Chapter 23: Assistive technology: Opportunities and implications[1]

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Editor's note

It is important to recognize the role of technology and the impact on the lives of people who mostly do not understand how much this technology is already shaping the future. Older people are often considered unable to learn about new sciences and uninterested in how technology can assist them to live their lives better. This assumption often restricts the use of assistive devices that could be life enhancing. The authors give examples of assistive technology and how it can be applied, both inside and outside the home environment. How to be informed and select the appropriate technology, as well as teaching understanding and acceptance, will be an increasing part of the role of the health care provider. Barriers to the use of assistive technology are discussed and the lack of business models to provide this at reasonable cost to consumers is addressed. The importance of evaluation of the assistive technology is stressed as this becomes the way to determine whether the devices are improving the life of the client or making it more difficult for them to manage.

Introduction

This chapter seeks to draw together three major issues – the ageing of the population, advances in the use of technology in the care of older people, and the need for evaluation of the impact of this technology within clinical practice.

There is no shortage of data that informs us that we are living longer, and as we get older, we are increasingly living alone and with disabilities. Over the next 40 years, the ageing of the population is projected to slow economic growth at the same time that spending pressures in areas such as health, age pensions, and aged care are projected to rise (Australian Government 2007). The major influence on government spending on aged care is the number of people aged 85 and over and this number is projected to more than quadruple (Australian Government 2007). The costs to society are increasing and individuals, families

[1] Authors' Accepted Version of: Horner, Barbara and Soar, Jeffrey and Koch, Bill (2009) *Assistive technology: opportunities and implications.* In: Nay, Rhonda and Garrett, Sally, (eds.) Older people: issues and innovations in care, 3rd ed. Churchill Livingstone Elsevier, Sydney, Australia, pp. 391-412. ISBN 9780729538985.

and heath care providers are looking at ways to reduce this burden while maintaining a preferred quality of life.

At the same time we are witnessing a technological revolution. Increasingly, the most innovative uses of technology are taking place in the home. Terms like ‘intelligent home’, ‘smart home’, ‘digital home’ and ‘connected home’ are being used to describe the convergence of a range of technologies and their increased use (Essen & Conrick 2007).

The ageing of the population and improvements in technology are creating a growing interest in the use of technology and its potential role to help support older people to stay independent and in their own homes for as long as possible by service providers, carers and health professionals. Connected home (that is a home with embedded technologies that support independent living and connect to families and carers) and related technologies are increasingly being employed to help older people and people with disabilities to live more independent and productive lives. Such connections also provide benefits beyond the individual and their home. They can assist health care professionals to manage data and improve communication; assist in the monitoring and treatment of chronic conditions; enable the delivering of services beyond the walls of a health institution; and facilitate responses to a critical event (Essen & Conrick 2007).

Assistive technology (AT) can be defined as ‘any item, piece of equipment, product or system that is used to increase, maintain or improve the functional capabilities of individuals and independence of people with cognitive, physical or communication difficulties’ (UK Audit Commission 2004). AT aims to increase the ability of a person to remain independent, reduce risk and maintain engagement in meaningful activities, and includes a wide range of products from simple, low tech and low cost to very technologically complex.

Key Point

Assistive technology (AT) aims to increase the ability of a person to remain independent, reduce risk and maintain engagement in meaningful activities.

UNDERSTANDING THE ROLE OF ASSISTIVE TECHNOLOGY

Control of one’s life, empowerment, integration and full participation in society, independence, autonomy, self-determination, self-respect and self-reliance, as

well as participation in diagnosis, treatment and decisions about care, all relate in one way or another to the concept of human dignity (Comyn et al 2006).

AT may contribute to the maintenance of human dignity as people get older, and older people often have decreased functional capacity resulting from increased frailty and/or decreasing cognitive ability. One solution is to offer assistance through technology in the form of a range of equipment or devices to enhance their living environment, thus extending their ability to operate effectively in the face of decreasing functional capacity.

The application of assistive technology should therefore aim to:

- Enable those who seek to age in their own home – maintaining independence, extending capability and productivity, enabling choices;
- Enable those who live in health care facilities and those who care for them – improvements in communication, access to data and professionals, monitoring and treatment of conditions;
- Support families to provide the support and care that is needed by an older person and to facilitate their role as part of the care team; and
- Foster innovation that is a response to 'clinical, social or personal need' (as opposed to technology driven).

Intrusive technologies or functions such as the location and monitoring can be of concern as is the potential for social isolation if technologies substitute for human caring. Privacy and confidentiality are a critical factor in acceptance of AT. Trust established between practitioner and consumer will assist individuals to see the benefit of data collection and, with appropriate guidelines, the value of sharing data and experiences with others. Anxiety around the perception of 'being watched' by the use of electronic devices is understandable. Surveillance is an uncomfortable concept for most people, particularly someone who is feeling vulnerable or at risk. Careful explanation, clear policies and procedures, rigorous monitoring and regular feedback can all facilitate understanding and acceptance. Engagement of the consumer in the selection, establishment and implementation of any AT will encourage acceptance and minimize anxiety.

Key Point

Engagement of the consumer in the selection, establishment and implementation of any AT will encourage acceptance and minimize anxiety.

CATEGORIES AND APPROACHES ACROSS THE SECTOR

THE ROLE OF TECHNOLOGY

In the future we can expect that technology will transform ageing and aged-care just as it has done for other industries and other aspects of our lives. It will allow greater choice including remaining safe and healthy in our own homes and delaying or avoiding a move to institutional care, and choosing to remain socially connected and active.

Philipson & Roberts (2007) identified four key areas where digital technologies can be used to improve the lives of the aged, disabled and chronically ill. These include self-management of healthcare in home settings with potential savings and other benefits; home automation, which will enhance security, safety and independence at home, and will help maintain quality of life and decrease the demand for carer support hours; communication technologies, which will provide important benefits for people whose mobility is limited, or who live alone; and finally, the various home automation and digital technologies can benefit the aged and the disabled, improving their quality of life by enhancing their independence. Technology has the potential to extend their physical independence, so they can stay for longer in their homes. It gives them a more dignified life, and it saves public and private money.

