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Technology Studies to Meet the Needs of People With Dementia and Their Caregivers

A Literature Review

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The aim of this article is to present the findings of a review of studies that focused on technology supporting people with dementia and their caregivers. A literature search was carried out in eight scientific literature databases covering literature published between January 1992 and February 2007. A total of 46 studies providing original data and one review were included in this review. Analyses covered the aims of the studies, the technology used, study design, methods, outcome variables, and results. Most studies were carried out in residential care and focused on the needs of formal caregivers. Only a few studies involved people with dementia actively using the technology. The studies are difficult to compare because of the large variety of aims, technologies, design, and outcome measurements. There is a need for more research in this area, in particular, with people who have a mild stage dementia living in the community.

Keywords: *dementia; assistive technology; residential care; family caregiving; community care*

Dementia is one of the major challenges affecting the quality of life of older people. Arguably, it is also the main challenge facing care providers for the elderly. It has even been estimated that if we could enable people with moderate to severe dementia to continue living in their own homes, the need for residential care would be eliminated. At the moment, a vast majority of people in residential care have problems with cognitive functioning (Gray et al., 2008).

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Because the risk of dementia increases with advancing age, the aging of the population will mean a large increase in the number of people with dementia. The prevalence of dementia in the 70- to 74-year-old age group is 4.2% and in the 75- to 79-year-old age group, it is 8.6%. It is even higher among people aged 80 to 84 (13.0%) and among those aged 85 to 89 (25.3%). Of those aged older than 90, one in three has dementia (Lobo et al., 2000). The very oldest age group (85+) is increasing most rapidly, and so the number of new cases of dementia can be expected to increase year after year (World Economic and Social Survey, 2007).

People with dementia need a great deal of support and assistance, and this need increases as the disease progresses. In cases of moderate and severe dementia, help is often needed 24 hours a day (Cohen-Mansfield, Werner, & Reisberg, 1995). When family carers of people with dementia were interviewed, their main concerns were safety in the home, lack of time for themselves, lack of meaningful activities for people with dementia, and difficulties experienced in time orientation (Bank, Arguelles, Rubert, Eisdorfer, & Czaja, 2006; Nolan, Ingram, & Watson, 2002). Studies based on interviews or observations of people with dementia in residential care have shown that meaningful activities are often lacking (Brooker, Foster, Banner, Payne, & Jackson,1998; Chung, 2004), and evidence exists that by providing more stimuli and activities, such people's quality of life can be improved (Marshall & Hutchinson, 2001; Robinson et al., 2006).

Technology has been identified as one tool that can be used to improve independent living, improve the safety and autonomy of people with dementia, and support the quality of life of such people and their family carers (Cahill, Macijauskiene, Nygård, Faulkner, & Hagen, 2007). Mary Marshall (1995) has argued that assistive technology is best seen as an extension of aids and the provision of adaptations "beyond static pieces of equipment." She has also listed several purposes of technology that could play a role in the care and support of people with dementia. Her list includes reminders, technology for stimulation, relaxation, compensation, behavior management, safety, surveillance, control assistance for relatives, and service coordination technology (Marshall, 1996). To this list, we should add technology for communication.

Dementia causes problems in the use of domestic technologies. Even if people with dementia have been found to use several methods to manage these problems, they are not successful in the long run (Kuchinomachi & Kumada, 1999; Nygård, 2004). Thus, assistive technology is needed to compensate for their loss of cognitive functioning. Stephen Wey (2006) has written on the role of assistive technology in the rehabilitation of people with dementia, summarizing five potential roles for technology. In his list, most attention is paid to the active involvement of the person with dementia—first, to support and facilitate the person's memory, orientation, and other cognitive abilities central to his or her everyday life; second, to enable the person to carry out tasks and activities that are moving beyond or that are in danger of moving beyond their reach. Third, such active involvement is also necessary to facilitate meaningful occupation during the day, including leisure activities, and the maintenance of valued roles in the family and other social networks. Two further roles involve ensuring the person's safety and supporting and reassuring carers.

Caregivers working in dementia care report frequent psychosomatic symptoms and tiredness (Pekkarinen, Sinervo, Perälä, & Elovainio, 2004). These symptoms have been found to be associated with a lower level of knowledge of dementia, lower levels of staffing in care units, and problems in care management (Pekkarinen et al., 2004, 2006). In addition, the frequent use of restrictive methods and psychotropic drugs has been found to be associated with these same issues (Pekkarinen, 2007; Wang & Moyle, 2005). The role of technology in improving the situation of people working in dementia care has been discussed, and a preference for personal care has been emphasized (Astell, 2006; Hughes & Campbell, 2003).

Depending on the aim of the technology used, the user may be a person with dementia, his or her family carer, a formal caregiver, or even police or emergency services; in some cases the users may be several of these same individuals. These different user groups have very different user needs and, thus, user requirements vary greatly. Designing products for the active use of people with dementia is demanding because it demands easy-to-use solutions (e.g., Orpwood et al., 2004, 2007), whereas solutions for family carers and formal caregivers may require learning new skills.

The same technology can be used for several purposes by one user and for different purposes by different users or actors known to a person with dementia. In addition, some researchers have reported conflicting needs associated with the use of technology (Nygård & Johansson, 2001; Topo et al., 2007). For example, a person with dementia may reject the installation of surveillance technology because he does not see any reason for its installation. On the other hand, a family carer may find this necessary to improve the safety of the person with dementia and to relieve his or her own stress arising due to the related concerns. Hagen et al. (2004) proposed that when assessing the use and usefulness of assistive technology for people with dementia, at least five aspects should be taken into account: (a) the impact of the technology, (b) the impact of the personal characteristics of the person with dementia, (c) the impact of the family carer, (d) the impact of the environment, and finally (e) the impact of the research process and the researchers.

Aim and Analyses

Despite some promising findings in development and research projects (Duff & Dolphin 2007; Jensen, Månsson, Holthe, Hurnasti, & Indriðadóttir, 2007), the use of technology to support people with dementia and their caregivers remains somewhat rare. The aim of this article is to present a review of previous studies on technology and dementia published between January 1992 and February 2007. There is a general expectation that technology will help us meet the increasing care needs of people with dementia (e.g., Penhale & Manthorpe, 2001; van Hoof & van Berlo, 2007). To exploit existing knowledge, we need to investigate what has already been discovered and what is lacking. In addition, we need to understand how knowledge on the use of technology in supporting people with dementia and their carers is constructed to analyze the strengths of and gaps in research.

The analysis begins by examining the aims of the studies, the environment of the studies, the technology users in the studies, and the dementia-related problems or symptoms tackled in the studies. Following this, two groups of studies are analyzed separately and in more detail: those in which people with dementia are actively involved and those where family carers are the main focus in the studies. The analysis focuses on the technology used, study design, methods, participants, outcome variables, results, and the main conclusions.

Material

The study literature was compiled from several databases: PubMed, Academic Search Elite, ASSIA, ERIC, Social Services Abstracts, Sociological Abstracts, CINAHL, and eLSC. The key words used for the search were dementia, technology, safety, assistive device, tracking, surveillance, and tagging. Studies on technology and dementia published between January 1992 and February 2007 were included.

A total of 247 articles were originally identified, but only a small proportion of those were articles providing original data from technology studies. After reading the articles, three more studies were identified and incorporated.

Only 57 articles provided original data, and finally out of these, 46 were intervention studies or assessment studies, with repetitions excluded. This article includes these 46 original publications, although one review on light therapy by Skjerve, Bjorvatn, and Holsten (2004) covering a further 20 studies was also identified. The studies presented in the review article are included in this article's results mainly as individual trials. The total number of studies analyzed in this article is therefore 66. All articles included in this review are published in peer-reviewed journals.

