The internet's potential for enhancing healthcare

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P. Wright. The internet's potential for enhancing healthcare. Gerontechnology 2012; 11(1):35-44; doi:10.4017/gt.2012.11.01.005.00. Computers have metamorphosed physically and functionally, from mainframes with few users to smart phones carried by many, and the internet has changed how people communicate with each other and with organisations. The world wide web (www) is widely used to access health information from public, commercial and self-help sources, albeit with risks that people may follow inappropriate advice. In contrast, risk free emergency alarm buttons enable wearers to summon help. Their market penetration is increasing, sometimes through pressure from carers rather than desire from wearers who may find them stigmatising. Healthcare support also comes via email contact. At present this seldom goes beyond activities such as making appointments and getting reminders, but research suggests it can provide a range of health related benefits. In some instances a phone call or text message may offer similar support, but email permits easy automation which potentially saves professionals' time, although the extent of the changes needed to working practices are unclear. Computers can malfunction and broadband speeds can drop, so at present healthcare support via email is for the early adopters. Assessing the longer term return on investment of www and email is complicated by falling technology costs and rising costs of skilled health staff. In future, contact between patients and healthcare professionals could be by video link. Video links between physiotherapists and patients have been found to aid recovery from a range of illnesses. As skype becomes a more familiar link between grandparents and grandchildren, video healthcare interactions will become more viable. Slower to enter the market place are systems that monitor people's well-being and safety. These systems range from those concerned with physiological states, such as sugar levels and blood pressure, to those concerned with behavioural events, such as falls or wandering by patients with dementia. Pilot research projects suggest telemonitoring can offer useful patient support, but cost-benefit analyses remain equivocal; so too does the acceptability of surveillance technology to those being monitored. In summary, where there is dispersal of appropriate technology among the public, the internet offers benefits both to patients and health professionals. Elsewhere potential health benefits are undermined by lack of interoperability between systems and devices. Nevertheless, as the number of older adults increases so does the need to harness the internet's potential for reducing the load on health professionals and enhancing the support available to the public.

Keywords: internet, www, e-health, telehealth, telecare

The microcomputers of the 1980s enabled the spread of computers from the workplace into the home. Since then digital technologies have brought about major changes in how organisations and people communicate with each other. Over 80% of the UK had internet access in 2010, and more than 60% of those aged over 61 years claimed to be actively using the internet every day[1]. For many organisations the internet is becoming their main method of disseminating information. Admittedly many people remain on the other side of the digital divide but some of the factors contributing to this gap may be receding. Laptop computers and other mobile devices eliminate the need for permanent space for a desktop computer in the home. Tablet PCs offer convenient and instant access to the internet from the comfort of an armchair, without the encumbrance of cables yet with screens that are large enough for text to be read easily by older adults. The complexity of learning how to make the computer do things is greatly reduced by mobile operating systems with touchscreen interfaces. When email is just a switch-on-and-tap activity, little learning is needed apart from the layout of the keyboard used to reply to messages. Cost remains a major barrier, but affordability is less of an issue as pre-owned devices become available. Broadband subscriptions are far from cheap but the internet can be accessed via WiFi hotspots in a growing number of public places. It therefore seems likely that in a few years time the internet will be as commonplace as the phone is today. Indeed changes in cell phone functionality are facilitating internet access. Given the increased longevity of populations, and that a substantial proportion of healthcare time and budget is taken up by older adults with increasingly heavy burdens being placed on people-based resources[2], it is appropriate to

explore in what ways the internet may be able to contribute to the delivery of healthcare services.

Older people have not usually been early adopters of digital technologies, but many of them have vicarious access through friends and relatives to the huge amount of health information on the world wide web (www). Reasons behind their reluctance to do it themselves include fears of incompetence, lack of interest and fears of addiction[3,4]. Yet with just a little experience these attitudes can change and the internet can be seen as a useful source of information, entertainment and fun – the importance of these 'pleasure' factors being sometimes overlooked when considering the well-being of older adults[5].

