Some non-technology implications for wider application of robots assisting older people

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Abstract

Assistive Technology (AT) for care of older people is now a major focus area for research, given the ageing of population and diminishing number of available caregivers. Robots have recently been recognized as a potential platform for remote monitoring and delivering healthcare assistance to older people. A literature search was conducted to explore potential issues and lessons learnt in similar situations. Surprisingly, the acceptance of home care technology by older people has not been a serious problem after proper introduction and training; however important practical challenges were related to privacy, autonomy and ethical responsibility. It was observed that an ethical framework for AT is virtually non-existent and is needed for people who feel vulnerable in dependent situations. A further challenge that potentially impedes AT implementation is its acceptance by the existing care giving workforce because of a perceived threat from technology to take away their jobs, add to their responsibilities and make them vulnerable to consequences borne out of a recorded human error. Aged Care Facility managers, caregivers and medical professionals have concerns, including: practical workflow adjustment, equipment maintenance, accuracy, cost effectiveness and potential for errors. International regulatory framework is generally supportive though variations exist across political boundaries. Using robot based AT solutions for elder care is desirable, and represents a promising technology option, but we must consider several non-technical implications before designing solutions.

1. Introduction

The care of the growing older population is centre stage of healthcare plans and policy frameworks for most developed countries as people address the increasing burden of chronic diseases, and the consequential burden on healthcare [1]. Also, older people’s increasing need for physical and cognitive assistance is being recognized. The problem is further complicated by diminishing numbers of healthcare professionals, caregivers and people available to provide useful companionship to older people [2]. A large share of focus is on AT and support systems aimed at promoting ageing in place [3]. These efforts are aimed at facilitating independent living in one’s own home as long as possible and reducing the burden on institutional care. It is also desired that those requiring institutional support should be enabled to live in Aged Care Facilities (ACFs) with minimal human dependence for routine tasks and activities [4].

There has been a great deal of interest in developing ICT (Information & Communication technology) to support frail elderly in their homes as we enter 21st century[5]. Some recent studies have even challenged the assumption that older adults would hesitate to use technology owing to limitations in dexterity and/or sensory acuity [6], and have demonstrated positive impact of home monitoring and telecare of older adults living in their homes. Patients and providers not only were found to accept the technology but use of telecare also positively
influenced chronic illness outcomes and reduced hospitalization and travel costs. More recently, robots have been identified as a potential option to enhance eldercare [7]. They could do so by enhancing mobility, improving communication capabilities, supporting continuity of care and sharing routine repetitive tasks with caregivers [8]. The Joint UoA/ETRI Centre for Healthcare Robotics and the National Institute of Health Innovation (NIHI) at the University of Auckland are involved in developing an elder care robot, and preliminary studies [9] have shown a possible role of Robots in monitoring location, recording vital signs, detecting falls and assisting with medication reminding.

To support this work, we have evaluated the ethical, social and cultural issues, as well as regulatory and professional environments, in order to guide a prototype design for maximum practical applicability. Out of many non-technological implications of information and assistive technology, we realized that healthcare robot designs need to be compatible on four important non-technical and overlapping fronts. These are ethical, socio-cultural, economic and regulatory considerations as represented below.

![Figure 1 - Some non-technological implications for robots in care of older people](image)

In this paper we discuss the ethical implications of healthcare robots in the context of older people and the impact on professionals involved in caring for them. The cost implications and the relevant institutional and national regulatory environments that influence the decision-making process relating to deployment, especially in publicly funded systems, are also discussed. Most of the information presented herein is gathered by literature review, including collecting expert opinions and Internet based information from government and institutional websites. These four areas are elaborated in following sections.

2. Ethical considerations

The introduction of any new technology in healthcare must address respect for autonomy, be beneficent, non-maleficent and just [10]. The ethical considerations require careful analysis because there is potential for significant infringement into personal lives of older people by deploying a constantly aware agent that can record, transmit and communicate personal health and activity information. The choice of deploying a robot poses significant responsibility and it should address possible concerns should they arise [11]. The assessment of ethical implications of healthcare technology involves consideration of a range of user experiences relating to personal autonomy, privacy, dignity, safety and choice, surrounding the use of technology [12].

