Chapter 11

The Role of Educational Technology in Caregiving

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Additional information is available at the end of the chapter

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Abstract

Huge demographic and socio-economic changes are part of the experience of present societies. One consequence is the aging of the population and increasingly more people without the capacity for self-care. The provision of intergenerational care, namely caring for the older individuals, is a focus of attention for health professionals, but is also part of the political and social agenda. There is a need to regulate, support, and facilitate the daily life of families who have a dependent aged member. In contemporary societies, the use of information and communication technologies (ICT) is an important driver of innovation, responsible for a large transformation of living standards and new social behaviors. Within the scope of the provision of informal care, ICT can provide a great support, representing a primordial tool for updating the organizations in order to improve their efficiency, incorporating and making available services, and anticipating needs. Thus, the development of equipment, electronic applications, and websites for the elderly or their family caregivers should be conceptualized and customized to the profile of these users. A major challenge faced by healthcare institutions is to focus their services by organizing them around citizens' needs.

Keywords: technologies, caregiving, self-care, impairment, nursing

1. Introduction

The human being is by nature a gregarious being and the family is a primordial system to ensure the continuity and development of its members throughout the whole life cycle. The family is a systemic and dynamic unit and it influences and receives influences not only from each of its members, but also from the context in which it is inserted.

Throughout history, despite the structural and functional changes that took place in families, societies recognize them an important social role, not only toward the socialization and protection of their members, but also due to its supportive and helping function in the events

during the different developmental stages as well as by assisting family members when they experience health/disease processes [1, 2].

The double population aging process (both in the base and top of the pyramid) observed in a large majority of current societies and particularly in developed countries, is accompanied by a successive decrease in the number of people who are able to respond to the challenges of caring for someone who may be unable to perform daily life activities (basic and instrumental), contrasting with an increasing number of elderly/very old people, often presenting chronic diseases associated with high levels of dependency. In fact, concomitantly with this demographic aging, the populations portray an epidemiological profile showing a prevalence of chronic and degenerative diseases that are potentially incapacitating. In the group of the elderly, along with these chronic problems that may progress gradually or with frequent acute episodes, with recurrent hospitalizations, there are other events that generate dependence that may abruptly present themselves, such as cerebrovascular accident (CVA) and fall events, whether they are associated or not with hip fractures.

These transitions (demographic and epidemiological) have prompted a (re-)emergence of an interest for informal systems on the political agenda, not only as a source of welfare provision, but also as an important resource for the continuity of care in situations of disease, particularly regarding society's older members. In fact, structural changes require new policies that ensure the sustainability of health systems and social support.

Whether the situation of dependency sets in unexpectedly or gradually, it requires the family to change its family dynamics in order not only to respond to the needs of the family member with Daily Life Activities (DLA) impairment, but also to regain their stability. The chronic illness and the functional compromise of the person with dependence have repercussions not only on the individual with a health problem, but also on the family, forcing constant adaptations in the family system. Compared to developmental transitions, health/illness transitions constitute an accidental crisis in the family, presenting a more disastrous character due to the unexpected way they are installed, and the need for rapid decision-making, creating situations that the family did not have time, neither knowledge nor maturity to face [3, 4].

After a period marked by the intrahospital occurrence of birth, death, and illness, the recent austerity policies have emphasized the role of the family in social protection and provision of well-being to its members, transferring to them a growing responsibility regarding the continuity of care when one of its members is affected by a health/illness process associated with different levels of functional disability [5].

Across the world, aggressive austerity policies have been implemented, especially in the health and social areas. These policies, in order to overcome the deficiencies, transfer to the caregiver an increased responsibility for the support and provision of care [1], even if the responses provided by the health services/teams are insufficient and inadequate when confronted with the physical, cognitive, and emotional needs expressed by the families/family caregivers [6, 7].

The experience of caring for a dependent person always implies a family (re-)adaptation, namely in terms of its functional dimension, by the need to redefine roles among the different elements of the system, in order to respond to the needs of the dependent person [6].

The scientific literature has identified multiple variables that can interfere in the way each individual and family adapt and manage the disease/dependence situation, finding favorable responses to the continuity of care. Among these variables are the resources the family has, as well as the capacity to mobilize and manage them, the stage of the life cycle in which the family finds itself, the cohesion among its members, the coping strategies that it is able to mobilize [3, 8] as well as the experience of previous similar experiences [4, 7]. There are also variables related to the type and beginning of the disease, expected results, and the level of dependence of the person who receives care [9].

The worsening of the functional level and the poor quality of life of the patient have a great impact on the family caregiver (FC) overload, not only because they require more time and requirements (physical, psychological, emotional, and economic) and also because family carers tend to have more concerns regarding meeting the needs and expectations of their sick relatives at the expense of their own needs, thus "forgetting themselves" [10].

