Assistive Technologies for People with Dementia: Personal Review

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Chapter 4 Low Tech Intervention: Assistance by Electronic Devices

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4.1 Assistance by Electronic Devices

Purpose of Assistance by Electronic Devices：To identify and review the latest research in the use of low and high technology in the areas of mild cognitive impairment and dementia. Navigation aids and computerized diaries assisted in maintaining independence in the normally ageing and mildly cognitively impaired. Benefits in this population with dementia included reductions in behavioral and psychological symptoms and carer's burden and increased independence, task engagement and safety (Westphal, Dingjan, & Attoe, 2010).

The idea of using computer technology to enhance the performance of cognitively disabled people dates back nearly forty years. Early aids included talking clocks, calendar systems, and similar devices that were not very technologically sophisticated;

yet many are still in use today (Pollack, 2002). The innate course of Alzheimer's disease is cognitive decline. This poses an additional concern for research and development as they continue to work toward solutions for a group whose situation may change on a daily basis (Willis & Price, 2014).

The overall objective of At Home with AT (Assistive Technology) wasto explore the potential of existing low-key technological devices whichare readily available. A range of devices available for purchase on the open market were identified from a wide variety of sources (Cash, 2004).

Augmentative and alternative communication (AAC), especially high-tech computer-based and speech-generating devices, is most often used by individuals with severe oral-motor or expressive language impairments and is rarely considered for persons with dementia who continue to speak well into the late stages of their disease (Bourgeois et al. 2010). People with mild to moderate dementia are capable of handling simple electronic equipment and can benefit from it (Lauriks, Reinersmann, van der Roest et al., 2010).

Review of Assistance by Electronic Devices：Older adults can be supported socially and emotionally through technology that helps alleviate the isolation. The preferred ICT solutions that person with dementias and carers brought with aids for reminding appointments, Electronic Memory Aids (EMA), Electronic calendar, and aids to find items. To enhance communication, simple photo phones, videophones or mobile phones were proposed and tested. Technological support for leisure activities was recommended by Sixsmith and Wherton, and amongst other things an activity guidance system with music and sung messages and a picture gramophone were tested. To enhance feelings of safety, several Global Positioning Systems were developed. Also, monitoring systems inside and outside the house were tested in which alarm messages are forwarded in case of potentially dangerous behavior of the person with dementia (Pollack, 2002).

Evaluation: The user driven or user-participatory design method is advocated to enhance the chances of developing an ICT device that is user-friendly and useful for the target group and will be accepted by users. It is therefore important that more studies are undertaken to evaluate the user-friendliness, usefulness and effects of ICT solutions in the target group. Not all ICT applications and services on today's market have been tested in advance or applied successfully for people with dementia. Although some untested systems could be beneficial to people with dementia or their carers, one cannot be sure of the efficacy of these systems (Lauriks, Reinersmann, van der Roest et al., 2010). Engström, Lindqvist, Ljunggren et al. (2016) studied relatives' opinions of IT support at a residential home for persons with dementia before and after. Relatives' opinions of IT support were generally positive

To assess whether verbal-instruction technology could help persons with mild and moderate Alzheimer's disease maintain their recaptured performance of daily activities, (i.e. table setting, coffee, tea or snack preparation, use of make-up and shaving). Most patients also showed mood improvement during activity. Verbal-instruction technology might be considered a critical tool to help persons with Alzheimer's disease enhance their activity and mood (Lancioni, Singh, O'Reilly et al., 2010).

Evaluation for ENABLE Project: Within the multi-national ENABLE project (enabling technologies for people with dementia) existing products were identified and their effectiveness to support memory, improve quality of life and reduce the carer burden was assessed. These assistive technologies were found to facilitate independent living and some devices may reduce anxiety in people with dementia as well as their informal carers. EMAs proved efficacious in stimulating memory in people with dementia (see review Grandmaison & Simard 2003). All in all, these studies show that persons with dementia are not only capable of handling electronic equipment, but also benefit in terms of more confidence and enhanced positive affect, thereby indirectly reducing the carer's perceived burden (Lauriks, Reinersmann, van der Roest et al., 2010).

For the health professional it often meant a device that would allow the person to remain safely at home for longer, for example the cooker monitor to ensure health and safety. Cares had to spend considerable time in locating items lost within the home. The locator required new learning, but some people with dementia were able to use it independently (ENABLE, 2004).

Greater success for the person with dementia was achieved with products that required the least interaction such as the night and day calendar, a device that can be plugged in and left alone. It was imperative to consult with the person using the device

about where and how to place a device within the home to ensure use. A medicine reminder was placed in the kitchen so that it would go off at times when the person would be having a meal. In other cases, two nights and day calendars were provided so that one could be placed in the bedroom to provide orientation at night, and also in the living room for the day time.

Some products such as the locator required a high level of interaction, whereas the other products required a lower level of new learning. If the motivation, attention or interest of the person with dementia was low or average there was a risk that he/she neglected the device, or did not remember why it was there. Co-habiting could create extra problems for the carer, not having time to relax, e.g. from repeated questions. The progression of the dementia itself was one of the reasons why a useful product was no longer used after a period of time. If the technology had been implemented earlier the person might have been more able learn and get used to the device. Ideally, one may think that all technologies should be provided free of charge.