The internet facilitates communication between people at a distance, through email and other messaging systems, and it provides an easily accessed repository of public and commercial information. Both these functions have expanded. The communication function has broadened to include social networks, chatrooms, tweets and blogs. One advantage to older adults is that these new social media let participants enjoy conversations without the effort of actively contributing to the discussion nor the embarrassment of feeling a bystander. Although these social internet activities do not appeal to some older internet users, older adults are diverse[6,7] and some find that these social networks facilitate communication and help to reduce depression and social isolation[8]. European researchers have been among those pointing out that health is not an objective quality; it is defined collaboratively and culturally with healthy ageing being inextricably linked to social participation[9]. Of course social interchange does not require the internet, but for those with mobility problems or those whose family and friends are geographically dispersed, the internet offers several ways to stay in touch.

In order to avoid being swept along in an optimistic haze of digital hype, it can be worth asking whether other technologies might be just as effective as computer links. In one study a comparison was made between the use of a website and a regular phone chat. Researchers made weekly contact with 525 Australians with internet access, a high depression score and a willingness to participate for six weeks. 166 were directed to a website on depression, 182 were directed to a cognitive behaviour therapy website, and 177 discussed their lifestyle in a weekly phone chat[10]. It was found that both online groups showed more reduction in symptoms than the phone chat group. During the six week period there were more dropouts from the cognitive behaviour therapy website (25%) than from the depression website (15%). This supports the suggestion that there is therapeutic value in a digital discourse that is under the patient's control. Nevertheless there are suggestions that it can sometimes be more helpful to view older adults' engagement with digital technologies as social and reciprocal rather than independent and self-determinant[11]. They enjoy being contacted by friends and will resond but may be less likely to initiate contact.

In the matrix clarifying the interdisciplinarity of gerontechnology, the term telecare occurred several times[12]. Within the research literature the terminology has not yet crystalised but three broad distinctions are commonly made, albeit with varying labels.

(i) *telemedicine*: communications among health professionals. There is evidence that improving media rich hospital access to consultants who are not on site can save lives[13]. Also there are suggestions for how the internet can support continuous professional development through the provision of a resource akin to a medical Wikipedia[14].

(ii) *telehealth*: communications between patients and health professionals. These communications include websites where the information flow is generally from professionals to the public, and emails where the information flow is mainly from the public to the professionals. The field of telehealth is very broad, and is an area alive with research activity[15]. A preliminary study of a national project in Korea examined the impact of telehealth in three residential environments: home care, day centre care, and residential care[16]. The authors reported that for those who were living at home, the package of telehealth services tailored to the relevant living conditions resulted in a reduction in hospital readmissions and hospital visits; for those who were attending the day centre there was an increase in adherence to medication; for those who were in residential care there were fewer readmissions to hospital and fewer adverse drug events. This study highlights the importance of matching services to living arrangements and also the need for diverse assessment criteria. No single assessment would have shown benefits across all three residential groups.

A review of other systematic reviews of research on telehealth located 1593 papers, although the number shrank considerably when quality criteria were applied[15]. It was noted that 21 reviews concluded that telehealth technologies were effective, 18 found them promising but incomplete, and others reported that the research evidence was limited and inconclusive. The reasons for this diversity are easy to understand. There are many different interventions to be found under

the umbrella of telehealth, and these technologies are provided for patients who have a range of health issues and are supported in a variety of residential contexts. Research in this area is difficult because in the real world so many factors will co-vary that it is hard to be sure what are the causal variables. Simple aggregation across studies may not give a clear picture.
(iii) *telecare*: the continuous, automatic and remote monitoring of a patient in order to manage risks. This includes the wearing of sophisticated personal emergency alarm systems that can summon help without the wearer needing to do anything, a desirable feature since people who have fallen and are unconscious cannot push buttons as is required by the simpler push-button alarms.

The changing sophistication of the personal alarm button serves to illustrate some of the issues associated with the introduction of digital technologies into healthcare. These issues extend far beyond the costs and reliability of the systems themselves. Numerous stakeholders are involved besides the patient and the technology manufacturer. Human intermediaries are needed to check and maintain the system; healthcare and/or other personnel need to respond to an alarm; health insurers may view expenditure on such devices as desirable or unnecessary, perhaps depending on whether they take a short or longer term perspective. So the adoption of any new health-related technology depends on much more than knowing whether or not it 'works', although efficacy remains the major criterion in most research studies.