In the face of a health-care transition experienced by a family member, care is usually provided by an informal support system (family or significant person), in which an individual assumes the unpaid responsibility of care with occasional support (instrumental, financial, and emotional) from other elements of the family [11, 12]. The literature presents several denominations for the family individual assuming these roles: informal caregiver; family caregiver, and primary caregiver. The first designation (informal caregiver) essentially aims to differentiate them from formal care, given by paid health professionals (e.g., nurses, doctors, and physiotherapists), both in public and private services. The designation of family caregiver refers to relationship of kinship, ties of consanguinity and affections with the person cared for. The term primary caregiver seeks to distinguish the person from the group of family members who participate in care, assuming the role of coordination and greater responsibility.

But irrespective of the designation, it is desirable that in the family, there is intergenerational collaboration among several members in the care for the dependent person, because it enriches the approach and care provided, also contributing to prevent and attenuate the caregiver's overload [11].

The selection of the person who usually takes care of the elderly person with self-care dependence essentially reflects four major criteria: gender (woman), kinship (spouse, daughters), physical proximity (living together), and affective proximity (conjugal). Although informal support has particular roots in the family system and/or affective bonds, the way a family member becomes FC does not always result from a willing decision, but from a "moral and social obligation" aggravated by a growing tendency by the aggressive and austerity policies (health and social security) to delegate to the family the responsibility of caring for their elderly dependent relatives [13].

In a sociological research on the role of the family and social networks in the production of well-being, it can be seen that in present societies, and particularly in the countries of southern Europe, intergenerational aid is processed essentially in a descending direction (from parents to children) and has still great relevance in domestic work, in the health care of children and the elderly. However, care for the elderly is a supportive area where aid clearly flows in an inverse flow (from children to parents) and the activated links are fundamentally feminine, showing that "what is mobilized is not properly the family, but rather women in the family" [1]. In fact, despite the many socio-political transformations and consequent changes in the family system in situations of illness and incapacity of one of its members, the female member continues to emerge as the main caretaker [1, 6, 10, 14, 15] because presently this duty is socially expected from women.

In countries where aging has been more significant, especially in southern Europe, where the number of families composed by very old couples has become expressive, it is increasingly frequent that continuity of care within the family is given by elderly caregivers, particularly women who care for their husbands, in fragile health and themselves having some type of handicap [6, 16, 17].

In several cultures and in particular for the Portuguese population in a situation of dependence, the family is the dependents' first choice. Institutionalization has a negative connotation and is only accepted when there is no alternative. In fact, in cases of illness and disability affecting the elderly, the family and home are the first choice for a large number of elderlies in order to receive the care they need, implying a greater family support [18].

The transition to this new role not only involves changes in the individual's life and family organization, but also requires the acquisition of new knowledge and skills, in order to be able to respond safely to the (increasingly complex) needs of family members returning home after a critical event that generates dependency or after a worsening of their chronic illness.

As observed in [5], in 2000, health policies lead to increasingly early hospital discharges, with patients leaving hospitals in a very fragile state, making it difficult for the FC and the family to be adequately prepared for the new role in a short space of time. At the global level, this home services provision has been strengthened as an important measure for the sustainability of health services, and under these circumstances, most FCs do not feel prepared to provide the care their family member needs when the patient returns home [7].

Although in some contexts, health services at community level develop programs aimed at providing some continuity in the preparation and support of FC, usually more directed towards the instrumental care of dependent persons, literature has shown that families often perceive it as falling short of their needs [6, 7]. In fact, more and more families take responsibility for the care of their families, but support policies and (health and social) services do not provide them with the necessary support and help [7, 10].

At the beginning of this century, the scientific community has reinforced the importance given to the problem of caring families, and particularly regarding the members responsible for managing and caring for their loved ones that are not to able to care for themselves. The research results show that their difficulties (physical, psychic, social, and economic), have a

negative impact on their well-being and health, hindering or impeding an adequate transition to the role of caregiver [8, 18–20].

Using an advanced nursing perspective, the process of breaking away from the biomedical model that still characterizes health care in several countries as well as incorporating the evidence produced on a caregiving family approach, health professionals, and specifically nurses should direct their practices to the family member caregiver who is considered as a care client and an authentic care partner and not just as a resource to ensure continuity of care for its dependent members [21]. In this context, the preparation to return home should be a central concern both in the hospital and in the community context [22]. Home-based care is the proximity care preferable of the population; so, nurses should help families in the transition process experienced when one of their members is afflicted with chronic illness/dependency, accompanying the family/family caregivers wherever they live in order to develop this new role, giving support and managing the resources (internal and external to the family) according to the identified needs (both for the person cared and for the family), facilitating them to make a healthy transition and consequently to rediscover a new balance.

The preparation of the family caregiver at the level of the cognitive knowledge, skills, and competences associated with the caring process is one of the strategies identified to reduce the overload. The most recent literature has echoed some implemented programs (in an anticipatory care approach) to respond to the needs of the family/FC, aiming at preventing overload in the person who is most involved in the provision of care. Although studies have reported some benefits associated with interventions (care training, education and counseling, problem solving, psycho-educational support, coping strategies, information, and help groups), studies are very heterogeneous and reveal methodological weaknesses lowering their level of evidence [18, 21, 23]. The scientific community faces the challenge of developing clinical trials of high methodological quality to produce evidence with transferability potential for decision-making in clinical practice.