When we consider how pervasive computer controls are in modern cars or aircraft it is perhaps surprising that computer-aided technology is not already more readily available in our own homes. Cars commonly contain many intelligent controls for security, engine and braking. Displays can show global positioning, fuel consumption, distance calculation, and can provide cameras or alerts to assist in reversing or parking. All doors can be locked remotely with a single press of a button and the car itself can turn off all interior and external lights. Much of the technology in cars has come from the highly sophisticated aviation industry.

There has also been increasing use of intelligent controls engineered into modern buildings. This includes smoke detectors linked to the building fire sprinkler systems. The elevators are often remotely monitored. CCTV (Closed Circuit Television) for security is ubiquitous in commercial and public places. The Department of Health in Queensland, Australia has begun installing intelligent controls with remote monitoring for some of its hospitals. These control, for example, hot water systems that can monitor use and then reduce energy-consumption according to demand. Knowing the periods of peak demand allows scheduling the boilers to prepare in advance. These kinds of controls applied to heating, lighting, air-conditioning and other services can learn patterns of use

and reduce energy consumption at quiet times and build up in preparation to periods of peak demand.

The use of technology within the home however is not so far advanced. Currently all doors, windows, curtains and light switches need to be operated individually. If we go out and forget to lock the doors there is no embedded intelligence that would recognise the house is vacant and turn off lights and lock doors in the way some modern cars are able. Heating, lighting and air-conditioning systems are dumb in that they cannot track the movements and numbers of people between rooms and ramp services up or down according to need.

Key Point

There has also been increasing use of intelligent controls engineered into modern buildings.

SELECTION OF ASSISTIVE TECHNOLOGIES:

Whilst there are many examples of AT in use there is also a high rate of abandonment of existing AT (Reimer-Reiss & Wacker 2000). There is little research into the reasons for abandonment, however Reimer-Reiss & Wacker (2000) recommend that users be involved in any decisions on AT that they are expected to use. It will be important to learn from experiences in use of non-intelligent technologies in planning for the evaluation and adoption of intelligent AT. Issues to consider include the availability of support for the technology, any stigma or embarrassment about its use, availability of people to respond to alerts such as a professional call centre or family carer, whether the potential user has been directly involved in the acquisition, whether it fits conveniently into the living arrangements of the user, and whether our care organisations are ready for the work practice and care model changes that may be necessary for adoption of the technology and realisation of the benefits. Older persons' accommodation can be quite small and limit the introduction of, for example, lift chairs.

Key Point

It will be important to learn from experiences in use of non-intelligent technologies in planning for the evaluation and adoption of intelligent AT.

When considering the selection and implementation of AT one may be confronted by a plethora of vendor claims and glossy brochures for their

products. To facilitate more judicious choices, particularly for care provider organisations, the following steps are suggested.

STEPS FOR SELECTION OF ASSISTIVE TECHNOLOGIES:

- Review the research evidence; what have been the experiences of others with this technology?
- Are there arrangements for technical support?
- Who will monitor the signals from the technology? Is there a call centre? If not, what is the capacity of other people to provide 24x7 monitoring?
- Conduct your own pilot research project before wide-scale deployment
- Develop a business case identifying:
    - details of problems and what the technology is expected to provide
    - identify infrastructure costs – cabling, maintenance support
    - do a cost-benefit analysis
- Selection processes:
    - Write a detailed specification outlining the problem and the functionality sought
    - Develop an evaluation matrix to be able to compare alternative products
    - Invite proposals
    - Visit places that already have the technology installed to learn from their experiences
    - Conduct a small-scale pilot of the technology before wide-scale implementation
- Plan for wide-scale implementation
    - Do you have expert project management – has your project manager delivered similar projects previously?
    - Ensure project governance, a Steering Committee involving key executives.

The following sections will discuss the benefits of AT to both the individual and service provider before addressing possible approaches to evaluation.

UNDERSTANDING AND ACCEPTANCE

Technology is now playing an important role in maintaining independent living, linking health services, housing, social care and community safety. For the individual, the benefits cited include improved quality of life, reduced emergency admissions for acute events, and reduced lengths of stay, particularly for those with long-term conditions. For family carers the benefit includes support to enable them to provide care at home for as long as possible.

FOR THE INDIVIDUAL

AT products can support self care, enable an individual to accomplish daily living tasks, assist them in communication, work or recreation activities and help them to achieve a level of independence that is necessary for them to remain out side of an institutional care environment.
There is growing evidence to show that supporting self care leads to a number of positive outcomes:

- Improved health and quality of life as the individual feels 'in control' of their situation,
- Increased patient satisfaction when the individual feels they can communicate with a health professional and contribute useful information about their health status, and
- Positive impact on the use of services and more appropriate use of services.

AT can be useful for someone who is finding basic household chores difficult or impossible, or who is anxious about their ability to remember events and activities. It is also useful for family members who need to maintain regular contact to 'monitor' heath status, security and safety of the individual who is living alone.

Key Point

AT devices can assist an individual who is living at home to manage their situation and monitor their health status.

Communication is particularly important for someone who has limited mobility, cognitive impairment or who lives a long way from family and/or friends. AT can provide many different ways for an individual to communicate, to maintain social networks, and to transmit and receive information. Family members and health professionals can monitor health and wellbeing daily and initiate intervention

when necessary. AT can manage the risks associated with living alone as well as monitor lifestyle changes or changes in regular behaviour. Individuals report that they feel better because they can manage their symptoms and respond to changes with, for example, pain management, anxiety, and depression.

Here are examples of how AT devices can assist an individual who is living at home to manage their situation and monitor their health status.

