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Empirical studies on the effectiveness of assistive technology in the care of people with dementia: a systematic review

Richard Fleming and Shima Sum

Professor Richard Fleming is based at NSW/ACT Dementia Training Study Centre, School of Nursing, Midwifery and Indigenous Health, University of Wollongong, Wollongong, Australia.
Shima Sum is an Assistant Professor, based at Discipline of Social Medicine, Faculty of Medicine, Babol University of Medical Sciences, Babol, Iran.

Abstract

Purpose – *The purpose of this paper is to assess the empirical support for the use of assistive technology in the care of people with dementia as an intervention to improve independence, safety, communication, wellbeing and carer support.*

Design/methodology/approach – *A total of 232 papers were identified as potentially relevant. Inclusion criteria were: studies published between 1995 and 2011, incorporated a control group, pre-test-post-test, cross sectional or survey design, type of interventions and types of participants. The 41 papers that met criteria were subjected to an assessment of their validity using the model provided by Forbes. Following the assessment seven papers were considered as strong, ten moderate and 24 weak. The review is presented around the following topics: independence, prompts and reminders; safety and security; leisure and lifestyle, communication and telehealth; and therapeutic interventions.*

Findings – *The literature exploring the use of assistive technologies for increasing independence and compensating for memory problems illustrate the problems of moving from the laboratory to real life. The studies are usually limited by very small samples, high drop-out rates, very basic statistical analyses and lack of adjustment for multiple comparisons and poor performance of the technology itself.*

Originality/value – *Research to date has been unable to establish a positive difference to the lives of people with dementia by the general use of the assistive technology reviewed here.*

Keywords *Assistive technology, Dementia, Elderly people*

Paper type *General review*

Introduction

The proportion of older persons relative to the rest of the population has increased considerably (United Nations, 2005). The World Health Organisation reported that the number of people aged 60 and over as a part of the global population will double from 11 per cent in 2006 to 22 per cent by 2050 (World Health Organisation, 2007). The oldest of the old – those 85 years and older – represent the fastest growing group (He *et al.*, 2005). As dementia is an age-related progressive neurodegenerative disorder this will result in an increase in the worldwide number of individuals diagnosed with dementia from the current estimate of 24.3 million individuals in 2006 to 81.1 million by 2040 (Ferri *et al.*, 2006). The consequences for the increase in care services required for the predicted number of people with dementia is alarming. One approach to this emerging crisis is the development of assistive technologies that may compensate for the physical and cognitive deficits of older adults with dementia (Mihailidis. *et al.*, 2008).

A number of definitions of assistive technology relevant to people receiving aged care services have been developed. The US Assistive Technology Act (1998) defined it as technology used by individuals with disabilities in order to perform functions that without it might be difficult or impossible (AccessIT, 2009). In the UK the Royal Commission on Long-Term Care (1999)

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defined assistive technology as "an umbrella term for any device or system that allows an individual to perform a task they would otherwise be unable to do or increases the ease and safety with which the task can be performed". This is a very generic description of assistive technology and clearly includes such items as handrails, electronic memory aid (EMA), community alarm systems, computers, telephones, light and motion sensitive night-lighting, telecare, anti-flood devices, flood and fall detectors, alarm and pagers, tracking devices, robot and bed alarms.

A slightly more specific definition offered by Marshall (1997) in the context of the care of people with dementia is "any item, piece of equipment, product or system, whether acquired commercially, off-the-shelf, modified or customised, that is used to increase, maintain or improve functional capabilities of individuals with cognitive, physical or communication disabilities". These definitions have an exclusive focus on function, limiting acknowledgement of the potentially significant contribution assistive technologies make to quality of life, by improving the emotional and cognitive state of the person with dementia.

The following definition from the Australian *Dementia Resources Guide* (Department of health Australia, 2008) addresses this to some extent in the definition outlined below "a product, equipment or device, usually electronic or mechanical in nature, which helps people with disabilities to maintain their independence or improve their quality of life". This review took this as a starting point for the definition of assistive technology but modified it slightly to supplement the concept of quality of life: "assistive technology" refers to a product, equipment or device, usually electronic or mechanical in nature, which helps people with disabilities to maintain their independence or improve their quality of life. Assistive technology may support the person with dementia or their families or carers by supporting independence in daily living tasks, enhancing communication, increasing sense of wellbeing, reducing risk of harm, and reducing family and carer stress.

The authors believe that the quality of the evidence supporting the application of assistive technology requires close examination to determine its credibility and therefore attempted to provide an assessment of the methodological strength of the papers reviewed. This review explores the ways in which technology has been applied to helping people with dementia carry out tasks and how it may be making a contribution to the wellbeing of these people by reducing their behavioural problems and improving their emotional state. The objective of undertaking the review was to assess the empirical support for the use of assistive technology as an intervention to improve independence, safety, communication, wellbeing and carer support.

Method

Methods for selection of studies

Screening criteria were established to identify potentially relevant articles that met minimum methodological standards for acceptance. Inclusion criteria were: studies published between 1995 and 2011, incorporated a control group, pre-test-post-test, cross sectional or survey design, evaluated an intervention utilising an assistive technology and focused on the care of people with dementia over 50 years of age.

Search methods for identification of studies

The following databases were searched: Medline, Cinahl, Ovid, Pubmed, PsycInfo, ProQuest, Web of Knowledge, IEEE, Google Scholar and Cochrane for articles published between 1995 and 2011. The following journals were searched manually: *Dementia*, *International Journal of Technology and Aging*, *Journal of Gerontological Nursing*, *The Gerontologist* and *Journal of Gerontology*. The reference lists in earlier reviews and related published articles were checked to identify articles not located in the other searches and two gerontologists were asked to identify papers that they considered to be significant.

The search terms used were a combination of the following sets: set 1: Cognition status including "dementia", OR "Alzheimer disease" OR cognitive impairment, OR cognitive decline, OR cognitive disorder; AND set 2: "Care centers including home", OR "nursing home", OR "assisted living", OR "day care", OR "hospital", OR "residential care", OR "public places", OR

"resident room", OR "SCU", OR "therapy"; AND set 3: assistive technology OR safety OR "technology", OR "smart home", OR "telecare", OR "telemedicine", OR telecommunication', OR "community alarm systems", OR "computers", OR "telephones", OR "intercoms", OR "low-level technology", OR "carbon monoxide sensors", OR "light and motion sensitive night-lighting", OR "anti-flood devices", OR "safety", OR "security", OR "flood and fall detectors", OR "activity monitors", OR "alarm and pagers", OR "tracking devices", OR "alarm bracelets", OR "automatic day/date calendar", OR "signs modifications OR", "universal remote controls", OR "reminiscence", OR "robot" OR "bed alarms".

Selection of studies

The titles, key words, abstracts and where necessary the methodology, discussions and/or conclusions of the papers identified by the electronic and hand searches were screened for potential relevance by one of two researchers. This was a process designed to eliminate only papers that were not meeting the criteria for inclusion. In total, 2,942 citations were identified prior to screening of which 232 papers were identified by the screening as potentially relevant. These were assessed for relevance by both researchers. This process resulted in the elimination of 191 papers because they did not meet the criteria listed above.