Taking into account that the elderly of the next decade are the current adults, with experience in the use of new technologies, it is pertinent that health services can optimize this resource as a complementary intervention, both for the elderly and for family caregivers. Although the research on this subject is still very incipient, the results obtained in a quasi-experimental study (pre and post test) using the conceptual framework from Meleis's theory of transitions [8, 24], show that tele-health care associated with a structured plan for the preparation of hospital discharge presented promising results in reducing FC overload and improved the mastery level with which FC in the intervention group were able to manage stress [25].

2. New technologies: a path to the future

In recent years, as a result of demographic evolution and the global aging of the population, changes in policies paradigms have taken place, namely the privatization of some services that provide care, the reinforcement of home support services, and the use of Information and Communication Technologies (ICT) [26, 27].

The use of ICTs for health organizations is today one of the most important resources. The value of technology comes from the capacity to use it, resulting not only from the information provided, but also mainly from its interpretation. It is necessary for health professionals to value the flow of information they access and to derive benefits from them to add value to the care they provide. On the other hand, the technology has an important utility represented by the remote connection when the groups or individuals geographically disperse [28].

In contemporary societies, the use of ICT is a relevant engine of innovation. Information Technologies have become a key tool for updating administration, making it possible to improve efficiency, incorporating and making available services and anticipating needs [29]. Its relevance stands out for both the handling of information and document management, as well as the provision of services to the citizen (even when they are face-to-face).

Society is facing enormous socio-economic changes. These include the great changes in living standards and new social behaviors, with the subsequent competitiveness of organizations as a result of the recent strategic resources of the twenty-first century, namely the development of ICT.

The major challenge that continues challenging the healthcare institutions relate to how to focus the provision of services on the citizens, structuring these services around their needs [30].

The scientific background points to a growing use of educational platforms for citizens' health education. The Internet is considered a privileged means of communication and information used to interact with the population in need of health care.

The great Internet revolution arrived through the Internet of Things (IoT), defined as the technological revolution of everyday objects interconnected via the Internet. The main purpose is to connect through sensors means of transport, clothing and watches, among other things, without human intervention. This means that the IoT will allow the interconnection of real-world objects with the virtual world through wireless (RFID) sensors. With IoT, the equipment is controlled and monitored remotely and is usually wireless. These sensors are capable of connecting household appliances, transport facilities, clothing and everything else, running without batteries. According to the report of the International Data Corporation (IDC), it is estimated that the quantities of these sensors will reach 30 billion in 2020. By IDC predictions, the IoT will be included in 212 billion things globally by the end of 2020 [31]. The main objective is to provide intercommunication of objects among them, exchanging information about status, location, functionalities, problems, etc. Algorithms will be responsible for processing this information, generating a large amount of data that will be stored on powerful servers in the cloud. The IoT is considered a global concept that will evolve from Machine to Machine (M2M) and other technologies.[1]

In future, several sectors will use Machine to Machine (M2M) applied, in particular in the health sector. Its application includes electronic health, m-health, telemedicine and assisted

[1]Machine-to-Machine is where "machines" use network resources to communicate with the remote applications' infrastructure for monitoring and control purposes, either of the "machine" itself or the surrounding environment. The potential interconnection of intelligent objects and the way we interact with the environment is how the Internet of Things is imagined, where the physical world will merge with the digital world.

living. Clients with non-critical health conditions can be monitored with sensors (e.g., blood pressure or blood sugar levels), sent home and supervised remotely by medical staff, and clients can often be instructed on how to interpret the data by themselves. It is important to emphasize the importance of these mechanisms in situations of remote surveillance of elderly people. Both scientific evidence and organizations such as the WHO and the EU have been urging member states to implement information and communication technologies in health care units. It is important to highlight the importance of introducing the new information technologies in health, not only in instruments for health organizations and professionals, but also in individual health plans, in particular in diagnostic and prevention instruments (e.g., blood pressure monitors), health care treatment and management devices and programs (e.g., smartphone devices).

The contribution in Ref. [32] regarding the development of a conceptual framework of information quality of a health platform defines quality dimensions and associated drivers specified for the education of an adult population. The five dimensions of health information quality were identified: completeness of information, understanding of information, relevance of information, depth of information, and accuracy of information; and the main driver themes: content, design, links, consumer resources, search functionality, supporting references, user focus, content FAQ, open access, policy statements and website performance.

It is now evident that technological developments keep pace with the aging of the population and provide important opportunities. For example, the Internet may allow for continuous connection between family members despite distance, access to information that can guide an older person's self-care or support caregivers. Support resources are more functional and accessible than in the past and handheld devices provide new opportunities for personalized health care and monitoring [33]. Thus, these social and technological changes lead to the need of redefining policies in order to benefit from the new opportunities that innovative approaches provide.

2.1. The paths of technological innovation

Political, economic, and social actors increasingly recognize innovation as a means for the sustainable development of organizations, thrusting their access to international markets. Innovating means creating new things, but in the opinion of [34], the innovations correspond to new creations with economic or social significance, mostly made by companies. They are the result of interactive processes among the multiple actors that are part of the innovation system, namely innovation in products, services, companies, public administration or society. Thus, innovation in organizations is related to the implementation of new ideas, whether related to new products or new business opportunities [35]. Innovation must be part of the DNA of winning organizations [35].

