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A Short Review of the Literature on Assistive Technologies for Alzheimer's Patients and Their Caregivers

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Abstract

Alzheimer's is one of the most disabling neurocognitive diseases. A person diagnosed with Alzheimer's slowly loses cognitive function and ultimately becomes entirely dependent upon the caregivers. Caregivers must help the patient in everyday activities ranging from walking to cooking, eating, and so on. In most caregiving facilities, a single caregiver often handles more than one patient, which results in caregiver burnout. Researchers are developing useful technologies to prevent caregiver burnouts and facilitate families in the best possible manner. The goal of this purposive short review of literature is to study the modern tools, devices, and gadgets available to Alzheimer's patients and caregivers and understand the focus areas for future research. The review identified a range of products and technologies that help in monitoring to diagnosis, aid therapy, and reduce the burden on caregivers. These technologies play a vital role in improving the quality of life for both the patients and the caregivers. The study identified reducing cost of the devices, increasing robustness and dependability of the devices, and various aspects of the assistive technologies, including ethical and privacy issues, as the focus areas for future research.

Keywords

Alzheimer's, Dementia, Caregiver Burnout, Assistive Technology

1. Introduction

Dementia, scientifically known as Alzheimer's, is a neuro-cognitive disease that slowly progresses causing impairment. It begins with cognitive impairment and progresses to the failure to perform ADL (activities of daily life). Then it affects language, cognition, social behavior, as well as cerebral cortical areas, leading to

apathy, sleep disorders, depression, hallucinations, delusions, aggression, and improper sexual behavior. According to a study in 2010, the prevalence of dementia doubles roughly every five years, affecting 5% of the global population of over 65 years of age [1]. As the number of elderly people increases, aging illnesses such as Alzheimer's disease, are becoming increasingly common. In the entire world, 44 million people live with Alzheimer's disease. Because of the demographic shift toward an older population, this figure will increase [2]. By 2050, this population will have tripled.

With time, Alzheimer's disease symptoms worsen, and patients lose the ability to take care of themselves. The person with this diagnosis eventually becomes dependent upon a caregiver and requires continual care. As the disease progresses, the care requirements of the patients increase as well. The disease progression is subjective but can be influenced by several factors such as weather and genetics. Alzheimer's illness is currently untreatable. Both pharmaceutical and non-pharmacological therapies can be used to minimize their symptoms. Treatment can reduce the rate of neurocognitive decline. However, the decline process cannot be altogether stopped. The patients remain physically active before losing all cognitive functions and physical abilities. Behavioral changes also begin to dawn, and the patients show signs of agitation. Old-age patients are amenable to losing the physical activity, which can cause depression, frustration, and anger outbursts [3].

Development in the field of technology has benefited the biomedical sector and tools have been developed to help people being affected by dementia. The development of technology facilitates not only the patients but also caregivers [4]. Many tools help patients lead a more liberating life. The relevant technologies can be divided into four main categories, which are as follows:

1) Monitoring Technologies;
2) Assistance technologies;
3) Therapeutic technologies;
4) Diagnostic technologies.

Although these technologies are expensive to acquire, they can improve the QOL (quality of life) manifold. These technologies can significantly improve the QOL for the patient. These technologies have proven useful in improving and slowing the rate of cognitive decline and enabling patients to live more independent life [5]. These technologies if used timely in Alzheimer's patient's treatment and is tailored to their unique needs, it can improve them [6]. Several researchers found that learning to use technology in everyday life-enhanced feelings of competence and success, which in turn raised a sense of satisfaction [7]. Use of computers is said to have both therapeutic and preventive effects on patients suffering from dementia [8]. This, in turn, is linked to gaining new skills and using networks to interact with old and new interests [9]. However, there are studies that suggest more longitudinal randomized controlled trials to establish the efficacy of learning new computer skills in dementia patients [10].