Summary (Cash, 2004): Whether people with dementia can use devices, it depends on how early on in the dementia it is introduced. People with dementia should be supported in finding appropriately qualified people to install devices. Staff involved in installing devices in the homes of people with dementia should be given appropriate training to work in the homes of people with dementia.

At Home with AT was an innovative study that investigated the ability of low technological devices to provide support to people with dementia. Devices are readily available for purchase: can be used in the existing home of the person with dementia: do not require the installation of sophisticated computer equipment. Devices could be returned to a central distributing agency when no longer useful thereby ensuring their most effective use. The need for assistive technologies should be included as a part of the person's care plan.

Instrumental ICT support for coping with behavioral and psychological changes in dementia is relatively disregarded as yet, while support for social contact can be effectively realized through, for example, simplified (mobile) phones or videophones or (entertainment) robots. GPS technology and monitoring systems are proven to result in enhanced feelings of safety and less fear and anxiety.

Support for social contact and company is realized through simplified mobile phones or video phones, that have been reported to facilitate communication between people with dementia and their family or friends. Enhanced positive affect as well as increased activity and communication levels have been observed with computer software providing music or video memories or robotics, such as a toy dog or an entertainment robot.

Though successfully applied in a single study (Yasuda et al. 2006), instrumental ICT support for coping with behavioral and psychological symptoms in dementia is relatively disregarded as yet and the same holds for personalized information on the diagnosis, condition and personal care appointments (Lauriks et al. 2010).

4.2 Reminder

Review for Reminder: Electronic devices offer some distinct advantage over stationary memory aids. For example, alarms or chimes are available on many wristwatches. They can be used as a reminder for patients to carry out a regular task, such as taking medication or consulting a diary/notebook. However, they also have limited utility because patients frequently forget what the alarm signifies.

Desktop and laptop computers with a scheduling program are another form of electronic memory aid. Some scheduling cueing system can also automatically log the task completion information. Nevertheless, these aids are not easily portable. These devices are acceptable for use as compensatory aids by consumers with moderate to severe brain injury. Researchers agree on the usability of memory aids for persons with dementia, the importance of defining their own reminders and of giving them and their informal carer's control over the reminders (see Yasuda, Misu, Beckman et al.,; Yasuda, Beckman, Yoneda, Yoneda, et al., 2006; Lauriks et al., 2010; Bonne and Idris, 2012, as review).

Reminder Intervention by IC Recorder: Yasuda, Misu, Murasugi et al., (1999) developed an "Voice Output Memory Aid (VOMA)" which can generate previously-recorded spoken messages at programmed times. Eight separate messages could be repeated up to 128 times a day. With the VOMA, patients do not need to remember what the alarm signifies or to read the message

on a narrow display. Yasuda et al. (1999) applied this aid to assist the daily prospective tasks of two memory-impaired patients: one with the Alzheimer's dementia and one with thalamic infarction. The two people, who were automatically given instructions about going for a walk or making notes in their diary at the planned time. We noted a considerable increase in the completion rate for the cued tasks.

Automatic output of verbal messages was again attempted by Yasuda, Misu, Iwamotovet al., (2002b) for an individual with Alzheimer's disease by using a Sony IC recorder. The messages were aimed at dealing with several daily problematic behaviors such as going out alone, refusing to take bath etc. To remedy behavioral disorders such as wandering, The Sony IC recorder emitted the intermittent messages giving reasons why he should not go out (Yasuda *et al.*, 2002b). This intervention were thus able to reduce this man's wandering to a considerable extent and enhance his completion of daily tasks, such as taking medication. The messages were recorded by a speech therapist. The subject was far more willing to follow the instructions of specialists than those given spontaneously by her relatives. However, after the individual became accustomed to receiving the messages from the aid, he began to disregard them.

Yasuda et al., (2002a) evaluated the utility of an Sony IC Recorder as a voice output memory aid for patients with prospective memory impairment. The IC Recorder can output about 500 previously recorded messages at programmed times. The spoken messages prompted various daily tasks of eight patients with acquired memory impairments. One of these tasks such as diary writing, or a letter-writing drill was selected for each patient as a main task, and its completion was logged.

The Sony IC Recorder is small and light enough to fit into a shirt pocket. Two batteries usually need to be changed once every three or four months. The IC Recorder (IC Rec) has a total capacity of long recording time. The IC Rec can present the user with about 500 spoken message at the programmed times. Daily and weekly outputs are also possible. The message is loud enough to be clearly heard. The time of recording is automatically saved and is shown when searching for a message.

Patients who participated were four males and four females, with memory impairments ranging from moderate to severe memory impairments. The primary goal of this study was for eight patients to perform various daily tasks by responding to spoken messages provided by the IC Rec.

