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Use of assistive technologies in daily life: A portrait of current knowledge

Pierre-Yves Therriault, Marie-Michèle Lord, Alexe Desaulnier, Galaad Lefay

ABSTRACT

Assistive technologies (AT) are increasingly used in rehabilitation to support the fulfillment of client occupations, particulary the elderly. Indeed, the use of technology is now seen as an effective mean to meet various needs for this population. Several researches are concerned with assistive technologies, their use and design. This article aims to provide an overview of current knowledge about assistive technologies in rehabilitation. Several questions are addressed concerning the different actors concerned in the use of assistive technologies and the main families of AT considered in the literature. A synthesis of knowledge had been made with the methodology of interpretative approach of Pope et al. (2007). In addition to targeting the differents actors of the technological continuum, this review found that a varied nomenclature and classification are used when it comes to assistive technologies. It also pointed out that the design and use objectives of these technologies are different. Among other things, the study makes it possible to question the relevance of research in identifying a integrative model that can support the technological continuum and encourage the collaboration of various actors in order to adequately empower a person in the prospect of realizing meaningful occupations.

Keywords: Aging, Assistive Technology, Rehabilitation, Technology continuum

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INTRODUCTION

The field of rehabilitation for people with physical, mental and cognitive difficulties involves the participation of different health workers (for example nurses, occupational therapists, doctors). These professionals intervene in order to promote the development or recovery of the autonomy of their clients in the perspective of a greater social engagement. Rehabilitation services are various and are offered in specialized public or private institutions. Whether for children, adolescents, adults or the elderly, a diverse population has different needs in terms of autonomy.

According to the World Health Organization (WHO) [1], over a billion people, which corresponds to 15% of the world's population, are estimated to live with disability. More specifically, people 15 years and older having significant difficulties in functioning represent between 110 million and 190 million people. Furthermore, still according to WHO, due to ageing populations and an increase in chronic health conditions, the rates of disability are increasing. Unfortunately, people with disabilities have, still at this day, greater unmet needs. Thus, in future years, the social and community services offered to this group will need to be better adapted [2].

In rehabilitation, several strategies, such as training for specific skills, compensation with members of the entourage, use of cognitive orthoses, are used to support individuals with limited autonomy. The use of assistive technologies is one of these strategies [3].

Assistive technologies are defined as any commercially acquired, modified, manufactured, or personalized object, device or system that is used to support a person with functional deficits in daily life [4]. In accordance with this proposal, the term technology used in this article refers, in our words, to "any technical object intended to prevent, compensate, alleviate or neutralize difficulties in an individual". Barlow, Singh, Bayer and Curry [5] demonstrated that technologies are associated with reduced consumption of health services, Bouchard [6] pointed out that the use of technologies leads to an improvement in the daily functioning of the elderly. Khosravi and Ghapanchi [7] indicate that positives impacts related to the use of technology affect not only individuals, but also those around them, especially the caregivers and relatives. In doing so, the use of technologies now appears to be an effective strategy for reducing social costs while at the same time leading to improvements in the quality of life of users [8]. Technological advances now make it possible to consider environments that can, among other things, compensate for disabilities, support the person in his desire for autonomy and increase his sense of security. However, it seems that the transition of technology between the different actors concerned in the field of rehabilitation is difficult.

Objectives

The purpose of this paper is to provide an overview of current knowledge about assistive technologies in rehabilitation. More specifically, several questions are addressed: 1) What are the main actors encountered when it comes to the use of assistive technologies in daily life? 2) What are the main families of assistive technologies considered in the literature? 3) Why are these devices used?

METHODS

A review of the literature was carried out in 2016 according to the approach proposed by Fink [9] in several stages: a) selection of the databases to be explored; b) inventorying of keywords and descriptors, c) use of purification strategies to refine the search, d) use of selection criteria to choose the relevant texts, e) knowledge of the content of the texts and finally, f) analysis and classification of texts.

The corpus was first compiled using the periodicals available on the databases: Academic Search Complete, CAIRN, CINAHL, Cochrane Library, Google Scholar, MEDLINE, OT Seeker, PsycInfo, Sciences Direct and Web of Science. In order to identify the relevant documentation in the different databases, the use of several descriptors or keywords was necessary. The following terms have been used: "assistive technology" and "accessibility" or "rehabilitat" or "autonomy" or "health and wellness" or "cognitive assistance" or "health" or "social participation".

