A double look at the application of information and communication technologies in patients with Alzheimer's Disease

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Abstract

The significant increase in the older population groups has been associated to a higher prevalence of neurodegenerative diseases such as Alzheimer's Disease (AD). In this context, digital technologies could be useful both for the patient (intervention strategies, biomarkers or in clinical assessment) living in the community and for the informal or professional caregivers. In the present work, the application of information and communication technologies for reminiscence therapy in AD patients and for interventions aimed to reduce burden and anxiety in caregivers are reviewed. New technologies are used in AD patients, Virtual Reality (VR) seems to be one of the most promising. Data obtained suggest that VR can be successfully used to stimulate reminiscence and more vivid memories in these patients. It has been suggested that in order to provide a useful service to the community new technologies should be easy for both the patient and the caregiver to use. Recent research suggests that mobile health (mHealth) applications can improve the quality of life both in AD patients and their caregivers, allowing more effective interventions.

Abbreviations: AAD: Alzheimer's Disease; eHealth: electronic Health; mHealth: mobile Health; ICTs: Information and Communication Technologies: MCI: Mild Cognitive Impairment; MMSE: Mini Mental State Examination; EEG: Electroencephalogram; ECG: Electrocardiogram; VR: Virtual Reality

Introduction

One of the consequences of the important growth of life expectancy is the increase in the prevalence of neurodegenerative diseases such as Alzheimer's Disease (AD). This notable increase in the older population groups has prompted different governments, as well as institutions, industries and other social agents to confront this demographic challenge proposing different interventions [1].

The World Health Organization (2017) calculates the number of people affected by some type of dementia at approximately 50 million, estimating that in the year 2050 this figure could reach 132 million people [2]. This significant increase in the number of dementia patients has been associated with a growing concern about the provision of care, both in the community and in day care centres or nursing homes for elderly people [3].

Internet--based interventions (eHealth and mHealth) could be a good alternative for the implementation of treatments for different neurodegenerative diseases. The progressive incorporation of internet use in daily life is based on its acceptance and accessibility. However, in general, this type of intervention encompasses economic, practical and administrative barriers that make it difficult for both clinicians and patients to adopt it [4]. Information and Communication Technologies (ICTs) are useful instruments in different areas related to health in a modern society [1]. The use of smartphones is growing rapidly [5] and different utilities through internet-based interventions are being proposed for the elderly [6]. We can found online platforms aimed to promote a healthy lifestyle and delay dementia [7] or web-based interventions aimed to family caregivers providing them with psychosocial support and information (8). In general, data indicate that the primary caregiver, despite being subjected to a high level of burden, rarely uses the support services provided by different institutions [9]. For that reason, internet-based interventions could aid to develop interactive and more tailored approaches for this population group [6].

eHealth is defined by the World Health Organization as the support provided by the effective and safe use of ICTs in the field of health and related areas [1]. These initiatives are supported by different studies that demonstrate the positive effects these interventions generate both on the wellbeing of patients and on the psychological health, burden and anxiety levels of the caregivers [6,10-12]. Digital technologies could be useful from a double perspective: a) For the patient, including clinical assessments and intervention strategies based on new technologies, and in the search of biomarkers of the disease [13], b) For the informal or professional caregivers, allowing to support the caregiving task in different settings (memory training, social interaction...) [14].

Information and communication technologies in Alzheimer's Disease

In the bibliographic review carried out for the present work we have identified different factors that show the potential of this type of technologies to support different groups (professionals, informal caregivers and patients of AD) both in education and in health promotion related to the care task [1] and in interventions aimed to improve the wellbeing of the patient [15,16]. It has been proposed that in order to provide a useful service to the community these technologies should be easy to understand and use. Furthermore, they should allow that materials included in the different applications be customized so that they can be adapted to the disease progression [17]. Specific recommendations for the use of ICTs in AD patients can be found in different sources [18]. Recently Klimova et al. (2018) have published an interesting review including the mobile phone applications developed for people with dementia and/or for their carers [19].

The look from the patient's perspective

The deterioration of episodic memory is a cognitive symptom characteristic of AD [20]. One of the non-pharmacological interventions to address this deficit is reminiscence therapy. It consists of stimulating the evocation of personal memories and of those that arouse positive feelings. The stimuli used to promote the evocation of personal memories of patients can be very diverse: photographs, recordings, smells, textures, taste, music, sounds... [21].

Several studies have explored the effectiveness of reminiscence therapies in AD patients. Dourado and Laks (2016) [22] found that those therapies based on reminiscence offer good results, improving patients' cognition and mood and decreasing the burden reported by caregivers. More recently, Bejan et al. (2018) [23] have emphasized the importance of multimodal interventions in reminiscence therapies. Irazoki, Garcia-Casal, Sanchez-Meca and Franco-Martin (2017) [24] in their systematic review of 14 studies about the efficacy of reminiscence therapy in patients with dementia found a significant improvement in patients' cognition, although non-significant changes were reported in quality of life, behavioural symptoms or activities of daily life. These results contrast with those obtained in previous studies in which significant positive changes in patients' mood were detected.