There are several papers published on different aspects of the technologies and

devices used to improve the QOL of dementia patients and their caregivers. The objective of this paper is to conduct a short review of these papers, to understand the latest position on the technological, therapeutical, legal, and ethical aspects of the use of technology in Alzheimer's patients care. This qualitative study uses the narrative review of existing literature as the methodology. The selection of papers for the review is not comprehensive but as per the subjective judgement of the author, using the perspective of a technology developer currently working on devices and technologies that can improve the QOL of Alzheimer's patients and their caregivers.

2. Literature on Assistive Technologies

The use of assistive technology (AT) has been proposed as a way to help people with dementia and those who care for them maintain their independence and live in the community. It is defined as "any item, piece of equipment, or product system that is used to enhance, preserve, or improve functional skills of persons with disabilities" [11]. Assistive technology aids in improving safety, confidence, and independence, as well as reducing psychological and behavioral symptoms of the disease and preserving cognitive function [12]. ATs can maintain patient cognitive capacities, which are needed to perform basic daily tasks [6]. Policies relating to aging in place are supported, in part by ATs. The frequency of severe clinical situations necessitating admission to care facilities can be decreased or people's institutionalization can be delayed by assistive technology [13]. Technology is also helpful when a person prefers or has to be admitted to a care facility. In these situations, ATs can remove social barriers and provide smoother communication between patients and family members [14]. Certainly, ATs can support language and other cognitive processes including distinct memory kinds and spatiotemporal orientation. In terms of the expected memory benefits, gadgets like digital organizers and reminders might improve the QOL for Alzheimer's patients. Furthermore, by preserving independence and upholding dignity, ATs promote people's safety [15].

People with Alzheimer's are increasingly dependent on others' assistance, which is frequently offered by a family member. Most of the time, caretakers are forced to leave their employment, as well as their personal and social lives [16]. Additionally, their financial position deteriorates. As a result, Alzheimer's disease is an emotional and financial hardship, not just for the patients but also for their caretakers. The use of Assistive Technology by those with Dementia may also be advantageous to the caregiver, as it may raise that person's level of support and lessen some of the stress associated with providing care [17] [18]. When caring for a dementia patient, use of AT may help caregivers deal with the increasing amount of responsibility [19]. The need for more dementia friendly designs and care environments in hospitals and other care homes is now well accepted [20]. A systematic review of literature conducted in 2018 had found that the most common use of assistive technologies is in devices of daily living and safety devices [2].

2.1. Time Keeping Devices and Simplified 24-Hour Clocks

An article appeared on the alzheimers.net webpage [21] summarized several key pieces of equipment available to dementia patients. The technologies listed in this article fall under the category of assistive technologies as their goal is to enable the patient to perform everyday tasks on their own. Specially designed clocks are available to dementia patients. These clocks help reduce anxiety levels as the layout is considerably simplified. The 12-hour clocks often confuse patients, so these clocks are designed. These clocks allow the patient to read time and tell which part of the day it is. Caregivers can guide the patients to do certain activities at specific time windows. This allows the patients to live a more regular life and be more independent. Additionally, these clocks have built-in reminder and alarm systems that can reduce wandering tendencies.

2.2. Communication Devices (Adapted Telephones)

It is important to establish communication between the patient and the family or caregivers. The patient might not remember the family members or have the means to contact them when lost. Research has shown that dementia patients may not remember the visits from the family members, but the feelings associated with family members stay for a lot longer. A survey was conducted in 2016 by the BBC that suggested that 42% of the public thinks there is no point in keeping up in contact with dementia patients with no memory [22]. Scientific research contradicts this as dementia patients still hold "emotional memory". This is because the frontal lobe is responsible for processing information such as facts, figures, and numbers [23]. A study found that an iPad delivered video content, involving a familiar face and voice of a family member while the hospital staff was giving care can have a positive impact on the dementia patients [24].

All the logical processing tasks such as planning, organization, logical thinking, reasoning, and emotion management are performed using this frontal lobe [23]. Meanwhile, emotional memories are stored by a different part of the brain known as the amygdala, which attaches emotional significance to memories. While the frontal lobe is first affected by Alzheimer's, the amygdala is affected at a much later stage [23]. To maintain effective communication between the patient, the family members, and the caregivers, a special type of communication device called the adapted telephone has been designed. These smart devices come pre-programmed with certain numbers and have key buttons larger. These phones do not have extra features and a simpler layout is used to avoid confusion. Video chat services have been incorporated and location tracking is also made part of the software. Talking Mats is an application that allows dementia patients to talk to their loved ones, express feelings, and share pictures, symbols, clipart, and video clips of up to 30 seconds in length. ATs can remove social barriers and provide smoother communication between sufferers and family members.