Results

Several different aims were targeted in the 66 studies. Nearly half of the studies were aimed at supporting people with dementia in residential care or hospital and only 10 of the 66 studies described their aim as being to support the well-being and independent living of a person with dementia living at home. As many as 15 studies were focused on supporting family carers, and 10 studies focused on improving the situation of a formal caregiver working in residential care. Another 5 studies aimed at improving access to information on dementia and access to diagnosis (Table 1).

Analysis of the study environments showed that most often they were carried out in a long-term care environment, especially in residential care. Homes where family carers lived either with the person with dementia or where they lived separately were also a common environment, whereas the between home and residential care environments, such as day care centers, were the context for a study in only two studies. The fact that many family carers are in the labor force was taken into account only in one study (Table 1).

Most studies focused on more than one dementia-related symptom or problem; the most common problems were challenging behavior, sleep disturbances, disorientation to time and place, and problems in access to diagnosis and dementia-specific information (Table 1). Challenging behavior such as anxiety, restlessness and agitation were the focus of several studies carried out in residential care. In addition, problems in activities of daily living (ADL) or physical functioning were common topics. Interestingly, only a few studies focused on problems in communication or social inclusion or lack of meaningful activities and stimulation. Furthermore, only two studies mentioned incontinence and problems in using the toilet. Problems related to perception were mentioned in four studies. Four studies did not mention any dementia-specific problem or symptom even if the aim was to improve the quality of life of a person with dementia and/or caregivers (Table 1).

Table 1
Study Aims and Environment, Technology Users, and Dementia Related Problems Dealt With in the Studies ($N = 66$)[a]

Category	*N*
Aim	
To improve independence/well-being of person with dementia in residential care/hospital	32
To improve/support family caregiver well-being/decrease caregiver burden	15
To support formal caregiver in his/her work	10
To support independent living/dignity/well-being of the person with dementia (at home)	10
To improve access to diagnosis/information	5
To restrict the behavior of the person	3
Environment	
Residential care	37
Home/sheltered housing of the person with dementia and/or family career	22
Other (hospital, clinic)	9
Day care	2
Workplace of the family caregiver	1
Active technology user	
Formal caregiver: in residential care	36
Formal community caregiver	15
Family caregiver	22
Person with dementia	15
Other: rescue workers, physicians, nurses, therapists assessing person with dementia	7
Symptom/problem/issue	
Challenging behavior/anxiety/restlessness/depressive or psychotic symptoms, agitation/wandering	23
Access to diagnosis/choosing care site/ access to information	18
Burden of care	18
Orientation in time	15
Sleep disturbances	15
Orientation in place	9
Problems in ADL/care receiving in ADL	8
Passivity/loss of initiative/lack of stimulation	6
Problems in moving/balance/physical functioning	5
Problems in perception	4
Problems in communication/social inclusion	4
Loss of autonomy	3
Lack of sense of security	3
Problems in short-term memory	3

(continued)

Table 1 (continued)

Category	*N*
Problems in continence	2
Problems in intellectual activities	2
Not defined	4

Note: ADL = activities of daily living.
a. Studies could be counted in more than one category.

In most studies, there were more than one user group involved. In nearly all of these studies, formal caregivers were one of the user groups, and the other user groups were either family carers or people with dementia living in residential care. In more than half of the studies, formal caregivers working in residential care were the active users of technology, whereas people with dementia were actively using the technology in less than a quarter of studies. In only 5 studies out of 66 were people with dementia living at home mentioned as a user group. Family carers were named as active users of technology in a third of the studies (Table 1).

The design, sample size, and research methods varied a lot in studies in which formal caregivers working in residential care or in a hospital were the only user group or one of the main user groups, and we can conclude that the studies were reporting the initial findings of the different experiments. These studies were either utilizing light therapy (Skjerve et al., 2004), or they were studies in which exit-modifying interventions such as camouflage of door were used in care (Dickinson, McLain-Kark, & Marshall-Baker,1995; Feliciano, Vore, LeBlanc, & Baker, 2004; Hewawasam, 1996), or formal caregivers were using technology to stimulate the resident with dementia (Baker, Dowling, Wareing, Dawson, & Assey, 1997; Burgio, Scilley, Hardin, Hsu, & Yancey,1996; Camberg et al., 1999; Lucero, Kijek, Malone, Santos, & Hendrix, 2000; McConatha, McConatha, & Dermigny, 1994; Tamura et al., 2004). In addition, formal caregivers were participating in studies in which information and communication technologies (ICT) were used for their own education (Calleson, Sloane, & Cohen, 2006; Engström, Ljunggren, Lindqvist, & Carlsson, 2005; Lyketsos, Roques, Hovanec, & Jones, 2001; Poon, Hui, Dai, Kwok, & Woo, 2005) or to improve access to diagnosis (Cullum, Weiner, Gehrmann, & Hynan, 2006; Gatz et al., 2002; Larner, 2003; Lee et al., 2000, Mundt, Moore, & Greist, 2005). Changing the indoor environment of the residential care by hiding doors or by using lines or bars on floor or door patters showed no success in stopping the wandering of people with dementia in these studies (Dickinson et al., 1995; Feliciano et al., 2004; Hewawasam, 1996), but they suggested that ICT can be used more effectively in providing information and education on dementia in delivering diagnostic (Cullum et al., 2006; Gatz et al., 2002; Larner, 2003; Lee et al., 2000) and support services, in integrating the residents and the residential care in society, and in providing meaningful activities for them (Baker et al., 1997; Burgio et al., 1996; Camberg et al., 1999; Lucero et al., 2000; McConatha et al., 1994; Tamura et al., 2004). In addition, there were 15 studies in which formal caregivers were one of the user groups and the studies aimed at providing technology-mediated support services for family carers. These studies are described below.

Studies Focusing on the Needs of Family Caregivers

Altogether, 15 studies identified were focusing on improving the situation of a family caregiver by utilizing technology. In all the studies, ICT was used for providing information, education, peer support, or support from professionals. The aim of all the studies was to provide these services at the home of the family caregiver and in most cases also at the home of a person with dementia. In one study, these services were provided in the workplace of the family carer. In these studies, no active involvement was expected from the care recipients with dementia (Table 2).

Three studies were cross-sectional, and the aim was to investigate the attitude of family carers toward computer-mediated services. All the others (n = 12) included a follow-up period which varied from 30 days to 18 months. In one study, the duration of the follow-up period was not specified. There were seven randomized controlled trials (RCTs) and four quasi experimental studies based on before- and after-assessments. One study had a qualitative approach and was based on three case studies. In all the other studies with a follow-up period, the number of participants was much higher (range 34-103; Table 2).

The outcome variables measuring the usefulness of the ICT-mediated services were mainly different aspects of well-being: the social, emotional, and information support received and changes in caregiver burden. The scales used to measure outcomes differed across all the RCTs; however, in the other studies the outcome was assessed by more open methods, such as asking about likes and dislikes, preferences, attitudes and opinions, dementia knowledge, and information applicability (Table 2).

Table 2
Studies Focusing on Needs of Family Caregivers ($N = 15$)

Author	Aims	Environment	Technology	Study Design; Number of Caregivers	Follow-Up Period	Outcome Variables	Results
Bank, Arguelles, Rubert, Eisdorfer, and Czaja (2006)	To demonstrate usefulness of technology in conducting support group	Home	Computer-telephone integrated system for calls, essages, and conference with other caregivers	Before and after; $n = 41$	18 months	Likes, dislikes, preferences, attitudes, opinions, and benefits achieved	Emotional support 88%, useful information 85%, to meet new people 64%, opportunity for social interaction 61%, gave break 36%, made new friendships 59%.
Beauchamp, Irvine, Seeley, and Johnson (2005)	To evaluate the efficacy of multimedia support program delivered over the Internet to employed caregivers	Home and worksite	Worksite-based Internet multimedia program	RCT; $n = 299$	30 days	Stress, self-efficacy, coping skills (RWC), strain (CSI), gain (PAC), depression (CES-D), anxiety (STAI), satisfaction, usefulness, recommend for a friend	Reduced depression, anxiety and strain and increased caregiver gain, positively affected participants' appraisal of their situation.
Brennan and Moore (1994)	To study the use and usefulness of information and social participation and support provided by the virtual network	Home	PC, computer network: electronic encyclopedia, communication, decision support module	RCT; $n = 102$	12 months	Use	Mean of use 92 times but varied a lot, typically 12 minutes long sessions including more than 2 functions, private mail most commonly used.