Vignette 1

Mr A has mild dementia and was starting to forget to turn off the gas when he was cooking. He had a gas detector installed with an automatic shut off valve when gas was detected in the air. This made him feel less anxious about the gas and his memory lapses. His family also felt better because they knew the gas would be detected and turned off if a situation occurred. Eventually the family installed other devices to 'detect' at risk situations with the water, open doors and lighting.

Vignette 2

Mrs B had a history of falling. Following an episode in hospital that resulted from a fall, she was provided with a basic bed pressure sensor pad that could detect when she left the bed during the night and turn on the lighting in the bathroom. It then triggered an alarm is she did not return to bed within an agreed time. The program attached to the sensor recorded how many times Mrs B left her bed during the night and this could be checked by the family or visiting carer. At one stage, it was noticed that her visits to the bathroom in the night had increased significantly. Following investigation, it was noted that Mrs B had a urinary tract infection and treatment was commenced.

Carers are usually partners or other family members. Their responsibilities for the dependent person can severely restrict their own activities. They may be unable to leave the dependent person alone if they are prone to wandering, falling or putting themselves at risk in other ways. As a consequence, they can become isolated. Carers often neglect their own nutritional needs and other aspects of their health as they may be too tired to prepare their own meals. They may also be at risk of injury through lifting the dependent person and assisting them in slippery areas like bathrooms.

Caring for someone with cognitive impairment can be particularly stressful. The need to give someone repeated reminders about ADLs (Activities of Daily Living)

can be frustrating. The technology that can assist with providing reminders will never become stressed or frustrated. Carers can also use telehealth Technology to assist in maintaining their own health as well as that of the person they are supporting.

Key Point

The technology that can assist with providing reminders will never become stressed or frustrated.

Examples of AT that may assist the individual are outlined below.

Telecare

There is a range of products of Telecare in home settings. These include a personal alarm that is wearable as a pendant or on a wristband, and a radio device connected to the standard home telephone that will pick up a signal from the device and allow voice communications with a call centre. Additional devices can include a radio pull-cord in the shower or bathroom, and detectors for gas, flood and falls. A detector is available for the home front door, which, when opened, can trigger an alert and/or an interaction with a call centre operator who can interact with the resident. This can be useful for people at risk of wandering and the operator can encourage the resident to stay in the home and can call for assistance.

Smart toilet

Incontinence is a major issue in aged care and a significant factor in decisions regarding admission to aged care homes (Department of Health and Ageing 2003).

There have been several attempts at a smart toilet and a Google search using this term finds over 500,000 hits reporting primarily on innovations in Japan and Korea. Innovators in this field include Matsushita & Toto (CNN.com 2005). At the Wonju campus of Yonsei University in Korea a toilet has been developed that will undertake pathology tests on wastes. The toilet is also the site for a telehealth consultation where vital signs can be taken. When a person steps up to the toilet their weight is recorded. The toilet is equipped with devices for blood pressure, oximetry and other measures. In countries like Japan and Korea, where almost every home has an electronic bidet-toilet, it is expected that the move to a diagnostic toilet would be a logical step.

Key Point

At the Wonju campus of Yonsei University in Korea a toilet has been developed that will undertake pathology tests on wastes.

Robots

Robots perform much of the work in manufacturing, including automobile assembly. Work has been underway for many years to build a humanoid robot personal assistant or carer. Honda's Asimo robot may be the most advanced to date and suggests that a robot assistant in homes may not be far off (http://asimo.honda.com/). In France, the Alcatel-Lucent research laboratory has enhanced Sony's Aibo robot dog (Sony 2006) to become a personal carer. The dog has a camera, microphone and wireless connection. It can provide reminders and alerts and through pattern recognition it will know its owner and can continuously monitor their safety and well-being. If, for example, a carer was unable to contact an older person, the dog could be contacted and could search for its owner. The carer could see though the dog's camera "eyes". REVES (Robot visant à Embellir la Vie des Enfants en chambre Stérile) was originally designed as a robot companion for children in hospital and particularly for those in isolation rooms. The robot dog would provide a companion to an isolated child patient as well as a multimedia terminal complete with camera, microphone, loudspeaker, gaming and links the child could use to clinicians, friends and family (Telemedicine-Alsace.fr (2007). The potential for similar use in care of older people is obvious.

There have been other developments of robots as media for telehealth or teleconsultations with clinicians. In 2004, a prototype known as Roy the Robot was built at the Centre for Online Health at the University of Queensland in Australia to support Gladstone Hospital, which is about 500 km north of Brisbane. At the time, there was no full-time paediatrician on staff, despite the hospital having a paediatric ward. The robot provided a link with a specialist in Brisbane who could make a virtual ward round (University of Queensland 2003).

Queensland is the largest state in Australia with enormous distances between cities, regional and rural centres. The majority of rural hospitals and some regional hospitals lack staff specialists, and telehealth can provide support for local clinicians in remote locations as well as direct patient consultations. The technology can also be used for training of registrars and other staff. To date, few healthcare payers or insurers will fund electronic or telehealth consultations. A challenge for research is to demonstrate the benefits and to develop the new models of care delivered through intelligent technology.

Wearable technology

There are wearable devices that have a long history of acceptance, such as chemotherapy pumps, and there has long been widespread acceptance of implanted devices such as heart pacemakers and artificial joints, as well as increasing acceptance of Cochlear implants. Wearable intelligent technology is used for the training and monitoring of elite athletes as well as for people with health issues that need to be monitored.

An Australian company (http://www.alivetec.com/) is an example of several companies that produce devices for both athletes as well as people with disabilities and the frail elderly. These companies produce wearable or portable devices for heart monitoring, oximetry and diabetes management.
A system called MagIC (Maglietta Interattiva Computerizzata) was developed in Milan. It is a textile-based system for unobtrusive monitoring of cardio respiratory and motion signals. Sensors are embedded in a vest and can measure ECG, respiratory activity and other vital signs. The system also includes a portable electronic board for motion detection, data preprocessing, and wireless communication with a remote monitoring station (Di Rienzo et al 2007).