COVID-19 pandemic had created additional challenges for the dementia patients and their caregivers. With many care facilities having to close their opera-

tions, the care for the patients suffered, even as the experts have emphasized the need to increase the support, such as situation highlighted the importance of developing and using more telemedicine and digital technology devices for remote care and monitoring [25]. More so because the distance is found to be complicating the communication about patient's health and care needs and the type of care that can be given [26]. Another study found that the adoption of technology can have significant impact on the burden and stress of dementia care givers from rural areas [27]. Pure "Technology Based Cognitive Behavioral Therapies (TB-CBT)" offers an economical and convenient method of delivering therapeutic interventions to the dementia patients [28].

2.3. Motion Detection Devices

Dementia patients tend to be forgetful and require continual reminders, causing strain to the caregiver. Automatic prompting and reminding devices are available that automatically provide audio/text prompts. These devices can be divided into three main categories [29]:

- Devices that detect motion to produce prompts,
- Devices that play set reminders, and
- Remote access devices.

Motion detection devices have a great application for caregivers as dementia patients can wake up at odd times and wander around the house [30]. They can trip from the stairs and cause severe injuries. To prevent such injuries from happening, sensors or pressure mat-based devices are available. These devices send regular alerts to caregivers and keep family members informed. Some devices go a step further by providing reminders when the alarm is tripped. For instance, a pressure mat placed at the kitchen entrance/exit can remind the dementia patient to turn off the gas while leaving the kitchen. Such reminders can help prevent disasters and losses [31].

2.4. Dosette Boxes and Automatic Pill Dispensers

Dementia patients must take medicines promptly. Skipping doses can result in faster disease progression, which can be harmful to the patient and cause turmoil for the family members [31]. Dosette boxes are an excellent way to organize pills. The caregivers can organize the pills for the patients to be taken later. Many dosette boxes have blank spaces for writing timings and dates as well, which can further add convenience. Automatic pill dispensers are an evolved form of the simple dosette boxes [31]. These pill dispensers are useful for all diseases, not just for dementia. There are pre-loader trays that can be filled with medicine. The device produces an alarm at fixed times, prompting the user to get their medicine. There are some issues with these automatic pill dispensers; they are costly and need to be refilled and recharged.

2.5. Locator Devices

Dementia Patients are forgetful and often wander. These wandering tendencies

are a cause of alarm for caregivers. Small electronic tags, similar to RFID chips, are available that allow caregivers and family members to locate the person in case the patient decides to take a solo trip. Many of these tags are accompanied by an android or iOS application that allows caregivers to track the exact location of the patients [32]. These technologies are particularly useful in nursing homes where one caregiver is providing care to more than one patient. Dementia patients often lose their belongings such as keys, wallets, and mobile phones. These tags can be placed on keys and similar items of everyday use so that these items do not get lost. Figure 1 below show a timekeeping and GPS-based tracking device.

2.6. Hearing and Vision Aids

Older patients with dementia begin losing cognitive function. Over time, hearing and vision are also affected. Some patients find it difficult to use a normal remote control. Braille remote controls are available to help the patients interact independently with the video screens [33]. Braille is also used in elevators of caregiving facilities to allow the users to interact independently.

2.7. Virtual Assistants

For dementia patients working full-time jobs, a virtual assistant can be handy. Amazon and Google have launched voice-activated virtual assistants. Dementia patients can control the lights, set reminders, call family members, play music, and complete a wide array of tasks using voice control [34]. This is a liberating experience and adds to the independence of the patients. The interface and commands can be further simplified using a controlled setting.

