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Rosemary Stockdale
Institute of Information & Mathematical Sciences Massey University Albany, New Zealand, r.j.stockdale@massey.ac.nz

Tony Norris
Institute of Information & Mathematical Sciences Massey University Albany, New Zealand

Farhaan Mirza
Institute of Information & Mathematical Sciences Massey University Albany, New Zealand

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Rosemary Stockdale
Tony Norris
Farhaan Mirza
Institute of Information & Mathematical Sciences
Massey University
Albany, New Zealand
Email: r.j.stockdale@massey.ac.nz

Abstract

Mobile technologies are anticipated to offer cost effective and efficient information management solutions for the chronic care sector. The increasing incidence of chronic diseases is leading to severe pressure on healthcare services struggling to meet increased demand. Although mobile technical solutions are being developed, there is little understanding of the issues affecting acceptability and sustainability of mobile health initiatives and the requirements for the development of holistic care services. This research uses a qualitative study to determine the potential for implementation of m-health across the spectrum of chronic disease care and to identify key factors affecting the stakeholders. While study participants paint an optimistic future for m-health, there remain several challenges before a holistic approach can be achieved, not least the standardisation and integration of information across the whole health sector.

Keywords

Mobile health, m-health, chronic disease, healthcare management, mobile technologies

INTRODUCTION

The increasing incidence of chronic diseases in the developed world has focused more attention on possible uses of information and communication technologies (ICT) to alleviate the costly and time consuming nature of chronic disease management and care (Alpay Toussaint & Zwetsloot-Schonk 2004). There are several stages in a complex chain of information sharing where ICT can be used to great effect for the dissemination of information and to improve delivery of care. The first stage addresses the need for lifestyle education options that delay or prevent the onset of diseases such as diabetes and heart conditions. From this preventative stage, through monitoring of patients to delay the onset of disease, to the management of chronic illness itself, there are many opportunities to enhance care through more efficient collation and sharing of information. A broad spectrum of stakeholders, from hospital clinicians through to home carers, is involved in the management and exchange of information relating to healthcare. More recently a move to extend the sharing of information to empower patients and enable them to take an informed role in the management of their conditions has begun.

The pervasiveness of mobile technologies promises much in the search to increase efficiency while restraining rising healthcare costs. To date, mobile health (m-health) research has focused more on specific applications and proof of concept studies (Guruajan & Murugesan 2005) rather than the examination of generic principles or the analysis of critical success factors. M-health studies seldom addresses the socio-emotional impacts of chronic conditions or emerging issues such as the change from a biomedical model of healthcare to the concept of the patient as customer and patient empowerment through self-management. The need to approach m-health research from a more holistic standpoint is expounded by a report on m-health in New Zealand, which acknowledges that 'technology is the easy part' (Miller 2005 p.32).

The contribution of this paper is the identification of key factors that potentially influence the adoption and sustained use of mobile technologies for information management in chronic disease care. A qualitative study is used to identify stakeholders' perceptions of the uses for mobile technologies and the benefits that might be gained. The study identifies key issues that influence the use of m-health in chronic disease management from early education to advanced care and finally, examines the potential of m-health to increase patient empowerment and self-management of chronic disease The following sections of the paper define what is meant by mobile health before discussing issues that influence its widespread adoption. A description of the research methodology is followed by the findings, the implications of which are discussed in the context of sustained use of m-health initiatives.

DEFINING M-HEALTH

In this paper we define m-health as the use of small, portable, and wireless computing and communication devices to meet the information and service needs of healthcare providers and consumers (Galpottage & Norris 2005).Within this definition, mobile devices can be identified as transceivers that run healthcare applications over wireless (and wired) networks. The armoury of such devices is increasingly diverse ranging from laptop computers, tablets, and PDAs to mobile and smart phones and RFID technologies (Hansmann et al. 2003; Miller 2005; Zheng & Ni 2006). A helpful way of identifying current uses of m-health is by classifying them as either clincial or non-clinical applications. The former refers to the broad spectrum of healthcare delivery ranging from prevention measures aimed at raising public awareness of lifestyle implications for health, to monitoring of patients, ongoing treatment, support for patients and their carers, and finally end-of-life care. Non-clinical applications support those activities that contribute to the smooth operation of any healthcare service which relies heavily on administrative and management functions to support the clinical imperative. Some typical examples of both clinical and non-clinical m-health applications, drawn from the literature, are identified in Table 1 (Connelly et al. 2006; Hodgson 2005; Istepanian & Lacal 2003; Vanjara 2006; Yu et al. 2006).