Evaluation of the strength of the research

While there are comprehensive reviews of the assistive technology literature (Cash, 2003) there have been few attempts at assessing the quality of the research covered. In the area of psychosocial research the Forbes approach to the evaluation of research methodology has been used in recent reviews (Opie *et al.*, 1999; O'Connor, 2007). The Forbes approach involves an assessment of six categories: design and allocation to intervention, inclusion, attrition (external validity), control of confounders (internal validity), and also data collection and statistical validity. For a strong rating, at least four of the criteria had to "pass" and none could "fail". For a moderate rating, no criteria could fail and no more than four could pass. For a weak rating, one or two criteria had to fail, and for a poor rating, more than two criteria had to fail. While the Forbes approach is not finely tuned to the methodologies used in the assistive technology literature an adaptation of it was used in the Cochrane review on bright light therapy (Forbes *et al.*, 2004). The validity tool, dictionary and rating scale were modified from those of Forbes (1998), pre-tested and revised. The authors independently assessed the validity of the first 20 articles. The level of agreement was high ($\kappa = 0.762$) allowing them to independently complete the validity ratings for all of the relevant studies. There were 13 discrepancies related to oversights or differences in interpretation of the criteria; these differences were discussed and a consensus was reached on the rating of all articles.

The 41 papers that remained after the screening process were subjected to an assessment of their validity using this tool, seven articles were considered as strong, ten moderate and 24 weak.

As the quality of the assistive technology literature on the whole is not high it was decided to report on the weak papers included in the final 41 while putting them in the context of the stronger articles to allow the readers to form their own opinion on how much credibility to put on the findings.

Presentation of the literature

For the purposes of making this review useful in the Australian context we have adopted the headings used by Baptist Community Services (2008) in their Department of Health and Ageing funded work on the provision of advice and product descriptions for people contemplating the use of assistive technology in the care of people with dementia. This list has been extended to include literature that deals with the use of assistive technology as an aid to communication, carer support and as a therapeutic tool. The review is therefore presented around the following topics: independence, prompts and reminders; safety and security; telecare and telehealth; and therapeutic interventions.

Results and discussion

The flow chart in Figure 1 summaries the flow of studies through the review.

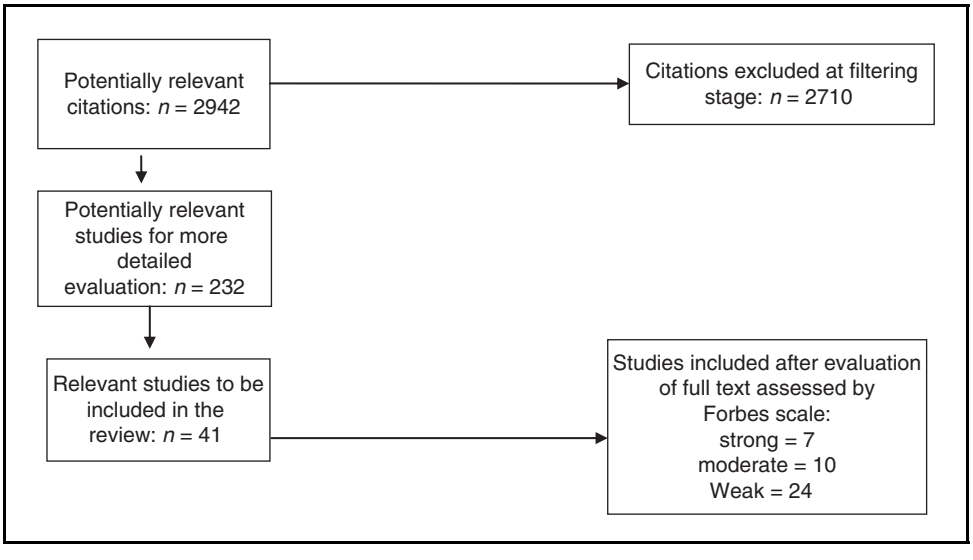
Independence, prompts and reminders

Everyone with dementia experiences a decline in memory and cognition. The availability of a device that could compensate for this decline would make a significant difference to the quality of life of a person with dementia. The feasibility of providing such an EMA has been assessed in a methodologically strong pilot study (Oriani *et al.*, 2003) (Forbes rating = strong). Five people with mild to moderate Alzheimer's disease were required to carry out seven tasks during a 45-minute period. In a free recall condition they were simply provided with spoken and written instructions on what tasks were to be done and when to do them, e.g. 10.15 a.m. – take a felt pen, 10.50 a.m. – take a sheet of paper from the table, and then left to carry them out. In the second condition the written list of instructions was left with them and in the third condition they were provided with an EMA. Statistical analysis showed a significant difference for EMA in comparison with the other two conditions. The authors concluded that the study demonstrates that it is possible to train a person with mild to moderate dementia to use an EMA to remember to do tasks at certain times.

This approach has been elaborated by the addition of audio visual prompts and applied to the task of hand washing (Labelle and Mihailidis, 2006) (Forbes rating = moderate). In this pilot study, eight people with moderate to severe dementia (seven men, one woman) and who required assistance with hand washing were observed going through the hand washing sequence during the baseline measurement. It is suggested that in practice technology using this approach is likely to be capable of assisting people with moderate to severe dementia to get to rinsing the soap off their hands before requiring the assistance of a carer to turn off the water and dry their hands. It must be noted that this pilot study did not actually use automated technology. A description of automated technology designed to assist with hand washing had been provided in an earlier paper written by the second author of this paper (Mihailidis *et al.*, 2000) (Forbes rating = weak). The single subject design greatly limits the generalisability of the findings but the study did demonstrate that the technology assisted a person with dementia to wash their hands and the subject had fewer interactions with his caregiver.

Use of verbal-instruction technologies to help persons with Alzheimer's disease daily activities (i.e. table setting, coffee, tea or snack preparation, use of make-up and shaving) to be independent was investigated in three experimental studies. In first study (Lancioni *et al.*, 2010) (Forbes rating = moderate), nine patients participated. During each trial, the participants

Figure 1 Demonstrating study selection process



performed all coffee-preparation or all table-setting steps with the assist of the technology and instructions. If the subjects failed to respond to an instruction for ten to 20 seconds or failed to do a step appropriately verbal and physical prompting (guidance) by a research assistant occurred and at the end of the sequence, the research assistant expressed social approval to the participants for their good effort. Each of them followed for at least six months after the intervention, most of them had largely accurate performance with some adaptations of instructions/steps. Most subjects also showed mood improvement during activity. It has been concluded that verbal-instruction technology might be considered a critical tool to help persons with Alzheimer's disease enhance their activity and mood. In the second study (Lancioni *et al.*, 2010) (Forbes rating = weak) subjects (11 participants) not only showed higher correct activity performance but also a higher indices of happiness during the activity trials as opposed to the nonactivity periods. In the third study (Lancioni *et al.*, 2012) (Forbes rating = moderate) authors developed a technology-aided intervention strategy relying on pictorial cues alone or in combination with verbal instructions and assessed these two versions of the strategy with three persons with moderate Alzheimer's disease. Results showed that both strategy versions were effective with all three participants and the percentages of correct activity performance increased to above 90. The efficacy of a computerised device, called COACH, intended to help people with dementia through activity of daily livings (ADL), while reducing caregiver burden was assessed in a single subject research design study conducted by Mihailidis *et al.* (2008) (Forbes rating = weak). The device uses artificial intelligence to autonomously guide six older adults with dementia through the hand washing ADL using audio and/or audio-video prompts. Result showed that patients were able to complete ADL activities better. It was concluded that there is a need for flexibility and dynamic personalisation in devices designed to assist older adults with dementia.