According to the OECD [36], innovation is already an important factor of economic growth in countries such as Sweden, Finland, or the United States of America. According to the calculations of this organization, in these countries, the investment in intangible assets (R&D, software, databases, patents) is already equal to or greater than the investment in physical assets (machinery, equipment or infrastructures).

Two of the great theories driving innovation are Technological Push and Demand Pull. The first theory, defends the idea that economic development is driven by innovation, where, through a dynamic process, new technologies, new skills, and new industries replace those that once dominated the market. This method wastermed "creative destruction" [37]. In this theory, the ideas that precede the creation of an innovation result from scientific research and the accumulation of the knowledge generated by it, and these ideas are not necessarily associated with a market need. The technology push theory is thus well identified with the linear model of innovation (pipeline) where, in a unidirectional sense and in a phase continuum, innovation starts in scientific research, advancing then to development, production and finally diffusion, with no feedback at any of these phases [34].

Based on the economic theory of market failures, governments have been promoting innovation by directly and indirectly supporting scientific research and the development of its results, in line with the idea that increasing the number of laboratories, researchers or registered patents should lead to an increase in the number of innovations and, hence, in sales, resulting in economic growth and job creation.

Examples of public policies for technology push include research and development (R&D) support, investment in infrastructure (laboratories), tax benefits for companies investing in R&D and support for education/training of researchers.

From the point of view of the demand-pull (or demand-side) innovation theory, it is argued that the capacity to generate innovation is dispersed throughout society and all its "actors" often require market demand for these innovations. For the demand-pull theory, demand is the main gravitational force that attracts resources and skills to innovation in order to meet social or market needs. Thus, a demand-side public policy seeks to increase demand and stimulate companies to respond to the needs of end users (market). It should also seek to reduce (legal, regulatory, and procedural) barriers to innovation, to stimulate end-users to adopt innovations, and to promote the emergence of new markets [37]. The process of innovation is thus achieved by numerous and complex factors. The enterprises rarely innovate sole, but through interaction with other organizations/institutions, they learn and transfer knowledge. These interactions between actors acting in different institutional contexts are therefore crucial to the process of development and diffusion of innovations [38].

In recent years, interest in holistic innovation policies (including the entire innovation cycle) has increased, recognizing the importance of interaction between the different elements of this process [34].

Demand-side innovation policies have an influence on the market; the main foundations for their use according to [39] are to overcome system and market failures and solve key societal challenges.

In Ref. [37], a study presents some examples where the effect of demand and lead users was decisive for the emergence of a new technology/innovation, among these, the Internet. Initially, the work that led to the development of the internet was done to meet the special needs of the US Department of Defense. After the development of the technology, a group of

scientific researchers who had worked on that solution used it to establish communications between research laboratories.

Thus, it is essential to introduce the definition of Public Procurement of Innovation (PPI) referring to the public purchase of innovative products or services. It occurs when a public institution places a purchase order to satisfy certain needs (or functions of public responsibility) of a product or service that, although it does not exist at the moment, can be developed in a reasonable period of time. The primary objective of the PPI is to respond to problems in society. It is proposed that it may contribute to the development of knowledge about the user's personal experience, based on the available results [40].

Innovative situations, including ICT, have the potential to contribute to the provision of high quality and personalized healthcare while simultaneously increasing the efficiency of our care systems. Due to research studies that emphasize the need to include strategies that integrate interactive educational technologies in the training of people in the organizational contexts [41–44], it becomes a challenge to implement and highlight health policies that include the training and application of educational technologies and their dominance in the educational processes of users and families.

The World Health Organization's World Health Report on Aging states that between the years 2000 and 2050, the number of people aged 60 and over will double; and that by 2050, more than one in five people will be over 60 years [33]. Against this backdrop, the report addresses these challenges, recommending equally profound changes in the way health policies should be formulated and health services delivered to aging populations. Some of the important recommendations to be considered include the need to make an individual assessment taking into account that the factors influencing the health of the elderly are in equal proportion individual (behaviors, age-related changes, genetic factors, and diseases) and also related to the environment in which they live (housing, support technologies, transport and services, and social and health support). Promoting healthy aging involves changing attitudes about aging and the elderly, creating environmentally friendly environments for all ages, adapting health systems to people's needs, and developing long-term care systems [27, 33].

WHO defines active aging as the process of optimizing health, social participation, and safety opportunities in order to improve quality of life as people age [45]. Europe is known for its capacity for innovation and its future involves the development of actionable initiatives, among which the "Innovation Union" is highlighted. Part of this strategy is the production of smart, sustainable, and inclusive growth that translates into tertiary quality care for the elderly [46, 47].