(continued)

Table 2 (continued)

Author	Aims	Environment	Technology	Study Design; Number of Caregivers	Follow-Up Period	Outcome Variables	Results
Chang, Nitta, Carter, and Markham (2004)	To determine the perceived helpfulness of telephone calls to caregivers	Home	Telephone calls to caregivers + video	RCT; $n = 83$	12 weeks	Length and helpfulness of the calls, stressors, social support, quality of life, problems in managing daily care	All except one found helpful: sharing thoughts and feelings, expressing feeling of being overwhelmed, discussing physical and psychosocial problems, seeking reassurance, asking for information.
Czaja and Rubert (2002)	To describe how technology can be used to support caregivers and improve their and pwds quality of life	Home	Computer integrated telephone system for communication and information access	Before and after; $n = 76$	18 months	Likes and dislikes, preferences, usability, utility	Easy to use and valuable for caregivers. Mainly used for communication with other caregivers.
Dang et al. (2004)	To study how the system can facilitate care coordination, support, and education	Home	Telephone-linked computer system and screen-phone for communication support, care coordinator, education	Before and after; $n = 76$	2 months	Use, usability, caregiver burden, depressive symptoms, dementia knowledge	83% used, mean number of calls 6/2 months, median number of minutes 12/call. No difference in care burden, depressive symptoms, or knowledge.

(continued)

Table 2 (continued)

Author	Aims	Environment	Technology	Study Design; Number of Caregivers	Follow-Up Period	Outcome Variables	Results
Eisdorfer et al. (2003)	To study efficacy of a family therapy and technology-based intervention in reducing depressive symptoms	Home	Computer-telephone integrated system for communication, and access for supportive resources	RTC; n = 94	18 months	Well-being (CES-D), burden, presence of memory and behavior problems (RMBPC), upset score on care recipients problem behavior	Caregivers in the combined family therapy and technology intervention experienced reduction in depressive symptoms at 6 months and 18 months but significant differences between the ethnic groups and between wives, husbands, and daughters.
Hanson and Clarke (2000)	To report how technology-based services can support autonomy, independence, and quality of life of caregivers and frail older people	Home	TV + remote control, multimedia PC + CD-ROM: education, assistance, information	Case study; n = 3	3 months	Quality of life, use, usefulness	Caregivers did not have sufficient time to devote to the intervention project. Some experiences of increased confidence and self-esteem.

(continued)

Table 2 (continued)

Author	Aims	Environment	Technology	Study Design; Number of Caregivers	Follow-Up Period	Outcome Variables	Results
Jang, Lee, and Sung (2000)	To study instructional and cosmetic adequacy and program adequacy of the training material	Home	CD-ROM on caring	Cross-sectional; (all $n = 15$, number of caregivers NA)	NA	Cosmetic, program and curriculum adequacies of the program	Cosmetic, program, and curriculum adequacies were higher than the mean score.
Mahoney, Tarlow, and Jones (2003)	To determine main outcome effect of the automated interactive voice response to assist caregivers to manage disruptive behaviors of pwd	Home	Automated telephone system + computer network	RTC; $n = 100$	1 year	Caregiver stress RMBPC, RMBPC Bother scale, STAI, CES-D	A significant intervention effect for participants with lower mastery at baseline on bother, anxiety, depression. Most positive intervention effect on wives with low mastery at the baseline.
Marziali, Damianakis, and Donahue (2006)	To study whether it is possible to duplicate online group interactions typical of face-to-face support groups		Internet-based support group	Before and after; $n = 34$	Follow-up after 10 sessions	Coping capacity, experiences of the use of computer and of participating the virtual support group	90 % had benefited: possibility to express and share feelings and thoughts, social inclusion.

(continued)

Table 2 (continued)

Author	Aims	Environment	Technology	Study Design; Number of Caregivers	Follow-Up Period	Outcome Variables	Results
Lynn, Johnson, and Cranston (2000)	To study if it is possible to provide rural caregivers nutritional information and to provide tool for interaction	Home	Videoconference	cross sectional; $n = 66$	NA	Quality of the conference, information applicability, willingness to participate future conferences.	The quality and applicability was mainly scored excellent or good. Saving time, interaction with others, and quality of practical information were valued high.
Smith and Toseland (2006)	To study effectiveness of a telephone support group program on spouses and adult children caregivers	Home	Telephone support group: education, problem solving, social support	RCT; $n = 97$	12 weeks	Tangible support, affectionate support, positive social interaction, and emotional and information support received (SSS) caregiver burden (ZBI), depression (CES-D), anxiety (STAI), problems being addressed by health and social services (PPP), Community Service Inventory	For adult child caregivers the program more effective than usual services in reducing burden and depression, in social support, and pressing problems, and increasing knowledge and use of community services. No significant differences for spouse caregivers.

(continued)

Table 2 (continued)

Author	Aims	Environment	Technology	Study Design; Number of Caregivers	Follow-Up Period	Outcome Variables	Results
Smyth, Rose, McClendon, and Lambrix (2007)	To analyze importance of dimensions of social support and expectations of technology-mediated support groups	Home	Computer-mediated support group	Cross-sectional; $n = 118$	NA	Importance of dimensions of social support (CASS-I), expectations regarding the technology (CATS-E)	Caregiver's gender and race were related to importance of social support; education, gender, and race were related to expectations regarding to technology.
Winter and Gitlin (2006-2007)	To evaluate feasibility and effectiveness of professionally led telephone-based support groups	Home	Telephone-based support group	RCT; $n = 103$	6 months	Feasibility and effectiveness on caregiver burden (ZBI), depression (CES-D) and personal gains (Kaye's Gain Through Group Involvement Scale)	Minimal benefits of support group participation and only for older women caring for a relative with AD (reduced depression) and greater upset.

Note: RCT = randomized controlled trials; RWC = Revised Ways of Coping; CSI = Caregiver Strain Instrument; PAC = Positive Aspects of Caregiving; CES-D = Center for Epidemiologic Studies-Depression; STAI = State-Trait Anxiety Inventory; pwd = a person with dementia; RMBPC = The Revised Memory and Behavior Problems Checklist; NA = not available; SSS = Social Support Survey; ZBI = Zarit Burden Interview; PPP = Pressing Problems Index; CASS-I = Caregiver Assessment Social Support-Importance Scale; CATS-E = The Caregiver Assessment of Technology Support-Expectations.

The results showed that computer- and telephone-mediated services were widely accepted by the family carers, although the usefulness varied. Most studies—both RCTs and before- and after-studies—reported positive findings: Social support and new social contacts, information, and support received from professionals and peers were acknowledged, caregiver burden and stress were decreased, and coping skills were improved. However, one study reported only minimal benefits (Winter & Gitlin, 2007) and the qualitative study underlined that the family carers interviewed hardly have time to learn to use new tools or to actually use them (Table 2).

Studies Involving People With Dementia

Involvement of people with dementia was defined as at least agreeing to wear a technology such as a transmitter of a monitoring system, at least to monitor physical activity even if not actively influence its functioning and act as informants. Studies in which people with dementia were involved are described in Table 3. There were 19 articles reporting original data, although 20 additional studies were included from a review summarizing the results of light treatment studies involving people with dementia (Skjerve et al., 2004). In these 39 studies, the number of the participants with dementia varied between 1 and 71, and most studies involved less than 20 participants. Nine studies were carried out in a home environment, or the participants were living at home; however, 30 studies were carried out in a residential care environment. Only one study was organized in both a home and a care environment. In most studies, the participants had moderate or severe dementia (Table 3).

