Technology Devices for Eldercare

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Abstract: The discourse of this paper is to examine some of the various devices used for Eldercare. In the literature, there exist assistive devices, assistive technology devices, smart homes projects and systems that cater for older people. These can be used to enhance graceful aging and sound health to solve the problem of the elderly living productive, fulfilled and longer lives. The process of rehabilitation is also important and these devices play a major role in prolonging life. Health Buddy and AlereNet systems are useful in heart failure management. A unique smart home facility, TigerPlace, utilizes university staff and students for Eldercare. The role of technologies in the ultimate care of the elderly is very important and will continue to be in the limelight in the future.

1 INTRODUCTION

The main aim of secure and healthy people is to increase their lifespan with emphasis on health and not just longevity. It is also important to close the gaps in health status and health outcome and achieve access to preventive services for various age groups (Fajemilehin, 2009).

Mankind are living longer and more fulfilled lives and they desire to live as independently as possible. But inherent health risks are associated with independent lifestyles. To address these issues, researchers are developing Assistive Technology Devices (ATDs) and smart homes technologies to help older adults (elders 60 years and above) remain independent at home or elsewhere while controlling costs.

The aim of this paper is to discuss some key health terms, some of the assistive devices, ATDs, eldercare technology projects and eldercare technology systems and how they promote Eldercare in various parts of the world.

2 OPERATIONAL DEFINITION OF TERMS

In this section, the operational definition of terms used herein is provided. The terms that are discussed are health, caring, Eldercare, assistive devices (AD),

assistive technology devices (ATDs) and smart homes. Defining these terms will provide a better understanding to what this research is all about in promoting eldercare.

"Health", as defined by the Oxford Advanced Learner's Dictionary, is the condition of a person's body or mind. Health may be defined as the absence of disease. However, health is defined in the World Health Organization (WHO) constitution as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. The adage "health is wealth!" is important and is essential to the well-being of mankind and especially the elderly. The Oxford Advanced Learner's Dictionary defines "caring" as kind, helpful and showing that you care about other people. From a nursing perceptive, caring can be referred to as the level of emotional involvement between the care givers and the client through seeking the client out, spending quality time with him, providing emotional support or ensuring manipulative therapeutic actions (Fajemilehin, 1999). Caring is essential for the elderly as they advance in age.

Eldercare is the care of the elderly who are unable to look after themselves. Eldercare refers to how governments, social service organizations and even individuals and families are turning to technology solutions to aid in care for the elderly.

An assistive device is any device that helps someone to do something that they might not otherwise be able to do well or at all. This term is

used for devices that help people overcome a handicap such as mobility, vision, mental, hand skills or hearing loss. The elderly make up the world's largest group of AD users (Garcon *et al.*, 2016).

Assistive Technology Device (ATD) are any item, piece of equipment, or product system whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain or improve functional capacities of an individual with a disability. The majority of these devices are used in Eldercare or care of senior citizens.

Smart homes as homes equipped with lighting, heating and electronic devices that can be remotely controlled by a smart phone or a computer. These devices and technologies that are discussed enhance restoring someone to health or normal lives.

Table 1: Examples of Assistive Devices per Area of Functioning and Environment.

Area	Examples of Assistive Devices
Mobility	Walking stick, crutch, walking frame, manual and powered wheelchair, tricycle
	Artificial leg or hand, caliper, hand splint, drop foot brace
	Chair leg extenders, special seat, standing frame
	Adapted cutlery and cooking utensil, dressing stick, shower seat, toilet seat, toilet frame, feeding robot, pickup stick, book stand, grip tool, nonslip pad, trolley
Vision	Eyeglasses, magnifier, magnifying software for computer
	White cane, GPS-based navigation device
	Braille system for reading and writing, screen reader for computer, talking book player, audio recorder and player
	Headphone, hearing aid
	Amplified telephone
Speech	Communication cards with texts, communication board with letters
	Electronic communication device with recorded or synthetic speech
Mental	Task list, picture schedule and calendar, picture-based instruction
	Timer, manual or automatic reminder, smart phone with adapted task list, schedule, calendar, and audio recorder
	Communication board with symbols or pictures, screen reader for computer
	Stove guard, automatic night light, smart home system
Environment	Ramp, wide door, handle, accessible toilet and bathroom
	Tactile map, Braille buttons
	Hearing loop
	Simple signs

Source: Garcon *et al.*, (2016)

Table 2: Top 12 Best Assistive Devices for the Elderly.