Smart Homes

There are smart homes in many countries as research and development laboratories. There is a paradox in that there is a very wide range of technologies available but the adoption is negligible. Chan et al (2008) present an international selection of leading smart home projects, as well as the associated technologies of wearable/implantable monitoring systems and assistive robotics. The extent of work and sophistication of technologies reported on in their paper is impressive, however it still remains the case that few people are as yet living in a smart home.

FOR THE SERVICE PROVIDER OR PRACTITIONER

Effective management of chronic illness and disability among older people requires a close partnership between the individual and all health care providers who are involved in their care. The individual who is responsible for their own day-to-day care is best placed to monitor their symptoms, and to respond to changes in condition. They need to be active participants in the treatment and management of their chronic illness.

Compliance with self management regimens is often not good, which is not surprising if instructions are complex and information confusing. The problem of compliance and the necessity for effective communication between older people and health professionals has led to the need for appropriate, cost-effective information and communication assistive technology.

The management of chronic illness, such as that often experienced by an older person, calls for changes in health care delivery and education for health practitioners as part of the 'package' of health care. What is needed is AT that will provide rapid access to general health information, reduce duplication of information and services, facilitate portability of records and enhance the quality of the information exchange (Celler et al 2003). Telecommunications and computer-based systems can deliver services, record and transmit data and information, and facilitate communication between an individual and health service or health care professional.

Key Point

Telecommunications and computer-based systems can deliver services, record and transmit data and information, and facilitate communication between an individual and health service or health care professional.

A technology framework that enabled seamless integration of all core systems and communication services, and incorporated telephone, computers, emergency alarms, nurse call systems, security and building systems would deliver technology and services to individual homes as well as provide communication and information channels to health professionals and service centres. Such a system that was installed across an aged care community that offered accommodation and services in independent living units as well as low and high care facilities would provide benefits for individuals, families, professional carers and health professionals.

Here is an example of such a system that exists in a larger community-based aged care community in Western Australia.

The *Intelligent Building Solution* supports the organisations commitment to 'create a community environment for seniors which fosters confidence, self worth and well-being' (SwanCare Group 2006). Interoperability is the key feature as this system is interoperable with virtually any application or system as the messaging gateway allows connection to a variety of protocols and interfaces (Schaper & Lapins 2007). This is a highly sophisticated and scalable messaging system that has multiple possible applications. The primary initial use for the system was risk assessment, with the monitoring of smoke, gas, water, electricity use and the detection of 'potential risk' levels of use. When such a level is reached, a message is transmitted via the phone. If not responded to, the system alerts a third party. There is also high speed internet access, Voice-over-IP telephone, security and video services, assistance call and nurse call options.

There is also potential for links to external services, health professionals and call centres.

It is highly likely that such a system could become a 'channel' for health information and advice, communication for the management of chronic illness, data transfer and links to family and other significant social connections.

It is essential to have clear goals and purpose when health professionals are considering the use of AT devices that encompass high-level organisational goals as well as clinical need goals (The Royal Society 2006). Examples of high-level goals are:

- Provision of a seamless service: breakdown barriers between institutions, integrate service delivery, link community and hospital care provision;
- Ensure interoperability of services, devices, data and external information sources;
- Provide better communication between health care professional and individual.

Examples of clinical need goals are:

- Assist individuals to better manage their health and their care: provide better information, support self-care, provide more options about treatment;
- Ensure data available to professionals is accurate, complete, relevant, up-to-date and readily accessible;
- Provide a better evidence base for practitioners to make decisions.

Telehealth

Devices are available that enable vital signs to be captured and stored or else communicated interactively with a carer. These include devices for weight, blood pressure, heart rate, oximetry, blood glucose levels and spirometry. The devices can transmit information in real time, enable an on-line consultation with a clinician or can store the information for later analysis.

Key Point

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Intelligent agent software

Devices need to be enabled by intelligent software that will also provide the communication links to meaningfully exchange information. Intelligent agents are software robots that will operate sensors and other devices. The intelligent agent will be able to link to a person's health history, be programmed to provide

reminders through a range of devices and will be able to learn an individual's patterns of normal living and provide alerts to abnormal events.

Call centres and monitoring

An essential component of assistive technology and smart homes is the arrangements for response to an event or signal. There is often a presumption that the person receiving the messages will be a family member or GP (General Practitioner or family doctor). If messages and alerts are directed to a family member, then protocols need to be developed; for example, what will happen if a carer's mobile phone battery is flat or they are somewhere that they cannot hear the call? For GPs to receive telehealth information and monitor signals there will need to be arrangements for funding and accountability and insurers would need to agree to reimburse these services. Those changes are not likely to happen in the near future.

There are companies that already provide the alert button that is widely used by frail older people and people with disabilities. Some of these are moving more into telecare and telehealth services. It is critical that these services operate according to standards and protocols. Consideration needs to be given towards what signals can be responded to by the software and what requires a human operator, especially given that many older people may not be comfortable with automatic voice response systems. In addition, some health authorities operate telephone triage and may also wish to extend into the home and AT monitoring market.

Standards

Recognition of the need for international standards to guide the development of assistive technology has lead to the establishment of the Continua Health Alliance (http://www.continuaalliance.org/home). This aims to develop and promote the adoption of standards to ensure that technologies are interoperable; that is, they can connect, exchange information and that the information has the same meaning to the sender and receiver. This will be critical for safety as well as for managing costs, ease of training, and reducing the potential for consumers to be locked into the products of a particular supplier.

Further work in standards is required to ensure the quality of call centre services, security and privacy, and also for protocols for operation; for example, at what point is it reasonable for a remote operator to activate web-cameras and potentially invade a person's privacy?