In order to control the number of texts identified from the key words and descriptors and to define which ones to retain, three inclusion criteria were applied. The first consists of selecting texts from peer-reviewed journalsfor validity. The second, only the writings published between December 2000 and December 2015 in order to know the most recent conclusions available in the literature at this time (literature review conducted in 2016). The third was to keep only French and English language articles. Subsequently, after removing the duplicates, the identified articles were screened by three evaluators. The titles and summaries of the articles were examined in order to identify the texts judged most relevant to the subject of the research. Once the screening was completed, the full texts of the selected articles were obtained and read in order to verify more in depth, using an analysis grid, their eligibility and relevance to the research questions guiding this study. To extract the data, all the selected articles had been confronted to the analysis grid. Data such as: 1). The reference 2) The technology discussed 3) The country where the study was conducted 4) The language 5) The population discussed. Data categorization has been made and compare between two research group to ensure the fidelity of the latter.

RESULTS

Results were presented in five separate sections. Firstly, details on the sample were identified. Subsequently, the results were presented according to the questions selected for this article: 1) actors involved with assistive technologies; 2) the main families of assistive technologies considered in the literature; the reasons why these technologies are developed and used.

Sample

A total of 59 articles (Table 1) were selected after a specific process (Figure 1). The selected articles were from several countries: Germany (n = 1), Bulgary (n = 1), Canada (n=3), China (n = 2), USA (n = 10), France (n = 9), Holland (n = 3), United Kingdown (n = 1), Sweden (n = 3), Switzerland (n = 1). The population concerned focus on childhood (n = 2), adult (n = 3), aging (n = 39) and all population mixed (n = 15). It can be seen that a wide range of nomenclature is used to describe assistive technologies.

Despite the presence of a very varied nomenclature when it comes to assistive technologies, three large families comprise the vast majority of the devices presented in the literature. These main families are Domotics, Adapted housing and Intelligent habitat. In each of these large families, different technologies are introduced (Figure 2).

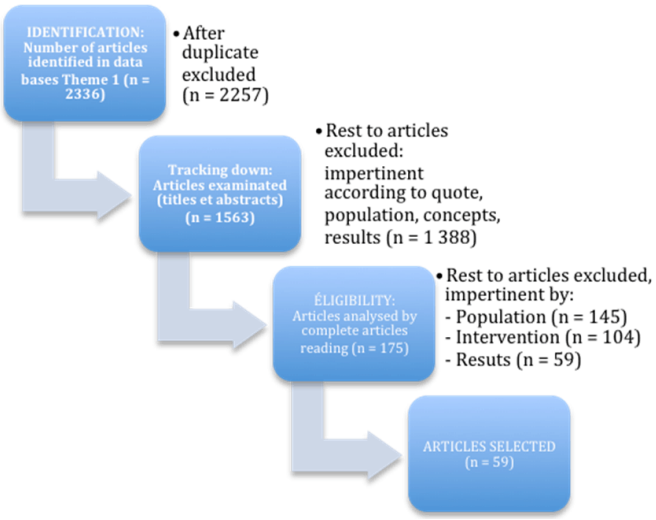

Figure 1: Articles selection process.

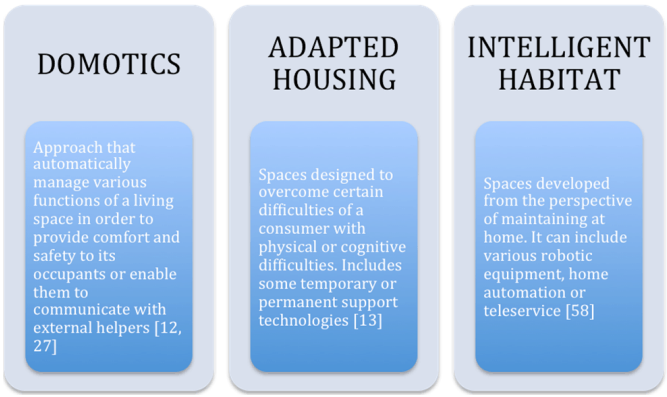

Figure 2: Families of assistive technology.