Case 4 *: A 56-year-old women showed a sudden prospective memory deficit and retrograde amnesia for the last several years. The MRI scan revealed the widespread neuro-pathological changes in both hemispheres including the thalamus. Her prospective memory deficits made it impossible to carry out her routine daily activities. A phase: the previously performed tasks were again picked up as the main task (the letter writing drill) and sub tasks. In spite of her promise, she could not carry out these tasks for three months. B phase: The IC Rec emitted the recorded messages. From the first day of the IC Rec intervention, she was able to carry out letter writing drills and other sub tasks six days a week. Her daughter was pleased and excited with the impact that the messages from the IC Rec had on her daily tasks. Second A phase: Three months latter, the IC Rec was withdrawn. Without the IC Rec the patient continued to perform the above tasks for a month. She gradually began to forget to do these tasks in the following two months. Total successful performance was reduced from 76% in the B phase to 34% in the second A phase.*

Dramatic improvement was observed in five of eight patients. this study provides additional evidence of the effectiveness of electronic memory aids. Teaching the use of memory aids, however, involves time and patience on the part of both therapist and patient (Wilson & Hughes, 1997a). It is important to note that little knowledge of the IC Rec was needed on the part of the patients who merely responded to the spoken message produced. Success with the IC Rec was achieved quickly with no enduring training.

In this study, the experimenter recorded all of messages for eight patients. Most caregivers thought that their voices were too familiar to the patients and might have hurt the patient's pride. They, therefore, insisted that the experimenter's voice would be more appropriate than that of caregivers. The Sony IC recorder is still on market (SonyICD-PX240).

New Devices and System for Reminder: ***PEAT*** was the marketed cognitive orthotic system that relies on automated planning technology. PEAT, which is marketed primarily to patients with traumatic brain injury, is deployed on a handheld device, and provides visible and audible clues about plan execution. PEAT maintains a detailed model of the client's plan and tracks its execution. Also, upon the addition of a new action. (Pollack, 2002).

Autominder's project is to develop a system that is flexible, adaptive, and responsive, and is thus more effective than a glorified alarm clock. To attain this goal, Autominder must maintain an accurate model of the client's daily plan, monitor its performance, and plan reminders accordingly. Consider, for instance, a forgetful, elderly person with urinary incontinence who is supposed to be reminded to use the toilet every three hours, and whose next reminder is scheduled for 11:00. Suppose that, using its on-board sensors, our robot Pearl observes the person enter the bathroom at 10:40, and conveys this information to Autominder. In this case, the client's plan must be adjusted, so that the next scheduled toileting occurs approximately three hours later, i.e., around 13:40. If the client's favorite television program is aired from 13:30 to 14:00, it might be better to issue the reminder at 13:25. (Pollack, 2002).

Memory Glasses is a context-aware memory aid that is embedded in glasses. The goal of the system is to deliver reminders to the wearer in a timely, situation-appropriate way, without requiring intervention on the part of the wearer. This system is different from passive reminder systems, which cannot know the user's activity context. Memory glasses leverages a variety of computer perception techniques, based in part on captured visual images, which permit context awareness. The accuracy of context-awareness when delivering a prompt is important since distraction at the wrong time (e.g., crossing the street or driving a car) could be life-threatening. In addition to Mild Cognitive Impairment, mild Alzheimer disease, and other dementias, this device is expected to be helpful in cueing memory for names (anomia) and faces (prosopagnosia) (Bharucha et al., 2008).

4.3 Assistance by other Electronic Devices

Medication reminder box (Cash, 2004): Several techniques and interventions have been used to help increase medication taking including social support, education about the impact of adherence, improved design of medication labels and instructions, and various prospective reminding devices. Medication reminder box range from low-tech solutions, such as plastic boxes divided into sections labelled by times and day, to electronic devices that have various levels of sophistication. The compartments have spaces for a number of different tablets.***Medicine Reminder box with alarm*** contains all the medicine for one week and is filled by a carer (ENABLE, 2004). When it is time for the person with dementia to take a tablet, the carousel gives an audible signal and goes on doing so every minute for half and hour until the tablet is taken out.

The more complex are systems that dispense the drugs at the correct time and sound an alarm if the drugs are not taken within a given length of time. The user is required to push a button on the device to indicate when the medication has been taken successfully (Alzheimer's society, 2015). It also requires someone to dispense the medication in the correct doses into the reminder. In some cases a carer performed these tasks. If a carer was unable to undertake these tasks, it required the support of a pharmacist. The device is battery operated and it requires someone to take responsibility for changing the batteries.

If you have a tablet device, you can use functions such as reminders. There are other applications (APP) on Computer or tablet device: that you can download from the internet. For example, you could use a medication reminder app to remind you when to take your pills, and which medicine to take (Alzheimer's society, 2015).

Existing automated reminding systems are sometimes ineffective because they do not take into consideration the user's context when making decisions regarding how and when to provide reminders. ***Intelligent assistive technology and systems lab (2005)*** will be able to determine user-specific information and characteristics in order to provide reminders that are more appropriate for that particular person's preferences and habits. 1) The system will provide various types of reminders, such as pre-recorded verbal messages. These prompts will be customized for each user; e.g. use of first or last names in the prompts etc. 2) The system will be able to automatically determine where in the home the person is located and provide reminders in that location. 3) The system will be able to automatically determine if the person has taken the medication. 4) If the person does not respond to the issued reminders by the system within an appropriate time frame, the system will provide this feedback to an external source, such as a neighbor or family member.

