Some Non-technology Implications for Wider Application of Robots to Assist Older People

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Abstract

Assistive Technology (AT) and telecare for older people are now a major focus area for research given the ageing of the population and the 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. Four important issues were identified for detailed analysis, namely: Ethical, Social-cultural, Economic and Regulatory implications of designing eldercare robots. Important ethical challenges were related to privacy, autonomy and 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 born 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. The cost considerations for such devices are important if targeted consumers are people who may not be financially independent. The international regulatory framework is generally supportive though variations exist across political boundaries. Using robot based AT solutions for older 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 peoples' need for physical and cognitive assistance is well recognized. The problem is further complicated by diminishing numbers of healthcare professionals, caregivers and people available to provide useful companionship to the 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].

Assistive Technology Device (ATD) is defined as "Any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities", by the Amended US Assistive Technology Act 1998. More precisely [5], AT or ATD has been envisioned to assist:

1. Performance of everyday activities in an efficient reliable and simple manner, in the designated environment.
2. Formal & informal care giving processes and/or substitute for the same
3. Promotion of Quality of Life, a sense of security & safety and prevention of accidents
4. Enhancing Communication while respecting user preferences and motivations
5. People to remain active and remain in their homes if possible
6. Other family members or co-inhabitants or caregivers in their own rights.

Robot in this context essentially means "computer on wheels" housing a repository of knowledge base, empowered by "intelligently moving parts, dynamically interactive speech, cameras and connectivity to the wider world through wireless internet", that opens up a wide range of possibilities to fulfil some of the above roles. Some robots are already assisting the dexterity of a surgeon, some extend the reach of a clinician to remote locations, some improve efficiency by packaging drugs and even more are being designed to assist the disabled and elderly [6]. In recent years stationary home-monitoring devices have shown positive impact on the health of older people [7-10], more recently, robots have been identified as a potential option to enhance telecare by introducing mobility, improving communication capabilities, supporting vital signs monitoring and activity tracking. These automated functionalities ultimately aim to reduce the burden of routine repetitive tasks on caregivers [11]. The Joint UoA/ETRI Centre for u-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 [12] have indicated features that would be desirable. Some of the areas being addressed by this project are: vital signs monitoring, medication management, falls monitoring and preventing wandering in cognitively challenged people.

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. Namely ethical, socio-cultural, economic and regulatory considerations as represented below. The safety regulations, clinical issues, psychological acceptance and other aspects of Human Robot Interaction have not been discussed in this paper.

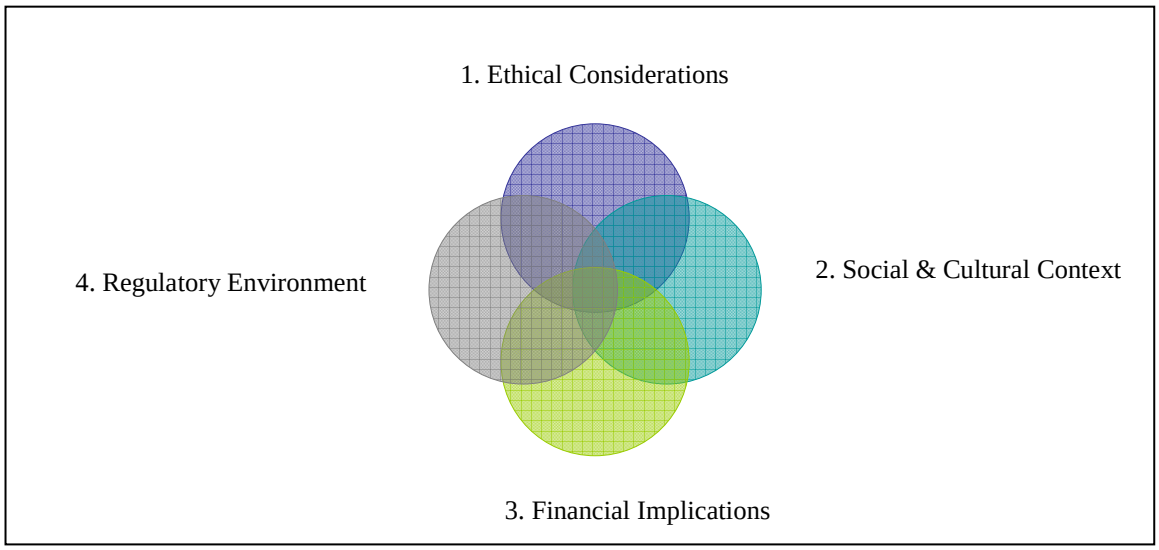

Figure 1 - Some non-technological implications for robots in care of older people

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 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 web sites.