Table 1: M-Health Applications

Clinical applications	Non-clinical applications
• Web access to evidence-based databases • Medication alerts using mobile phones • E-prescribing for repeat prescriptions via mobile phones • Telemonitoring to transmit patient results to clinicians • Transmission of test results to patients via SMS • On-line electronic health records via computer/ phone • Community nursing contact with clinical expert advice • Public health and lifestyle messages over mobiles • Care of at-risk people, e.g. pilots, military personnel • Emergency care for accidents, natural disasters	• Efficient workflow via wireless communication • Rapid collection/sharing of current data via mobile phones • Optimal asset utilisation, e.g. hospital bed rostering • Patient or asset (e.g. clinical equipment) location using RFID • Patient appointment booking and alerts via wireless e-mail • Mobile phone support for patients and carers • Safety of staff checks with RFID or mobile phones/networks

M-HEALTH AND CHRONIC DISEASE MANAGEMENT

A significant driver in healthcare is the ageing of populations in developed countries (Lloyd-Sherlock 2000). In New Zealand, for example, the proportion of over 65s will account for 25% of total population by 2051. These ageing populations, together with significant changes in lifestyles, have led to epidemic levels of diabetes and heart disease. The psychological and social challenges for people diagnosed with such conditions are severe (McArthur et al. 2006) while the impact on health services is increasingly burdensome. Economic consequences are extensive as costs escalate and professionals attempt to meet patients' needs with inadequate resources. At the same time, current developments in healthcare are moving towards the concept of the patient as 'the customer' with a corresponding shift of responsibility to the 'customer' to manage their own needs (Alpay et al. 2004; Opie 1998; Paterson 2001).

Experimental mobile health initiatives, covering many of the applications in Table 1, have shown some positive results in supporting the transition to the patient empowerment model (Connelly et al. 2006; Hodgson 2005). These range from building on simple diary reminders for appointments and medication via text messaging services (Hodgson 2005) to developing systems for automatic transference of blood pressure and sugar level readings from patient to clinician for ongoing feedback on a patient's condition. Nevertheless, more sustainable initiatives require a radical rethink from within the health sector to determine the issues that influence the design, implementation and acceptability of mobile technologies and their use. Such a rethink includes adapting mobile health initiatives to the older market where mobile phone adoption is rapidly increasing as the baby boomer generation, with a 66% mobile penetration rate, move into retirement (Dwyer 2004) and increased likelihood of developing a chronic disease.

M-HEALTH ADOPTION AND USE

As frequently happens with the introduction and diffusion of new technologies, the benefits are driven partly by the needs of the domain and partly by the capabilities and opportunities offered by the technologies themselves

(Rogers 2003). Within the mobile environment there is also strong evidence that the external and internal organisational contexts impact on a user's satisfaction with mobile devices (Scheeper, Scheepers & Ngwenyama 2006). This section discusses the adoption of m-health from several perspectives, addressing the expected benefits, cost of adoption and reward elements; the contributing elements of 'relative advantage' as a predictor of rates of innovation (Rogers 2003).

Perceived Usefulness

The adoption of mobile technology has several implications beyond those identified in more familiar IT environments, although the need to balance the introduction of technology with the needs of stakeholders remains. Reducing face-to-face interaction through the use of IT can impact on the social needs of people and lead to resistance to new technologies, even at a subconscious level. This is of concern where there is an adverse impact on those needs arising from rejection of the technology (Vanjara 2006). However, mobile phones are now an integral part of the mainstream and are perceived as symbols of affluence and integration in many segments of society. This may reflect the status-conferring quality of innovation adoption described by Rogers (2003) and prove to be a positive driver for m-health within certain socio-economic groups where the incidence of chronic diseases is high. This can have an advantageous impact on patient use for healthcare management as it removes the stigma that may arise from more obvious medical monitoring devices (Connelly et al. 2006) and encourages regular and sustained use.