Locator for lost Items: People with dementia often forget where they have put things like keys, spectacles or their purse. Their carers can spend a great deal of time searching for such objects and can find this very irritating. It can also lead to accusations of theft by the person with dementia against carers (ENABLE, 2004). ***Locator Device*** has four color-coded buttons each of which has space for a picture or the name of the object to be located (Cash, 2004). Four tags whose colors correspond with

the buttons on the locator unit can be attached to items by means of akey ring. When the user touches a button, it initiates a bleeping sound from the tag attached to the misplaced item. If the user lives alone, they have to understand how to operate the device. The most commonly tagged items were keys, handbags, wallet, remote controller, hearing aids etc.

With ultra-small sticker with Bluetooth, user stick on any device, person or animal, and find them with your Smart Phone. ***StickNFind*** (2012) is only 4.1mm thin. That means user stick it on your keys, TV remote, kids, cat, dog, iPod, phone, tablet, wallet, purse, passport, laptop, backpack, suitcase. Stick-N-Find Stickers have a range of about 100 feet. The radar Screen will display all user's devices in a radar type Screen. User start walking in a specific direction and see if it gets closer or farther.

Then we have the Virtual leash feature. This allows user to create a virtual Leash on a sticker, if that sticker moves away more than the selected distance from user's phone, user's phone will alarm you. User can also create a Reverse Virtual Leash: User put a Sticker on user's keys etc. if you forget user's phone behind, the sticker on keys will buzz.

Shinnishi, Iga, Higuchi et al. (2005) proposed a novel concept of ID tag called "***Hide and Seek"***. Hide and Seek is a small interface device which can be attached to books, physical real artifacts and so on. When a user calls the name of a physical artifact to voice recognition system, Hide and Seek responds to the user by sound. The device changes the generated sound with the distance between the user and the device. Searching an object in office or home is time-consuming even if they are organized and stored in boxes with proper labels. Nakagawa, Tsukada, & Siio (2008) proposes ease-of-use technique to create picture database about contents of boxes, and to browse them through network. They have implemented a system to easily take pictures inside boxes and identify them using an RFID reader and tags that are attached to the boxes.

Monitoring Systems for Safe (Lauriks et al., 2010): Implementing monitoring technologies and detection devices or alarm systems inside and outside the home of elderly persons is potentially useful to enhance safety and security of the person suffering from dementia as well as carers. GPS technology for tracking wandering or lost persons as well as monitoring systems to detect fire or gas leakage or signal night-time activity allow for unobtrusive yet efficient assessments of safety. A fully automatic multi-sensor system composed of Infra Red (IR) sensors connected to a personal computer installed in a patient's room was evaluated by Chan et al. (2002). This smart tool system proved valid in assessing and recording data on activities such as getting out of bed, mobility and travel patterns of a psychotic patient with moderate cognitive decline and behavioral disorders.

By fusing data from a network of heterogeneous sensors and applying artificial intelligence, these systems not only improve activity and behavioral recognition above and beyond the capacity of unimodal sensors, but also advance the level of sophistication of the supervision, guidance, and feedback provided to their users (Bharucha et al., 2008).

CareWatch consists of a security system control panel, wireless receiver, and motion, door opening and bed occupancy sensors to alert the caregiver of both emergency and non-urgent situations through customizable text or voice alarms. The investigators plan to measure the family caregiver's sleep, daytime fatigue, mood, burden, and depression.

CareMedia leverages fundamental advances in video image processing to track and analyze the activities and behaviors of nursing home dementia unit residents. Specifically, the project attempts to capture in real-time, continuously video/audio data that were processed to identify normative behavior, and aberrant low frequency, high impact behaviors such as falls, physical, and verbal aggression. A feasibility study involving four ceiling mounted video cameras and microphones in then on private spaces of a locked dementia unit. (Bharucha et al., 2008).

Social safety alarm systems usually is activated by neck or wrist-worn pendants, and is able to monitor a wide variety of activities and situations via additional sensors. Normally, any alert is picked up by a monitoring center that contacts the resident, family, carers, mobile wardens or emergency services, depending on the seriousness of the situation. Telecare equipment such as a pendant is sometimes viewed as a 'badge of vulnerability (Bonner & Idris, 2012). Tele health refers to remote monitoring of a person's vital signs. Readings are transmitted to an appropriately trained person who can interpret the health readings and make decisions about potential interventions in real time, without the patient needing to attend a clinic.

Fall-Detection System (Bharucha et al., 2008): The Smart Inactivity Monitor using ***Array-Based Detectors Project*** deploys wall-mounted low-cost, array based passive infrared sensors to detect inactivity and falls. Although it does not require the individual

to wear or activate a device, falls were accurately detected. In contrast, the University of Virginia is developing ***a piezo sensor-based system*** that records floor vibration patterns. Neither system has been deployed in real world residential settings with dementia subjects.

A pilot study evaluated the efficacy and performance of a fall-detection system that uses a ceiling-mounted video camera. The system can only track one person at a time. The investigators are now linking this fall-detection system with a community emergency response team and experimenting with artificial intelligence techniques to determine what level of assistance a fallen person may require in various scenarios.

Sleep Monitoring (Bharucha et al., 2008): Continuous telemetric monitoring is tested for an active social alarm system of the user's activity. Results of these studies support the use of telemetric actgraphy in long-term screening and follow-up of elderly subjects for sleep and circadian rhythm-related problems associated with dementia and changes in functional capacity.