FOR THE CARE PROVIDER ORGANISATION

Health and aged care around the world faces huge shortages of both professional and family carers. Meeting workforce issues is a major imperative for interest in AT. There is interest in giving professional staff access to

productivity tools as well as enabling them to better supervise semi-skilled staff. Telehealth could reduce the need for home visits for the purpose of taking vital signs. It could log and track the movements of staff to ensure the visits took place, to direct the carer to the next client and provide on-line access to information to optimise the effectiveness of the visit. Currently carers have few details about other services someone might be receiving in their home. Electronic communities of care would provide access to relevant patient records for all carers. They could share concerns and alerts as well as have electronic referrals with complete patient information. There is interest in the installation of intelligent technology as a marketing-edge to attract retirement village residents. Technology in residential care will assist residents to be more independent and manage more of their own care as well as support staff in providing quality care.

Key Point

Meeting workforce issues is a major imperative for interest in AT.

SOME POSSIBLE APPLICATIONS OF AT

Rapidly developing technologies that focus on communications, data transfer and processing or that address issues/risk associated with the home environment or the behaviour of an older person, and therefore issues such as carer burden, are under utilized.

This section outlines some examples and how they can be used as a strategy to educate practitioners and draw their attention to how some of the 'less complex' devices might be utilized in practice to address common areas on concern. Not all options will work for everyone, but options are worth investigating for individuals and individual situations.

Tracking people and objects

Hand-held devices and mobile phones can be utilized to track a person with a tendency to wander. Wandering behaviour often creates anxiety for the partner or carer who finds themselves in conflict over a security and behaviour management issue. An individual can be allowed to wander from home but not be 'lost' as their movement can be monitored. They can be spoken to and can call a pre-set number if they become confused or concerned.

Key Point

Hand-held devices and mobile phones can be utilized to track a person with a tendency to wander.

There is a device that will monitor the front door and provide an alert to a carer as well as an audible message to the dependent person if they attempt to wander from their home. That way the person can be encouraged to return to the house and the carer can be alerted.

Vignette 3

Mr W has mild dementia; he lives at home with his wife who is his carer. Before his dementia, he was strong and a regular walker and he and his wife often walked to the local park in the afternoon, then back home along a pathway. His pattern of behaviour now includes a 'wandering' period in the afternoon when he becomes agitated, walks around the house, in and out of the back door and into the garden. While he can be distracted, he continues to be agitated. His wife used to let him go for a walk in the afternoon and she would follow him, keeping an eye on him, concerned that he would get lost or not come home. He always followed the same path and always came home. Following a counseling session, it was suggested that they try a tracking device for Mr W so that he could go for his walk and she would not have to follow him. The device worked well: after lunch, Mrs W asks him if he would like to go for his walk and fits the tracking device to his belt. He knows what is happening and why he is wearing it. He heads off on his walk, same pathway and same time frame, and Mrs W stays home. They both know that this will need to be reviewed regularly as the situation may change. But for now, he gets his walk and enjoys the routine and the independence. Mrs W has learnt to let him go alone and now enjoys the hour on her own. She says that she usually works in the garden 'just in case' and keeps an eye out for his return.

Sensor technologies, personal healthcare devices

Devices that are based on low-cost computer technology and bought over the counter or internet are available. These currently include pedometers (monitor an exercise regime), scales, thermometers, heart-rate monitors, blood pressure monitors, body fat analysis and blood sugar monitors. Information can be collected, stored and transmitted to another person. Other technologies that would enable a person to live independently in their home for longer include passive infrared detectors, door entry systems, bed and chair sensors, and emergency monitoring systems.

Mobility and falls monitoring

Home monitoring devices such as sensor pads have been around for some time. They have been fitted in homes in places where a person is more likely to fall such as by the bed, at the foot of a chair, and in the bathroom. Similar devices can be worn on the body and networked to monitor physiological state, or sewn into clothing.

Vignette 4

Mr O lives alone in a retirement unit. He was diagnosed with Parkinson's disease some time ago and while managing very well on his own with meals-on-wheels and home help, his family are becoming increasingly worried about him as he seems to becoming more unsteady on his feet and reports that he is falling over quite a lot, particularly when he gets out of his chair or out of bed to go to the toilet at night. In discussion with his visiting nurse, he agrees to have sensors fitted to several places in his home; adjacent to his chair in the dining room where he has his meals, lounge room where he watches the TV, and bedroom. He also agrees to an 'alert system' connected to a central service. The sensors give the family peace of mind and he feels 'better protected' without losing his independence.

Behaviour patterns and monitoring

'Smart homes' are being piloted in a number of countries. Simple surveillance technology can observe and record routine behaviour within an individual's home, for example, when they get up, in the kitchen, sleep patterns, and when they leave the home. Routine activity and behaviour patterns can be analysed and interpreted with the intention that mechanisms can be put into place to recognize potential risk and 'alert' the individual or a third party when a situation requires intervention.

Vignette 5

Mrs C lives alone with the help from her family and a home and community care package. She has some deficit in her left arm and hand from a stroke about 3 years ago and mild cognitive impairment, but not a diagnosis of dementia. She manages well and is very proud of her independence. She is sociable and has many friends; she 'loves a chat'. Her family were getting concerned that Mrs C was not coping quite as well as she had been, and in particular, forgetting things and getting side-tracked. With the assistance of a company XYZ, they enrolled her in a program that developed patterns of her usual behaviour and identified potential risk areas and events, like when she was cooking and had the stove on. The program installed a 'voice-over' action that was alerted by certain events and time patterns. The value was demonstrated with one particular event. Mrs C was cooking at the stove, getting her dinner ready. The door bell rang and it was Mrs D from another unit. They struck up a conversation about activities planned for the next day. Mrs C completely forgot that she was cooking. Suddenly, an alarm sounded and a loud, programmed voice said, "please go to the kitchen immediately; there is a problem at the stove." This was repeated several times. Mrs C responded to the alert, left Mrs D and returned to the kitchen, turned off the gas burner, and chastised herself for forgetting what she was doing. As soon as the 'risk' was eliminated, the voice alert ceased.