For convenience the different ways in which the internet can support healthcare will be considered separately but in practice these can be combined. For example, the Veteran's Health Administration in the USA has provided a range of digital technologies to over 30,000 patients[17]. It is estimated that this has resulted in a 25% reduction in hospital bed days, a 19% reduction in hospital admissions, and a high degree of satisfaction among patients. The potential usefulness of the technology is not in doubt but it remains unclear whether similar health benefits could be achieved more economically by other means. The following discussion of the internet's potential will start with health support that is already commonplace, such as the world wide web, before considering support systems that may become more widespread in a decade or so, such as smart homes.

WWW and health

People are diverse and the health information on the www caters for this diversity. Even people sharing the same clinical condition have differing information needs. A survey of 175 patients with cancer at a US clinic found that 44% had accessed the internet. Some sought the meaning of symptoms, others wanted reassurance about tests. Some were looking for more information on treatment options and side effects, others wanted to know about details of hospitalization and subsequent recovery, yet others sought information on diet and finances or social support[18]. Appropriately designed websites can cater for this diversity and have an advantage over print in being easily updated.

Sweden trialed an internet service run by family practitioners under the name *Ask the Doctor*. A survey of 1,223 users found 71% were women and 77% asked from home and on their own behalf[19]. 45% of the queries were about problems that had not previously been referred to a doctor, and 43% of enquirers did not intend pursuing their query any further. If these patients would otherwise have requested an appointment with their doctor, the economic benefits to health professionals are self-evident.

Because peer groups become more diverse with age[6] websites need to accommodate this diversity. Layering information so that those who want to dig deeper is one way of doing this. Web pages can be designed to be easily adapted by the user but without the stigma of using a special 'assistive' interface[20]. Having audio as a selectable option can assist older people even though it often slows down younger adults[21,22]. Audio benefits have been found for declarative information such as explanations of symptoms or illness, and for procedural instructions such as how to apply a bandage. Listening to a voice becomes particularly helpful if there are animations on screen to watch[23] as may be the case for advice on movement or lifting after surgical procedures such as hip replacement. Because many people already download music, the relevant audio technology is already in many homes.

Accessing a website and understanding the information given is only the start of the discourse with health information on the www. Readers will subsequently decide whether to trust what they have been told. Trust and mistrust seem to be influenced by different design factors[24]. 13 people diagnosed with hypertension were invited to a UK university to find information on the www that was relevant to their condition. It was observed that mistrust was often (83%) based on factors such as the presence of adverts, small text size, commercial appearance, and looking too complicated. In contrast people's trust was mostly (74%) based on factors such as coming from a respected source, the inclusion of real life examples that were similar to the patient, practi-

cal advice, cross referencing and external links, question and answer sections. With more experience people will become increasingly atuned to recognising reliable sources. Meanwhile, it may be helpful to give people advice on checking the source of the information before they too willingly believe what they read or become confused by conflicting advice. Coping with this mountain of information requires new skills for searching and filtering the results[25,26]. Interface design has a major role to play in reducing the amount of learning that is needed to successfully use and enjoy the potential of the new information technologies[27].

There will always be concerns about the accuracy of the information on websites. One study found that only ten of 46,000 postings on a breast cancer self-help site were factually inaccurate, and these were corrected within five hours[28]. Missing information may be more common. Analysis of 44 pharmaceutical websites where products were sold direct to consumers discovered that only half the sites listed common side effects – for instance, those that occurred with an incidence of 10% or more[29]. Again this suggests the need to urge caution on those using health websites. People can be encouraged to check the source of a web page, and to be aware that those providing the information may have their own agenda – such as commercial sales.

Very different from commercial websites are the forums, chat rooms, and informal networks created and maintained by members of the public with a common interest in a particular health topic. A comparison of the content of websites concerned with either breast or prostate cancer analysed 3,203 messages from post-treatment survivors. It was noted that the breast cancer site was mostly focusing on emotional support whereas the prostate cancer site was mainly providing factual information[30]. It is not clear whether this difference is the result of the different topics or reflects a gender difference between the users. It is known that when men talk to men the conversation is more often about impersonal topics (sport, politics, etc). In contrast when women talk to women the conversation is often personal, dealing with feelings, people and life problems[31]. The role of the internet in providing not just information but emotional support to patients is slowly being appreciated.