Wandering Monitoring: The step watchs particularly are able to assess amount and daily course of wandering behavior in people with dementia. In this context, Boundary alarms (activated by a wristband) or electronic tagging with bracelets and monitoring stations were found to be effective, reliable and successful in detecting wandering. A bedside monitoring system tested in a hospital setting with patients with dementia who frequently wandered during the night, additionally provides floor lighting upon wandering detection and relays an alarm to a personal handheld device alerting the carer to the situation (Lauriks et al., 2010).

We wish to look at genuine alternatives to restricting the movements of those with dementia, such as locking doors, making a door difficult to open, or using floor patterns/color schemes which would discourage crossing a threshold. This is unnecessary when suitable devices, such as technological systems could be used. Technological systems in which GSM is combined with GPS (Global Positioning Satellite), could be a solution to the problems encountered by getting lost and wandering behavior (Rasquin, Willems, de Vlieger et al., 2007).

The person with dementia is recommended to carries the mobile phone when leaving the house. If a carer or relative needs to know his or her whereabouts, a 24-h control center can be called. By getting the coordinates of the phone they can pinpoint the person's location with an accuracy of 5 m. The computer generates a map of the area, and then automatically sends this map via email to the carer who can view it on a mobile phone ((Lauriks et al., 2010).

There may be an over-emphasis on these risks and their costs, at the expense of consideration of the autonomy of people with dementia. A further GPS device was tested, suggesting it is promising for supporting people with early stage dementia in terms of facilitating more freedom to go out (Bowes, Dawson, & Greasley-Adams, 2013). It is also important to recognize that wandering can serve to keep the person physically active and allow them to express needs or emotions that they otherwise might not be able to communicate (Peterson, Prasad, & Prasad, 2012).

iWander is a device that collects GPS and other sensor data about location, weather conditions, stage of illness, etc. This data is then evaluated using Bayesian network techniques to determine the probability the person is wandering. Although the experimental results showed its effectiveness in detecting wandering behavior, GPS cannot prevent the person from going outside in the first place (Oshima, Yasuda, Machishima et al (2015).

Wandering Prevention: A number of different door alarms were identified. The one trial was a wire free PIR contact door alarm with a portable alarm unit. This device requires someone to attach contact switches to the door and door frame. A wire free door alarm, contacts fitted on a door send a signal to an alarm unit when the door is opened (Cash, 2004). ***Electronic keys and door sensors*** can accommodate for entry and exit of the home and fall detectors can alert caregivers or emergency personnel when an incident occurs (Peterson, Prasad, & Prasad, 2012).

Yasuda et al. (2002b) dealt with the above behavioral disturbances using verbal messages delivered by a Sony IC recorder. The automatic verbal messages presented information to him, for example, "Dog-walking has already finished. You do not need to go out with the dog". These messages were automatically output about 20 times a day. His leaving home has ceased.

In case of an emergency, the person with dementia can activate an emergency button which sends a message to the call center

where the situation, location and geographical information and location coordinates are analyzed and relayed to care providers, search teams and family members. This system was expected to be beneficial in helping locate elderly people with dementia (Lauriks et al., 2010).

The Intelligent Mobility Platform is a walker-based device that uses a laser beam range-finder, a handheld computer with a touch-screen interface, and a navigation software to orient a person in the proper direction using a red arrow. ***Opportunity Knocksis*** is a cell phone-embedded device using Global Position Sensor chip and Bluetooth that learns the individual's standard routes in the community. It alerts the person of a navigational error by making a knocking sound and subsequently recalculating the proper route. ***Activity Compass*** is another Global Position Sensor-based system that accomplishes much the same as Opportunity Knocks. None of these systems is commercially available, and all wait rigorous clinical testing in applicable populations (Bharucha et al., 2008).

Reminder at special location : ***The Memo Minder*** is a message recorder/player. A message of up to 20 seconds in length can be recorded onto a circuit board. The message is triggered by a passive infra-red motion detector whenever anyone moves within a range of 5 meters. The following reminders were recorded; *To remember to lock the door and take the keys with them when they were going out, Not to go out during the night, To wait until home care arrived, To indicate whether it was a day to attend the day center*. It is important to locate the device in a position where the message can be activated by the movement of the user (Cash, 2004). Several devices of this type are commercially available. ***Motionsensor*** goes near a door and senses movement nearby. User can set it to play a voice message as a prompt when you approach. One placed by the phone could remind you to check that callers are not bogus, or you could have one near the kitchen door to remind you to check you have switched the oven off (Alzheimer's society, 2015). In order to guide one person who was no longer able to find the toilet at night, Yasuda (2007) fitted a similar device near the bedroom door which played the message, *"The toilet is on the right"*.

Special Watch and Calendar: Some people with dementia do not know whether it is night or day, and may go out or phone relatives in the middle of the night. Carers are also often stressed by frequent questions as to what day or time it is. The ***Night-and-Day Calendar*** has a display, which shows the day, the date and 'Morning', 'Afternoon', 'Evening' and 'Night'. At midnight, the day and date change automatically. Similarly, the sign shifts from 'Morning' to 'Afternoon' and so on, at set times **(**ENABLE, 2004).