Model	Brand	Purpose
Rotating Reacher Grabber	Vive	Used if one suffers from back pain, knee, or hip pain when bending or reaching.
Medical Alert System	Touch "N Talk	Used if falls or accidents occur to contact loved ones or emergency services.
Universal Stand Assist	Able Life	Used to get out of low chairs or sofas.
Bed Ladder Assist	Vive	Used for sitting up in bed or getting out of bed.
Leg Lifter Strap	Vive	Used to reposition weak or injured legs.
Sock Assist	Vive	Used for injury or limited mobility
Bottom buddy	Vive	Used for back and joint pain and helps in the bathroom.
Dressing Stick	Vive	Used after knee or hip surgery or for back pain or arthritis.
Button Hook	Vive	Used if arthritis disallows doing up buttons.
Handy bar	Stander	Used to help with standing and sitting. Includes seat-belt, cutter and window breaker.
Bed Safety Rail	Vive	Used to provide peace of mind when sleeping and helps one get out of bed.
Foam Tubing	Vive	Used for poor dexterity and helps in gripping items.

Source: (vivehealth.com/blogs/resources/assistive-devices-for-elderly).

3 ASSISTIVE DEVICES

Research indicates five major areas of functioning and the environment in which ADs provide essential support for older adults (WHO, 2014). Examples of each major area and ADS that aid rehabilitation and activities of daily living are provided in Table 1.

Some of the best assistive devices for elderly adults which have been adjudged the top twelve devices by Vive Health are given in Table 2. The model of these devices, their brand and the purpose of their use are given in the table.

4 ASSISTIVE TECHNOLOGY DEVICES

Miskelly (2001) indicated a variety of assistive technology devices that can be used for the elderly care. For example, the community alarms have been available in the United Kingdom for almost 60 years. They are used to alert the warden who is able to respond to calls of the tenant. If the warden is offsite, the alarm sends a message to the telephone system which will alert appropriate authorities of the mishap that has taken place. Other ATDs are also discussed along with some of the top technology devices as given by Orlov (2012). Price (2017) also indicated some ATDs for home-based elders from TELETASK which is a home automation system. A few of these will be discussed in this section.

4.1 Video-monitoring

Developments in communication processor design, network protocols, video and audio compression algorithms can provide colour audio-video communications in real-time. It makes use of ordinary telephone lines or smart phones or other devices.

An example of the video-monitoring device is the GrandCare System. This system logs into the device website to send communications to their loved ones, view activity and tele-wellness sensor information and customize caregiver alerts to their clients. Family members can send messages, pictures, emails and reminders, play games, listen to music, watch family videos or films, view news and weather reports on the GrandCare system. This system can be seen in Figure 1.

Also the Claris Companion is a tablet computer, digital picture frame, mobile phone and remote monitoring system all-in-one. It can be used to make

video calls, reply to emails and SMS messages, browse the web and play videos. It can also provide medication reminders according to Price (2017).

Figure 1: The GrandCare System (Source: Orlov, 2012).

Telkin is also one of the top ten technology devices for the elderly. It is a easy-to-use family computer that combines video chat, photo sharing, email facility and other features into a sleek, touch screen device (Orlov, 2012).

4.2 Health Monitor/Movement Detector

Some health monitors are the same size and shape of a wrist watch and are worn on the wrist. They monitor pulse, skin temperature and movement of the individual. These devices develop a pattern for the user and are designed to detect falls, blackouts or any events which affect the monitored variables.

GreatCall Responder and MobileHelp are wireless, mobile devices that have a help button. They allow one to summon help anytime, anywhere. Trained certified response agents can identify the user and their location, conference in family or friends and dispatch 911 emergency services. These devices are small and portable.

Another device called Liftware is used for muscle tremors which become problematic and when it becomes difficult to carry out basic tasks among the elderly. Liftware uses advanced sensors and motion technology, allowing cutlery to shake 70 percent less than a user's hand. It ensures that nothing falls off the cutlery.

BeClose is an aging in place technology which can allow the elderly, their families and caregivers to communicate with each other using discrete wireless, battery operated sensors placed in the home. BeClose tracts the elderly person's daily routine and if there is any disruption to this routine, remote caregivers are alerted by phone, email, or text messages. The BeClose device can be seen in Figure 2.

Figure 2: BeClose (Source: Orlov, 2012).

Another ATD device considered is FitBit. FitBit Ultra Wireless Activity tracker displays real-time activity statistics and tracks steps taken, stairs climbed, distance travelled, activity level, calories burnt and sleeps quality. Another model tracks individual's weight body fat percentage and body mass index (BMI) overtime.

4.3 Fall Detectors

The fall detector is a small bleep-sized device designed to be worn around the waist or the upper chest according to Miskelly (2001). It detects an impact greater than a particular threshold and the wearer's orientation.