One of the initiatives carried out by the Innovation Union was the creation of the European Innovation Partnership on Active Healthy Aging, (EIP-AHA)[2] [48]. Under this EIP-AHA [48] partnership, innovative ICT-based solutions should play an important role in achieving the objectives. Its strategic implementation plan sets out the priorities for accelerating and

[2]EIP-AHA access: http://ec.europa.eu/research/innovation-union/index_en.cfm?section=active-healthy-ageing&pg=about

intensifying innovation in the field of active and healthy aging across the EU in three areas: disease prevention and health promotion, health care and treatment, autonomous living and social inclusion. Thus, the objectives of the innovation partnership by 2020 are to allow citizens to live longer with good health, to increase their average number of healthy years by two years (number of years a person of 65 can expect to live without limitations), and achieve this goal by improving the sustainability and efficiency of our social and health systems, creating a market both in the EU and globally for innovative products and services with new business opportunities [49].

In Portugal, there are institutions and researchers that are part of this European Partnership, seeking to carry out initiatives, scientific research, and technological applications that promote general well-being and healthy aging, namely Ageing@Coimbra which is a consortium aimed at enhancing the role of the elderly in society and the application of good practices for general well-being and active and healthy aging. It is considered by the EU as European Reference Region for Active and Healthy Aging, a unique status within the Portuguese territory. It acts through the following action groups: adherence to therapy; prevention of falls; prevention of frailness; remote health monitoring; and elder-friendly services [50].

Simultaneously, in order to respond to this challenge, the concept of Ambient Assisted Living (AAL), which aims at the application of ICTs in the health field, results from the fusion of areas such as science, technology, health, and engineering. In this way, the AAL concept aims to increase the time the elderlies can live in their preferred environment, with autonomy and independence, through assistance in their daily activities [51]. In practical terms, AAL systems help prevent and classify situations such as falls, physical immobility, day-to-day activities, health parameter monitoring, and behavioral analysis. In general, the following objectives can be defined to respond to the concept of AAL: (1) to extend the time that people can live in their preferred environment, increasing their autonomy, self-confidence and mobility; support the maintenance of the health status and functional capacities of the elderly; (2) promote a healthier lifestyle for individuals at risk; (3) increase security, prevent social isolation and support the maintenance of a multifunctional network around the individual; (4) support caregivers, family members and care organizations; and (5) increase the efficiency and productivity of resources used in aging societies [52]. Some examples of home care projects will be presented considering the abovementioned background.

Thus, the project AAL4ALL[3] presents an idea by developing an ecosystem of products and services for Ambient Assisted Living (AAL) associated with a business model and validated through a large-scale pilot study. The project aims to bring together key stakeholders (public institutions, industry, user organizations, and R&D institutions) to discuss the definition of a basic set of AAL services of general interest. Analysis of standards, as well as other existing international activities, is the key principle of the project to avoid reinventing the wheel, focusing all efforts on implementing solutions to identified gaps. The definition of reference models for different environments will serve to reduce the risk of investment and to shorten the time-to-market of products and services developed in the future. The project is broken

[3]Project AAL4AAL link: http://www.aal4all.org/?lang=Pt

down into a number of areas that respond to the challenges and market segments for products (home and mobile users, ICT and logistics services, and users of care providers) in an integrated way.

The *European Joint Action*[4] is a project aimed at the prevention of chronic diseases, in particular cardiovascular diseases and type-2 diabetes. One of the fundamental objectives is the development of a platform for the exchange of knowledge, providing a more advanced updated repository and best practices on chronic diseases.

The project *Valorisation of Innovative Technologies for Aging in Europe* (VInTAgE)[5] was born in response to the i2010 European Initiative on Inclusion. The project aimed to propose innovative solutions to make information and communication technologies more accessible and attractive for the elderly, promoting benefits for their quality of life and independence in respect of them.

The Fall Prevention Project: For an active aging in community, two European cities (FP-FAAC:2EC)[6] aim to contribute to active aging through the prevention of falls and associated injuries. It is being developed with national and international partners. At a national level, they partner with a group of Health Centers of Porto and at international level, the University of Cordoba. The orientation of the project is based on a methodological approach of action-research, focusing on the process centered on praxis, seeking to change the practices in use, together with the actors of the contexts.

The project *Interactive Educational Technologies for Family Carers* (INTENT-CARE)[7] is a platform aimed at family caregivers who care for dependent people. Innovative solution is selected to be a part of the platform: Innovation Procurement Platform—AHA Innovative Solutions of the European Commission. It is proposed to contribute to the development of knowledge about the personal experience of the user, based on the available results. In addition, this knowledge is intended to help meeting user needs in order to increase the use of technologies. This project aims to develop and validate an interactive tool that allows specific information to be provided to family caregivers of people with dependency that complements their orientation and promotes their autonomy. The main innovative element will be the interactive design of the platform allowing a quick response to the needs of the user, aiding in the decision process and the selection of the most relevant information. The contents will be constructed focusing on the basic needs of daily life, in order to overcome difficulties regardless of the clinical diagnosis of the patients. This platform will be supported by demonstration videos of procedures and audio documents. Family caregivers already supporting dependent family members will enact videos to be produced to this end. Through the reliable information that the platform provides, adapted to the needs of family caregivers, this technological tool is an important facilitator to improve the care provided to dependent people. The current socio-professional context advocates the adoption of multiple resources and health policies that promote the

[4]European Joint Action link: http://www.chrodis.eu/
[5]VInTAgE link: http://www.vintageproject.eu/index.php/pt/pthome/7-general/67-itthevintageproject-2
[6]Project developed for professors from ESEP. FPFAAC link: http://www.esenf.pt/pt/i-d/projetos-internacionais/fp-faac/
[7]Project developed for professors from ESEP. Intent-Care link: http://www.esenf.pt/pt/i-d/projetos-internacionais/intent-care/

training of family caregivers, contributing to the sustainability of the National Health Service. This research suggests new educational strategies aimed at the family caregivers, using information and communication technologies [53].