Use of wireless connectivity to control semi-autonomously mobile agents also needs protocols to ensure that personal data can only be accessed by those authorised to do so, similar to other electronic health data exchange and communication platforms to prevent misuse. Moreover, most people would not want to lose their sense of privacy even if they are semi-dependent, to be constantly observed by someone else through robot mounted cameras relaying images. The ethical dilemma arises as to when to give a choice, where a user may allow or block certain features, e.g. a user should have choice when not to allow observational recording [13] but it also may be a compromise on safety when a potentially lifesaving device was turned off and it was needed. A balance can be sought by designing some rules that cannot be overruled by the user (e.g. reporting of falls) and
by creating some functions that can be defined by the user (e.g. frequency of reminders). These rules could be defined in partnership between users and providers. Furthermore, respect for user autonomy becomes equally important as we interpose intelligent agents that are capable of making their own decision by virtue of rules that are designed to bring safety and prevent inadvertent mistakes committed by humans. For example, the Anti-lock Braking System in a car prevents the driver from executing action (i.e. stopping the car immediately), in order to prevent skidding and accident. It justifies curtailment of user autonomy to enhance safety. Similarly robots in healthcare may entail some curtailment of user autonomy by incorporating safety and instructional protocols, either built in (e.g. cannot switch off alert to the nurse if vital signs are in danger zone or if dose of important medicine is omitted) or programmed by caregivers (e.g. must issue reminders to drink water every 6 hours). Though it may be perceived as infringement of autonomy of an older person, this could be justified with respect to improving healthcare outcomes.

On one hand robots may appear to be more controlling but on the other hand the presence of robots may actually enhance autonomy of the person by offering more choice (e.g. not depending on nurse to give medication or waiting for her every time to carry out a task) and also more freedom (e.g. an older person with a tendency to wander and get lost may get more freedom if a robot is monitoring them, because they may be allowed to wander over a wider area since they can always be found). In addition, some older people are expected to be ‘active users’ of technology and some ‘passive recipients’ of the technology with different preferences [14]. Therefore, the degree of autonomy ultimately experienced by an old person in an ACF could become a function of defined system design (i.e. combination of functionality of robot, institutional environment and rules defined by healthcare providers) on which they depend to carry out various health related tasks [15]. The flexibility of system design therefore becomes more important as an age-related frailty or disability continues to curtail a person’s autonomy even further.

Despite general acceptance of home telecare and AT there has been a small number of users denying the home-monitoring technology installation in their homes and many do not use AT as intended due to a variety of reasons [16]. In a large-scale Philips National Study on the Future of Technology and Telehealth in Home Care, spanning the US, Fazzi et al. [17], found that around 5% of patients were refusing to use telecare and fear of equipment (31.1%) and intrusiveness of equipment (24.0%) were the two biggest reasons cited why patients refused. These challenges are likely to be highlighted by large bulky anthropomorphic robotic devices where conjectures from sci-fi movies and media are likely to colour patients/users perception. This phenomenon needs to be studied further. It could be concerning if older people feel that they are controlled by technology, rather than using it as a tool to remain in charge of their lives [18]. Subordination to technology could become increasingly problematic as enabling technology is developed that exhibits increasingly intelligent behaviour. This can, of course, happen to everyone who uses such technology; but older people may be in a particularly vulnerable position due to the lower degree of control that they appear to exert. Therefore the design needs flexibility to strike a balance between user preferences and level of frailty, where more independent people get to exert wider choices and gradually delegate more control to robots as people decline in cognitive and functional capacities.

2.1. Robots are not an excuse to withdraw or deny human contact

Social isolation can be ethically problematic. Robots may cause loss of contact with a caring person, which could be emotionally debilitating. However, providing tele-connectivity and live video capabilities may overcome this obstacle. Moreover the success of companion robots in alleviating isolation for older people, seems to support their use [19]. Conversely, the question arises: Is it ethically appropriate to delegate care of older people with limited mental and/or limited emotional resources, to a robot? This aspect of human dignity, and the potential for robots to provide ‘permission’ for family members to abdicate responsibility on the pretext that their elders have artificial company, is a source of moral jeopardy. On the other hand, denying robotic assistance or removing the robots without replacing them with true human contact is not necessarily an improvement [20].