Forget-Me-Not device could be useful for persons who are confused about day and date. Beneficial effects of computer systems on orientation, feelings of anxiety and independency was observed in a patient suffering from Alzheimer's disease. Computer screens in the bedroom and living room reduced the needed support and the number of nighttime calls to the informal carer (Lauriks et al., 2010).

Alarm Clock and Timer: An alarm clock is a watch with an alarm, or a kitchen timer to remind you when you need to leave the house for an appointment, or when you have to check something cooking in the oven. Write down on a piece of paper nearby why you have set the alarm, so you know why it is going off (Alzheimer's society, 2015).

For people who forget tasks to be performed within ten or twenty minutes, it might be useful for them to wear a timer around their neck. These people often have difficulty remembering why the timer has gone off, so a pencil and a small notepad can be attached to the back of the timer listing the tasks to be carried out. They can then carry out a program of household tasks regulated by the audible timers. One person with mild dementia used to place timers at strategic points around the house, such as the refrigerator, the cooker and the bathroom (Yasuda, 2007).

Devices for frequent question: Carers are also often stressed by frequent questions as to what day or time it is. This can be very irritating and have a negative effect on the relationship between the carer and the person with dementia **(**ENABLE, 2004). There have been few reports on patients with dementia using electronic devices to assist them in following daily schedules. Yasuda (2007) attempted to evaluate the use of an IC Recorder and Lingo for voice output to a patient with Alzheimer's disease.

Yasuda (2007) also developed ***Voice alarm linked to a touch sensor.*** Certain people have to have catheters in their stomach, nose, urethra, *etc*. Some of them forget why these Catheters are there and try to pull them out. He conducted a trial where one such

person was given a device equipped with a voice alarm linked to a sensor which generated a message whenever the catheter was touched. This system proved to be partially effective.

Other Devices: ***Gait analysis*** employs motion sensors and accelerometers can predict falls before they occur. ***Automated shut-off devices*** for cooking appliances or ***water isolation devices*** in the event of a tap being left running. Many devices can be linked to the telecare which can be used to summon assistance in the event of an alarm being raised. This may include a ***fire or flood alert***, a notification of a fall, an alert when they fail to get out of bed in the morning, or perhaps sending an alarm when a person leaves the house at an unusual time of the day/night. Bath plug that prevents flooding by letting excess water out of the bath. Bath water level and temperature monitor and controller. ***Flood Prevention*** automatically turns off taps if water level reaches a certain level, and keeps temperature within certain limits. ***Refrigerators*** can monitor weight in the contents to evaluate if food is being eaten regularly and ***water taps*** can register how often the tap is used (see Peterson, Prasad, & Prasad, 2012; Bonner & Idris, 2012 as review).

4.4 Assistance by Cell-phone, and Smart Phone

Memory problems may mean that people with dementia can forget well-known numbers and/or how to look them up. This is a particular difficulty when the person with dementia lives alone.

Phone: A ***pre-programmable telephone*** (calls initiated by just pressing one large button containing a name or photo). Trials among people with mild to moderate dementia indicate that these assistive technologies can enhance well-being by giving positive experiences and reduce anxiety in people with dementia and their informal carers (Lauriks et al., 2010). A ***picture telephone*** had nine large pre-programmable keys, to which a photograph or the name of a person couldbe added. This allows the person to dial a number by pressing one key and eliminates the need to remember a string of numbers. A similar telephone was located but the pre-programmable buttons on thistelephone only had space for a name to be written by the side ofthem. The person with dementia needs to be able to recognize the names written by the side of the buttons in order to identify the correct button to push (Cash, 2004).

The aim of Poon, Hui, Dai, Kwok, Woo (2005)'s project is to examine and compare the feasibility, acceptability for older patients using telemedicine versus a conventional face-to-face method. There was significant and comparable cognitive improvement in clients in both treatment arms. The videoconference arm was highly accepted by the clients and the community center.

People with mild dementia are able to learn how to use a mobile phone with an "errorless learning" method (Clare et al. 2000). The "Mobile Tele coach", a one-button mobile phone which allows direct answering, had an effect on positive social experiences and self-esteem in people with dementia (Lauriks et al., 2010). The FP4 project ***MORE*** was aimed at redesigning existing mobile phones and simplifying the user interface to meet the many differing needs of elderly and disabled people. Various MORE-based telephones with an integral GPS function were produced by Benefon (Lauriks et al., 2010).

Yasuda (2007) proposed the following ideas. A simplified model intended for use by the elderly can be used as a memory aid, rather than as a means of telecommunication. ***Memo pad attached to the mobile phone*****:** a small notepad can be glued to the back of the phone and a pencil attached to it by a strap. This allows subjects to jot down the names of people they meet. ***Recorder*****:** this function can be used to record the user's own voice or those of people talking to him, and these can then be played back to check exactly what has been said. For example, users can ask their doctors to record their explanations during consultations. ***Programmable voice alarm*****:** as with a Sony IC recorder, recorded messages can be automatically output at programmed times and photos displayed simultaneously on the screen. For example, when the doctor's voice says, *"Take your tablets"*. ***Timer*****:** some mobile phone models have an in-built timer. For example, if a dish needs to cook for 20 minutes, the timer can be set for 20 minutes. ***Address book*****:** with age, it becomes increasingly difficult to learn and retain names. To overcome this problem, a number of different categories of names can created (work, friends, hobbies, *etc*.) and people's names classified accordingly. When someone cannot remember the name of the person he or she is talking to, one solution is to pretend to receive a phone call and