The most common aim of the studies was to improve orientation to time and place by providing light therapy, by using compensational assistive technologies, or by enabling the caregiver to follow the independent movements of the person with dementia via a monitoring system. In addition, there were several studies aimed at providing stimulation and occupation or improving the social participation of people with dementia. In three studies, no specific aim was described concerning the well-being of people with dementia; despite the fact that they involved people with dementia, they were focused on caregiver well-being and improving care work (Table 3).

The design of the studies varied from RCTs to descriptive case studies. Follow-up periods varied from 2 weeks to 7 months. One study was retrospective and two were cross-sectional. Data collection methods also varied from open interviews and videotaped user sessions to structured surveys or systematic observations. In nine studies, people with dementia were acting

Table 3
Technology Studies in Which People With Dementia Were Involved[a]

Author	Aims	Environment	Technology	Number of People With Dementia (*n*); Severity of Dementia	Data Collection Method, Follow-Up Period	Outcome Assessment Tools/ Variables	Results
Altus, Mathews, Xaverius, Engelman, and Nolan (2000)	To study the use and usefulness of the monitoring system for caregivers peace of mind	Home (*n* = 2) Residential (*n* = 4)	Electronic monitoring system (passive)	*n* = 6; moderate/severe	2 caregiver interviews, 3-5 months	Time used in searching the person, peace of mind	Easy to use, reduced time for searching, helpful for caregiver's peace of mind.
Margot-Cattin and Nygård (2006)	To identify and describe influences of the access control technology on the every day lives of residents	Hospital	Access control technology	*n* = 15; moderate/severe	Observations of pwd, staff interviews, 6 months	Use, usability, usefulness: freedom to move, privacy, orientation	Supported the residents' sense of security, territoriality, orientation, and adaptation to environment.
Rowe (1999)	To illustrate the use of the home monitoring system to prevent night time injuries	Home, living with the family caregiver	Home monitoring system	*n* = 1; moderate	2 interviews with the family caregiver, 7 months	Night time activity worry scale, hours of sleep	All items about the system being of help in relieving caregiver's worry.

(continued)

Table 3 (continued)

Author	Aims	Environment	Technology	Number of People With Dementia (n); Severity of Dementia	Data Collection Method, Follow-Up Period	Outcome Assessment Tools/ Variables	Results
Taylor (2005)	To describe care managers' experiences and perspective of using AT to support people with dementia	Home, living alone	Home environment monitoring system	$n = 6$; NA	Retrospective narration by care managers interviewed	Reduction of anxiety, ensuring help to be received if required	Promoted independence and ensured that help was received relatively quickly when needed, the service minimized the risks and relieved stress of the caregivers.
Kinney, Kart, Murdoch, and Conley (2004)	To evaluate the use and usefulness of the monitoring system for caregivers	Home	Internet-based monitoring system (passive)	$n = 19$; severe	Family caregiver interviews, telephone calls, 24 weeks	Time budget, peace of mind, relationship in the family/with the person with dementia	Made life easier for 14 out of 16. Made life more difficult for 7 out of 16.
Baruch, Downs, Baldwin, and Bruce (2004)	To describe the use and usefulness of the individually tailored computer program for supporting time orientation	Sheltered accommodation	Computer to reassure	$n = 1$; NA	Observation and interview, descriptive case study	Night time telephone calls, stress	Midnight telephone calls dropped almost to 0, decreased stress.

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Table 3 (continued)

Author	Aims	Environment	Technology	Number of People With Dementia (n); Severity of Dementia	Data Collection Method, Follow-Up Period	Outcome Assessment Tools/ Variables	Results
Labelle and Mihailidis (2006)	To compare the effectiveness of verbal and audio-visual prompts in reduced human caregiver interaction during hand-washing	Residential care	Automated audio-visual prompting system	$n = 8$; moderate/severe	Videotaped use sessions; 60 days	Steps completed on hand-washing without caregiver, caregiver interventions	The participants more able to complete more steps with the assistance of automated prompt and required fewer caregiver interactions.
McConatha, McConatha, and Dermigny (1994)	To examine the effects of interactive computer-based education and training on the rehabilitation of long-term care residents	Residential care	PC-based education and training (email, encyclopedia, bulletin boards, games)	$n = 14$; severe	Pre- and posttest; NA	Functioning: Katz's ADL, GDS, Geriatric Depression Scale, MMSE	ADL and MMSE scores increased, depression score dropped (t-test p 0.05)
Schreiber, Lutz, K., Schweizer, Kalveram, and Jäncke (1998)	To examine the effectiveness of interactive memory training	NA (participants lived at home)	Computer-based memory training	$n = 14$; mild/moderate	Interview of the participants with dementia, control group; Pre- and posttest after 10 sessions	Cognitive functioning: RBMT, NAI (picture and route learning)	Increase in scores for immediate recall of meaningful visual information and delayed retention of topographical information.

(continued)

Table 3 (continued)

Author	Aims	Environment	Technology	Number of People With Dementia (*n*); Severity of Dementia	Data Collection Method, Follow-Up Period	Outcome Assessment Tools/ Variables	Results
Topo et al. (2004)	To describe the use and usefulness of music-based multimedia programs	Day care centers	Computer and touch screen assisted music activities	*n* = 28; from mild to severe	Questionnaire for formal caregivers, observations and interviews with pwds; 3 weeks	Frequency and length of use, impact on social interaction and mood	All except 1 used, 52% had problems with the use, 21 of 23 benefited, improved mood 74% and social interaction 70%.
Tamura et al. (2004)	To compare the effectiveness of a robot animal with a toy in occupational therapy	Health care facility	Entertainment robot	*n* = 13; severe	Observation in two OT sessions	Frequency of patient activities in the sessions	Increased interaction of people with severe dementia.
Camberg et al. (1999)	To evaluate the efficacy of simulated presence to enhance well-being of pwd	Nursing homes	Audiotapes, videotapes	*n* = 54; moderate/severe	RCT; 38 days	Agitation (SOAP, OAS, AVAS, PARS) and withdrawn (FACE, WVAS)	Most subjects accepted the intervention. Produced equivalent happy facial expressions as usual care. Superior to usual care and placebo in improving interest. Decreased agitation and withdrawal.

(continued)

Table 3 (continued)

Author	Aims	Environment	Technology	Number of People With Dementia (*n*); Severity of Dementia	Data Collection Method, Follow-Up Period	Outcome Assessment Tools/ Variables	Results
Baker, Dowling, Wareing, Dawson, and Assey (1997)	To investigate the long-term and short-term effects of the Snoezelen environment on behavior, mood and cognition	Two day hospitals	Snoezelen rooms	$n = 31$; severe	RCT; 4 weeks	Behavior (Rehab, BMD Scale, BRS, CAPE, CAS); cognition (MMSE, CAS)	Long-term impact: no change in deviant behavior scores and speech skills, decreased social disturbance. Short-term impact: improved spontaneously talking and recalled memories and talked with normal length sentences and scores for touched objects.
Burgio, Scilley, Hardin, Hsu, and Yancey (1996)	To study efficacy of environmental white noise audiotapes for the treatment of verbal agitation	Two nursing homes	White noise machines	$n = 13$; severe	Before and after; 10 days	Cognitive, psychological and social functioning: MMSE, Barthel Scale, CMAI, SDVB, Social validity item, Medication tracking form	23% reduction in verbal agitation.