Benefits

Mobile devices have the advantage of being location independent, giving flexibility and mobility to the range of healthcare stakeholders (Istepanian & Lacal 2003; Prentza, Maglavera & Leondaridis 2006). This also improves the ability of both patients and clinicians to access information with consequent advantages for constant monitoring of patients' conditions, interactive consultancy, remote/rural care and fast emergency responses (Istepanian, Jovanov & Zhang 2004; Istepanian & Lacal 2003; Prentza et al. 2006). Mobile technologies also offer the possibility of managing non-critical care within the community thus reducing hospitalisation, improving patients' quality of life and controlling costs (Norris 2002).

Costs

A core value proposition of mobile technologies for healthcare is their apparent low cost. Certainly, unlike many medical innovations, the cost of mobile technologies to the consumer is very small and their cost-effectiveness very high (Norris, Stockdale & Sharma 2008). There are the capital and operational costs of the supporting infrastructure but such costs are shared over many markets and the expansion of generic mobile services has produced dramatic falls in service costs; a trend that shows no signs of abating. Indeed, as the technologies become more powerful the introduction of more innovative and seamless applications is anticipated to drive down costs even further (Srivastava 2008). These effects will also encourage enterprises that previously had no presence in the health sector to offer value-added products and services.

There remain some concerns about the high cost of mobile connections in some countries that may affect the ability of some patients, particularly those suffering the economic hardships often associated with chronic diseases, to participate in m-health benefits (Istepanian et al. 2004). This is particularly true in New Zealand with its small population and lack of competition in the telecommunications marketplace that gives rise to high call costs. Currently this has led to a preference for the cheaper method of texting over voice calls, but has not greatly inhibited the sale of mobile phones. In the context of chronic diseases where patients frequently attend healthcare centres over several years, there may be a trade off between mobile costs and the reduction in travel costs. However, as with telemedicine (Norris 2002), cost benefits may accrue more readily to patients than to providers and there is a need for the latter to identify real savings if they are to adopt m-health more widely (Istepanian & Lacal 2003).

Preventative Care

The full spectrum of chronic disease includes dissemination of information aimed at preventing increased incidence of such conditions as diabetes and heart disease. The longevity that results from the success of modern medicine increases individuals' demand for better standards of health over a longer period of time. Despite this, public health interventions and campaigns frequently report limited success and fail to raise personal awareness of preventative health management strategies through appropriate lifestyle and care (Miller 2005; Stockdale 2008). However, the pervasive nature of the mobile phone offers opportunities for targeted marketing of the health message and its reinforcement by repetition and with incentives (Neville et al. 2002). The possibility of reducing the incidence of chronic disease through preventative education is a positive driver towards m-health initiatives.

Efficiency & Effectiveness

The potential health benefits of mobile applications as seen in Table 1 represent two of the generic improvements, namely efficiency and effectiveness, that are sought from the introduction of new technologies (Norris et al. 2008). A third general benefit, which builds on experiences in telehealth, is increased access to services and resources (Economopoulos 2006). The pervasiveness of mobile technologies, particularly mobile phones, is set to have a major impact on how we think about the delivery of healthcare and the relationship between provider and consumer (Martins & Jones 2005). Although it seems highly probable that the increased ease of communication between clinicians and patients will be beneficial to patient empowerment, it will also lead to higher workloads with more informational demands on healthcare providers (Alpay et al. 2004; Brennan & Safran 2003; Opie 1998; Paterson 2001). This will involve the development of new services potentially managed by the involvement of intermediaries who can add value for all participants.

Key Issues

Mobiles, like emails, are often seen as an interruptive technology that can increase workloads by the immediacy that they offer, creating an expectation of instantaneous response without regard to time or situation (Alpay et al. 2004). This immediacy requires a substantial change in the management of the work/social boundaries as people increasing find that work issues "invade their private time enabling the institutionalization of 'anytime, anywhere' availability" (Prasopoulou, Pouloudi & Panteli 2006 p.280). The blurring of boundaries is not necessarily negative as the contextual influences of voluntary and mandatory use have been shown to influence user satisfaction (Scheepers et al. 2006). The latter study found that in one firm the encouragement of the private use of work-issued mobile devices had a strong influence on the satisfaction levels of workers.

Technical Issues

Rapid communication contributes to efficiency of the service operation and to the ease of data collection and exchange. This ease in turn increases the value of data leading to improvements in their quality and longevity (Kerr & Norris 2006). These advantages have particular importance in countries such as New Zealand that derives added-value from its national data collections. If data can be collected directly and effortlessly from people via their mobile phones then, with the appropriate management and analysis, the derived information could have an enormous impact on the quality and efficiency of service planning and operation.

