AGING SOCIETY AND GERONTECHNOLOGY: A SOLUTION FOR AN INDEPENDENT LIVING?

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Abstract: Recent studies report that the majority of older adults wish to live in their own homes, for as long as possible. This creates a growing interest in technologies to enable older people to remain living independently at home. The purpose of this article is to provide a narrative review of current technology appropriate for older adults' home use. The key research questions were as follow: 1- What is the evidence demonstrating that gerontechnologies are effective in enabling independent living? 2- What are devices designed specifically for frail elderly persons? Several publications were identified about devices targeting social isolation (videophonic communication, affective orthotic devices or companion-type robots, personal emergency response systems [security]), autonomy loss (technologies for maintenance of autonomy in the activities of daily living) and cognitive disorders (cognitive orthotics, wandering management systems, telemonitoring). Very few articles dealt specifically with the frail older person. In particular, there was extremely limited evidence on use and efficacy of these devices within this population. There is a need to obtain a consensus on definition of the technologies, and also to revisit work strategies and develop innovative business models. To meet this goal, we need to create a network of technological companies, aging services organizations, end-users, academics, and government representatives to explore the real needs of the frail older population and to develop and validate new devices promoting aging at home.

Key words: Frailty, elderly, technologies, home, review, disability, evaluation.

Introduction

Alternative ways of monitoring and support are needed for people growing old in their own homes. Chronic conditions are common in older persons and their prevalence increases with age (1). In this context, technologies can play a key role. Telecare, for example, offers an alternative to visits by healthcare staff to older disabled people which could potentially be avoided (2), even if its impact on healthcare access and quality of care remains unknown. Today, telesurveillance services can be deployed across a wide area. For example, the Veterans Health Administration introduced a national home telehealth program to coordinate the care of patients with chronic conditions and assist independent living at home, with promising results (3). Information and communication technologies (ICT) have the potential to alleviate some of the access barriers (organizational, geographic and financial) to medical services and improve quality of life (4). A study involving 223 caregivers of Alzheimer disease (AD) patients reported that ICT systems can be very useful in improving quality of life, care, and safety (5). Another study of caregiver requirements for robotic agent functions (6) showed very similar findings with special importance given to social contact, psychological and educational support, cognitive orthotic functions, and monitoring.

The avoidance of disability and institutionalization is a major priority from a public health perspective (7). To achieve this objective, it seems much more relevant to target frailty upstream, before disability sets in. Frailty is a common clinical syndrome in older adults that carries an increased risk for poor health outcomes including incident disability and mortality. It is considered as a reversible status, and so is still amenable to intervention (8, 9, 143, 144). Therefore, one can assume that technologies could prevent negative health-related outcomes by detecting early signs of deteriorating health (10). While telecare has shown some efficiency for various chronic diseases such as heart failure or diabetes, for frail people and the elderly with multiple comorbidities the findings are much more controversial (11). Very few studies concern frail elderly people at home, and most of them relate to information and support services and systems outcomes more than to individual outcomes. The largest randomized controlled trial (RCT) to assess telemonitoring of physiological data in elderly people with multiple illnesses (12) showed no benefit on emergency admissions and hospitalizations. Nevertheless, some authors (13-15) showed a possible benefit of a support network on potentially frail caregivers, and this could be a valuable way of preventing institutionalizations and disability.

It is also noteworthy that these technological tools have considerable potential commercial impact. Nevertheless, this potential is not yet fully realized because several barriers limit their wide implementation: complexity of the technologies (installation, training, maintenance, lack of interoperability between the different systems and interoperability to guarantee continuity of information), high costs, low acceptance from end-users (usability, intrusiveness), inadequate comprehension of user needs (technology-push rather than demand-pull approach), and sometimes ethical issues (stigmatization, intrusiveness) (16). Another barrier is the lack of evaluation.
and validation (17), especially regarding cost-effectiveness and efficiency. Experts and key opinion leaders generally agree that a major issue is the uncertainty about who will take charge of sustaining the economical and financial implementation of these systems in the population (18).

In this paper, we review the literature on technological solutions for aging at home. We particularly focused our research on prevention of disability in the frail elderly.