For home-based elders, Bed and Chair Fallguard is used when an elder with mobility concerns leaves his bed or chair. His caregiver receives an alert. This is to prevent a possible fall before it happens (Price, 2017).

Hip protectors are specially designed underwear with polypropylene shields sewn inside the underwear. If a person falls when wearing it, the impact of the fall should be diverted away from the hip, preventing it from fracturing (Miskelly, 2001).

A pressure mat is an electro-mechanical device which detects a person's fall from a bed or a chair. It provides an automatic communication link between the user and his caregiver.

4.4 Other Assistive Technology Equipment for the Elderly

Other technology equipment for the elderly include magnifiers, door alerts, dawn/dusk lights, smoke alarms, fire alarms, cooker control alerts and electronic calendar/speaking clocks.

An example of a magnifier for the elderly is USB Dolphin Super Nova Magnifier. This was viewed to be the world's best magnifier according to Price (2017). This app magnifies on-screen text up to 64 times and shows roughly three lines of text on the entire screen. All the world's most common languages are supported using this equipment.

An example of a door alert is Ring Video Doorbell Pro. This door alert is seen in Figure 3 and is used for the elderly with hearing loss. The doorbell includes a video feature. It allows users to talk to anyone who comes to the door in real-time. The bell has a motion sensor to indicate if someone is prowling around without ringing the doorbell. It also has infrared LEDs to allow the user to see the porch clearly at night.

Figure 3: Ring Video Doorbell Pro (Source: Price, 2017).

An example of a speaking clock is Reminder Rosie. This is a senior-oriented voice-controlled clock. Caregivers can record up to 2 different messages and set them to be broadcasted at different times a day. These are gentle reminders and can be heard up to 100 feet away (Price, 2017).

Another technology device is the TabSafe medication management system which reminds, dispenses, alerts and posts information on compliance, inventory and other health information that is accessible from any internet device.

This section also describes a robot technology device. Roomba is a robot vacuum cleaner. It allows for multi-room navigation, a three-stage cleaning process and a filter for allergies and other dirt. It is very portable and effective.

This section has indicated just a few of the assistive technology devices in the literature. Hundreds of more devices exist especially when the Internet of Things (IoT) devices are considered. These devices will be for another discussion beyond the scope of this paper.

5 OTHER TECHNOLOGIES IN PLACE FOR THE ELDERLY

Some eldercare technology (smart home) projects and eldercare technology systems and how they promote rehabilitation and eldercare in various parts of the world are discussed in this section. The smart home projects discussed are TigerPlace, University of Missouri-Columbia, USA (Rantz, 2005; 2017);

SmartBo, Sweden (Elger, 1998); Smart Home (Berte et al., 2014); and Aware Home, Georgia Tech, USA (Kidd, 1999). The Eldercare technology systems described are Digital Family Portrait (Abowd, 2002); home-based monitor (Goldberg, 2003); and Health Buddy (LaPramboise, 2003)

5.1 TigerPlace

A concept for a unique eldercare facility near University of Missouri-Columbia called TigerPlace which promotes elders living independently in smart homes allow them to remain healthier and active longer by providing ongoing assessments, early illness recognition and health promotion activites within well-designed apartments.

The Sinclair School of Nursing at the University of Missouri-Columbia has developed licensed home health agency, Senior Care, to provide the care needed for the elderly residents of TigerPlace. Collaboration between Nursing, Computer Engineering and Health Informatics faculty and research students using technology has the potential to address common health problems encountered by older adults related to functional decline. The collaboration effort will help to improve the quality of life of the elder population (Rantz et al., 2005). The author of this paper was opportune to work on a three month fellowship with other researchers at TigerPlace.

Students who worked on this project who were undergraduate engineering students designed and constructed a microprocessor system to read and store time data at which medicines were taken from a standard 28-bin medication box. This allowed the Senior Care nurses to download the data into their laptops, refill the medications and reset the medication assessment system during their weekly visits to the clients. Nurses were able to detect when the elders had difficulty taking medication according to their plan which was one of the most common challenges encountered in the care of elders (Rantz et al., 2005). The GrandCare system and the Claris Companion discussed in subsection 4.1 could be used in this facility for medication reminders. Proper taking of medication can enhance rehabilitation and recovery in eldercare.

Rantz et al. (2017) also highlighted that another device developed by students who worked at TigerPlace was a walker with automatic breaks. Also an in-home monitoring system consisting of a set of wireless motion sensors, a stove temperature sensor and a pneumatic bed sensor is also being used in some clients' apartments at TigerPlace. These are

similar to the BeClose technology device discussed in subsection 4.2.