BARRIERS TO THE USE OF ASSISTIVE TECHNOLOGY

From an industry perspective, low market awareness and visibility, lack of standards, and uncertainty can limit take up of AT. Older people may have limited knowledge of possible products and their application. Consumer education and awareness is not common. There is limited literature on product reviews or comparison of products to inform consumers. There is also limited literature on comparative user requirements such as economic factors, gender issues, income levels or environmental factors. A lack of a systematic approach to market developments leads to high costs for research and market validation (Commission of the European Communities 2007). Innovative small scale implementation due to fragmented approaches to risk-sharing and a lack of forward-looking activity limit good practice.

From the perspective of the consumer, there are other concerns. Older people, when faced with new technologies, can find themselves in a difficult, vulnerable position. This may be due to their personal situation – income, location, health, disability. The complexity of the technology may be overwhelming, the equipment not available or difficult to access. Products are sometimes not adapted to meet specific needs of older people; directions are in small print, or not in print at all. This can increase an existing sense of frustration and vulnerability and close down any desire to 'try something new'. Instead of being empowering, taking control of a challenging situation and managing a health condition, AT can be 'the last straw' for an older person and just too much to take on.

The health condition or disability can be the challenge in itself in the use of a piece of equipment. Shaking hands, poor eyesight, failing memory and restricted movement can all be challenges in the use of AT devices. Lack of previous experience with technology can be a deterrent, as can complicated instructions.

Barriers and challenges can be considered under several categories.

- Attitudes of seniors to technology

Restricted accessibility to the user interface from physical disability restricts the ability to handle the device, just as cognitive barriers can limit the understanding of procedures and navigation.

- Ethical concerns

Intrusive technologies or functions such as the location and monitoring can be of concern, as is the potential for social isolation, if technologies substitute for human caring.

Key Point

Intrusive technologies or functions such as the location and monitoring can be of concern, as is the potential for social isolation, if technologies substitute for human caring.

- Training and support for staff

Health professionals' lack of training on the use of the technology or the ability to act on information that is realised when applicable can be a barrier.

- Confidentiality and privacy

Transmission of personal data to other providers or professionals can be seen to be an invasion of privacy. Essen's study in Sweden, seeks to offer an account of how elderly caretakers experience electronic care surveillance in relation to their privacy (Essén 2008). The study was based on in-depth interviews with seniors who participated in a telemonitoring project and who had experience of being continuously activity monitored in their own homes. The findings suggest that elderly caretakers can perceive electronic care surveillance as freeing and as protecting their privacy in the sense that it enables them to continue living in their own home rather than moving to a nursing home. One individual, however, experienced a privacy violation and the surveillance service was interrupted at her request. This illustrates the importance of built-in possibilities for individuals to exit such services. In general, the study highlights that e-surveillance can be not only constraining but also enabling. Thus, the study supports a notion of the dual nature of surveillance.

- Developing new models of care

An issue that has not been widely addressed in the literature and which is likely to be a major issue will be changes in models of care resulting from adoption of AT and smart home technology. Essen & Conrick (2007) explored the constituents of and challenges related to the innovation of technology-based services in the long-term homecare sector.

Their findings indicate that the claimed and the rather abstract benefits of the technology espoused by information technology vendors were difficult to transform into a service concept. There are conflicts between technological possibilities, as well as the prevailing service delivery systems, user preferences and decisions about the extent to which services need to be reengineered to align with new technology. Other as yet unanswered issues include the specification of technologies required, the non-technology resources required, the role of the consumer in a new care process, and identifying the primary beneficiary of a new service. New AT and smart home technology has the

potential to lead to radical and profound service innovation; it remains to be seen whether health and aged-care authorities are ready for the social and political challenges for such profound reform.

- Lack of business models

There is a paradox with AT. That is, that there is a plethora of innovative technology that is increasingly more sophisticated but uptake is less than ideal. There are smart homes in many countries; the need for such technology is evident in the prevalence of issues such as wandering leading to getting lost or to harm, falls, medication complications, continence management and the high fear of crime amongst the elderly with which the application of the technology would assist. However, the adoption rates of AT are very low in most countries; very few people live in smart homes and those that exist are for research and demonstration purposes. One missing element is the business process for assessment, specification of suitable technology, installation and maintenance, and a service to monitor the signals. Another element is in supply models to make the technology affordable.

EVALUATION OF ASSISTIVE TECHNOLOGY

PRINCIPLES

It is essential that health care professionals give thought to the evaluation of these technologies to ensure appropriate examples are selected for clients and intended outcomes are achieved. Such evaluation may be achieved by examining both the technologies themselves and their impact upon individuals. Lindenberger et al (2008) suggest three main principles for evaluating AT. Importantly they suggest examining how such technologies make provision for person specificity rather than taking an off the shelf approach whereby the technology is matched with a problem not a person. Secondly they highlight the need to consider impact upon resource allocation, an area examined by Mann et al (1999) who suggested that the use of AT slowed the rate of functional decline, whilst also reducing both institutional and in-home personnel costs. Lastly Lindenberger et al (2008) also stress the importance of interim and regular evaluation. This common- sense advice simply means that clinicians are advised to evaluate early and often and seek to discover any problems at an early stage when remediation should be easier and more cost effective.

Key Point

Evaluation of these technologies and their impact upon individuals is essential to ensure appropriate examples are selected for clients and intended outcomes are achieved.