2.2. Safety concerns and accountability for failure

While it is understood that robots would be expected to conform to a wide variety of the standards of the electronics, software and medical device industry regulations, and possibly also pharmacy regulations, what complicates the ethical dilemma is the fact that healthcare itself is prone to multiple errors which are difficult to address. The Institute Of Medicine report “To err is human” raised significant concerns about medical errors due to human imperfections [21]. To mitigate these errors, the precise information storage and retrieval capacity of
technology is considered a valid mechanism to some extent. However, the automation of clinical processes is not necessarily beneficial. Many studies\cite{22,23} have revealed that Computerized Physician Order Entry (CPOE) applications seem to foster errors rather than reduce their likelihood. This raises serious concerns of safe use of technology in vulnerable elderly populations. In addition, there are concerns on the safety of keeping a robot in hostile or adverse environmental conditions such as sloping roofs, staircases, small apartments, and especially bathrooms (where many falls happen and where privacy is usually guarded) where the water and humidity may short-circuit or malfunction the device \cite{24}. It is only by a heightened awareness of these issues that informaticians can educate stakeholders to design, implement appropriate systems and conduct research in such a way that minimises the unintended consequences of obvious as well as subtle silent errors \cite{25}.

In summary, for the development of robots to be ethically designed, developed, implemented and appropriately used, we need to understand the ethical implications. While a person’s privacy, safety, autonomy and independence may be affected, we also need to bear in mind that this kind of technology does not give people permission to abdicate responsibility for a person’s need for human contact, protection from medical error, and the disadvantages that result from aversion to using technology. This leads to consideration of the next non-technical front indicated in Figure 1 – the social and cultural context implications of using AT.

3. Social and cultural context

Healthcare robots would be perceived to be useful if they fit into organizational workflows, usually after approval and acceptance by healthcare professionals and patients alike, as described by the ‘Technology Acceptance Model’ proposed by Venkatesh and Davis \cite{26}. Although the virtues of many technology based solutions have been advocated for a long time, basic tools like Electronic Health Records, Clinical Decision Support Systems and guideline conformance alerts are not adhered to by many physicians and healthcare providers, due to factors such as lack of perceived strong financial and quality benefits \cite{27-29}. The acceptance of technology by healthcare professionals is a complex problem that needs to be addressed comprehensively \cite{30,31}, from the perspectives of an organisation, its work force in general, and the healthcare professionals in particular.

3.1. Organization acceptance

In most countries healthcare is considered to be one of the most complex sectors in terms of hierarchy, distributed authority in decision making and the variety of funding mechanisms. Negotiating implementation of an innovative solution can be a frustrating task in these settings \cite{32}. The Audit Commission of the NHS in the UK observed important barriers to acceptance of homecare technology as - fragmented organizational structure, funding issues, change averse mindset, lack of consumer pressure and lack of end-to-end solutions \cite{33,34}. In order to bridge some of these gaps, dependence upon technology vendors tends to be high. The key role of vendors as a systems integrator and service provider to overcome the skills and organisational deficit in most health and social care organisations is recognized to be important \cite{35}. The same should hold true for robotic technology applications.

3.2. Impact on existing work force

In many industries manual labour has gradually been complemented or replaced by automation \cite{35}. People affected by such changes to the way they work respond in reasonably predictable ways, e.g. following a change or adaptation process such as that described by Elrod and Tippett \cite{36}. However, other implementations could result in failure due to an insurmountable ‘concept-reality gap’ described by Heeks et al \cite{37}. There could be initial resistance to change or an unrealistic enthusiasm based on a disconnect between the expectations of the workforce and what is actually delivered. This kind of resistance happened when machines were introduced in factories and also when computers were introduced into offices. Almost uniformly the organizations pass through initial reaction of the existing workforce to automation, which frequently later on translates into improved processes, reduced work burden, enhanced skills and productivity leading to improved efficiency and efficacy \cite{38}. Information technology is proven to be a source of increased demand for skilled labour and rising wages in the long run \cite{39}.

Furthermore, concerns of technology replacing the human interface do not seem to dominate the horizon given the fact that artificial intelligence and robotics have not achieved human-level perfection or a range of expressions like caring and supporting \cite{36}. However, it is likely that robotic assistance will bridge demand-
supply gaps in the healthcare workforce by enabling the existing workforce to handle more clients and supplementing their role in ways like - automatic handling of repetitive tasks and enhancing communication.