2.8. Robotic Technology

The AAL Project eWare was launched to develop smart robots that can assist dementia patients in everyday core activities such as cleaning, eating, and moving. These devices were aimed to improve mobility and enhance cognitive function while promoting the elements of sustainable care [35]. The secondary purpose of these devices was to reduce the level of distress in caregivers, allowing them more free time to do other chores. A robot named ReMind was created, which was a merger of James (a nursing robot) and a tablet computer. MI-Tale helped old-age patients have better conversations with younger generations (Figure 2).

Music therapy has proven useful with dementia patients and this robot can help improve cognitive function through music therapy [36]. Additionally, the robot can help patients perform guided exercises and stimulate memory by using music. A biography app called Keosity has been integrated into the schema of the robot, allowing the patient to refresh memories and relive moments. The only drawback of these robots is the associated costs. These robots are expensive to acquire and maintain. Since the functions performed by caregiving robots are limited, they cannot fully replace human caregivers yet [36].

Figure 1. A Timekeeping and GPS-based tracking device.

Figure 2. A patient using the Sense-Garden tool.

Reference [36] discussed a technology called the Sense-Garden. This is a digital space where a patient's memories are stored. The Sense-Garden provides a holistic experience by incorporating sight, touch, hearing, balance, and smell. Researchers considered a test group of 14 patients and subjected the patients to this new technology. The patients had failed to recognize the family members and the memories were wiped out completely. After using the Sense-Garden for a few weeks, the patients showed excellent signs of recovery. Some patients could recognize facts, experiences, and important social connections. Another closely associated project was MI-Tale. This UK government-funded project helped patients by triggering memories in the patients. These memories were triggered with the help of AR and VR-based interactive games. The games incorporated pictures and videos from the person's past while adding new material. The player's/patient's feelings and emotions were noted. MI-Tale helped old-age patients have better conversations with younger generations.

2.9. Home Monitoring Technologies

Many families insist that the patient remains at home for as long as possible. It is a popular belief that caregiving facilities lack individualized attention, which causes many people to keep the patients at home. When family members are away, the CARU smart sensors can be used to track of the patient. The device allows the user to interact using voice chat and mobile applications. The applica-

tion learns about the daily routine of the patients and alerts the family members if anything different from the regular patterns happen. The small gadget has AI and machine learning integration that alert the family members or support services if something is not right [37]. Furthermore, there are weather-based suggestions where the patients are reminded to close the windows when it is about to rain, take medication on time and shut the water taps after using the washroom.

The cameras can be placed in the kitchen and non-private areas of the house for monitoring purposes. These cameras would allow the caregivers to observe the patient remotely. However, the use of cameras inside homes and in caregiver facilities is not recommended because it is a violation of personal space. Secondly, the patients feel uneasy while being monitored all day. Thirdly, the use of such remote technologies can result in caregiver negligence, which can have serious consequences [38]. The implementation of actigraphy technology, according to one evaluation, may be useful for monitoring patients in nursing homes [39].

2.10. Electrical Appliance Use Monitoring

Smart sockets are available and can be installed in caregiving facilities and homes. These sockets can be remotely controlled and issue alerts to connected smartphones. Whenever a patient plugs into an electrical appliance, a notification is sent to the caregiver. If the caregiver finds the device unsafe for use by the patient, the caregiver can turn off the electricity supply for the patient's safety.

2.11. Smart Planning Applications for Caregivers

Reference [15] proposed smart planning software that can be used by caregivers for advance care planning. The researchers emphasized the need to incorporate smart planning tools in modern caring facilities for effective planning. These planning tools would not only help in the documentation but also enable the caregivers to plan their schedules. Patient data can be better stored and retrieved on demand. The researchers proposed a question whether the assistive technologies were prolonging the period during which a person living with dementia would have the capacity to make their own decisions.

Smart planning application provides many advantages, including lowering the frequency of negative incidence and offering assistance and intervention for disorders including chronic illness, falls, dementia, medication issues, roaming, and social isolation. The fundamental benefit of smart home technology is that it helps the elderly to remain in their comfortable and familiar environment, preventing or delaying admission to a nursing home. Patients can maintain their autonomy while being constantly watched, motivating them by allowing them to feel more educated and knowledgeable in their treatment [40].

