygen level. Peak expiratory flow rate, sleep quality, ECG and blood gas were also measured.	Patients answer questions on respiratory symptoms, daily and relief medication, number of hours spent on oxygen and ventilator and any need for medical emergency appointments at the end of each day. Once a week, patients answer questions on how often they left the house and quality of life. This lasted 9 months.	No No	Learning to use the system was difficult and most patients reported problems with the equipment. Reduced number of hospital admissions and improved quality of life. Patients felt well supported and would use the system again in future. The majority of asthmatic patients would have liked to have maintained this type of monitoring.