(continued)

Table 3 (continued)

Author	Aims	Environment	Technology	Number of People With Dementia (n); Severity of Dementia	Data Collection Method, Follow-Up Period	Outcome Assessment Tools/ Variables	Results
Lucero, Kijek, Malone, Santos, and Hendrix (2000)	To determine the feasibility of developing sensory stimulation products for people with dementia	Residential care	Sensory stimulation products (low tech)	$n = 49$; severe	Videotaped sessions; cross-sectional	Product and non-product interaction time, perseveration time, WAIS-R, SCT, ADS, Geriatric Depression Scale, GDS, Memory Scale, Orientation Scale, OPIC	The products engaged the subjects for 33% of the time. If products were introduced in a multisensory manner product interaction was enhanced.
Skjerve, Bjorvatn, and Holsten (2004 review)	To review literature concerning efficacy, clinical practicability and safety of light treatment for behavior al and psychological symptoms of dementia	Residential care 20 studies, home 1 study	Bright lights, 21 studies	Pooled $n = 347$, range 5-71; mild to severe	RCT $n = 5$, one group $n = 11$, case series $n = 4$; 5-60 days	Psychotic and depressive symptoms and agitation (CRS, BEHAVE-AD, Cornell Scale, CMAI, ABRS), Sleep disturbances and activity rhythm disturbances	11 studies showed improvements in sleep disturbances, 6 studies showed improvements in activity rhythm disturbances and six decrease of agitation, one study showed decrease of psychotic symptoms.

(continued)

Table 3 (continued)

Author	Aims	Environment	Technology	Number of People With Dementia (*n*); Severity of Dementia	Data Collection Method, Follow-Up Period	Outcome Assessment Tools/ Variables	Results
Nygård and Johansson (2001)	To describe clinical implementation process and outcome of time aid interventions	Home, 3 lived with spouse, 2 alone	Time aids	*n* = 5; mild cognitive impairment to moderate dementia	Case analyses: 2 interviews with the pwd and spouse, contact once a week; 6 weeks	Use and usefulness: planning of time, orientation to date and weekday, taken medication at right time	2 out of 5 benefited from the time aid. *Knowing when* was most responsive to aids, whereas *knowing how long* were not met by the time aids.
Topo, Jylhä, and Laine (2002)	To examine usefulness of the easy to use telephone for communication of pwds	Home, with the family caregiver	Easy to use desk-phone	*n* = 6; mild or moderate	4 interviews with pwd and family caregiver, diary kept by the caregiver; 2 months	Use: IADL and frequency of use, usefulness: impact on social inclusion, peace of mind	Eased making a phone call, in some cases helped to remember who called and what was discussed. Most problems the participants had did not disappear.

(continued)

Table 3 (continued)

Author	Aims	Environment	Technology	Number of People With Dementia (*n*); Severity of Dementia	Data Collection Method, Follow-Up Period	Outcome Assessment Tools/ Variables	Results
Wolden, Strand, and Gjellestad (2006)	To evaluate how caregivers feel about the use of electronic vs. manual toothbrushes for the elderly in long-term care	Residential care	Electric toothbrush	NA; NA	Cross-sectional survey for formal caregivers	Time use for dental care, usability, acceptance	Was used frequently: 77%. Used less time on oral care: 44%. Among people with dementia 45% of the nurses found oral care procedure simpler, 24% found no difference and 31% more difficult.
Chan, Campo, Laval, and Esteve (2002)	To introduce a tool for the assessment of the mobility of a patient with motor disorders and to evaluate its performance	Residential care	Sensors connected to PC and communication network	$n = 1$; severe	Log data gathered by the system and real mobility observations; 39 nights	Agreement between the system data and real mobility data	Good agreement between two types of the data.

Note: $n = 19$ original studies + a review including 20 studies. AT = assistive technology; pwd = a person with dementia; GDS = Global Deterioration Scale; MMSE = Mini Mental State Examination; NA = not available; RBMT = Rivermead Behavioral Memory Test; NAI = Nuremberg Aging Inventory; RCT = randomized controlled trials; OT = occupational therapy; SOAP = The Scale for the Observation of Agitation in Persons With Dementia; OAS = Observed Agitation Scale; AVAS = Agitation Visual Analog Scale; PARS = Philadelphia Geriatric Centre Affect Rating Scale; FACE = Facial Diagrams of Moods; WVAS = Withdrawal Visual Analog Scale; BMD Scale = Behavior and Mood Disturbance Scale; CAPE = Clifton Assessment Procedures for the Elderly; CAS = Cognitive Assessment Scale; CMAI = Cohen-Mansfield Agitation Inventory; SDVB = Survey of Disruptive Vocal Behavior; WAIS-R = Word Fluency Measure, Story Retelling Task; SCT = Self-Concept Test; ADS = Alzheimer's Differentiation Scale; OPIC = Objective Product Interaction Checklist; CRS = Confusion Rating Scale; BEHAVE-AD = Behavioral Methodology in Alzheimer Disease Scale; ABRS = Agitation Behavior Rating Scale.

a. At least agreeing to wear technology even if not actively influencing its functioning and not acting as informant.

as informants, either by being interviewed (Baruch, Downs, Baldwin, & Bruce, 2004; McConatha et al., 1994; Topo et al., 2004; Topo, Jylhä, & Laine, 2002) or by videotaping and by direct observational methods (Burgio et al., 1996; Camberg et al., 1999; Lucero et al., 2000; Margot-Cattin & Nygård, 2006; Nygård & Johansson 2001). In most studies, the informal or formal caregivers were the main information source concerning the use of the technology and its usefulness for the participants with dementia.

In several studies, the main outcome was investigated by standardized scales, whereas others were using explorative and qualitative methods to define the outcome. Similar tools were used to assess cognitive functioning (Mini Mental State Examination, Global Deterioration Scale, or Dementia Rating Scale), but all the other outcome variables varied between the studies so much that it is difficult to make any comparisons between them. In addition, in some studies, the researchers were able to make clear hypotheses about the expected outcome, although in most studies, the interest was also in investigating the experience of a particular dementia-related problem. The main questions concerning the outcome of the technology studies were whether the technology can be used by the person and/or how could it benefit her or him? In some studies in which people with dementia were involved (e.g., use of monitoring systems) the impact on their well-being was not assessed. All these differences make it very difficult to compare and summarize the findings (Table 3).

All the studies except one that investigated phototherapy-delivered light visors reported at least some positive findings. According to the single reports, technology can be helpful in providing more freedom for the person with dementia to move around; in providing new activities, in reassuring and reminding the person, in supporting circadian rhythm and orientation in time; and in decreasing stress, anxiety, and agitation. In addition, some studies showed improvements in different aspects of caregiver well-being. However, because the design, size, and methods used in assessing the value of the technology vary so much, we need to be very cautious in drawing conclusions. Even Skjerve et al. (2004), who were able to identify 20 studies, including 5 RCTs focusing on light therapy, were willing to conclude that light therapy has positive influence on sleep and circadian rhythms but noted that there “are still too few well-designed studies” to draw any conclusion about the influence on behavioral and psychological symptoms (Table 3). Many of the other articles also showed caution in drawing conclusions. Most of the conclusions are of the type that can be useful, but far more research is needed to be able to identify who can benefit and when the time is optimal to introduce the technology. In the discussion section of some articles, the ethical issues such as consent, potential harmful effects of the technologies, or the situation following the study were discussed, but others did not mention them at all.

Discussion

The results show that the number of studies done on technology and dementia are limited compared to other fields of dementia research, particularly clinical trials on antidementia drugs, other pharmacological research, quality of care or caregiver burden, the economic cost of care, and quality of life issues. Moreover, the research is very much biased toward the residential care setting and toward moderate to severe stages of dementia. In several studies, involving people in residential care, consent was asked only from the family members and not from the person with dementia. Ethical implications of such procedure were discussed only in some articles. The studies included here and a study published after the literature search was done (Topo et al., 2007) have reported difficulties in motivating people living at home to participate in such studies. However, the results of this review suggest that there are assistive technologies already available that could be tested in a home environment.