One of the platforms developed within the framework of active aging is the "Aging well academy,"[8] a new online platform that aims to be a reliable source of information and counseling for seniors and caregivers on health prevention for the senior population promoting active and healthy aging. Developed by Porto4Ageing, the Center for Excellence in Active and Healthy Aging coordinated and promoted by the University of Porto and Porto City Council, this project aims to fill the gap in Portugal regarding the lack of reliable tools on health for the elderly, providing information on issues such as vaccination, healthy living habits, and adequate use of antibiotics.

The Porto4Ageing[9] was also responsible for selecting the Porto Metropolitan Area as one of the 74 reference sites in Active and Healthy Aging throughout Europe since 2016. The Porto4Ageing consortium has the specific objective of being an aggregating center and a forum for the discussion of issues related to active and healthy aging in the Porto metropolitan area, bringing together the various regional actors who work and who have an interest in this area, already comprising more than 90 partner institutions from four different profiles (universities and research centers, policy makers, users and industry). This quadruple-helix partnership, which involves different stakeholders (decision makers/caregivers, business/industry, academia/research and civil society/users), who are well placed to drive structural change, is far beyond the scope reachable by one organization on its own, in order to innovate and test in real-world contexts.

The HEARTEN project[10]—the HF collaborative tool for HF management, a project developed for people with heart failure. The HEARTEN project is designed to give heart failure patients extra support in everyday tasks and routine. According to an agent from the European Heart Network, this contributes to improving patients' overall quality of life.

The eWALL[11] is the outcome of a EC-funded project that contributes to the prolongation of independent living of various patient types and senior citizens. Unlike traditional eHealth/eCare solutions, eWALL offers a new experience to the users by creating Caring Home Environments based on advanced sensing and reasoning in an unobtrusive way.

The "Active Ageing at Home"[12] (AA@H) project delivers services to improve quality of life for elderly people by means of ICT solutions based on AAL paradigms, building a comprehensive platform. The proposed scenario includes a set of AAL solutions available to the seniors. It means to improve the sense of safety and comfort perceived by self-sufficient elderly people, and to foster active aging behaviors in their home environment. The key concepts of AA@H

[8]Aging well academy link: http://24.sapo.pt/tecnologia/artigos/academia-do-bem-envelhecer-a-plataforma-que-promove-a-saude-e-vacinacao-na-terceira-idade

[9]Porto4Ageing link: https://noticias.up.pt/porto4ageing-participa-em-tres-projetos-de-promocao-do-envelhecimento-saudavel/

[10]HEARTEN project link: www.hearten.eu

[11]eWALL project link: http://ewallproject.eu/

[12]Active Ageing at Home project link: http://activeageingathome.eresult.it/

are adaptability (seniors' needs change in time and the system adapts to variable requirements) and personalization (seniors can choose among a set of services and design their own support platform).

In addition to these programs, we list some proposals for ongoing activities, initiatives focusing on physical exercise (Portuguese National Walking and Running Program) and nutrition (*Health Ageing with Innovative Functional Foods/Needs for degenerative and metabolic diseases /INOVAFUNAGEING and Bioactive Natural Food Ingredients for aging-people functional diet/ NutriBioFun)* [54].

It is important to use examples of experiences from different countries to illustrate how specific situations can be addressed through innovative solutions. These solutions range from comprehensive care strategies focused on older people to health policies that enable older people to live with wellness and safety.

New technologies must be designed to allow interaction and meeting people's needs [45]. They do not replace face-to-face education with distance education; they are rather intended to move into a situation of interaction with other alternative forms of learning where professionals, patients, caregivers, and organizations are considered potential learning subjects [32, 55–57]. Technology has the potential to help patients and caregivers to become more autonomous in managing their own health and care [53, 55]. The Internet can be used as a complement to the provision of information through a helpline associated with a broad program of health promotion strategies [58]. In these studies, the use of educational technologies as a caring activity can be an innovative way of experiencing, in a healthy way, the transitions of the dependent person and the family caregiver. Thus, it is necessary to advance in more evidence-based ways, recommended to be used in the health area. Its use is a valuable resource in the educational strategies adopted by health professionals in the training of dependent people as well as family caregivers.

3. Recommendations for the development of new technologies for the elderly and their caregivers

ICT and the Web are resources with a strong impact on people's lives and well-being. The computer, the mobile phone, and the tablet are today's examples of essential work equipment, which are also used in leisure activities. Many of us cannot imagine our day to day life without these devices. The older population and those caring for them (usually with a close demographic profile) have had a more modest use of these resources due to the limitations associated with aging and the fact that they have not had prior used these technologies.