An alternative strategy of making people with dementia more independent was using a machine-based promoting device. In an exploratory study aimed to assess the effectiveness of these devices, 11 community-dwelling seniors with moderate cognitive impairment were followed (Bewernitz *et al.*, 2009) (Forbes rating = weak). At the beginning of the study to determine participants' current level of independence on selected tasks (drinking water, brushing teeth and upper body dressing), the functional independence measure scores of subjects were collected. Subjects were prompted through these tasks with simulated smart machine-based prompting. Authors reported that although the need for prompts was highly individual, but given appropriate machine-delivered messages, subjects completed the tasks better across the three self-care tasks. It has been concluded that this kind of device may aid caregivers as well as increase independence in some tasks.

The "Enabling technologies for people with dementia" project (ENABLE) (Gilliard and Hagen, 2004; Topo and Saarikalle, 2004) (Forbes rating = weak) by a cross-national survey provided an opportunity to assess the impact of the provision of a range of devices with the potential to aid memory and increase independence. They were: night-and-day calendar, locator for lost objects, pre-programmable telephone, automatic bedroom light, "Do-it-yourself" picture gramophone, medicine reminder, cooker monitor – for gas cookers, remote day planner – a remotely programmed device to remind the user of the day's activities. The study took place in Lithuania, Finland, England, Ireland and Norway, involving a total of 155 people with dementia. While there was an intention to assess changes in the quality of life of the people with dementia and carer burden the high drop-out rate renders the conclusions very tentative. Quality of life was reported as showing no change between the baseline measurement and the final measurement although there was some improvement shown in the intermediate measures. However the results are reported only as aggregates, not broken down into results relevant to each device. The results which are reported for each device relate to usefulness reported by person with dementia and his or her family:

- In total, 68 per cent of people said they used the calendar and, a surprising, 84 per cent of people remaining in the study said they found it useful. The family carers also found it useful. The calendar was found to be easy to install, however some calendars were faulty, showing squares instead of letters and numbers. They were exchanged and no further maintenance problems were encountered.

- In all, 80 per cent of people remaining said they used the lamp and, again surprisingly, 100 per cent of people remaining in the study said they found it useful. The family carers were a little less inclined to describe it as useful. The installation of the light involved placing a sensor under one of the legs of the bed. This proved to be unreliable and was modified to placing sensors under two legs. The installation was relatively simple.
- In all, 86 per cent of people supplied with the gas cooker monitor dropped out of the study leaving only one person who completed the trial. S/he, and his/her carers, found it useful. The installation of the gas cooker monitor proved to be complicated, involving two technicians and taking "a few hours". When operating the cooker is fitted with sensors which detect pan overheating and also reacts to gas leakage and smoke. However there were many technical problems with the monitor switches. This was the cause of the drop outs and the disappointment reported by the professionals and carers.
- In all, 50 per cent of people supplied with the locator dropped out of the study, 72 per cent of people remaining said they used it and 61 per cent said they found it useful. The family carers agreed with the rating of usefulness. The locator is installed by placing it on a wall and plugging it in. A good location has to be found, presumably by trial and error. Tags are attached to the items that are commonly lost. The author notes that "the product requires ability to learn new routines" and suggests that help from someone living with the person with dementia may be necessary.
- For the picture telephone nobody dropped out of the trial. In all, 77 per cent of people supplied with the phone said they used it and 85 per cent said they found it useful. The family carers agreed with the rating of usefulness made by the care recipient.
- In all, 17 per cent of people supplied with the dispenser dropped out of the study, 60 per cent of people remaining said they used it and 80 per cent of people remaining in the study said they found it useful. All of the family carers described it as useful. The dispenser was battery operated so no installation was necessary. Family carers were trained how to set the alarms and change the batteries.
- In all, 25 per cent of people provided with access to the picture gramophone multimedia programme dropped out before completing the trial. The author notes that "there were many problems in use of the Editor and in getting the Picture Gramophones ready. But when ready most users were satisfied with the end product".

Summarising the empirical studies on the use of assistive technologies for increasing independence and compensating for memory problems it seems fair to say that once the evaluation moves from the laboratory significant practical and methodological problems emerge. These are reflected in very small samples, high drop-out rates, very basic statistical analyses and poor performance of the technology itself. In general the use of the technology reported to date makes little difference to practical outcomes.

Safety and security

No methodologically strong evaluations of the use of assistive technology to improve the safety and/or security of people with dementia were found. Two weak studies, as assessed using the Forbes criteria, investigated the impact of the introduction of a package of assistive technologies including general and individualised passage alarms, sensor-activated night-time illumination and fall detectors on staff and relatives associated with a cluster of small residential units for people with dementia. (Engström *et al.*, 2005, 2006) The authors concluded that staff members' job satisfaction and perceived quality of care improved in comparison with a control group and that the relatives' opinions of IT support were positive and improved during the implementation of the support package. No attempt to assess the impact on residents through direct measurement was reported.

One of the most critical safety concerns encountered in the care of people with dementia is that of ensuring that the person with dementia is safe when they attempt to leave the building in which they live. A range of interventions are used to address this issue ranging from physical and chemical restraints, the locking of doors and windows, environmental modifications, e.g. placing visual barriers on or in front of doors (Namazi *et al.*, 1989; Dickinson *et al.*, 1995) through to

constant supervision. There is a strong desire to replace these draconian and/or labour intensive interventions with technology-based approaches that maximise individual freedom while providing safety from getting lost. However, to date, there is no methodologically robust investigation of any technological device that might assist with this issue. Given that 40 per cent of patients with dementia get lost at some point in their illness and 5 per cent get lost repeatedly over many months (McShane *et al.*, 1998a) this issue is of such importance that the results of four studies that are classified as poor by the use of the Forbes criteria will be described.

The earliest investigation dealt with the issue of finding a person with dementia who has wandered away from home (McShane *et al.*, 1998b). A telephone survey of 99 carers suggested that 20 per cent of a sample of people with dementia living at home with the help of community psychiatric nurses were at continuing risk of traffic accidents and 45 per cent of getting lost. The use of a tracking device involving wearing a transmitter on a belt was described to the carers, 7 per cent said that it was likely to be of benefit at the time of the interview and a further 11 per cent said it could have been of benefit at an earlier stage.

A study designed to assess the feasibility of using the tracking device in practice was carried out on 24 patients referred by psychogeriatricians and community psychiatric nurses. In total, 17 were male and 7 female, five had never been lost before but were regarded as being at risk, 14 had been lost on up to five occasions. Following the initial assessment the transmitter was worn by 13 patients of whom eight were living at home. The reasons for the exclusion of 11 of the patients initially referred were one or more of the following: increased disability leading to reduced mobility (nine cases), no carer available to use the receiving device (seven cases) and carer thought it unlikely that the patient would tolerate wearing the transmitter (six cases). The transmitter was the size of match box, had a 15-centimetre aerial and could be worn on a belt, wrist, as a pendant or attached to clothing.