Another bias is the emphasis on safety issues and caregiver well-being. Even if these issues are very central when considering ways to support a person with dementia, they are not the only ones. For example, a lack of anything to do, lack of a feeling of security, social withdrawal, or restricted and limited access to outdoors are reported in studies looking at the everyday life of people with dementia (Bank et al., 2006; Brooker et al., 1998; Chung, 2004; Harris, 2006; Nolan et al., 2002; Nygård & Borell, 1998; Nygård & Johansson, 2001). These studies also reported social isolation and problems with everyday activities at home (see also Sabat, 2001). These issues were tackled in only a few studies, but all of them suggested that these problems can be somewhat alleviated by the use of technology even among people with severe dementia.

The bias toward caregiver needs and safety may be associated with the fact that in a vast majority of the studies, informal or formal caregivers were the main source of information, and the role of people with dementia was limited, that is, if they played any role at all. When looking at the differences between studies that present the perspectives of family caregivers or formal caregivers and those reporting the results of interviews with people with dementia, there seem to be some differences. The caregivers have a tendency to emphasize care issues such as management of IADL and ADL and safety issues (Kirsi, Hervonen, & Jylhä, 2004; Pollitt, Anderson, & O'Connor, 1991), whereas people with dementia report how difficult it is to find something to do, to sleep, or to live with the insecurity that you do not know where you are and what time of day it is (Harris, 2006). Only a few studies were interested in the experience of people with dementia (Baruch et al., 2004; Margot-Cattin & Nygård, 2006; Nygård & Johansson, 2001; Topo et al., 2002, 2004). One of the exceptions was a study by Baruch et al. (2004), where the technology was designed according to experiences and needs described by the study participant. All others used available technology and assumed that it suited the purpose of the users.

Another issue that needs to be discussed is the lack of information provided on the environment where the technology was used. According to Hagen et al. (2004), the local environment is one of five factors influencing the use and usefulness of the technology. This also includes the services the person is receiving. The issue of services was a central point in studies supporting family carers by providing opportunities for virtual support. However, when discussing monitoring systems, applications to improve cognitive performance, or technology for oral care, environmental issues were not studied in detail. It is obvious that we need more understanding of how to study the impact of environmental factors in the use and usefulness of technology.

The study designs and the follow-up periods varied greatly between studies. The most common design was based on before-and-after assessments and there were no RCTs focusing on people with dementia living at home. The analyses show that only a very limited number of assessment studies were focused around supporting the independent living of people with dementia. Clearly, the more active a role given to people with dementia in the studies, the more demanding becomes the design, data collection, measurements, and analyses of the data (see Hagen et al., 2004). Only a few studies involved people with dementia who were living alone. Such a context is ethically and methodologically complex and the related issues were discussed in these articles (Nygård & Johansson,, 2001; Taylor, 2005; Topo et al., 2002). The background of the users with dementia, apart from their cognitive and other functioning, is described in only a few studies.

The technologies implemented varied from audiotapes to robots. In most studies, ICT was used, and the aim was to improve the quality of life of the informal caregiver and to reduce their care burden. In some studies, people with mild cognitive impairment or mild, moderate, or severe dementia used ICT for communication and recreation. The very limited number of studies where people with dementia were using the technology by themselves indicates that assistive technologies developed for the active use of people with mild cognitive impairment or mild, moderate, or severe dementia are lacking. Researchers and designers may find undertaking work of this nature complex from the methodological point of view. However, this review suggests that there is a need for thorough user needs analyses and for the inclusion of people with mild to moderate dementia in research that evaluates the effectiveness of technology. There is also a need to do further work tracking the appropriateness of technology in relation to the different stages of dementing illnesses.

The concordance between the studies on the benefits of ICT-mediated support for family caregivers has practical implications. When Gitlin et al. (2003) conducted a meta-analysis of 15 studies on family caregiver support, they concluded that such interventions should be multicomponent and tailored. This conclusion was based on the fact that there were differences between female and male caregivers, between educational groups, and between ethnic groups. The results of this review suggest that there are also differences between spouses and adult children and that they are in accordance with the conclusion drawn by Gitlin et al. (2003).

This review has certain limitations. First, there have been many more evaluation reports done on the use, usefulness, and efficacy of the use of technology, but this current article looked only at peer reviewed works published since 1992. Only peer-review journals were included because they have a similar quality assurance system. Second, defining the search keywords was difficult, and it was learned that not all studies that should have been identified were found in the search, although they were later included after discovering their being referred in articles found in this literature search. Third, defining exactly what counts as technology was left open. The only two criteria used were that the technology should be something concrete and should not be medical technology.

Despite these limitations, we can conclude that the findings show that research on the role of technology in dementia care is still in its infancy. Far more work needs to be done to develop methods for assessing its use, usefulness, and efficacy. Global cooperation is also needed to improve the coherence of the design and outcome measurements. One issue that needs urgent attention is how to promote assessment studies focusing on the perspective of people with dementia who live at home. These studies should be carried out in a home environment, and some kind of control group design needs to be developed. At the moment, we know that there are promising findings, but it is impossible to draw a holistic picture about the potential of technology in developing services for people with dementia and in supporting their living in the community. No studies were identified that investigated the potential of technology in postponing residential care.

Three conclusions of this study can be made. First, national and international multidisciplinary research programs are needed to improve the knowledge on the possibilities and limitations of technology in supporting people with dementia, their family caregivers, and formal caregivers. Research should focus on mild to moderate dementia and community living and cooperate with organizations of people with dementia and their family members. Because the research is still in the very beginning stage, we need both qualitative and quantitative explorative research activities to develop methods for user involvement and for studying use and usefulness and to develop hypothesis for research. Second, technology can already be successfully used for supporting people with different stages of dementia and their family carers, but it requires assessment of their needs, individually tailored and reliable applications, personal assistance, and adequate social and health care services including follow-up of the situation of each individual. Third, no conclusions can be drawn about the cost-effectiveness of the use of technology at the moment.

References

Altus, D. E., Mathews, R. M., Xaverius, P. K., Engelman, K. K., & Nolan, B. A. D. (2000). Evaluating an electronic monitoring system for people who wander. *American Journal of Alzheimer's Disease, 15*, 121-125.

Astell, A. J. (2006). Technology and personhood in dementia care. *Quality in Ageing—Policy, Practice and Research, 7*, 15-25.

Baker, R., Dowling, Z., Wareing, L. A., Dawson, J., & Assey, J. (1997). Snoezelen: Its long-term and short-term effects on older people with dementia. *British Journal of Occupational Therapy, 60*, 213-218.

Bank, A. L., Arguelles, S., Rubert, M., Eisdorfer, C., & Czaja, S. J. (2006). The value of telephone support groups among ethnically diverse caregivers of persons with dementia. *The Gerontologist, 46*, 134-138.

Baruch, J., Downs, M., Baldwin, C., & Bruce, E. (2004). A case study in the use of technology to reassure and support a person with dementia. *Dementia, 3*, 372-377.

Beauchamp, N., Irvine, A. B., Seeley, J., & Johnson, B. (2005). Worksite-based Internet multimedia program for family caregivers of persons with dementia. *The Gerontologist, 45*, 793-801.

Brennan, P. F., & Moore, S. M. (1994). Networks for home care support: The ComputerLink project. *Caring, 8*, 64-66, 68-70.

Brooker, D., Foster, N., Banner, A., Payne, M., & Jackson, L. (1998). The efficacy of dementia care mapping as an audit tool: Report of a 3-year British NHS evaluation. *Aging & Mental Health, 2*, 60-70.

Burgio, L., Scilley, K., Hardin, J. M., Hsu, C., & Yancey, J. (1996). Environmental "white noise": An intervention for verbally agitated nursing home residents. *Journals of Gerontology: Series B: Psychological Sciences and Social Sciences,* 51B, P364-P373.

Cahill, S., Macijauskiene, J., Nygård, A.-M., Faulkner, J.-P., & Hagen, I. (2007). Technology in dementia care. *Technology and Disability, 19*, 55-60.