Although not solely a technical issue, from a healthcare standpoint, concerns over the privacy and security of personal healthcare information are often concentrated in technical discussions (Galpottage & Norris 2005). Whilst apprehensions over ethical issues surrounding the electronic storage and transmission of sensitive data and their misuse cannot be ignored, they are sometimes more perceived than real. Wireless security protocols are improving rapidly and compliance standards for both security and privacy are being developed in several countries along with effective biometric and cryptographic systems (Yu et al. 2006). From a technology perspective, one aspect of m-health offers an interesting paradox. The acceptability of the mobile phone is based on the simplicity and the convenience with which they perform their main function - voice communication by telephone. However, as the technology and power of the devices progresses, their expanded functionality betrays them as examples of a disruptive technology (Christensen 1997; Pagani 2005). A disruptive technology is a technology that when introduced does not meet the needs of users. Thus, a desktop personal computer or a laptop meets the computing needs of users in terms of modelling (e.g. Excel), office applications, or web searches but mobile phones, some of which are as powerful as a 1960s mainframe, cannot satisfy these requirements. The main limitation here is the form factor. The demands of portability have not so far been matched by the release from the constraints of small screens and cramped keyboards. The matching of mobile devices to clinicians' needs is important if acceptance of the technology is to be widespread (Yu et al. 2006). Similarly, the reliability of mobile devices and their fault tolerance attributes do not meet the exacting requirements of the mission-critical applications found in healthcare.

Further technical issues that remain to be addressed before mobiles can become a ubiquitous part of healthcare include familiarity with the equipment and the applications. This will take education and training if it is to encompass all stakeholders regardless of demographic influences (Yu et al. 2006). Another issue remains the inadequacy of battery power (Istepanian et al. 2004; Yu et al. 2006). While computing technology doubles in power every 18 months, battery power has taken 30 years to achieve the same level of improvement. Finally, in countries where payment for healthcare is more prevalent than in New Zealand, there is a requirement for mobile payment methods to be available (Istepanian & Lacal 2003).

Change Management

A further clinical, and perhaps more limiting, challenge to m-health is the acceptability of the technologies to patients and healthcare practitioners. Consumer empowerment and convenience may overcome patient concerns without too much resistance but clinicians are rather more traditional when it comes to alternatives to face-to-

face delivery of medicine (Skulimowski 2004). Organisational change needs to accompany the development of mobile health technologies and the associated shift in stakeholder power that they will support. Acceptance and adoption by clinicians is seen as a primary success factor in the development of m-health (Yu et al. 2006), and will influence other practitioners to embrace initiatives in the delivery of healthcare services. This will require that all stakeholders identify the reward elements of the relative advantage of adoption (Rogers 2003). Chronic disease management presents several concerns to clinicians; the potential for automating readings, information delivery and clinical-related decisions concerning treatment. The multidisciplinary nature of such care requires that all the team accept the technologies if treatment is to be seamless and integrated. They must also adapt to the impact that wireless and mobile devices and services may have on the doctor-patient relationship (Skulimowski 2004). These requirements, and the attending change management issues, will become increasingly important as the impact of chronic disease care on under-resourced health services becomes more severe.

THE CONTEXT OF THE STUDY

New Zealand is an excellent case study for healthcare research (Miller 2005). Its small population is representative of a vast range of ethnic backgrounds, with a high level of cultural integration. The standard of living parallels that of most developed nations with the accompanying increase in the incidence of chronic disease to alarming proportions. This has put a corresponding pressure on health services to deliver cost-effective healthcare whilst sustaining quality. New Zealand has a national health system with well-developed standards for information sharing and reporting via national databanks while the public health system has a parallel private sector thereby covering a range of healthcare situations. The key issues regarding adoption and use of m-health initiatives within New Zealand has the potential to inform m-health development in other nations. The deeper understanding of the phenomenon allows for specific implications to be drawn that bear relevance to other contexts (Schofield 2002).

METHODOLOGY

A case study methodology enables an exploratory approach to be taken to a research area that requires in-depth understanding. Case study research has been endorsed as a method of investigation for a phenomenon that is broad and complex (Yin 1994). This type of research also supports a need to understand "the complex and ubiquitous interactions among organisations, technologies and people" (Dubé & Paré 2003 p.598). Although the findings from the case cannot be specifically applied or generalised to a wider population, specific implications and analytical generalisations can be drawn that may be of value to other organisations (or healthcare systems) and contexts (Iran, Sharif & Love 2001; Schofield 2002). This reflects the intent of a case study to increase understanding of the phenomenon within cultural and contextual situations from the perspective of the participants (Orlikowski & Baroudi 1991).