search for the person's name in the address book. ***Portraits*****:** sometimes, a person's face is more easily remembered than his or her name. Therefore, it may be useful for subjects with a memory disorder to ask the person with whom they are talking to let them take a photo with their mobile phone. ***Video***: They can also make a video and thus keep a record of the latter's voice and facial expressions. This avoids having to record his or her name. ***Photos of storage places*****:** When they leave an object somewhere, they should therefore take a photo of it, showing the place where it has been put. That way, when they can no longer remember where it is, they have only to look at the photo. ***GPS*****:** If they carry one around with them, they can be located using GPS from another mobile phone. This is why it is so important for them to familiarize themselves with mobile phones from the very outset. They may also forget to take it with them or recharge it. The "Programmable voice alarm" function should therefore be activated, so that it automatically reminds them every day to *"Take your mobile phone with you"*.

PEAT™ software is designed to provide cueing and planning assistance for people with memory, attention, and cognitive disorders. Typical users include patients with traumatic brain injury (TBI), neurodegenerative conditions including Alzheimer's disease, and attention deficit and hyperactivity disorder (ADHD). PEAT lets people become more independent by helping them to plan and execute daily activities, and to stay on schedule. It is also important that users carry a mobile version so that they can add and modify their calendar, names and notes throughout the day. PEAT automatically cues the user with sounds and pictures, monitors task performance and adjusts the schedule whenever delays, interruptions or other calendar changes occur. Automatic Cue Card uses graphics and sounds to remind users when to start and stop tasks on schedule and within deadlines. Automatic rescheduling whenever tasks are added, rescheduled, interrupted, or canceled.

Prospective Memory Aids reviewed below are context-aware and use artificial intelligence to determine whether and when an appropriate reminder or procedural is necessary for task execution. They are programmed either to improve performance of multiple different tasks throughout day (***Memory Glasses***, ***Memo Clip***, ***Friedman***) or a sequence of steps in either single or multiple tasks (***ISAAC***, ***AutoMinder***, ***Friedman***). However, clinical trials specifically with dementia subjects are lacking for all of them (Bharucha et al., 2008).

Some studies are targeting life-logging aspect for the elderly, such as the ***HERMES*** project. The key services are reminding the user of what happened in the recent past, helping users to manage their daily schedule, and offering a series of exercises to strengthen the user's memory. The HERMES project aims to boost existing memories, while ***Memory Lane*** proposes a solution for building lasting episodic memories, and to recall past activities for maintaining those memories (Hallberg, Kikhia, Bengtsson, Sävenstedt, & Synnes, 2010).

4.5 Researches for Future Assistance

The ***MAPS*** project is focusing on the HCI issues involved in building a hand held cognitive orthotic. The Independent Life Style Assistant Project (***ILSA***) is another recent related effort. There are a lot of projects as follows; Research Projects and Programs, MIT research Affective Computing, The Remembrance Agent, The Personal Area Network, Wearable Audio Computing, Columbia Mobile Computing Laboratory, Georgia Tech wearables, University of Toronto Humanistic Intelligence Lab, U. Washington HIT Labs guide to wearable computer literature, MoBIC: Mobility of Blind and Elderly People Interacting with Computers University of Magdeburg project, WebABLE "First-Stop-Shop" for people with disabilities (Pollack, 2002).

Sense Cam is a wearable digital camera that is designed to take photographs passively while it is being worn. It is fitted with a wide-angle (fisheye) lens, thus ensuring that nearly everything in the wearer's view is captured by the camera. Sense Cam records events as they happen, requires little effort on part of the user, is thought to lead to consolidation of autobiographical memory (Bharucha et al., 2008). Carnegie Mellon University Quality of Life Technology Center is developing a product called the ***MemeXerciser***. This product is a Life-logging technology which provides memory support to AD patients by capturing life experiences via sensors or cameras. Their research is based on the product SenseCam (Willis & Price, 2014).

Yasuda et al. (2003) have produced a system where they wear a CCD small camera under the peak of their cap. This is linked to a digital video recorder kept in a pouch on their belt. With this equipment, they can record the speech noises and scenes around

them, the faces and voices of the people they talk to, and what they are holding or reading. Prior to the test, five objects were placed in four different rooms. We then instructed one of the subjects to find the objects while playing and viewing the video. It took the subject 7.54 minutes to find them all, whereas it took 29 minutes to find only one item, for onother subject while not viewing the video (Yasuda, 2007).

Foo, Pang, & Zhang (2014) developed ***UbiCuts*** system. It consists of a wearable image/video/voice capturing device and a suite of mobile apps. To use the device, older adults need to open the app, send a voice message or take a photo/video using the wearable device or a smartphone. The first prototype of the wearable image-capturing device is in the shape of a bracelet that supports the capture of images but not videos. The second prototype will be able to capture images, video and voice, and the "Surveillance" app will be able to monitor both indoor and outdoor safety of older adults and the disabled. The image matching simply requires mere pattern recognition.