Calleson, D. C., Sloane, P. D., & Cohen, L. W. (2006). Effectiveness of mailing "bathing without a battle" to all U.S. nursing homes. *Gerontology and Geriatrics Education, 27*, 67-79.

Camberg, L., Woods, P., Ooi, W. L., Hurley, A., Volicer, L., Ashley, J., et al. (1999). Evaluation of simulated presence: A personalized approach to enhance well-being in persons with Alzheimer's disease. *Journal of the American Geriatrics Society, 47*, 446-452.

Chan, M., Campo, E., Laval, E., & Esteve, D. (2002). Validation of a remote monitoring system for the elderly: Application to mobility measurements. *Technology and Health Care: Official Journal of the European Society for Engineering and Medicine, 10*, 391-399.

Chang, B. L., Nitta, S., Carter, P. A., & Markham, Y. K. (2004). Perceived helpfulness of telephone calls. *Journal of Gerontological Nursing, 30*, 14-21.

Chung, J. C. C. (2004). Activity participation and well-being of people with dementia in long-term-care settings. *OTJR: Occupation, Participation and Health, 24*, 22-31.

Cohen-Mansfield, J., Werner, P., & Reisberg, B. (1995). Temporal order of cognitive and functional loss in a nursing home population. *Journal of the American Geriatrics Society, 43*, 974-978.

Cullum, C. M., Weiner, M. F., Gehrmann, H. R., & Hynan, L. S. (2006). Feasibility of telecognitive assessment in dementia. *Assessment, 13*, 385-390.

Czaja, S. J., & Rubert, M. P. (2002). Telecommunications technology as an aid to family caregivers of persons with dementia. *Psychosomatic Medicine, 64*, 469-476.

Dang, S., Bank, S. L., Harris, J., Malphurs, J., Maymi, E. M., Portales, A., et al. (2004). Utilization of tlc technology by dementia family caregivers. *The Gerontologist, 44*, 604-604.

Dickinson, J. I., McLain-Kark, J., & Marshall-Baker, A. (1995). The effects of visual barriers on exiting behavior in a dementia care unit. *The Gerontologist, 35*, 127-130.

Duff, P., & Dolphin, C. (2007). Cost–benefit analysis of assistive technology to support independence for people with dementia—Part 2: Results from employing the ENABLE cost–benefit model in practice. *Technology and Disability, 19*, 79-90.

Eisdorfer, C., Czaja, S. J., Loewenstein, D. A., Rubert, M. P., Arguelles, S., Mitrani, V. B., et al. (2003). The effect of a family therapy and technology-based intervention on caregiver depression. *The Gerontologist, 43*, 521-531.

Engström, M., Ljunggren, B., Lindqvist, R., & Carlsson, M. (2005). Staff perceptions of job satisfaction and life situation before and 6 and 12 months after increased information technology support in dementia care. *Journal of Telemedicine and Telecare, 11*, 304-309.

Feliciano, L., Vore, J., LeBlanc, L. A., & Baker, J. C. (2004). Decreasing entry into a restricted area using a visual barrier. *Journal of Applied Behavior Analysis, 37*, 107.

Gatz, M., Reynolds, C. A., John, R., Johansson, B., Mortimer, J. A., & Pedersen, N. L. (2002). Telephone screening to identify potential dementia cases in a population-based sample of older adults. *International Psychogeriatrics/IPA, 14*, 273-289.

Gitlin, L. N., Belle, S. H., Burgio, L. D., Czaja, S. J., Mahoney, D., Gallagher-Thompson, D., et al. (2003). Effect of multicomponent interventions on caregiver burden and depression: The REACH multisite initiative at 6-month follow-up. *Psychology and Aging, 18*, 361-374.

Gray, L. C., Bernabel, R., Berg, K., Finne-Soveri, H., Fries, B. E., Hirdes, J. P., et al. (2008). Standardizing assessment of elderly people in acute care: The interRAI Acute Care Instrument. *Journal of the American Geriatrics Society* [Epub ahead of print].

Hagen, I., Holthe, T., Gilliard, J., Topo, P., Cahill, S., Begley, E., et al. (2004). Development of a protocol for the assessment of assistive aids for people with dementia. *Dementia, 3*, 281-296.

Hanson, E. J., & Clarke, A. (2000). The role of telematics in assisting family carers and frail older people at home. *Health and Social Care in the Community, 8*, 129-137.

Harris, P. B. (2006). The experience of living alone with early stage Alzheimer's disease. What are the person's concerns? *Alzheimer's Care Quarterly, 7,* 84-94.

Hewawasam, L. (1996). Floor patterns limit wandering of people with Alzheimer's. *Nursing Times, 92*, 41-44.

Hughes, J., & Campbell, G. (2003). The electronic tagging and tracking debate. *Nursing & Residential Care, 5*, 174-177.

Jang, H. J., Lee, K. W., & Sung, M. S. (2000). A CD-ROM based caring program for the family caregiver for the Korean demented elderly. In V. Saba, R. Carr, W. Sermeus, & P. Rocha (Eds.), *Nursing informatics 2000. One step beyond: The evolution of technology and nursing. Proceedings of the 7th IMIA international conference on nursing use of computers and information science, Auckland, New Zealand, 28 April-3 May, 2000* (pp. 434-437). Auckland, New Zealand: Adis International.

Jensen, L., Månsson, I., Holthe, T., Hurnasti, T., & Indriðadóttir, B. (2007). How cognitive assistive technology can be useful for and a benefit to persons with dementia in their daily living. Guidelines for service delivery of cognitive assistive technology to persons with dementia. In G. Eizmendi, J. M. Azkoitia, & G. M. Craddock (Eds.), *Challenges for assistive technology. AAATE 07* (pp. 227-232). Amsterdam: IOS Press.

Kinney, J. M., Kart, C. S., Murdoch, L. D., & Conley, C. J. (2004). Striving to provide safety assistance for families of elders: The SAFE house project. *Dementia, 3*, 351-370.

Kirsi, T., Hervonen, A., & Jylhä, M. (2004). Always one step behind: Husbands' narratives about taking care of their demented wives. *Health: An Interdisciplinary Journal for the Social Study of Health, Illness and Medicine, 8*, 159-181.

Kuchinomachi, Y., & Kumada, T. (1999). The relationship between the cognitive function decrease of elderly people and the usability of domestic appliances and participation in outside activities. *Technology and Disability, 11*, 169-175.

Labelle, K. L., & Mihailidis, A. (2006). The use of automated prompting to facilitate hand washing in persons with dementia. *The American journal of occupational therapy: Official publication of the American Occupational Therapy Association, 60*, 442-450.

Larner, A. J. (2003). Use of the Internet and of the NHS direct telephone helpline for medical information by a cognitive function clinic population. *International Journal of Geriatric Psychiatry, 18*, 118-122.

Lee, J. H., Kim, J. H., Jhoo, J. H., Lee, K. U., Kim, K. W., Lee, D. Y., et al. (2000). A telemedicine system as a care modality for dementia patients in Korea. *Alzheimer Disease and Associated Disorders, 14*, 94-101.

Lobo, A., Launer, L. J., Fratiglioni, L., Andersen, K., Di Carlo, A., Breteler, M. M., et al. (2000). Prevalence of dementia and major subtypes in Europe: A collaborative study of population-based cohorts. Neurologic diseases in the elderly research group. *Neurology, 54*, S4-S9.

Lucero, M., Kijek, J., Malone, L., Santos, R., & Hendrix, K. (2000). Products for Alzheimer's patients with "null" behavior. *American Journal of Alzheimer's Disease and Other Dementias, 15*, 347-356.

Lyketsos, C. G., Roques, C., Hovanec, L., & Jones, B. N. (2001). Telemedicine use and the reduction of psychiatric admissions from a long-term care facility. *Journal of Geriatric Psychiatry and Neurology, 14*, 76-79.