In practice the transmitter was worn for no more than a few days in four cases, up to three months in three cases and for three to eight months in six cases. The primary reason for the early drop outs was lack of willingness of the patient to wear the transmitter. The device was used in a search four times and was instrumental in finding the person on two occasions.

The device used in this study was, by current standards, clumsy, especially the receiver which was similar to a small television aerial and gave only an approximate indication of the direction in which the person lay. The availability of GPS technology integrated with a mobile phone promises much greater accuracy and ease of use. The first report on the use of this technology was published in 2005 (Miskelly, 2005). GPS equipped mobile phones were provided to 11 patients with dementia (no details of type or severity of dementia provided) for a total of 84 patient weeks. The relative/carer was responsible for ensuring that the phone was "worn" by the patient every day. The person with dementia was "sent out to walk randomly […] In an attempt to simulate the walk of a lost elderly person" (p. 497). To confirm that the tracking was accurate the participant's location on the central computer was compared with either the information given by the relative/carer during the preliminary interview where a description of the regular activities of the participant had been obtained or with a description given by the carer over the phone. The location was correctly identified by the GPS system more than 90 per cent of the time. However, five of the 11 participants dropped out of the study because of "usability or comfort issues". The author concluded that "a simpler phone that is easier to use and more comfortable to wear may be necessary. When compliance is high, however, the system works well enough to be used as a reliable tracking device for dementia patients".

A simpler phone was used in the most recently reported investigation of the use of GPS tracking of people with dementia (Rasquin *et al.*, 2007). This phone had only three buttons, one to switch it on and off, one to send an alarm call to a service centre and one to dial a pre-programmed number. This type of phone combines a tracking function, which is of particular use to a carer, with a function that assists the person with dementia to make contact in an emergency. The authors caution that the GPS technology is not accurate or reliable if the signal is not stable/or identifiable because of environmental factors, for example, if the person is in a steep valley, inside a building or under trees. In good circumstances it provides a location to an accuracy of four to ten metres when interrogated by remote calling to the phone.

Seven participants were selected for inclusion in the study. Selection criteria included being in an early stage of dementia, living at home with an informal caregiver, able to go for a walk outside and able to have basic communication. By the time the field trial began "four patients were too […] deteriorated in cognitive functioning, and going outside alone was not possible anymore. The fifth couple was willing to participate. However, when the researchers explained the use of the technology they decided that it was too complicated for them. For the sixth couple the informal caregiver would participate, but the patient with dementia refused to participate. The seventh couple agreed to participate" (p. 117). The investigation continued with one subject. This person was described as having had dementia for three years, being mildly patients with dementia with word finding and short-term memory problems and likely to get lost in an unknown environment.

The results of the field trial are described: "The informal caregiver made a telephone call. This went how it should be, the person with dementia picked up the telephone, but had some problems in remembering the correct button. Localisation of the person with dementia was not accurate, due to technical problems. The caregiver asked the location of the person with dementia via the service centre. The wrong location was given (the streets that were located were three blocks further away than the actual location of the patient)" (Rasquin *et al.*, 2007, p. 118).

Leaving aside the technical problems that resulted in the wrong location being provided the authors concluded that "[…] using technological devices to increase the possibility of going outside alone for the person with dementia depends on a lot of prerequisite constraints, which should be specified before broad implementation of technological devices in health care is decided on. More specific information is needed to define the typology of the user group, before implementation of technology can be started" (Rasquin *et al.*, 2007, p. 119).

It is clear that in the area of mobility outside of a home there are major technical problems and issues of user acceptance and ability to operate the technology that remain unsolved, or if they have been solved no sound assessment of the solution has yet made its way into the literature. The provision of a safer environment within a home provides another opportunity for technology to be of assistance. Tagging systems are widely used for monitoring prisoners in Europe. The prisoner wears a bracelet which is a small radio transmitter. One or more monitoring stations detect the signal from the transmitter and this identifies which zone the prisoner is in. If the prisoner is in the wrong zone then a warning is transmitted to a pager worn by a staff member. This technology has been adapted for use in residential care. "Residents wearing a bracelet are able to move freely around the facility, or can be restricted to certain zones within that facility. The system can vary the conditions of warning depending on time of day so that, for instance, the resident's presence in the garden may be acceptable during the day but not at night. The advantages of the system are that no permanent wiring is required making it easy to install and it only generates an alarm when wearers of the bracelet approach a pre-determined area of risk" (Miskelly, 2004, p. 304) (Forbes rating = weak).

It was tested on four residents (no details supplied) living in a 39 bed, three storey residential home for an unspecified but apparently prolonged period. Two episodes of wandering outside the building were detected by the system and attended to by staff. A daily average of 15 events involving wandering into an internal "at risk" area were detected. False alarms were few. As the bracelet is designed to require two hands for its removal it was difficult for the residents to remove it; however one of the four was successful and this was detected as an alert by the system. The author concludes that the system was successful in preventing dangerous situations from developing and reports that staff and relatives felt reassured by being alerted to every wandering event. He also notes that "Only the use of a Control Group in a Randomised Control Trial (without the ability to intervene) would allow us to estimate the true benefit of the equipment" (p. 305) and recommends that large-scale trials be undertaken. It is clear that the ethical aspects of this intervention require close scrutiny.

In general it must be concluded that the evidence for the effective use of assistive technology to improve the safety and security of people with dementia is, as yet, very weak. The common problems associated with lack of acceptance by the user, difficulties with use and technical

reliability are evident. The need for careful assessment to determine the likely benefit of the technology to an individual is also clear, one size does not fit all and there is a strong suggestion that the window of opportunity for the successful application of technology is quite small.

Telecare and telehealth

Approximately 24 per cent of people with dementia live alone in the community (Australian Institute of Health and Welfare, 2006). The availability of a reliable method of communication could, potentially, support them in maintaining their social networks, performing daily activities and in getting help when needed. The telephone is perhaps the most commonly used and reliable method of communication used by people with dementia living by themselves so the question arises can modern styles of telephone be used by people with dementia to assist them maintain their independence, interdependence, health and safety. The introduction of a "simple-to use" telephone into the homes of people with dementia who were accustomed to using a telephone was evaluated in six homes in Finland (Topo *et al.*, 2002) (Forbes rating = weak). Participants were six people aged 55-90 and having either mild or moderately severe dementia. The telephones had 12 keys with clear plastic covers under which a photograph or written information could be displayed. Four of the people with dementia showed an improvement in their use of the phone. Three of the people with dementia showed an improvement in their use of the phone by moving from "Answers telephone but does not dial" to "Dials a few well known numbers". One improved from "Does not use telephone at all" to "Answers telephone but does not dial". The authors concluded that "Most of the problems that the people with dementia had with phone use in general did not disappear with the use of the new phone". "In most cases it did not help the person to remember whom he called and when". However carers found the phones easier to use and purchased them for use after the study. Most of the carers commented that the phone may have been more useful at an earlier stage in the dementia.