In conclusion, it may be unclear as to how this technology will impact the existing workforce. Nonetheless, it is prudent to think about the impact of technology on the existing workforce [40], so that it may be possible to institute transitional measures to minimize the discomfort of workers who will be affected by this form of automation.

3.2.1. Provider acceptance

Creating cultures of safety requires major changes in behaviour, changes that professionals easily perceive as threats to their authority and autonomy, which has been a challenge in implementing safety measures and use of automation [41]. At the same time many practitioners are vocal and resistant to unproven technologies. They argue that it is clinicians who are ethically and legally responsible for the patient outcomes and errors; but what if the error is because of the technology and not because of wrong intentions of doctors? To argue further, even if the safety protocols are implemented at professional and technological levels, user behaviour would still remain unpredictable.

Some large scale studies however, have shown that receptivity of the staff and patients to telecare programs improves with time and more than doubles by the end of the year after the implementation of new technology as was seen in Philips’ national study done across America [17]. In the same study, decreased workloads in terms of physical visits without reduction in reimbursement for virtual visits and improved quality of care appear to be the major acceptability factors. Secondly, a major impact was seen that combined chronic disease management with telecare both in terms of clinical outcomes and cost of care. Although some suggest that the separation from the bedside will necessarily lead to medical errors and potentially avoidable morbidity and mortality, the literature (limited though it may be) would suggest otherwise [42]. Therefore, physicians’ buy-in may be obtained by understanding and acknowledging their perspective [43-45]. In light of the above considerations and earlier works regarding provider acceptance, we identify the following five principles for deployment of robots for the care of older people:

- Robotic Technology is a tool, not a replacement device. It should not be expected to go far on its own. A tool should be treated like a tool not an expert.
- The design focus should be primarily on the organization of work, not on technology; it must determine clinical actions only if they improve, or at least do not deteriorate, patient care. Substitution of technology for people is a misunderstanding of both.
- A good tool in the hands of good users can deliver beyond expectation. A tool once rejected will face difficulty in finding its way back in.
- Successful implementation should be supported by the development of a community of practice of users, as well as an opportunistic approach to learning about the technology [46].
- Aggressively troubleshoot problems and plan for continuous revisions and quality improvement, recognizing that all changes generate new error risks.

To summarize social-cultural factors relating to organizations, doctors, nurses and other caregivers need careful and balanced consideration, without losing emphasis on professional competence as the foremost determinant of ultimate care process for older people. That leads us to consider the next element of Figure 1.

4. Financial implications

The care of older people with help from robotic technology is an actively researched area with multiple solutions being developed, tested and evaluated. The market competition is telecare or homecare monitoring, smart homes and similar alternatives. The use of robots for care of older people may potentially be a superior and comprehensive AT tool, depending upon its features, functionalities and outcomes. However, robots can be expensive. If the solution meets design expectations then the relatively higher cost of robots can be justified by reduction in cost of institutionalization (by promoting ageing in place), reduction in morbidity, hospitalization (lesser adverse drug events and falls, better chronic disease outcomes leading to fewer visits), and containment of manpower cost despite increasing demand supply gap. The challenge is highest in initial demonstration projects but wider acceptance would eventually make availability easier, cheaper and reduce repair, replacement and maintenance costs and will bring down overall cost over a period of time [47].
Moreover across the developed countries that face the demographic challenge of ageing, financial support for the care of older people is mostly met by social security and public funding. Expecting minimal active contribution from consumers the marketing drive should focus on the priorities and constraints of these public agencies rather than consumers. Though it has been suggested that public funding with some deductibles from pension is justified if there is significant contribution to increased quality of life; it remains to be seen how it effects the decision making [48].

Given these challenges, it is suggested that the design of robotic AT should be cost conscious and tailored to areas of maximum cost-efficiency impact. An elaborate design may have advanced features but the incremental impact on solution robustness, quality of life and cost of care should be carefully justified in financial terms. This may be in itself be a challenge when one considers that evaluations of most telecare implementations have no cost-benefit or cost-efficiency reports [49].

Therefore, the appropriate designing approach should look at basic, simple and highlighted areas of concerns about health of older people (for example minimization of medication errors, falls, reminders and chronic disease complications) that have maximum potential for impacting healthcare costs and outcomes, without being too expensive.