This research therefore addresses the views of stakeholders within the context of chronic disease management as its primary data source. Supplementary data from the literature, industry reports and personal contact is used to support the participants' perceptions. A total of 18 semi-structured interviews, averaging one hour, were conducted, recorded, transcribed and verified with the participants over the course of several months. Interviewees were drawn from all segments of the New Zealand health sector and included primary (e.g. General Practitioners) and secondary care practitioners (e.g. hospitals), community health workers and employees of technology companies involved in healthcare service. Selection of interviewees was initially through personal contact from academics working in health informatics and expanded through a snowball strategy (Henry 1990).

Following the research objectives previously described, the interviews began by introducing the role of mobile technologies in healthcare in New Zealand to establish a starting point and generate ideas from the interviewee. The guiding themes subsequently used by the interviewer focussed on the benefits of m-health (relevant to interviewees' sector) and the perceived usefulness of mobile applications to the healthcare staff. Interviews were moved towards discussion of the key issues that influenced sustainability of m-health in assisting chronic disease care, and its applicability to the aiding management of healthcare delivery in this area. Finally, interviewees were encouraged to discuss any other factors relevant to their role in an m-health environment with emphasis on patient empowerment.

Data analysis was ongoing and iterative and was centred on these broad themes which were drawn from the research questions that formed the semi-structured basis of the interviews. Thematic analysis was used for both the interview text and for secondary data sources. The ordering of the data was carried out by coding the interview transcripts, using the themes as the units of analysis. More detailed coding of the themes using sub-texts were derived from the interview transcripts and iterative analysis of the contents. Coding was conducted

separately by two members of the teams, before cross matching of the ideas and determining a coherent, holistic view of the content.

FINDINGS AND DISCUSSION

The findings are presented and discussed within a framework of issues that influence the adoption of m-health. This allows for the perceptions and issues identified in the interviews to be presented within the context of a holistic perspective of preventive-to-end healthcare. This approach accords with Harvey and Myers' (1995) contention that the holistic nature of qualitative studies is more suited to a story-telling approach in preference to the more traditional 'hypothetico-deductive approach' (p.11) common to information systems.

M-health research to date has been mainly of a 'proof-of-concept' nature. Although study participants were clear that much more systematic work was needed to develop m-health technologies, they had focussed ideas on the potential applications and uses of the applications. In particular, looking further ahead, all clinicians felt that patients should have mobile access to their electronic health records (EHRs) but many problems, operational, technical, and ethical, had to be addressed before this facility would be generally available Once the discussion of m-health as a beneficial direction for future development was covered, participants were eager to discuss the difficulties and benefits that they foresaw.

Benefits and Use of M-Health Applications

There were a wide range of perceived uses of mobile technologies by those interviewed with many covering a range of ideas related to the applications given in Table 1. Vital signs monitoring and the transmission of test results for patients with chronic conditions were recognised as increasingly important roles for mobile technologies and the simplicity and standard format of short message services (SMS) promoted them as backbone mobile phone services for the present and foreseeable future. SMS services could also boost the impact of public health and lifestyle messages within the context of preventative care if a suitable format or incentives could be found. The increasing use of mobiles in marketing and greater understanding of m-marketing techniques is likely to increase recognition of this.

Providers saw the use of mobile technologies to collect data in an electronic format as a major advance in increasing the utility of data and its value in both operational and strategic decision making. Data collection in chronic disease care is an ongoing and vital procedure for both clinician care and patient self management. The perceived focus in the earlier stages of development is anticipated to be on mechanisms for routine data collection and these should be as independent as possible of the nature of the data.

Secondary care providers were especially vocal about the value to them of mobile technologies as vehicles for communicating with colleagues, particularly members of the care team, and, obtaining access to clinical information. On a more mundane level, one District Health Board (DHB) had managed to reduce its missed appointments percentage from 18 to 9% over the last two years and was determined to exploit SMS to reduce this number even further. This corresponds with Hodgson's (2005) study that found that messaging significantly reduced the number of missed hospital appointments although a further effect on patient behaviour in respect to increasing self management was not recognised by those interviewed.