3. Findings from the Review

The review of the above discussed literature clearly shows the current state of as-

sistive technologies for Alzheimer's patients and their caregivers and direction for the research and development professionals ahead. The findings from the review are briefly captured in the following sub-sections.

3.1. Understanding Patient Requirements and Needs

As various studies demonstrated, a patient of dementia has many requirements, which need to be fulfilled. All patients require a feeling of independence, which can be made possible by modern technologies. Remote technologies, artificial intelligence, and machine learning can be combined to develop systems similar to eWare that encourage independence. The technologies for Alzheimer's patients should facilitate independent decision-making and have a positive impact on the patient's life. The patient should be provided support and should not be viewed as a person with disabilities. In other words, these devices should be empowering and liberating. Use of technologies, however, should be dovetailed to the needs and condition of the patients. Instead of standardized prompts from the assistive devices, the prompting strategy should consider the individual patient's cognitive profiles [41].

3.2. Summary of the Latest Technologies

AT assist people with Alzheimer's in four areas: general and personalized information; practical treatment for Alzheimer's symptoms; social engagement; and health monitoring and safety concerns [42]. Monitoring technologies are a requisite because the number of patients is higher compared with the number of caregivers. One caregiver was engaged with several patients, and the attention was divided. If appropriate camera technologies are employed, the caregiver strain can be reduced [43]. AT EASE (Automated Technology for Elder Assessment Safety in Environment) technology has been developed by MIT (Massachusetts Institute of Technology). This technology uses the ZigBee system for monitoring elderly patients. The system is still in the beta-testing phase and several reliability tests need to be checked. The AT EASE system produced false positives and a sensor malfunction can sound alarms. The sensor calibration is also an important issue that has not been tackled yet. Another robust solution is Care Media, which is still in the experimental stage. The researchers used video recording and machine learning algorithms to understand the requirements of patients. 14,000 camera hours over one month were collected, and 5000 h were focused on mealtime. The data were digested and correlated with 168 variables. The goal is to help caregivers better understand the needs and requirements of patients when they have lost most of their neurocognitive function.

A smart assistance technology called The Coach was recently introduced. This technology has built-in tools that guide the patient in everyday routine activities, such as washing the face, combing hair, and so on. The patient must wear a bracelet that has motion tracking embedded. When one step is performed, the software automatically moves to the next instructions. There are two primary issues: 1) a large percentage of patients are physically challenged so they cannot

perform a full range of motion on their own, and 2) most people find it uncomfortable to wear a plastic band all day long. This technology is still in the early developmental phase and can be simplified by continual research. Researchers aim for developing a complete autonomous care system comprising four elements, which are as follows:

1) Patent Mobile Device (PMD);

2) Carer Stationary Device (CSD);

3) Carer Mobile Device (CMD);

4) Secure Server.

However, according to [33], many caregivers do not have access to these technologies. The digital gap, societal considerations, and technology literacy are only a few of the many variables contributing to this limited access. The next challenge for the researchers is to strengthen each module and establish secure low latency connections between the four foundational pillars [44].

Numerous studies and literature reviews are present, explaining the importance of digital technologies. Reference [45] conducted a study focused on the United States. In this study, interviews were conducted, and several case studies formed the basis of the theoretical framework. This study highlighted the importance of GPS trackers and mobile locators for patients with dementia. Using these technologies, another study focused on Ireland was conducted [46]. Semi-structured interviews formed the core of the study design and thematic analysis was conducted for the thematic analysis. This study focused on the importance of automatic night and day calendars. Additionally, some other gadgets such as lost item locator, automatic night lamp, timed gas cooker devices, and picture button telephones were discussed. This study [46] concluded that the use of automatic day/night calendars played a useful role in improving awareness for early-stage dementia patients. However, older patients are indifferent to the use of such devices as the neuro-cognitive decline has crossed a certain threshold. Reference [47] reported an experiment where 14 dementia patients were studied. The patients ranged from 34 to 79 in age. For this study, interviews and observations were conducted. Grounded theory was used as the theoretical framework. The researchers noted that there has been a massive increase in the number of stove-related accidents during cooking as dementia patients often forget to turn off the gas. A stove timer design was suggested as part of the study, which would help significantly reduce the number of kitchen accidents by acting as a reminder to turn off the gas. The timer would incorporate picture cues to further improve the efficacy of the remainder. In 2009, another research was conducted using a single dyad case study theoretical framework [48]. The findings supplemented the earlier studies on the importance of GPS tracking devices. Another study involving a focus group comprising of 36 participants, various measures were discussed for improving the efficiency of GPS tracking devices [49]. Various use cases for GPS tracking devices were also explained. In another study [50] on the same subject, 14 family members were asked various questions in the form of a semi-structured interview. The patients were aged between 38 and 86