Another kind of help offered by websites is interactive advice-giving and online support for health and lifestyle issues such as diet and exercise[32]. Related to this are interactive displays that help people make decisions, such as which of the treatment options to pursue. For simple decisions about whether or not to proceed with a treatment, print can often suffice to explain the risks, especially if graphics are used to convey frequency (for instance, one in a thousand). Websites providing animations become helpful when multiple conflicting factors must be taken into account. For example, it can be hard to decide about screening tests that not only have risks as well as benefits, but also yield results that may have false positives (suggesting a health issue when there is none) and false negatives (failing to detect a health problem). It may be possible to provide a succession of graphics to get these points across, but an online decision aid can let people weight the various factors to accord with their own subjective value of the outcomes. This can offer a very helpful synthesis of different strands of information[33].

Websites often contain links to other sites where further help can be obtained. For example, pointing to sites that offer assistance with transport or with shopping[34]. Such links can be a source of valuable additional support with daily living for people with acute or chronic health needs.

Internet access to the www is already impacting on healthcare in several ways. Notices in the waiting rooms of family practitioners may urge patients not to take in their printouts from the web because the doctor does not have time to read them. Not everyone wants to know all the details of their illness but for those who do the web has the answers, and the 'expert patient' may be better informed about their specific health issue than their family doctor.

Email contact

Implementation is currently patchy, but people with email access at home expect to have this form of contact with their family doctors for messages such as the results of routine tests, ordering repeat prescriptions, making and changing appointments. Emails can be sent to patients as reminders, and these reminders offer the opportunity for including extra information such as the need to bring both reading and distance glasses to an eye test or to provide urinary samples[35]. If automated, these emails do not increase workload, so their provision becomes a win-win outcome for both patient and doctor.

The availability of email contact can reduce the demand on clinic time. In a Norwegian study 200 patients from six family doctor practices were randomly allocated either to a group that was provided with a secure email link to their doctor via the web for one year or to a group that received standard care for one year. It was found that during the year 46% of the email group used

it to contact the clinic, but only 10% of these emails resulted in a visit to the clinic. Over the course of the year the email group made significantly fewer visits to their family doctor than did those receiving standard care[36]. This reduction in visits has been noted in other studies and suggests that email contact creates 'safety net' feelings. For example, providing email contact for people with diabetes reduced their number of clinic visits[37]. Email contact improved the eating behaviour of adults in a weight loss program[38] and it has been found to help patients with recurrent headache, panic disorder, and the distress of tinnitus[35]. Although these studies have not always had older adults participating, they strongly suggest that when people feel they can easily contact their doctor at any time, this reduces stress.

Email contact is not the only option. Use of telephone contact between an older adult and a health professional, both for voice and for text messages, has been found to be helpful in several studies. A systematic review noted that of the 16 randomised controlled trials examined, 10 reported improved outcomes such as better adherence to medication[39]. Unravelling the importance of synchronous rather than asynchronous contact awaits further research. Each has distinct benefits.

Of course a satisfactory email system requires the computers at both ends to be up and running. Also the message 'server unavailable' is frustrating. There are issues of privacy and security that are non-trivial when the information needs to be shared among health professionals, perhaps between the family doctor and a hospital. Encryption technologies are addressing some of these issues but human behaviour remains a weak link – for instance, losing laptops or leaving printed pages in the printer tray.

Video links

Video links can be delivered in diverse ways. Instead of a computer monitor, one study provided a set-top box that could be attached to the television[16]. Now that tablet PCs have cameras facing in both directions and Skype is commonly used, there may be no need in future for the older person to move from the comfort of their armchair to show the surgeon how their post-operative scar is healing and discuss when the stitches can be removed. Perhaps YouTube videos will supplement or replace patient information leaflets – for instance, for exercises during rehabilitation. Increasingly the technology is in the home, the delay is in exploiting its potential in the context of healthcare.