The technological continuum and its actors

Given that technology is from the outset a human creation, an object conceived, manufactured and used. It implies a process of use in which different actors are involved. In terms of Dejean & Naël, these actors interact together in a more or less flexible continuum. As part of this study, this continuum is referred to as the "technological continuum" and three main types of actors contribute to it: 1) designers; 2) facilitators; 3) consumers. First, the category of designers refers to people who design technological objects (eg computer scientists, engineers, mathematicians): their goal is to create devices that meet the needs of various stakeholders and consumers. The participants in this group are mostly in academic circles, in research and development departments, or work independently (inventor). The second category refers to facilitators. They are intermediaries between designers and consumers (eg sellers and distributors, health workers). They integrate technology into their actions with people with varying needs to carry out their occupations. Finally, the third category is that of consumers of technology. These are the people who are confronted with obstacles in carrying out their daily activities. In doing so, consumers mobilize a variety of assistive technologies to realize their daily business patterns and live in different living spaces, private or public, in the community.

Design objectives

Four main goals guide the work of designers: ensuring safety and surveillance develop autonomy, providing comfort and supporting communication. The designer seeks as a first objective to ensure consumer safety and surveillance [4, 16, 29, 45, 52]. Technological devices thus provide a safe environment for consumers in a given space, or in the expression of their behaviours. It is also expected that technological devices will provide a sense of security. The second goal is to develop the autonomy of consumers given their singular characteristics [6, 7, 10, 17, 29, 54]. In this case, the assistive technology aims to promote or compensate for a lack of autonomy for the performance of a particular task. The third goal is to provide maximum comfort to people with disabilities [3, 19]. The goal is that the consumer feels a physical and psychic well-being in a living space. Finally, the final goal of designers is to support communication [6, 19, 48, 54]. In this case, the technological devices are intended to enable the consumer to communicate with their relatives, or other community members.

Table 1: Description of Selected Articles (n = 59)

Autors	Technologies reaches	Countries	Language	Population concerned
Agree, 2014 [10]	Assistive technology	United States	English	Ageing Population
Balta-Ozkan, Davidson, Bickey, & Whitmarsch, 2013 [11]	Smart home	UK	English	All populations
Barlow, Singh, Bayer, & Curry, 2007 [5]	Telemedicine	UK	English	Frail elderly living at home with chronic illness
Bismuth, Villars, Durliat, Boyer, & Oustric, 2012 [12]	Gerontotechnology	France	French	Aging Population with Mild Cognitive Impairment and / or Alzheimer's
Bobillier-Chaumon et Opra-Ciobanu, 2009 [3]	Information and communication technology	France	French	The elderly
Bobillier-Chaumon, Cuvillier, Durif-Bruckert, Cros, Vanhille, & Salima, 2014 [13]	Home support technology	France	French	Elderly dependents at home
Leuty, et al., 2013 [14]	Support technology	Canada	English	Adult with dementia
Boll, Heuten, Meyer, & Meis, 2010 [15]	Multimodal recall system	Germany	English	Senior> 50 years
Bouchard, 2013 [6]	Smart home	Canada	French	Person with Alzheimer's
Brandt, Samuelsson, Töytäri, & Salminen, 2011 [16]	Smart home	Danmark	English	All populations
Brummel-Smith, & Dangiolo, 2009 [17]	Home support technology	United States	English	Elderly at home
Cao, Xie, Das, & Zhu, 2014 [18]	Robot to assist with stroke rehabilitation	New Zealand	English	Person with Stroke
Carbone et al., 2013 [19]	Walking assist devices	United States	English	Person in need of walking assistance
Chan, Estève, Escriba, & Campo, 2008 [20]	Smart home	China	English	Senior citizen and / or disabled person
Chan, Estève, Fourniols, Escriba, & Campo, 2012 [21]	Intelligent Portable Devices	China	English	All populations
Chau, Eaton, Lamont, Schwellnus, & Tam, 2006 [22]	Virtual reality	Canada	French	People with rehabilitation needs
Chen, & Chan, 2013 [23]	Gerontechnology	China	English	The elderly
Chi et Demiris, 2015 [24]	Telemedicine	United States	English	Family caregiver
Craig, Moses, Tran, McIsaac, & Kirkup, 2002 [25]	Remote environment control system	Australia	English	Person with significant movement limitation
Cressot, 2013 [26]	Gerontechology	France	French	Elderly dependent or at risk of loss of autonomy
Culnaert, Galy, Chotard, & Tomas, 2009 [27]	Domotics	France	French	Elderly at home
De Craen, Westendorp, Willems, Buskens, & Gussekloo, 2006 [28]	Assistive technology	Netherlands	English	Senior> 85 years living at home
Demiris, & Hensel, 2008 [29]	Smart home	United States	English	Senior citizen and / or disabled person
Eaton et al., 2014 [30]	Telemedicine	United States	English	Population with chronic pain
Farrar, 2015 [31]	Telemedicine	United States	English	Person with mental health problem
Fok et al., 2011 [32]	Assistive technology	Canada	English	Adult with low vision
Gentry, 2009 [33]	Smart home	United States	English	All populations