However, the use of ICT and an accessible Web can directly or indirectly support (through caregivers) social participation and independence at more advanced ages. There is a need to create more inclusive and facilitating measures for older people and their caregivers to also have access to information technologies and other electronic devices that facilitate a better quality of life. Some studies emphasize that the elderly have an interest and possibility of

achieving good interaction and mastery in the use of technologies, improving their social interaction and mental stimulation [59, 60].

Physiological changes, associated with the aging process, determine a wide range of functionality and disabilities in the elderly, which may limit the use of new technologies. However, elderlies could get more value in the use of computer technologies and their role in communicating with others, their usefulness in risk management as well as functionalities that provide more well-being. Hence, the need to rethink and devise strategies promotes the inclusion of older people in this process.

Thus, there is a need to look at the process of aging and the physical, emotional, and social changes associated with it. We will only address the most relevant and which may become obstacles in the use of technologies. These include sensory decline as well as reduced attention and working memory.

Vision and hearing are two senses that undergo significant changes during the aging process. From the age of 40, humans begin to have more difficulties in reading a text with small print at a short distance. The eye loses the ability to detect fine details, loses contrast sensitivity, and the ability to distinguish similar colors. Between 40 and 80 years, contrast sensitivity may decrease to less than 83%. It is easier to see red and yellow compared to blue and green, and it is difficult to distinguish darker blue from black. There is pupil shrinkage, resulting in a greater need for light, and a decreased ability to adjust for changing light levels. For example, at age 60, the retina receives only 40% of the usual light (compared with the retina at age 20) and, at 80 years, it receives only 15% of the usual light [61]. There is also a progressive reduction in visual field with loss of peripheral vision.

At the hearing level, there is also a gradual impairment with age, with an increasing inability to hear high-pitched sounds.

Also mental and motor skills, namely dexterity, decrease with age. The presence of incapacitating pathologies such as arthritis and Parkinson's disease, hinder or even inhibit the use of technological equipment, such as the mouse, pointing devices and even the use of the keyboard [61].

Aging changes the way we think. The ability to simultaneously recall and process new information, perform complex cognitive tasks, and understand text can be hampered, making it difficult to use computers and other electronic equipment. Some people may have a clear thinking process in their 80s, while others already have severe cognitive impairment at 60. Despite this variability, three areas are particularly relevant in the development of technologies for the elderly: memory, attention, and decision-making [62].

There are different types of memory. These are differently affected by the aging process. For example, procedural memory (that is, remembering how it is done) is usually not affected. People can learn new skills and reproduce them over time. But other types of memory are affected as we age. Short-term memory and episodic memory are the most vulnerable. Older people often find it difficult to handle the content of their working memory. This means that they may have trouble understanding how to combine complex new concepts into a product

or interface. Prospective memory (remembering to do something in the future) is also affected. This is particularly relevant to the usual tasks, such as remembering to take medications on time every day. Older people use paper records or calendars as memory aids to remember appointments, tests, and other future events, while younger people turn to electronic calendars and synchronize a set of applications that automatically update [62].

The pace of task execution is substantially slower with age. The elderly require more time to complete the tasks. Older people are less capable of dividing attention among multiple tasks. Regarding the design and development of technology products, the option for solutions that help people focus on one thing at a time may have benefits for all age groups.

Young people tend to weigh many options before choosing one. Older people base their decisions using other mental schemes, choosing in particular what enhances their prior knowledge and also pay attention to the opinions of experts (for example, their personal doctor for health decisions).

However, aging does not only have to be associated with negative aspects, but it is a stage of life in which it is necessary to invest in the full potential to carry out actions that allow the inclusion, participation and experience in a family and social context giving the maximum quality of life.

Older people are usually alert, persistent, and dedicated to learning what they recognize as interesting and accessible to their abilities [62]. Pickering [62] uses a funny expression regarding the attention of older people compared with young people, noting that the average person's attention has fallen below the level of a goldfish. The author notes that older people interact differently with the world and often find meaning and pay attention to things that younger people ignore.

Most creators of electronics, applications, and websites are young people who design interfaces based on commonly known concepts and features. The technological industry places its bets mainly on products for young people since they are their main clients. Most young people grew up playing, studying, and making use of a large number of equipment and applications. But many of the older ones lived without computers and may have never had contact with interface elements that we consider mundane. In the development of equipment, app and websites, there is usually little sensitivity to the physical and psychological problems of the elderly. However, it is important to pay attention to the detail that in the next decade, the number of elderly people with technological illiteracy will decrease substantially.

Accessibility and usability are two central concepts in the design and development of materials and technological equipment. Accessibility refers to the ease of accessing a given resource, even if architectural barriers, communication availability, physical access, adequate equipment and programs, content and presentation of information in alternative formats are created. Usability is defined by the International Organization for Standardization – ISO 9241, "The extent to which a user can use a product to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context" [63]. The greater the ease of learning and memorizing, the faster the tasks are performed, the lower the error rate and the higher the user satisfaction and the usability the interface has. As considered in Ref. [59], usability is the

ability of the software to allow the users to reach their goals of interaction with the system. The principles of good usability are: to be easy to learn, to allow efficient use, and to present few errors [59].