Lynn, P., Johnson, A. O., & Cranston, G. M. (2000). A successful videoconference satellite program: Providing nutritional information on dementia to rural caregivers. *Educational Gerontology, 26*, 415-425.

Mahoney, D. F., Tarlow, B. J., & Jones, R. N. (2003). Effects of an automated telephone support system on caregiver burden and anxiety: Findings from the REACH for TLC intervention study. *The Gerontologist, 43*, 556-567.

Margot-Cattin, I., & Nygård, L. (2006). Access technology and dementia care: Influences on residents' everyday lives in a secure unit. *Scandinavian Journal of Occupational Therapy, 13*, 113-124.

Marshall, M. (1995). Technology is the shape of the future. *Journal of Dementia Care, 3*, 12-14.

Marshall, M. (1996). Dementia and technology: Some ethical considerations. In H. Mollenkopf (Ed.), *Elderly people in industrialised societies. Social integration in old age by or despite technology?* (pp. 207–215). Berlin, Germany: Edition Sigma, Rainer Bohn Verlag.

Marshall, M. J., & Hutchinson, S. A. (2001). A critique of research on the use of activities with persons with Alzheimer's disease: A systematic literature review. *Journal of Advanced Nursing, 35*, 488-496.

Marziali, E., Damianakis, T., & Donahue, P. (2006). Internet-based clinical services: Virtual support groups for family caregivers. Internet-based clinical services: Virtual support groups for family caregivers. *Journal of Technology in Human Services, 24*, 39-54.

McConatha, D., McConatha, J. T., & Dermigny, R. (1994). The use of interactive computer services to enhance the quality of life for long-term care residents. *The Gerontologist, 34*, 553-556.

Mundt, J. C., Moore, H. K., & Greist, J. H. (2005). A novel interactive voice response (IVR) systems for dementia screening, education, and referral: One-year summary. *Alzheimer Disease and Associated Disorders, 19*, 143-147.

Nolan, M., Ingram, P., & Watson, R. (2002). Working with family carers of people with dementia. *Dementia, 1*, 75-93.

Nygård, L. (2004). Responses of persons with dementia to challenges in daily activities: A synthesis of findings from empirical studies. *American Journal of Occupational Therapy, 58*, 435-445.

Nygård, L., & Borell, L. (1998). A life-world of altering meaning: Expressions of the illness experience of dementia in everyday life over three years. *Occupational Therapy Journal of Research, 18*, 109-136.

Nygård, L., & Johansson, M. (2001). The experience and management of temporality in five cases of dementia. *Scandinavian Journal of Occupational Therapy, 8*, 85-95.

Orpwood, R., Bjorneby, S., Hagen, I., Maki, O., Faulkner, R., & Topo, P. (2004). User involvement in dementia product development. *Dementia, 3*, 263-279.

Orpwood, R., Sixsmith, A., Torrington, J., Chadd, J., Gibson, G., & Chalfont, G. (2007). Designing technology to support quality of life of people with dementia. *Technology and Disability, 19*, 103-112.

Pekkarinen, L. (2007). *The relationships between work stressors and organizational performance in long-term care for elderly residents* (Research Report 171). Helsinki, Finland: Stakes.

Pekkarinen, L., Sinervo, T., Elovainio, M., Noro, A., Finne-Soveri, H., & Leskinen, E. (2006). Resident care needs and work stressors in special care units versus non-specialized long-term care units. *Research in Nursing & Health, 29*, 465-476.

Pekkarinen, L., Sinervo, T., Perälä, M.-L., & Elovainio, M. (2004). Work stressors and the quality of life in long-term care units. *The Gerontologist, 44*, 633-643.

Penhale, B., & Manthorpe, J. (2001). Using electronic aids to assist people with dementia. *Nursing & Residential Care, 3*, 586, 588-589.

Pollitt, P. A., Anderson, I., & O'Connor, D. W. (1991). For better for worse: The experience of caring for an elderly dementing spouse. *Ageing and Society, 11*, 443-469.

Poon, P., Hui, E., Dai, D., Kwok, T., & Woo, J. (2005). Cognitive intervention for community-dwelling older persons with memory problems: Telemedicine versus face-to-face treatment. *International Journal of Geriatric Psychiatry, 20*, 285-286.

Robinson, L., Hutchings, D., Corner, L., Beyer, F., Dickinson, H., Vanoli, A., et al. (2006). A systematic literature review of the effectiveness of non-pharmacological interventions to prevent wandering in dementia and evaluation of the ethical implications and acceptability of their use. *Health Technology Assessment, 10*, iii, ix-108.

Rowe, M. A. (1999). Intervening to prevent nighttime injuries in cognitively-impaired persons living at home: A case report. *Internet Journal of Advanced Nursing Practice, 3*(2). Retrieved May 25, 2007, from http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ijanp/vol3n2/night.xml

Sabat, S. R. (2001). *The experience of Alzheimer's disease: Life through a tangled veil.* Malden, MA: Blackwell.

Schreiber, M., Lutz, K., Schweizer, A., Kalveram, K. T., & Jäncke, L. (1998). Development and evaluation of an interactive computer-based training as a rehabilitation tool for dementia. *Psychologische Beiträge, 40*, 85-102.

Skjerve, A., Bjorvatn, B., & Holsten, F. (2004). Light therapy for behavioural and psychological symptoms of dementia. *International Journal of Geriatric Psychiatry, 19*, 516-522.

Smith, T. L., & Toseland, R. W. (2006). The effectiveness of a telephone support program for caregivers of frail older adults. *The Gerontologist, 46*, 620-629.

Smyth, K. A., Rose, J. H., McClendon, M. J., & Lambrix, M. A. (2007). Relationships among caregivers' demographic characteristics, social support ratings, and expectations of computer-mediated support groups. *Journal of Applied Gerontology, 26*, 58-77.

Tamura, T., Yonemitsu, S., Itoh, A., Oikawa, D., Kawakami, A., Higashi, Y., et al. (2004). Is an entertainment robot useful in the care of elderly people with severe dementia? *Journals of Gerontology: Series A: Biological Sciences and Medical Sciences,* 59A, 83-85.

Taylor, F. (2005). Care managers' views on assistive technology. *Journal of Dementia Care, 13*, 32-36.

Topo, P., Jylhä, M., & Laine, J. (2002). Can the telephone-using abilities of people with dementia be promoted? An evaluation of a simple-to-use telephone. *Technology and Disability, 14*, 3-13.

Topo, P., Mäki, O., Saarikalle, K., Clarke, N., Begley, E., Cahill, S., et al. (2004). Assessment of a music-based multimedia program for people with dementia. *Dementia, 3*, 331-350.

Topo, P., Saarikalle, K., Begley, E., Cahill, S., Holthe, T., & Macijauskiene, J. (2007). "I don't know about the past or the future, but today it's Friday"—Evaluation of a time aid for people with dementia. *Technology and Disability, 19*, 121-131.

van Hoof, J., & van Berlo, A. (2007). Home automation for persons with dementia and their carers. *Gerontechnology, 6*, 118-119.

Wang, W.-W., & Moyle, W. (2005). Physical restraint use of people with dementia: a review of the literature. *Australian Journal of Advanced Nursing, 22*, 46-52.

Wey, S. (2006). One size does not fit all: person-centred approaches to the use of assistive technology. In M. Marshall (Ed.), *Perspectives on rehabilitation and dementia* (pp. 202-208). London: Jessica Kingsley Publishers.

Winter, L., & Gitlin, L. N. (2006-2007). Evaluation of a telephone-based support group intervention for female caregivers of community-dwelling individuals with dementia. *American Journal of Alzheimer's Disease and Other Dementias, 21*, 391-397.
Wolden, H., Strand, G. V., & Gjellestad, A. (2006). Caregivers' perceptions of electric versus manual toothbrushes for the institutionalised elderly. *Gerodontology, 23*, 106-110.
World Economic and Social Survey 2007. (2007). *Development in an Ageing World.* New York: United Nations.

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