Lazar, Thompson and Demiris [25] (2014) conducted a systematic review of studies on the application of ICTs to reminiscence therapy. The conclusions suggest that in general results of these interventions were positive, although some difficulties were revealed: small samples, absence of differentiation between different stages of the disease or lack of specification of therapies received.

Among new technologies used in different patients, VR seems to be one of the most promising [26]. VR is a technology that allows to perceive the feeling of being in the scene that we are looking at. There are basically two ways to obtain the purpose of VR systems: the first one uses VR glasses (equipped with an high definition screen and a gyroscope) and a remote controller as, for example, Oculus Go. It is also possible to combine a smartphone with a pair of VR glasses, like Google Daydream or Samsung Gear VR, in order to use a lot of apps [27]. García et al. (2012) in their research on the use of VR in patients with dementia have analysed different areas in which it would be interesting to apply this technology [28]. It was observed that VR offers interesting possibilities in both research and intervention. One of the most interesting aspects of this technology lies in the possibility of modifying virtual environments based on the requirements of researchers or therapists and adapting them to the preferences of each patient, offering personalized stimulation. Interactive experiences based on VR could be also useful for educating caregivers about signs and symptoms of dementia [29].

Mosadeghi and collaborators (2017) have used Samsung's VR glasses with patients admitted to hospitals, offering them

experiences such as exploring the ocean or sharing the stage with Cirque du Soleil acrobats. In this study, patients suffering from dementia were excluded and some patients found that the glasses used were uncomfortable although data obtained can be of interest in future research with AD patients [30].

García-Betances and collaborators (2015) recently performed a review of studies in which VR was applied to patients with AD and Mild Cognitive Impairment (MCI) [31]. Results indicated that in general the virtual environments offered a limited level of immersion and interaction. The authors proposed some factors to take into account in order to improve the applications of VR for patients with AD. The tools should be customized for the patient but they should also be useful to both professionals and family caregivers, offering the possibility of applying some interventions based on VR in their own domestic environment. VR tools can offer different psychophysiological and psychological measures (emotional state, cognitive status, level of stress…) [31]. This type of data would allow evaluating patient's performance and improvement. The knowledge obtained in these studies could be essential for future developments and applications of these technologies for AD patients.

Benoit and collaborators (2015) [32] have conducted an experimental study regarding the use of VR to stimulate reminiscence. They compared the results of the exposure to 4 different experimental situations: a grey screen as baseline measurement; a photo of a known place; a virtual reconstruction of a known environment and a virtual reconstruction of an unknown environment. The subjects participating in the experiment were 18 volunteers with a mean age of 68.2 years old with subjective complaints of memory and with a Mini Mental State Examination (MMSE) score greater than 27, without a history of neuropsychiatric disorder. Results indicated that VR exposure to the photo of a known place or to the reconstruction of a known environment induced more detailed memories in comparison with those induced by the stimuli of the grey screen or the unknown virtual environment. Verbal fluency was also significantly higher after the exposure to the representations of the known places [32]. Data obtained in different studies suggest that VR can be successfully used to stimulate reminiscence and more vivid memories in elderly subjects.

Abichou, La Corte and Piolino (2017) conducted a review of studies that have investigated the use of VR as a tool for evaluation and diagnosis of episodic memory deficits in normal and pathological aging [33]. The VR tool is a dynamic system and presents multisensory aspects that allow creating more personalized environments for each subject. The advantage of VR lies in its potential to perform measurements or research in a more ecological approach than traditional tests. For example, episodic memory tests based on VR sceneries seems to be promising to detect subjective memory complaints of the elderly. In AD patients VR is a useful tool for evaluating episodic memory and developing training protocols and interventions for mnesic functions [33]. In AD, visuospatial abilities also influence the ability to use environmental references [20,34]. VR can be a useful system also for the cognitive training of visuospatial abilities. It offers the possibility of visiting virtually the most important places and locations for each subject [35].

The look from the caregiver's perspective

The care of AD patients is usually carried out by a family member who takes on the role of informal caregiver. Among the characteristics of these informal caregivers are the lack of

preparation to develop the role they adopt and the absence of economic compensation for the work they do [36].

In general, data indicate that the primary caregiver, despite a high-level of burden and stress, resorts infrequently to the support services provided by different institutions and public services [9]. In addition, the caregiver generally finds it difficult to access the interventions that best suit his needs, mainly due to administrative issues or lack of knowledge of the available options [37]. Likewise, the services offered by different institutions are considered scarce, not easily accessible or flexible or even inadequate to cover all the needs of the AD patient or of the caregivers themselves [38]. Traditionally, the interventions that have been offered to the informal caregiver have been: psychoeducation, skills development programs, psychotherapeutic interventions, multicomponent interventions and support groups [39,40]. These interventions usually have a format of group sessions (combined or not with individual sessions). The most frequent interventions are psychoeducational interventions taught by one or more specialists who teach caregivers strategies, stress management techniques and skills that enable a more adaptive coping of the care task [39,41]. It is considered that providing information about the evolution of the disease and about the consequences of the care task itself are necessary interventions to improve the quality of life of the informal caregivers and of the person receiving the care [10].