When considering how well an assistive device or technology meets the criterion of person specificity and impacts upon resource allocation, one evaluation approach that can prove useful is multi-attribute evaluation theory (MAUT), which was specifically developed to facilitate evaluation of complex scenarios. It also allows the evaluation task to be broken down into manageable segments and provides a score to indicate users' overall degree of satisfaction with both the evaluation object and its constituent attributes, which in this case would be an example of assistive technology. MAUT has been in use for many decades but more recently it has been used as an evaluation tool for such diverse aged care issues, such as satisfaction with home care (Samuelsson 2000), diagnostic decision support in aged care (Koch 2004), and selection of atypical antipsychotics (Bettinger et al 2007).

Whilst it is not possible in the context of this chapter to provide a detailed explanation of the calculations that underpin MAUT, it can be simplistically viewed as having three main phases. Firstly, it allows intended users of assistive technology to identify what attributes of the technology would be most useful to them. Next, users rank this resultant list in their order of importance. These rankings in turn provide weightings with those attributes deemed more important to an individual given a higher weighting. Lastly, users are then asked to evaluate the actual performance of each attribute using a visual analogue scale. Final utility scores are a product of weighting and perceived performance, and thus if individuals rank an aspect of an assistive device highly, but it performs poorly, then this will have the impact of substantially lowering the final utility score. If a more lowly ranked item performs poorly this will have less impact upon the final score. Reflection on these outcome scores should help clinicians identify the specific strengths and weaknesses of the assistive technologies that they may propose for individual clients, plus clients' views on the relative importance of attributes.

Lee, Donaldson, and Cook (2003) recognised that many healthcare decisions are problematic because of their complexity and in turn their important consequences on both the quality of life of individuals, and on the allocation of limited resources. They also observe that traditional healthcare decision modelling is often inadequate to properly assess these decisions, and suggest that approaches such as MAUT may provide a more useful alternative. Readers wishing to further explore the types of problems best suited to evaluation using MAUT should consult Olson (1995) for a detailed analysis of the approach. Additionally, the AT

devices mentioned in section 2, which provide physiological measures for the individual, may lend themselves to such evaluation. Examples of issues that could be ranked for importance and scored for performance could include:

- Cost
- Durability
- Ease of use
- Impact on client independence
- Impact on treatment compliance
- Meets intended purpose
- Portability.

EXAMPLES OF EVALUATION TOOLS & STRATEGIES

From the above discussions it is evident that the use of assistive technologies seeks to empower individuals by maintaining their sense of independence, autonomy, self-determination, self-respect and self-reliance by providing support for tasks vital for daily living.

Many readily available tools that focus on an individual's functional ability can assist health care professionals in assessing either the need for, or the impact of, assistive technologies on clients. Such tools also serve several other useful purposes such as profiling clients' progress over time, considering pre- and post implementation scores, reflecting on outcomes of rehabilitation planning, impact upon carer burden, and lastly, allowing national and international benchmarking using these commonly used reliable and validated tools.

Key Point

Many readily available tools that focus on an individual's functional ability can assist health care professionals in assessing either the need for, or the impact of, assistive technologies on clients.

Activities of Daily Living

One of the most common tools that remains in everyday international use is the Barthel Index (BI) developed by Dorothea Barthel in the 1950s, which measures an individual's ability to carry out activities of daily living (ADL). Importantly, as pointed out by Chen et al (2007), the Barthel Index may be used by clinicians or self administered by clients. They also note that this latter version has good concurrent validity and is well-correlated with the original Barthel Index, and its test–retest reliability is sufficiently high for practical use. Self administration

where possible may be another means of maximising client participation in care decisions.

The BI items allow assessment of clients' feeding, transferring to and from bed, grooming, transferring to and from a toilet, bathing, walking on level surface, going up and down stairs, dressing, continence of bowels and bladder. By summing the scores of the ten items in this index a client may generate a score between zero and 100. A client scoring 100 on the BI is continent, feeds him or herself, dresses him or herself, gets up out of bed and chairs, bathes him or herself, can walk at least a block, and can ascend and descend stairs. It should be stressed that this does not necessarily mean that that this client is able to live alone as he or she may not be able to cook, undertake housekeeping, and function outside of the home.

One real advantage of the BI is its simplicity. It is useful in evaluating a patient's state of independence at several stages: before treatment, progress while undergoing treatment, and status when maximum benefit is reached. It should easily be understood by all who work with a client and can accurately and quickly be scored by anyone who adheres to the definitions of items listed above. Perhaps even more important than the overall score are the scores for individual items, since these indicate where the client ADL deficiencies lie and where the use of assistive technologies is most likely to be recommended.

Many examples of using the BI as a means evaluating the impact of assistive technology can be found. Ng et al (2008) undertook a randomised control trial to evaluate the impact of an electromechanical gait trainer relative to other gait training techniques. They also provide an example of the evaluation techniques advocated by Lindenberger et al (2008) as the BI was used at baseline, at the end of the 4-week intervention program, and 6 months after the program ended. Logan et al (2007) used the BI to profile the number and cost of assistive devices used by older people who had fallen at home and subsequently called an ambulance. Prior to this, Wielandt et al (2006) used the BI to predict the post-discharge use of rails and bathing, toileting and dressing AT, which had been recommended by an occupational therapist during hospitalisation. All provide examples of how the use of the BI may impact upon clinical decisions and the use of assistive technology.

Instrumental ADLs (IADL)

Unlike the basic ADLs, which focus on activities undertaken in the course of living at home, the instrumental activities of daily living (IADL) are concerned with more complex and demanding activities of daily living performed within a social environment. These activities are necessary for older persons to live independently within the community. In other words, IADL performance also reflects community living skills such as use of the telephone, travel, ability to handle finances, responsibility for own medications, meal preparation and

shopping. Capezuti et al (2007) recognise the diversity of methods for assessing IADL performance and measurement of task performance and emphasise the need to also consider the educational capacity of the client, the objectives of undertaking the assessment, and the environment in which the task will be performed when using such rating scales.