A secured web-based interface was developed to display sensor data in a user-friendly, easy to use and clinically meaning manner for health-care providers, researchers and residents. It showed sensor data of motion, breathing pulse and restlessness via histograms, pie charts and line graphs. This can be compared with the FitBit Ultra Wireless Activity Tracker and the GrandCare system discussed in Section 4.

5.2 SmartBo

The Swedish Handicap Institute conducted a three year project in the late 1990s which showed how Information and Communication Technology (ICT) and a computer-based demonstration home might help elderly and disabled people achieve a richer and more independent lifestyle (Elger, 1998).

Some of the technology devices used were a video-door phone for motor-impaired people and a special door phone for death-blind people. A home bus system, the EIB (Europe Installlation Bus), was chosen to monitor and control functions in the home such as practically all lighting, most electrical power outlets, motorized lock of entrance door and door opener and motorized blinds/curtains/window opener. The system can be controlled via the computer, speech recognition devices and other devices. Elders and others enjoyed a full and independent life at reduced costs to the society in this facility.

5.3 PROSAFE Project

The PROSAFE project utilized a set of infrared motion sensors connected to either a wireless or wired network to support automatic recognition of resident activity to accommodate patients with Alzheimer's disease. PROSAFE is a multisensory remote monitoring system for the elderly or handicapped. It also features a human presence data collecting system and the related data processing software providing synthetic information or warning caregivers and a machine-man interface (Chan et al., 1999). It detects restlessness in bed, immobility and run away patients.

5.4 Smart Home Project

The Smart Home Project was done in Finland where a house with ten flats for elders was renovated to provide assistive technology for daily living. The

elders had lived in these apartments for over forty years and did not want to leave them. Two flats on the ground floor were converted to a doctor's office and a nursing and service station which operated 24 hours a day and 7 days a week.

This project implemented an intelligent system to monitor the house and provided help to residents if need be. A environmental monitoring and control system measured room temperature and made adjustments if it became too cold or too warm. Detection sensors were used to check entry and exit from the house to message service desk. Automated window/window blinds were controlled by remote control. The house has a communication and home control system which is accessed via an intercom system.

Cameras with interpreting software can be used for detecting falls. A portable wireless communication system can be used to make video calls and perform other functions. A shower chair was needed for people using a wheelchair. An adjustable toilet seat was used for elders who are handicapped. An adjustable bed was used by residents who had trouble getting in and out of bed. Some of the ATDs used in the Smart Home are compared later in this paper.

5.5 Aware Home

The Aware Home Research Initiative at Georgia Institute of Technology aimed to enhance the quality of life of elders and help them maintain independent lifestyles while staying at home (Kidd, 1999).

A digital family portrait which is like a family portrait was designed to represent the well-being of the elderly resident. This is discussed more in subsection 5.6. An unobtrusive camera was also installed on the first floor in the ceiling tiles to provide occupancy information of known residents in the house.

All of the smart home technologies in different parts of the world; Finland, France, Sweden and the United States; are suitable for eldercare and more smart homes will be available in future to cater for the increasing elder population and others.

5.6 Digital Family Portrait

One of the goals of the Aware Home Research Initiative at Georgia was to support awareness of the long-term health activity and social well-being of elders living alone. They designed the Digital Family Portrait which was to be hung on a wall or propped on a mantle (Kidd, 1999). It should blend

with other household decorations. In the interface, the well-being of the family member was represented by icons, based on sensing data from their homes (Abowd, 2002). Each icon represented a day with the current day being a white butterfly icon with time moving clockwise. The size of the icon represented the resident's activity level in the home. By touching a particular icon, the viewer obtained information about that day with activity based on room-to-room movement in 15 minute increments. A graph displayed room transitions throughout the day. Current weather and temperature conditions were included in the interface.

5.7 Home-based Monitor

Data to support daily weight monitoring for patients with heart failure is lacking according to Goldberg et al. (2003). Using a technology-based heart failure monitoring system, AlereNet system (from Alere Medical, Reno, Nevada), was used to determine whether daily reporting of weight and symptoms in patients with advanced heart failure would reduce rehospitalisation and mortality rates despite aggressive guideline-driven heart failure care.

The result of the Weight Monitoring in Heart Failure (WHARF) trial indicated that 138 patients received the AlereNet system and 142 patients received standard care of a sample of 280 patients from heart failure centers across the United States. The findings reported that there was a 56.2 percent reduction in mortality for patients randomized to the AlereNet group. There was no difference in the primary end point of rehospitalisation rates despite specialized and aggressive heart failure care in both groups.