Video links with physiotherapists can be very effective, especially in supporting rehabilitation after major surgery. In one study a video link over broadband was found beneficial in supporting patients who had had shoulder joints replaced. The patients reported that they experienced feelings of closeness at a distance[40]. A systematic review reported benefits for patients needing rehabilitation exercises after experiencing a stroke[41]. Another systematic review that focused on patients who had experienced congestive heart failure, concluded there was a significant reduction in mortality when patients had digital support (of diverse kinds) during rehabilitation[42]. A broad review of telerehabilitation for any disability other than mental health, noted that 71% of the research studies reported success, and in 51% the effects of telerehabilitation, seemed to be clinically significant[43]. These researchers suggested that it was the poorer research studies that were more likely to fail to find beneficial outcomes. Nevertheless there remain questions about whether similar health benefits could have been achieved by other means. Adequate answers to such questions require looking not just at the the patient's recovery process but at the time, effort and convenience associated with not having to travel to a clinic – or visit a patient if therapy is given at home.

It seems as though it may not always be necessary for the patient to be linked to a person. In one study 21 adults between the ages of 62 and 84 interacted daily for two months with a talking, animated character on a computer screen, an avatar. The purpose of the interaction was to encourage the participants to exercise more. A control group were given pedometers and a leaflet outlining the benefits of exercise. It was found that the group interacting with the avatar were more active than the control group[44]. Inevitably this study leaves many questions unanswered. Would any kind of daily prompting have been as effective as the avatar? Would a human rather than an avatar have been more effective? How life-like do avatars need to be? What if the patients had joined a group for their daily exercise? Such questions highlight the difficulties of research in this area because the answers involve many factors that will vary across individuals. For example, the avatar can be summoned at any convenient moment whereas regular appointments with other people may be harder for some adults to fit into a busy schedule.

Telemonitoring

Computing functions are now embedded into many other products. A familiar example is the supermarket checkout that can identify a product from its bar code and knows how much that product costs. More broadly this technology is giving rise to the concept of the Internet of Things

(IOT)[45] where products may recognise who is using them and adapt their characteristics accordingly. IOT can support developments such as the smart home[46] which help older adults remain in the community for longer than would otherwise be possible, particularly when coupled with digital systems for monitoring physiological changes in health status[47]. These monitoring systems can offer security and support for older adults, particularly those living independently and alone[48]. Nevertheless these changes in the relationship between technology and the user raise ethical issues that can be further complicated by any doubts about an older person's capacity for meaningful consent[11].

There are several research reviews suggesting telemonitoring can be beneficial[49,50]. For patients with chronic illnesses (for instance, cardiovascular diseases) telemonitoring was found to empower patients, influence their attitudes and had potential for improving medical conditions[51]. However the field is large with several major subcategories. One important division is between services that the older person actively participates in and others in which they are passive recipients of monitoring services. Active participation includes the transmission of self-monitoring data (for instance, glucometers for diabetics, peak flow meters for people with asthma) information that is sent by the patient to health professionals, with the professionals only making contact with the patient when the data being provided raises cause for concern. Monitoring the data against set criteria can be done by software, so the system potentially can save everyone's time. It is not yet in widespread use and there are issues about data adequacy. If patients forget they can be reminded but if, having forgotten, they send a guestimated reading the safety of the system is compromised. Checks and balances are clearly needed.

In future the human link in the chain may be circumvented through the use of small computer chips that monitor physiological functions. These could enable routine check-ups without the logistic hassle of visiting a health centre, a regular chore for patients with some chronic illnesses such as diabetes. As with the 'manual' system, these check-up-by-chips could alert health professionals if there was any deterioration in status. This in turn should lead to early intervention and better prognosis[52].

Services in which the patient is unobtrusively monitored are usually provided for the purpose of reducing risks to the patient. For example, an alert may result from the cooker being left on with nobody in the kitchen, or from the person leaving their home unaccompanied, or from inactivity during a normally active period[53]. Among the successes claimed for such monitoring has been the early detection of a urinary tract infection, signalled by a sudden increase in visits to the bathroom. But there remains the technological challenge of analysing the potentially huge amounts of data generated from continuous patient monitoring. There is also the emotional challenge of feeling constantly under surveillance.