2. Ethical considerations

The introduction of any new technology in health care must address respect for autonomy, be beneficent, non malefic and just [13]. The ethical considerations require careful analysis because there is potential of 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 [14]. The assessment of ethical implications of healthcare technology involves consideration of the entire range of user experiences relating to personal autonomy, privacy, dignity, safety and choice, surrounding the use of technology [15].

Wirelessly connected robots also need 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 an aware agent. The ethical dilemma arises as to when to give a choice, where a user may allow or block certain features, e.g. users should have choice when to allow observational recording [16] although there should be a compromise for safety when a potentially lifesaving device could be 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.

Hence, 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 Antilock Braking System in the car prevents the driver from executing actions (i.e. stopping the car immediately), in order to prevent skidding and accidents. It justifies curtailment of user autonomy to enhance safety. Similarly robots in healthcare may curtail user autonomy by incorporating safety and instructional protocols, either built in (e.g. the user cannot switch off an alert to the nurse if a vital sign is in the danger zone or if a 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 an infringement of the autonomy of an older person, it may 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 robot may actually enhance autonomy of the person by offering more choice (e.g. not depending on nurse to give medication or waiting for her or him 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 old people are expected to be some ‘active users’ of technology and some ‘passive recipients’ of the technology with different preferences [17]. Therefore, the degree of autonomy ultimately experienced by the old person in an ACF could become a function of defined system design (i.e. a combination of functionality of the robot, institutional environment and rules defined by healthcare providers) on which they depend to carry out various health related tasks [18]. The flexibility of system design therefore becomes more important as the 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 [19]. In a large-scale Philips National Study on the Future of Technology and Telehealth in Home Care, spanning the US, Fazzi et al. [20], observed that *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 users’ perceptions[21]. But 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 [22]. 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 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 old people, seems to score positively [23]. Conversely, the question arises: Is it ethically appropriate to delegate care of older people with limited mental and 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 contacts is not necessarily an improvement [24].

2.2. Safety concerns and accountability for failure

Robots will be expected to conform to a wide variety of standards of the electronics, software and medical device industry, and pharmacy regulations, however, complicating the ethical dilemma is the fact that healthcare itself is prone to multiple errors which are difficult to address. The Institute of Medicine reports "To err is human" has raised significant concerns on medical errors due to human imperfections [25]. To mitigate these errors, the precise information storage and retrieval capacities of technology are considered a valid mechanism to some extent. However, the automation of clinical processes is not necessarily beneficial. Berger and Kichak [26] 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 a vulnerable older population. In addition, there are concerns about the safety of keeping a robot in hostile or adverse environmental conditions such as sloping roofs, staircases, small apartments, and specially bathrooms (where many falls happen and where privacy is usually guarded) – the water and humidity may short-circuit or malfunction the device [27]. 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 [28].

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 the 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 [29]. Although the virtues of many technology based solutions have been advocated for a long time, basic tools such as Electronic Health Records, Clinical Decision Support Systems and guideline conformation alerts are not adhered to by many physicians and healthcare providers due to factors such as lack of perceived strong financial and quality benefits [30-32]. The acceptance of technology by healthcare professionals is a complex problem that needs to be addressed comprehensively [33, 34], 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 variety of funding mechanisms. Negotiating implementation of an innovative solution can be a frustrating task in these settings [35]. The audit commission of the NHS 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 [36, 37]. 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 [38]. 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 [35]. People affected by such changes to the way they work respond in reasonably predictable ways, e.g. following a process such as that described by Elrod and Tippett [39]. However, other implementations could result in failure due to an insurmountable 'concept-reality gap' described by Heeks et al [40]. 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 to factories and also when computers were introduced into offices. Almost uniformly the organizations pass through an 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 [41]. Information technology is proven to be a source of increased demand for skilled labour and rising wages in the long run [42].

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 and a range of expression such as caring and supporting [36]. However, it is likely that the 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 such as 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 it [43], 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.

3.3. 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 [44]. 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, the 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 across USA [20]. 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 [45]. Therefore, physicians buy-in may be obtained by understanding and acknowledging their perspective [46-48].