**Methods**

We conducted an extensive research on technologies aimed at preventing disability in frail older persons in the following bibliographical databases: Medline (no limit - May 2011), Google Scholar (May 2011), Cochrane database (no limit - May 2011), Embase (no limit - May 2011). Bibliographies of identified articles were hand searched for additional studies. The keywords used (alone or in combination) were gerontology, e-health, telemedicine, telehealth, assistive technology, smart home, health smart home, telecare, telehomecare, home monitoring, telemonitoring, telesurveillance, community alarm, social alarm, emergency detection, aged, elderly, and frail elderly. We completed the search with specific technical keywords such as fall detectors and Global Positioning System.

We examined the potential effects of technologies in terms of benefits to individuals, rather than system benefits which are much more dependent on the deployment context. Trials of any size were eligible for inclusion if they concerned elderly people or elderly carers. We specifically explored innovative interventions based on novel or existing technologies, excluding low technology devices (canes, walkers, phones without additional functions). We excluded from our review, technologies with very specific objectives, unless the main goal was to maintain autonomy of the elderly at home (such as sensory orthotic devices, technologies for housekeeping, domotics, cognitive simulation systems, or mechanisms for chronic disease management). We limited our research to clinical trials, meta-analyses and reviews published in English. Due to the lack of quality evaluation in this domain (11, 19), we also selected peer-reviewed articles and conference contributions.

We identified 1246 publications. For the selection process, two reviewers selected publications on their title and secondly on their abstract using predefined selection criteria. One reviewer made the final selection based on the full text articles. Finally, 184 publications were included in our review. Additional publications were added based on free search and from reference lists. Due to the lack of traceability and homogeneity of the technological studies included, as compared to the usual medical publication standards, the results were summarized in narrative form. We did not classify the studies according to the type of evidence or the type of technology used, but according to elderly and carer needs (20).

**Results**

Research on technological solutions is mainly dominated by chronic obstructive pulmonary disease, diabetes mellitus, heart failure and other chronic conditions, but also by assistive devices for patients with stroke and systems for monitoring various medical symptoms. Very limited evidence is available about the application of technologies in early prevention of physical disability. In the publications reviewed, there is usually limited data about population description and a lack of standardized frailty assessment. Current evidence seems to be increasingly based on a medical model without meeting the required clinical standards for evaluation (11). Nevertheless, we found numerous studies on the general topic of technologies for aging at home. Most included robust volunteers in a laboratory or “living lab” context, or demented and/or disabled elderly in institutions or at home.

There are extensive variations in terminologies used between publications (Figure 1). For this article, we used definitions as follows: 1- Gerontechnology is concerned with research on different aspects of aging and exploits the potentials offered by the progress of technology (21); 2- Assistive technologies (AT), from wheelchairs to telecare or telehealth, cover any service or tool that helps to perform or to better perform a task (22); 3- Telehealth, telecare, telemedicine, telemonitoring, telesurveillance are overlapping terms often used interchangeably, and even if some differences exist, pragmatically they mean the use of technology to provide monitoring, care, or health services at a distance (11, 22). They range from user-activated community alarms to smart homes sensors; 4- “Smart homes” are residences equipped with all kinds of technologies that facilitate telemonitoring or telesurveillance and/or promote autonomy (10, 23-25).

Technology applications were classified by user’s need: devices targeting social isolation (such as visiophonic communication and personal emergency response systems), functional decline (technologies for prompting or maintenance of autonomy in the activities of daily living), and cognitive disorders and Behavioral and Psychological Symptoms of Dementia or BPSD (such as companion-type robots, cognitive orthotics, wandering management systems, telemonitoring).

**Social isolation**

**Social connectedness technology**

Cell phones and computers can be adapted and designed for the elderly and can have additional communication modalities such as prompting and video conferencing. E-mail and web portals can also be adapted for the elderly (18). These technologies can be used to supplement social alarms. By using videophone technology, the quantity and quality of conversations between the person with cognitive impairment and others could be enhanced (26).

It is also interesting to measure interpersonal interactions