Table 1: *(Continued)*

Autors	Technologies reaches	Countries	Language	Population concerned
Holz, Botrel, Kaufmann, & Kübler, 2015 [34]	Computer-brain interface	Germany	English	Woman with ALS
Ivanoff, & Sonn, 2005 [35]	Support devices for macular degeneration	Sweden	English	Elderly> 85 years at home - Macular degeneration
Karmarkar, Dicianno, Graham, Cooper, Kelleher, & Cooper, 2012 [36]	Mobility device	United States	English	Senior> 60 years
Khosravi, & Ghapanchi, 2015 [6]	Gerontechnology	United States	English	The elderly
Kristoffersson, Coradeschi, Loutfi, & Severinson-Eklundh, 2011 [37]	Robotic Telepresence System	Sweden	English	The elderly
Kueider, Parisi, Gross, & Rebok, 2012 [38]	Cognitive training on computer	United States	English	The elderly
Laila, 2009 [39]	Telemedicine	France	French	The elderly
Lange, Requejo, Flynn, Rizzo, Valero-Cuevas, Baker, & Winstein, 2010 [40]	Virtual reality	United States	English	An aging person with a disability
Laufer, Dar, & Kodesh, 2014 [41]	Nintendo Wii Exercise Program	United States	English	The elderly
Lockey, Jennings, & Shaw, 2010 [42]	Gerontecnology	Canada	English	Senior> 60 years with hearing aids
Marchibroda, 2015 [43]	Gerontecnology	United States	English	The elderly
Mehrabian, Extra, Wu, Pino, Traykov, & Rigaud, 2015 [44]	Telemedicine	Bulgaria	English	Elderly - Mild cognitive impairment and / or Alzheimer's disease
Melander-Wikam, Fältholm, & Gard, 2008 [45]	Mobile safety device	Sweden	English	The elderly
Melillo-Wikam et al., 2015 [46]	Portable electrocardiogram devices	Italy	English	Person with high blood pressure
Michel et Franco, 2014 [47]	Gerontechnology	Swiss	English	The elderly
Mickus, & Luz, 2002 [48]	Telemedicine	United States	English	The elderly
Nef et al., 2015 [49]	Passive infrared detectors	Swiss	English	The elderly
Nguyen, Demers, & Raymond, 2011 [50]	Assistive technology	Canada	French	Elderly with cognitive impairment
Noury, Virone, Barralon, Rialle, & Demongeot, 2004 [51]	Telemedicine	France	French	Elderly at home
Nygård, 2009 [52]	Home help device	Sweden	English	Elderly with cognitive impairment
Peetoom, Lexis, Joore, Dirksen, & De Witte, 2015 [53]	Monitoring technologies	Netherlands	English	The elderly
Piau, Campo, Rumeau, Vellas, & Nourhashémi, 2014 [54]	Gerontechnology	France	English	The elderly
Reeder, Meyer, Lazar, Chaudhuri, Thompson, & Demiris, 2013 [55]	Smart home	United States	English	The elderly
Rialle, Rumeau, Ollivet, Sabliera, & Hervé, 2014 [56]	Telemedicine	France	French	Fragile Elderly

Table 1: *(Continued)*

Autors	Technologies reaches	Countries	Language	Population concerned
Roy, 2012 [57]	Assistive technology	Canada	French	Elderly with cognitive impairment at home
Sakaki et al., 2013 [58]	Support Robots	Japan	English	Population with spinal cord injury
Salas-Lopez et al., 2012 [59]	Support Robots	Mexico	English	Population in Need of Rehabilitation
Sanford et al., 2007 [60]	Telemedicine	United States	English	The elderly
Soler et Trompette, 2010 [61]	Assistive technology	France	French	Epileptic Population
Thomas, Barker, Rubin, & Dahlmann-Noor, 2015 [62]	Assistive technology	UK	English	Population with low vision
Tuntland et al., 2009 [63]	Assistive technology	Norway	English	Population with rheumatoid arthritis
Van der Roest, Van der Roest, Wenborn, Dröes, & Orrell, 2012 [64]	Information and Communication Technologies	Netherlands	English	Elderly person with dementia

Objectives of facilitators

Four main objectives guide the use of technologies by facilitators: improving functional abilities, assisting singular capacities, compensating for singular capacities and stimulating the functions of the person.