An alternative strategy of training people with dementia to use their existing phones, in this case a mobile phone, has also been evaluated in a pre-test and post-test study (Lekeu *et al.*, 2002) (Forbes rating = weak). Two people with mild Alzheimer's disease were trained for 45 minutes one or two days per week for three months. Each training session was divided into two parts. In the first part the spaced retrieval technique was used to promote the consultation of a card pasted on the back of the phone. The card described each stage of making a call. In the second part calling exercises were repeated many times using errorless learning principles, e.g. trainer anticipation of an error and intervention with correct response to avoid the memorising of an incorrect response. One person was able to make a call without using the card as a prompt after 11 weeks of training and the other after 14 weeks. This study illustrates the level of sophisticated effort required to maintain the abilities of a person with dementia to use technology with which they are already familiar. If it is impractical to enable the person with dementia to initiate communication perhaps technology can assist with health and safety issues by providing easier access to prompts and assistance from a remote carer.

The possibility of providing cognitive assessment and an intervention aimed at improving cognitive performance via a videoconferencing system was investigated in an experimental study with a sample of 22 people randomly allocated to videoconferencing or face-to-face contact (Poon *et al.*, 2005) (Forbes rating = moderate). There was no significant difference between the two groups of 11 after random allocation. A total of 12 cognitive intervention sessions in the areas such as attention and memory, calculation and language were conducted over six weeks via either videoconferencing or face-to-face without their being any major modifications in the assessment and training methods for either group. Both groups improved significantly in the areas of attention and memory, calculation and language with the face-to-face group also improving in spatial construction. Ten of the 11 people in the videoconferencing group were satisfied with the audio and visual quality of the videoconferencing system and the majority of this group expressed a preference for this mode of delivery as it saved the time and cost of travelling. While drawing attention to the small sample size and short follow up period the authors concluded that telemedicine is a feasible and acceptable means of providing cognitive assessments and interventions to older people with mild cognitive deficits.

However an experimental investigation of the use of a similar system to monitor and prompt the taking of medications has also been carried out (Smith *et al.*, 2007) (Forbes rating = weak). This project involved 14 people with mild dementia who lived alone, eight of whom received video monitoring and/or a "plain ordinary telephone service" monitoring service. Medication compliance was assessed over a two-year period and compared with six people who received standard care, defined as "whatever the family might independently arrange". During this time more than 4,000 telemedicine contacts were conducted. Over time, the video-monitored group remained stable in their compliance while the other groups declined. The rate of change between video and no video monitoring was significantly different ($p < 0.05$), as was the difference in compliance at the end of the evaluation period ($p < 0.05$), with values of 81, 80 and 62per cent, for video, phone and no monitoring, respectively. The authors concluded that their study provides encouraging results for the ability of a home telehealth application to positively affect mild dementia patients.

A much broader use of telemedicine for people with dementia and their family and professional carers is reported in an earlier experimental study (Lee *et al.*, 2000) (Forbes rating = weak) which describes the experience of a telemedicine system operated from Seoul National University for dementia patients in a nursing home and a medical centre. The service, which included assessment, diagnosis, counselling and staff education, reached 140 patients, 680 family carers and 140 care staff over a two-year period. The results of assessment of the severity of dementia obtained via the telemedicine link and from resident specialists were identical in 76 per cent of the medical centre patients and 89 per cent of the nursing home patients and the diagnosis of dementia was agreed to 100 per cent of the time. The education provided through the telemedicine system was over traditional face-to-face education and the telemedicine interactions between clinicians and patients were well accepted by the patients.

In general the literature seems not to support the use of technology (in its current form) to enhance communication initiated by the person with dementia but it provides some promise that remote carer initiated communication can be used for assessment and simple therapeutic interventions. However the studies are not methodologically strong.

Telehealth and carer support

Family caregivers have been described as the "second victims" in dementia care (Ory *et al.*, 1999; Winter and Gitlin, 2006). They tend to under-utilise existing services (Brodaty *et al.*, 2005) while being at risk of stress, depression, sleep deprivation, mortality and social isolation (Schulz and Beach, 1999). Factors that contribute to depression include the behaviour problems of the persons with dementia being cared for, the carers' perception of their own lack of mastery of the skills needed and isolation (Ory *et al.*, 2000). Support and education have proven to be effective in alleviating some of the consequences of providing prolonged care to a family member with dementia (Brodaty and Gresham, 1997; Brodaty *et al.*, 2003). The contribution of technology to these interventions has been investigated in methodologically sophisticated studies.

The reduction of caregiver stress by the provision of an interactive voice response (IVR) system providing the following functions has been investigated in a randomised clinical trial (Mahoney *et al.*, 2003) (Forbes rating = strong): weekly caregiver's conversation, personal mailbox, bulletin board and activity-respite conversation – an automated, personalised conversation designed to reduce disruptive behaviours and to provide caregivers with respite time. When initiated by the carer, this module offered the care recipient a personalised pleasant conversation designed to engage the listener in a safe, comforting, and non-demanding activity. The conversation lasted 18 minutes and would repeat once if not disconnected. The IVR system was designed to be available 24 hours per day without the need for human intervention. People with dementia and their caregivers were randomly allocated to an intervention group and a control group. All participants were interviewed at six, 12 and 18 months post-baseline. Assessments of the "bothersome nature of the care recipient's disruptive behaviours", anxiety and depression were made during these interviews. The overall results did not support the hypothesis that this type of intervention would reduce caregiver stress. Bother, depression and anxiety scores did not differ significantly between groups at any assessment point. However more detailed analysis revealed a significant effect in all three measures for those caregivers who scored in the low-mid range of

the Caregiver Mastery scale (Pearlin and Schooler, 1978). The authors concluded that the significant improvement in this group highlighted the need to target technological interventions to those who have the potential to benefit from them.

The benefits of a fully automatic support system appear to be limited to a particular group of people with a low sense of their ability to manage the situation. The use of telephone-based support where the discussions and support are facilitated by trained social workers interacting with a small group of caregivers has been investigated in a randomised controlled study on 103 female caregivers (Winter and Gitlin, 2006) (Forbes rating = strong). The 58 caregivers randomised to the intervention group were provided with the opportunity to take part in weekly, one-hour support groups via telephone from their own home. There were no significant or large differences between the intervention and control groups at six months but there was some indication that older participants gained more benefit. The authors concluded that "Overall, these results argue for minimal benefits of support group participation […]".

The benefits of using technology, in the form of the telephone, as an adjunct to psychosocial therapy so that it supplements an intervention based on human contact rather than being the only medium through which contact is made has been investigated in a methodologically sophisticated study weakened by a high attrition rate (Eisdorfer *et al.*, 2003) (Forbes rating = weak). A sample of 225 people caring for people with dementia for at least four hours per day was randomly divided into groups receiving family therapy, family therapy plus access via telephone to a computer-aided information network and a minimal support control group. Overall the family therapy plus access to the information network intervention was effective in lowering caregiver depression scores relative to the control group, measured by the CES-D (Radloff, 1977), at six months but at 18 months the reduction, though apparent, was no longer statistically significant. The family therapy alone intervention did not have a significant effect on depressive symptoms for most of the caregivers. In summary the limited literature available provides some support for the use of assistive technology to facilitate communication and access to support and information for caregivers of people with dementia. However the benefits are small as is the uptake of opportunities to use the technologically supported systems. The best results appear to come when the technology is used by people who consider that they lack mastery over their situation and when used to augment face-to-face contact (Brignell *et al.*, 2007).