meaning that the patients belonged to different dementia stages. In-home night-time monitoring systems, movement sensors, cameras, and automatic water and gas switches were discussed at length. The ethical aspect of installing cameras inside residential units was discussed. Another study on the use of community alarms, telecare systems, and reminiscence tools provided promising insights regarding the efficacy of several latest technologies such as automatic pill dispensers [51]. Reference [13] conducted a detailed analysis of the Arts used for PWD in residential care settings. The paper made a note of telecare technologies and other novel devices such as pet robots. The use of light therapy was discussed and the results of therapy for various patient groups were discussed. The research concluded that pet robots decreased BPSD and depressive symptoms. Additionally, light therapy was proven useful for improvement in circadian rhythms.

4. Conclusions

This purposive short review of literature captured the current knowledge on the assistive technologies for improving the quality of life for both Alzheimer's patients and their caregivers. The cost of the devices will have to be brought down so that more patients and caregivers get the benefit. The robustness and dependability of the devices also require further research and improvements. The review also brought out the need for further debates and studies on various aspects of the assistive technologies, including ethical and privacy issues. Specifically, the review highlights the prospects for future research to consider the following questions:

1) How to make Dementia care products and gadgets cost-efficient?

2) How to incorporate the element of individuality in the patients while designing new technologies?

3) How to improve the existing technologies and add more features?

4) Is it possible to maintain an element of privacy while designing monitoring devices?

5) How to develop a robust data regulatory policy? Who will have access to the personal data of the dementia patients like pictures, passwords, etc.?

Only with a consensus in responses to the above questions, the assistive technologies will become more widespread and useful for the growing number of Alzheimer's patients and caregivers.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix

Appendix A: Literature Review Summary Table

Author	Year	Summary
Abdul Razzak *et al.*	2019	We emphasize the importance of assistance and monitoring technologies forimproving patient independence and reducing caregiver strain.
Hagen	2007	We highlighted the core factors that need to be worked about by companies developing Dementia care technologies. The use of communication and location monitoring devices is discussed. The ethical aspects of a camera The installation for dementia patient monitoring is discussed.
Bertule	2020	Currently, available dementia care technologies such as smart robots,telecommunication devices, electric equipment monitors, and medicinedispensing equipment are discussed in detail. The importance of AI and machine learning is highlighted for developing smart Dementia Care products.
Harton	2018	We talked about different areas of the brain and how technology can be used To improve the neurocognitive function of Dementia patients.
Bennett *et al.*	2017	We discussed the use of high-tech devices such as robots, for improving the health of people living with dementia. The use of memory and communication aids, safety devices, and companion robots are also discussed. Cost factors are discussed and standardization of technology is Proposed as a solution for cost reduction.
Cuffaro, *et al.*	2020	Evaluated the role of dementia care technologies during the COVID-19 era.
Hagen	2007	Paper is used to understand the technologies available in the past Versus the technologies available in 2022.
Brando *et al.*	2017	An evaluation of the benefits and drawbacks of using technology with dementia sufferers. Moreover, he concluded that technology-based cognitive therapy had advantages over conventional rehabilitation.
Brims and Oliver	2019	An investigation of how well assistive technology improves safety. The use of safety assistive technology in dementia patients is currently supported by evidence.
Daly Lynn *et al.*	2019	Analyses of AT in residential care settings for dementia patients. Positive results confirm the possibility of assistive technology in dementia.
Dove and Astell	2017	Studies on motion-based technologies accessible in the setting of Alzheimer's. Results indicate that it is possible to excite dementia patients using motion-based technology.
El-Saifi *et al.*	2018	Evaluation of an intervention to increase dementia patients' compliance with their drug regimens. The only intervention that increased compliance was telemonitoring.
Fleming and Sum	2014	This study aimed to analyze AT effectiveness in dementia patients.
Garcia-Casal *et al.*	2017	Evaluation of computer-based cognitive therapies for dementia patients' effectiveness. He concluded that computer-based cognitive therapies had a slight impact on depression and a moderate impact on cognitive function.
Klimova and Maresova	2017	An examination of the efficiency of computer-based cognitive training for dementia patients. Conflicting findings called for more research.
Liapis and Harding	2017	Highlighted the efficiency of computer-based cognitive training for dementia patients. Possible positive outcomes that require further research.
Lorenz *et al.*	2019	Focus on the use of mapping technologies by patients and caregivers. There is scant evidence to support the use of the specified technologies.
Maia *et al.*	2018	Analysis of an intervention for a patient with dementia employing help with daily life tasks. He concluded that can support ADL in dementia.
Yousaf *et al.*	2019	Evidence on the use of health applications for patients with dementia. Interactive, simple to use, and independence-promoting mobile health applications.