The primary goal is to stimulate the functions [10, 45]. This goal involves technological devices that encourage the realization of an activity by encouraging the consumer to act, to continue his action or to maintain an effort. The second goal is to improve functional abilities [13, 40, 42]. Several technological devices are selected in order to enable a consumer to develop his capacities or his functions and his field of action. The third goal is to assist the singular abilities [12, 15, 23]. Different technological devices are used with the view to support and assist the consumer in the pursuit of the tasks he wishes to initiate and carry out and which he is not fully capable of performing independently. The fourth and last goal is the compensation of singular abilities [15, 36–37, 53]. Some assistive technologies are identified to perform a task that the consumer cannot independently carry out.

Recurring objectives in the literature

The data analysis allowed drawing the objectives pursued by the designers and facilitators. The recurring of some goals was identified and results indicated for the designer, the comfort goal is not so much considered. For the facilitators, the stimulation and the amelioration goals are more rarely approach.

DISCUSSION

The aim of this article was to draw the picture of current knowledge about the use of assistive technologies in rehabilitation. Several questions were initially formulated: what are the main families of assistive technologies considered in the literature? Why do designers develop these technologies? Why do facilitators mobilize these devices?

First, the synthesis of knowledge has brought to light an important nomenclature used to describe the technologies. It appears that when a single entity is treated in a set of domains as in the field of assistive technology, the associated evidence can take all sorts of directions. As Piau, and his collaborators [54] point out, this can cause confusion.

Second, a divergence in the aims between designers and facilitators is found. Designers tend to create technologies with the main objectives: 1) to provide security and surveillance, 2) to develop autonomy, 3) to provide comfort, and 4) to support communication. While facilitators, acting as intermediaries between designers and technology users, integrate technology into their actions for the person with rehabilitation needs, while also pursuing four main objectives: 1) to improve functional abilities, 2) to assist singular capacities, 3) to compensate for singular abilities, and 4) to stimulate the person's functions. For both groups of actors, the objectives differ and do not always seem to correspond. However, the analysis of scientific literature shows that very little, if any, model seems to support the use of assistive technologies across the technological continuum. Indeed, the various actors of this continuum do not seem to mobilize a transversal model which would not only standardize the terms used but also guide the design and use objectives. Perhaps the absence of a model guiding the technological continuum could explain the divergence between the objectives currently pursued? This may constitute a barrier to collaboration between technology creators and rehabilitation practitioners and may indicate that stakeholders do not use assistive technology in the same way as the function for which

they are created. For example, there is a growing body of research on the potential drift in the use of social media between physicians and their patients, initially created for the general public and now increasingly used to reach clients in remote areas [65].

Moreover, this review of the literature also highlighted that decision-makers are not currently actors involved in the technological continuum. This group of actors refers, for example, to governments and granting agencies that govern technological development. Yet, from a collaborative perspective, it is important to guide the actions of different actors, not only with conceptual frameworks and models, but also with clear policies. Mobilization of all, including decision-makers, seems essential to anchor best practices and foster collaboration.

Strengths and limitations

To begin, the study is focused on the occidental countries with just two Asian articles. This could be explained by the aging of population, the culture and the socio-economics favourable conditions. It could be interesting to focus a new study to try to understand if the culture or the country could impact the results of this study.

The results of this synthesis of knowledge should be analyzed with caution due to methodological constraints, in particular because of inclusion criteria based on peer review in scientific journals, the number of articles studied which remains limited given the disciplinary fields concerned and the fact that the articles selected do not cover all the possible experiences. On the other hand, this article is a first step towards a better understanding of the vast field of assistive technology, a constantly expanding and innovative field of daily activities in private and public spaces public.

CONCLUSION

The purpose of this article was to conduct a review on assistive technologies literature in rehabilitation to better understand the motivations of the main actors who design and use them in everyday life. Given the different objectives pursued by the actors involved, it seems legitimate to ask whether an integrating concept would document in a more homogeneous manner the development, use and evaluation of assistive technologies. It is now necessary to ensure that designers have the necessary tools to oversee their development.

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Authors declare no conflict of interest.