Therapeutic interventions

Bright light. There is a growing interest in the potentially beneficial effects of increasing light levels to overcome the exceptionally low exposure to bright light experienced by many people with dementia living in institutions (Ancoli-Israel *et al.*, 1997) which lead to sleep disturbance.

A methodologically robust randomised control trial (RCT), marred only by lack of information on participation rate, (Ancoli-Israel *et al.*, 2003) (Forbes rating = weak) involving 92 patients randomly assigned to morning bright light, morning dim red light, or evening bright light (mean of 105 minutes exposure to 2,500 lux), showed that increased bright light exposure, whether in the morning or in the evening, consolidates night-time sleep by lengthening the maximum sleep bouts during the night. These findings are generally consistent with those found in a small study (Koyama *et al.*, 1999) (Forbes rating = weak) in which four of the six nursing home patients with dementia showed less waking during the "lights out period" ($p < 0.05$) and two showed less sleeping during the day ($p < 0.05$) However these results were challenged by a RCT (Lyketsos *et al.*, 1999) (Forbes rating = moderate) which found no significant improvement in nocturnal sleep or agitated behaviour in a group of patients in a dementia specific, chronic care facility who were exposed to 10,000 lux at a distance of three feet daily for four weeks.

The application of this approach in a more naturalistic way, i.e. avoiding the restrictions inherent in getting people with dementia to sit beside light boxes for extended periods by providing elevated light levels in public areas, has been well investigated (Sloane *et al.*, 2007) (Forbes rating = strong). Results of this study indicate that high-intensity ambient light therapy in the morning or throughout the day resulted in a small but statistically significant increase in night-time sleep minutes ($p = 0.02$) and inconsistent effects on night-time sleep consolidation and daytime sleepiness.

These results had been anticipated to some extent in a study involving bright light treatment for 22 patients with dementia that avoided the use of light boxes and the need for restraining patients to one location by installing bright lights into the living rooms of patients with severe dementia on a psychogeriatric ward (Van Someren *et al.*, 1997) (Forbes rating = weak). Rest-activity rhythm was assessed two weeks before baseline (average light intensity 436 lux), three weeks after installation of the light (average light intensity 1,136 lux), and then four weeks after the removal of the light (average light intensity 372 lux). Results showed that during increased illumination the rest-activity rhythm increased in patients with intact vision, but not in significantly visually impaired patients, suggesting that the change was not due to a placebo effect.

Further supportive evidence comes from a study (Rheaume *et al.*, 1998) (Forbes rating = weak) where residents with difficulty in sleeping were exposed to intense light (2,500 lux at eye level) in a pleasant room when residents had difficulty in sleeping. The light treatment room was a room – eight by 17 feet – furnished as a living room with a warm and comfortable seating arrangement around a television and video player used to play favorite movies and musicals. The room had a ceiling in which most of the ceiling panels have been replaced by high-intensity fluorescent lights operated by four switches which could gradually increase the light intensity. Outcomes, which were positive in three case studies of people with dementia, were not statistically analysed.

In addition to beneficial effects on sleep patterns the provision of very high light levels (10,000 lux) during a 30-minute breakfast period has been shown to have positive effects on behavioural disturbance as measured by the Cohen Mansfield Agitation Index in a sample of 16 patients with dementia residents ages 60-89 using a repeated measures ABA design (Thorpe *et al.*, 2000) (Forbes rating = moderate). The brightness of this illumination may be gauged by comparing it to the 1,000 lux which is approximately equivalent to being outside on a cloudy day. The provision of simulated dawn/dusk variations in light produced similar consolidation in sleeping patterns (Gasio *et al.*, 2003) (Forbes rating = weak because of high attrition rate). Significant improvement in MMSE scores ($p = 0.0012$) was obtained in a group of nine nursing home residents with either Alzheimer's disease or vascular dementia given two hours of bright light therapy (3,000 lux) each day for ten days. No improvement was observed in the randomly allocated control group (Graf *et al.*, 2001) (Forbes rating = weak because of high attrition rate).

In another supportive RCT study (Van Hoof *et al.*, 2009) (Forbes rating = moderate) with a hypothesis that high-intensity lighting, with luminance levels of well over 1,000 lux, may play a role in the management of dementia; the effects of prolonged exposure to high-intensity light (about 1,800 lux horizontal on table level) on behaviour and circadian rhythmicity of institutionalised older adults with dementia was assessed. Authors installed ceiling-mounted luminaires emitting bluish (6,500 K) and yellowish (2,700 K) light in an intervention group that was compared to a control group of traditional dim lighting equipment. Results showed a significant improvement in restless behaviour in the intervention group and a significant increase in the range of tympanic temperature in the bluish light scenario. It was concluded that high-intensity bluish light may play a role in managing restless behaviour and improving circadian rhythmicity in institutionalised older adults with dementia. In summary there is good evidence to show that the use of technology to provide periods of relatively high-intensity lighting helps residents with dementia sleep better and reduces behavioural disturbances. These results may be particularly important for residents of aged care facilities in high latitudes or cloudy climates where access to sunlight is limited. The application of artificial light in the Australian context, where there is a great deal of natural sunlight, may be redundant if staff is encouraged to help residents access outside areas for safe periods of time.

Multi-sensory environments. Over the last 15 years there has been steady interest shown in the possibility that exposure to multi-sensory stimulation (MSS) may have beneficial effects on the wellbeing of people with dementia (Chung *et al.*, 2002). The term Snoezelen has become synonymous with this approach. It is a Dutch neologism bringing together the idea of exploring stimuli and being in a state of pleasant relaxation.

The effects of enriching the environment by providing MSS in a Snoezelen room and through activity therapy have been investigated in a carefully described RCT (Baker *et al.*, 2001) (Forbes rating = strong). In total, 50 patients with diagnoses of moderate to severe dementia were randomised to either MSS or activity groups. Patients participated in eight 30-minute sessions over a four-week period. Authors reported that both methods of increasing the level of stimulation were effective. Immediately after MSS and activity sessions patients talked more spontaneously, related better to others, did more of their own initiative, were less bored/inactive and were more happy, active or alert. Both groups were more attentive to their environment than before, with a significantly greater improvement from the MSS group ($p = 0.03$). The effects evident during the sessions were not detected at the one-month follow up. A replication of this approach in a multi-centre study (Baker *et al.*, 2003) (Forbes rating = strong) failed to show any significant difference between an MSS group and a credible control group after providing 8×30 minute sessions of either MSS or activities such as playing cards, looking at photographs. Both interventions produced improvements in relationships between residents and boredom measured after the sessions finished. However this improvement was lost at one-month follow up.