The first recommendation given by Pickering [62] is that the development of a technological product must be based on intuitive bases and it should not require prior knowledge. As per Ref. [59], it is recommended to keep a good contrast between the page background colors and the text.

Very bright backgrounds that completely obscure the dark letters should be avoided. When the background color of the web page is very bright, the elderly people find it difficult to perceive the text. A study in Ref. [59] suggests that in order to be more favorable for the elderly, web interfaces should appear with clear letters on a dark background with low brightness. It is convenient to avoid blue as the interface color and pay attention to the contrast indexes related with the text. The yellow, blue, and green tones should not be used nearby to each other.

The text view should have a font size compatible with the characteristic limitations of old age, being the most recommended a font up to 16 pixels that the user can adjust depending on the device and the viewing distance (National Institute on Aging and the National Library of Medicine, Making Your Web Site Senior Friendly, 2002 https://www.nlm.nih.gov/pubs/checklist.pdf). A sans serif font (Helvetica, Arial, Univers, or News Gothic) is a good choice (Making Your Web Site senior friendly). The text should be written in uppercase and lowercase letters, using only uppercase and italics in titles or headlines. A double spacing should be used in the body of the text, favoring rapid eye movements for the jumps between the end of one line and the beginning of the next.

The alignment of the text should be done by the left margin, as it favors reading by creating uniform spaces between words and by allowing jumps between the end of a line and the beginning of the next line [63].

With age, the elderly loses the ability to understand a text. Thus, the information should be clear and simple. To reduce the number of inferences in message comprehension, it is necessary to use positive statements using the active voice and avoid unnecessary punctuation marks. The information must be chained following an argument and logical order. Computer applications should use familiar words, phrases, and concepts, rather than technical terms. If the text includes technical terms, a glossary should be made available. The content of the information should be organized into shorter sections and segments, facilitating download time on older equipment. Elderlies usually have outdated equipment with less power.

The most important information should be placed in the upper left corner in the cases when the screen contains a lot of information. If the screen does not have much information, it can be placed in the central part.

Only relevant images should be used. Providing alternative text information with animation, video, and audio is generally well received by all users, including the elderly.

Study regarding contents for elders in Ref. [59] recommends avoiding the use of links in the middle of content that have associated the opening of other windows. Older people may get lost and disoriented by opening multiple links in new windows as it increases the set of actions to reach a goal or accomplish a task. The opening of new windows increases the perceptual and cognitive load of the elderlies. It is recommended that only one link can be opened from the primary page. This respects the perceptual, cognitive, and motor capacity of the elderly [59]. By decreasing the number of pages the user has to access, the workload and the probability of errors will be reduced.

The use of scroll bars to access longer text may be interesting, but this mechanism should be very visible and intuitive in its use.

Equipment with touch screen technology may be less user-friendly than equipment that uses buttons and keys. Thus, equipment should be simplified and tools such as fields and forms should be avoided. They should have a separation distance between interface elements of less than 2 mm [62]. Ref. [62] recommends that the buttons on the touch interfaces should be at least 9.6 mm diagonal (for example, 44 × 44 pixels on an iPad) for ages up to 70 and even larger for older people. Interface elements to be clicked with a mouse (such as forms and buttons) must be at least 11 mm diagonal.

When using icons in an interface, the number of elements and colors must be reduced in order to allow them to be identified and understood. Images must be enlarged and associated with textual labels. It is recommended to use large, legible, and significant icons that are easily discriminated and labeled.

The product must be tested on a screen reader and must provide captions whenever video or audio content is critical to the customer experience.

Sites must have a navigation map, allowing for greater understanding and guidance. The site map should clarify the organization of the site.

Security issues in accessing accounts that involve verification and validation procedures, reading difficult codes and letters are rarely recommended in the elderly. Also, validation issues that involve issues such as your preferred color, or a significant date may be confusing and demotivating for the older users. For those reasons, security processes must be streamlined and carefully considered.

In summary, we can conclude that there are a set of recommendations for the creation of applications, equipment, and websites for the elderlies that aim at their improved participation and social inclusion. A large proportion of elderly people present severe handicaps and changes in their functionality and they depend on third parties for a set of activities. These technologies can play an active and decisive role in the caring process. The previously described INTENT Care project (http://www.esenf.pt/pt/i-d/projetos-internacionais/intent-care/), is an example of this trend. The technologies associated with the care process should not replace professionals, but rather represent a resource that facilitates their approximation.

The emergence of technological products has come up at an accelerated pace creating an inability to keep abreast of all the proposals. Another problem that has recently appeared

is related to the difficulty of articulating the different technological solutions due to the fact that they have different operating systems and present incompatibilities when used jointly. Therefore, it is desirable in the short term to develop criteria for the greater operability of technological products, in particular computer applications. The constitution of a set of free access technology repositories will be another relevant aspect for the creation of synergies in the field of active and participatory aging.

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