5.8 Health Buddy

LaFramboise et al. did a pilot study to determine the feasibility of providing a heart failure disease management program through an in-home telehealth communication device (Health Buddy). They were also to compare the effectiveness of Health Buddy with traditional home visits and telephone calls in achieving selected patient outcomes such as depression, functional status and health-related quality of life.

The results of a mixed model ANOVA revealed that of the ninety participants in the study, those who received telephone disease management experienced decreased confidence in their ability to manage heart failure whereas other groups experienced increased confidence. Further ANOVA analysis showed

improvement over time with no group difference in the selected patient outcomes mentioned.

The findings of this research suggested that delivering a disease management program through a telehealth communication device (Health Buddy) is feasible and may be a good as traditional methods.

Each of these technologies promotes Eldercare to ensure that elders are active, rehabilitated and enjoy longer, healthier lives while aging in place.

6 COMPARISON OF TECHNOLOGY DEVICES FOR ELDERCARE

This section compares some of the technology devices discussed in this paper. Some other ATDs not previously discussed are also indicated. Most of the information that has not been previously discussed in this paper was provided by Berte et al. (2014) in the following subsections when they made a comparison of different technologies.

6.1 Comparison of Communication and Home Control Systems

A comparison for the Communication and Home Control system is initially given. Claris Companion is an all-in-one system to make video calls, reply emails and SMS messages, browse the web, play videos and provide medication reminders. It is portable and needs to be charged. It can be installed on the wall. It cannot control windows/window blinds. It is not connected with a door camera.

Compared with Digital Family Portrait, Claris Companion can also be mounted on a wall and is also a digital picture frame. It is more versatile; it has more capabilities and does not just indicate the activity level of the home resident.

BeClose is similar to the Digital Family Portrait in that both technologies tracks the resident's daily routine but the Digital Family Portrait supplies more information such as weather and room temperatures.

Each of the technologies is beneficial in their own way in enhancing eldercare.

6.2 Comparison of Home Adjustment Technology Devices

One of the home adjustment technology devices is the shower chair which is needed for people who use a wheelchair. One model of the shower chair is the Pressalit Care Shower Chair 310. It is moveable and

attached to a wall. Its height can be adjusted by moving it. Another model which is preferable is the Swift Shower Chair because it is more lightweight and the height is adjustable. Its armrests and backrests are removable. It has rubber foot pegs that do not slip.

Another device to consider is the adjustable toilet. There are two options. First there exist the high-tech toilets from Japan. These have a heated seat, water sprayer and air dryer. They also play music and sounds to cover toilet noise of a person. While this toilet is sophisticated and costly, another option is the normal toilets that are height adjustable. A person can elevate the seat to the right height, sit down and afterwards, lower the seat by using two buttons. This can be attached to a normal toilet and is a more viable option.

Another necessity is having a bed. An adjustable bed would be perfect for residents who have trouble getting in and out of bed. The Saga-bed is moveable, remote controlled and adjustable but looks more like a hospital bed. The Hepburn height adjustable bed is similar to the Saga-bed but is better looking. It is however big and looks heavy. Another model is the Ateliers du haut forez Bed Corail which has the same features of other beds but is nice, simple and has every necessary feature that one would want in a bed. This model is the preferable option.

There also exist two of the best assistive devices for the elderly that are used when getting out of bed. Bed Ladder Assist is used for sitting up in bed or getting out of bed. Bed Safety Rail helps one get out of bed and keeps one from falling out of bed. Each of these ADs has its merits.

For responding to possible falls of the elderly or others, the assistive device Medical Alert System is useful to contact loved ones or emergency services. MobileHelp can also be used if one falls to summon emergency help anytime, anywhere. Bed and Chair Fallguard can also be used to alert a caregiver in case of a fall. Hip protectors can be worn to divert the impact of a fall. Pressure mats detect falls and provide an automatic communication link between user and his caregiver. BeClose and Digital Family Portrait can also be used to track a resident's movement and send an alert if a fall occurs. All of these technologies are helpful in alerting caregivers or family members if one falls.

Health Buddy and AlereNet are useful technology systems in heart failure management. They each have their own peculiarities in helping to reduce mortality.

7 CONCLUSIONS

This paper has discussed various technology devices that have been used for eldercare in the 20th and 21st centuries. It describes different assistive devices, assistive technology devices, eldercare technology projects and eldercare technology systems. As technology keeps advancing, and medical science and engineering comes up with new devices, smart homes and new technologies and equipment will be available in the future to help elders live longer, active, independent and fulfilled lives while they age in place.

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