Continued

Tyack and Camic	2017	Analysis of the effects of a touch-screen intervention for dementia patients on their wellbeing. The psychological health of patients with dementia can be improved through touch-screen-based interventions.
Pinto-Bruno *et al.*	2017	Talked about ICT-based treatments to support social health and active aging were examined for their validity and effectiveness. ICT-based treatments produced the first promising results.
Hung *et al.*	2018	Study on Acceptability and viability of an iPad solution for dementia support. iPad-based simulated presence treatment can benefit dementia patients in a medical environment.
Neubauer *et al.*	2018	Assessment of the many technologies used to control patients with dementia's wandering behavior Results show that technology can increase a dementia patient's mobility autonomy and lower the dangers associated with wandering behaviors.
Jackson *et al.*	2016	An examination of technology aimed at caretakers that use the phone and the internet. Better results have been achieved by integrating several programs and gadgets into one intervention.
Waller *et al.*	2017	Analysis of the usability, acceptability, and efficacy of an ICT-based intervention aimed toward carers. Emerging were the possible advantages of the ICT-based intervention.
Parra-Vidales *et al.*	2017	Evaluation of an online psychoeducational intervention for dementia patients' carers. The findings showed that online interventions have positive social effects and are frequently viewed favorably.
Egan *et al.*	2018	Evaluation of an online intervention for dementia patients' carers. Positive results from the heterogeneous design were obtained.
Boots *et al.*	2014	Analysis of the efficacy, viability, and quality of online interventions for dementia patients' caregivers. The results showed a favorable outcome, however, because of the limited sample size, more research is needed.
Scott *et al.*	2016	Evaluation of the TB-CBT intervention aimed at Alzheimer's patient caretakers. Few investigations should examine TB-long-term CBT's effects. Traditional CBT can be more reasonably replaced with TB-CBT.
Ruggiano *et al.*	2018	Evaluation of a technology-based intervention for rural Alzheimer's patient caretakers. Only a few studies noted that the sample population was from rural areas.
Lucero *et al.*	2019	The evaluation of the efficacy of an ICT-based intervention aimed toward caretakers. Positive results were attained.
Altus DE *et al.*	2000	This study highlights the importance of GPS trackers and mobile locators for patients with dementia.
Cahil *et al.*	2007	Focus on the importance of automatic day/night calendars. He concluded that the use of automatic day/night calendars played a useful role in improving awareness of early-stage dementia patients.
FaucounauV *et al.*	2009	The paper supplemented the earlier studies and discussed the importance of GPS tracking devices.
Gibson G *et al.*	2015	We examined the use of community alarms, telecare systems, and reminiscence tools. This study provided promising insights regarding the efficacy of several latest technologies, such as automatic pill dispensers.