Short-term improvements in mood and activity were reported in an early evaluation of exposure to MSS in a Snoezelen room (Hope, 1998) (Forbes rating = weak). The author noted that, while the experience was predominantly positive, some patients responded negatively and suggested that further research is required to identify the groups that benefit. Much longer lasting effects were observed when Snoezelen sensory stimulation techniques were integrated into a 24 hour, individualised, person-centred care inspired intervention (Van Weert *et al.*, 2005) (Forbes rating = strong) This intervention involved the use of detailed social histories, the identification of preferences of the various sensory stimulation modalities available within the Snoezelen approach, extensive training of staff and 18 months of intervention. Assessments of depression, agitation and emotional responses were made at baseline and 18 months later. While most ratings in the control group showed negative changes, the intervention group had significant positive changes ($p < 0.05$) for distorted consciousness, rebellious behaviours and depression. No negative changes or side effects were found in the intervention sample.

The relative benefits of providing stimulation via artificial and natural environments has been investigated (Cox *et al.*, 2004) (Forbes rating = moderate). This two-stage project examined how effective two types of multi-sensory environments were in improving the wellbeing of older individuals with dementia. The two multi-sensory environments were a Snoezelen room and a landscaped garden. These environments were compared to the experience of the normal living environment. The observed response of 24 residents with dementia in a nursing home was measured during time spent in the Snoezelen room, in the garden, and in the living room. In the second part of the project, face-to-face interviews were conducted with six caregivers and six visitors to obtain their responses to the multi-sensory environments. Both the Snoezelen room and the garden decreased the signs of sadness, ($p = 0.05$) as measured by the Affect Rating scale (Lawton *et al.*, 1996) shown by residents in comparison with the living room. However there was a significant increase in pleasure in the three environments when the residents were approached by staff.

In summary it must be said that there is little in the way of convincing evidence to support the use of Snoezelen technology over the use of other activities to improve the wellbeing of people with dementia. This conclusion is shared by other reviewers (Chung *et al.*, 2002).

Simulated presence therapy (SPT)

The original form of SPT involves playing an audiotape to a person with dementia over a personal stereo of his or her carer's voice. A systematic attempt to assess its efficacy by comparing it to usual care and the opportunity to listen to a favourite music tape involved six nursing home residents with a diagnosis of Alzheimer's disease or another form of dementia resulting in moderate to severe cognitive impairment and high levels of anxiety (Cheston *et al.*, 2007) (Forbes rating = moderate). In total, 21 periods of intervention and baseline conditions were carried out with the six participants, with six further sessions

being offered, but declined by participants. Although each participant was offered a music tape to listen to, on each occasion they chose to listen to the SPT tapes. However the acceptance of the SPT tape reduced across time, participants were less likely to give consent for their tape to be played with successive presentations. Results showed a significant change in levels of distressed behaviour across the three conditions ($p = 0.025$). Specifically SPT was more effective for participants asking or seeking to go home.

A randomised, single-blind study has been carried out comparing SPT and preferred music (Garland *et al.*, 2007) (Forbes rating = weak). In total, 30 nursing home residents with frequent, severe behavioural disturbances were observed by research staff before, during and after multiple, randomised, single-blind exposures to 15-minute audiotapes of simulated family presence (a conversation prepared by a family member about positive experiences from the past), music preferred by the resident in earlier life and a placebo condition of a reading from a horticultural text. Simulated presence and preferred music both proved effective in reducing counts of physically agitated behaviours ($p = 0.003$ and 0.039, respectively). Simulated presence, but not music, resulted in significantly reduced counts of verbally agitated behaviours ($p = 0.037$).

The lack of advantage of SPT over other forms of activity was illustrated in a study aimed at reducing verbally disruptive behaviour (Cohen-Mansfield and Werner, 1997), (Forbes rating = weak). The careful design of this study was marred by a high attrition rate. In total, 32 nursing home residents suffering from dementia and manifesting verbally disruptive behaviour were observed before, during and after the interventions. The interventions were presentation of a videotape of a family member talking to the older person, *in vivo* social interaction, and the use of music. Behaviours decreased by 56 per cent during the social interaction, 46 per cent during the videotape, 31 per cent during the music and 16 per cent during the no-intervention. The effects of the interventions were clinically and statistically significant ($p < 0.05$), indicating the importance of providing stimulating activities and a richer environment to cognitively impaired nursing home residents but not providing any support for an enhanced effect from SPT.

Another technological approach to increasing stimulation and providing emotionally satisfying relationships has been explored through the provision of robotic pets (Libin and Cohen-Mansfield, 2004) (Forbes rating = moderate). Traditional pet therapy has been shown to enhances individual wellbeing (Churchill *et al.*, 1999). However, the authors contend, there are situations where a substitute artificial companion (i.e. robotic pet) may serve as a better alternative because of insufficient available resources to care for a real pet, allergic responses to pets or other difficulties. They compared the benefits of a robotic cat and a plush toy cat as interventions for nine women with moderate dementia in a nursing home. The design of the robotic cat was based upon the concept of an emotional communication enhanced artificial intelligence and built-in sensors provide for a variety of responses during interactions, which can be either verbal (meow, purr, or hiss) or nonverbal (stretching paws, wagging tail, opening and closing eyes, turning head and spreading ears, and sitting or lying down). Both cats were covered with soft synthetic gray fur of different shades. The plush cat was lighter and softer than the robotic cat. The plush cat produced a significant lowering of agitation as measured on the agitated behaviours mapping instrument (Cohen-Mansfield *et al.*, 1989) ($p = 0.04$); there was no significant effect for the robotic cat. The robotic cat significantly increased the amount of pleasure and interest expressed ($p = 0.007$ and 0.028, respectively), there was no significant effect for the plush cat. Only 22 per cent of participants held the robotic cat during the sessions while 78 per cent of the residents held the plush cat. In summary the robotic cat had no significant advantage over the plush cat. Similar results were obtained in a comparison between a motor-driven toy dog and AIBO, a "metal entertainment robot" that looked like a dog and responded to 75 spoken commands (Tamura *et al.*, 2004) (Forbes rating = weak).

Overall, the effects of SPT appear to be modest and short lived. There is a substantial level of resistance to it and it does not have any advantage over simpler approaches to providing comfort. A summary of the strong moderately strong papers is presented in Table I which includes Forbe's rating, sample, type of intervention and outcomes.

Table I Summary of strong and moderately strong papers

Study	*Forbe's rating*	*Sample*	*Intervention*	*Outcomes*
Baker *et al.* (2003)	Strong	136 patients with dementia from three countries were randomised to multi-sensory stimulation (MSS) or activity groups (playing card games, looking at photographs, etc.)	MSS	MSS was not found to be more effective than activity in changing the behaviour, mood or cognition of patients with dementia, in the short- or long term
Baker *et al.* (2001)	Strong	50 patients with diagnoses of moderate to severe dementia	MSS, Snoezelen room	Both methods were effective in terms of spontaneous speech, relationships, being focused on the environment, enjoying themselves, being active or alert and being less bored and inactive ($p = 0.001$)
Mahoney *et al.* (2003)	Strong	100 caregivers were randomly assigned to the usual care control group ($n = 51$) and the technology intervention group ($n = 49$)	Computer-mediated automated interactive voice response telephone system – giving access to weekly care givers conversation, bulletin board, personal mail box, activity-respite conversation	There was no significant main effect of the intervention in reducing bother, depression and anxiety scores. There was a significant intervention effect for caregivers who where wives, only on their bother scores ($p = 0.02$)
Oriani *et al.* (2003)	Strong	Five people with mild to moderate Alzheimer's disease	Electronic memory aid (EMA)	The use of an EMA significantly improved patients' prospective memory ($p = 0.001$)
Sloane *et al.* (2007)	Strong	66 older adults with dementia	Bright light	Small but statistically significant increase in night-time sleep minutes ($p = 0.008$)
Van Weert *et al.* (2005)	Strong	62 residents from 12 psychogeriatric wards of six nursing homes	Snoezelen room	The intervention group had significant positive changes for distorted consciousness, rebellious behaviours and depression
Winter and Gitlin (2006)	Strong	103 female caregivers were recruited which 58 were randomised to treatment and 45 to usual care (control)	Telephone	There were no significant or large differences between the intervention and control groups at 6 months. Older caregivers (>65) in telesupport reported lower depression than control group caregivers ($p = 0.005$)
Cheston *et al.* (2007)	Moderate	Six participants with dementia	Simulated presence therapy (SPT) – an audio tape on a personal stereo	SPT interventions were associated with lowered levels of both distressed behaviour ($p = 0.025$) and efforts to return home ($p = 0.038$)