Although the value of m-health applications for community health services was well recognised, use specifically by patients was discussed only in general terms. Only one interviewee discussed the value of patients sending information to practitioners and pulling information relevant to their own healthcare from secondary health sources. This same interviewee recognised the advantages for elder and chronically sick patients where *'it is better to have an ageing population staying at home powered with mobile services'*

A key point in the discussions was the use of m-health applications in an appropriate manner. Interviewees had a widespread understanding that the necessary technology was available for the development of m-health, but that translating the correct processes into suitable applications was a major barrier to more effective use:

"People are bored with the latest and greatest device. It is important to have the adequate clinical process to make it a value. The health industry is not like other businesses which have workflow issues which can be easily solved by a business analyst. This makes it slower to pick out the clinical processes which can potentially be mobilised."

Such work is already underway and examples were given such as a DHB that "*has a long history of customised applications*' with clinical involvement in the development and production of solutions. Web services were also predicted to be a major driver in further development of customised applications despite the costs involved. This corresponds with the perceived growth in intermediaries' role within the health sector as ICT plays an increasingly important part in the stakeholder information networks (O'Dell 2000).

Key Issues of M-Health Implementation

A response volunteered by many participants identified a key element to the successful application of m-health technologies. This concerned the need for seamless use of these technologies through the several stages in a communication or information sharing chain such as required in the chronic care context. The example of a community nurse collecting data from a patient manually or receiving instructions on paper and then transmitting the data or issuing the same directions electronically was viewed as something that would hinder rather than promote m-health. A holistic systems or business process re-engineering approach was needed to avoid such barriers to progress. This holistic approach also applied to the need for common standards across the national health sector where;

"there has to be a common language that needs to be spoken within the health sectors of New Zealand….the way one practice records information isn't necessarily compatible with the way another practice does it. There needs to be either a national or a regional dialect."

This was echoed by all the interviewees from different perspectives and reflects the findings from previous research (Guruajan & Murugesan 2005; Istepanian & Lacal 2003). One participant saw the Ministry of Health as a facilitator that could encourage health boards towards common standards, although he remarked that the necessarily collaborative nature of the Ministry's efforts tended to slow down the initiatives. Another interviewee was concerned that the lack of:

"initiative from the centre…encourages people to lead region wide projects or introduce region wide systems. Unfortunately, regions are having to lead the way."

This means that systems within each specialisation in each region are developing independently and thereby hindering the ability to integrate information to support holistic, sustainable systems. This again reflects Gurajaran & Murugesean's findings (2005) from their technical study. However, there are currently initiatives to standardise across district health boards (DHB) in the Auckland region where neighbouring DHBs are working to integrate their systems to enhance information access.

As previously noted by Yu et al. (2006), interviewees saw the involvement of clinicians as vital to the continued use of technologies in healthcare. The situation in New Zealand was seen to be positive with one interviewee reporting on three stages in clinicians' acceptance of technology:

"Five years ago there were systems imposed on clinicians and they hated these systems. Three years ago clinicians were much more involved in the development of their systems. Now there are clinician led initiatives."

Change management was recognised as a vital issue in the development of sustainability. A pro-active approach to m-health, and therefore acceptance of the need for change, was noted amongst the interviewees from all sectors of health. We believe that this reflects that only those committed to progressing m-health initiatives were willing to take part in the research, rather than total health service consensus on the issues.

Privacy and Security

Those who took part in the survey were keen to separate the issues of privacy and security. Participants felt that security was not the main issue since its governing parameters were mainly operational and technical. Privacy of information and consent to its use or to treatment (Galpottage & Norris 2005), however, were more conceptual and philosophical matters with strong ethical overtones. Objections to the transmission of information using m-health would probably diminish over time as the technologies matured and the benefits and convenience were seen to outweigh the risks but privacy concerns were paramount and m-health protagonists must incorporate them in the new ways of working. Interestingly, the privacy issue divided clinicians almost equally on the possibility of supporting electronic health records (EHR) on mobile devices. Everyone saw the merit of maintaining the health records via mobile devices but whilst some providers would alter the privacy requirements to make EHRs available, others said that they were unlikely to become available until security improvements could guarantee privacy.