An ***adaptive prompter*** for people with Alzheimer's disease will use ubiquitous sensors to monitor the performance of routine tasks, and provide prompts when a client gets "stuck". For instance, a sensor in the bathroom might notice that a person with A.D. has picked up a toothbrush but then stopped; in response, the adaptive prompter would provide guidance to the person about putting toothpaste on the brush and using it to brush his or her teeth (Pollack, 2002).

A prototype ***agitation monitoring system*** for persons with dementia illustrates the ability of multiple simple environmental sensors. The investigators instrumented a laboratory with acoustic, pressure and ultrasound sensors to detect movements of a single experimental subject. The intensity and duration of the movements were rated according to the total body movements and up and down movements' subscales of the scale to observe agitation in persons with dementia of the Alzheimer type. The ultrasonic and pressure sensors alone detected agitation in 59% and 73% of instances, respectively. This prototype system demonstrates the application of multiple inexpensive sensors to tackle a specific clinical problem (Bharucha et al., 2008).

Fabrics with embedded biosensors have now been developed that permit continuous remote physiologic monitoring of multiple vital functions. These "***smart garments***" are capable of alerting family and professional caregivers of aberrations and incident medical conditions that may otherwise escape detection until complications are evident and unavoidable. A large-scale field trial has only recently been launched for one of these bio textile-based systems (***Smart Shirt***). These include light weight, capacity to embed biosensors in inconspicuous everyday clothing, resistance of these biosensor fibers to physiologic functions such as sweating, ease of laundering, and lack of discomfort or potential for allergic skin reactions (Bharucha et al., 2008).

The ***eHealth Strategic Objective*** is aiming to create an intelligent environment. The focus is on key technologies, such as biosensors and secure communications in smart clothes and implants, as well as software tools for monitoring and managing health status and patient safety. Such technologies are not yet being applied and validated for persons with dementia (Lauriks et al., 2010).

There were no mentions of computer chips which could be implanted in the brain which would remind it to breathe, eat, eliminate, or other bodily functions. It is really no different than an artificial heart valve or a bionic arm or leg. The literature all agreed on the basic types of assistance, which was to record memories and play them back or ensure the safety of the AD patient. Could a memory chip be implanted in the brain which would allow the AD patient to keep the memory of themselves alive? (Willis & Price, 2014).

The fear of all people facing Alzheimer's disease is not just losing who their family is, but in losing themselves. Social media could assist in keeping the AD patient in touch with other people and help with facial recognition of those people using the profile picture and making a game of matching names and faces. A personal website with pictures uploaded of family, friends and the AD patient at different stages of their life could assist in keeping memory alive (Willis & Price, (2014).

4.6 Summary

People with dementia are ideal nominees for benefitting from context-aware technologies and, from an engineering stand point, they are an ideal challenge to design for. The best, currently known method to intuitively and seamlessly change and adapt the environment to the fluctuations of the user is through technologies associated with Ambient Assisted Living (Peterson, Prasad, & Prasad, 2012).

There is a gap between what individuals with dementia want, what developers design, and how outcomes are evaluated. Despite widespread acceptance that ATs improve quality of living (QOL), there is relatively little data to support such claims. The results shows the need for future ATs to be more integrated into the environment, combined with ambient and intelligent technologies, the Internet of Things (IOT), and the potential of cloud computing. They will also become more personalized to individual needs and user requirements (Peterson, Prasad, & Prasad, 2012).

Some of the standard high-tech ATs consist of following modalities (Peterson, Prasad, & Prasad, 2012). ***Communication*** (e.g. e-mail, real-time alarms, telecare and medical networks, social support networking). ***Robotics*** can perform household maintenance (e.g. vacuum), as a butler (e.g. assistance with bathing or eating) or companionship activities. ***Home automation*** technologies could monitor and ensure home safety features (e.g. fire and smoke alarms, ventilation, sensors for water temperature, power control). ***Sensors*** for monitoring, initiating alarms and data collection (e.g. motion detection, PIR, water usage, thermostats), and computer-vision (e.g. user recognition, motion analysis). Radio Frequency Identification (***RFID***) technology is used to locate items in the home and GPS/GSM for navigation or locating the person outside the home.

The technology will also become more personalized to individual needs and user requirements and social and health care services will have streamlined electronic records and communication.

Homes in general will have more electronic features, such as keys, window and door locks and sensors. Gait sensors and accelerometers will not only be able to predict falls, but to determine the physiological root and recommend training or rehabilitation. Context-aware systems have the capacity to be cognizant of environmental activities and characteristics through networked equipment, such as mobile, pervasive and ubiquitous computing components (Peterson, Prasad, & Prasad, 2012).

Cloud Computing will play in connecting the Internet of Things for the future of dementia care (Peterson, Prasad, & Prasad, 2012). Furthermore, there is potential for communities (Smart Cities) to play a role in the future of living with dementia by connecting the user and their devices (Internet of Things) to services through Cloud Computing. Of course, there are major issues in data storage, system integrity, privacy and security, networked architecture and service provision, but it is worth starting a dialogue on these issues and setting forward-thinking, goal-directed research ambitions for the future of dementia care. We can imagine what the future holds, now we need to create it (Peterson, Prasad, & Prasad, 2012).

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