The distinction between being an active or passive participant in a monitoring service can give rise to different clusters of ethical issues[11]. For example, passive monitoring can raise issues of privacy, autonomy and obtrusiveness as well as stigma and the fear of reduced human contact. But this was not found to be a problem in a Swedish study of 17 seniors living in their own homes who for 6-7 months wore a wrist band with embedded activity sensors that continuously transmitted data about the wearer to a care centre where these data were displayed graphically and software detected deviations from normal activity. Only one participant felt their privacy was invaded, the others felt the surveillance was protective and liberating[48]. However, three potential participants dropped out because of allergies or other problems with the wrist bands. So there would seem to be scope for further development.

A review of several international projects involving smart homes noted that after 20 years of development work there has not been the anticipated market penetration for this technology[54]. Several of the reasons for slow take-up of new technology have already been mentioned. Another possibility comes from reflecting on the demise of the original picturephone that was developed by AT&T's Bell Labs in the mid 1960s and abandoned in the 1970s. Very few people wanted to see or be seen when talking on a landline; but with the arrival of cell phones the option for taking and sharing photos was eagerly seized. Sometimes the acceptability of one technology depends on the availability of another. Perhaps smart homes need that innovative catalyst, and perhaps remote controls might be among the contenders for this role.

People are familiar with remote controls for TVs and car doors. WiFi can facilitate technology being extended into the home for use both by residents and where appropriate by carers. Using remote controls, lights could be switched on, curtains drawn, food left in ovens could be cooked. Through developments in interface technologies these actions may not in future need a plethora of separate remote control handsets. Among the innovative forms of control becoming available are a table top surface that shows the room with

all the objects in it, and this display functions as an interface to control many of the objects in the room[55]. By extension of the concept it could show the entire house, so that the bedroom window could be closed and the electric blanket switched on without ever needing to leave the armchair. Since the display is mediated via the internet, a caregiver accessing a similar display could make any adjustments that seemed necessary. While the use of such technology may start as the indulgence of the wealthy, its potential in other contexts may be realised as prices fall.

This movement of technology from mainstream to healthcare may happen in several areas. It was mentioned earlier that the Internet of Things enables everyday objects to have embedded within them a means of identifying themselves to the internet. The Radio Frequency Identification Device (RFID) is one example of this technology that is currently used by industry for activities such as stock control. Once equipped with a RFID chip, an object can contact other objects via the internet, and appropriate software determines how these objects will interact. Technology such as this offers benefits to those who are healthy and active as well as to older people. For example there is the running shoe that, via the internet, enables the wearer to see at the end of a run details such as the route taken, the speed on different parts of that route, the calories used, etc, and applications on smart phones now offer similar information about movements. RFIDs in a bedside carpet could detect when a person has fallen out of bed and alert appropriate help services. The point being made is that digital technologies are developing on many fronts, and that software designed for other purposes may have unanticipated application in a healthcare context. The pervasiveness of the internet facilitates this.

Intelligent robots that can help with the activities of daily living are too futuristic for detailed inclusion here but it is worth noting that not only can they be controlled locally by their keeper but also remotely via the internet. The assistance robots could provide is highly diverse and includes:
(i) personal robots to assist with household duties,
(ii) leisure robots that encourage fitness activities for both body and mind,
(iii) companion robots that offer emotional support,
(iv) travel robots that can enhance mobility,
(v) health robots to assist with medication and monitor physiological signs.

As products acquire embedded digital technologies, the IOT blurs the boundary between robotic and smart interactive devices. For example, prototypes such as the iWalker, developed within a project funded by the European Union, indicate that technology is now available for an older person to tell their wheeled walker "Take me to the kitchen" and being safely guided to their destination[56]. But there are several constraints on the widespread adoption of smart devices and intelligent robots. Initial cost is currently very high. Reliability and maintenance are serious issues involving additional costs. Acceptability is hard to assess and may critically depend on the ease of use of the control interface. All of us who have wrestled with a washing machine out of control know that the thought of a robot running wild around the house feels unbearable.