(continued)

Table I

Study	*Forbe's rating*	*Sample*	*Intervention*	*Outcomes*
Cox *et al.* (2004)	Moderate	24 residents with dementia in a nursing home	Snoezelen room	Both the Snoezelen room and the garden decreased the signs of sadness and increased the pleasure and wellbeing of the participants ($p < 0.05$)
Labelle and Mihailidis (2006)	Moderate	Eight people with moderate to severe dementia	Automated prompting system to facilitate hand washing	Patients get to rinse the soap off their hands before requiring the assistance of a carer ($p = 0.004$)
Lancioni *et al.* (2010)	Moderate	Nine patients with diagnoses of moderate to severe dementia	Verbal-instruction technology	Most patients recaptured and maintained daily activities, and showed significant mood improvement during activities (i.e. with peaks exceeding 30% of the recording intervals)
Lancioni *et al.* (2012)	Moderate	Three participants with moderate Alzheimer's disease	Technology-aided pictorial cues alone or in combination with verbal instructions	Both strategy versions were effective ($p < 0.05$). The percentages of correct activity performance observed with those versions increased to above 90
Libin and Cohen-Mansfield (2004)	Moderate	Nine women with moderate dementia in a nursing home	Robot cat	The plush cat produced a significant lowering of agitation ($p < 0.03$). The robotic cat may have increased the amount of pleasure and interest expressed ($p < 0.07$)
Lyketsos *et al.* (1999)	Moderate	15 patients with dementia and agitated behaviours residing in a chronic care facility	Bright light	The difference between the control and active treatment groups at 2 weeks was of borderline significance ($p = 0.08$); at week 4 was not statistically significant
Poon *et al.* (2005)	Moderate	22 older subjects with dementia were randomised into two groups of 11 each	Telemedicine (cognitive intervention programme using telemedicine (VC) vs a conventional face-to-face (FTF) method)	Significant improvements in attention, memory, calculation and language ($p < 0.001$)
Thorpe *et al.* (2000)	Moderate	16 people with dementia ages 60-89	Bright light	Positive significant effects on behavioural disturbance ($p = 0.05$)
Van Hoof *et al.* (2009)	Moderate	26 residents of a psychogeriatric ward (10 in control group)	Bright light	A significant improvement in restless behaviour in the intervention group ($p < 0.05$)

Discussion

People are living longer and more people are experiencing cognitive problems associated with the age related, neurodegenerative disease, dementia. In recent years dementia has been recognised as a major public health issue (Itua and Naderali, 2010). The expected increase in care services required for the predicted number of people with dementia is alarming. One approach to this emerging crisis is the development of assistive technologies that may compensate for the specific cognitive deficits of older adults with dementia (Mihailidis. *et al.*, 2008). It has been reported that such devices decrease the time required for caregiving assistance (Mann *et al.*, 1993), supply caregivers immediate relief, reduce their stress, and assist them provide care more easily and safely (Gitlin *et al.*, 2001). This review aimed to explore the ways in which technology has been applied to helping people with dementia carry out the tasks of daily living and how it may be making a contribution to the wellbeing of these people by reducing their behavioural problems and improving their emotional state.

The review has demonstrated that the research has been characterised by very small samples, high drop-out rates, very basic statistical analyses, lack of adjustment for multiple comparisons and poor performance of the technology itself. This may well be explained by the fact that this research is at a very early stage of development and many of the studies are small scale, pilot studies evaluating prototype technologies.

Regarding the use of assistive technologies for increasing independence, this review showed that once the evaluation moves from the laboratory significant practical and methodological problems emerge and the use of the technology reported to date makes little difference to practical outcomes.

One of the most critical safety concerns encountered in the care of people with dementia is ensuring that the person with dementia is safe when they attempt to leave the building in which they live. The evidence for the effective use of assistive technology to improve the safety and security of people with dementia is very weak. No methodologically strong evaluations of the use of assistive technology to improve the safety and/or security of people with dementia were found. The common problems associated with lack of acceptance by the user, difficulties with use and technical reliability are evident. The need for careful assessment to determine the likely benefit of the technology to an individual is clear and there is a strong suggestion that there is quite a short span of time during which the person with dementia is able to use the technology.

Approximately one quarter of people with dementia living in the community live alone. The availability of a reliable method of communication may help them to maintain their social networks, perform daily activities and get help when needed. This review demonstrated that there is some promise that remote carer initiated telecare and telehealth can be used for assessment and simple therapeutic interventions and there is support for the use of assistive technology to facilitate communication and access to support and information for caregivers of people with dementia. However the benefits are small and the uptake of the opportunity to use this approach to accessing support is limited. The best results appear to come when the technology augments face-to-face contact. There is a great need for better designed, methodologically stronger studies.

Support for the use of assistive technology in the provision of “therapies” is mixed. Therapeutic interventions in this review focused on three different strategies; using light therapy, multi-sensory environments and SPT. The provision of high levels of illumination appears to have some benefits. There is good evidence to show that the use of technology to provide periods of relatively high-intensity lighting helps residents with dementia sleep better and reduces behavioural disturbances. The provision of multi-sensory environments by the use of fibre optics, audio stimulation, etc is beneficial when it is accompanied by increased contact with staff but the evidence for effectiveness when used in isolation is limited.

The effects of SPT, appear to be modest and short lived. There is a substantial level of resistance to it and it does not have any advantage over simpler approaches to providing comfort. The substitution of artificial contact for real contact by the provision of simulated presence through robotic cats, dogs and audio tapes results in modest, short lived changes for a significant proportion of people with dementia, avoidance of the situation by many and an increase in agitation in some. Overall there is a great need for better designed studies with larger samples.

It is clear that our attempts at using assistive technologies to aid people with dementia are at an early stage of development. The current status might be likened to the Wright Brothers' attempts to use the contents of their bicycle workshop to build an airplane and fly. While they had the vision it required a great deal of time, energy, ingenuity and courage before they were successful. However they were successful and progress accelerated dramatically once the basic problems were solved. The same may happen with assistive technology as the devices improve and the next generation of technologically literate older people begin to take it up.

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Corresponding author

Assistant Professor Shima Sum can be contacted at: sumshima@yahoo.com

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