An example of a complete IADL instrument and the instructions for administering the assessment are provided by Lichtenberg (1999). The outcomes of these IADL assessments in turn can guide clinicians to the choice of assistive technology best suited to the clients' needs. McDowell (2006) reported on the reliability and validity of the IADL assessment tool. In the former context, pairs of nurses who independently evaluated 36 patients demonstrated a correlation of 0.87, and research assistants who assessed 14 patients was slightly higher (0.91), as determined by Pearson correlation co-efficient.

Clinicians also utilise caregiver input in evaluation, so thought should be given to the level of agreement between users of AT and caregivers. In support of IADL assessment authors such as Izal et al (2005) and later Davis et al (2006) found overall agreement between caregiver and care recipient estimates of instrumental activities of daily living (IADL) functioning. Izal et also noted that greater agreement between caregiver and care recipient ratings was in turn associated with increased care recipient life satisfaction and self-efficacy, regardless of the level of impairment. Thus it is worth checking this level of agreement when evaluating the impact of AT on clients.

It should be noted that clients with dementia may present differently at different times of day, for example, when undertaking ADL or IADL assessment in late afternoon or early evening. This may yield an entirely different picture from night time, or early morning when the client is rested. This has been described as Sundowners syndrome and Volicer et al (2001) provide some insights into the circadian rhythms induced by Alzheimer's disease and explore relationships among rhythm disturbances, sundowning, and sleep disturbances in patients with Alzheimer's disease. When evaluating clients with a view to recommending the use of assistive technologies, this should be taken into account.

Functional Independence Measure (FIM): FIM is a commonly used tool in rehabilitation settings. It demonstrates acceptable reliability across a wide variety of settings, raters, and patients (Ottenbacher et al 1996). It is, however, recommended that clinicians using this tool receive formal training in its use to maximise inter-rater reliability.

The FIM can be completed in approximately 20-30 minutes in conference, by observation, or by telephone interview. It consists of 18 items on two subscales, with 13 motor and five cognitive items each of which is scored using a seven

point level ordinal scale. It was developed to provide uniform measurement and data on disability and rehabilitation outcomes.

FIM items on which a client may be rated include self care, sphincter control, mobility, locomotion, communication, psychosocial adjustment, and cognitive function. Clients are given a score on each item based on their functional ability, which in turn may be used to assess their need for, or their response to, the use of assistive technology. The seven ordinal points are as follows:

7 Complete Independence (timely, safely)
6 Modified Independence (extra time, devices)
5 Supervision (cuing, coaxing, prompting)
4 Minimal Assist (performs 75% or more of task)
3 Moderate Assist (performs 50%-74% of task)
2 Maximal Assist (performs 25% to 49% of task)
1 Total Assist (performs less than 25% of task)

Thus as scores increase, so too does the level of independence. In this way, clients can be assessed on their need for AT, or outcomes of AT use using either the FIM motor and / or cognitive subscales used to assess functional status (Zwecker et al 2002).

Sangha et al (2005) report on frequency and patterns of use of the BI and FIM specifically in the context of stroke rehabilitation trials, and their overview of all randomised controlled trials (RCTs) published between 1968 and 2002 provides a useful comparison to other measures of disability, which can be more widely used. Additionally both Hobart et al (2001) and Hsueh et al (2002) note that the FIM was developed to be a more responsive and comprehensive assessment of function than the BI, and that the FIM appears more popular in the USA, which may be a reflection of its creation by a US task force dedicated to finding a national consensus instrument.

CONCLUSION

Searches using CIHAHL and online search engines will yield a wide variety of other assessment tools that will assist clinicians in their choice of interventions including assistive technologies. These tools cover a myriad of issues such as cognitive function, level of social support, pain perception, quality of life, satisfaction with care support, and self esteem. Useful discussion of the interaction of these variables and their impact on client assessment is provided by both Arnadottir & Mercer (1999) and Savard et al (2006).

The tools may also be downloaded from a variety of Internet sites but it should be noted that the copyright status of instruments does change over time. Some instruments that were previously in the public domain and free to use have

subsequently been commercialised and require a licence fee for use. Readers should check the conditions of use of individual instruments prior to their use for clinical practice or research purposes. A useful repository of tools is provided by Lichtenberg (1999) who highlighted a range of reliable and valid assessment for assessing functional status, psychosocial health, comorbidity, and behavioural issues, along with case examples to illustrate their use. An additional challenge for evaluation is the speed of development of assistive technology, which in turn is likely to need clinicians to find alternative and appropriate means of evaluation that focus on the impact on the end user as opposed to simply accepting the claims of developers and vendors who are likely to have a quite different agenda for the adoption of their products.

Future directions

This chapter has provided an overview of the actual and potential application of assistive technology and evaluation strategies that are available in the care of the older person. There are still many questions that need to be explored to ensure that we:

1. Adopt appropriate research strategies to accompany AT innovation, design and implementation

2. Work towards common language and ontology to provide a basis for standards, performance indicators, evidence-based practice and for benchmarking

3. Devise and apply tools for impact assessment to provide a fuller and fairer picture of true cost and benefits.

4. Inform policy at government and service sector levels.

There is also need for multi-disciplinary research to bring technology development in line with socio-economic realities of health systems and user expectations and to share successes and challenges.

Reflective questions

1. How can busy age care providers keep up with the latest in assistive technology?

2. Is there a planning process happening in your workplace to consider the use of this technology?

3. Consider how much technology is impacting on your life in the community at present. Street surveillance, shopping centre surveillance, bank transactions, airport

ticketing, computer linkages between government departments, e.g. Centrelink and Immigration, eBay purchasing, etc. Most older people have adjusted to card banking and Medicare cards, many are using computers. What are the main difficulties in the use of assistive technology?

4. Are there ethical issues in the use of assistive technology?

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