Bendixen et al. (2017) found that most caregivers use their mobile devices at all times and this continuous connectivity could be taken as an advantage to the development of mHealth applications for the caregiving tasks. Furthermore, caregivers evaluated positively the possibility of receiving daily messages that would provide encouraging and supportive notifications [42]. One of the objectives that these programs must achieve is to offer useful tools to identify caregivers in terms of overload, anxiety or depression. This type of intervention can also be considered as an adequate instrument for collecting information, thus enabling the provision of more personalized services and supports. The identification of problems and needs is considered one of the first steps that this type of intervention has to perform to show the usefulness of the new technologies to reduce the caregiver's burden [43]. Recently the World Health Organization (WHO) has developed iSupport (http://www.who.int/mental_health/neurology/dementia/isupport/en/), an online training program for carers of people with dementia. These resources offer information about dementia itself and a support program for the caregiving of people with dementia, all based on scientific data [44].

In relation to the possibility of using VR with carers we can find examples such as the app called "A Walk Through Dementia" (http://www.awalkthroughdementia.org/) developed by Alzheimer's Research UK. This app uses VR to represent three possible scenarios (at home, on the road and at the supermarket) in which patients may face orientation, planning and memory difficulties. In the same way, The virtual forest (https://www.alzheimers.net/2014-04-03/how-a-virtual-reality-forest-helps-alzheimers-patients/) is an intervention project being carried out in Victoria, Australia, in which virtual scenarios have been developed based on natural environments. These scenarios are projected on a screen and caregivers can accompany patients during their interaction with the virtual environment. This application uses Microsoft Kinect to facilitate interaction with some of the objects present on the stage, such as butterflies, flowers, snow… Another interesting example is represented by

the possibilities offered by projects such as GoogleBikeAround (combining a static bicycle, a jDome screen and a projector together with Google Street View) that allow dementia patients to take virtual rides. The patient navigates through the virtual representation of significant places in their lives, evoking emotional events whereas caregivers and relatives can share these pleasant moments with the patient [45].

The task of caregiving has a profound impact on physical and psychosocial health of the caregiver (stress, overload, subjective complaints from memory...) [46]. Internet-based interventions or technology aids could be a useful method in order to improve wellbeing of patients and diminishing burden in caregivers [8]. Some programs, such as those based in VR, can also help caregivers to better understand dementia, contributing to increase their sense of competence and improving subjective and objective health [47].

Conclusions

Increasing life expectancy is a major challenge for societies concerned with successful aging. mHealth could be considered as a tool with great potential for the promotion of active aging on a large scale [48]. Different authors have proposed interesting utilities of these technologies in the community (for example, cognitive screening and therapy for patients, support for the carers...) although it would be necessary to take into account both the functionality and the usability of the new applications [49]. For example, reminiscence interventions based on VR should be customized for the patient but they could also be of practical use both for the professionals and for the family caregivers, offering the possibility of applying some interventions in the own domestic environment and allowing a more personalized approach [30].

Strategies based on tele-assistance could be applied in order to make health care more accessible to all age groups in the community and to promote preventive measures that reduce the costs of care [50]. The use of robotics in people with dementia could contribute to lengthen independent living contributing to a greater welfare, independence and autonomy of the patients [51].

ICTs could offer new interventions that overcome many of the limitations defined by the caregivers themselves, such as the difficulty of accessing interventions, limitations related to the inflexible schedules of conventional interventions and the resistance of the caregivers themselves to seek professional help. This type of programs could also be useful to increase social support, self-efficacy and sense of competence that caregivers have in reference to their care work. The use of internet-based interventions attempts to respond to difficulties such as little flexibility of standardized programs or lack of family support to replace the primary caregiver in the tasks related to the care of the AD patient [6,52,53].

According to most authors, applications based on mHealth should not replace professionals, but could be considered a complementary tool for the management and provision of medical care in the community, although it is necessary to discuss the safe use of these technologies. The European Commission within its Action Plan 2012-2020 (Innovative healthcare for the 21st century) launched a public consultation on Green Paper on Mobile Health (mHealth) to interested parties in order to obtain information about barriers related to mHealth [54]. The mHealth programs can also help in self-management tasks or in the establishment of daily self-care routines by patients themselves [42].

In conclusion, digital technologies can be an interesting tool for Alzheimer's patients in the next future [13]. We need to establish how to fit these new technologies for the professional, the informal caregiver of the people with dementia, improving their quality of life and allowing more effective interventions [14,55,56]. This training can help to lighten the burden that dementia currently places on patients themselves, carers and health systems given its high global prevalence.

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