5. International regulatory environment

Most of the developed countries appear to have taken a proactive approach to AT solutions in the face of the growing burden of an ageing population. To date, the countries identified as having some defined e-health policy or clear policy activity are: Australia, Canada, China, Croatia, Denmark, Finland, Iran, Malaysia, Malta, New Zealand, Russia, Singapore, South Korea, Sweden, Taiwan, Tanzania, Thailand, UK, USA and Vietnam [1].

Within the European Union (EU) many telehealth activities flourish, funded by both national governments and the EU, but policy development lags. The EU has invested more than 650 million Euros in funding telehealth and telecare initiatives, and sees it as a strategic objective in light of the growing need for efficient aged care [50].

The US has predominantly private-sector driven aged care facility and home care agency industries; however, the federal government has come out with definitive guidelines for implementation of Information System and Assistive Technologies. It has promoted industry wide responses through the establishment of ‘CAST’ and ‘Continua’ and the passage through Congress of bills that permit the funding of Telehealth services. The adoption of such technologies is steadily growing proving its acceptance and developing a stronger business case for aged care facilities to be IT enabled. With the recent policy to promote electronic health information across the country by the Obama administration, the business case becomes even stronger. The United Kingdom has come up with a well defined “UK Telecare policy and strategy,” and with the National Health Services focussing attention on elders there is a large fund available for AT applications. The NHS Audit Commission has provided a wide scope of AT and recommends a practical approach to large-scale funding support by the Department of Health. A £31 million project for installation of home telecare devices and smart homes is already underway [51].

In Australia, with the establishment of NEHTA – the National E-Health Transition Authority - in 2008 and its recognition of telecare for chronic disease management and elder care there seems to be some movement forward. An aim has been set to establish standards in e-health in the next three years with inclusion of telecare/service delivery tools in priority areas [52]. Policy of the New Zealand government closely follows Australian policies and in fact is grouped under the “Australia New Zealand Policy for Telehealth” Working Committee. The policy so far covers evaluation methodologies in telehealth as an initial step towards large scale acceptance and drafting of national policy framework. Although initial interest is seen there is a long way to catch up with the developments in other countries [1, 53].

Canada enjoys a significant level of federal and provincial policy support for e-health, and development of the e-health sector is viewed as a strategic priority. Several years of deliberation resulted in the creation of the Office of Health and the Information Highway (OHHI) in 1999. A ‘Canadian Health Infrastructure (CHI)’ initiative has also been established. The National Initiative for Telehealth (NIFTE) Guidelines project is developing a framework of national guidelines for telehealth and the Canadian Society for Telehealth (CST) is also active [54].
Japan, despite its technology savvy image, is lagging behind in terms of a structured approach to its ageing population. The diffusion of telecare and AT has now caught momentum after establishment of the Japanese Telemedicine and Telecare Association (JTTA) in 2005[55].

Thus it becomes clearer that UK, USA and Canada are moving rapidly towards telecare solution implementation to care of older people and would be most favourable countries to propose newer technologies that are superior to those currently deployed. It is hoped that EU, Japan and Australia will soon catch up with the above. The scenario in New Zealand is likely to be that of cautious observation and slower implementation mostly owing to the fragmented decision making by District Health Boards, unless the newly proposed National Health Board takes proactive stance.

6. Conclusion

There seems to be a global drive towards technology driven solutions for elder care, including the use or robots. The solutions may be technologically advanced, but designers, developers, implementers and users need to address non-technological issues appropriately, especially in the early phase of deployment and commercialization. Significant ethical issues and concerns on personal autonomy in addition to the practical problems of introducing new technology into organizations, including acceptance by healthcare professionals, need to be addressed. As such, it is the responsibility of the designers and vendors to provide sound solutions that enable healthcare professionals to do a better job for their patients at a cost that is affordable for publicly funded programs. It is through this synthesis of practical implementations and demonstrations of benefit that success of this new technology can be supported. Health-care policy, including e-health policy, will remain the sovereign domain of individual countries. However, if an e-health solution (such as an elder care robot) is to be successfully developed commercially for global application, the solution designers should equally consider ethical, socio-cultural, financial and international regulatory frameworks. The future research would further clarify which features of robotic support are most useful and acceptable, and how they compare with mobile phone based or internet based home monitoring devices and other smart home technologies.

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