Design issues and innovation

Changes in digital technologies during the past 50 years have been revolutionary rather than evolutionary, with the visions behind the revolutions being the desire to solve real-world problems (such as wanting to access emails while out of the office) rather than by a push from the research findings on computer users' behaviour[57]. Nevertheless, the behavioural research on interface design has created methodologies for assessing usability[58] and has increased understanding of the relation between ease of use and cognitive processes such as perception, attention, language and memory. This understanding helps when wanting to adapt an interface to support people who have physical or mental challenges[59,60].

Design processes often start with an assessment of people's needs, but for the combination of digital technologies and older people this is not straightforward. People may not feel the need for something, or even see the point in having it, if they have never had it before. But ownership can change attitudes. Whether it is appreciating the convenience and speed of email messages with photos attached, or discovering the enjoyment of interactive games, there are benefits from internet access that may not be apparent to older people at the outset. I know of more than one older adult who would agree that prior to purchase they would have dismissed the suggestion that they would ever play games on their iPad, but who now enjoy the convenience of card games without the hassle of physically handling the cards. Similar reports of attitude change have accompanied other digital technologies[4]. Undoubtedly there remains scope for improvements to many touchscreen interfaces[62] but tablet PCs offer older adults a relatively comfortable route to the internet.

Designers of interfaces for older adults also face challenges from the diversity within their audience. Even when the same functionality is re-

quired it is unlikely that one design solution will be appropriate both for those who are in good health but have a transient medical problem and also for frailer older adults with several co-morbidities[61]. Being easily able to tailor the interface to suit the user is an essential requirement.

The technology enthusiasts point out that digital advances hold promise for enhanced access to health information, improved quality of care, a reduction in health care errors, increased collaboration among health professionals, and better illness prevention by encouraging the adoption of healthy behaviours[63]. Although there is evidence to support each of these claims, a clear understanding of what, when and how telehealth is best deployed is still to come.

Research projects may highlight what can be done but the pace of change will often be slow because there exist a variety of barriers to innovation[64]. These include problems relating to the interoperability of the technology between service sectors[65], problems which are exacerbated by rapid changes in computing technologies. The latest version of the software may be needed to open the file just received, but the necessary software upgrade may not run on hardware that is just a few years old. Without reasonable stability of the hardware and software, telehealth applications would seem to offer limited return on the financial investment.

Further barriers to innovative uses of the internet's potential concern the implications for health professionals and health organisations of changing their established methods of working. Websites require design skills and take time to maintain. It is unclear how the workload of health professionals will change if patients can make email contact 24/7. We have seen that the expected benefits from computers have not always been realised by businesses[66]. Computers change the nature of the work done but may not save an organisation time or money. It is to be hoped that the health industry can take note from lessons learned in the commercial world.

Perhaps the most off-putting feature of letting computers have a bigger role in healthcare is that the technology is also prone to having problems, and these can cause great inconvenience to the user. The software may insist on offering help when this is not wanted; the hardware may fail to comply with reasonable requests. Computer systems may breakdown entirely or be maliciously invaded or the battery on which an interaction depends may run down. Sometimes these glitches are easily cured, but the consequences of such failures could be serious for people relying heavily on telehealth services. This issue rarely surfaces in short-term pilot studies of the technology but it becomes important when considering wider and longer term deployment. Perhaps, as with the evolution of cars, it may be reasonable to expect that computers will become more reliable real soon now. Meanwhile investors in innovations bide their time.

The needs of older adults have not been at the forefront of interface developments but many of the underlying principles relating to usability and enjoyment apply to a senior audience. These principles are summarised in numerous texts[67,68,27]. They include display principles such as *legibility* and *consistency*, principles that apply to both the text and the graphics on buttons. The needs of older adults are now being addressed in the design of some smart phones because older adults may need handsets that cater for arthritic fingers, weaker vision and hearing loss. Particularly encouraging are software developments in adapting the interface of ordinary cell phones[69], as distinct from the manufacture of products with reduced functions that are marketed as 'senior phones'. Awkward fingers do not mean lower aspirations.

In short, the internet is changing the way members of the public become informed, lobby for change, maintain contact with each other and, in the future, control various objects. Mobile devices can now offer people relatively simple access to the internet. So clearly there is potential for the internet to support the delivery of a range of health related services. Just how much of that potential will be realised within the next decade remains to be seen, but as the generations change so do the public's expectations about the support that technology can provide.

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