Technology

Technical issues were only lightly touched upon by interviewees, although two were from the technology sector and all respondents had informed views on technical matters. Overall, they did not agree with Howard et al.'s finding (2006) that technology was a barrier for wireless uptake, although there was agreement that the complexity of the health context increased the need for training programmes for all practitioners. The main concern was the form factor needed to ensure the portability of a mobile device and the necessary constraints it imposed on the small screen and keyboard size, particularly with mobile phones. Doctors felt that m-health applications should not require users to enter significant amounts of free-field data but rather they should be able to enter items into specified fields by accessing options from pick lists. Thus, keyboards are not the main

problem but all responses pointed to the limitation of a mobile phone screen and felt that new technologies such as folding screens would be needed before multimedia or web-based services could come of age.

A valid point made by healthcare systems developers drew attention to the difficulty of achieving a critical mass of sales and the negative impact it had on software construction times and cost (Burley & Scheepers 2003). Given the pervasiveness of mobile technologies, this is potentially less of a long-term problem but the short-term difficulty focused squarely on the proliferation of so-called standards and the need to port applications across multiple protocols and platforms.

Patient Empowerment

A frequently expressed view from the study was the perceived impact that mobile technologies would have on patient empowerment. The convenience aspect, patients' greater access to information, and easier communication with clinicians were all seen as triggers for patients to become more involved with and responsible for their own care. For example one interviewee saw mobile technology as of great benefit to the NZ health industry "*because it can enable patients engaging in their own monitoring and get patient's involvement in their healthcare planning.*"

The need for patient empowerment within the context of chronic disease management is well recorded (Brennan & Safran 2003; Opie 1998; Paterson 2001). Recognition of its importance was reflected in the attitudes of this study. However, the idea of an holistic approach from prevention to end care was not addressed by the respondents and responses reflected the literature in recording acknowledgement of the concept but no real understanding of how it can be truly achieved (Opie 1998). There are several possible reasons for this beyond merely paying lip service to a key but flawed concept (Paterson 2001). In the mobile health environment the study participants were more committed to the collaborative health information systems described by Brennan & Safran (2003) that commit to patient empowerment through effective system design. Interviewees saw the central issues affecting true empowerment as arising from a lack of integration of information, not only between DHBs but also across primary and secondary and community sectors and between specialisations. The slow development of such integration will impact on the ability to provide truly holistic solutions in the immediate future.

CONCLUSIONS AND FURTHER RESEARCH

The study participants painted an optimistic picture for the future and promise of m-health and, whilst this research was conducted in New Zealand, the implications and the results and conclusions can reasonably be extrapolated to most developed nations. Benefits and uses for mobile technologies were well recognised, with all participants confident that m-health initiatives that contribute to improving the health sector will continue to be developed. The prospect of advantages for patient empowerment were recognised and welcomed although extensive understanding of how this would support better development of health services and improve the management of chronic care was not evident. Overall, acceptability and recognition of the advantages of mobile health were strong. It is in the regard to key issues that influence sustainability within chronic disease management that the main barriers were articulated. Although M-health within the chronic care sector will develop alongside other health services, progress towards holistic, sustainable systems across the stages of chronic disease management is likely to be challenging. There are several reasons for this. The most pressing in the case of chronic disease management are those of standards and of integration of information. The wide range of stakeholders involved in chronic care requires very careful analysis of the processes involved, radical changes in the way information is collected, assimilated and disseminated and a national approach to m-health standards. The potential to integrate information across the full range of stakeholders concerned with a chronically ill patient is, as yet, beyond the perceived possibilities for the health sector.

This is not to say that such integration is not envisaged, but rather that several other issues regarding m-health require more immediate attention. These include privacy concerns, detailed analysis of workflows and processes plus considerable effort towards recognising and alleviating social and organisational effects of change as they arise. It is also noteworthy that small, local initiatives such as using text messages for appointment reminders are having a positive effect beyond increasing attendance levels. Incremental involvement of the chronically ill and their clinicians in m-health developments may be a more effective method of increasing patient empowerment than large scale initiatives to impose self-management concepts. This requires considered and systematic research alongside product and service development that extracts the principles of good practice and disseminates them to all who can deploy them.

To achieve a truly holistic view of preventive to end care management of chronic disease, it is necessary that all stakeholders be included in ongoing research. The nature of participant selection in this study has resulted in interviews with positive thinkers rather than a much broader spectrum of stakeholders. Further research is required to gain a much wider range of views. In the case of chronic disease management where self management is a crucial issue, there is a need to address the views and perceptions of patients and their carers.

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