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 the 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 would have to justify competition from stationary home monitoring and/or ambient sensing devices. 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 are expensive (e.g. the reported cost of a tele-rounding robot is US$5,000 for the base station plus upwards of $5,000 per month [49]). If the solution meets design expectations then the relatively higher cost of robots can be justified indirectly [50] by reducing overheads in some of the important areas such as:

1. Reduction in the cost of institutionalization by promoting ageing in place
2. Reduction in the cost of hospitalization by reducing Adverse Drug Events, falls and complications of chronic disease
3. Reduction in morbidity and the cost of care including containment of manpower cost despite an increasing demand supply gap

The challenge is highest in initial demonstration projects but wider acceptance would eventually make availability easier and cheaper, reduce repair, replacement and maintenance costs, and bring down the overall cost over a period of time [51].

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 a 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 the pension is justified if there is significant contribution to increased quality of life; it remains to be seen how this effects decision making [52].

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. This may in itself be a challenge when one considers that evaluations of most stationary telecare implementations have little evidence to support cost-benefit or cost-efficiency [53]. An elaborate robotic 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.

5. International regulatory environment

Many 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 varies amongst member nations. The EU has invested more than 650 million Euros in funding telehealth and telecare initiatives, and sees it as a strategic objective in the light of the growing need for efficient older care [54].

The US has predominantly private-sector driven ACF 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 acceptance and developing a stronger business case for ACFs 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 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 [55].

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 older 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 [56]. The policy of the New Zealand government closely follows Australian policies and in fact is clubbed 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 a national policy framework. Although initial interest is seen there is a long way to catch up with the developments in other countries [1, 57].

Table 1 – Summary of international regulatory environment supporting telecare

	National policy for Telecare	Structured implementation plans	Public funding support	Supportive forums and organizations
Japan	No	No	No	Yes
Australia /NZ	Yes	No	Yes/No	Yes/No
EU	Mixed	No	Yes	Yes
UK	Yes	Yes	Yes	Yes
USA	Yes	Yes	Yes	Yes
Canada	Yes	Yes	Yes	Yes

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 (OHIH) in 1999. A 'Canadian Health Infostructure (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 [58].

Japan, despite its technology savvy image, is lagging behind in terms of a structured approach to its older population. The diffusion of telecare and AT has now caught momentum after establishment of the Japanese Telemedicine and Telecare Association (JTTA) in 2005 [59].

In summary, if we take the liberty of extrapolating these observations onto robot enabled telecare then some countries (such as USA, UK and Canada) appear more favourably inclined than others (such as Japan, Australia or New Zealand).

6. Conclusion

There seems to be global interest in technology driven solutions for care of older people, including the use of robots. The solutions may be technologically advanced, but need to address non-technological issues appropriately, especially in the early phase of deployment and commercialization. Although there are significant ethical issues involving personal autonomy and practical problems of introduction of new technology into organizations, but the end users are not technology averse. As such, it is the responsibility of the designers and vendors to provide sound solutions that enable healthcare professionals, caregivers and family members to support older people. It is through this synthesis of practical implementations and demonstrations of benefit that success of this new technology can be supported. Healthcare and elder care policies will remain the sovereign domain of individual countries. However, if a borderless innovative solution (such as an elder care robot) is to be successfully implemented, international regulatory and supportive frameworks should be considered. It remains to be seen in dynamically evolving scenarios if other countries catch-up or move past the leaders in innovation. There is paucity of observation directly in relation to healthcare robots; hence in this paper extrapolations have been made from related domains such as: AT, telecare and e-health. This further affirms that there is need for specific studies on elder care robotics through international participation to validate how the implications change with increasing frailty, with change from living at home to living under residential care and how healthcare system design or funding mechanisms influence the use of these innovative solutions.

7. Acknowledgements

The authors wish to thank the members of the Joint UoA/ETRI Laboratory for u-Healthcare Robotics. The work was supported by a New Zealand Foundation for Research Science and Technology (FRST) International Investment Opportunity Fund (IIOF) Grant, a University of Auckland PhD scholarship and Tertiary Education Commission (TEC) Partnerships for Excellent endowment. This work was also supported by the R&D program of the Korea Ministry of Knowledge and Economy (MKE) and the Korea Evaluation Institute of Industrial Technology(KEIT). [2008-F039-01, Development of Mediated Interface Technology for HRI]

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